Assessment of Skill for Coastal Ocean Transients
ASCOT-01

Massachusetts Bay / Gulf of Maine
June 2001

An Experiment for Ocean Coastal Prediction and NATO Rapid Environmental Assessment Skills Evaluation

A.R. Robinson, J. Sellschopp, R. Onken, W. G. Leslie

Harvard University
NATO SACLANT Undersea Research Centre

REAL-TIME OPERATIONS, DATA AND PRELIMINARY ANALYSIS
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Introduction

The Assessment of Skill for Coastal Ocean Transients (ASCOT) project is a series of real-time CPSE/REA experiments and simulations focussed on quantitative skill evaluation and cost-effective forecast system development. ASCOT-01 was carried out in Massachusetts Bay/Gulf of Maine in June 2001.

ASCOT Overall Goal: to enhance the efficiency, improve the accuracy and extend the scope of nowcasting and forecasting of oceanic fields for Coastal Predictive Skill Experimentation and for Rapid Environmental Assessment in the coastal ocean and to quantify such CPSE and REA capabilities.

ASCOT General Objectives

- obtain data sets adequate for: 1) definitive real-time verification of regional coastal ocean predictive skills, with and without REA constraints; 2) CPSE and REA Observational System Simulation Experiments (OSSEs), both for ASCOT design and more generally; and, 3) definitive knowledge of dynamics
- define useful skill metrics and real-time forecast validation and verification procedures for REA
- assemble, calibrate, exercise in real-time, evaluate and improve a generic, portable, scalable advanced ocean forecast system (dynamical models and data analysis, management and assimilation schemes) applicable for CPSE in general and NATO REA in particular.

ASCOT-01 Objectives

- carry out and quantitatively evaluate in Massachusetts Bay (MB) and the Gulf of Maine (GOM) a coupled multiscale interdisciplinary real-time forecast experiment
- obtain a data set adequate to define coupled dynamical processes (submeso-, meso-, bay-, gulf-scales) that govern the formation and evolution of structures and events, including generic processes and the coupling of wind-forced events and buoyancy currents
- obtain an intensive data set adequate for definitive quantitative skill assessment and suitable for the design of minimal data requirements for both REA and for an efficient regional monitoring and prediction system.

REA requires multiscale capabilities for different kinds of warfare (e.g. anti-submarine (ASW), mine warfare (MW), etc.). An experiment which is to assess the predictive skill of a forecast system must therefore measure and evaluate on multiple scales. Knowledge of the multiscale dynamics is essential. For ASCOT-01, the coupling extends from Massachusetts Bay, through the Gulf of Maine, out to the northwest Atlantic. Skill metrics have been designed to take the coupling of scales into account. All coastal regions require both generic and regional-specific metrics for the dominant variabilities. For example, upwelling is a generic process, however, the location and time of occurrence of upwelling is specific to the region.

As a predictive skill experiment, ASCOT-01 included oversampling, in order that sources of error can be tracked. During the verification survey a significant fraction of the initialization survey was repeated. Adaptive sampling survey patterns were designed to address: 1) the interactions of Massachusetts Bay and the Gulf of Maine (inflow updates, exchanges, etc.); 2) response to storms or air-sea exchanges (upwelling, structures of currents and gyres, bifurcation structures in the Gulf of Maine, etc.); coupling of wind-response and buoyancy currents; reduction of multi-variate forecast errors; and, update of information for feature model parameters.

Hydrographic Data Collection

The ASCOT-01 experiment utilized three research vessels throughout the June 2001 field exercise. These vessels were: the NRV Alliance (NATO SACLANT Undersea Research Centre), the RV Lucky Lady (University of Massachusetts – Dartmouth), and the RV Neritic (University of Massachusetts – Boston). Each of these vessels collected vertical profiles of temperature, salinity and fluorescence using a Seabird SBE 911 CTD system. In addition to CTD's and fluorometry, basic measurements of biological and chemical fields from the RV Lucky Lady and RV Neritic included nutrients, chlorophyll and a full suite of plant pigments on selected stations, samples collected but not immediately processed for phytoplankton microscopic counts, zooplankton net collections and microscopic counts, and nitrogen turn-over times. Calibration stations (stations nearly simultaneous in space and time) for hydrographic and biological measurements were carried out. The NRV Alliance collected CTD measurements only.

In addition to the dedicated research vessels, additional hydrographic data was available during this time period. As part of the ECOHAB project, the RV Oceanus made a CTD survey on a dense station grid in the northern Gulf of Maine (OC366) during early June 2001. The profiles of temperature and salinity were made available to the ASCOT program in real time by chief scientist Jim Churchill. The Massachusetts Water Resources Authority (MWRA) conducts routine surveys of Massachusetts Bay as part of an ongoing monitoring program. Data from survey WF017 was provided to the ASCOT program in real time.

Data Inventory

During the ASCOT-01 experiment, a total of 602 usable profiles of temperature and salinity were collected. The breakdown by vessels is shown in the table below.

Research Vessel	No. of Profiles	Dates	General Location
Alliance	286	6-24 June	Mass. Bay/Gulf of Maine
Lucky Lady	116	6-25 June	Massachusetts Bay
Neritic	52	7-25 June	Massachusetts Bay
Oceanus	121	6-11 June	Gulf of Maine
MWRA	27	19-21 June	Massachusetts Bay

Data Availability

A CDROM is available from the NATO SACLANT Undersea Research Centre (CD-49) which contains all of the *in situ* data collected during ASCOT-01 as well as considerable additional information. To acquire this CDROM, contact the Centre via the mail address:

Mr. Arthur Green
Information Service Branch
NATO SACLANT Undersea Research Centre
Viale S. Bartolomeo, 400
19138, La Spezia, Italy

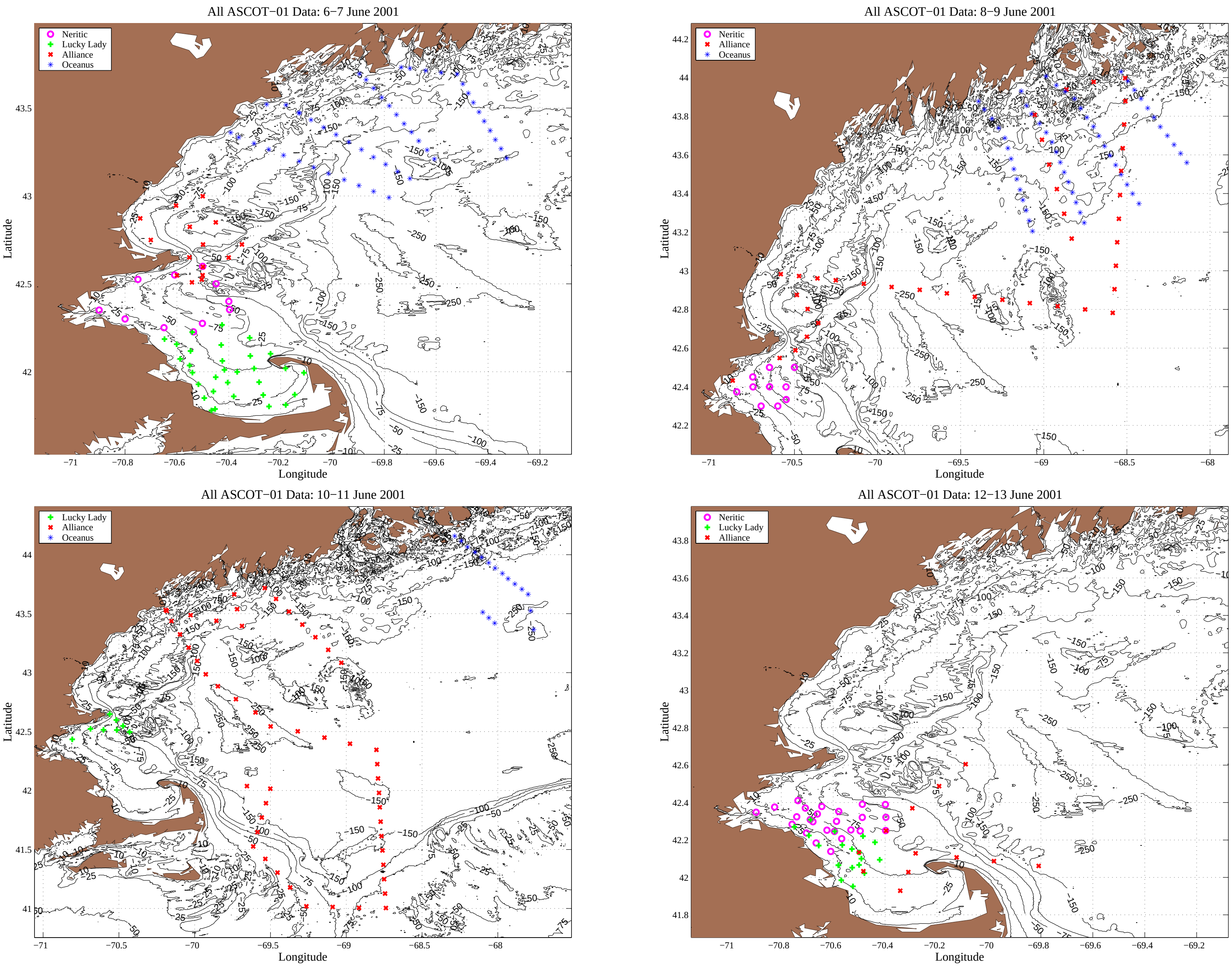
or via fax (39-187-527-700).

Much of the data is also on-line at Harvard University. This data can be acquired by contacting Wayne Leslie (617-495-4569, leslie@pacific.deas.harvard.edu) and making a specific request.

Table of Contents

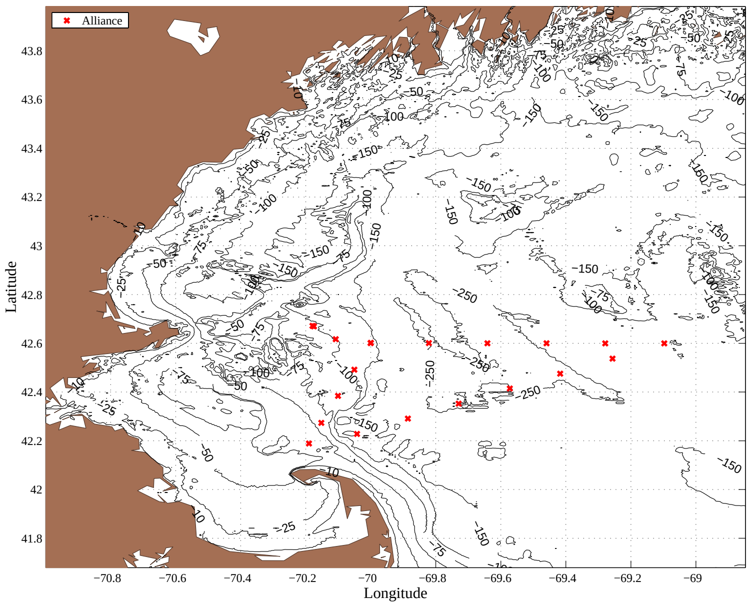
Composite Station Positions

This section includes plots of the positions of CTD casts from all vessels involved in the ASCOT-01 exercise during the period 6-25 June 2001. The plots are composites over two-day intervals. Each vessel is identified by a unique symbol: Alliance – red x (**X**), Lucky Lady – green plus sign (+), Neritic – lavender circle (**O**), Oceanus – blue asterisk (*), MWRA – black diamond (◊). The plots are made on a consistent domain in order to present an overview of stations positions over the course of the experiment.

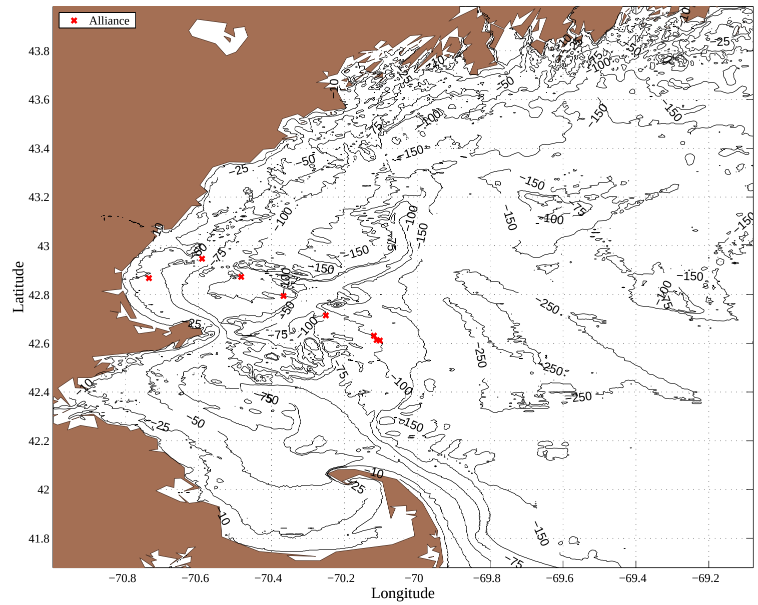


All ASCOT−01 Data: 6−7 June 2001
Neritic
Lucky Lady
Alliance
Oceanus
Latitude
Longitude
All ASCOT−01 Data: 8−9 June 2001
Neritic
Alliance
Oceanus
Latitude
Longitude
All ASCOT−01 Data: 10−11 June 2001
Lucky Lady
Alliance
Oceanus
Latitude
Longitude
All ASCOT−01 Data: 12−13 June 2001
Neritic
Lucky Lady
Alliance
Latitude
Longitude

All ASCOT−01 Data: 14−15 June 2001



All ASCOT−01 Data: 16−17 June 2001



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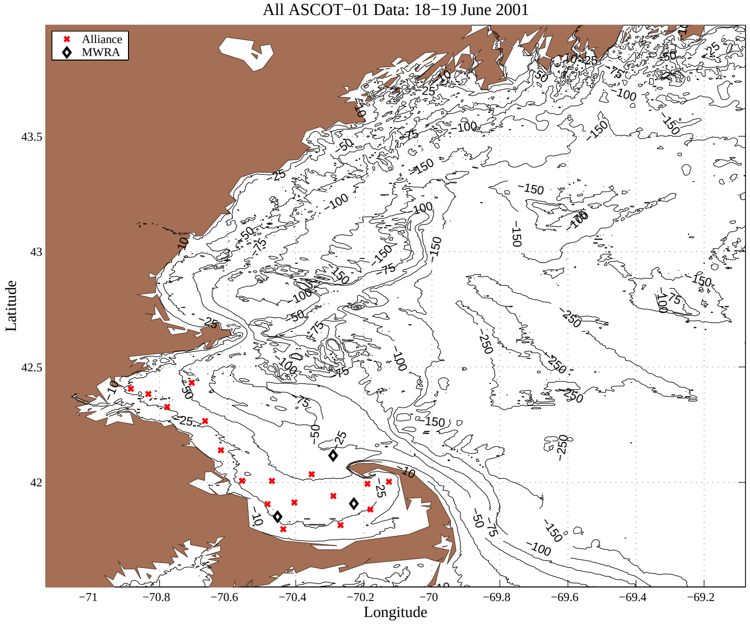
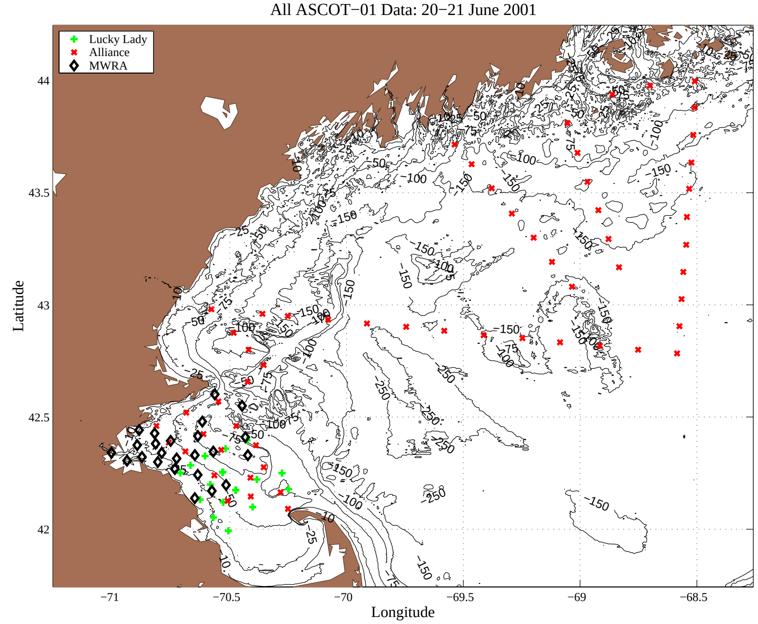
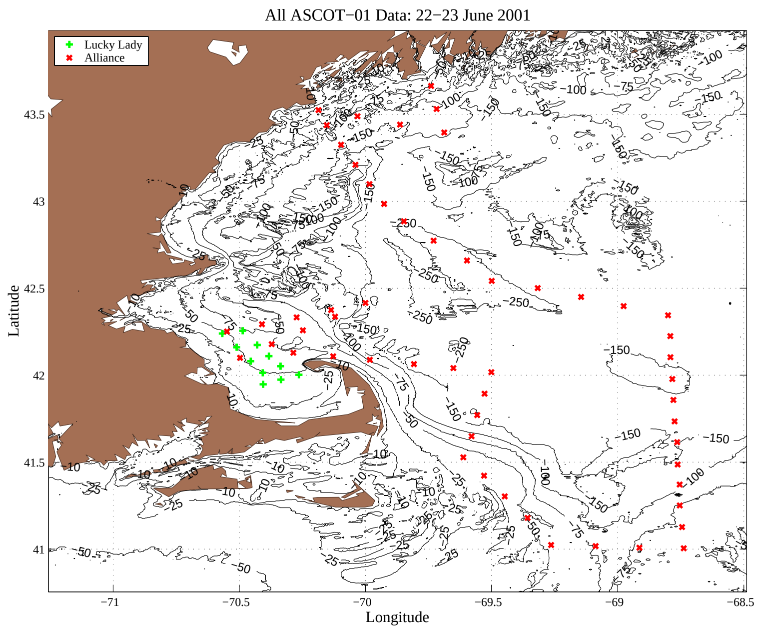
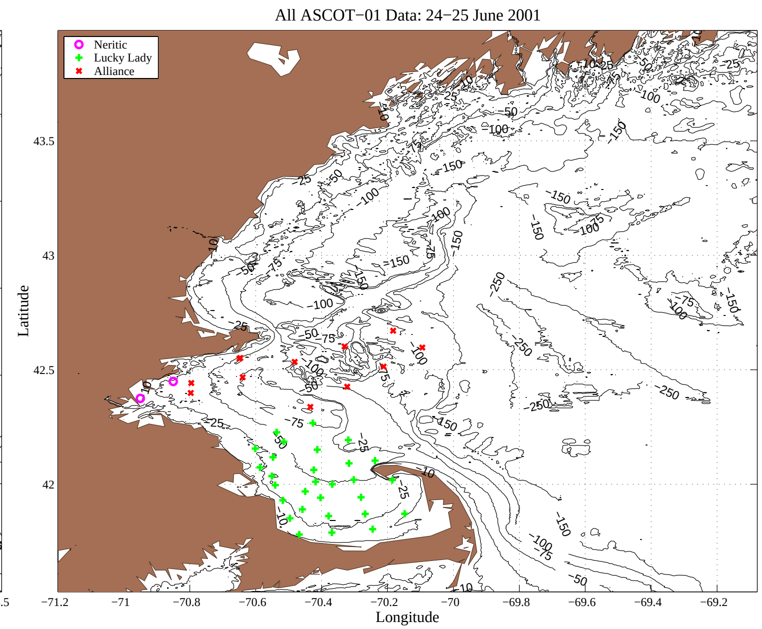


All ASCOT−01 Data: 20−21 June 2001




All ASCOT−01 Data: 22−23 June 2001
Lucky Lady
Alliance
Latitude
Longitude
43.5
43
42.5
42
41.5
41
−71
−70.5
−70
−69.5
−69
−68.5


All ASCOT−01 Data: 24−25 June 2001
Neritic
Lucky Lady
Alliance
Latitude
Longitude
43.5
43
42.5
42
−71.2
−71
−70.8
−70.6
−70.4
−70.2
−70
−69.8
−69.6
−69.4
−69.2

Station Positions – by Cruise Segment Intent

The ASCOT-01 data sampling was conducted in segments. Each of the segments was designed with a specific intent. Those included gathering data for model initialization, model updating and model verification. In addition, portions of the cruise sampling were adaptively designed in order to satisfy modeling needs. The five plots in this section are: a composite of the station positions during the initialization, updating and verification phases in which each phase is identified, the initialization sampling, the updating sampling, the adaptive sampling and the verification sampling.

Adaptive Sampling Objectives

The ASCOT-01 data sampling was adaptively designed on certain dates in order to satisfy modeling or scientific needs and criteria. That motivation is described below on a day-by-day basis.

11 June 2001

- Check inflow/outflow structure for MBAY/GOM
- Explore eastern edge of northern MBAY anti-cyclone
- Measure associated biology

12 June 2001

- RV Neritic to complete circulation survey of MBAY and inter-calibrate with RV Lucky Lady
- RV Lucky Lady to investigate possible upwelling event off Scituate

13 June 2001

- Explore upwelling, mixing and development of advective blooms (Scituate-Duxbury, Plymouth-Manomet)
- Interweave boats for inter-calibration and intercomparison

14 June 2001

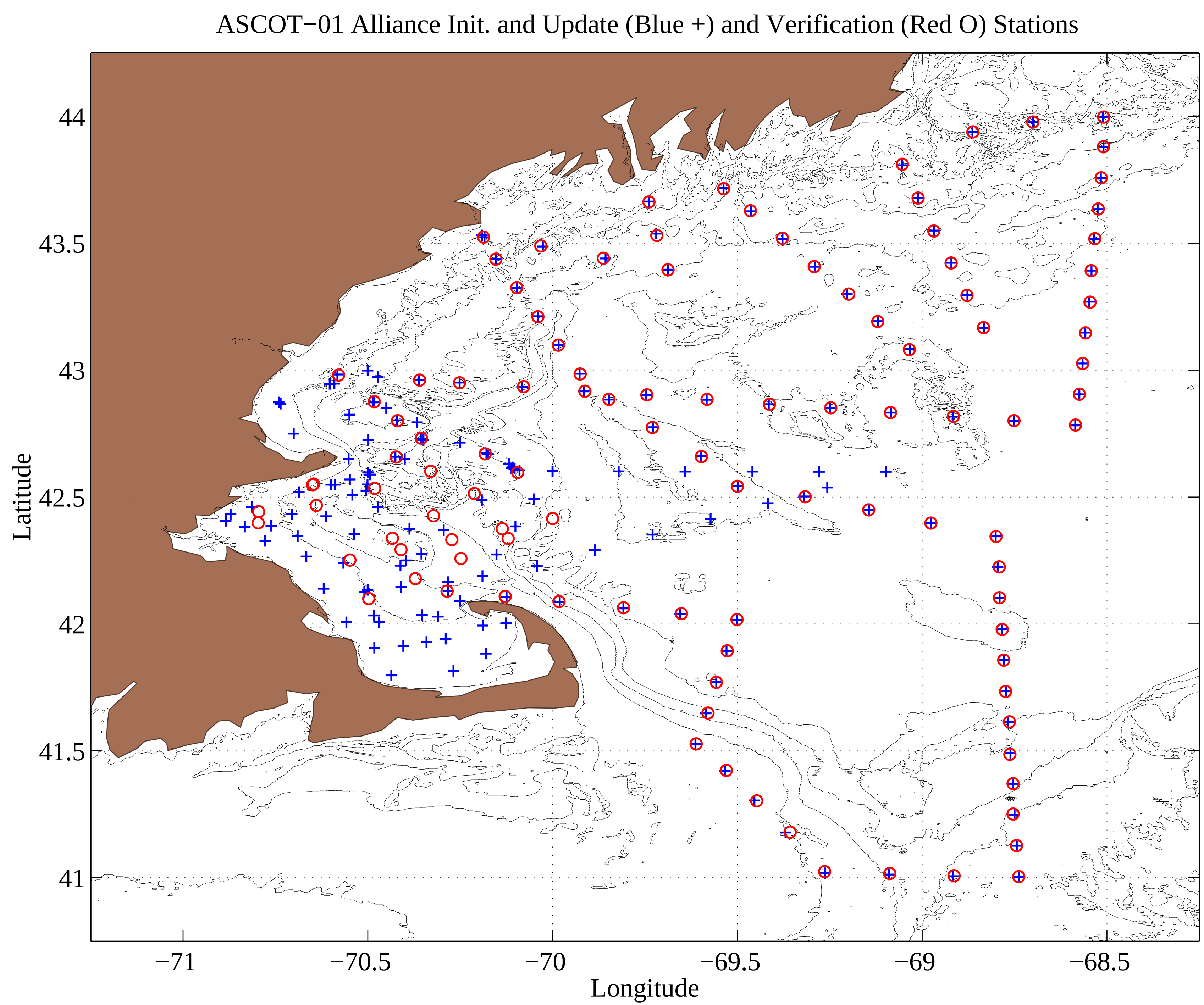
- Plan updating based on 25m circulation rather than highly variable surface current
- Cross-deep basins in GOM and trifurcation point near Georges Bank
- Return path to Boston based on data gaps and circulation patterns

18 June 2001

- Investigate upwelling events off Scituate and Plymouth
- Re-sample coastal currents

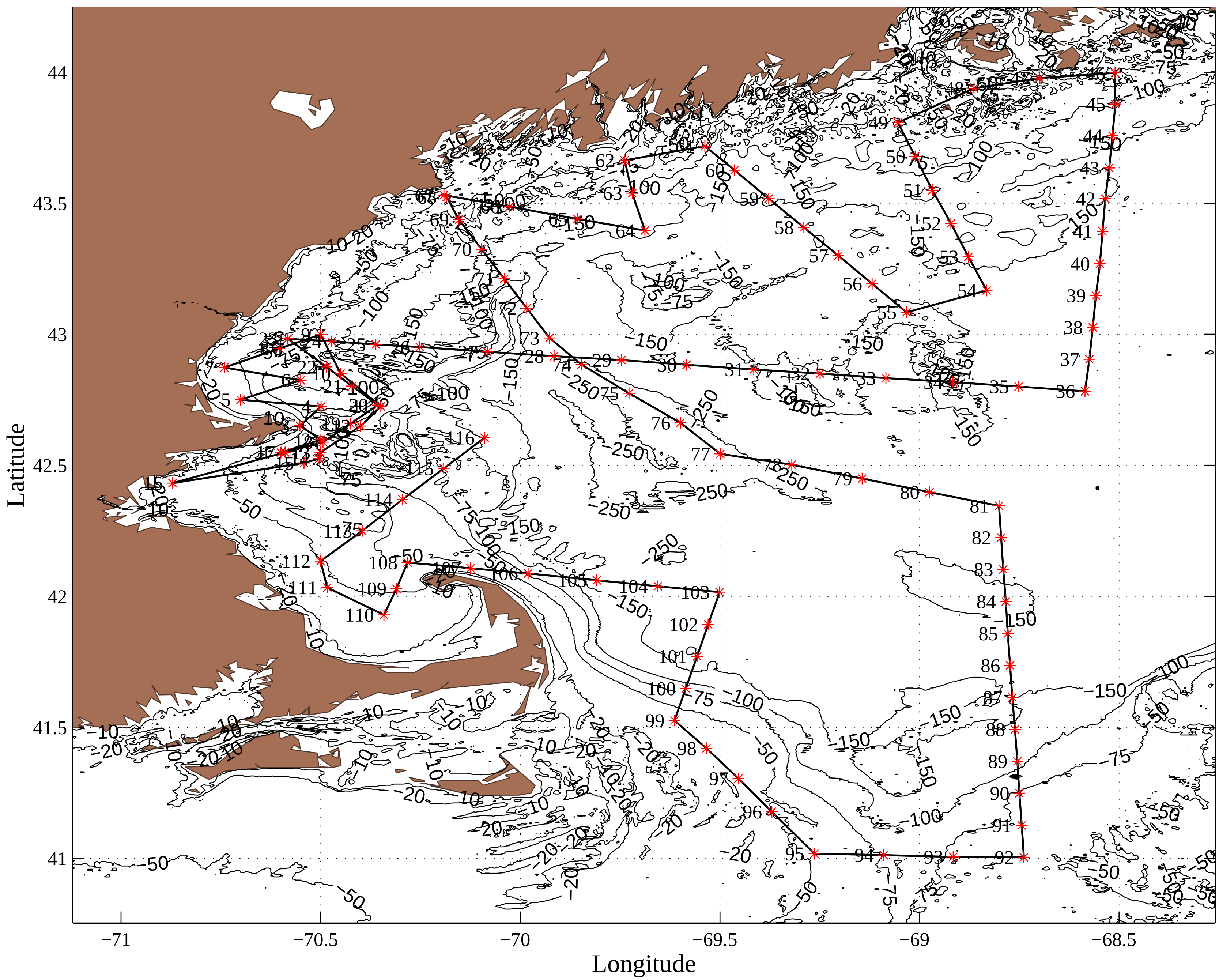
24 June 2001

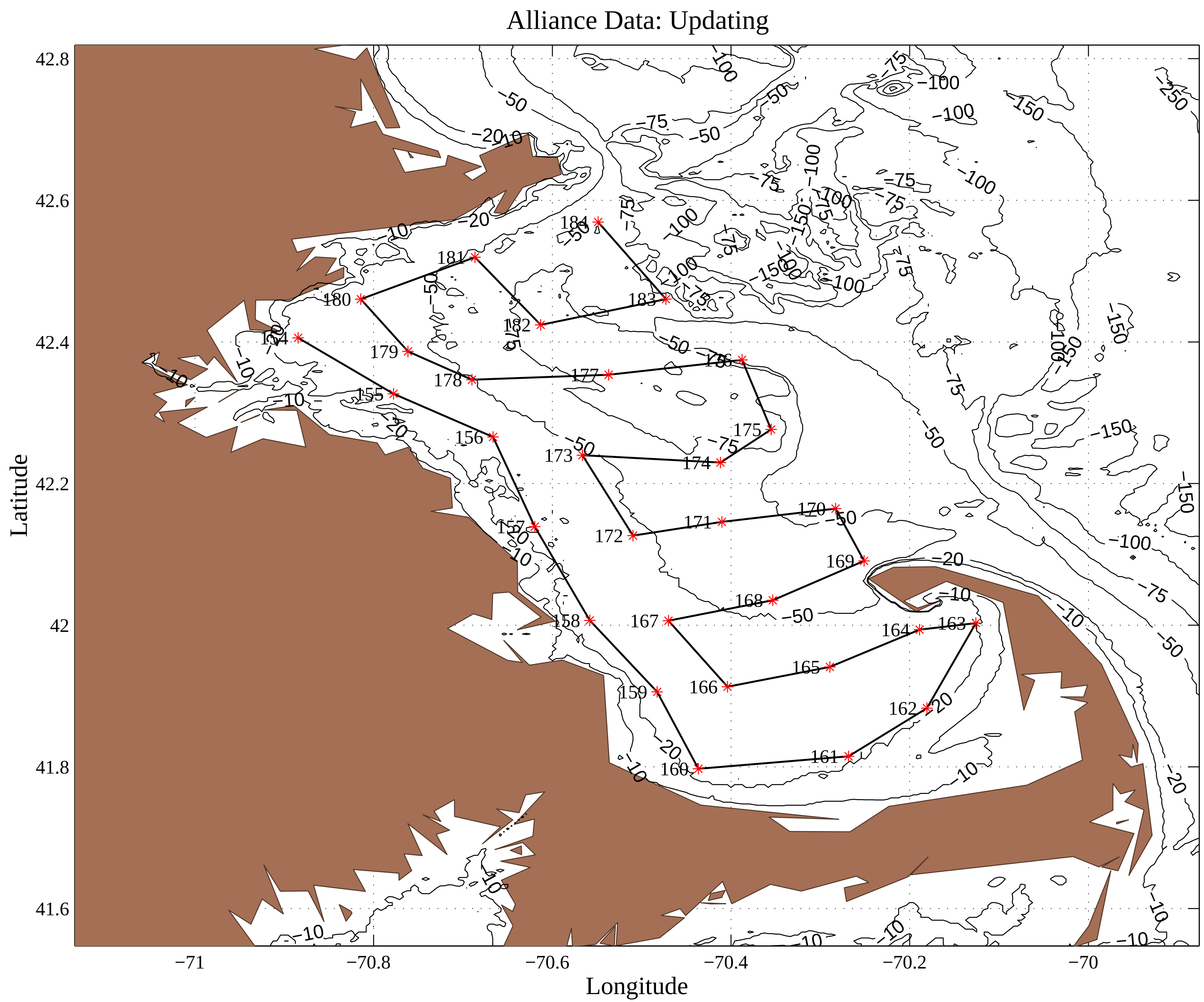
- Explore Maine coastal current in vicinity of MBAY
- Connect the Bay to Gulf circulation
- Fill in data gaps to the east of Stellwagen Bank



ASCOT−01 Alliance Init. and Update (Blue +) and Verification (Red O) Stations
44
43.5
43
42.5
42
41.5
41
Latitude
−71
−70.5
−70
−69.5
−69
−68.5
Longitude

Alliance Data: Initialization





Alliance Data: Updating
Latitude
Longitude
42.8
42.6
42.4
42.2
42
41.8
41.6
−71
−70.8
−70.6
−70.4
−70.2
−70
154
155
156
157
158
159
160
161
162
163
164
165
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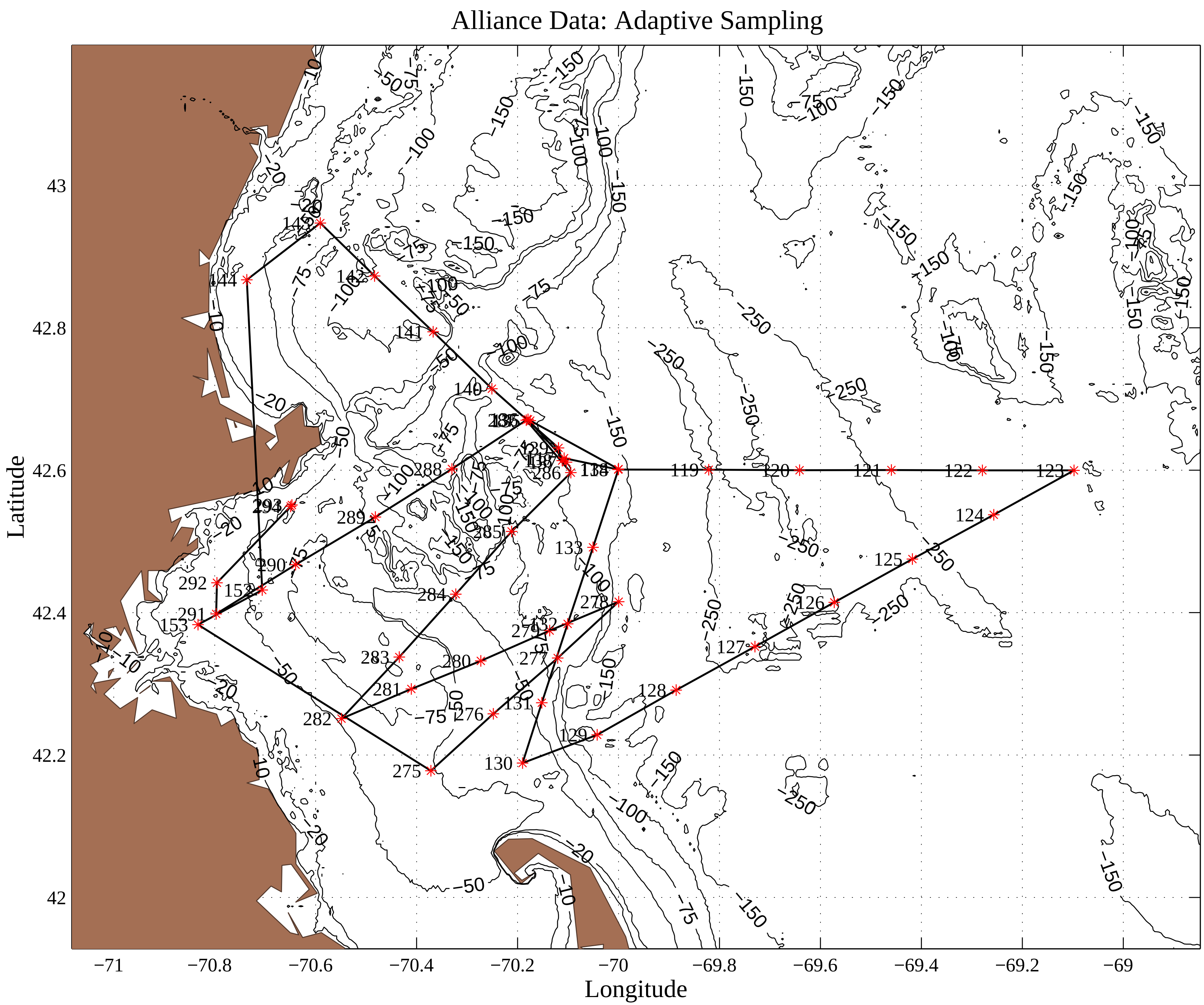

Alliance Data: Adaptive Sampling
Latitude
Longitude
43
42.8
42.6
42.4
42.2
42
−71
−70.8
−70.6
−70.4
−70.2
−70
−69.8
−69.6
−69.4
−69.2
−69
145
144
142
141
140
119
120
121
122
123
124
125
126
127
128
129
130
131
133
132
153
152
275
276
277
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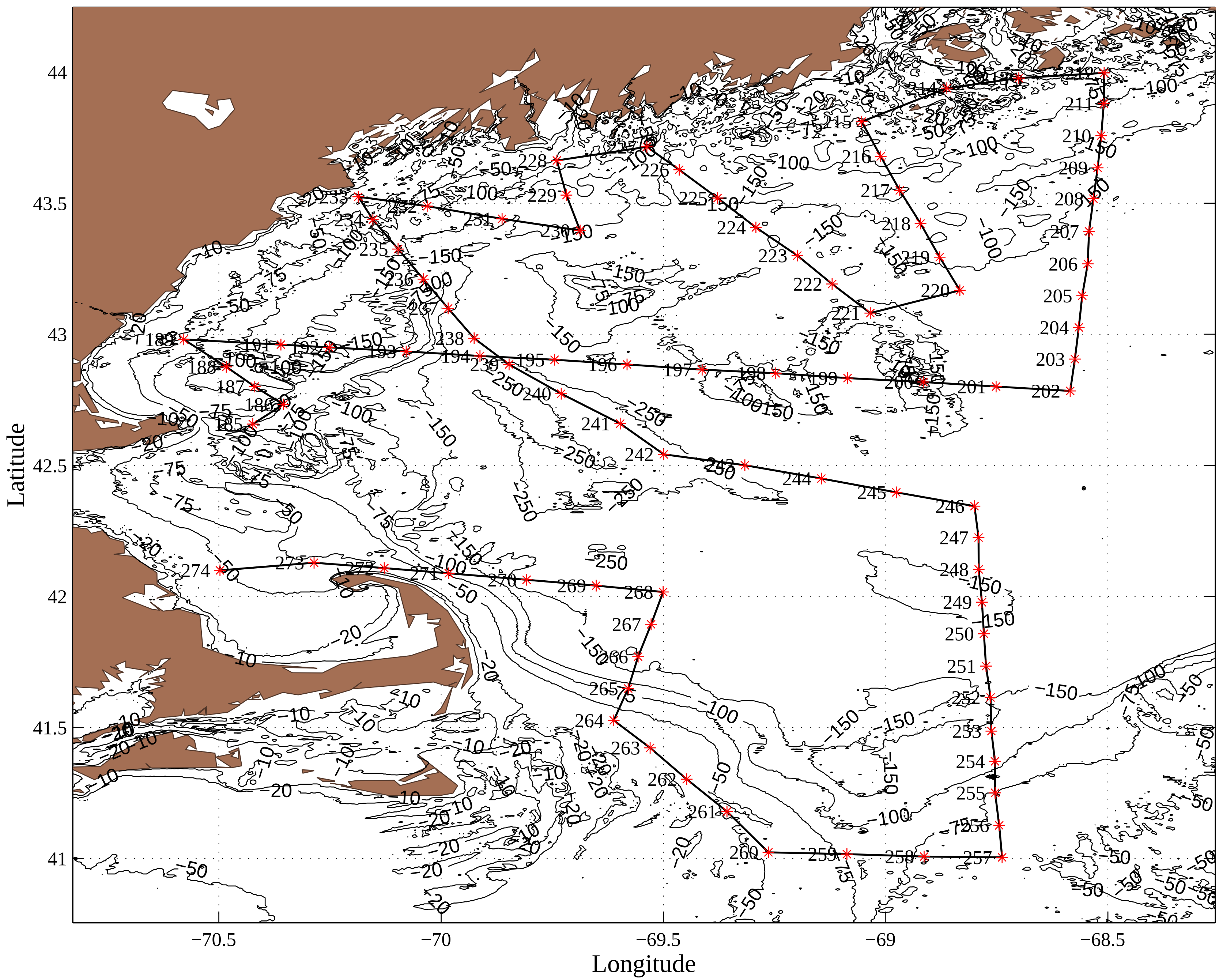
292

Alliance Data: Verification

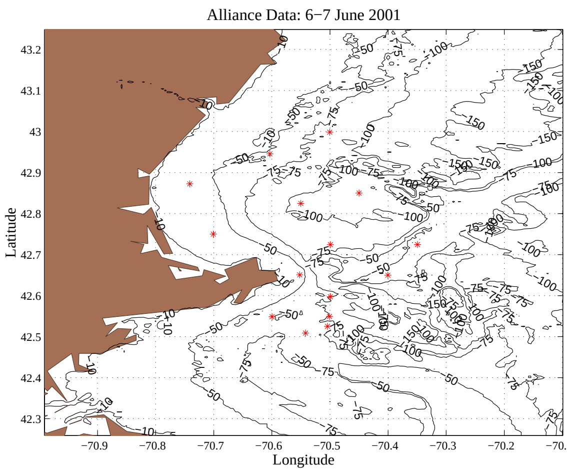


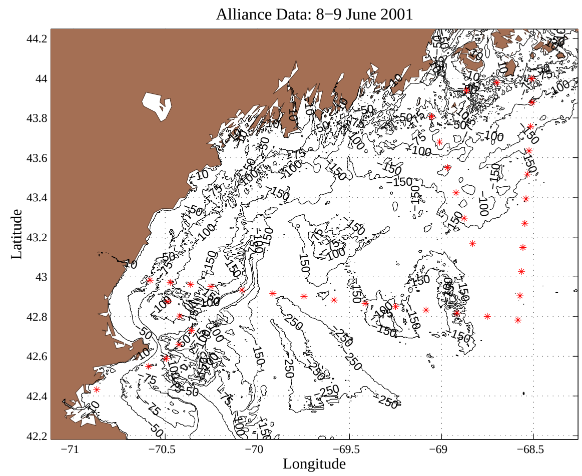
NRV Alliance

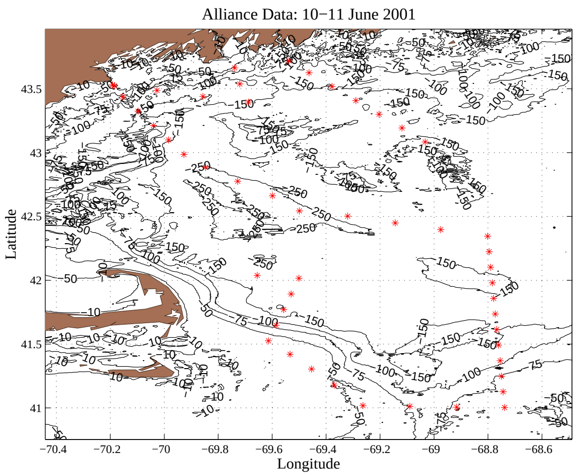
The NRV Alliance performed 294 CTD stations over the period 6-24 June 2001. The stations were carried out with a Seabird SBE 911 system and processed with Seasoft. Data were averaged over 1m depth intervals.

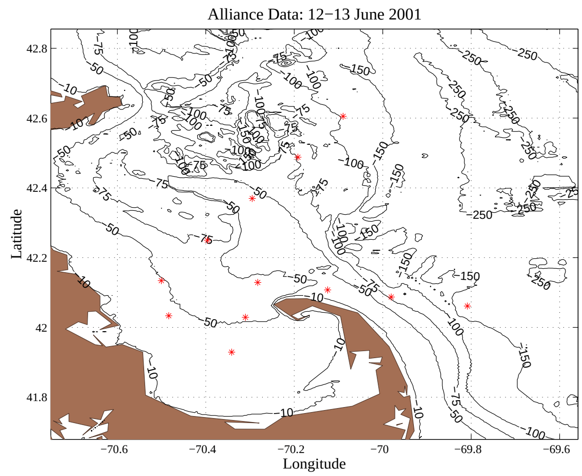
Of those 294 stations, 286 were considered acceptable for modeling purposes. Inconsistencies were noted between the primary and secondary conductivity sensor, resulting in some doubt on the data quality for stations 48, 50, 63, 87-90, 99, 145-151, 190, 256, 261-262. The primary and secondary temperature and conductivity sensors were used for stations 1 and 251. The stations which were not recoverable for modeling purposes were 145-151 and 190.

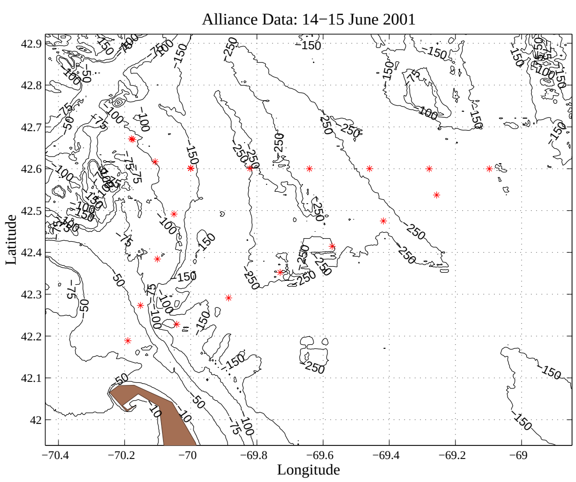
Station positions have been plotted as two-day composites. Vertical profiles of temperature, salinity, and fluorescence are included for each station. Fluorescence was measured beginning with station number 75. Axes are uniform among the plots included in each two-day grouping but not from one grouping to the next.

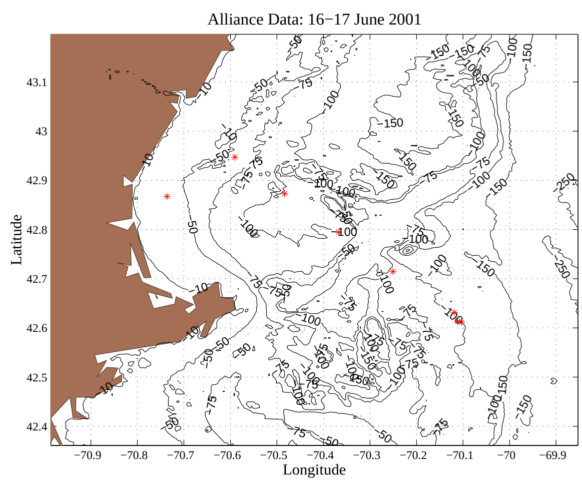

Alliance Data: 6−7 June 2001
Latitude
Longitude


Alliance Data: 8−9 June 2001
Latitude
Longitude

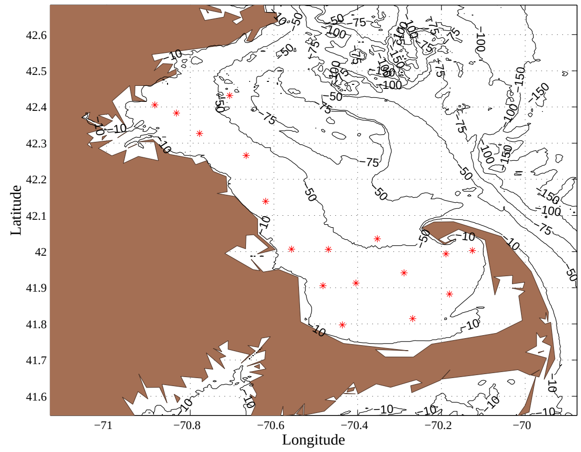

Alliance Data: 10−11 June 2001
Latitude
Longitude


Alliance Data: 12−13 June 2001
Latitude
Longitude

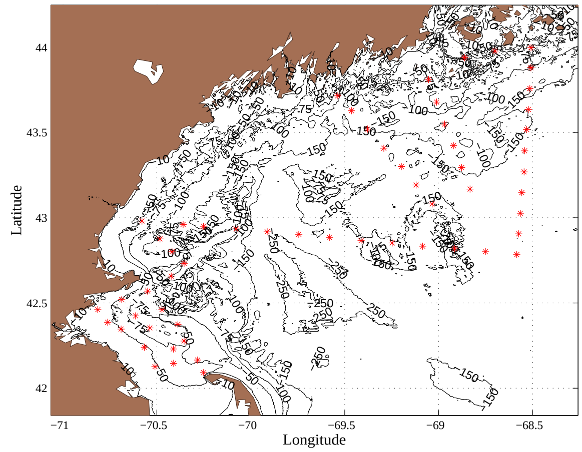

Alliance Data: 14−15 June 2001
Latitude
Longitude


Alliance Data: 16−17 June 2001
Latitude
Longitude

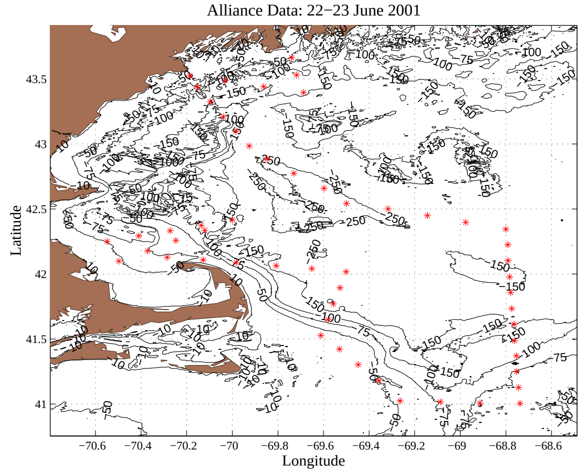
Alliance Data: 18−19 June 2001



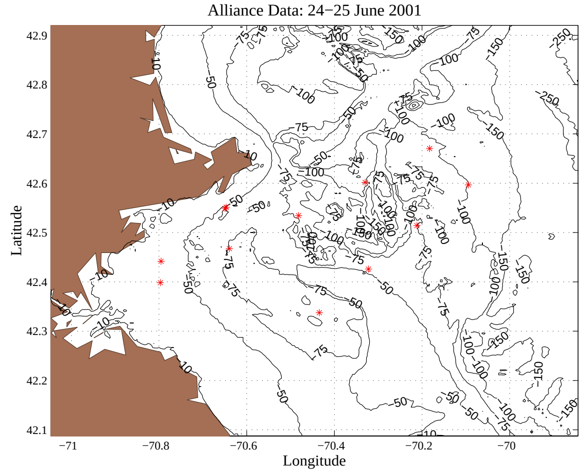
Alliance Data: 20−21 June 2001

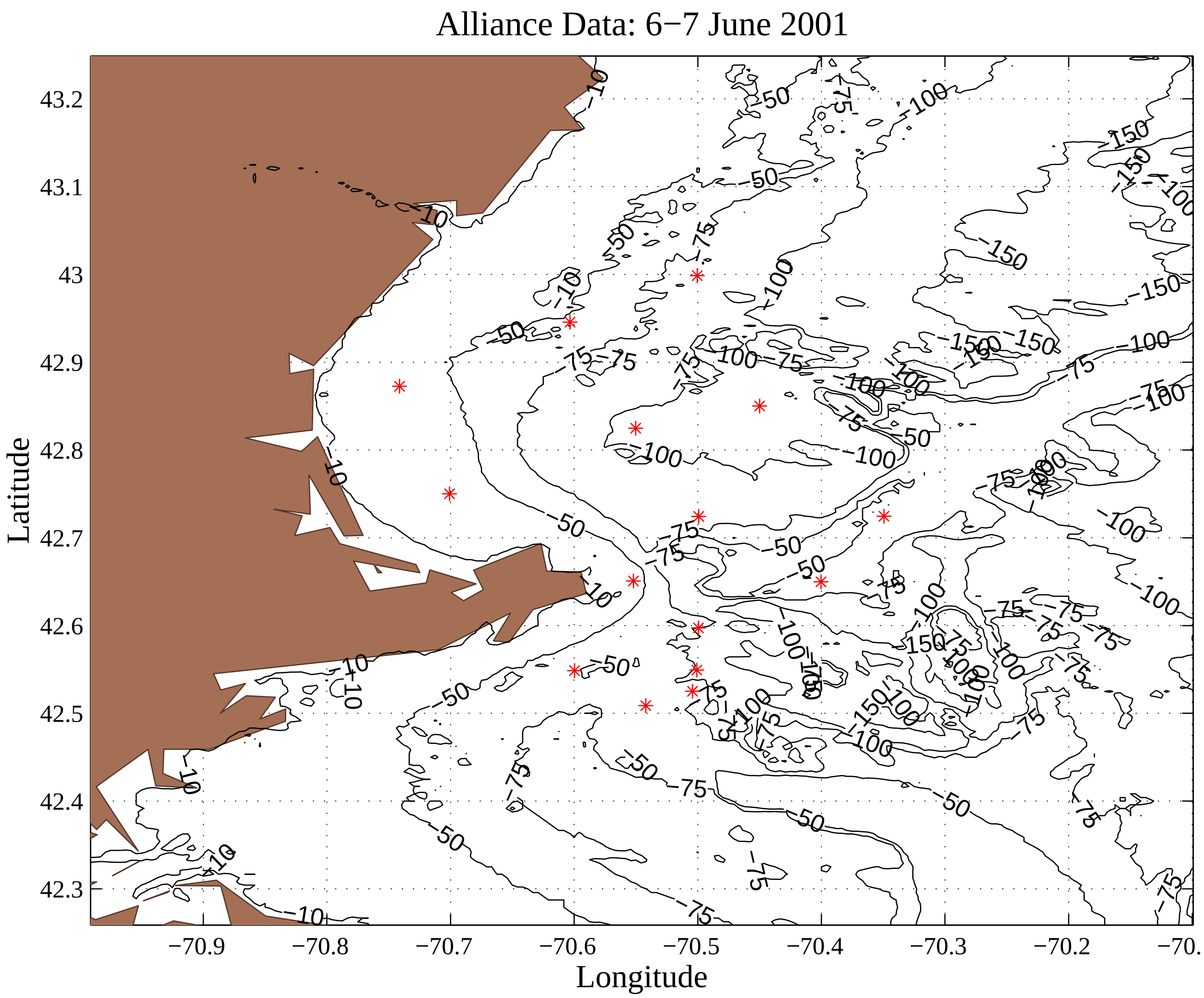


Alliance Data: 22−23 June 2001



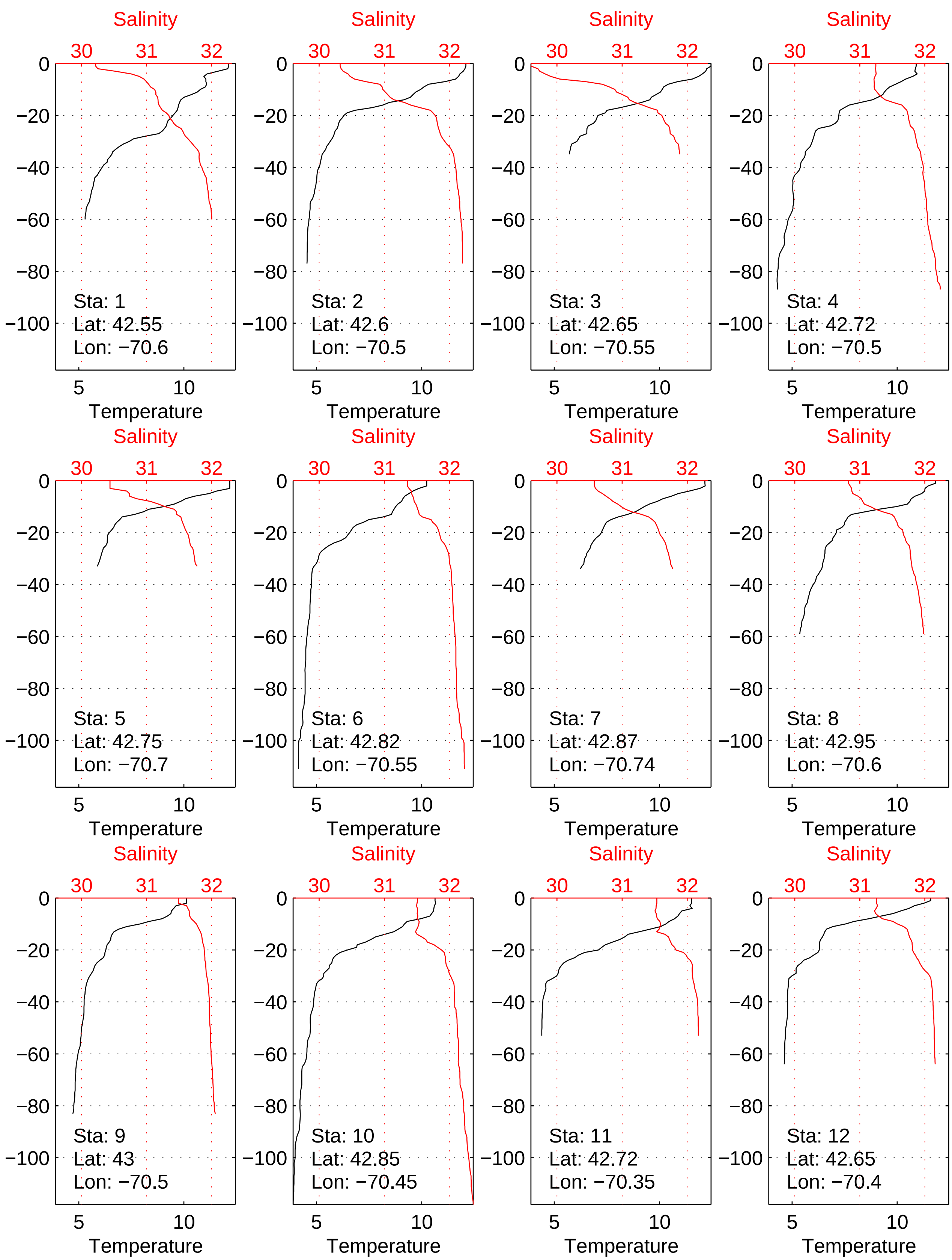
Alliance Data: 24−25 June 2001





Alliance Data: 6−7 June 2001
Latitude
Longitude
43.2
43.1
43
42.9
42.8
42.7
42.6
42.5
42.4
42.3
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2
−70.1

Alliance Data: 6−7 June 2001



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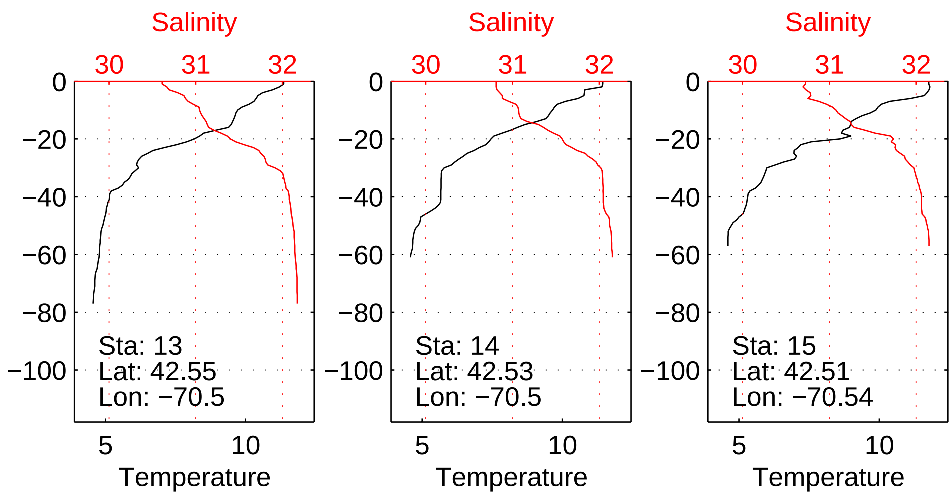
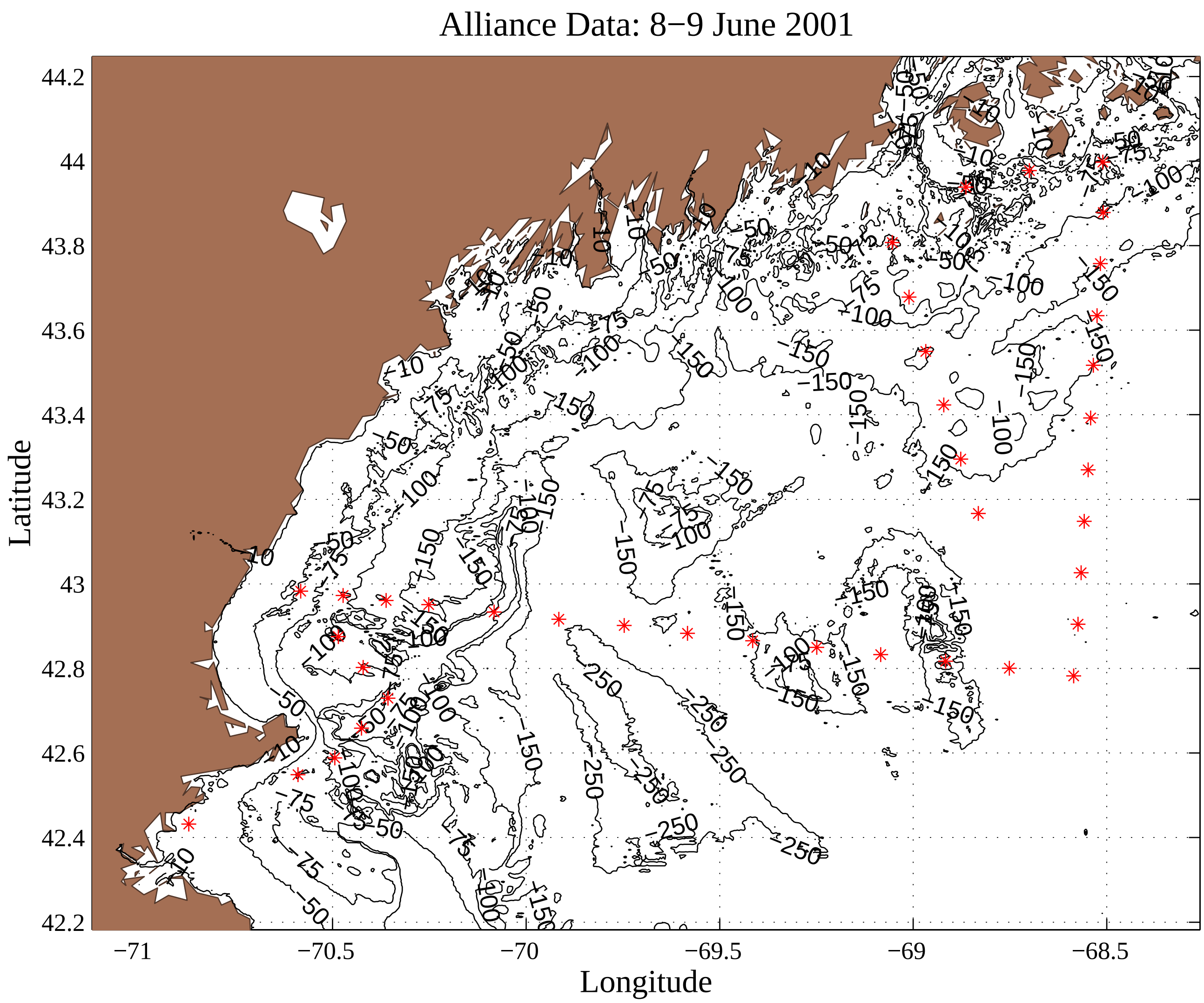
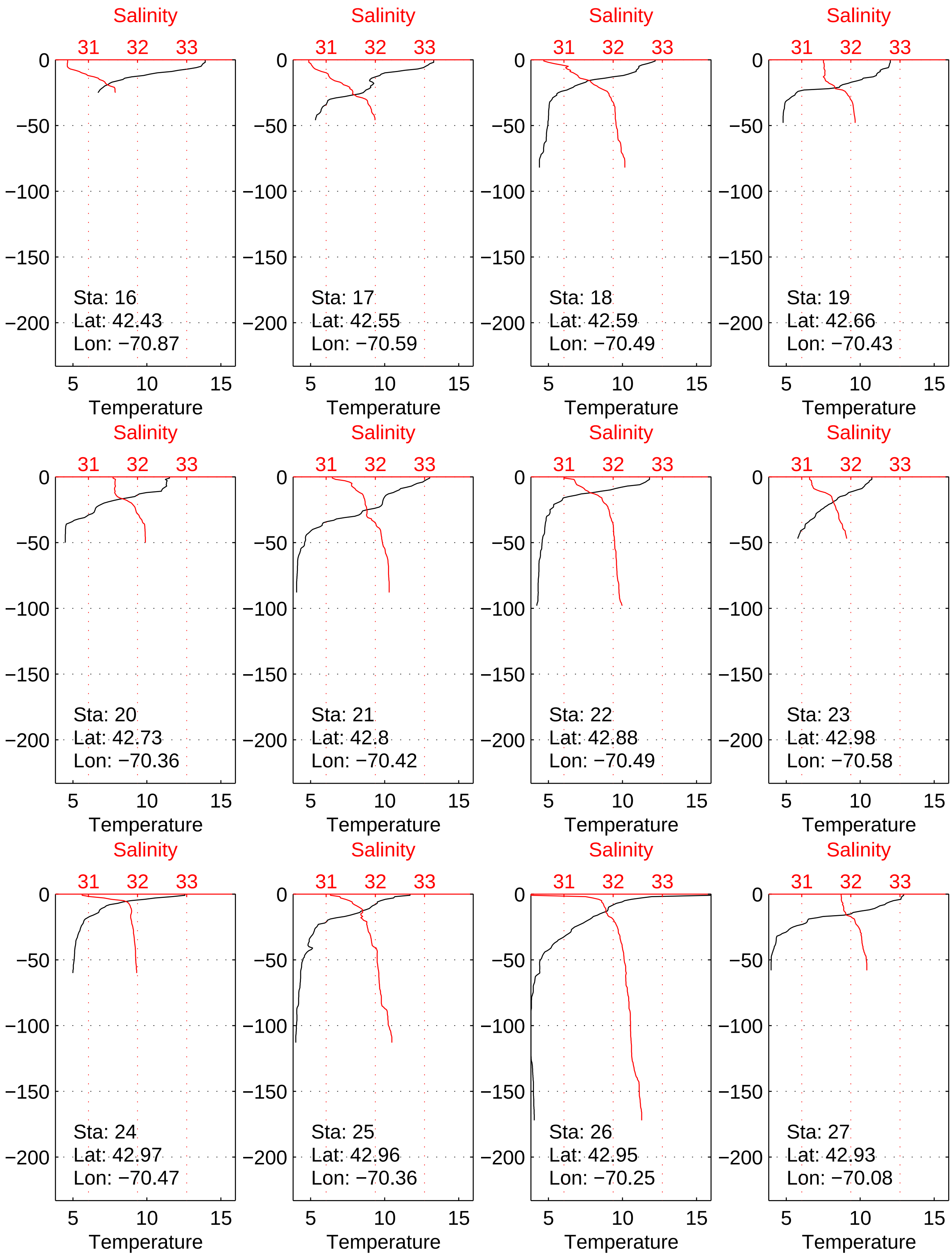




Alliance Data: 8−9 June 2001
Latitude
Longitude
44.2
44
43.8
43.6
43.4
43.2
43
42.8
42.6
42.4
42.2
−71
−70.5
−70
−69.5
−69
−68.5

Alliance Data: 8−9 June 2001



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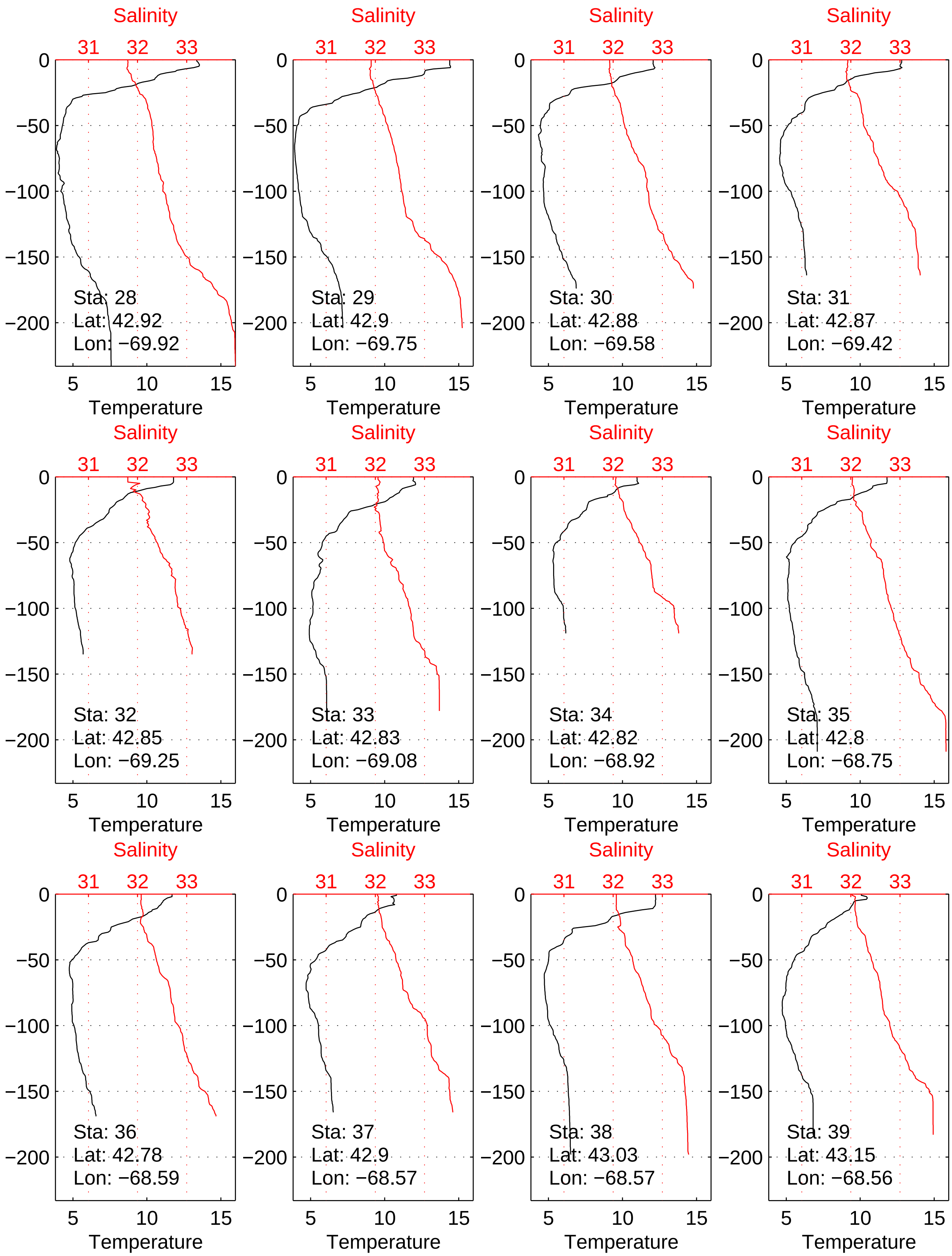

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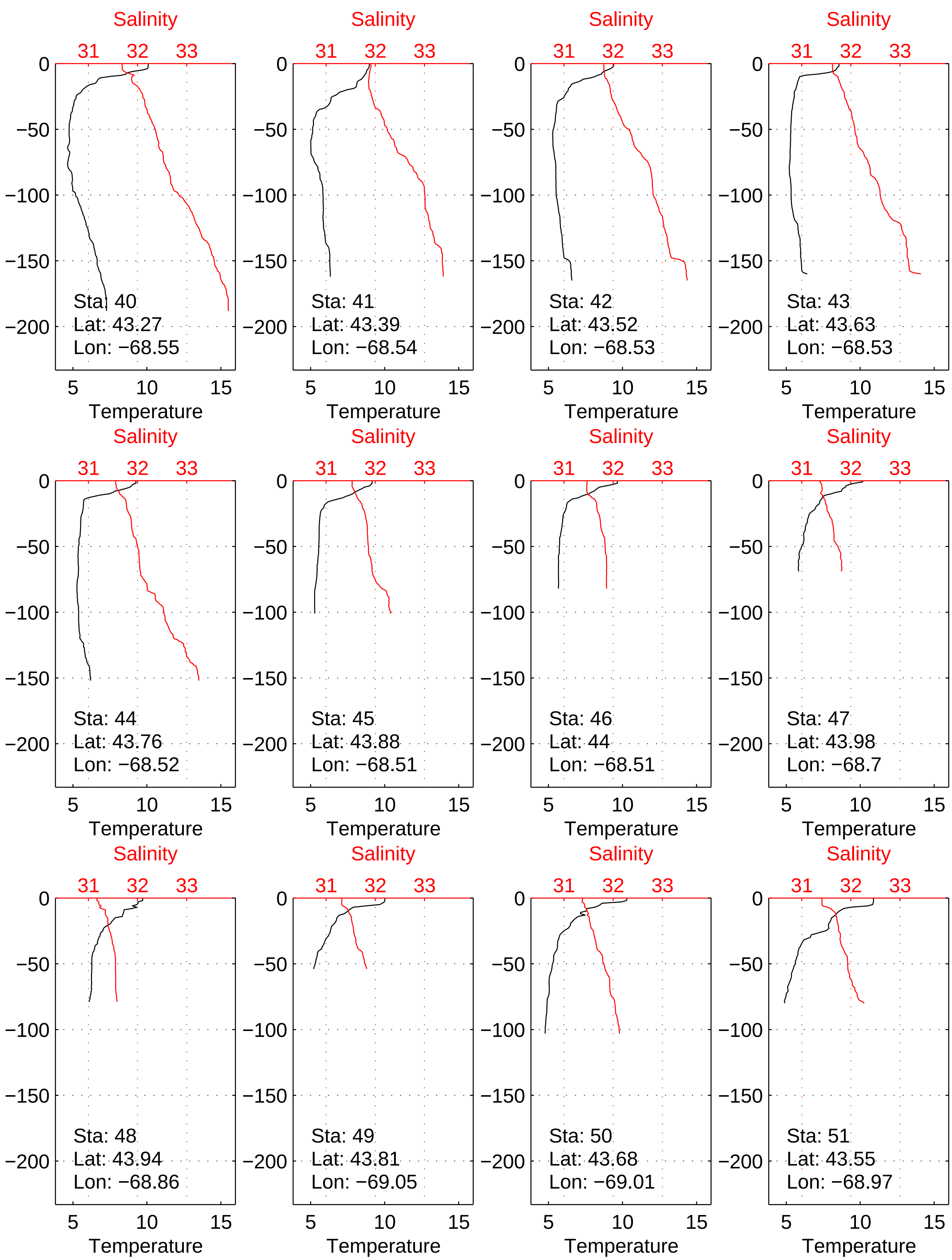

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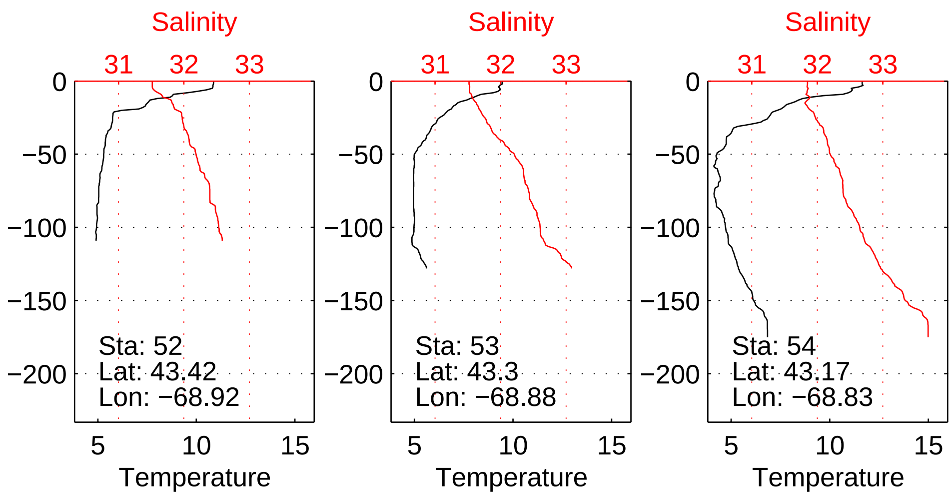

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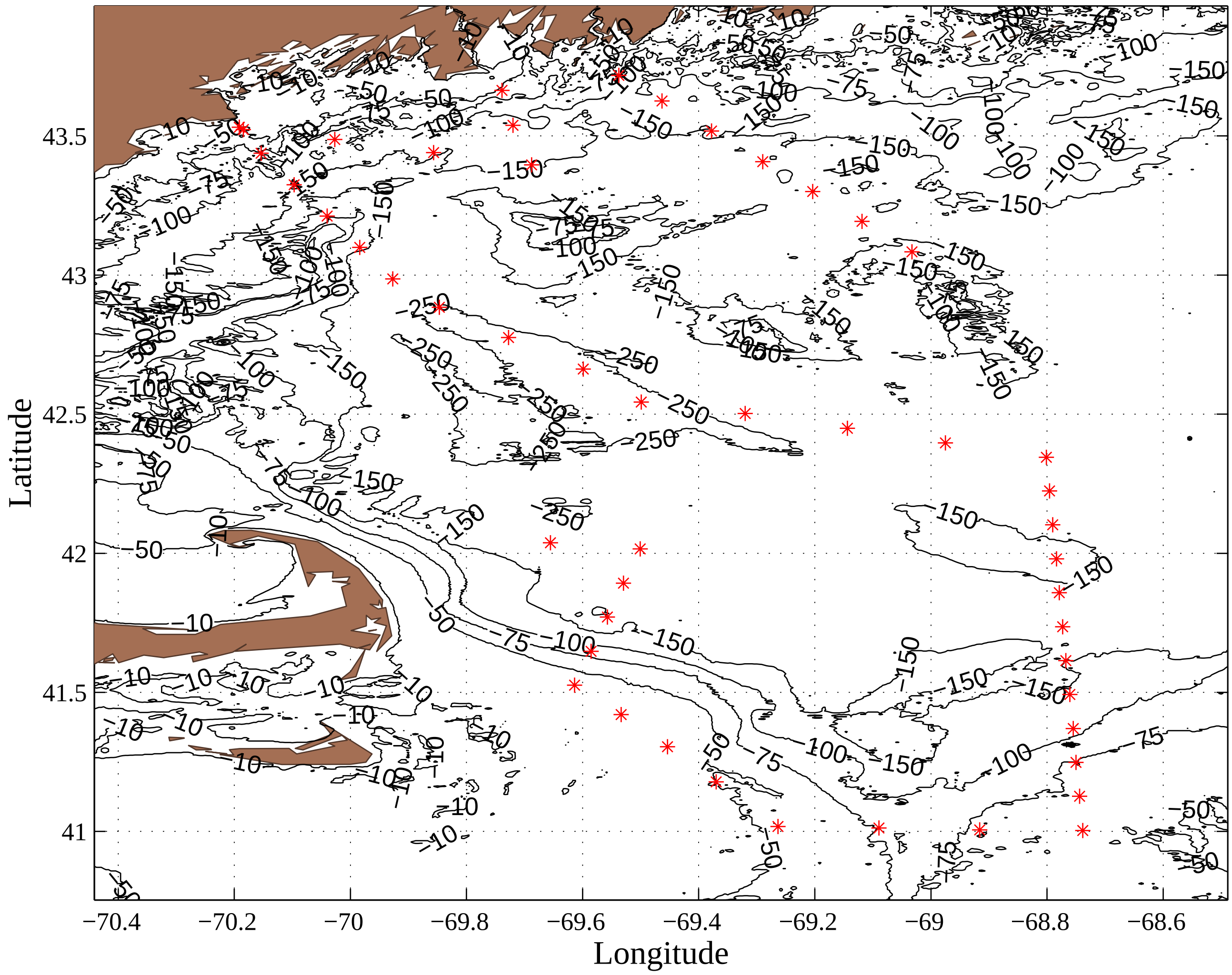

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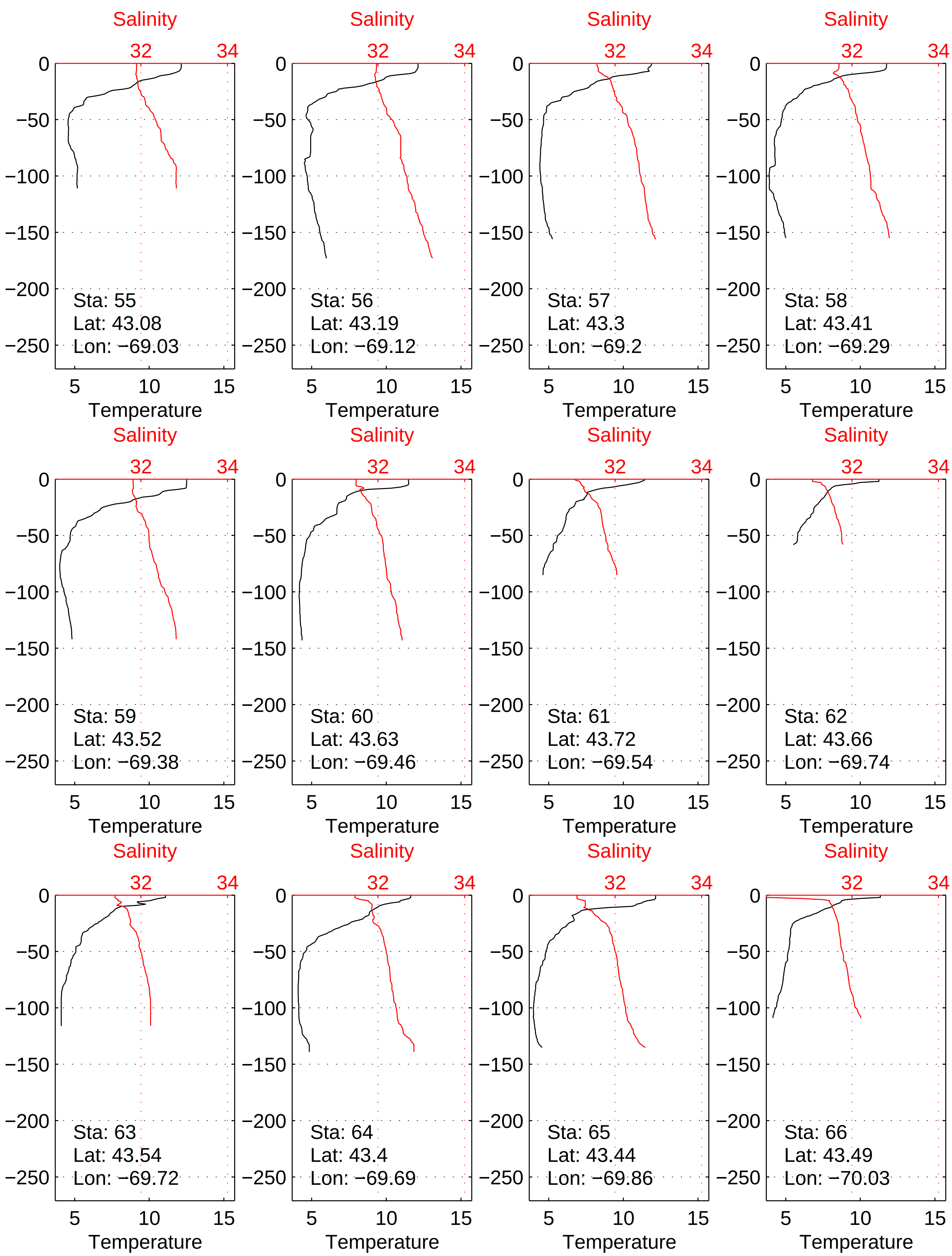

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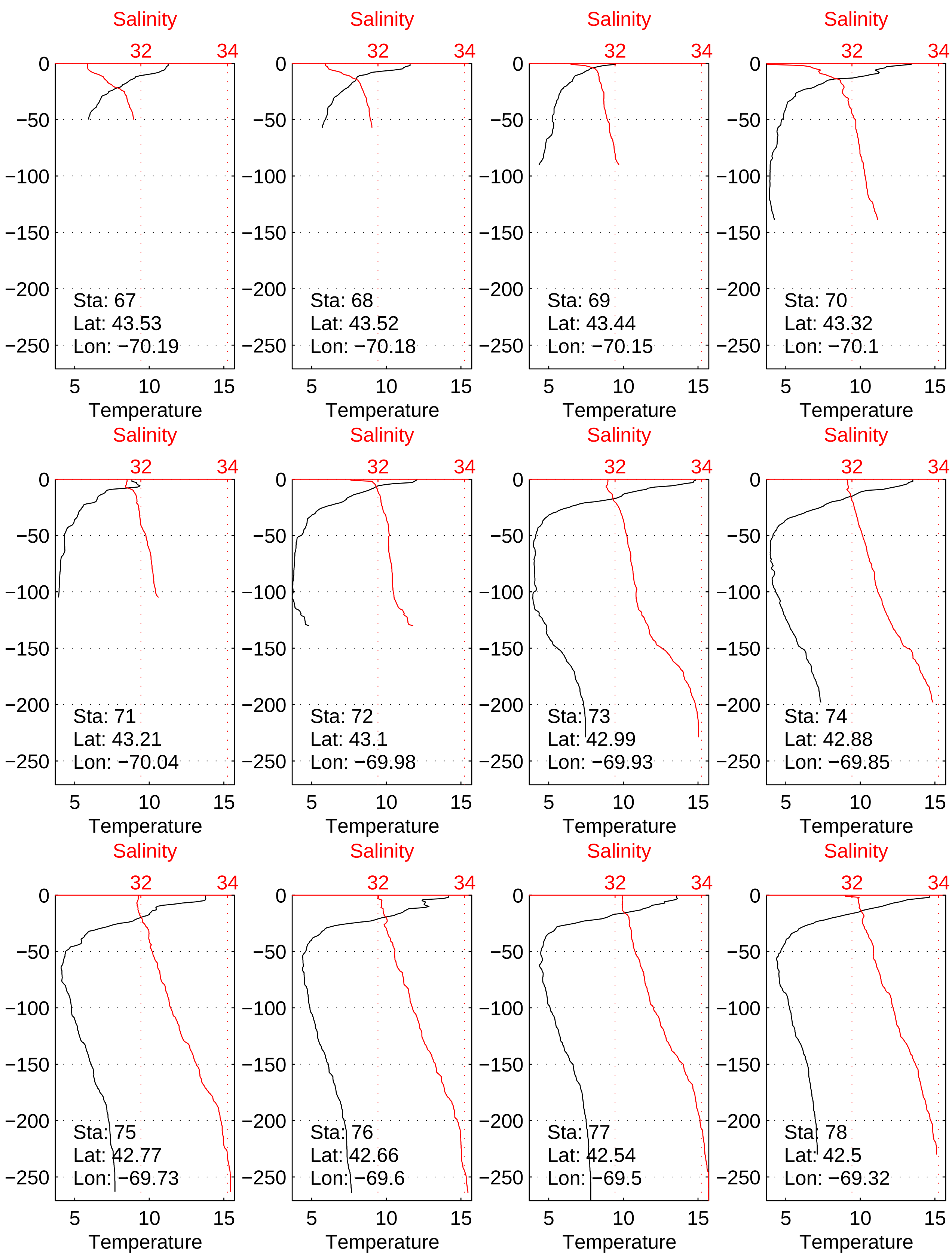

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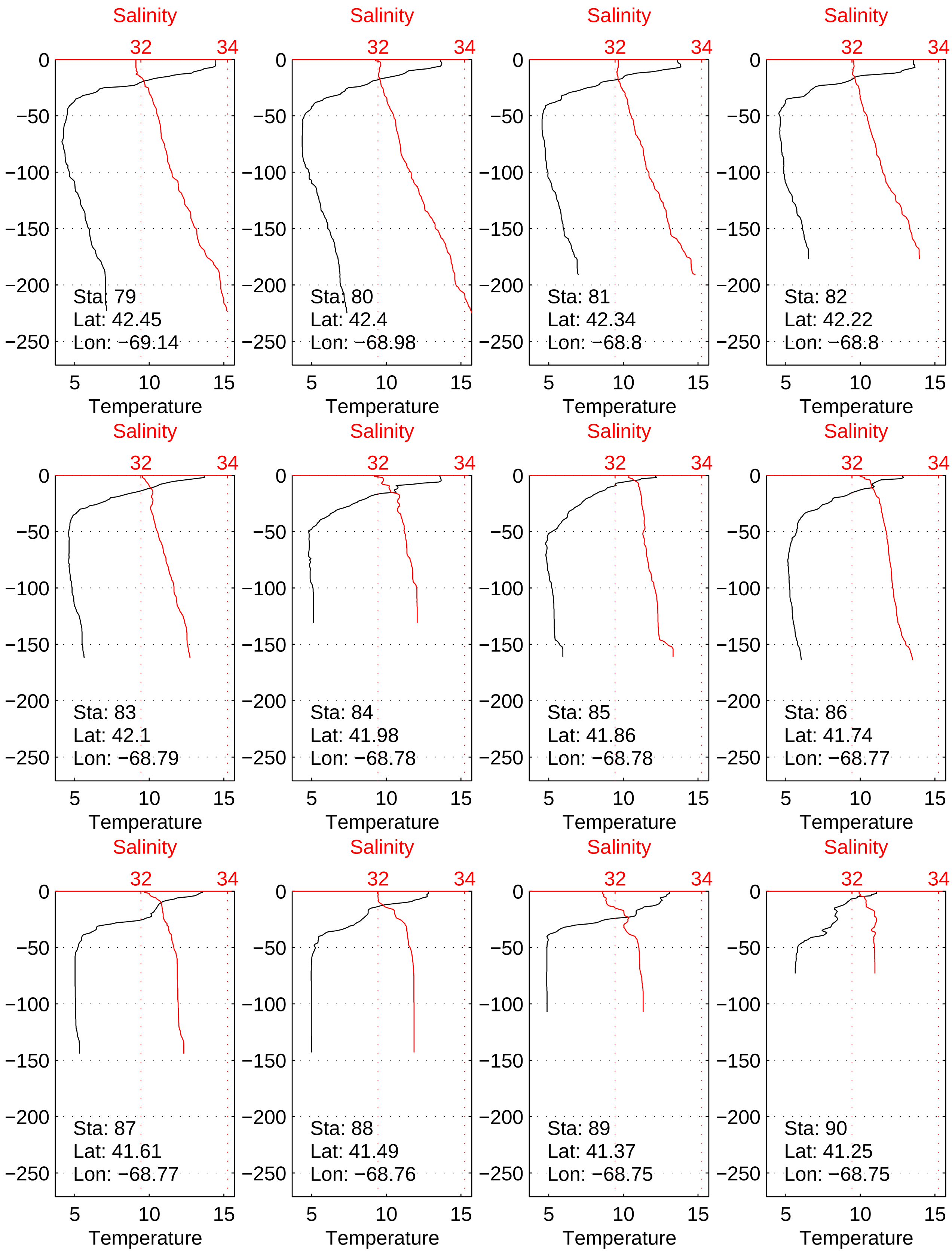

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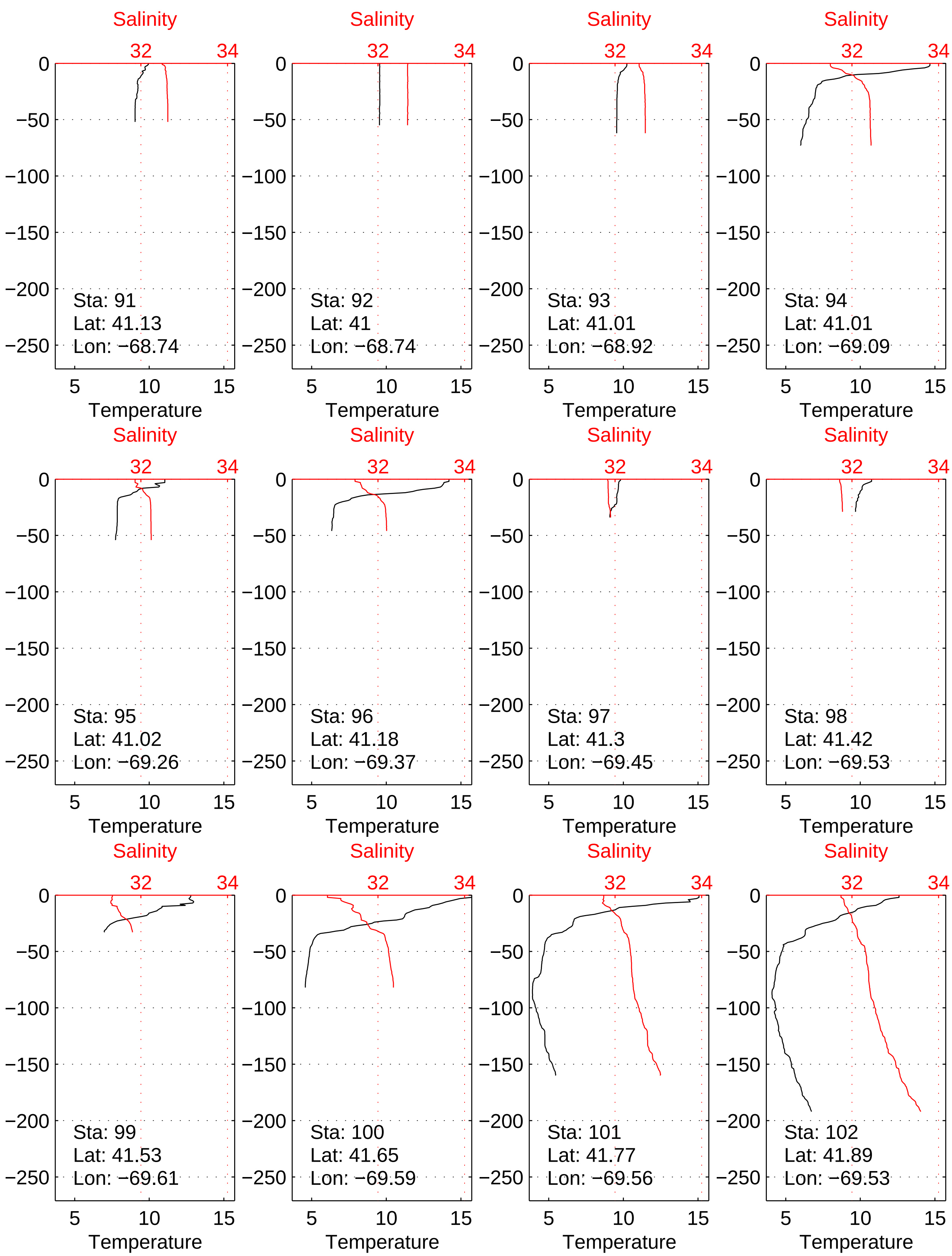

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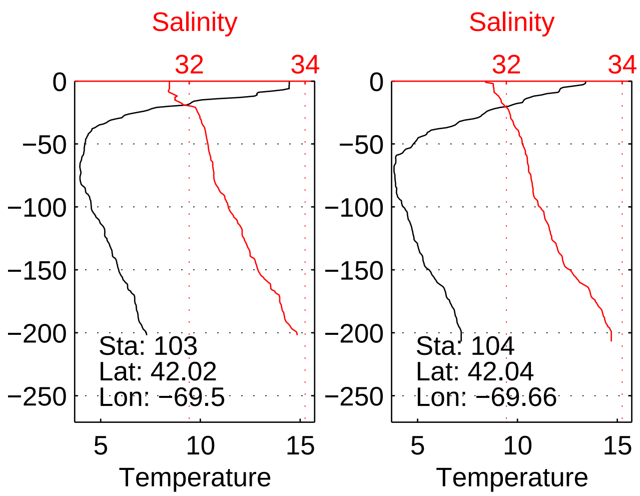

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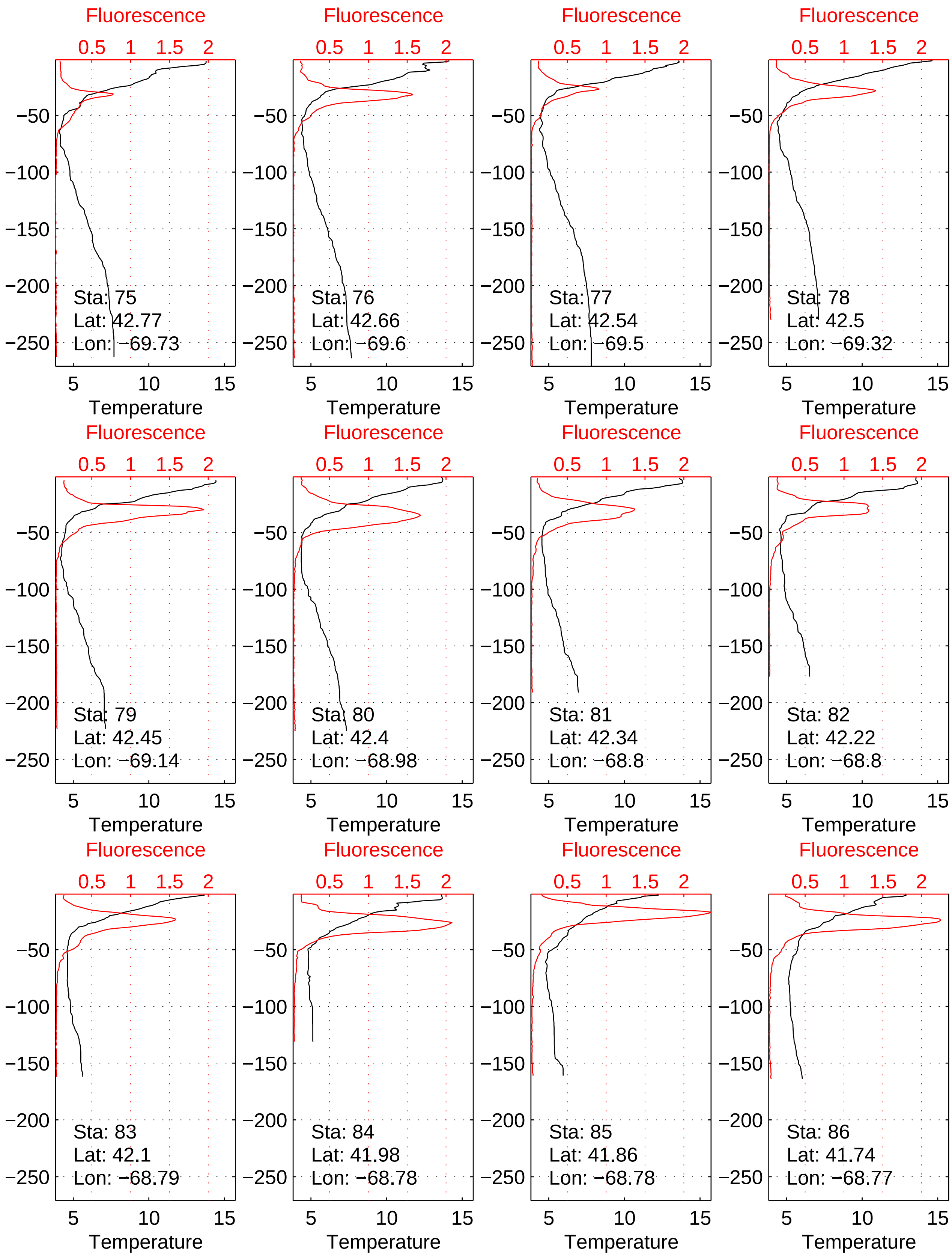

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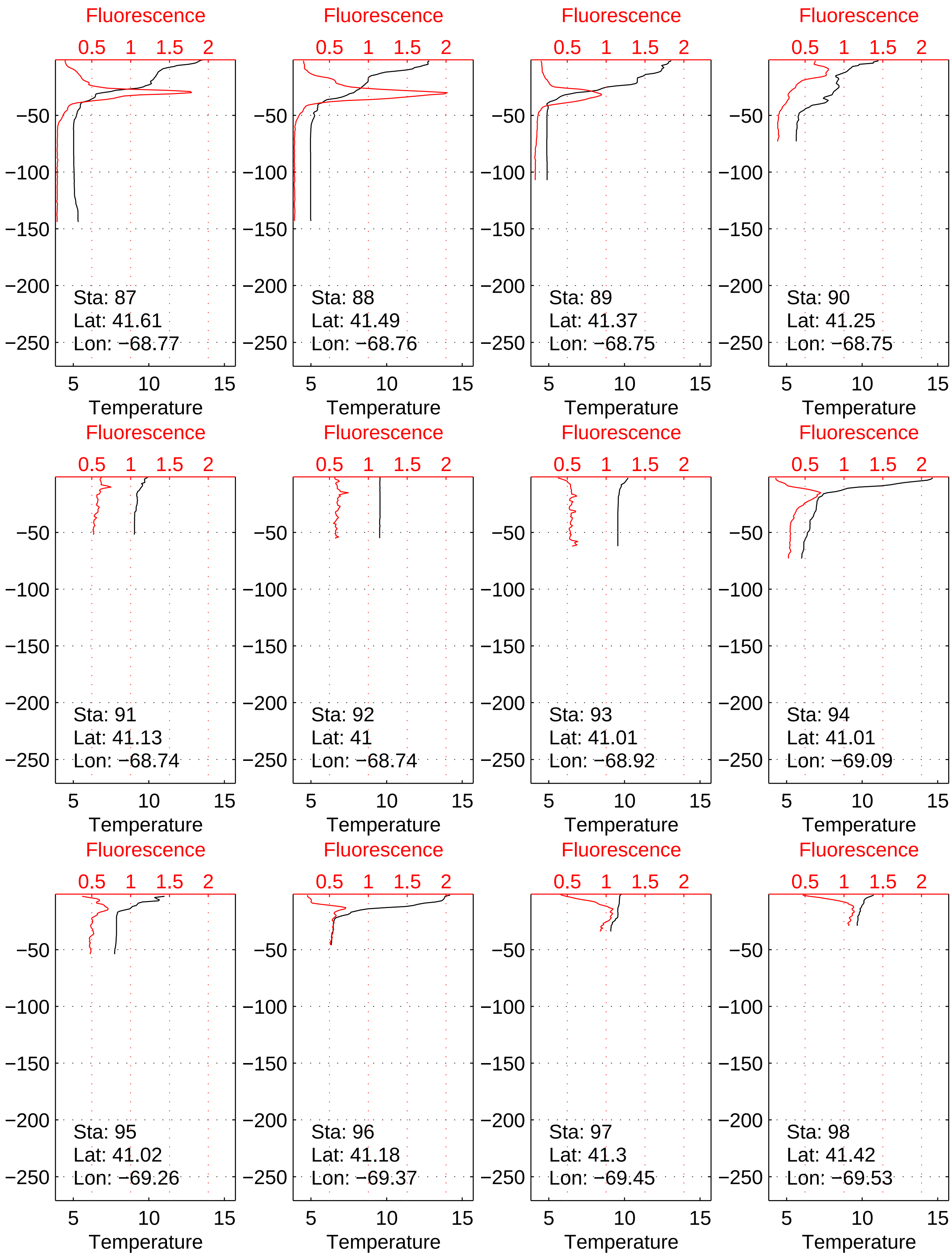

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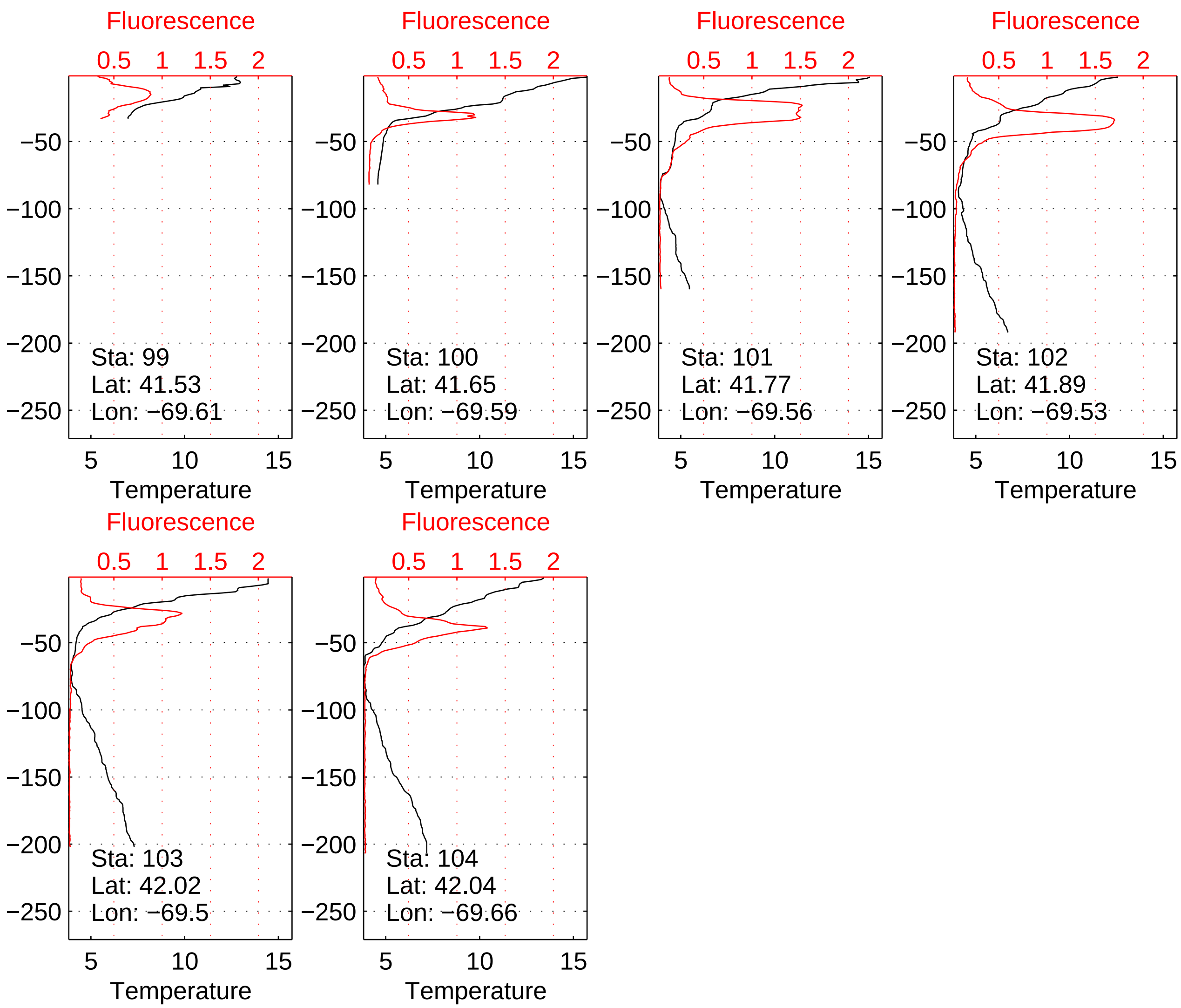
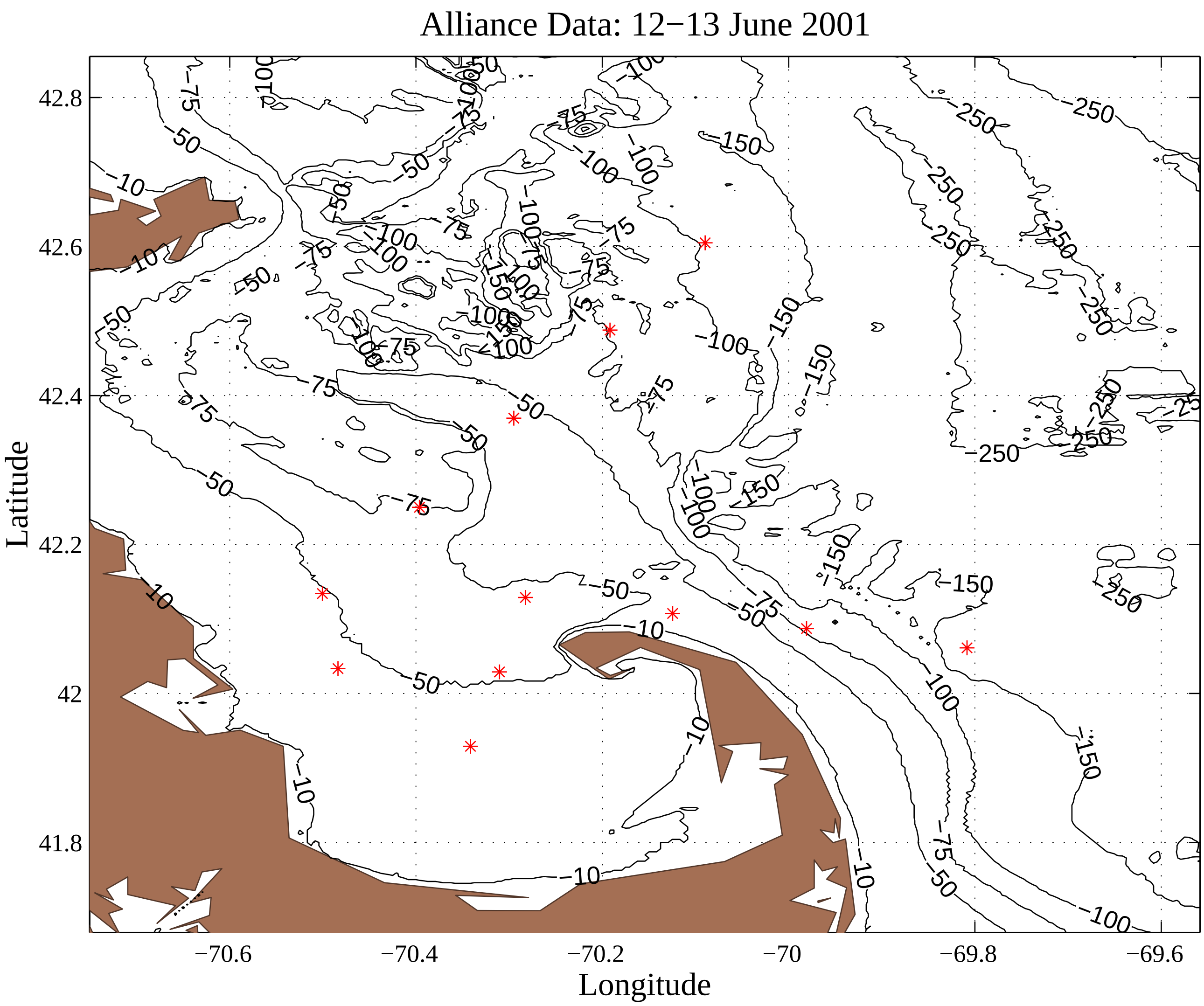
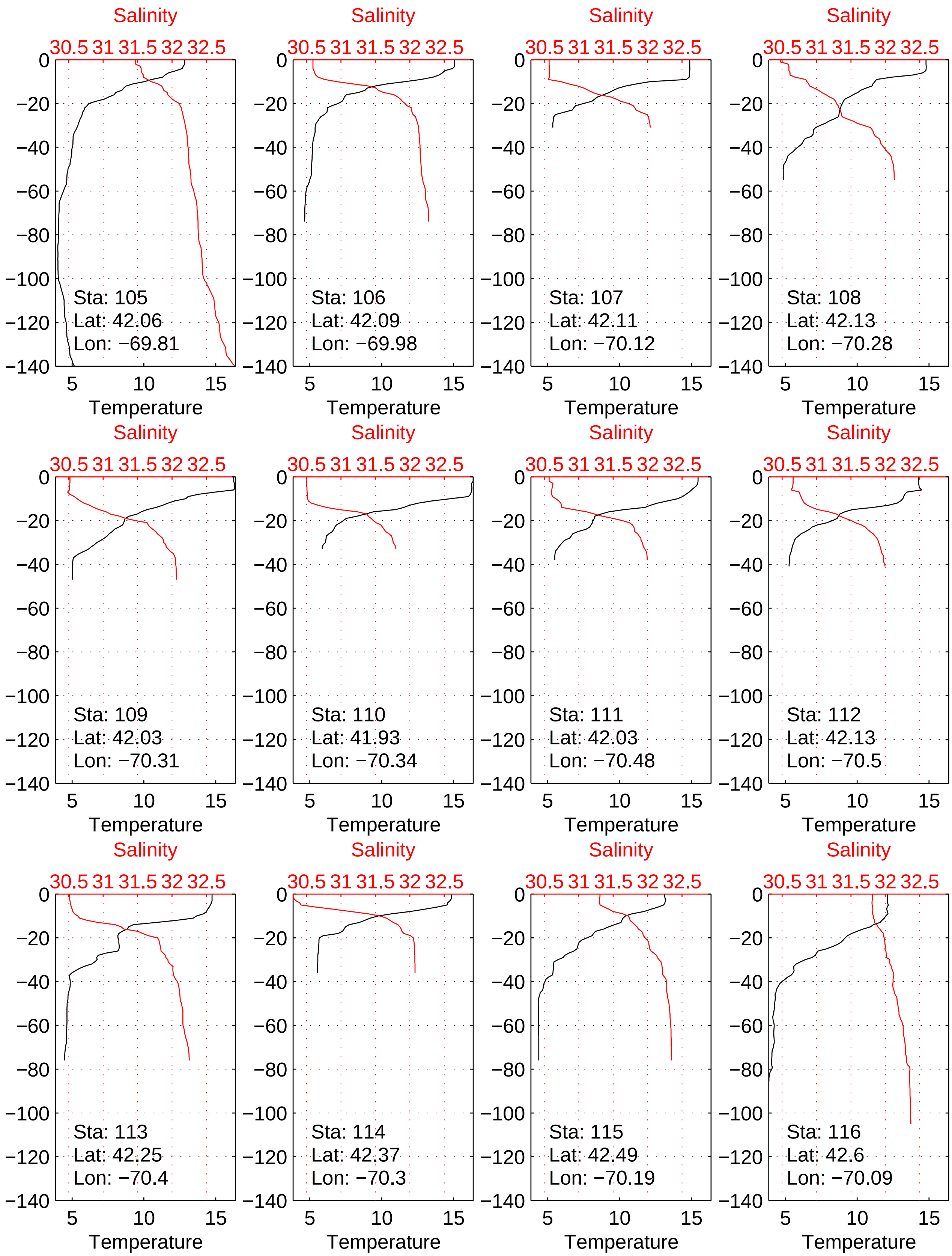


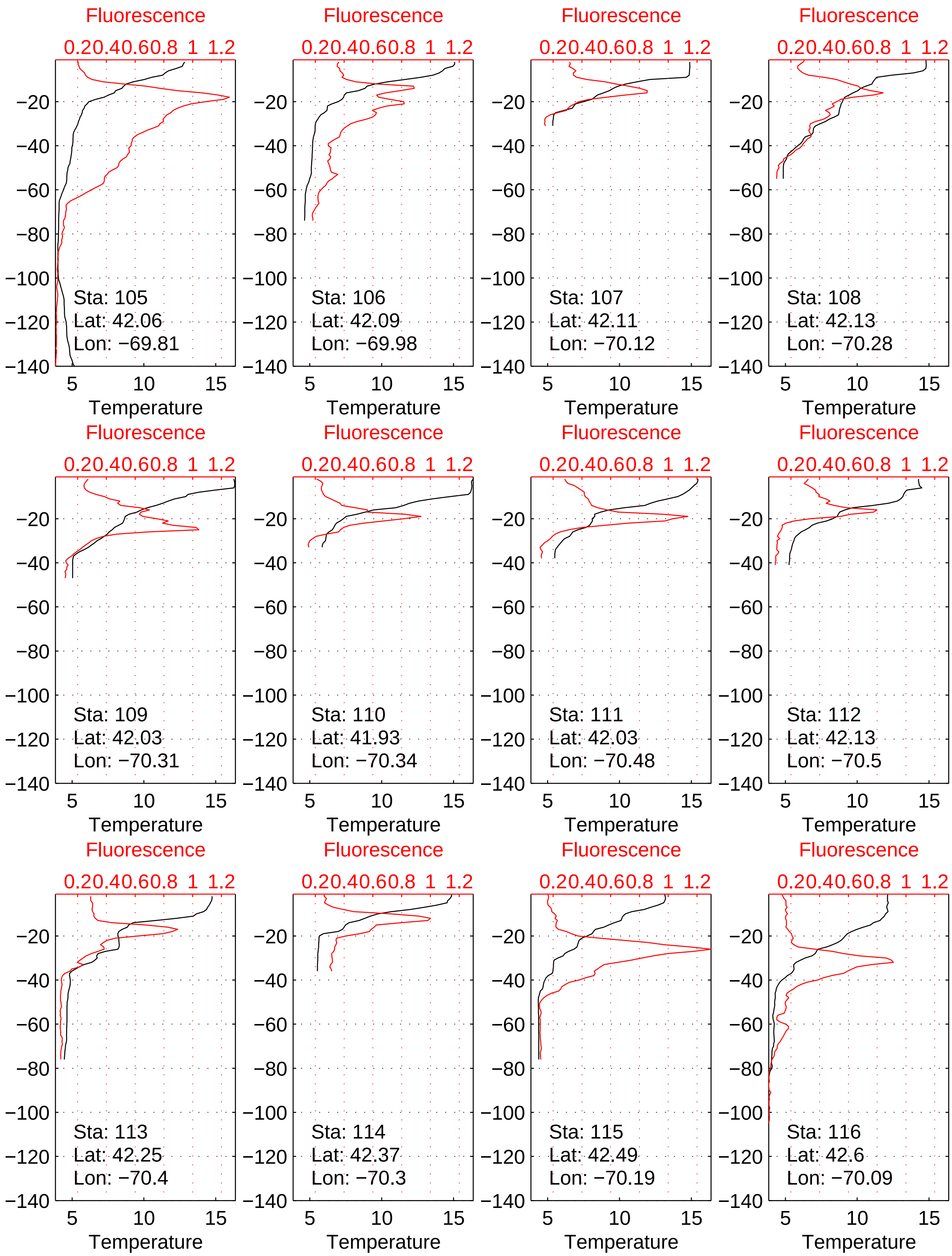


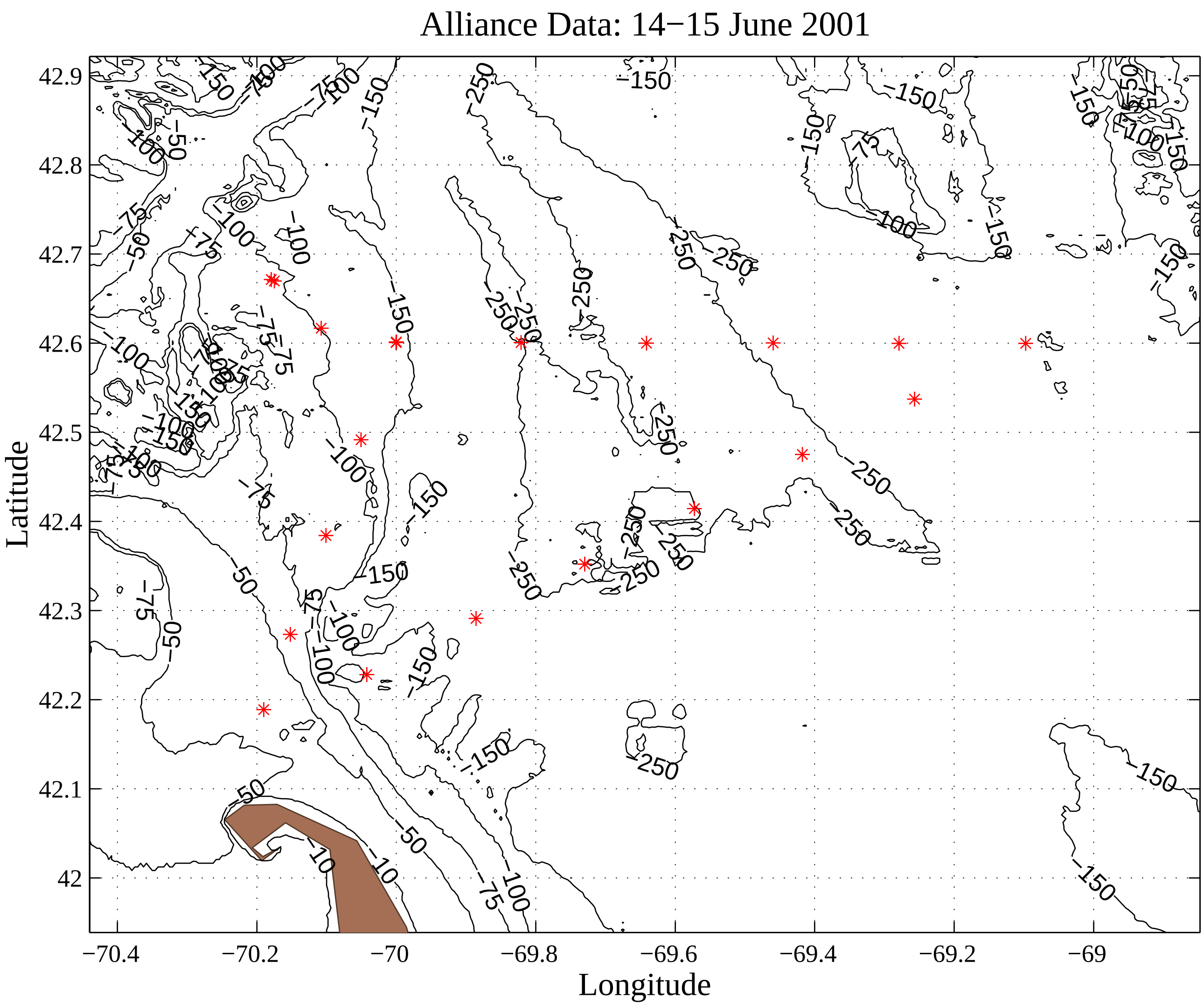
Alliance Data: 12−13 June 2001
Latitude
Longitude
42.8
42.6
42.4
42.2
42
41.8
−70.6
−70.4
−70.2
−70
−69.8
−69.6

Alliance Data: 12−13 June 2001

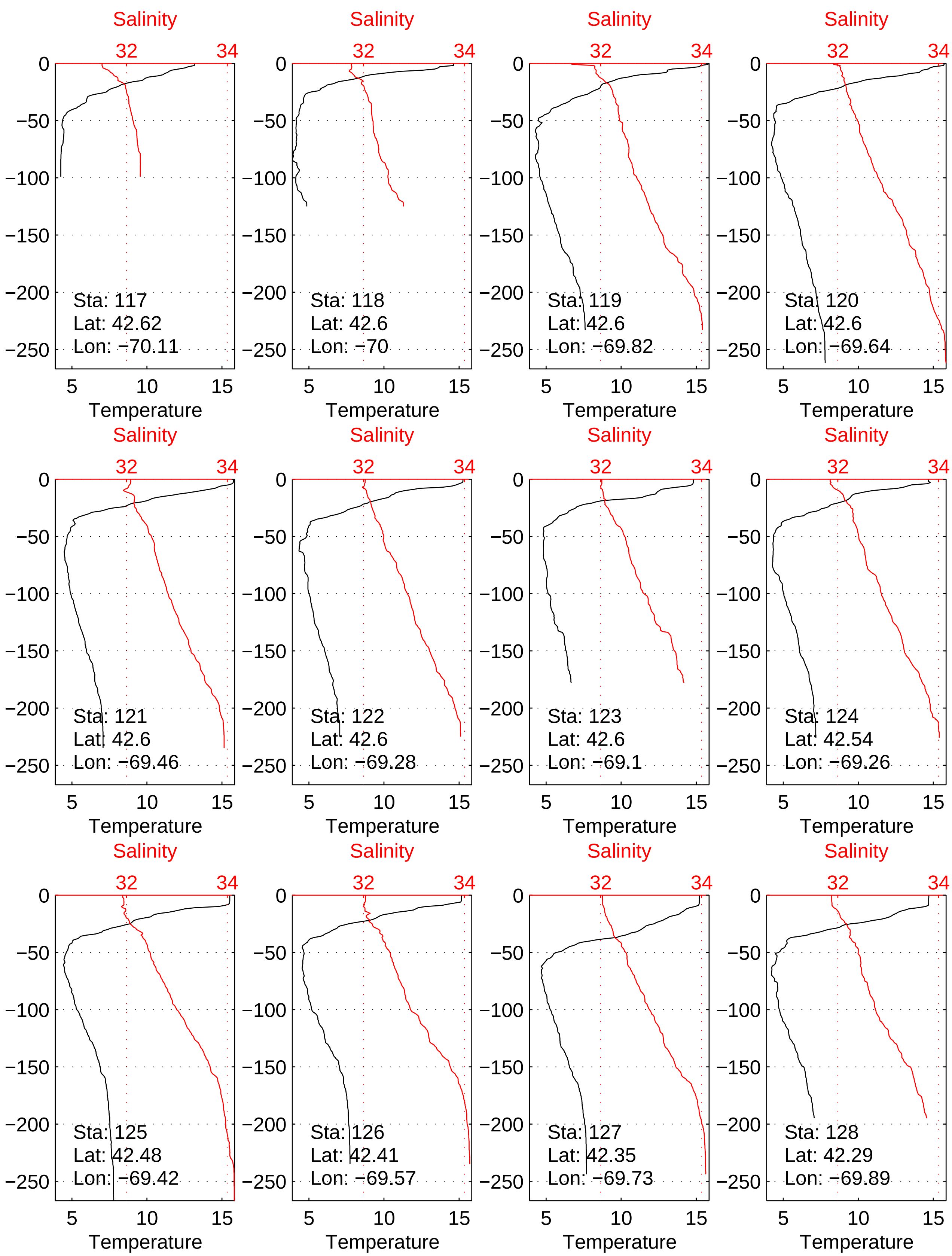


Alliance Data: 12−13 June 2001

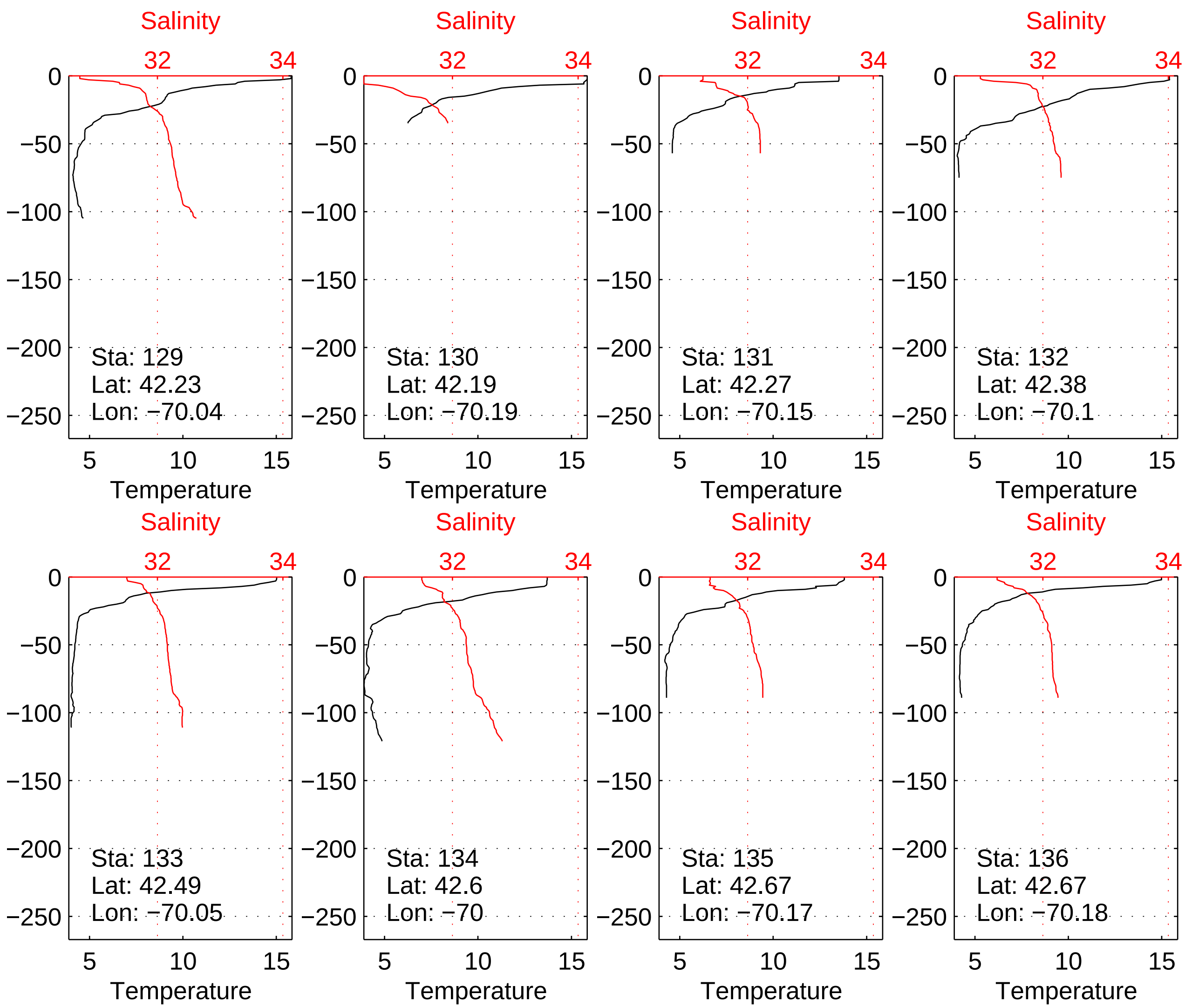


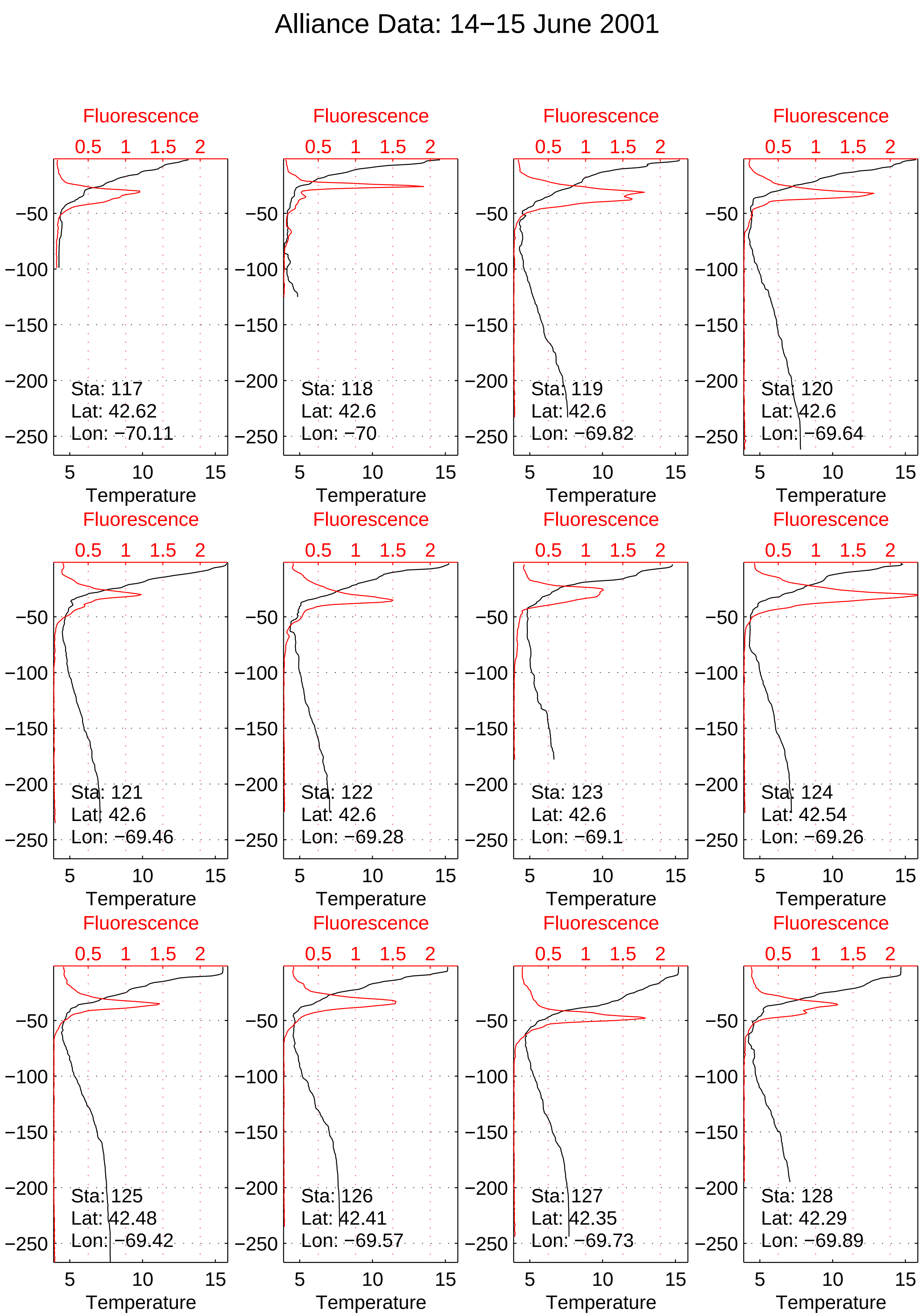

Alliance Data: 14−15 June 2001
Latitude
42.9
42.8
42.7
42.6
42.5
42.4
42.3
42.2
42.1
42
Longitude
−70.4
−70.2
−70
−69.8
−69.6
−69.4
−69.2
−69

Alliance Data: 14−15 June 2001



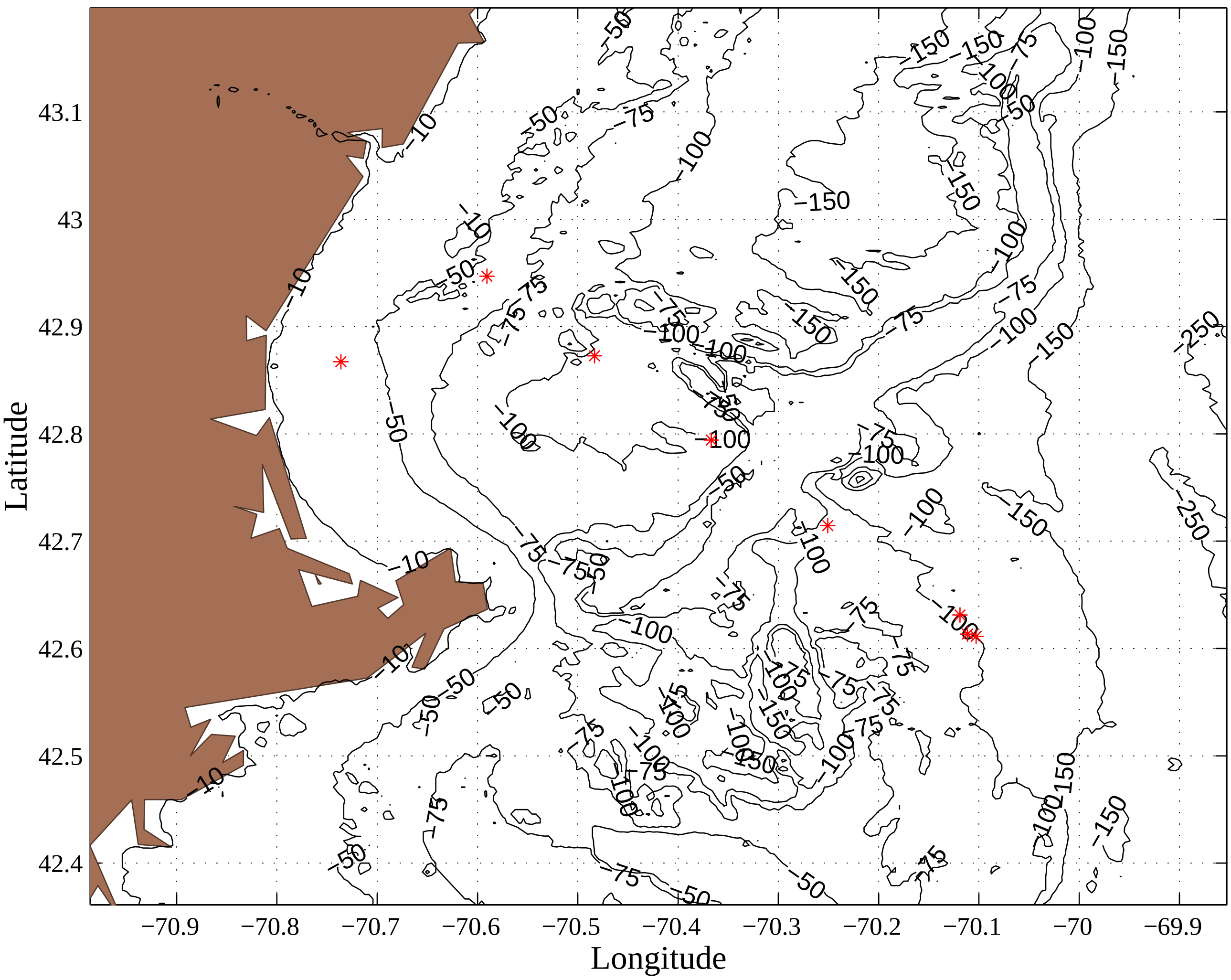
Alliance Data: 14−15 June 2001



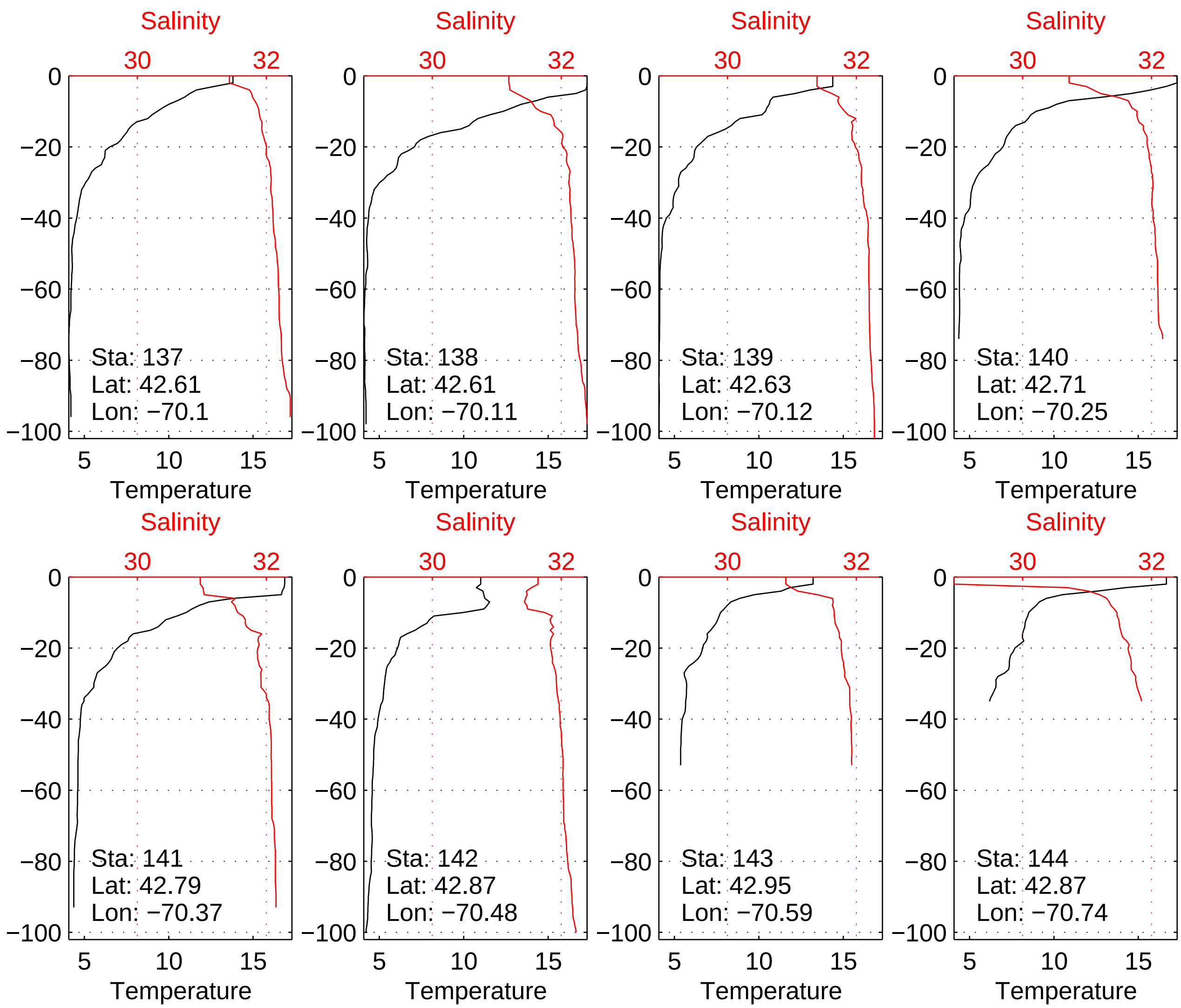


Alliance Data: 14−15 June 2001
Fluorescence
0.5 1 1.5 2
−50
−100
−150
−200
−250
5 10 15
Temperature
Sta: 117
Lat: 42.62
Lon: −70.11
Sta: 118
Lat: 42.6
Lon: −70
Sta: 119
Lat: 42.6
Lon: −69.82
Sta: 120
Lat: 42.6
Lon: −69.64
Sta: 121
Lat: 42.6
Lon: −69.46
Sta: 122
Lat: 42.6
Lon: −69.28
Sta: 123
Lat: 42.6
Lon: −69.1
Sta: 124
Lat: 42.54
Lon: −69.26
Sta: 125
Lat: 42.48
Lon: −69.42
Sta: 126
Lat: 42.41
Lon: −69.57
Sta: 127
Lat: 42.35
Lon: −69.73
Sta: 128
Lat: 42.29
Lon: −69.89

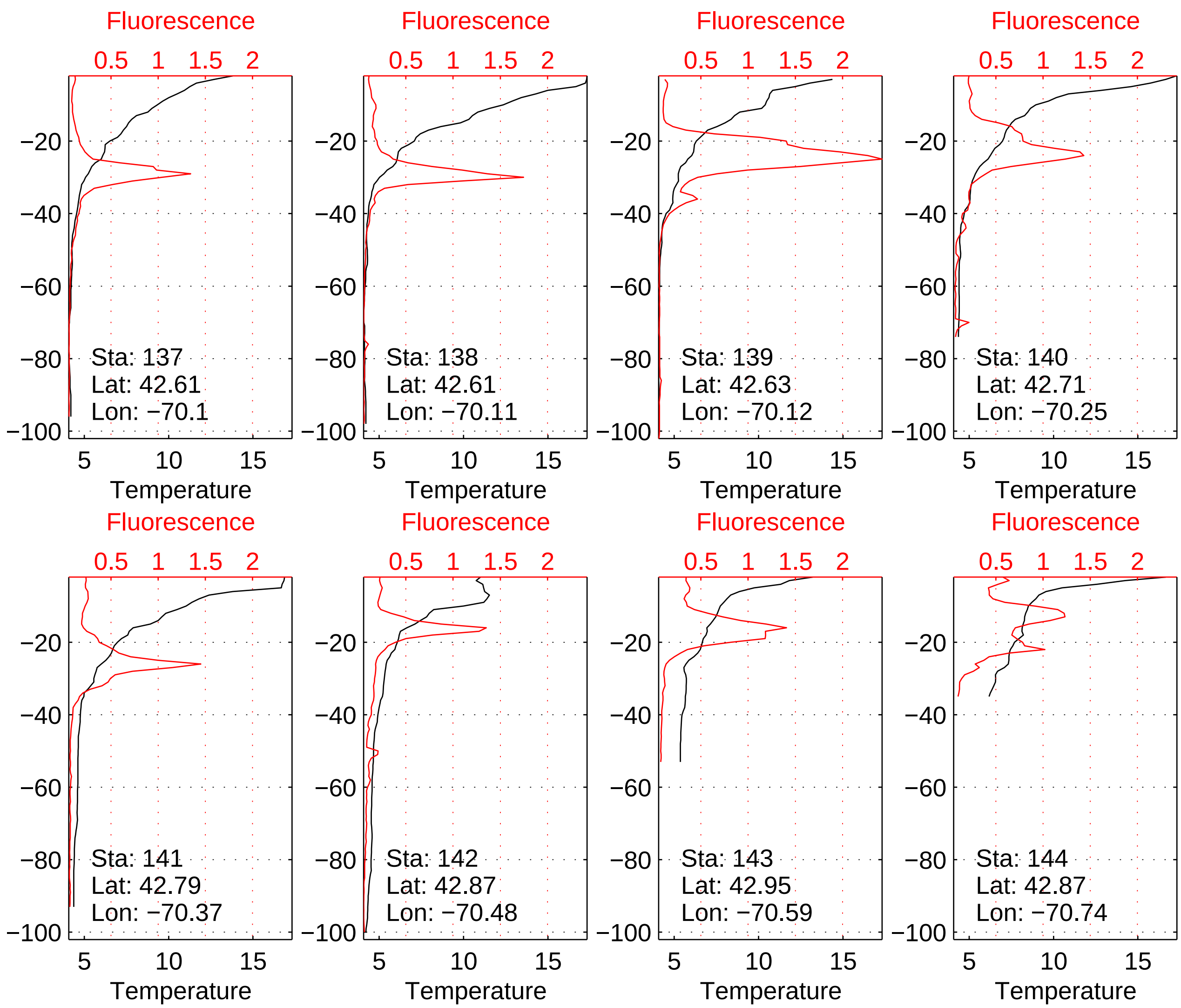
Alliance Data: 16−17 June 2001

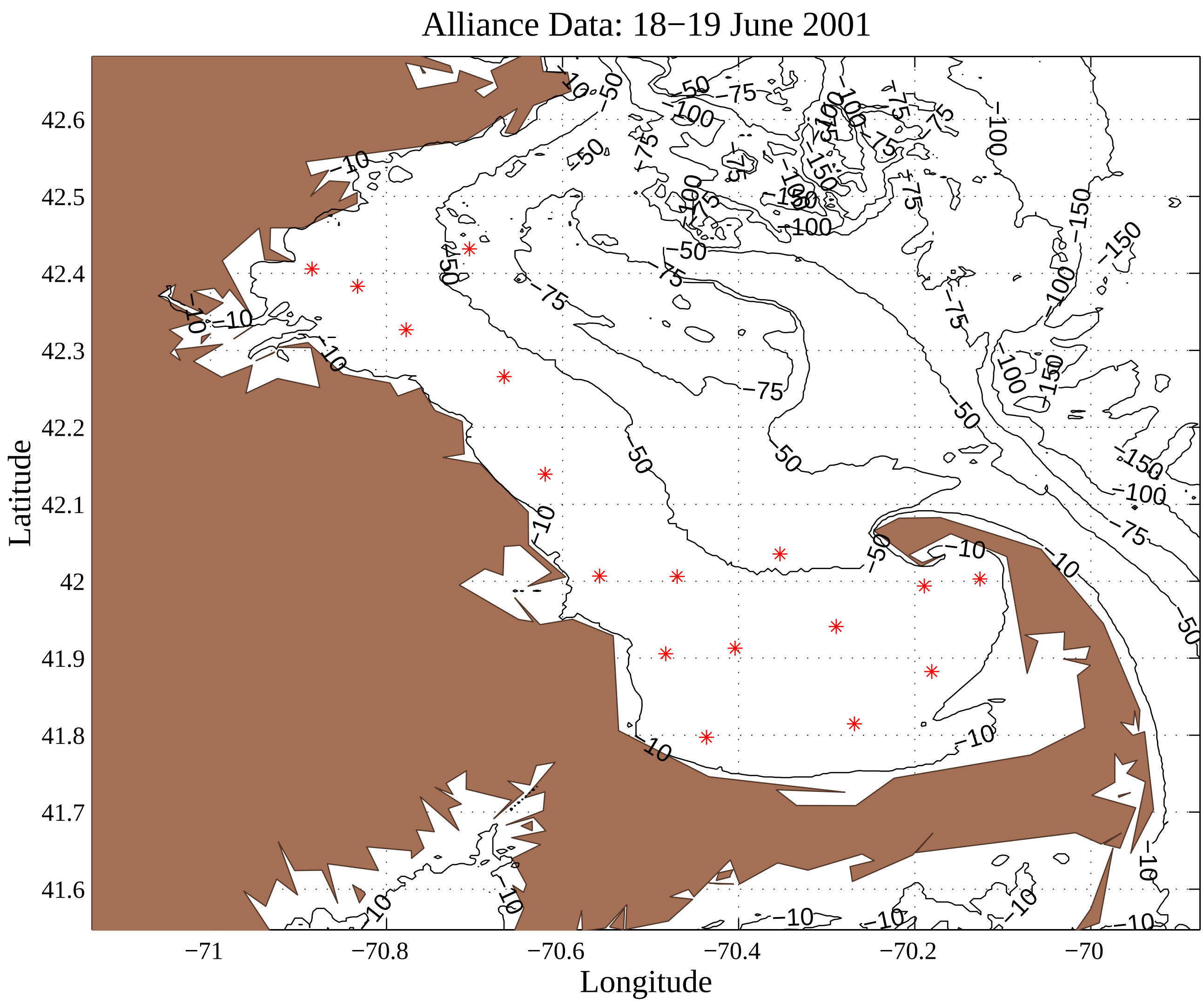


Alliance Data: 16−17 June 2001

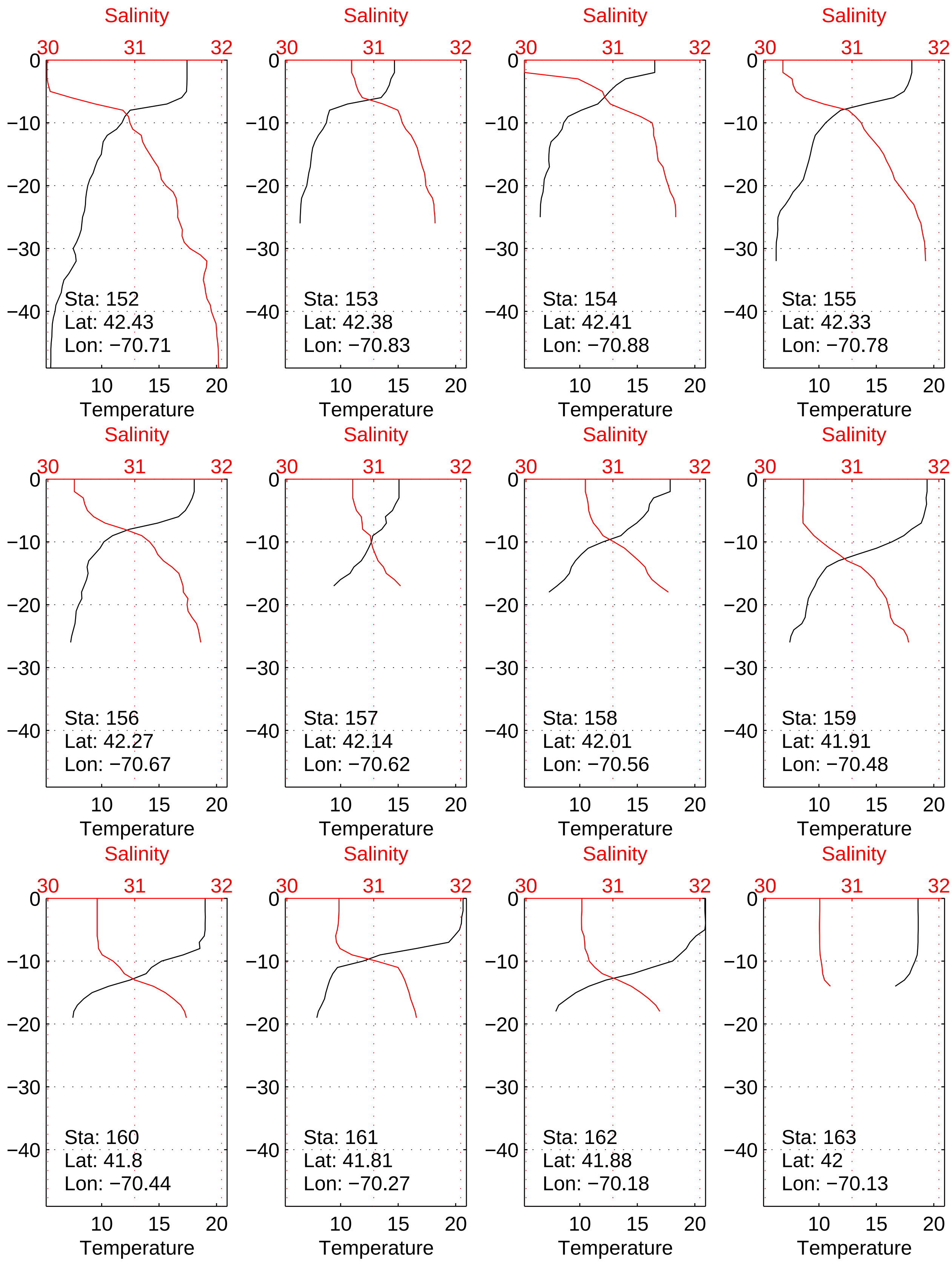


Alliance Data: 16−17 June 2001

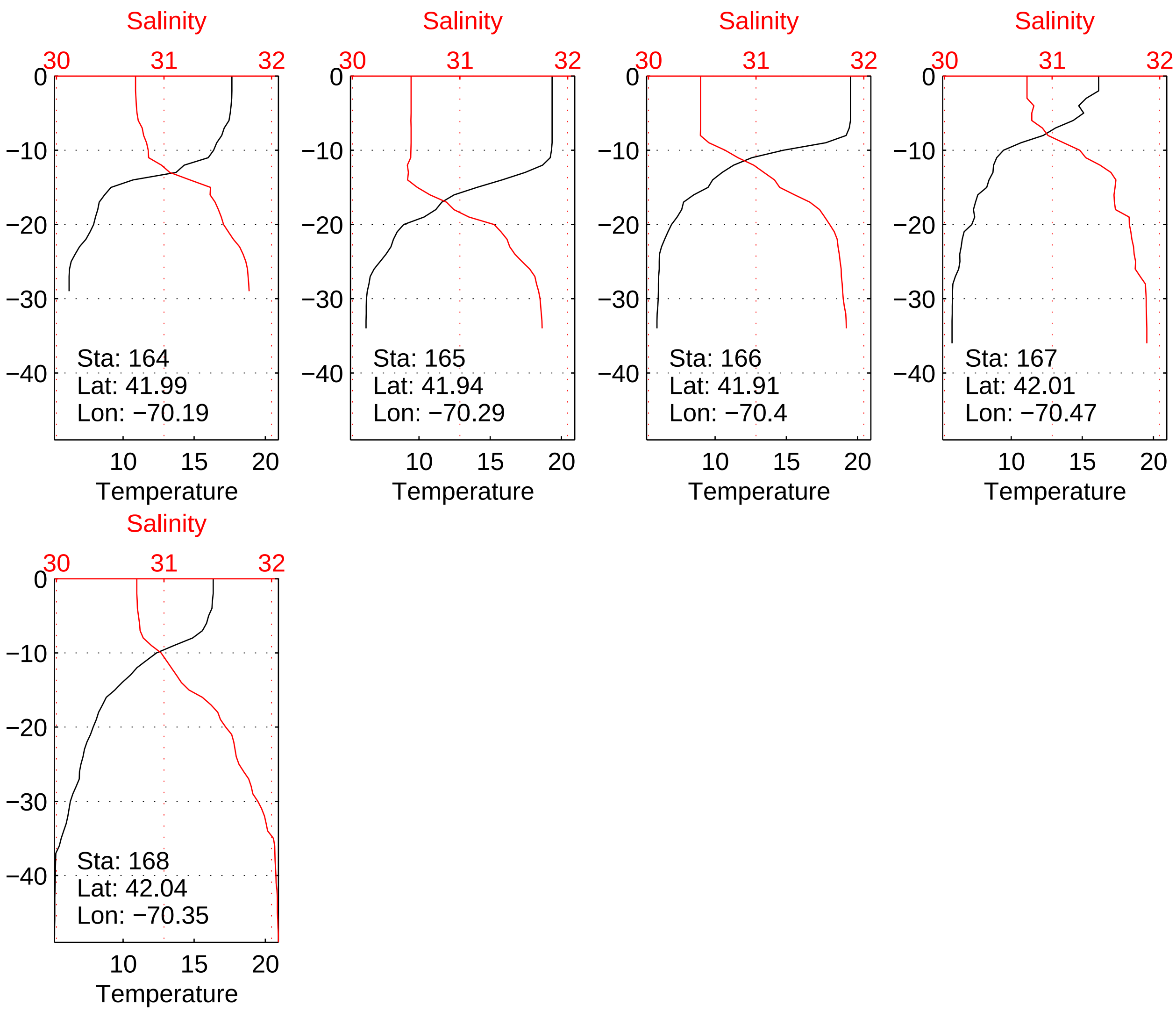



Alliance Data: 18−19 June 2001
Latitude
Longitude
42.6
42.5
42.4
42.3
42.2
42.1
42
41.9
41.8
41.7
41.6
−71
−70.8
−70.6
−70.4
−70.2
−70

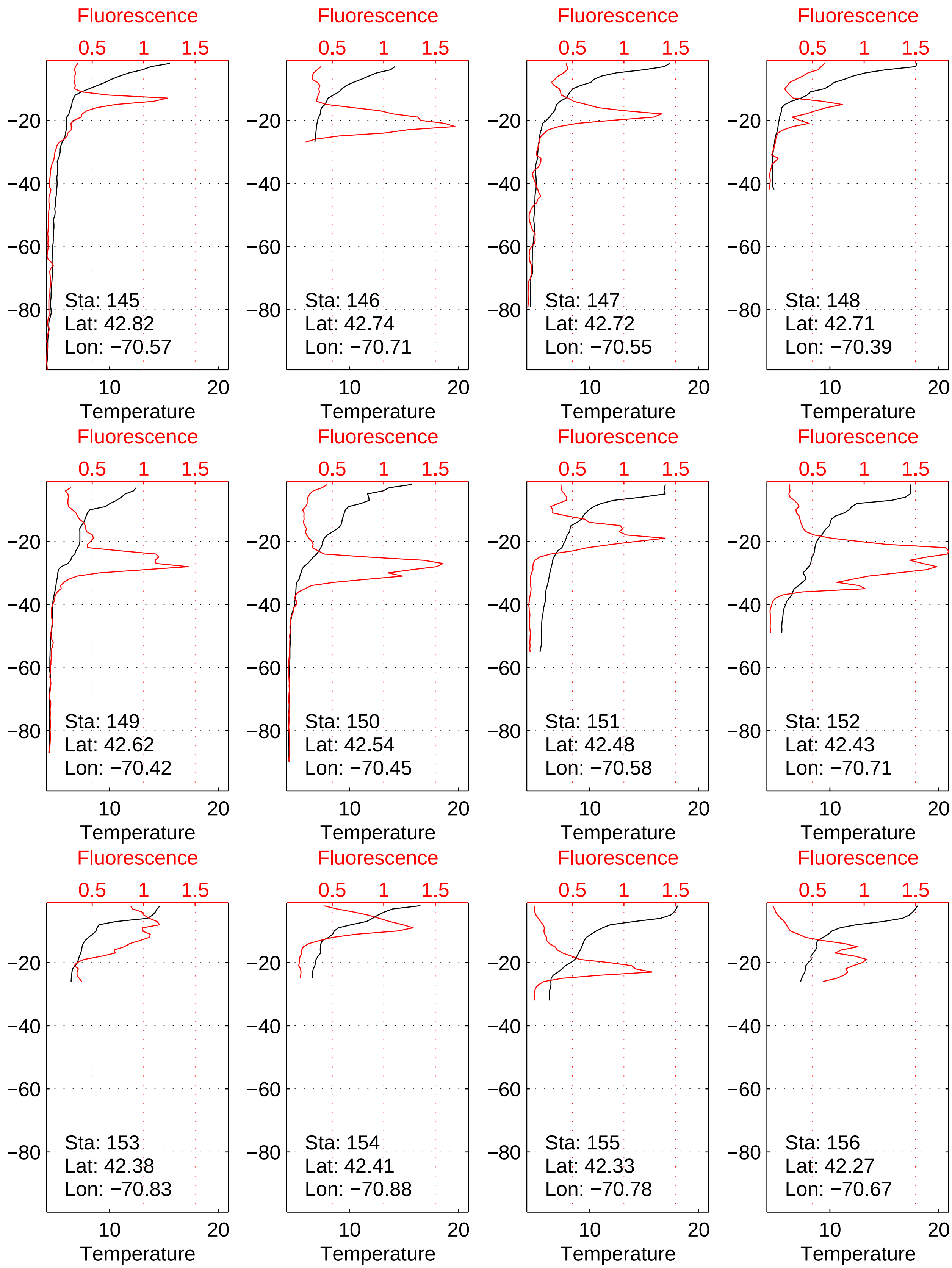
Alliance Data: 18−19 June 2001



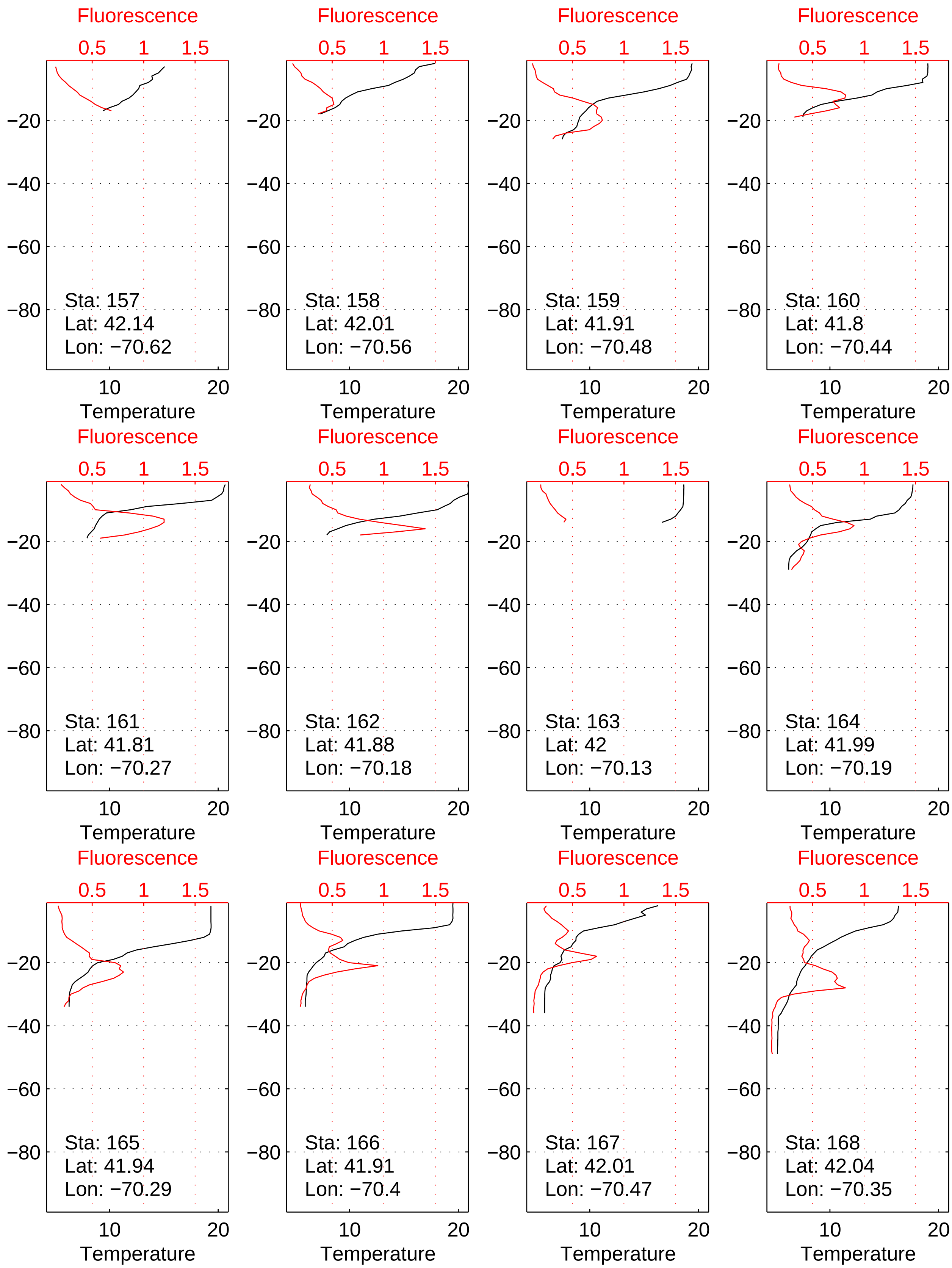
Alliance Data: 18−19 June 2001



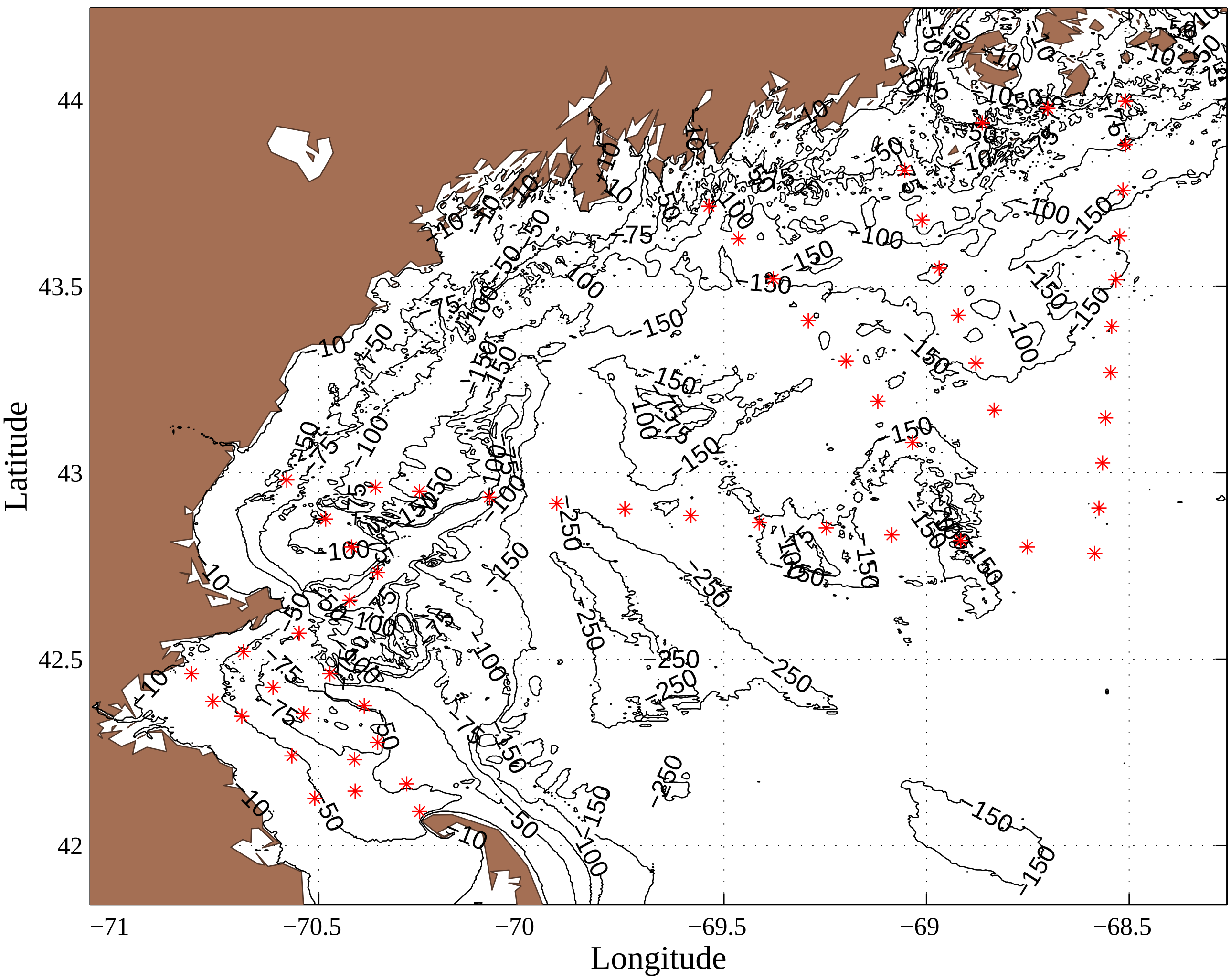
Alliance Data: 18−19 June 2001



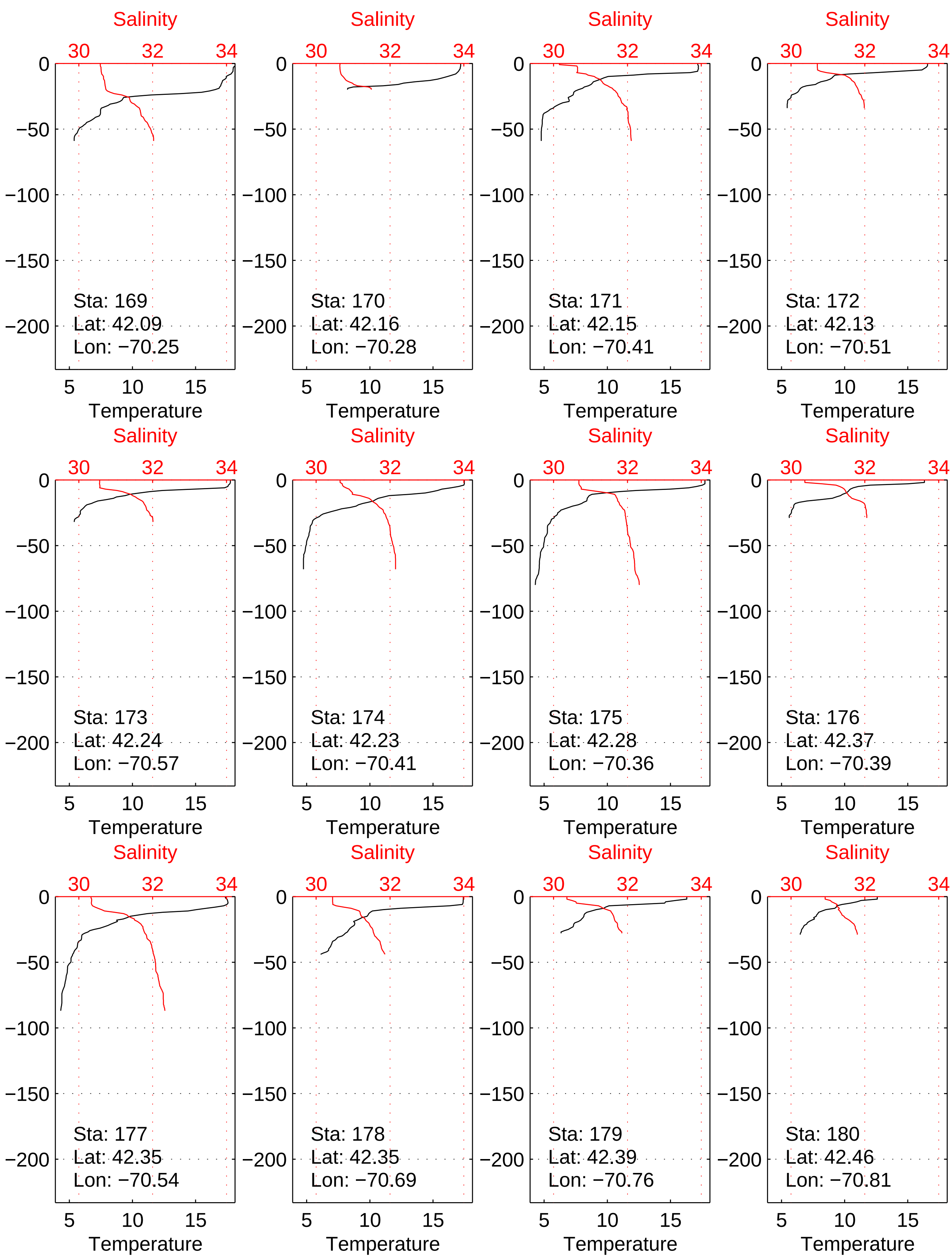
Alliance Data: 18−19 June 2001



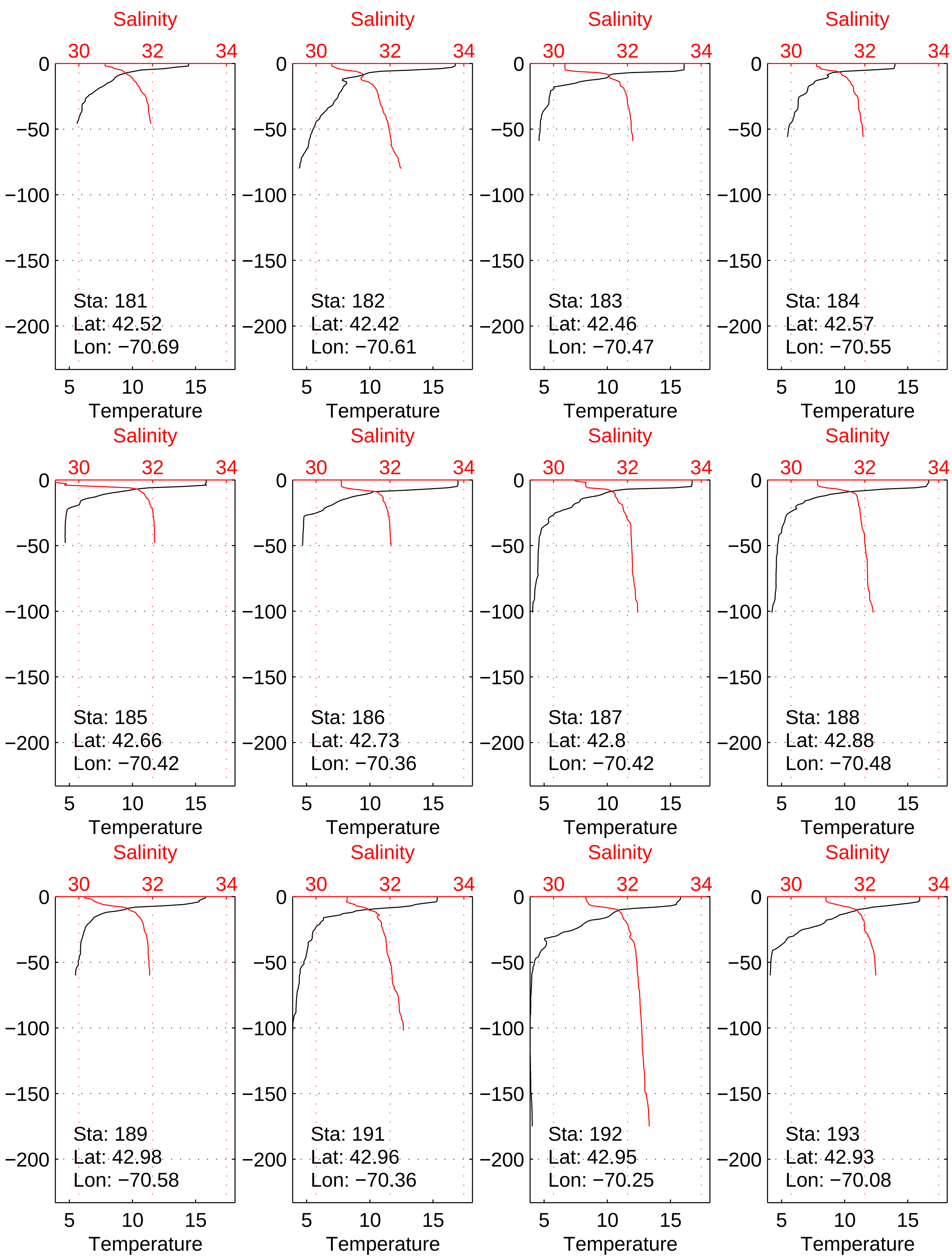
Alliance Data: 20−21 June 2001



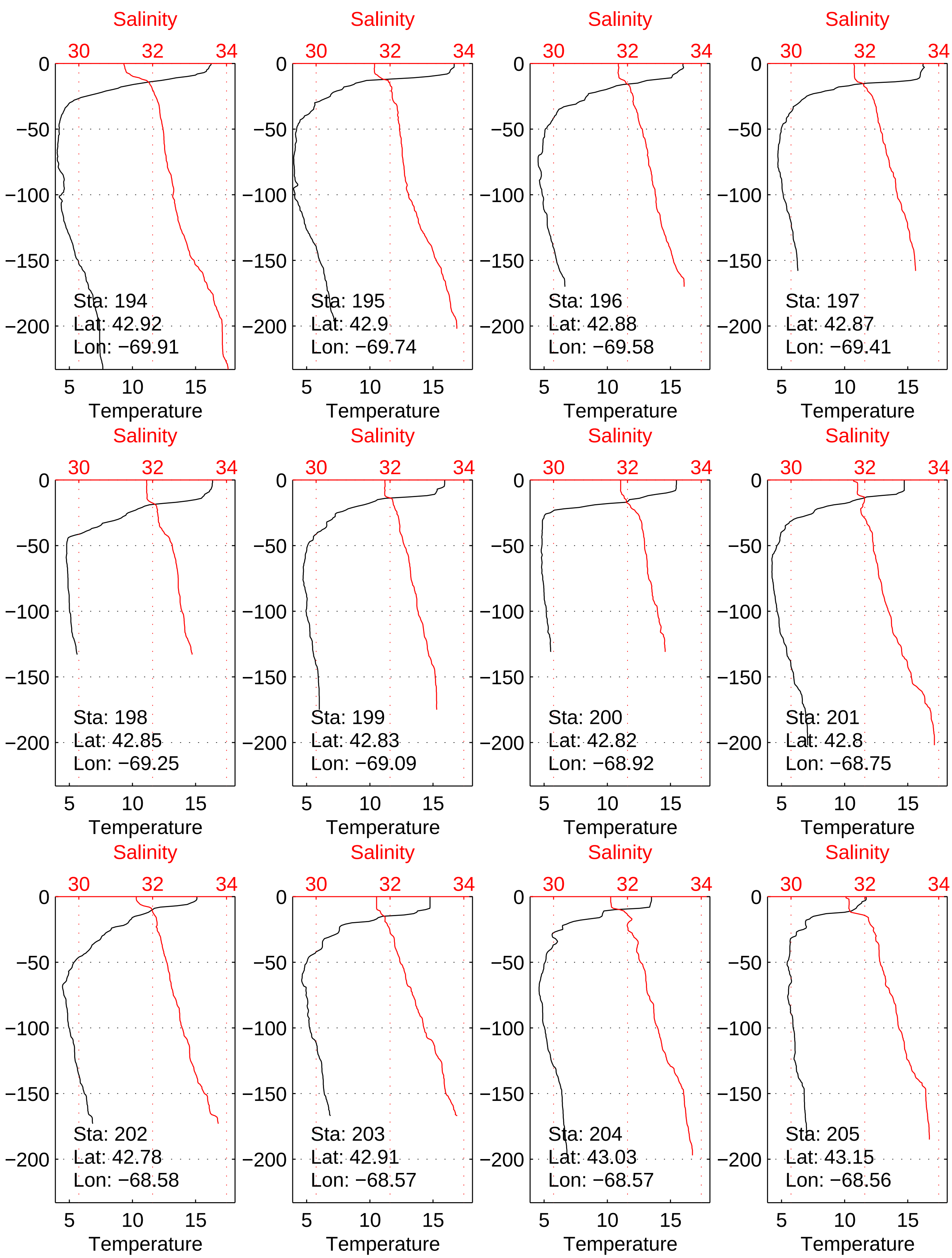
Alliance Data: 20−21 June 2001



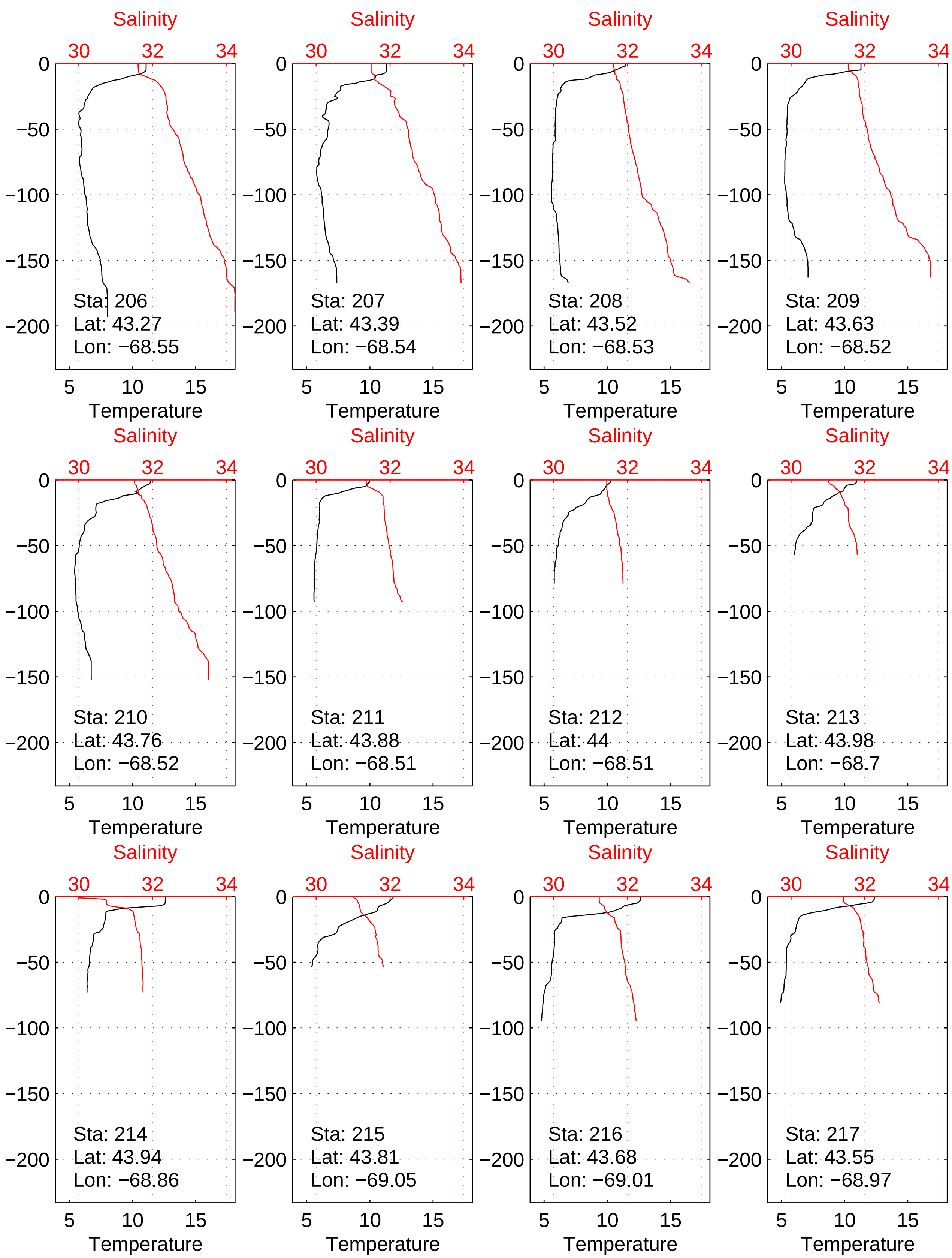
Alliance Data: 20−21 June 2001



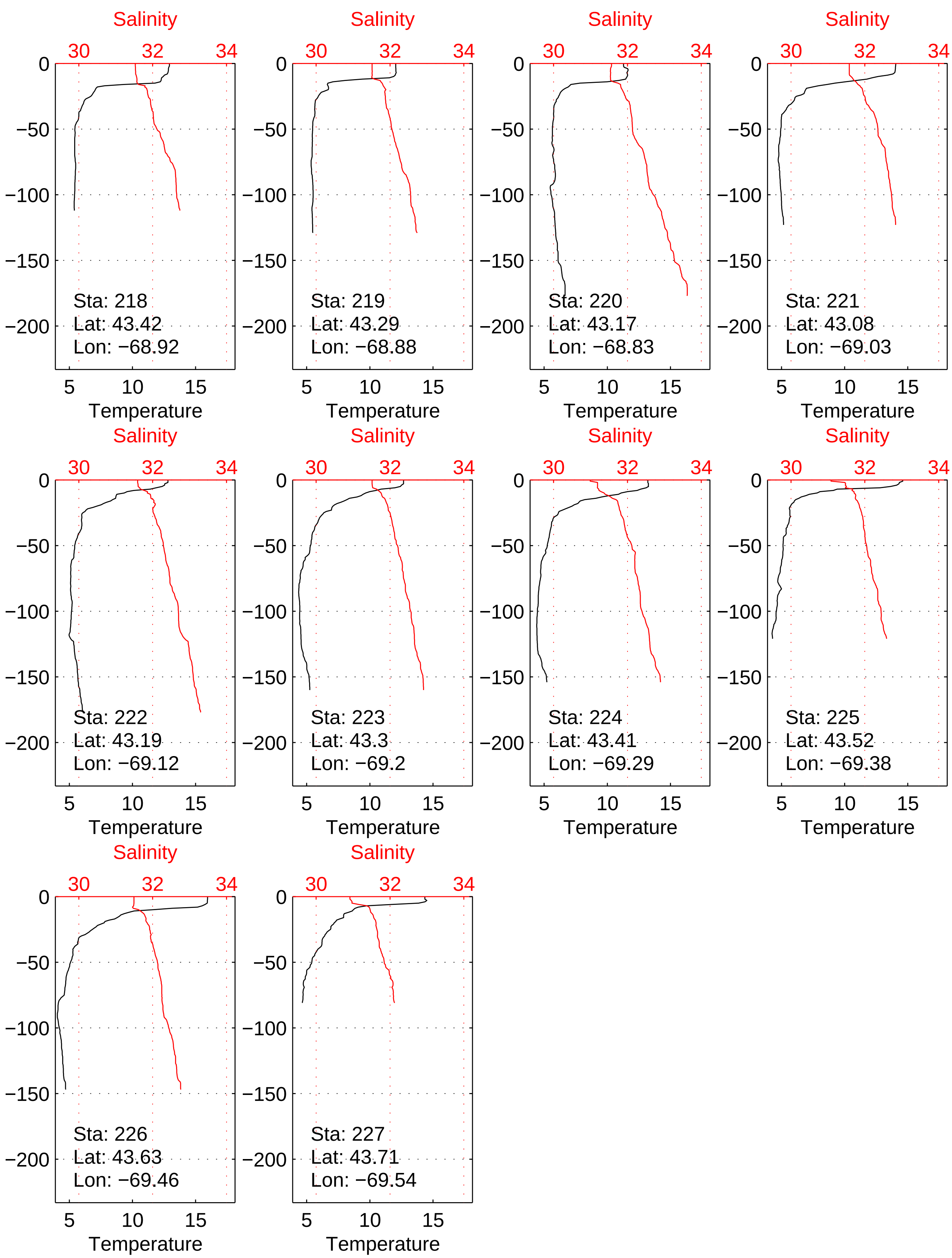
Alliance Data: 20−21 June 2001



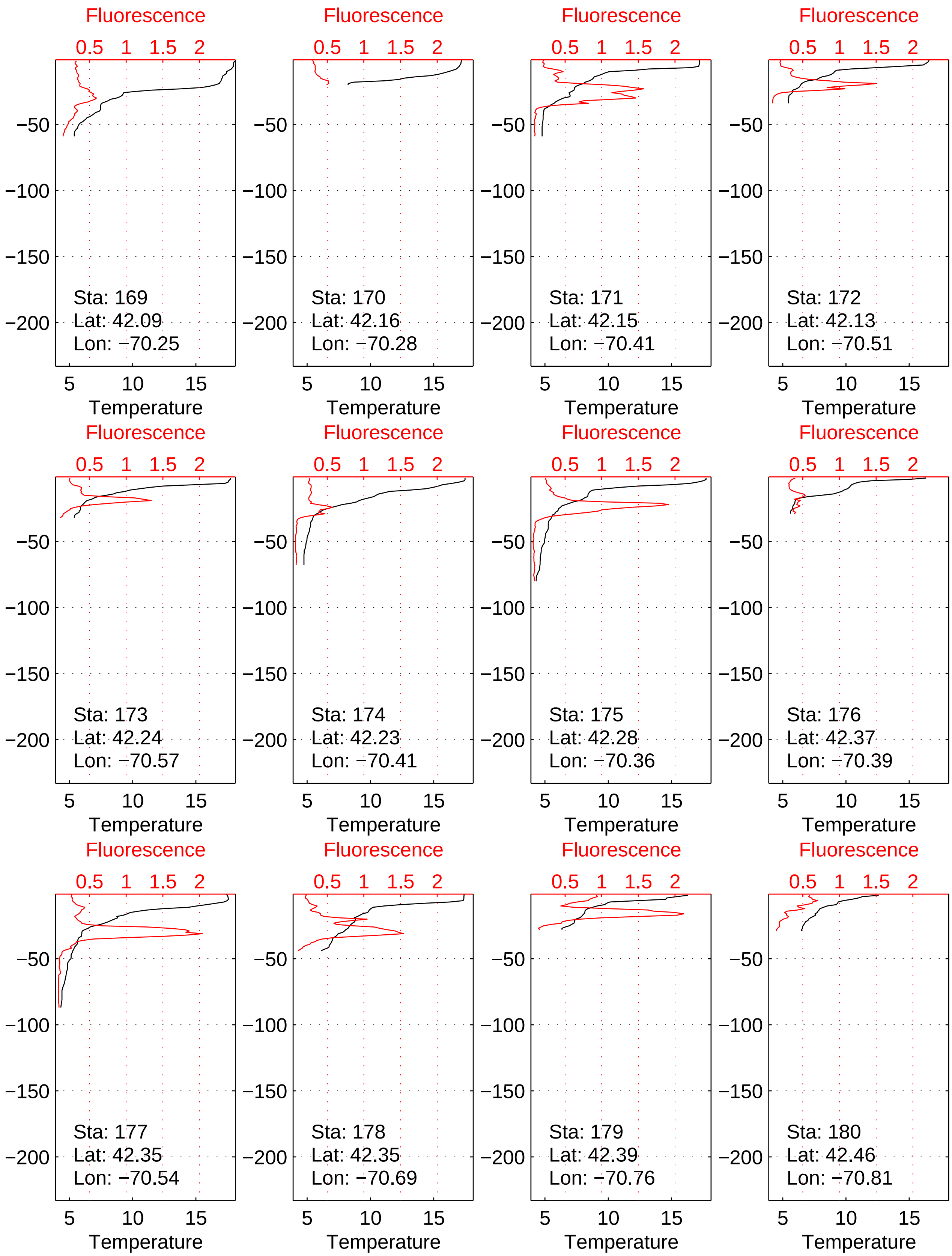
Alliance Data: 20−21 June 2001



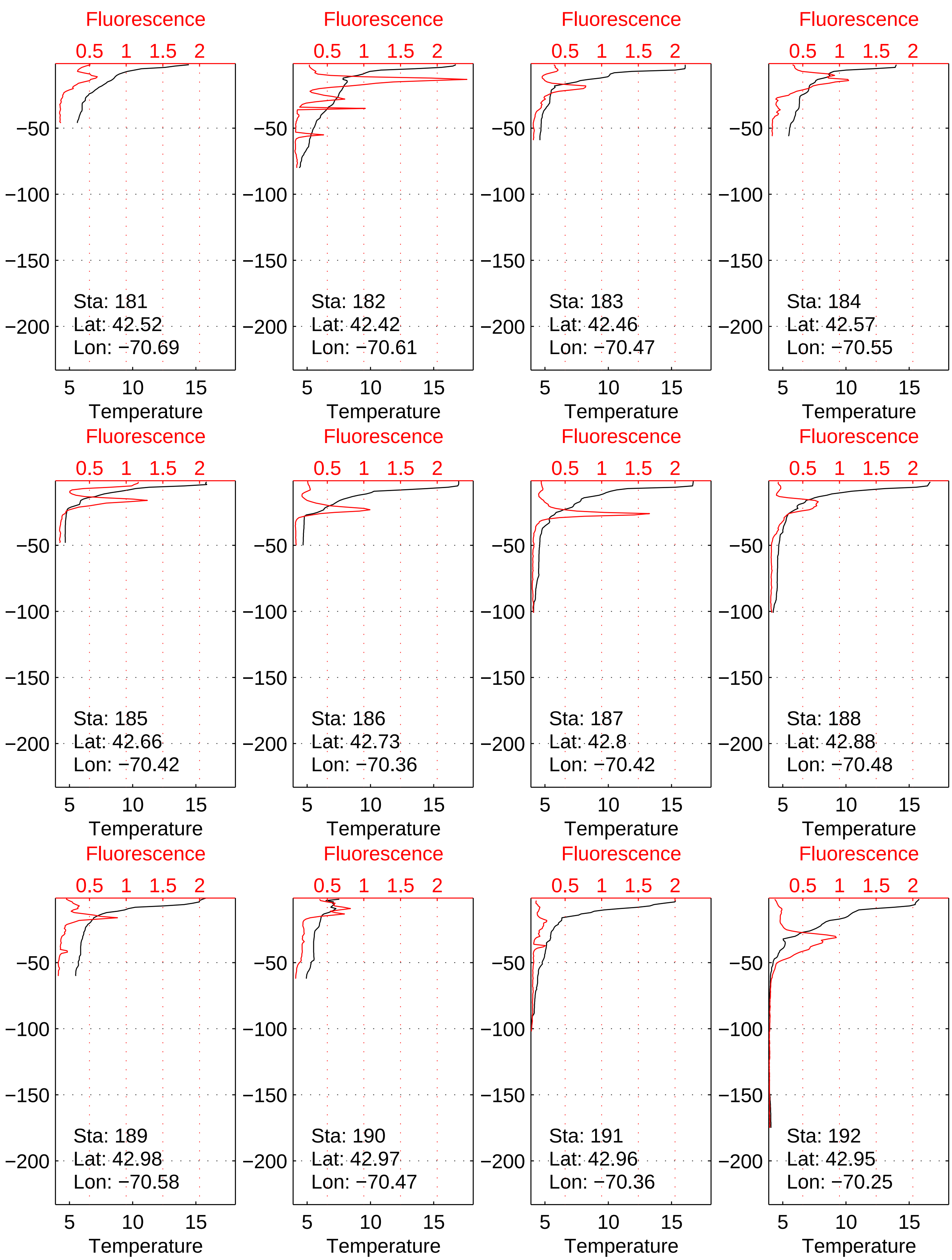
Alliance Data: 20−21 June 2001



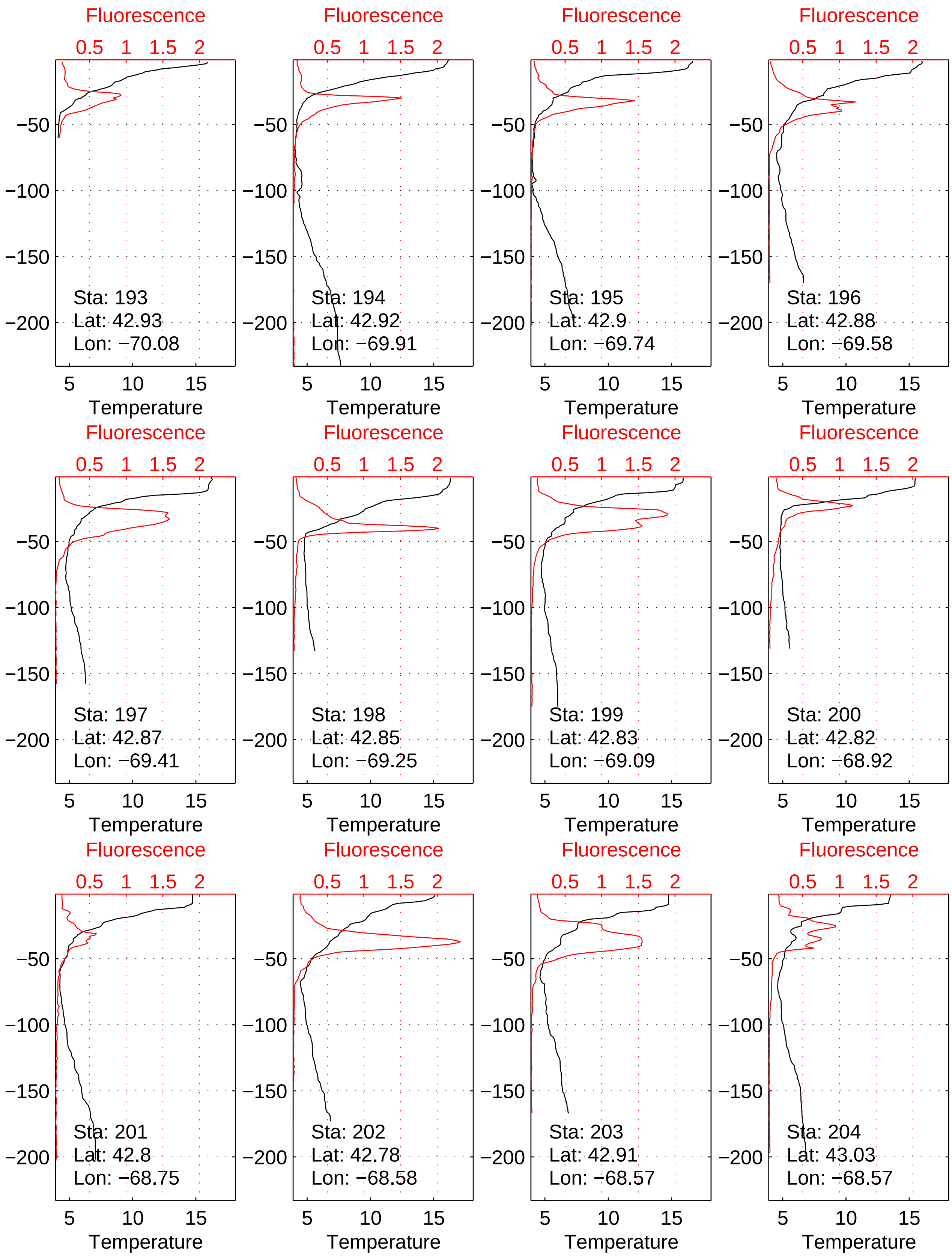
Alliance Data: 20−21 June 2001



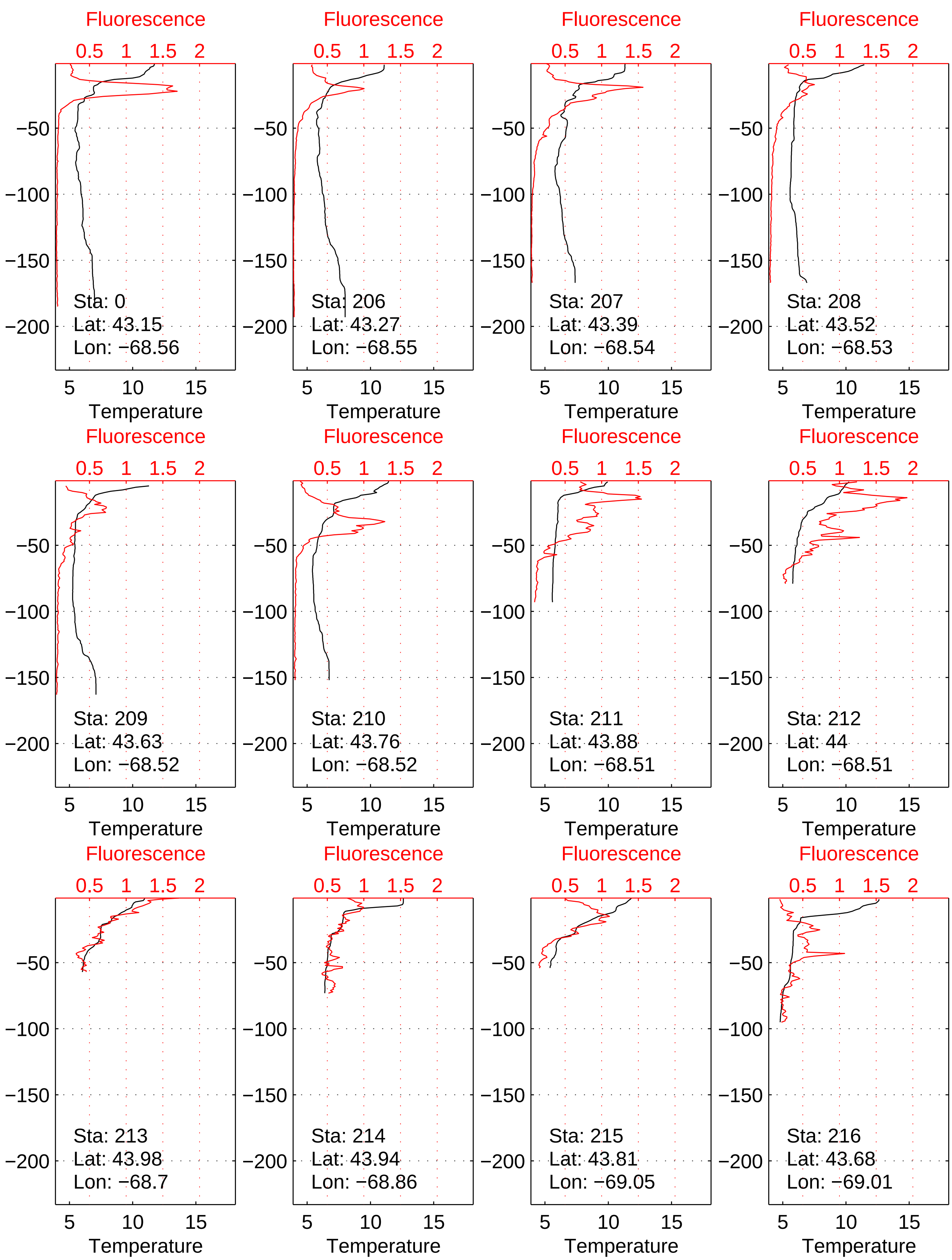
Alliance Data: 20−21 June 2001



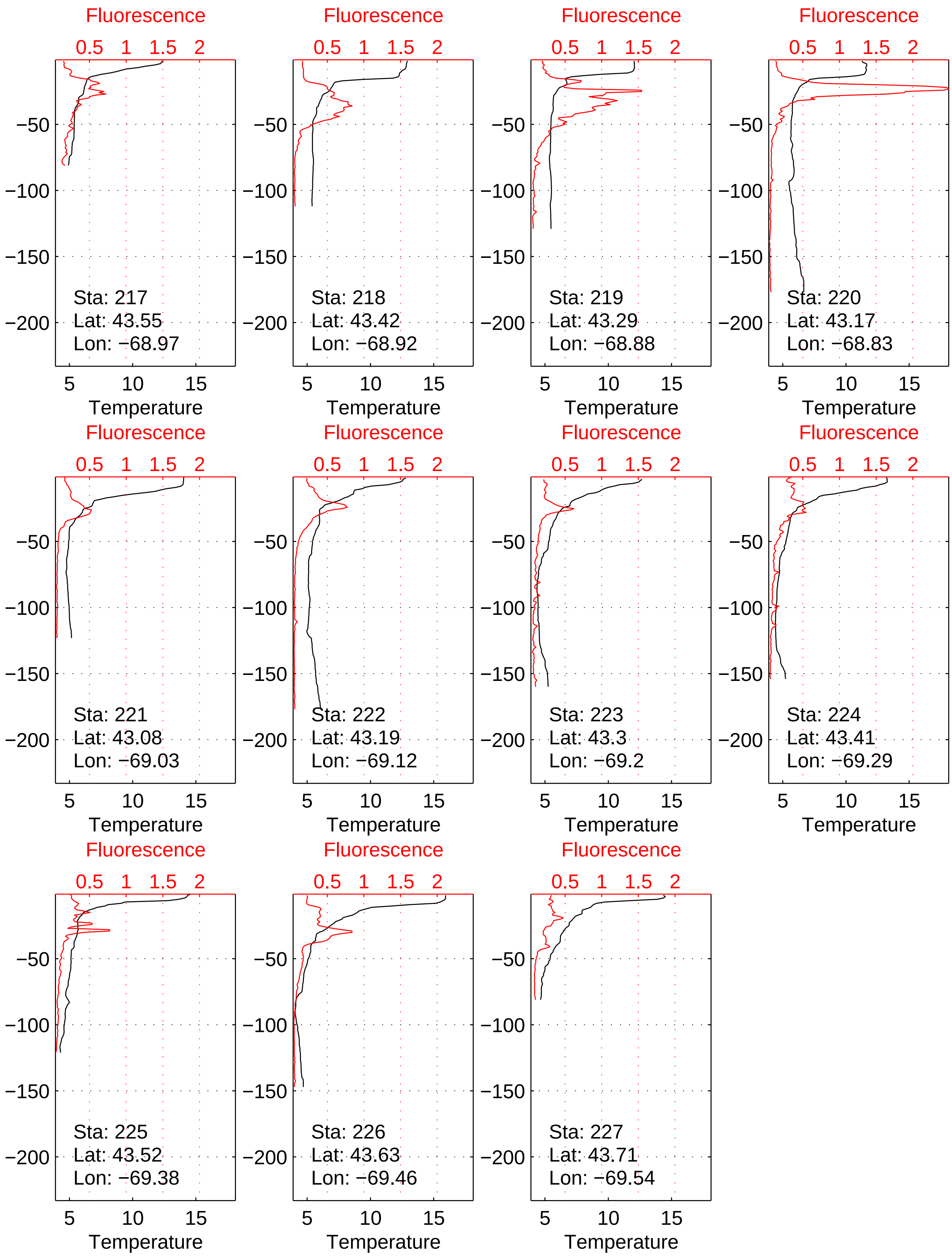
Alliance Data: 20−21 June 2001

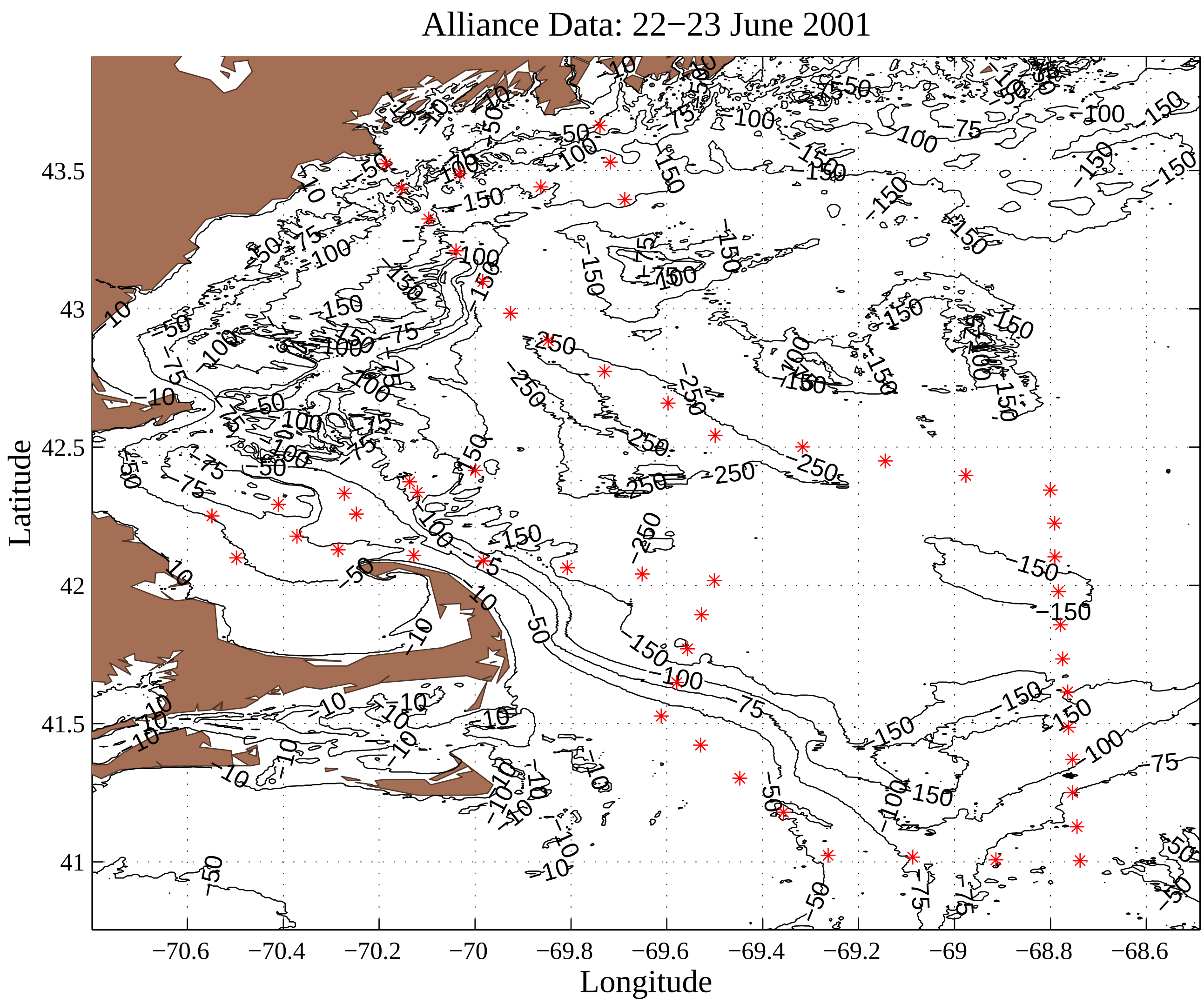


Alliance Data: 20−21 June 2001



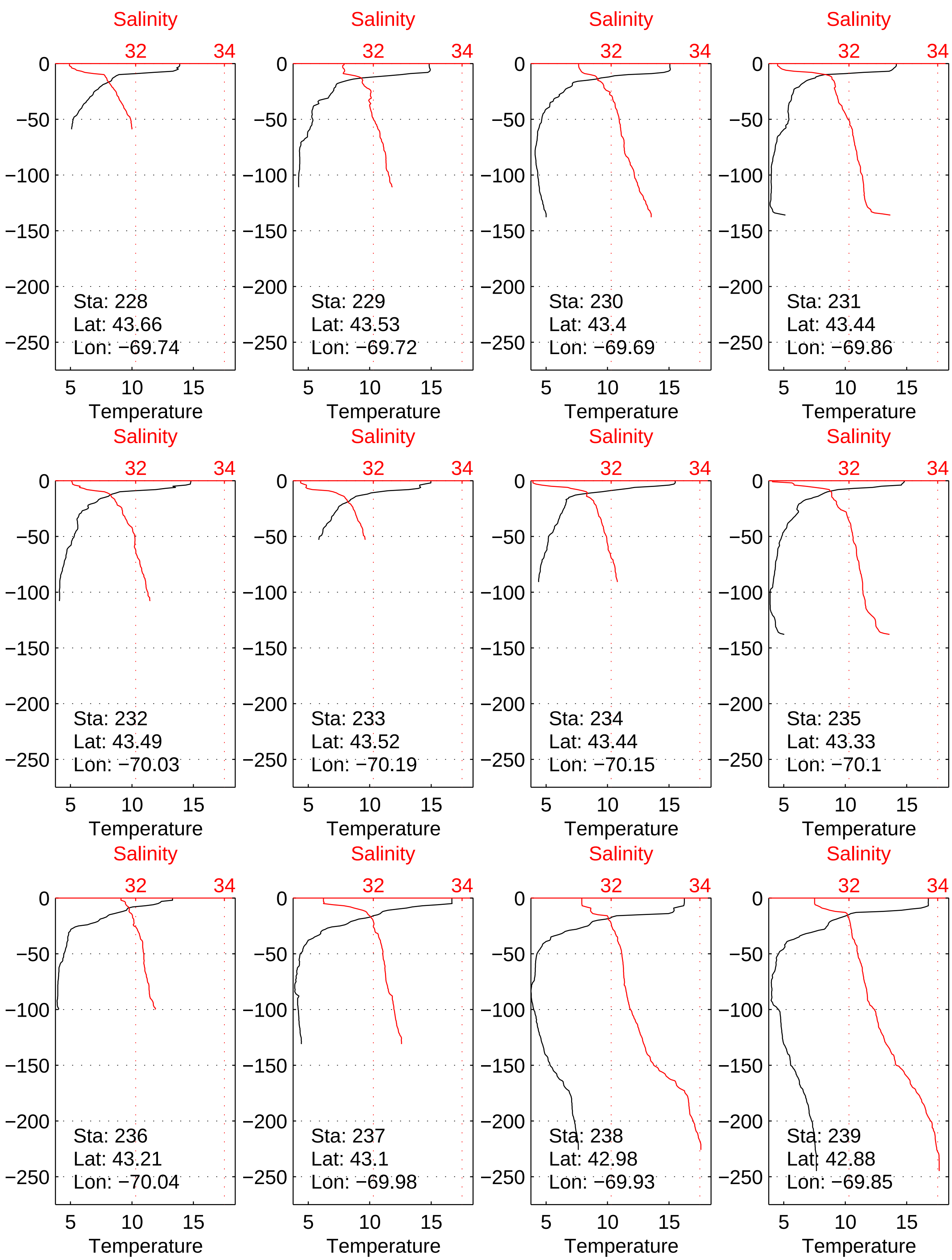
Alliance Data: 20−21 June 2001



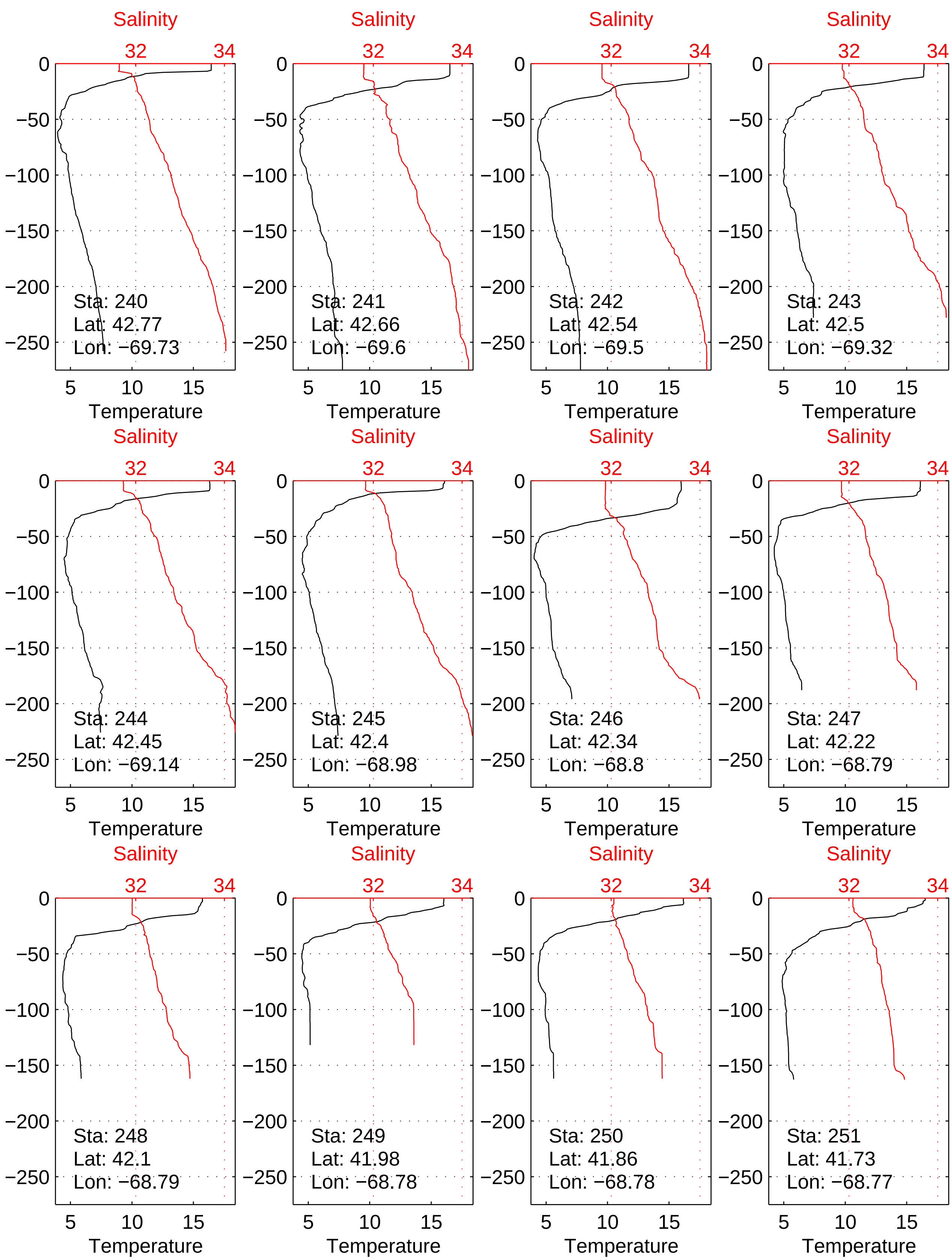


Alliance Data: 22−23 June 2001
Latitude
Longitude
43.5
43
42.5
42
41.5
41
−70.6
−70.4
−70.2
−70
−69.8
−69.6
−69.4
−69.2
−69
−68.8
−68.6

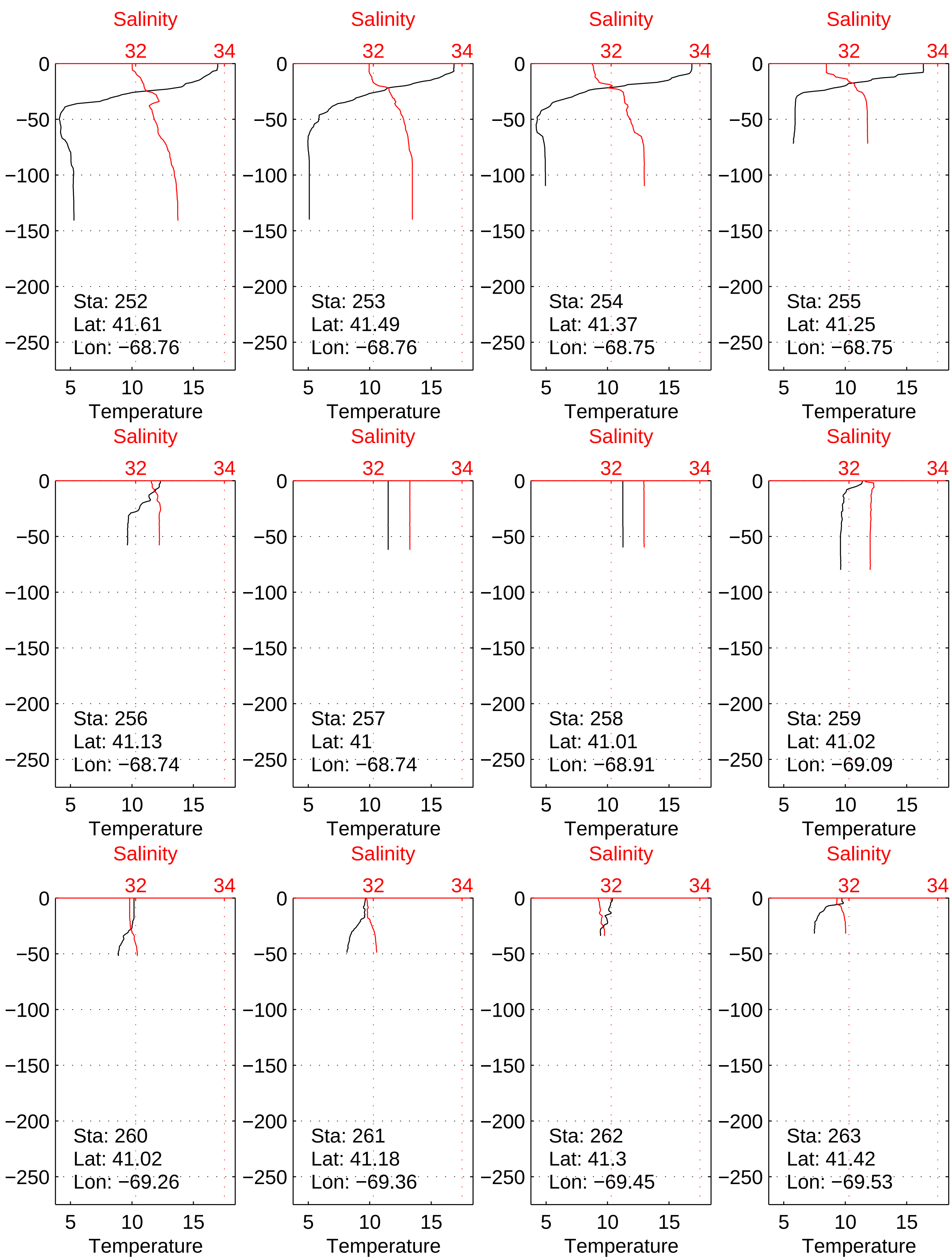
Alliance Data: 22−23 June 2001



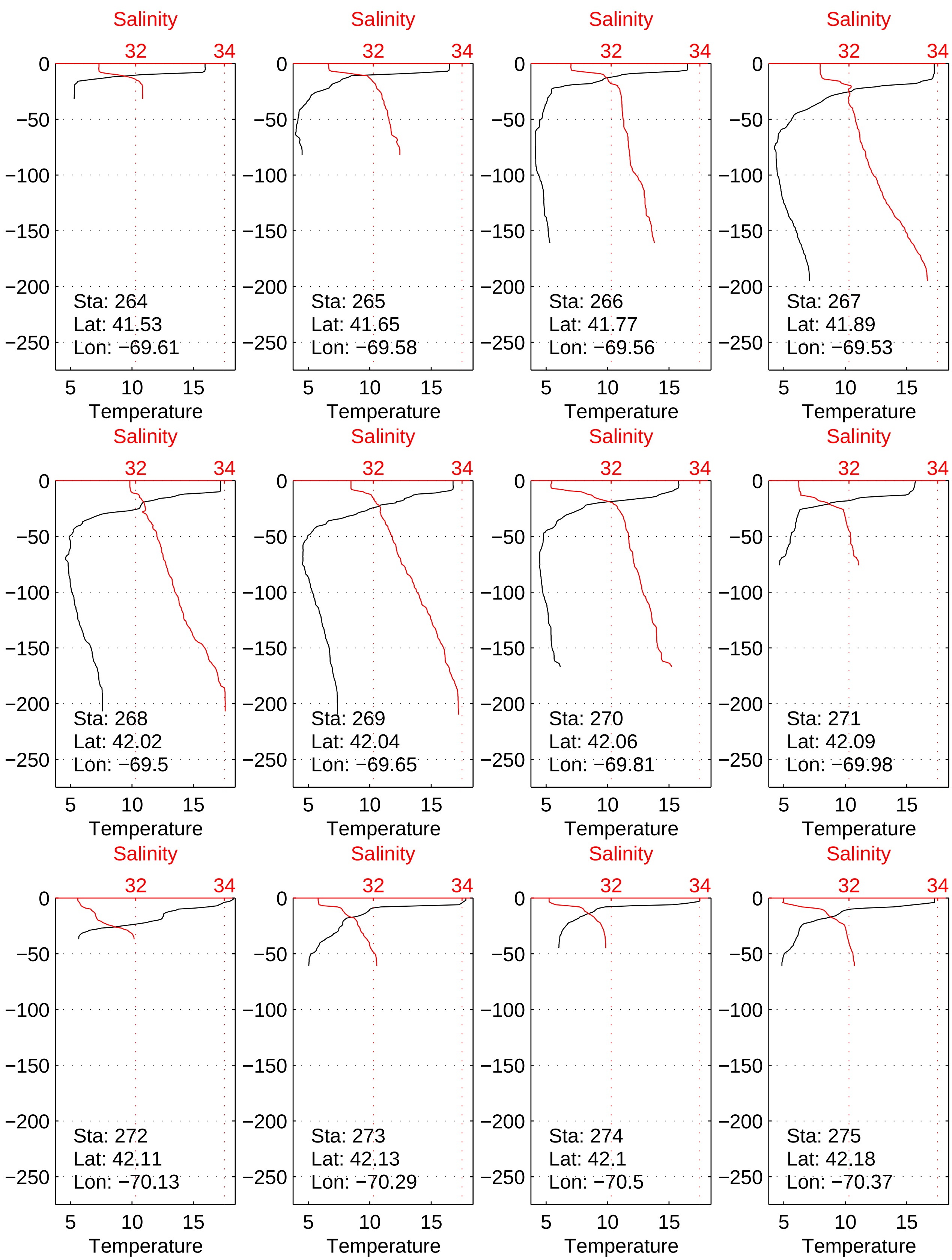
Alliance Data: 22−23 June 2001



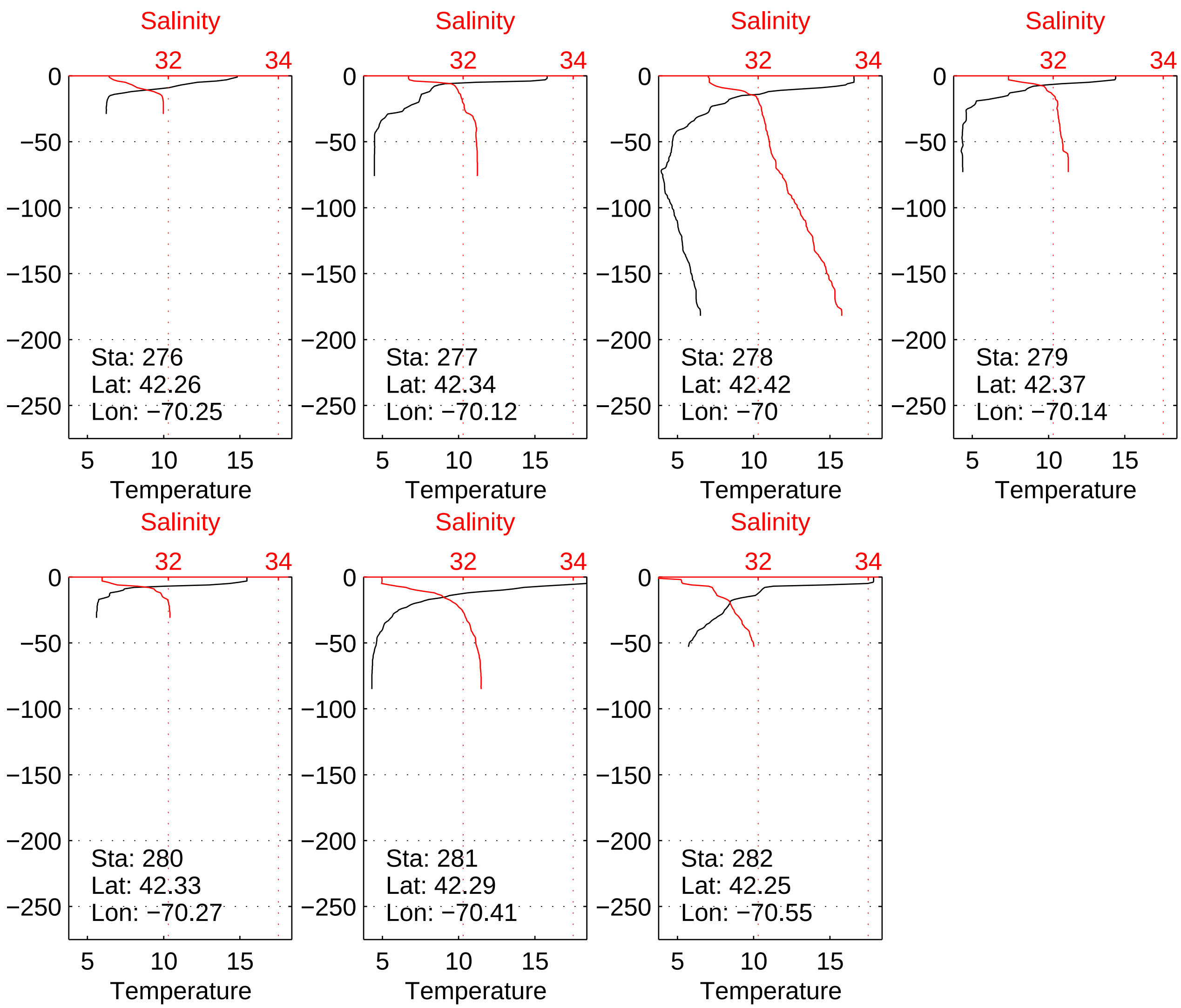
Alliance Data: 22−23 June 2001



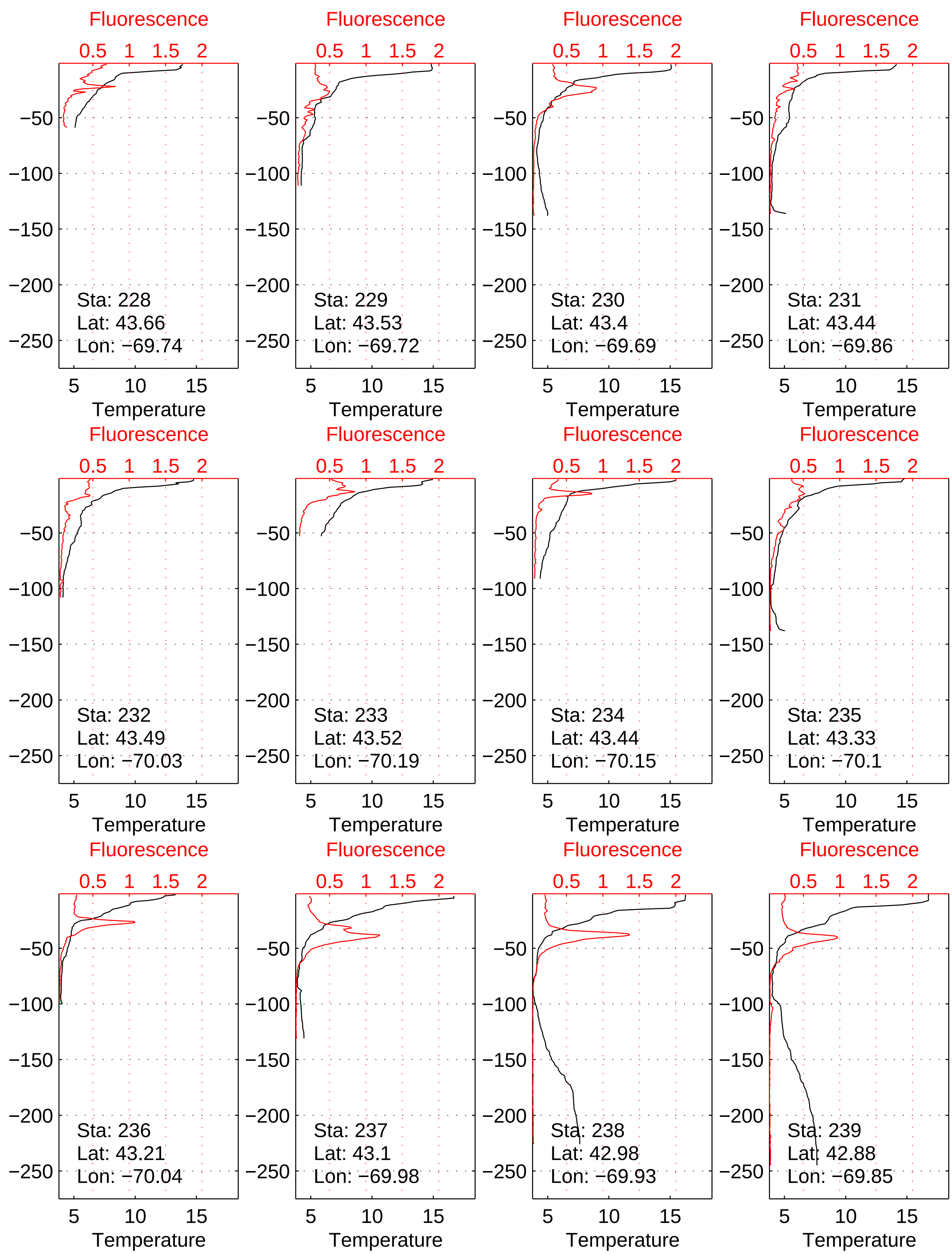
Alliance Data: 22−23 June 2001



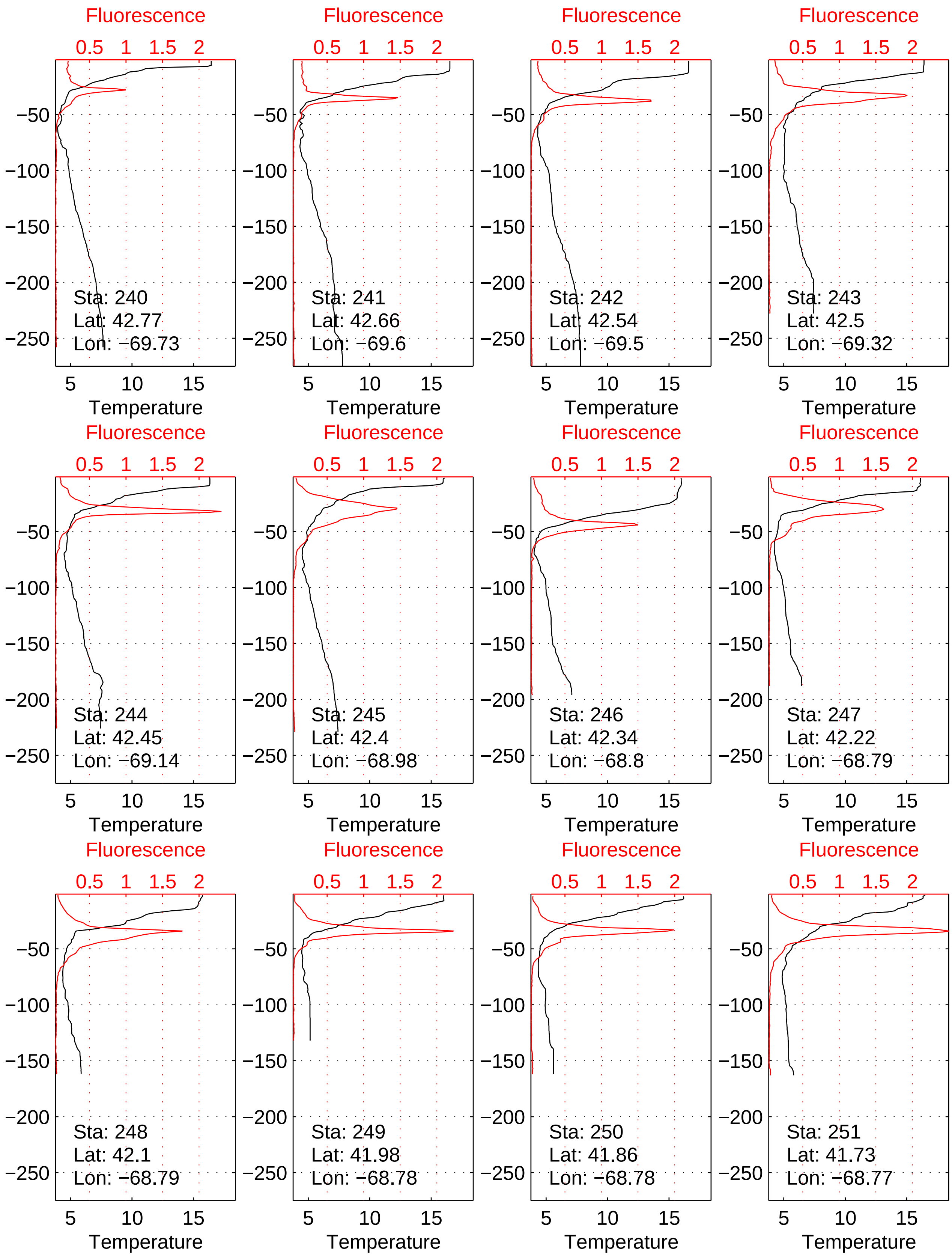
Alliance Data: 22−23 June 2001



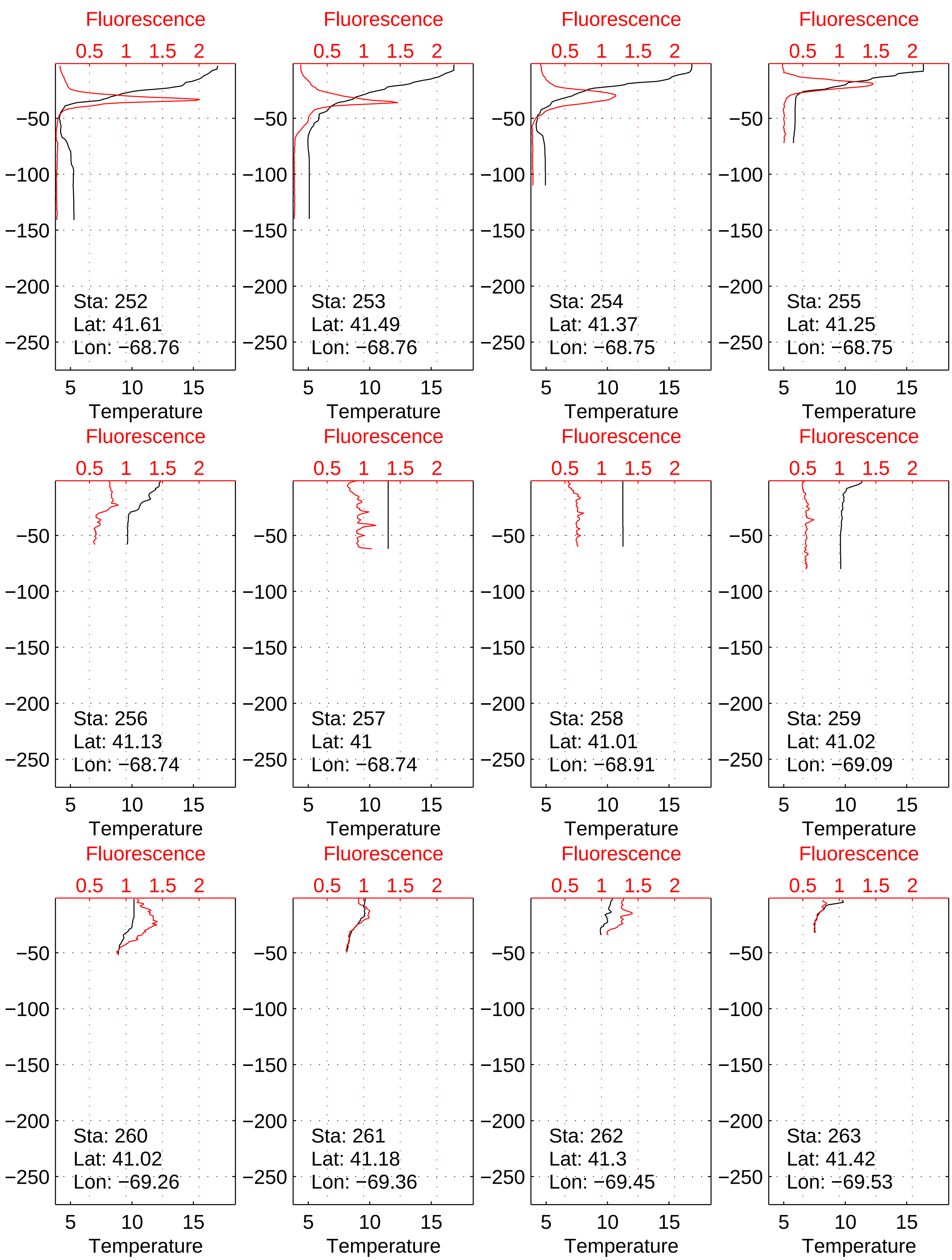
Alliance Data: 22−23 June 2001



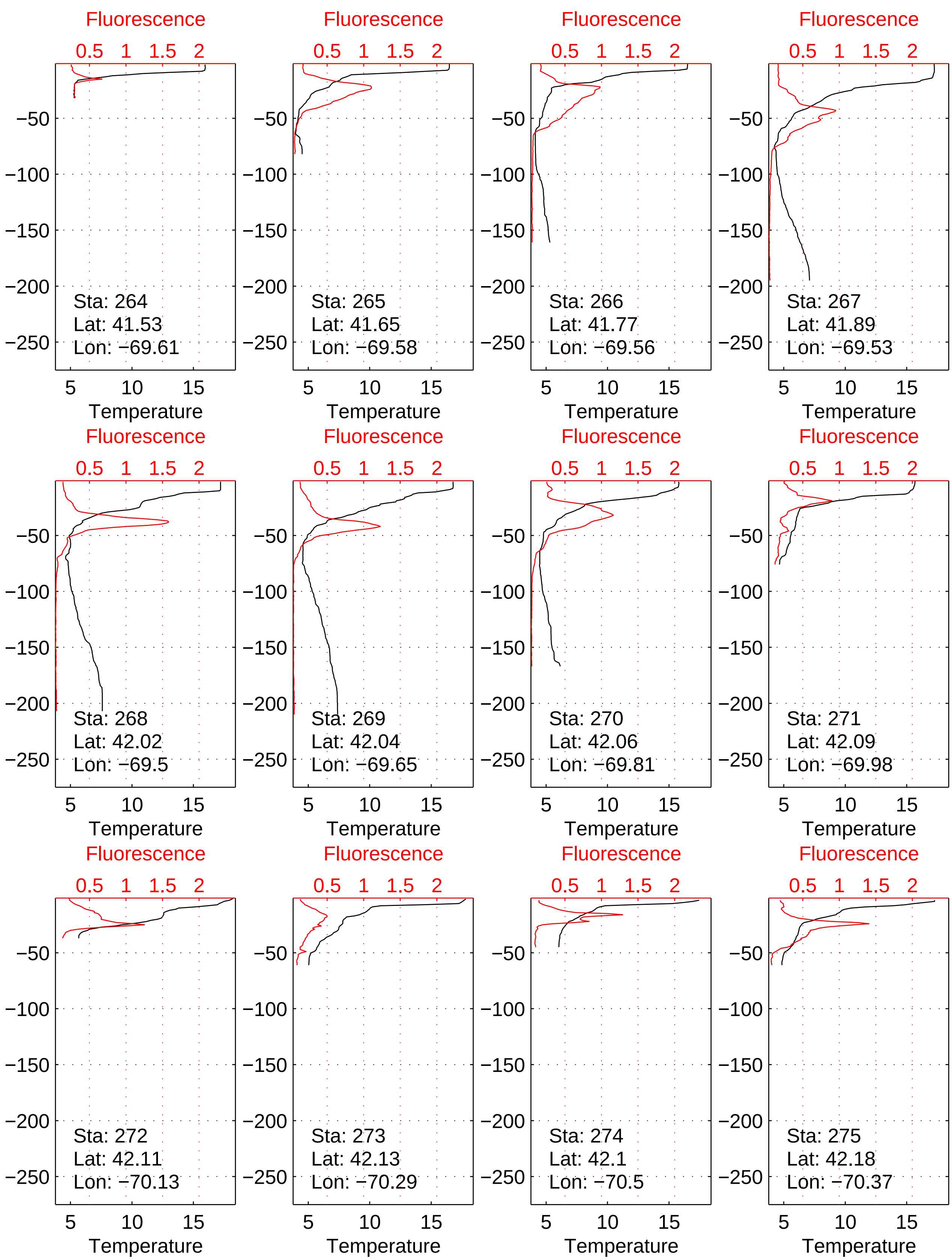
Alliance Data: 22−23 June 2001



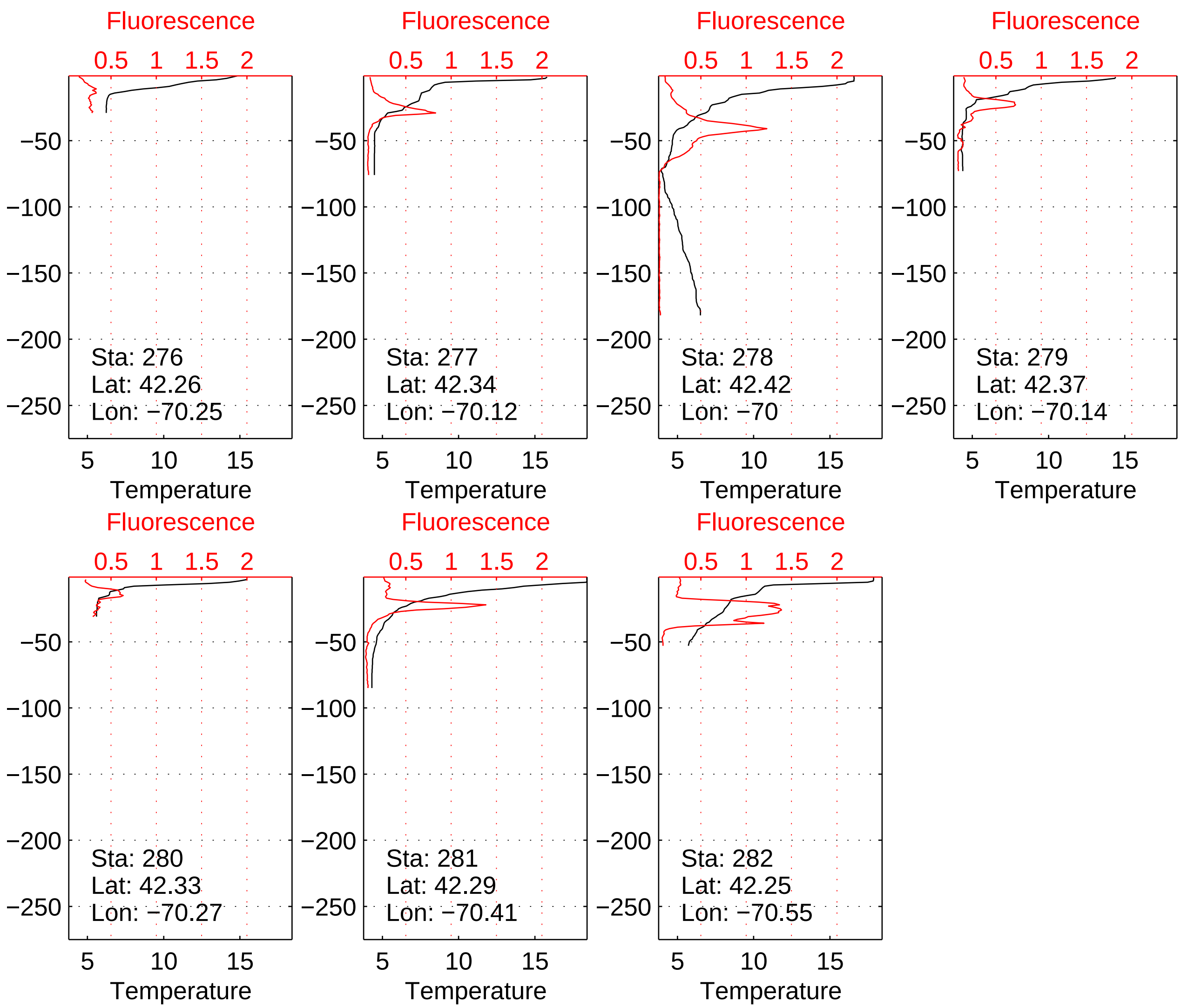
Alliance Data: 22−23 June 2001

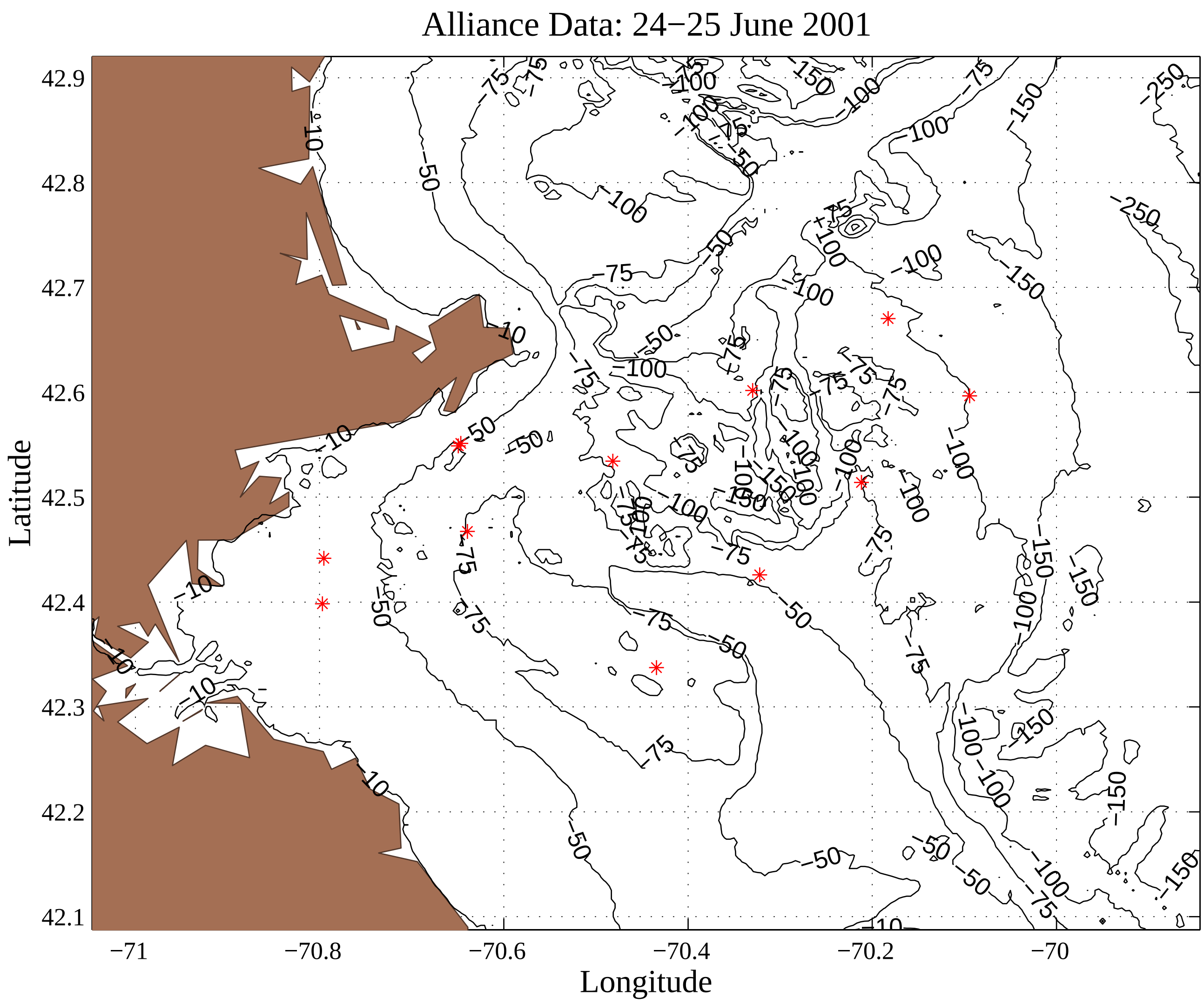


Alliance Data: 22−23 June 2001

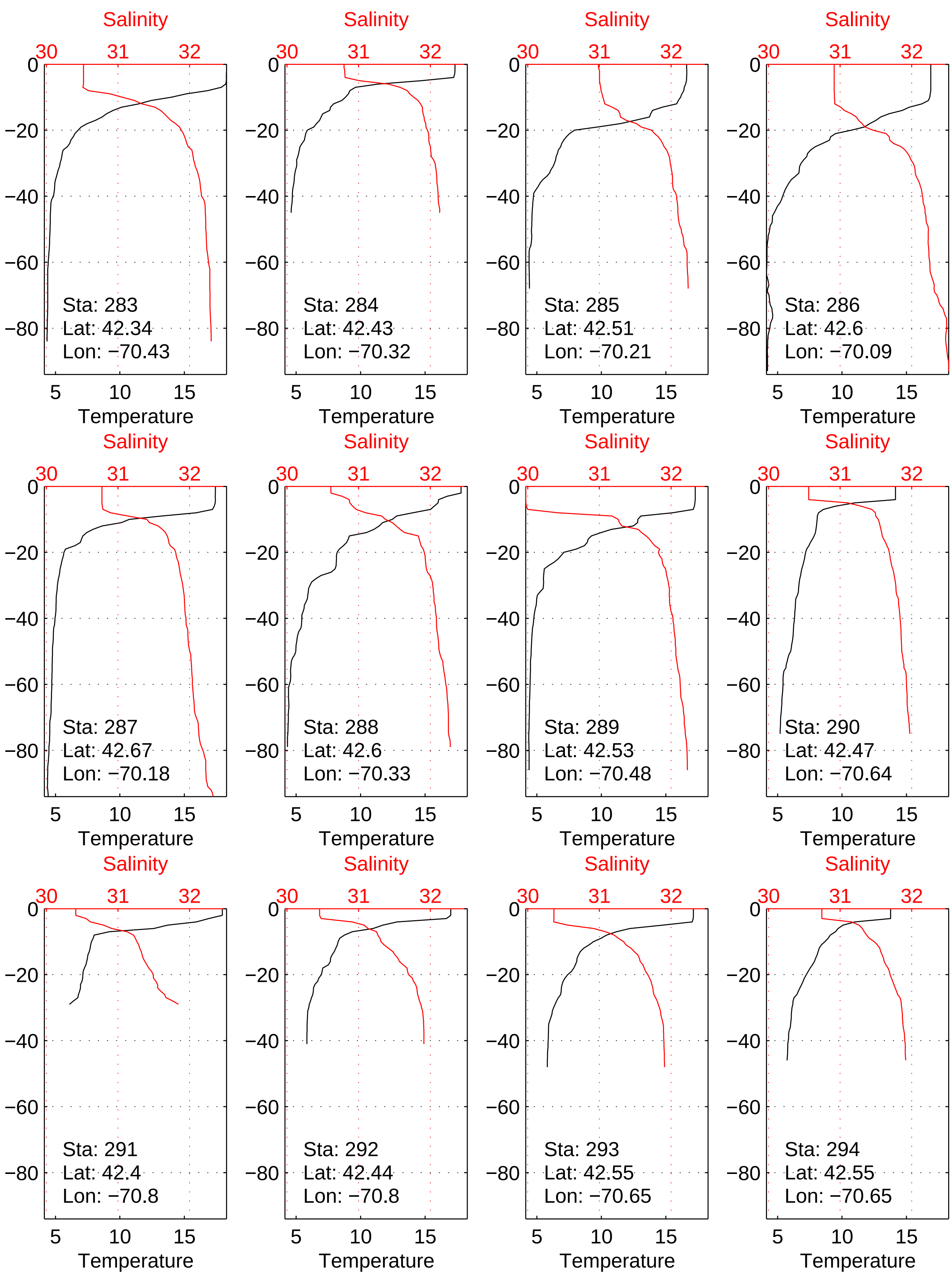


Alliance Data: 22−23 June 2001

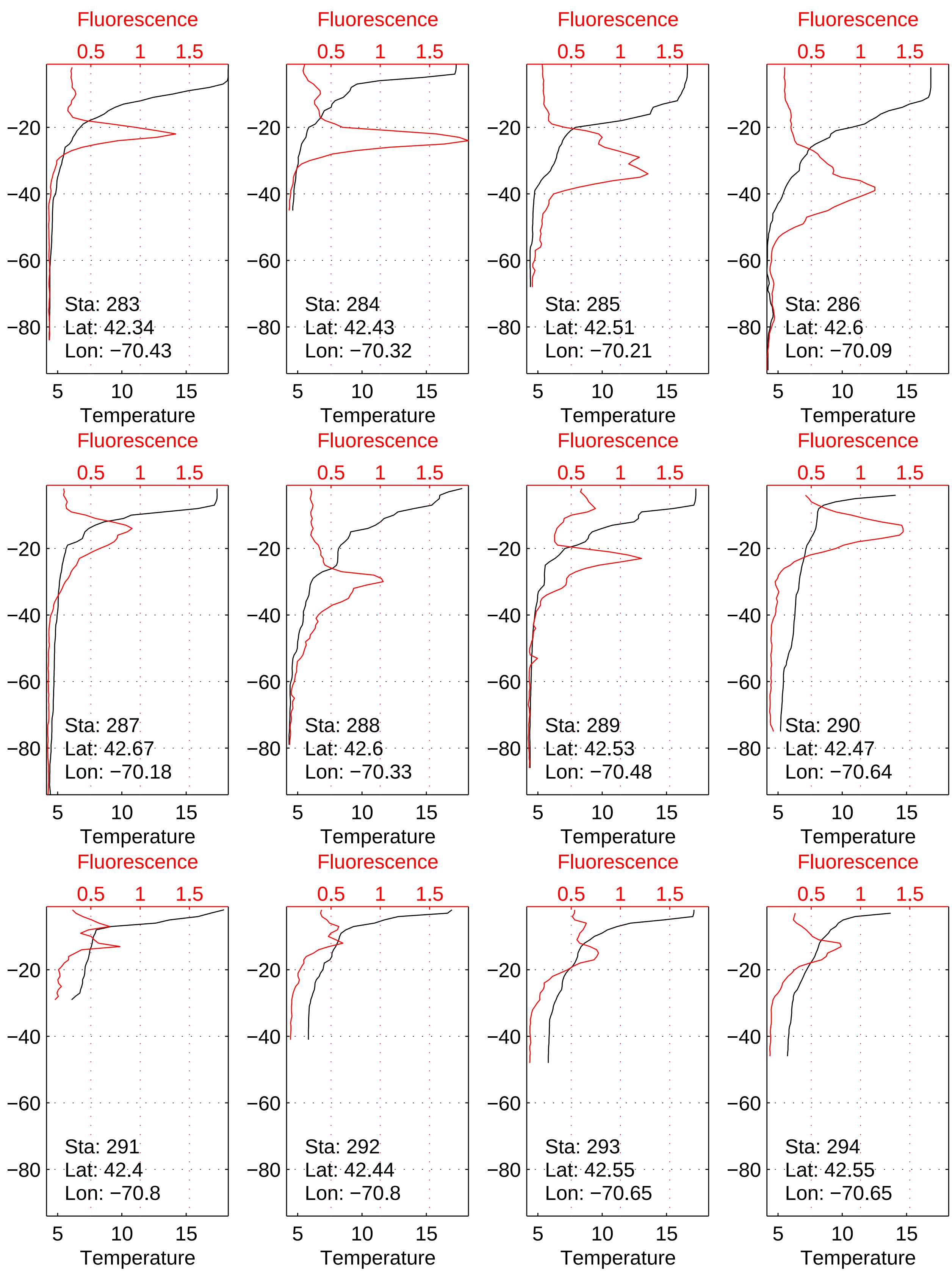



Alliance Data: 24−25 June 2001
Latitude
Longitude
42.9
42.8
42.7
42.6
42.5
42.4
42.3
42.2
42.1
−71
−70.8
−70.6
−70.4
−70.2
−70

Alliance Data: 24−25 June 2001



Alliance Data: 24−25 June 2001



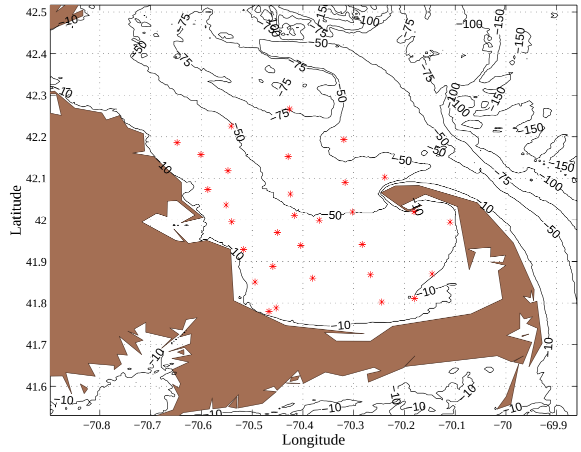
RV Lucky Lady

The RV Lucky Lady performed 116 CTD stations over the period 6-25 June 2001 in Massachusetts Bay. The stations were carried out with a Seabird SBE 911 system and processed with Seasoft. Data were averaged over 1m depth intervals.

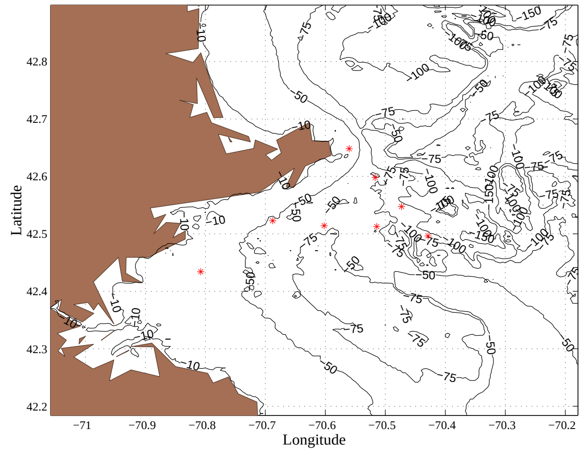
Station positions have been plotted first as the standard two-day composites and then as the individual cruise tracks. Vertical profiles of temperature, salinity, and fluorescence are included for each station. Axes are uniform among the plots included in each two-day grouping but not from one grouping to the next.

The fluorescence data from the individual vessels can not be compared directly. Calibration of this data is ongoing. Of most interest at this time is the profile structure, rather than the specific numbers.

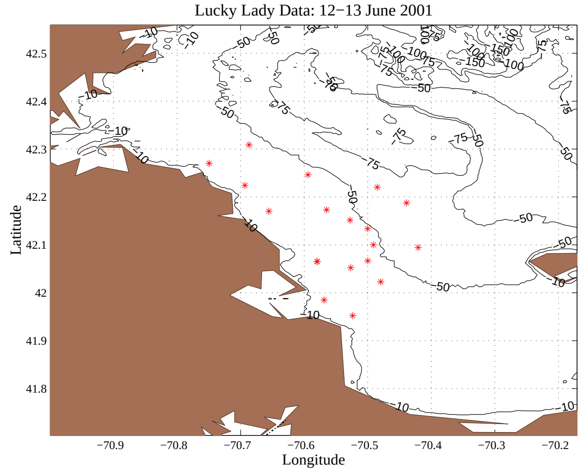
Lucky Lady Data: 6−7 June 2001



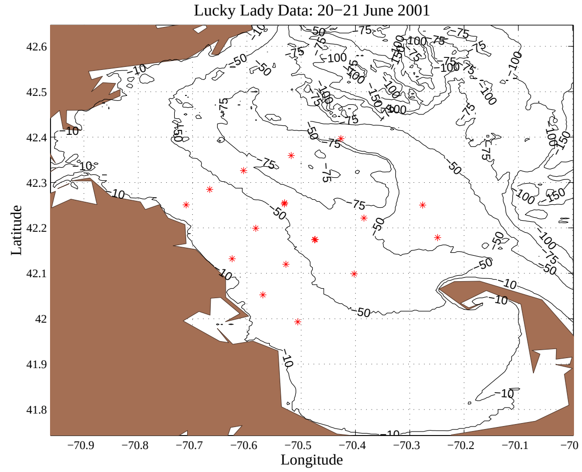
Lucky Lady Data: 10−11 June 2001



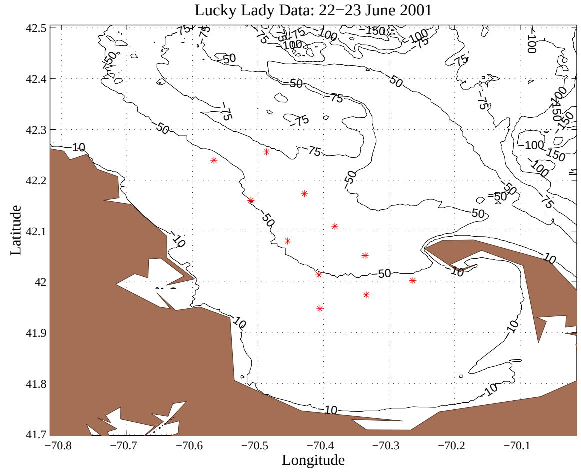
Lucky Lady Data: 12−13 June 2001



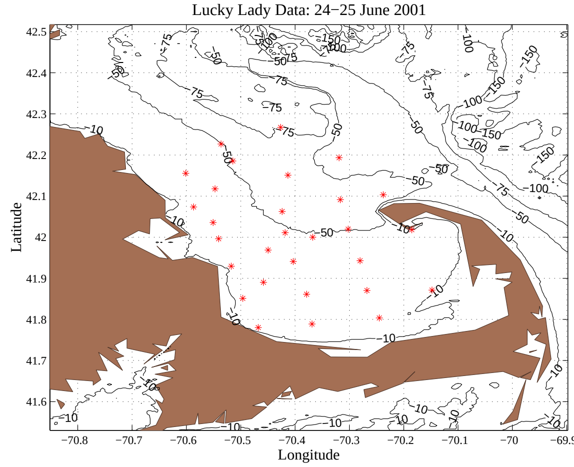
Lucky Lady Data: 20−21 June 2001

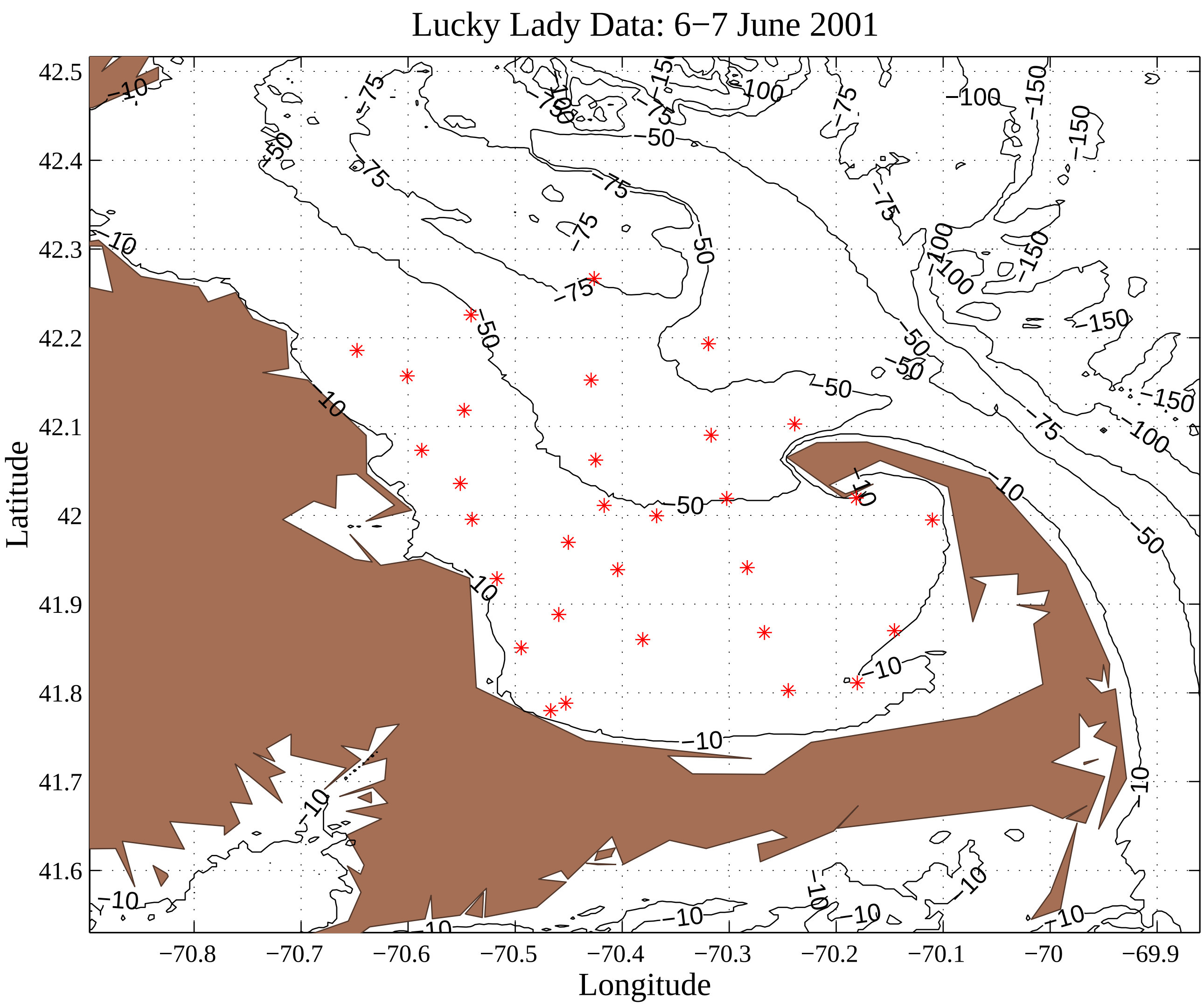


Lucky Lady Data: 22−23 June 2001



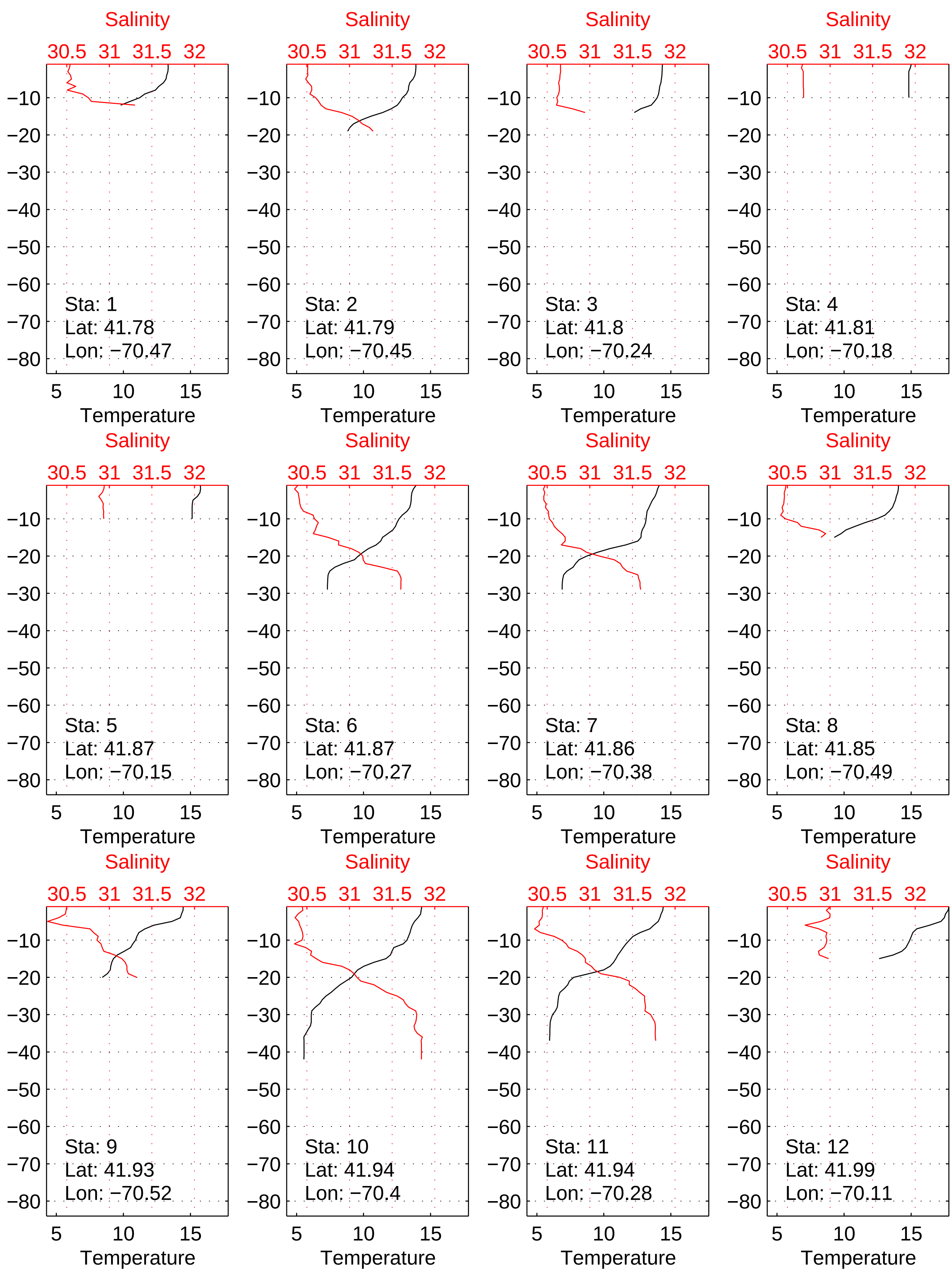
Lucky Lady Data: 24−25 June 2001



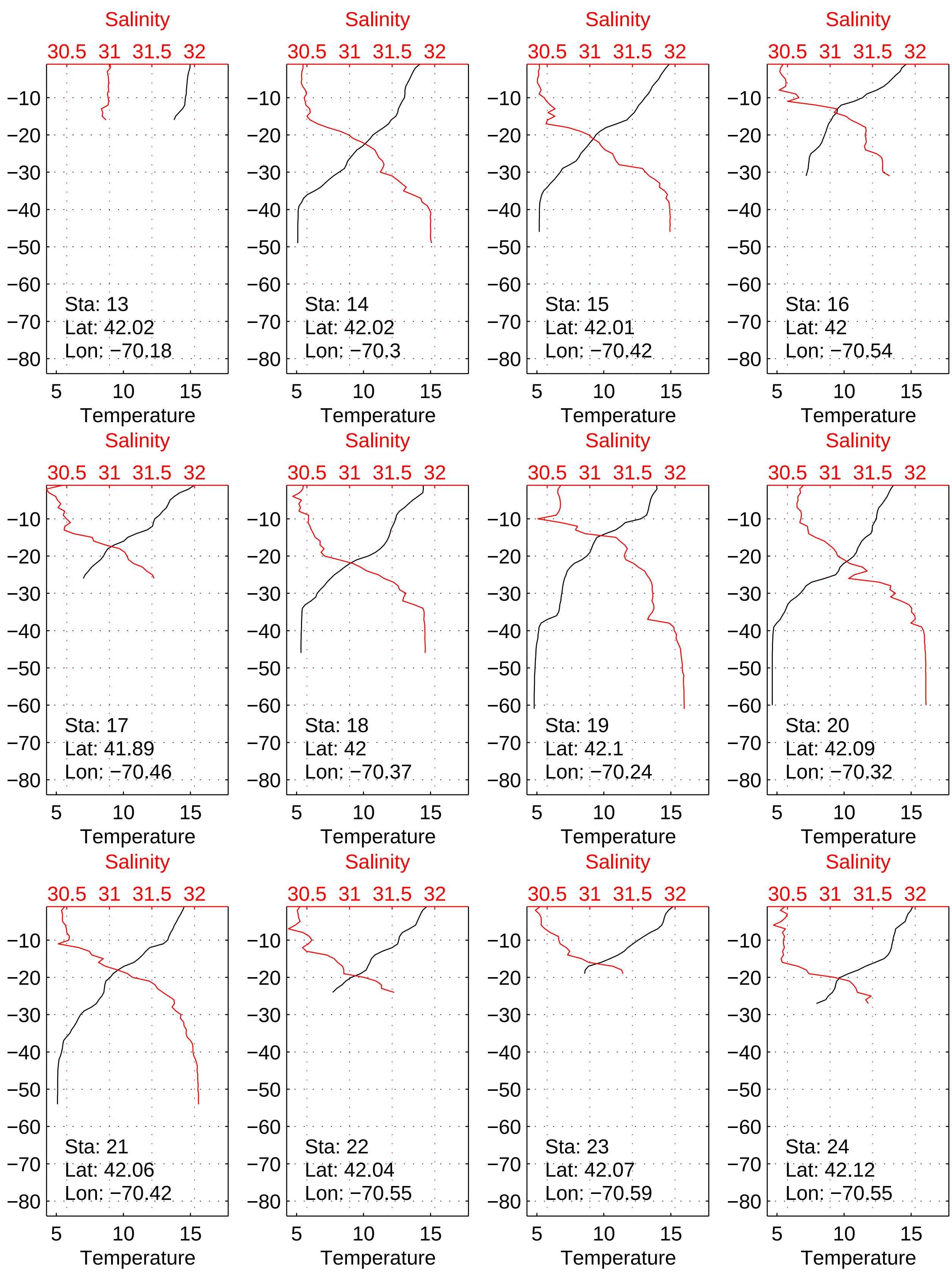


Lucky Lady Data: 6−7 June 2001
Latitude
Longitude
42.5
42.4
42.3
42.2
42.1
42
41.9
41.8
41.7
41.6
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2
−70.1
−70
−69.9

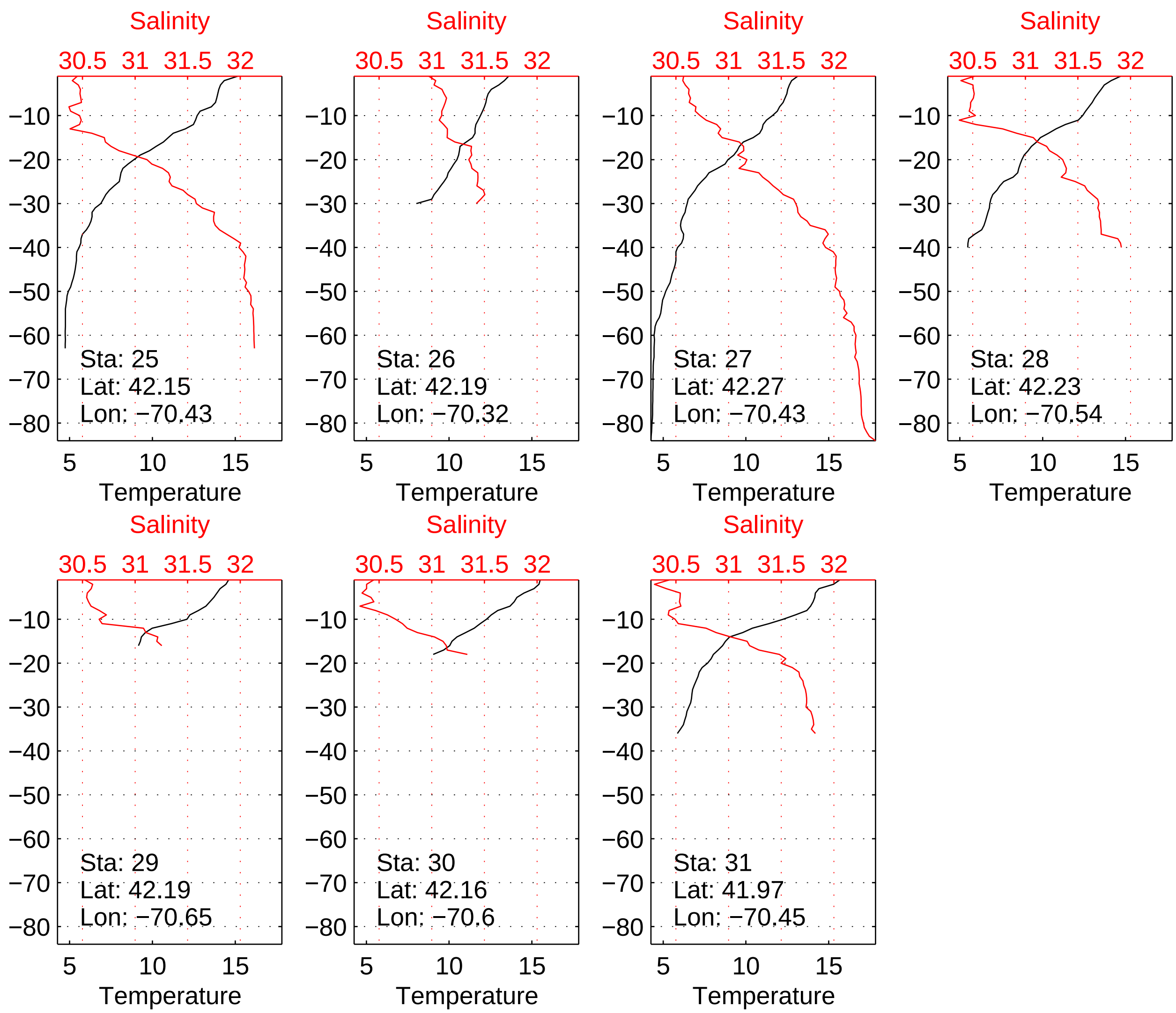
Lucky Lady Data: 6−7 June 2001



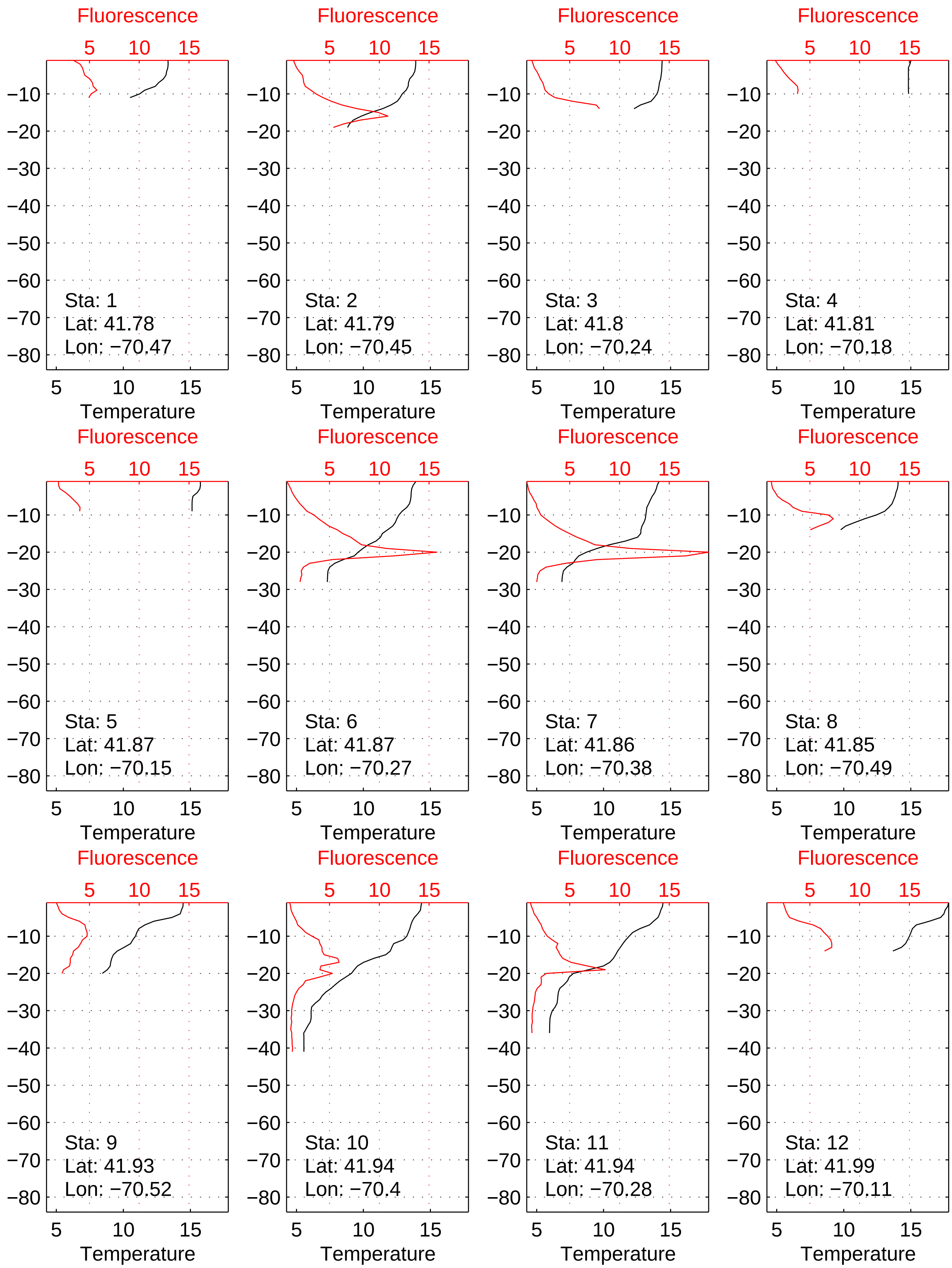
Lucky Lady Data: 6−7 June 2001



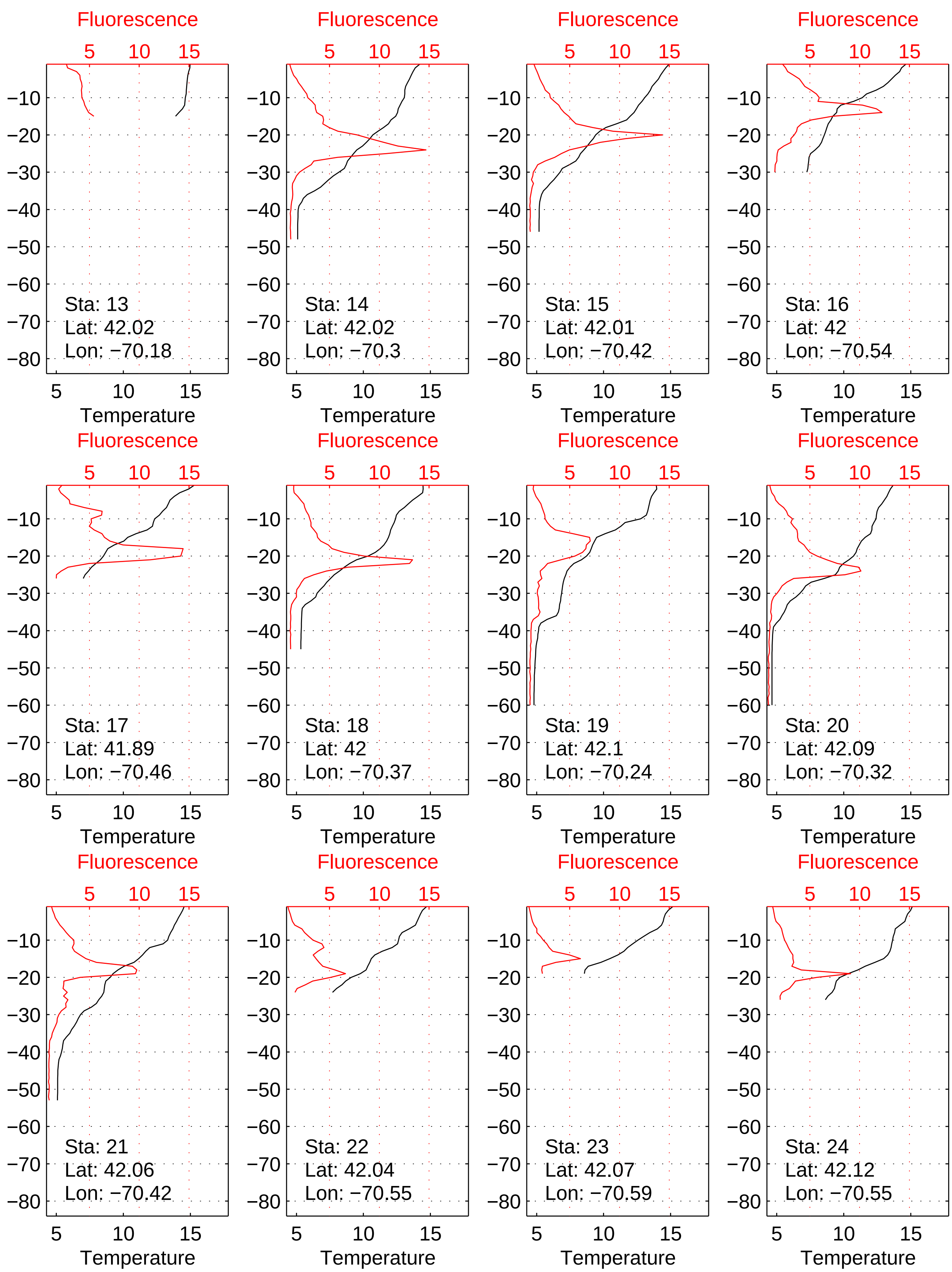
Lucky Lady Data: 6−7 June 2001



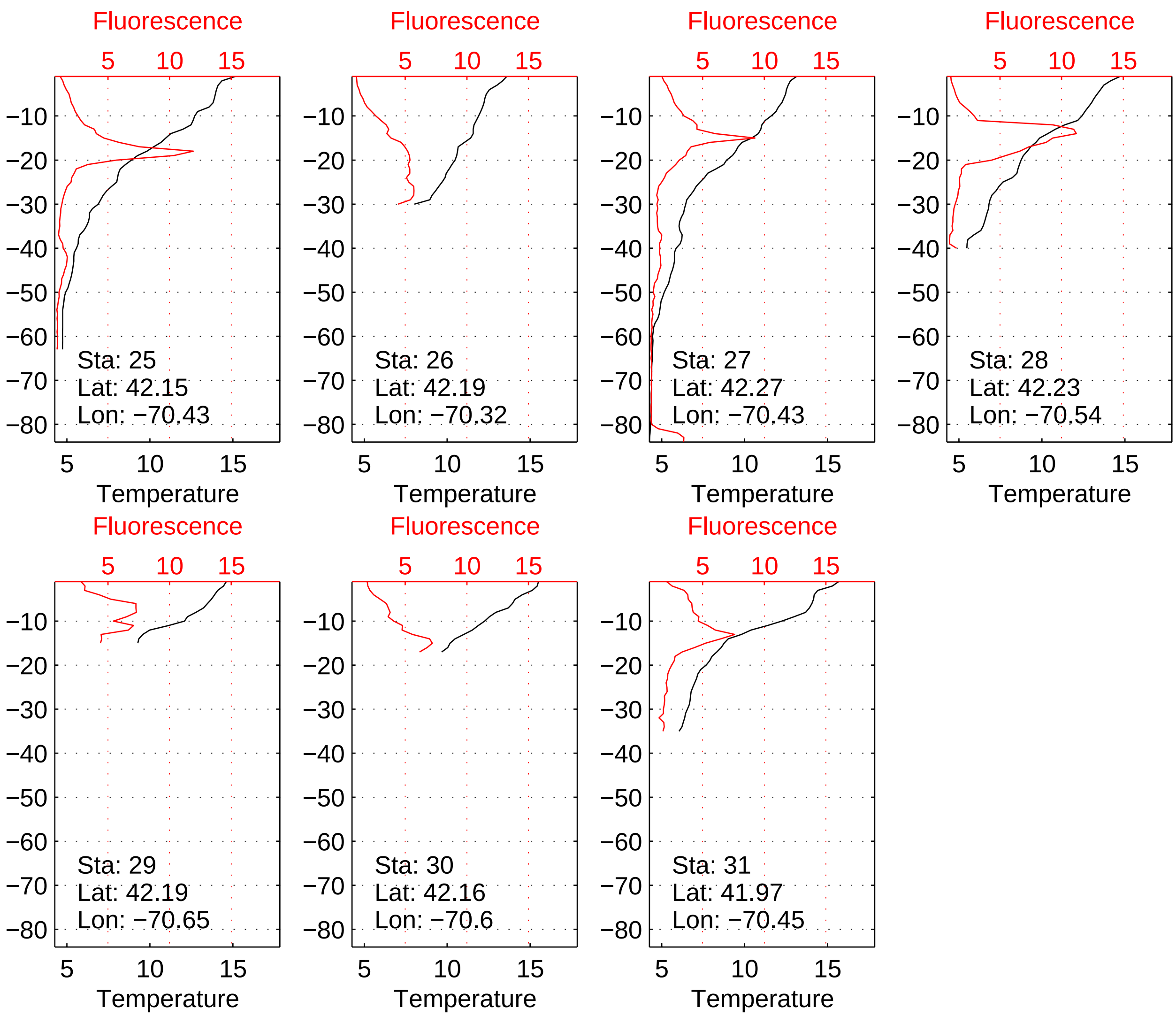
Lucky Lady Data: 6−7 June 2001



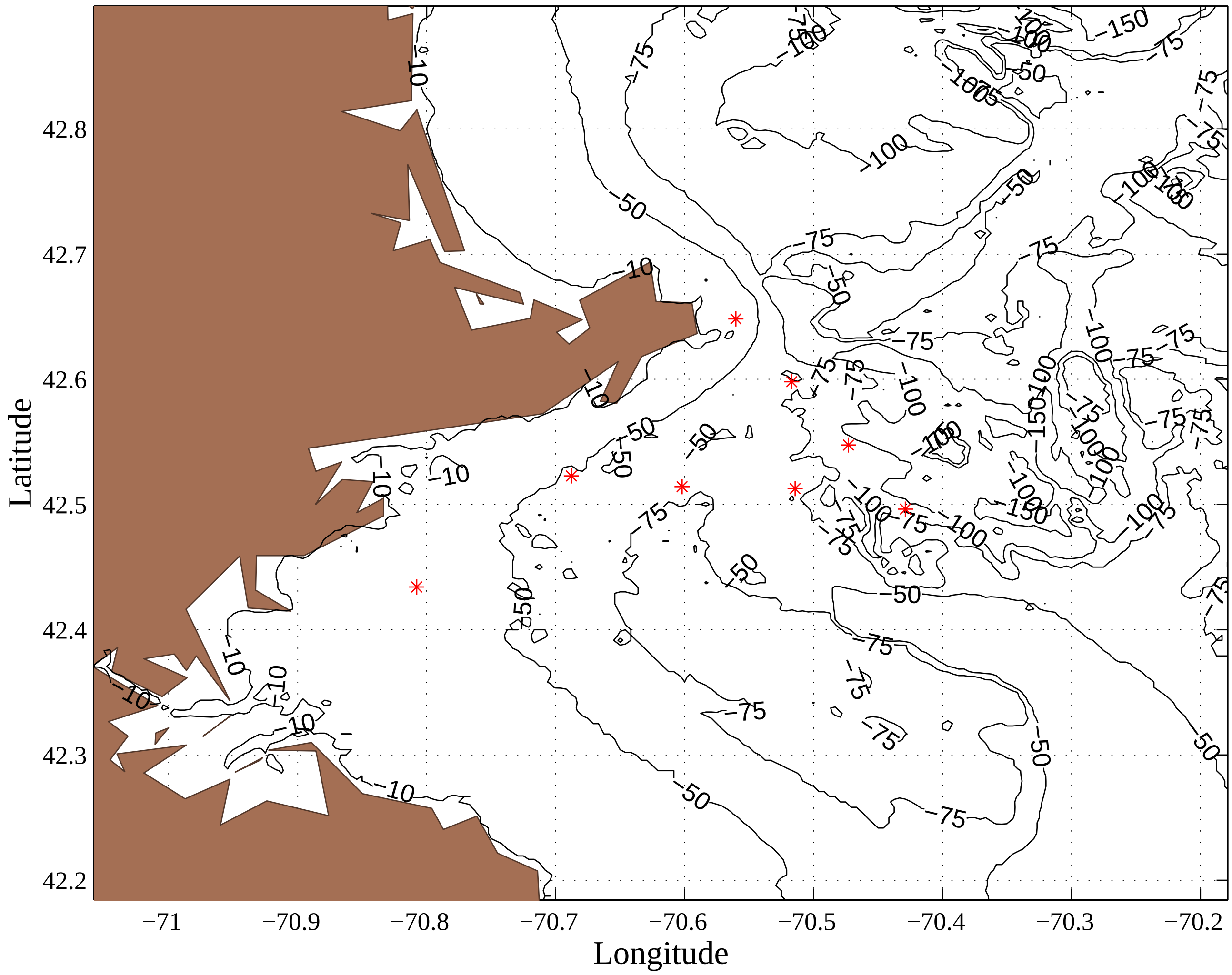
Lucky Lady Data: 6−7 June 2001



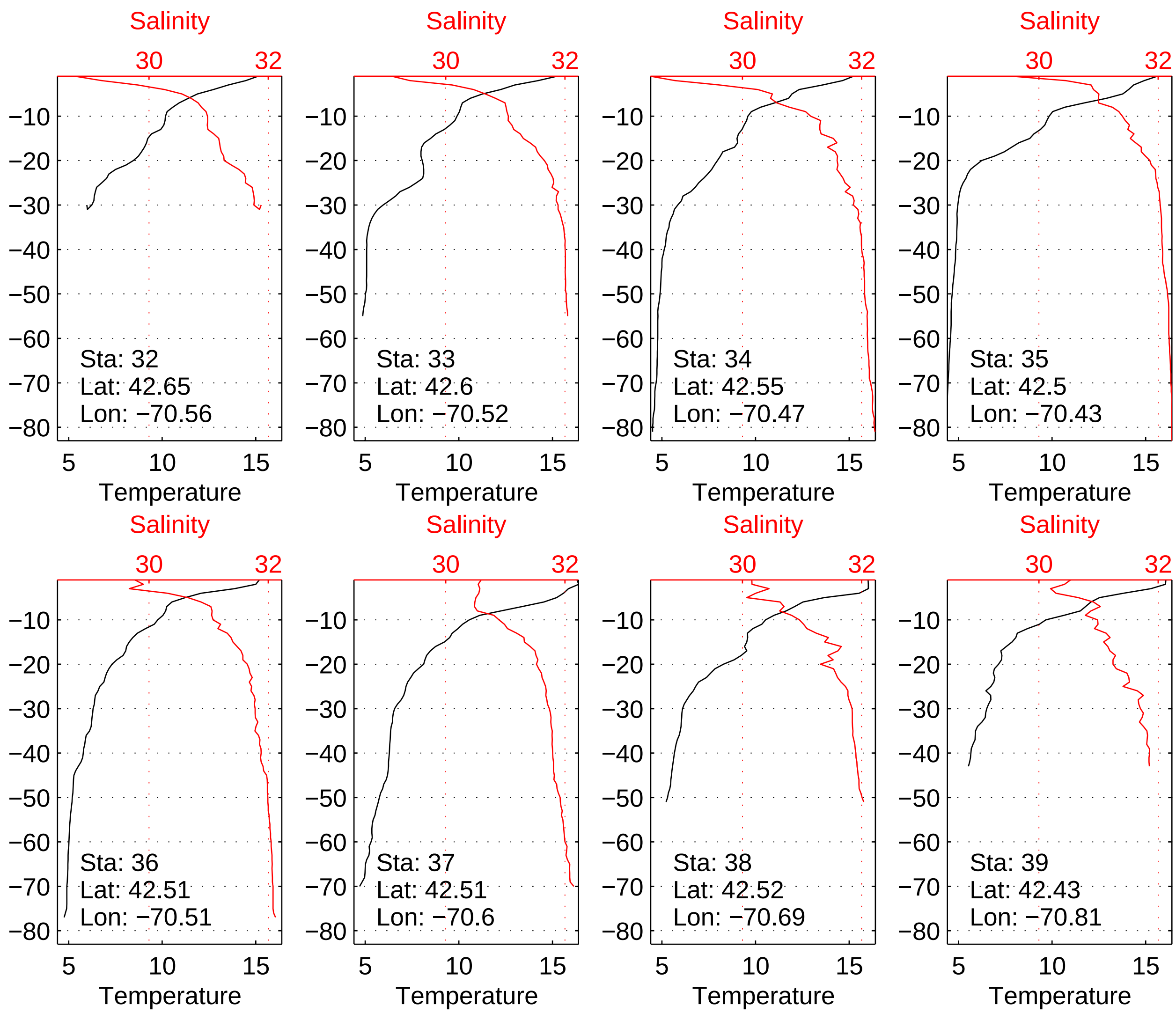
Lucky Lady Data: 6−7 June 2001



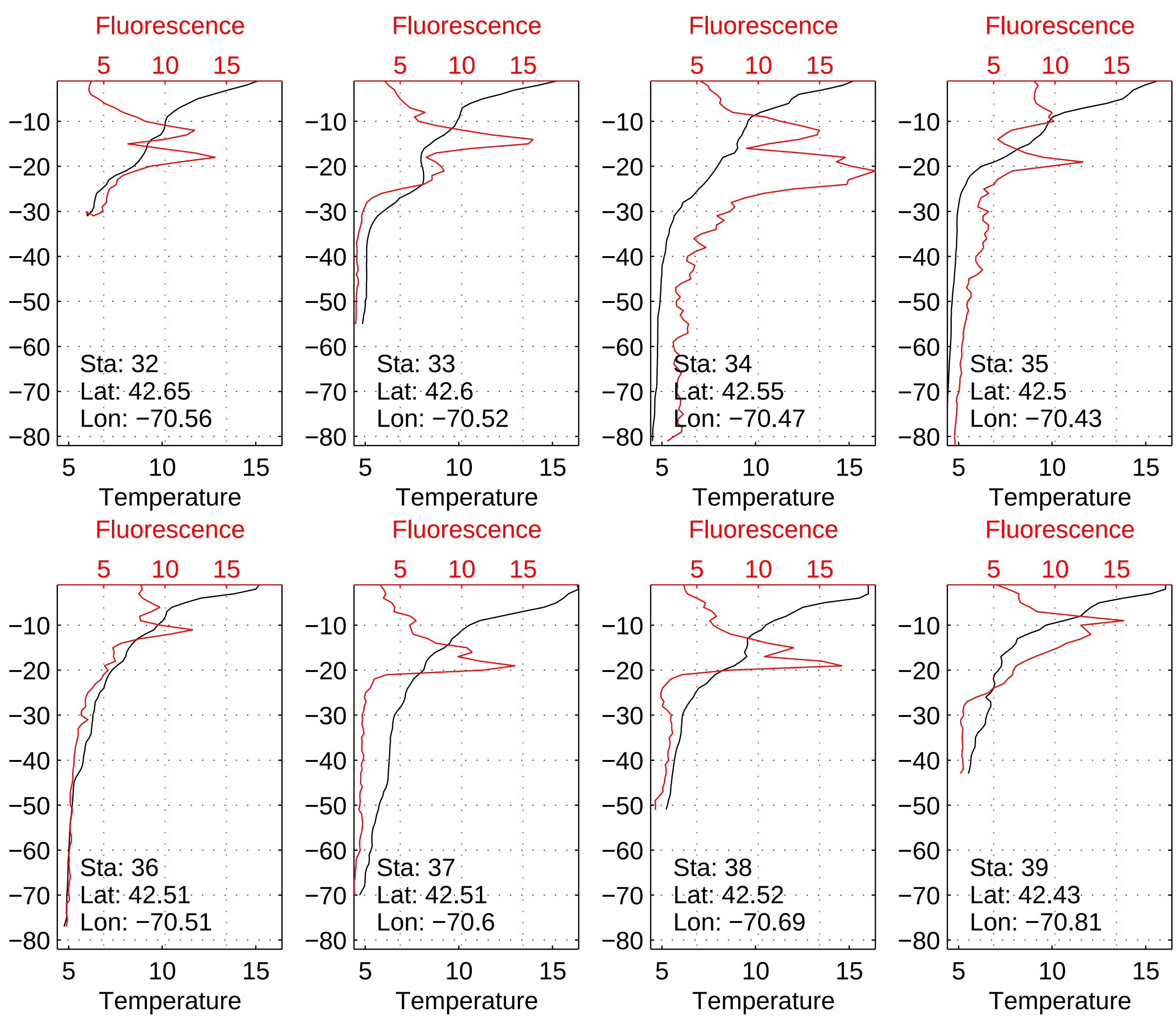
Lucky Lady Data: 10−11 June 2001

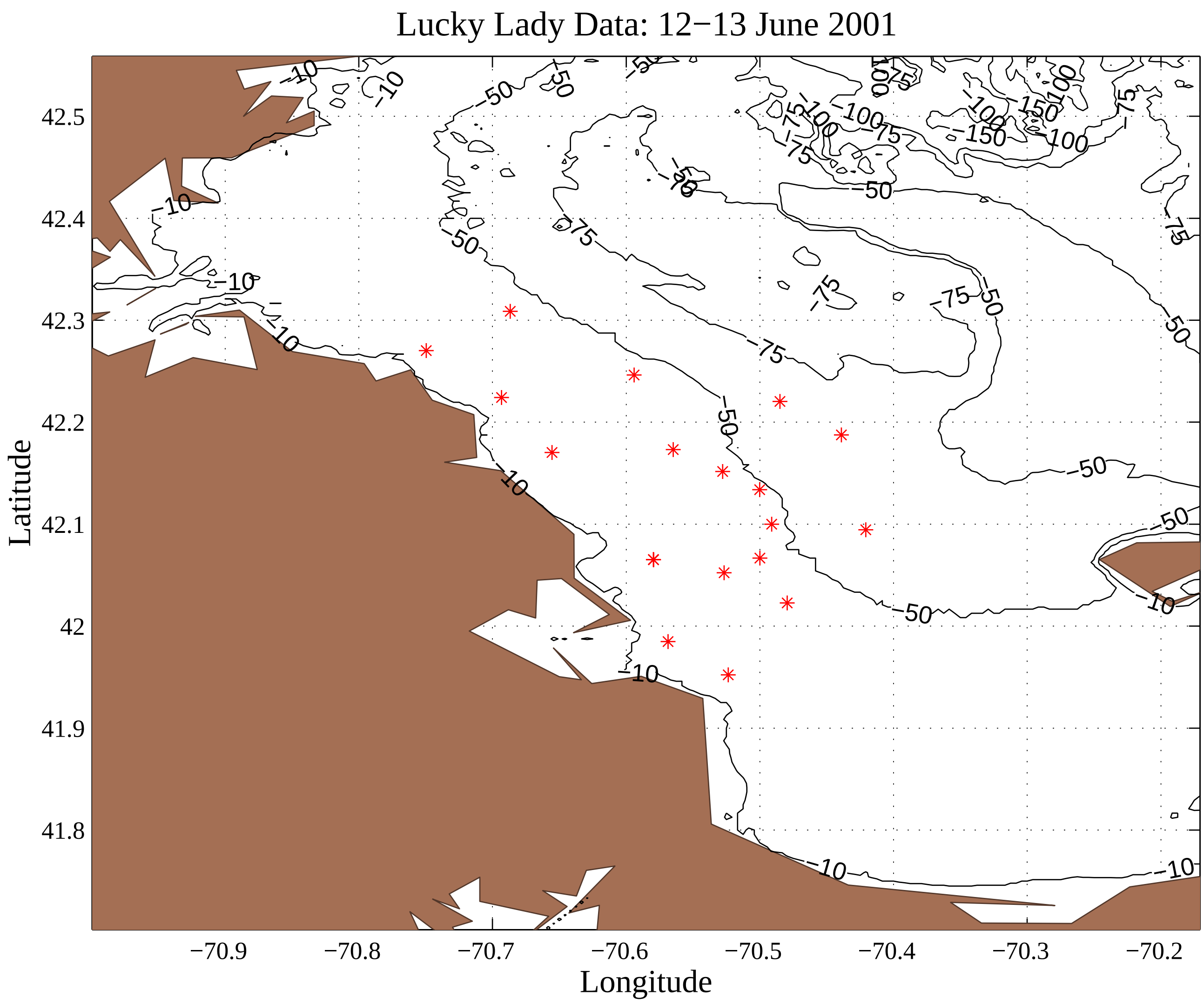


Lucky Lady Data: 10−11 June 2001



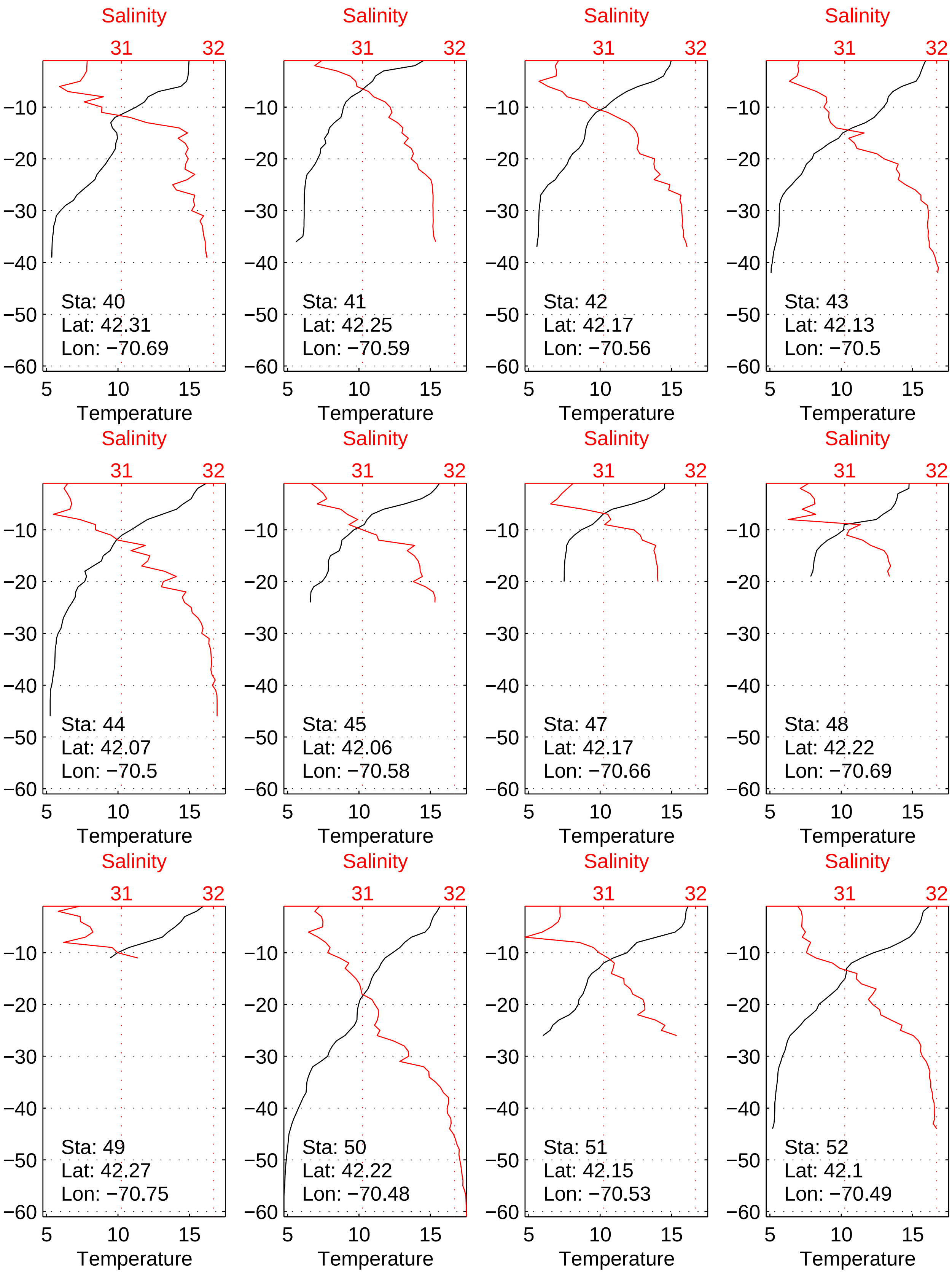
Lucky Lady Data: 10−11 June 2001



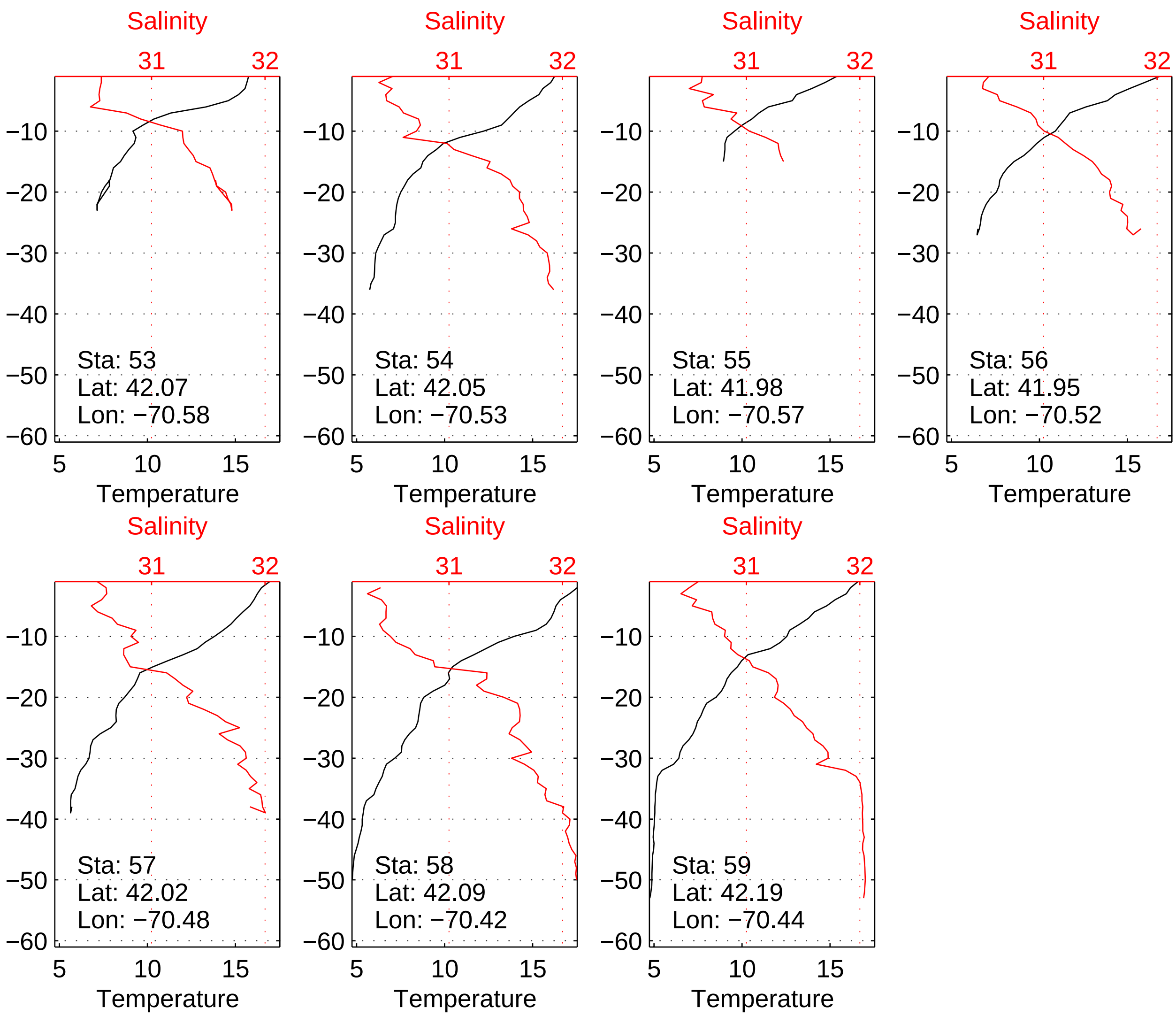


Lucky Lady Data: 12−13 June 2001
Latitude
Longitude
42.5
42.4
42.3
42.2
42.1
42
41.9
41.8
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2
−10
−50
−75
−100
−150

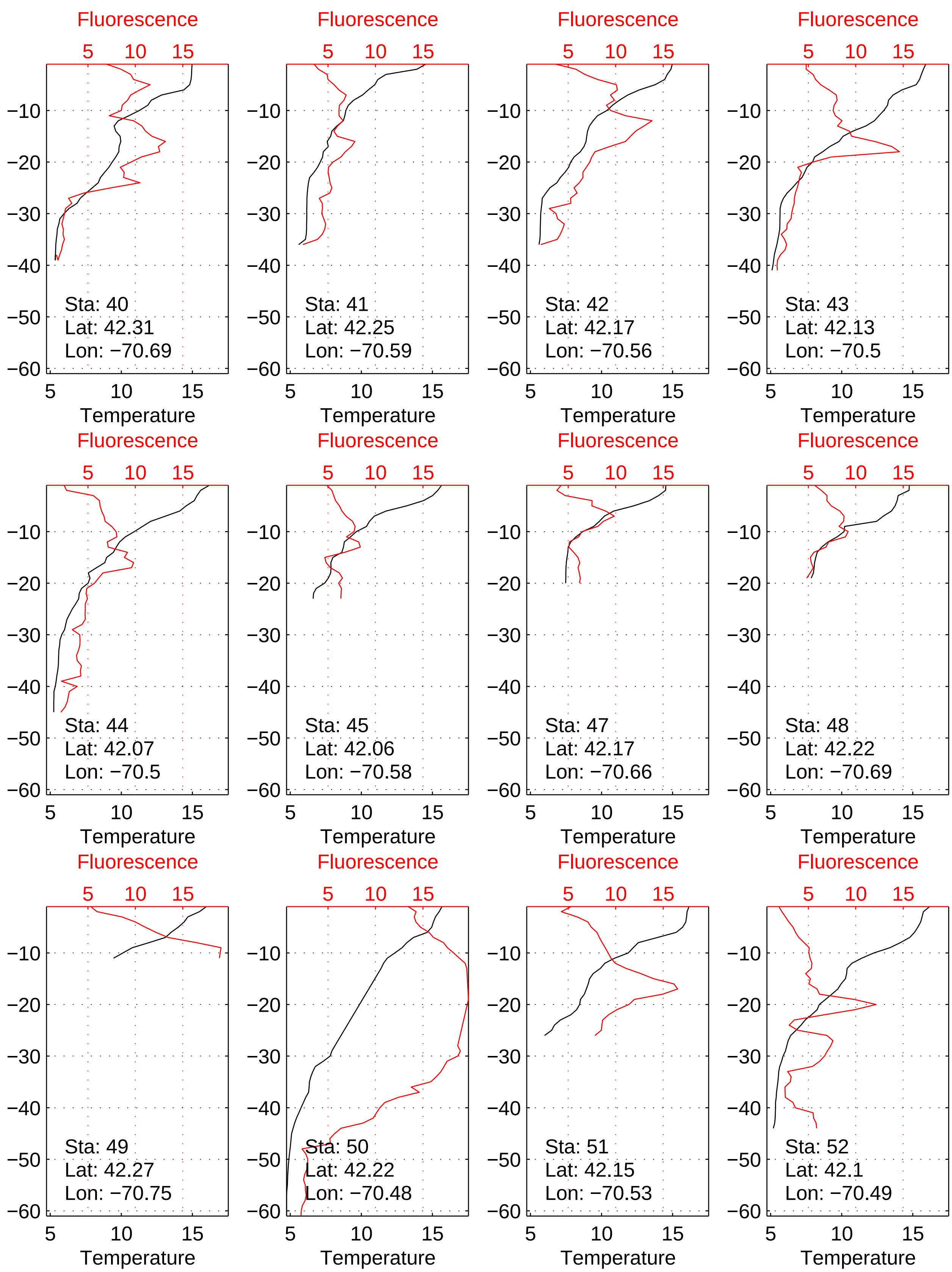
Lucky Lady Data: 12−13 June 2001



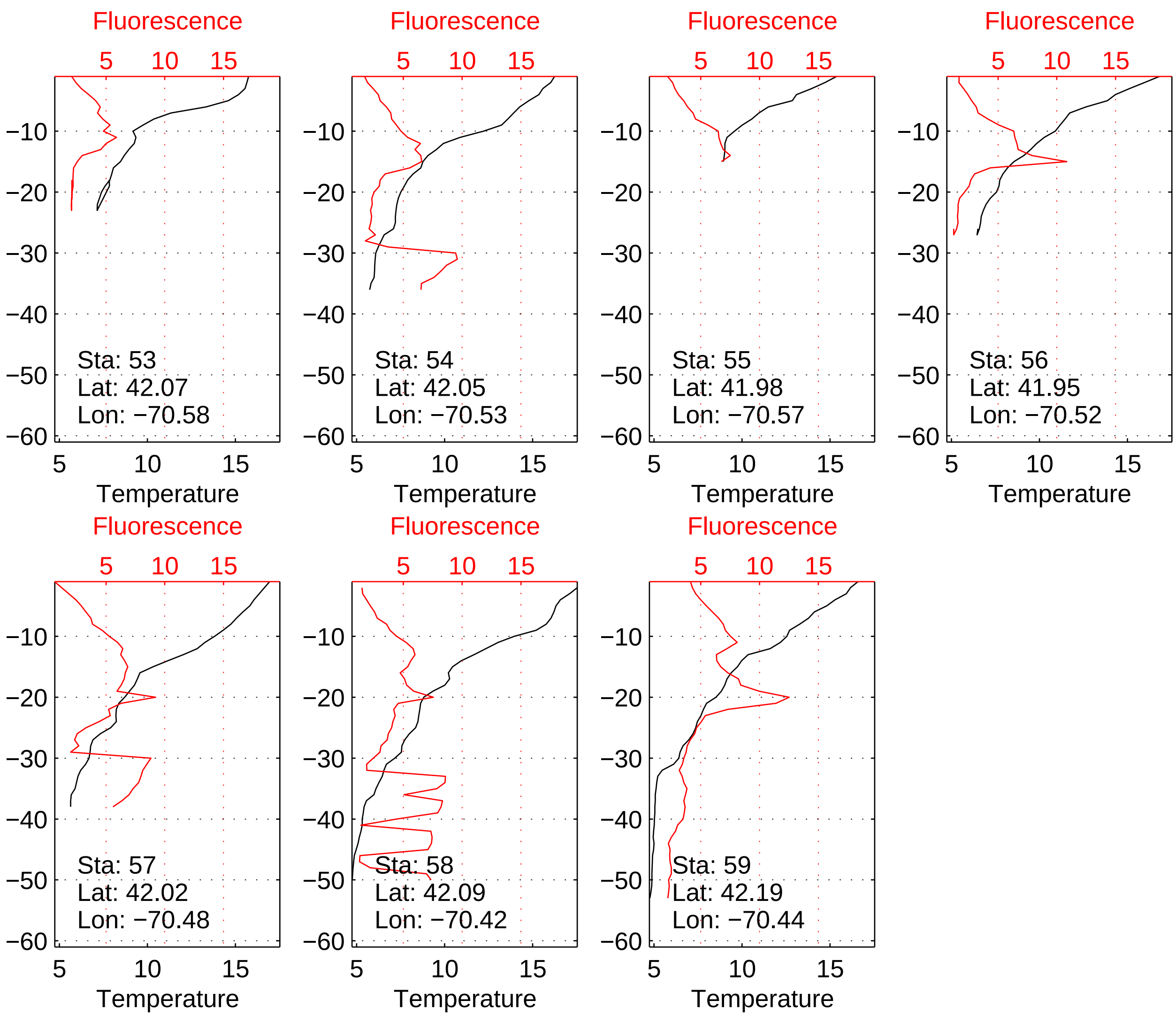
Lucky Lady Data: 12−13 June 2001



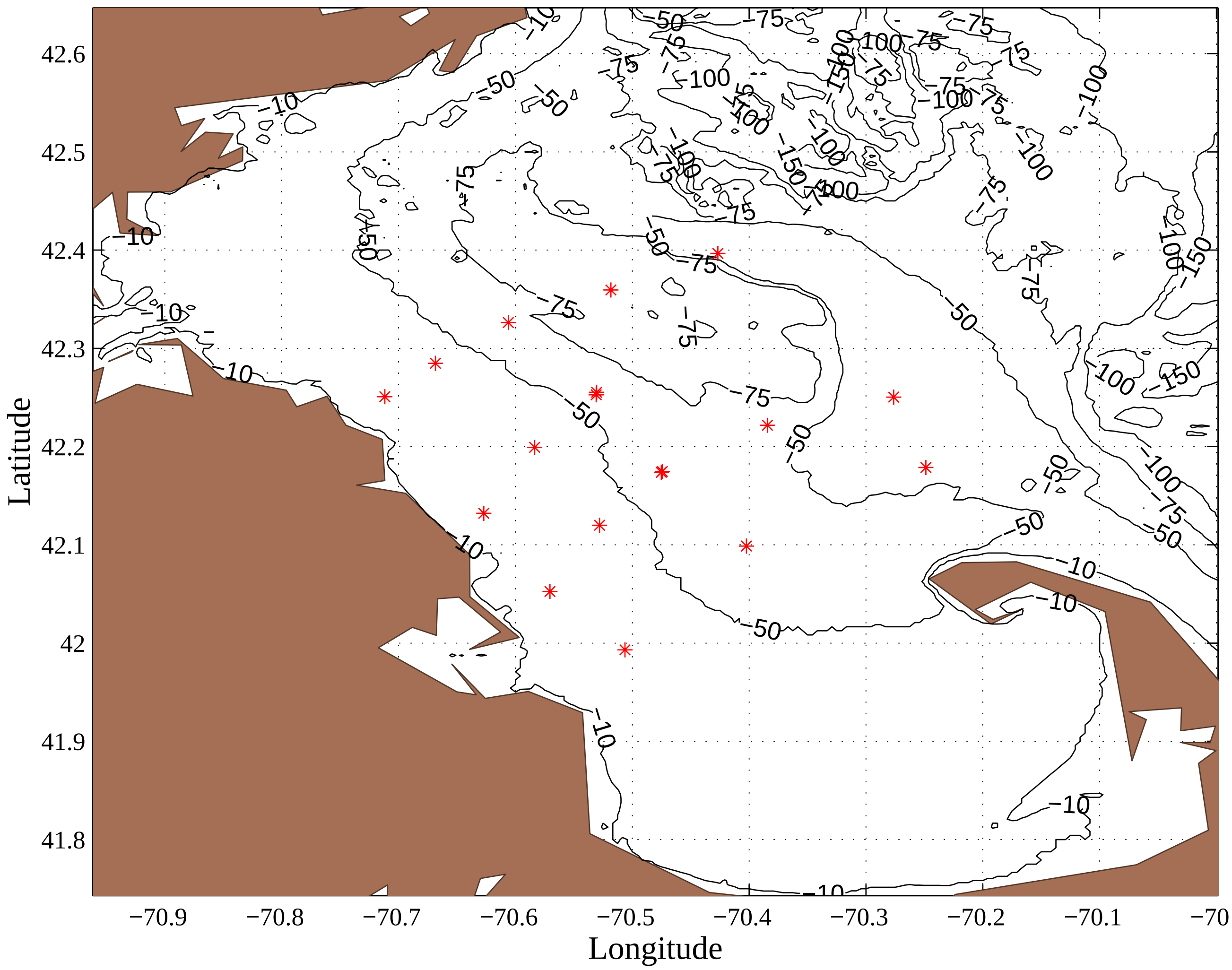
Lucky Lady Data: 12−13 June 2001



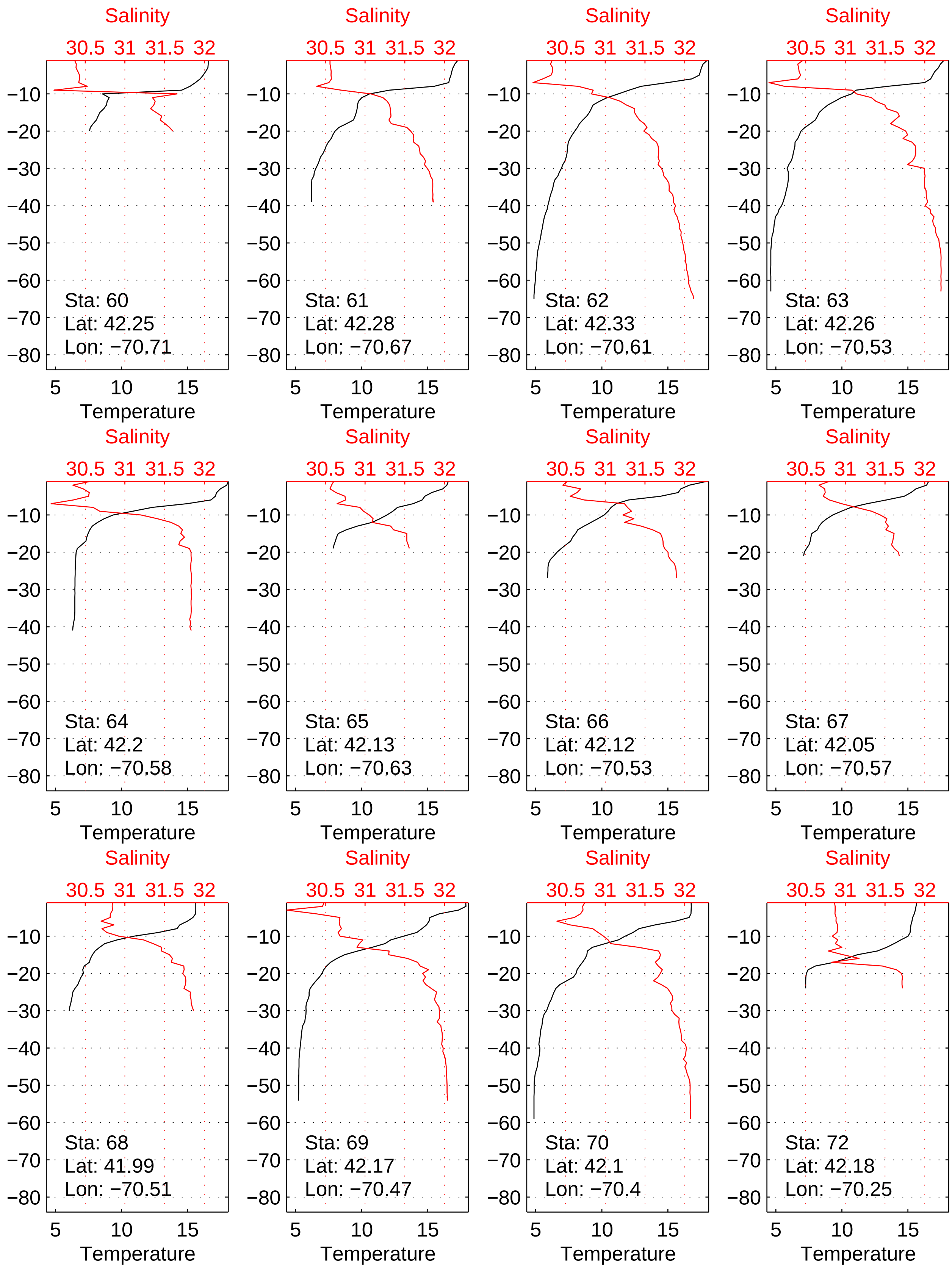
Lucky Lady Data: 12−13 June 2001



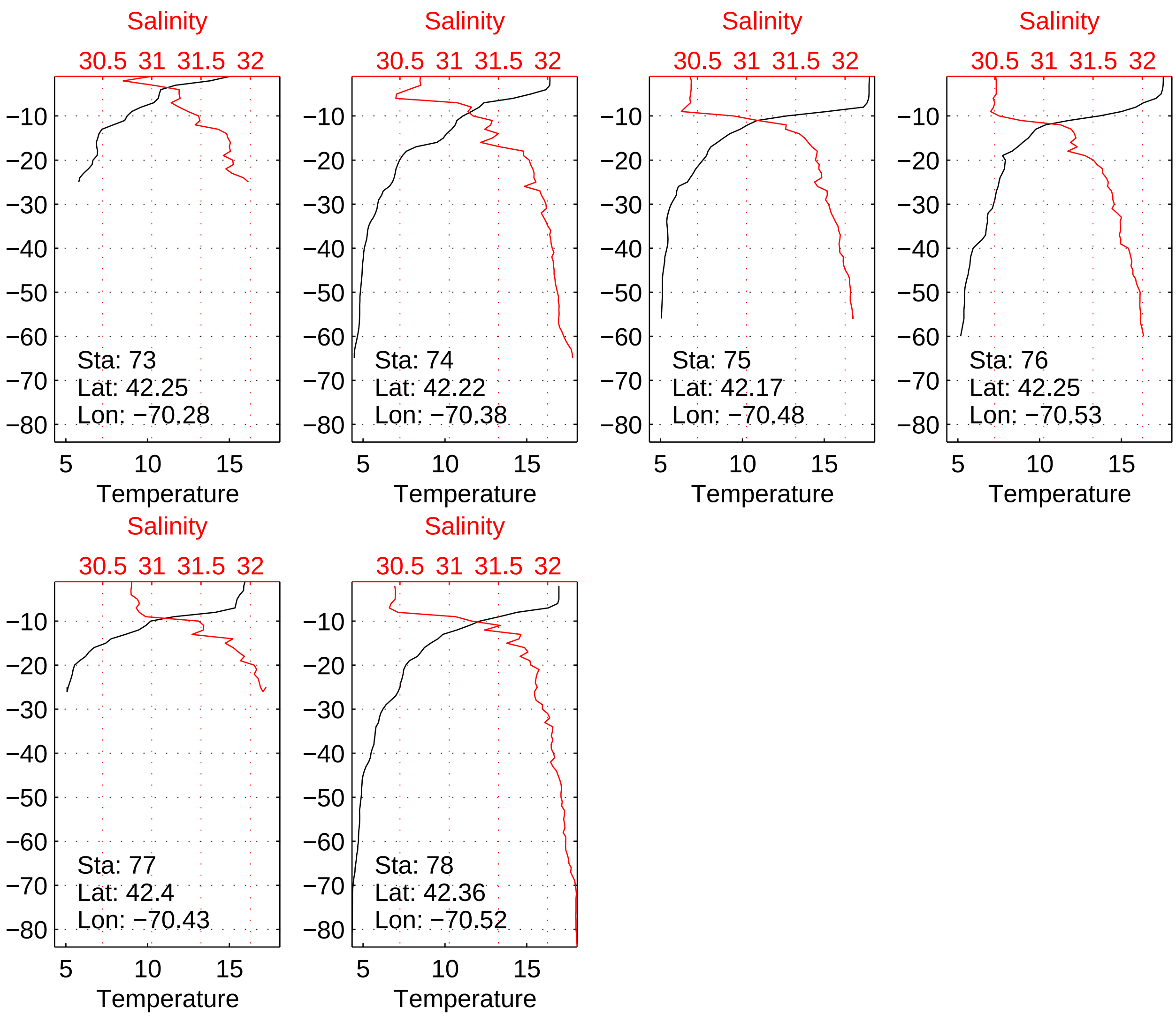
Lucky Lady Data: 20−21 June 2001



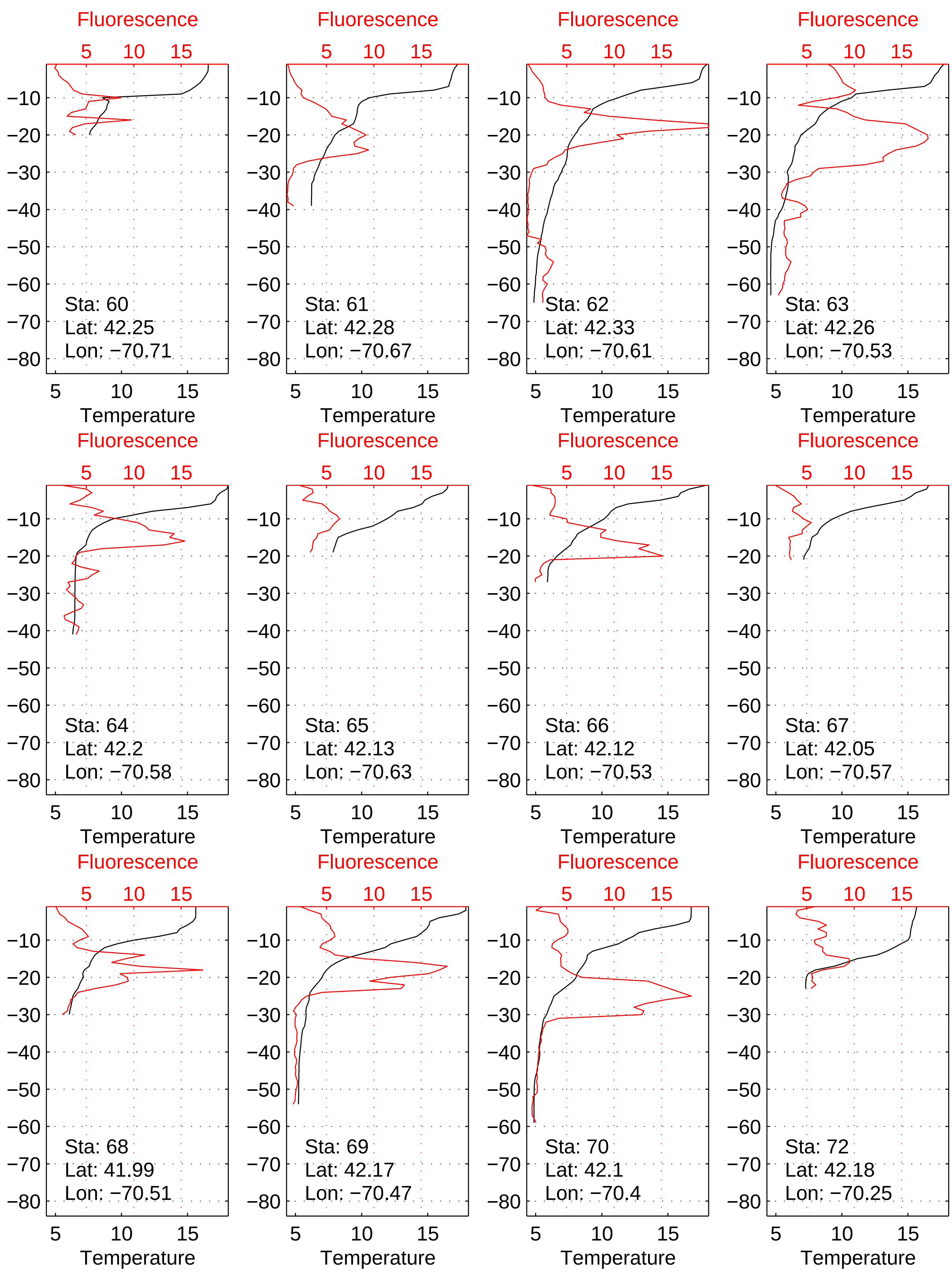
Lucky Lady Data: 20−21 June 2001



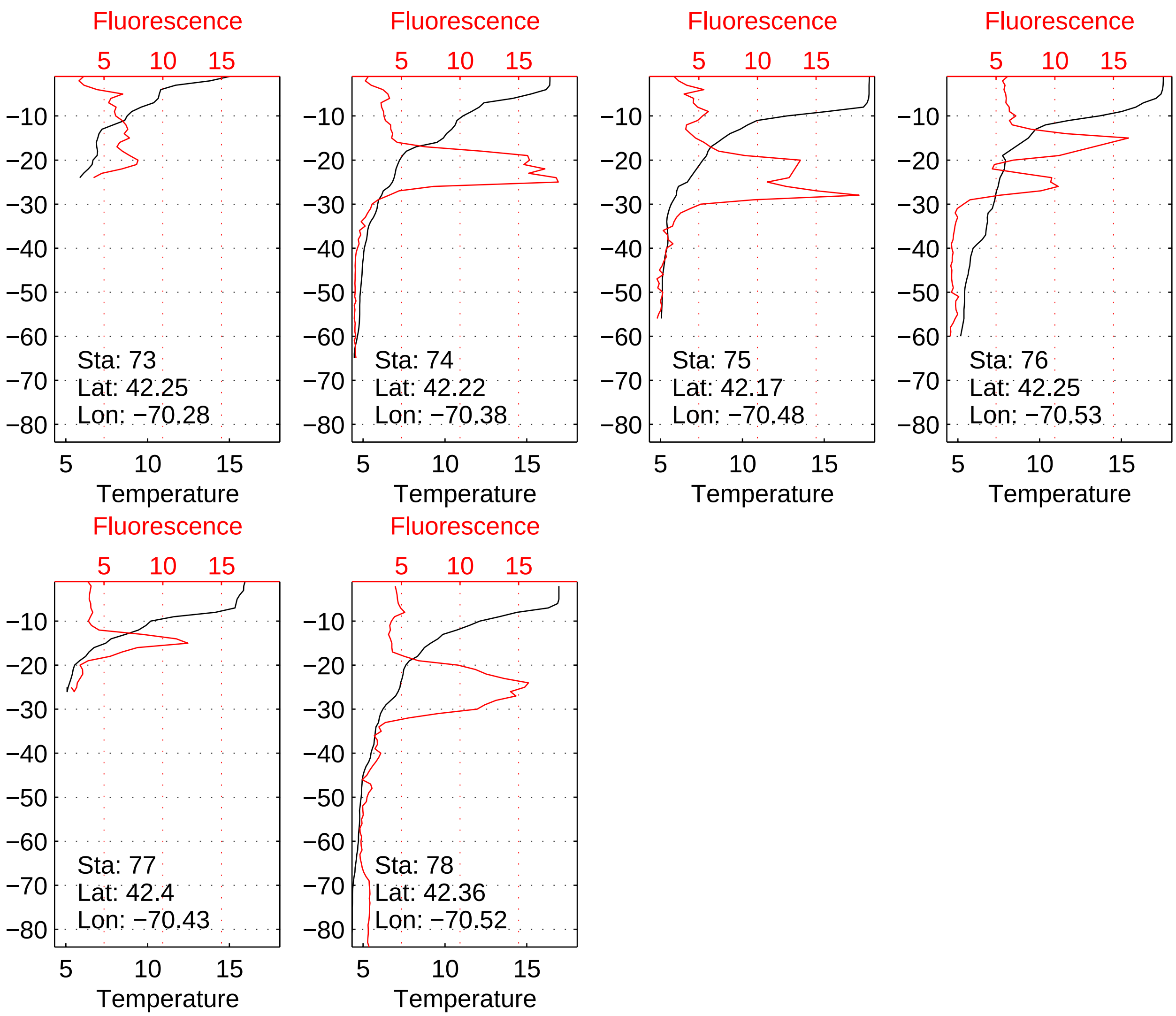
Lucky Lady Data: 20−21 June 2001



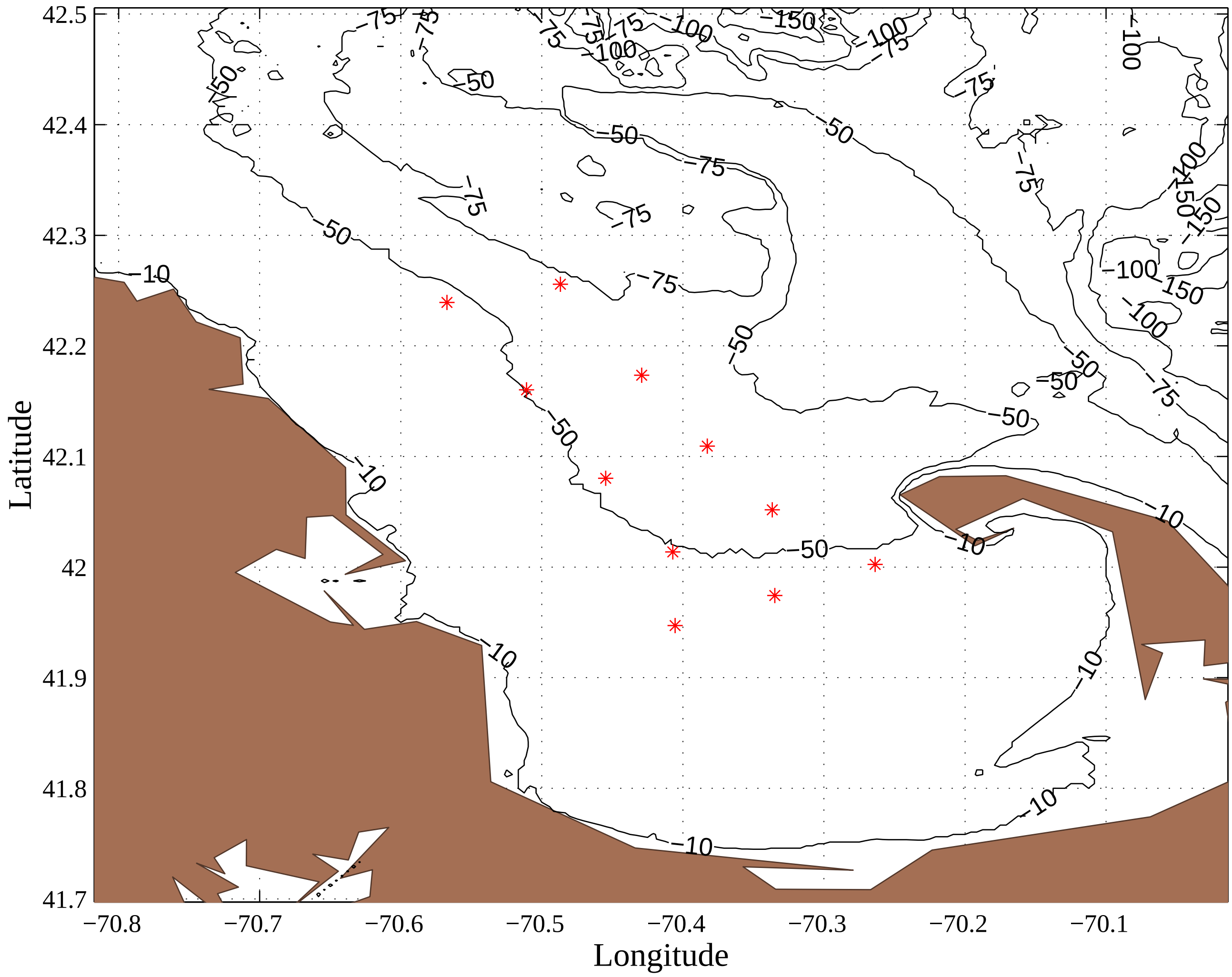
Lucky Lady Data: 20−21 June 2001



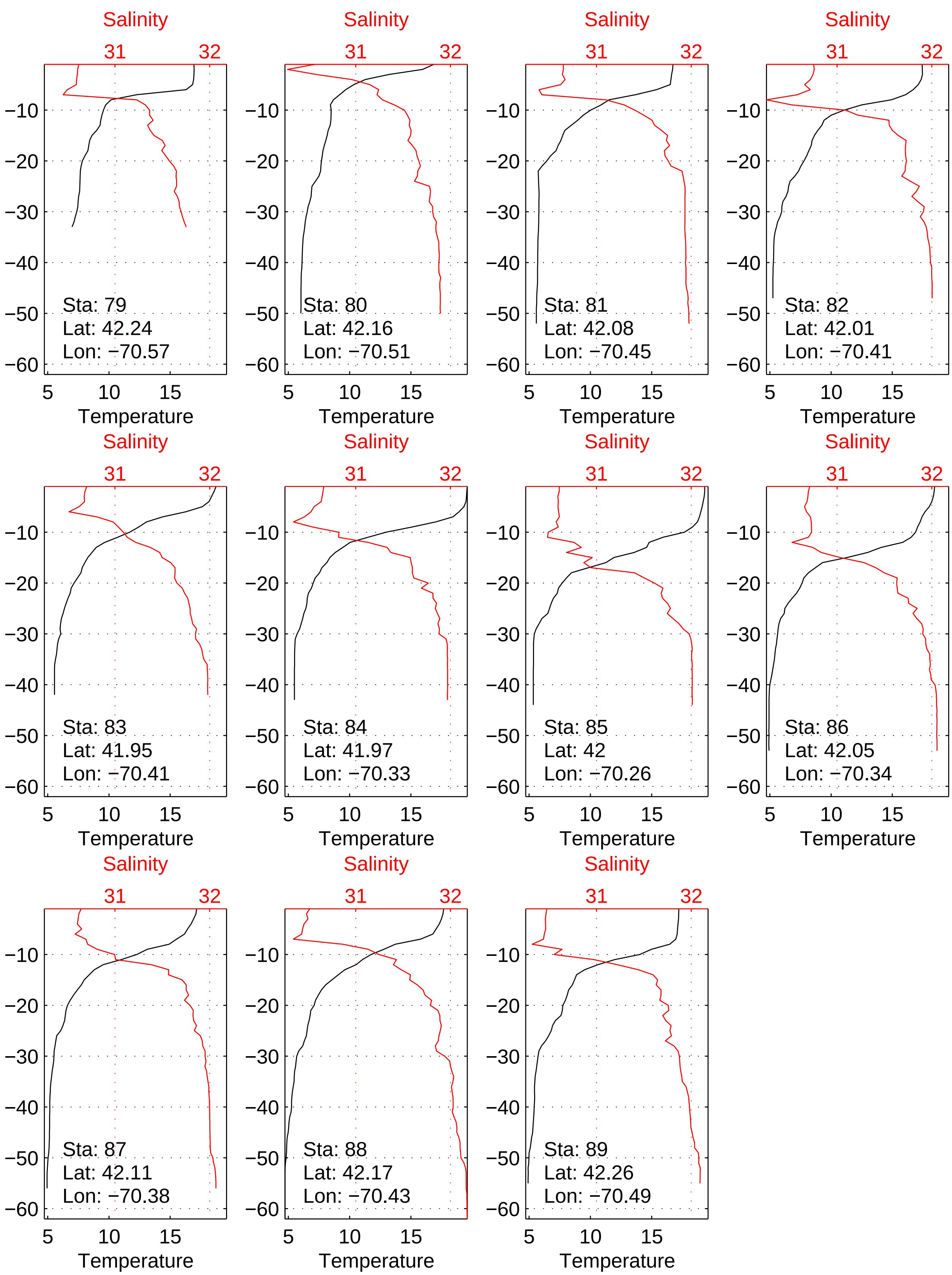
Lucky Lady Data: 20−21 June 2001



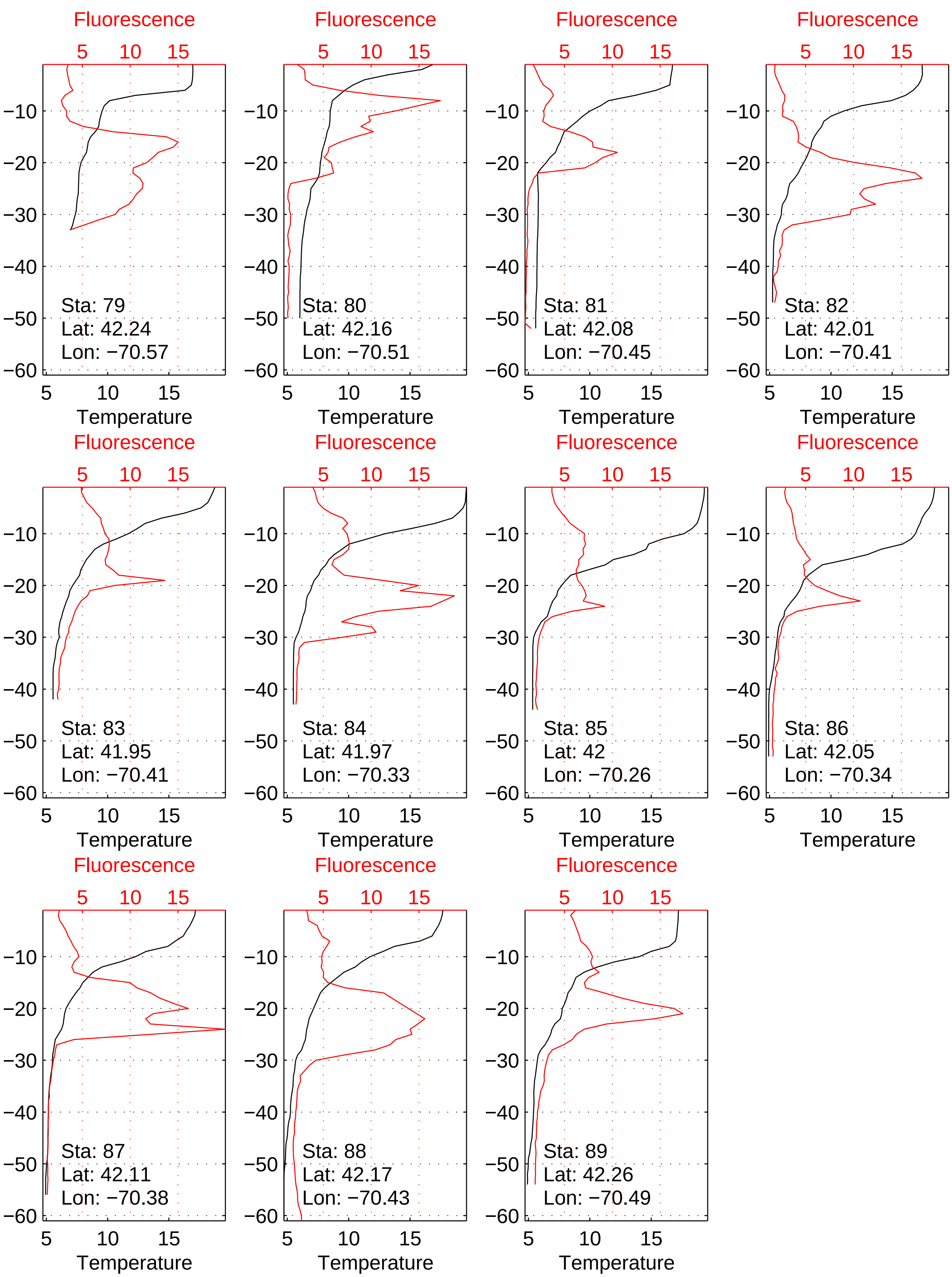
Lucky Lady Data: 22−23 June 2001

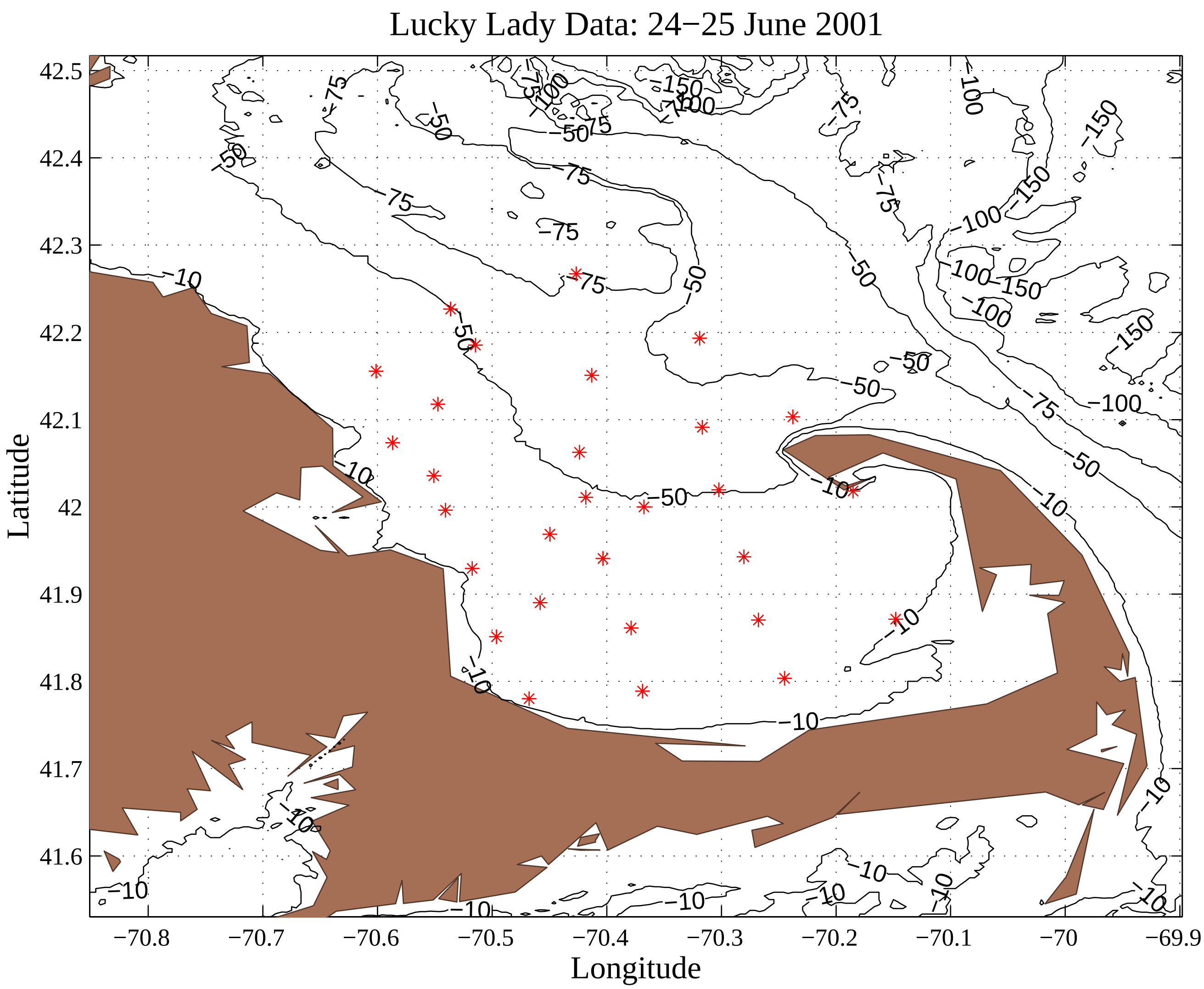


Lucky Lady Data: 22−23 June 2001



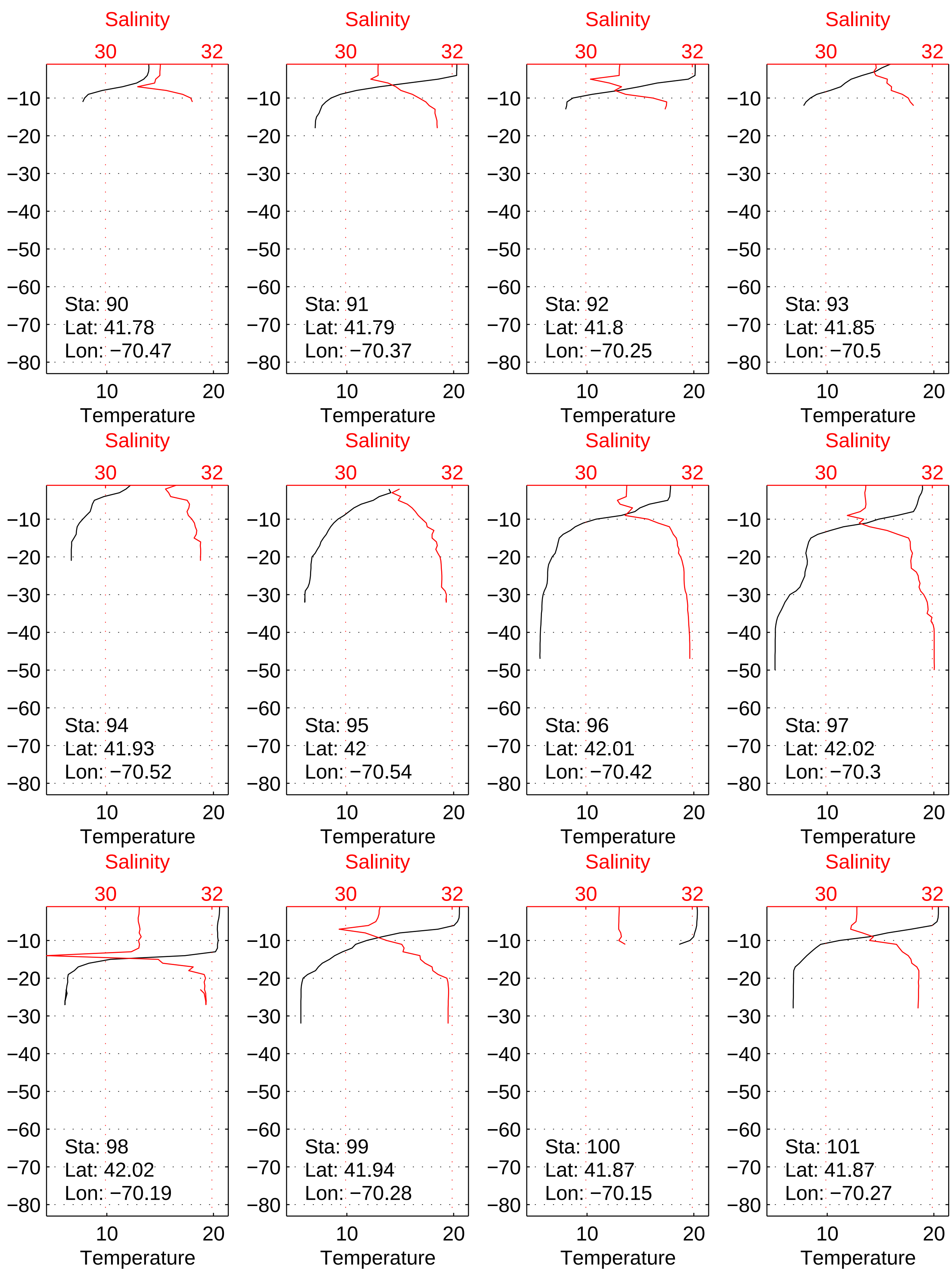
Lucky Lady Data: 22−23 June 2001



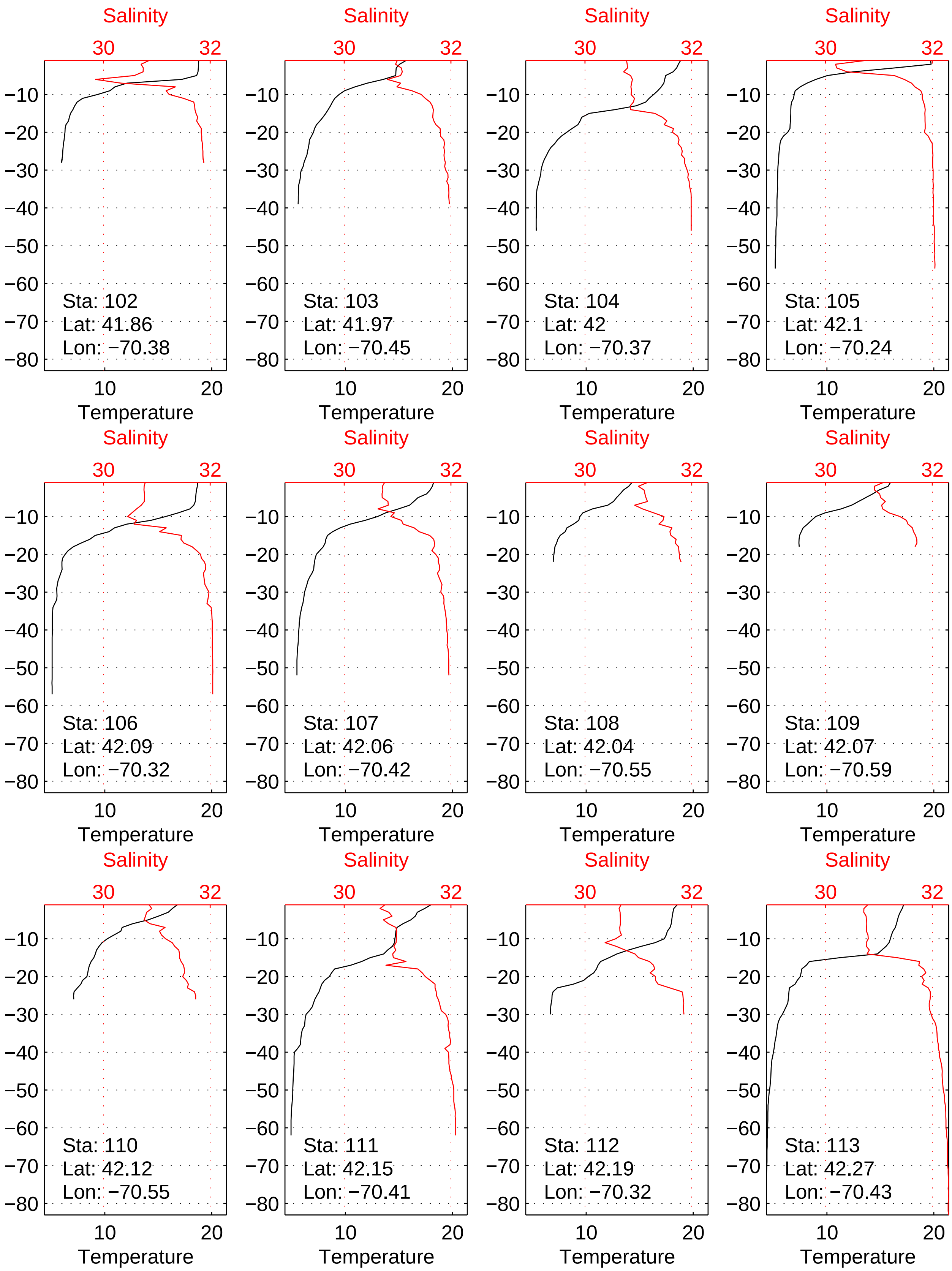


Lucky Lady Data: 24−25 June 2001
Latitude
Longitude
42.5
42.4
42.3
42.2
42.1
42
41.9
41.8
41.7
41.6
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2
−70.1
−70
−69.9

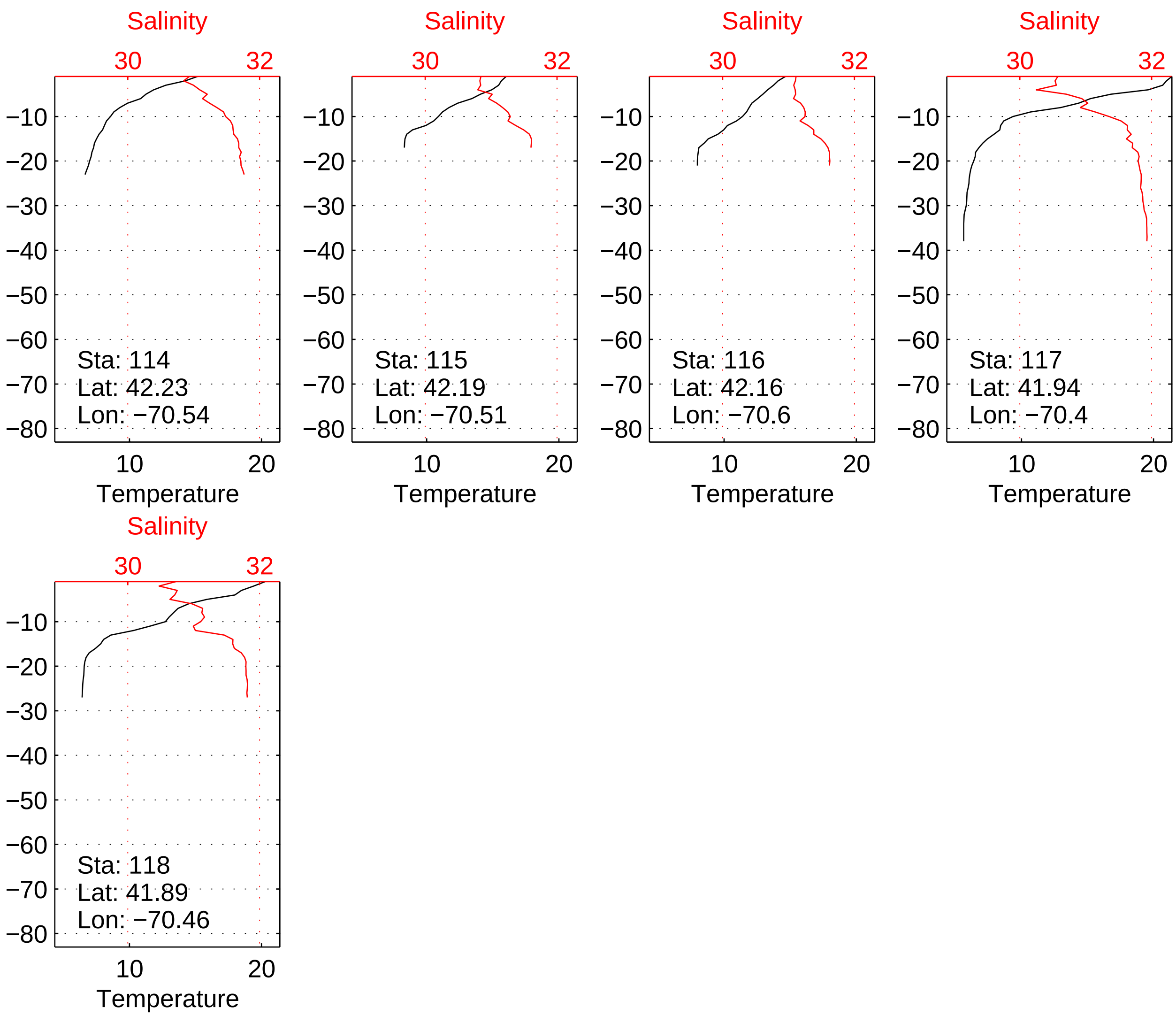
Lucky Lady Data: 24−25 June 2001



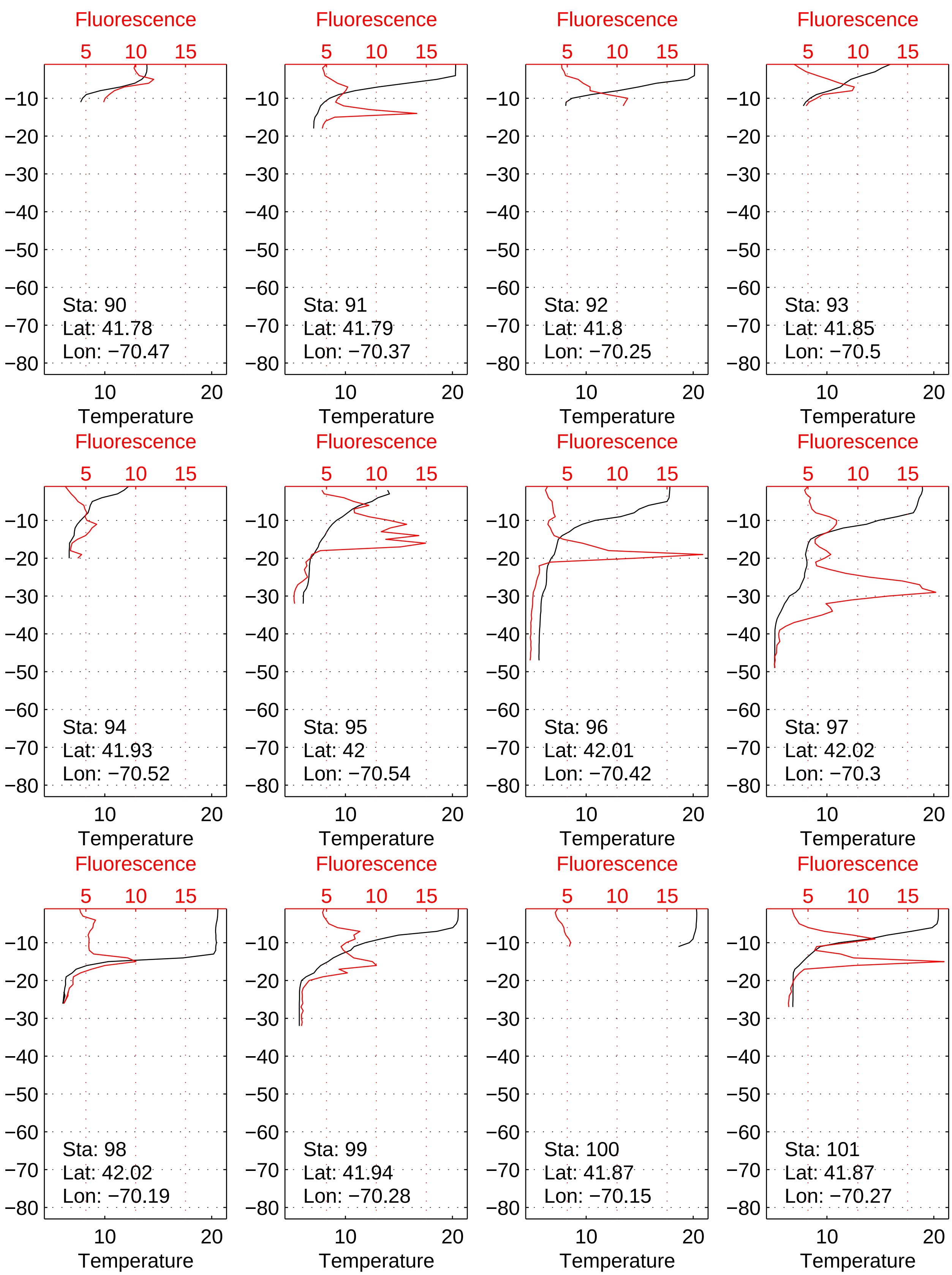
Lucky Lady Data: 24−25 June 2001



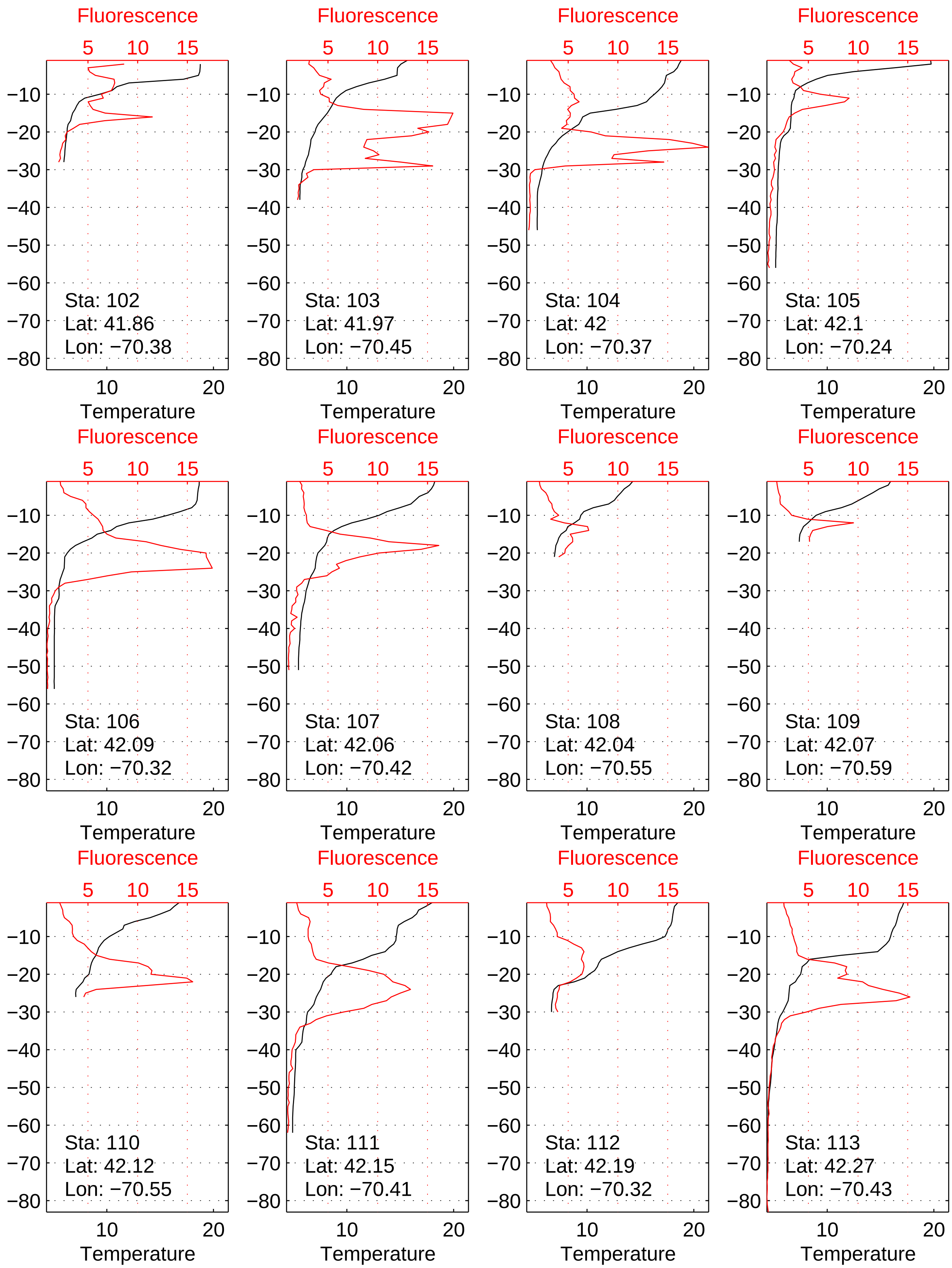
Lucky Lady Data: 24−25 June 2001



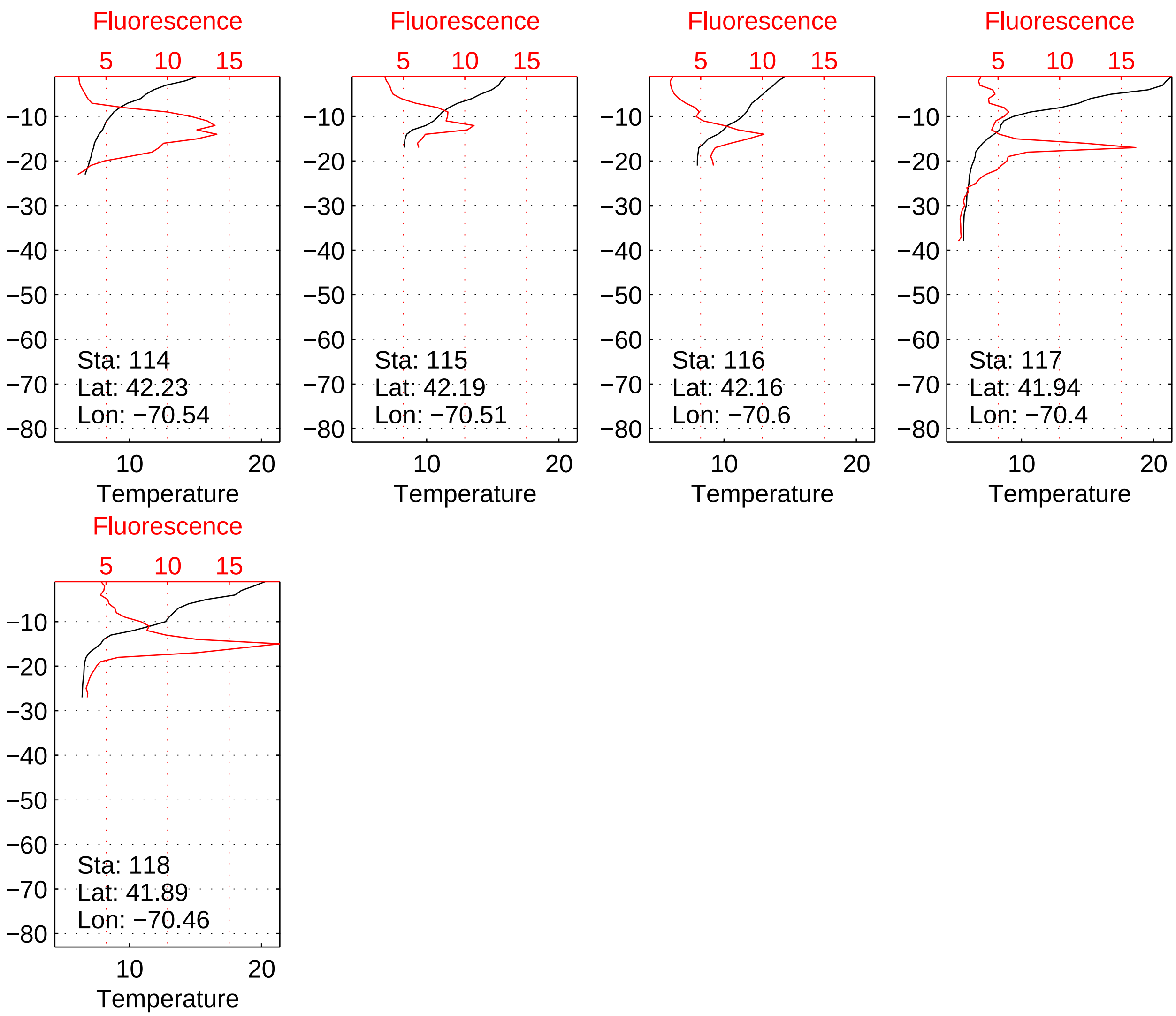
Lucky Lady Data: 24−25 June 2001



Lucky Lady Data: 24−25 June 2001



Lucky Lady Data: 24−25 June 2001

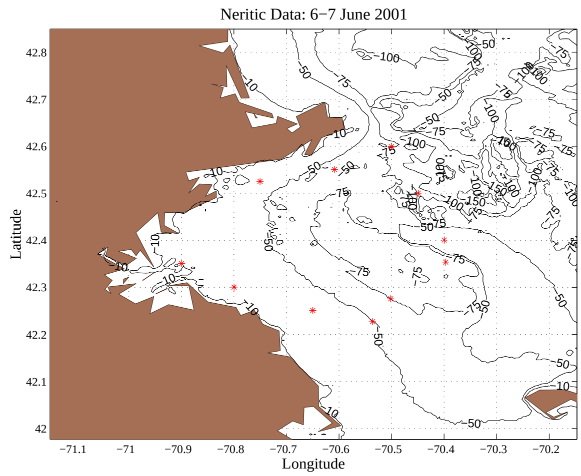


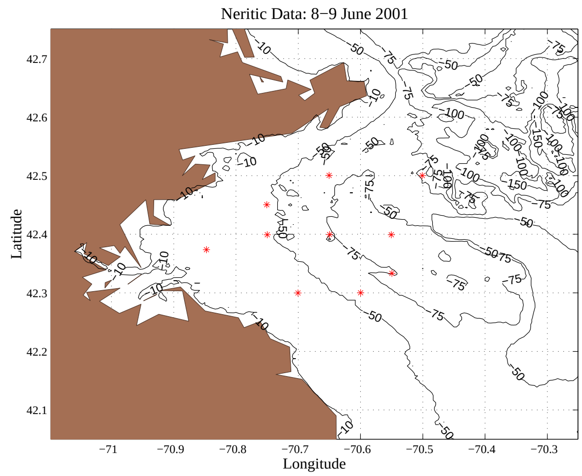
RV Neritic

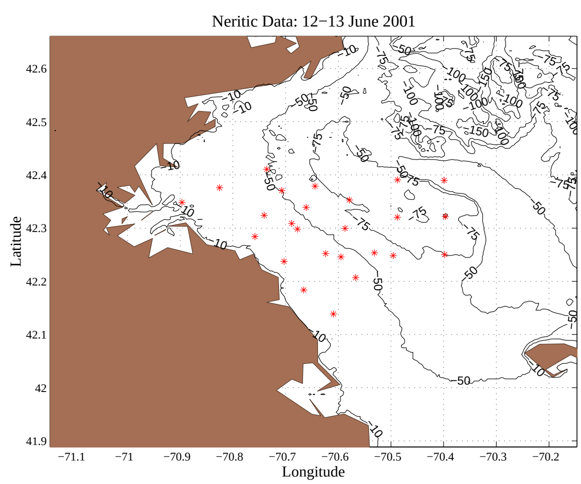
The RV Neritic performed 52 CTD stations over the period 7-25 June 2001 in Massachusetts Bay. The stations were carried out with a Seabird SBE 911 system and processed with Seasoft. Data were averaged over 0.5m depth intervals. The sampling program of the RV Neritic was hampered by equipment problems.

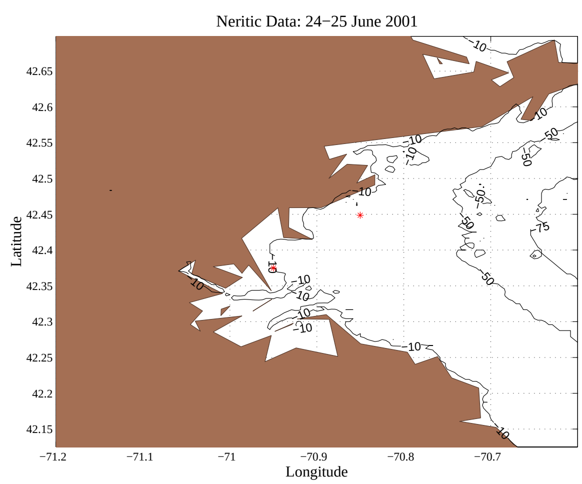
Station positions have been plotted first as the standard two-day composites and then as the individual cruise tracks. Vertical profiles of temperature, salinity, and fluorescence are included for each station. Axes are uniform among the plots included in each two-day grouping but not from one grouping to the next.

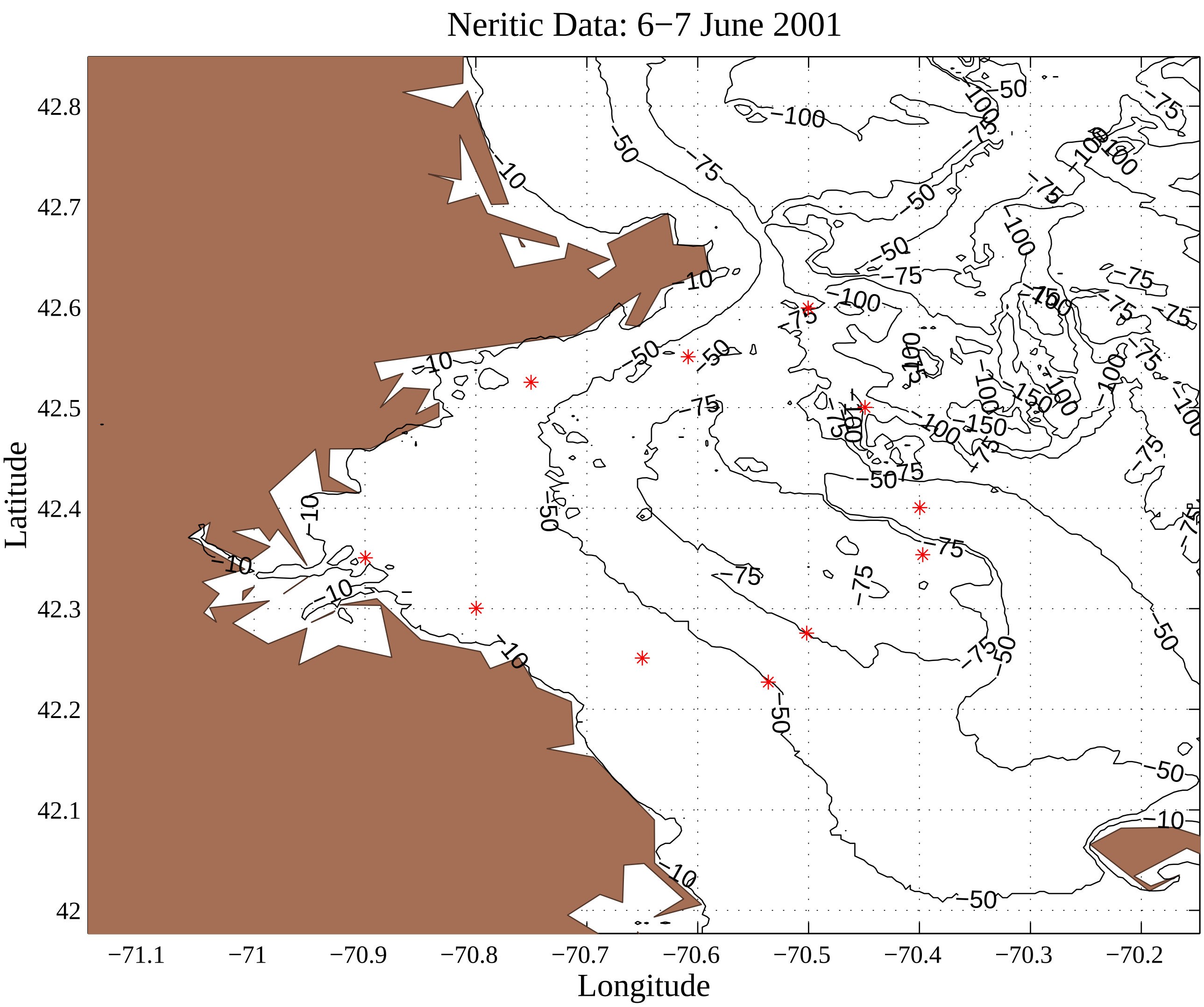
The fluorescence data from the individual vessels can not be compared directly. Calibration of this data is ongoing. Of most interest at this time is the profile structure, rather than the specific numbers.


Neritic Data: 6−7 June 2001
Latitude
Longitude


Neritic Data: 8−9 June 2001
Latitude
Longitude

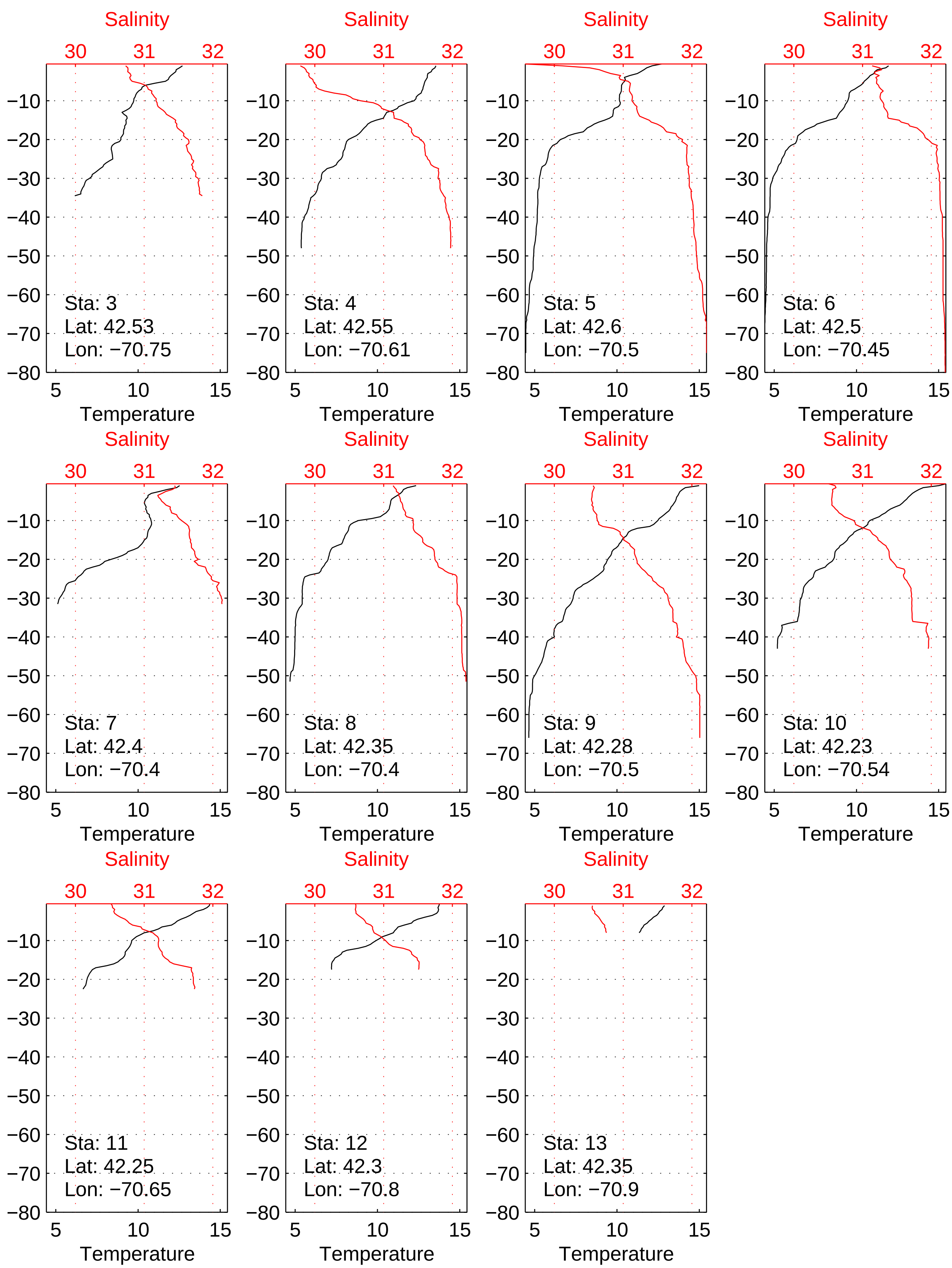

Neritic Data: 12−13 June 2001
Latitude
Longitude


Neritic Data: 24−25 June 2001
Latitude
Longitude

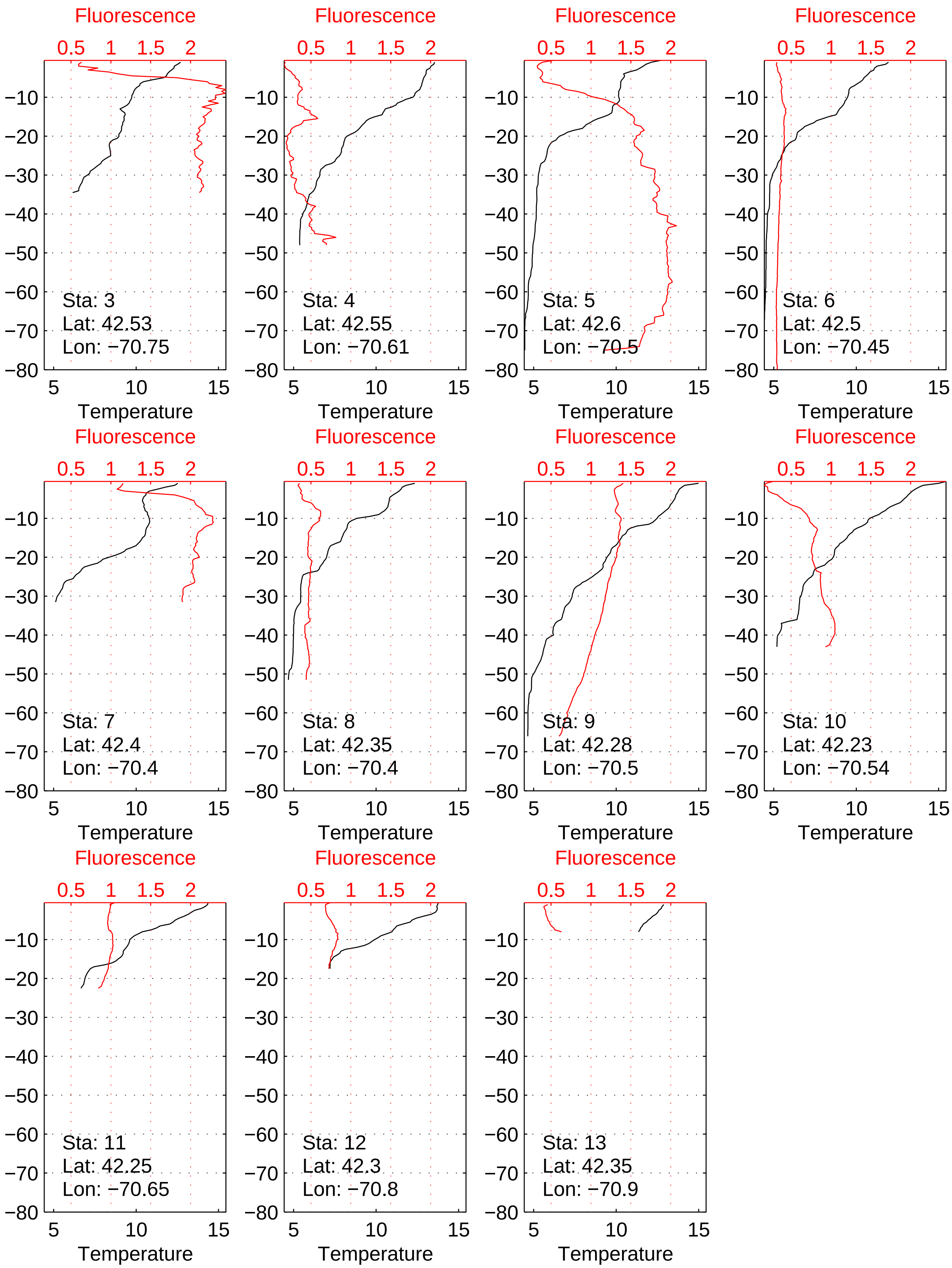


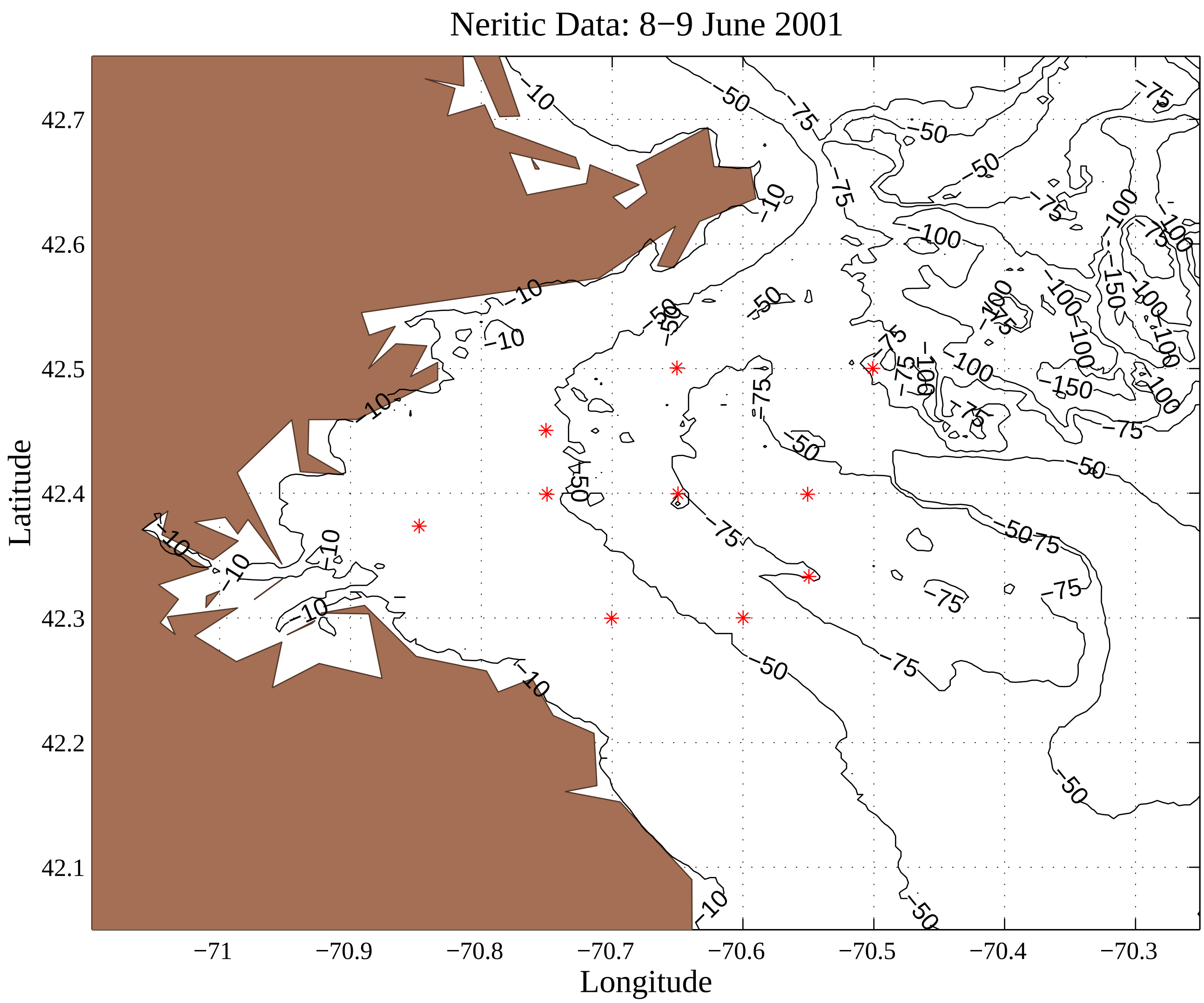
Neritic Data: 6−7 June 2001
Latitude
Longitude
42.8
42.7
42.6
42.5
42.4
42.3
42.2
42.1
42
−71.1
−71
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2

Neritic Data: 6−7 June 2001



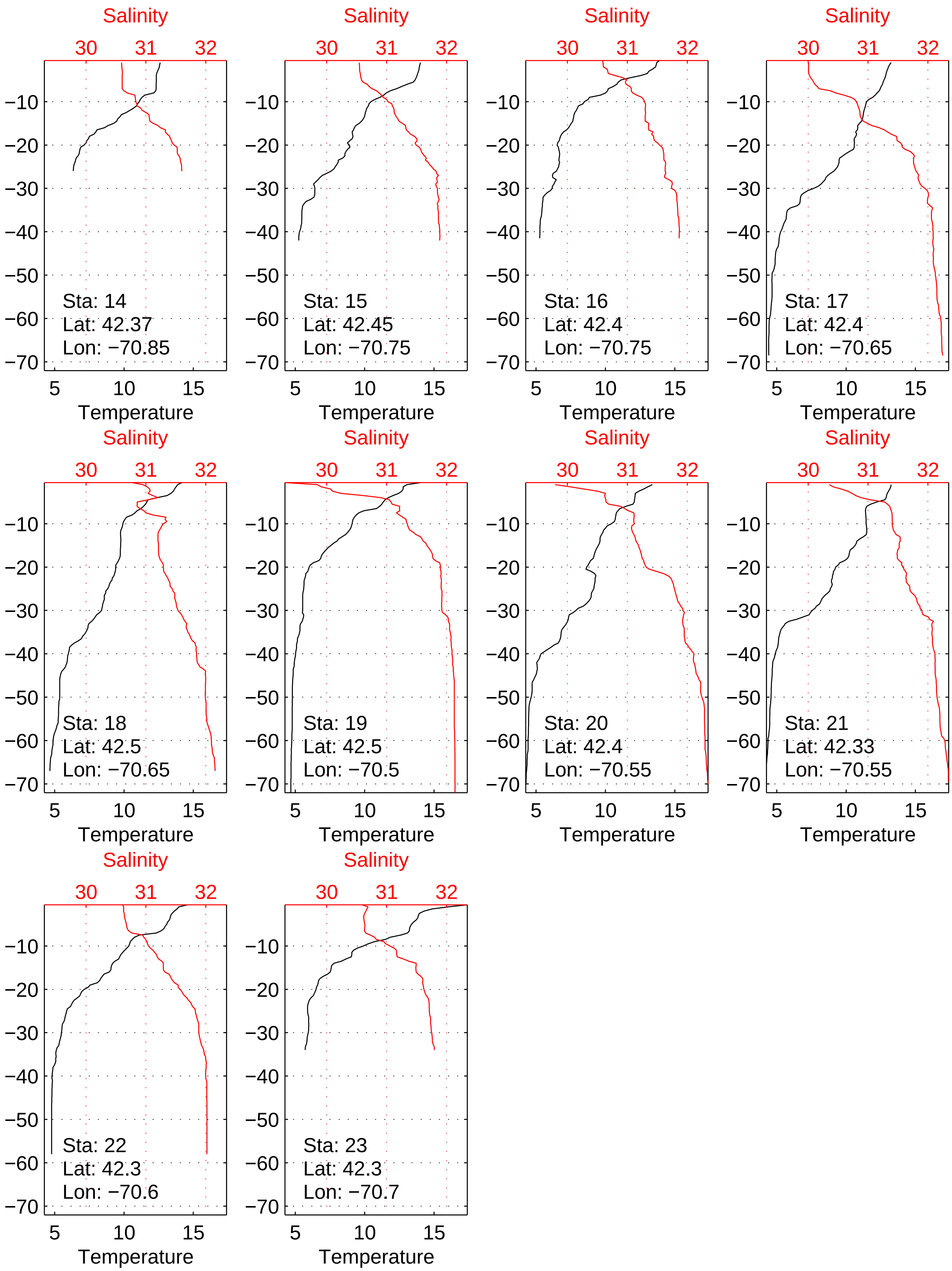
Neritic Data: 6−7 June 2001



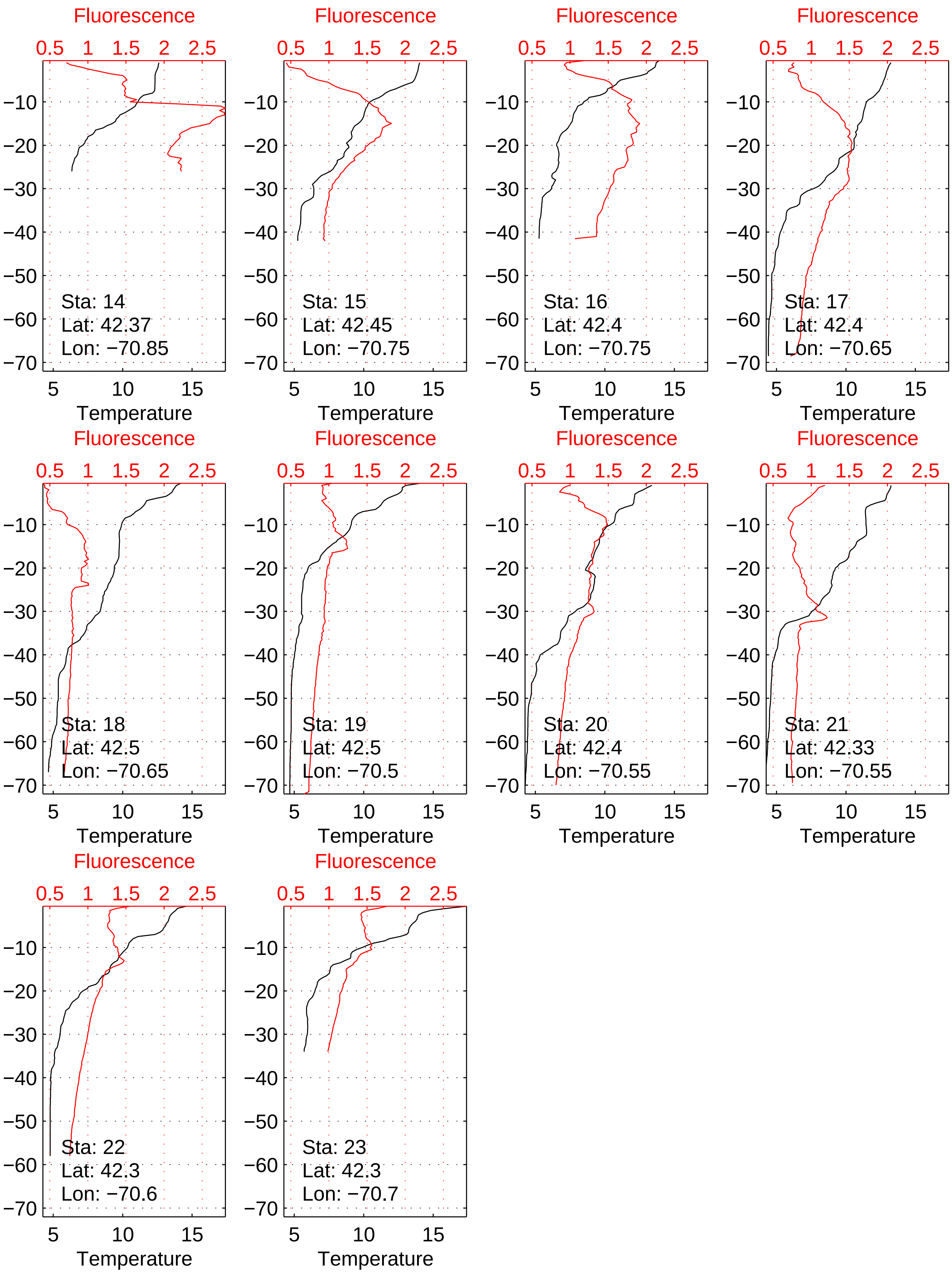


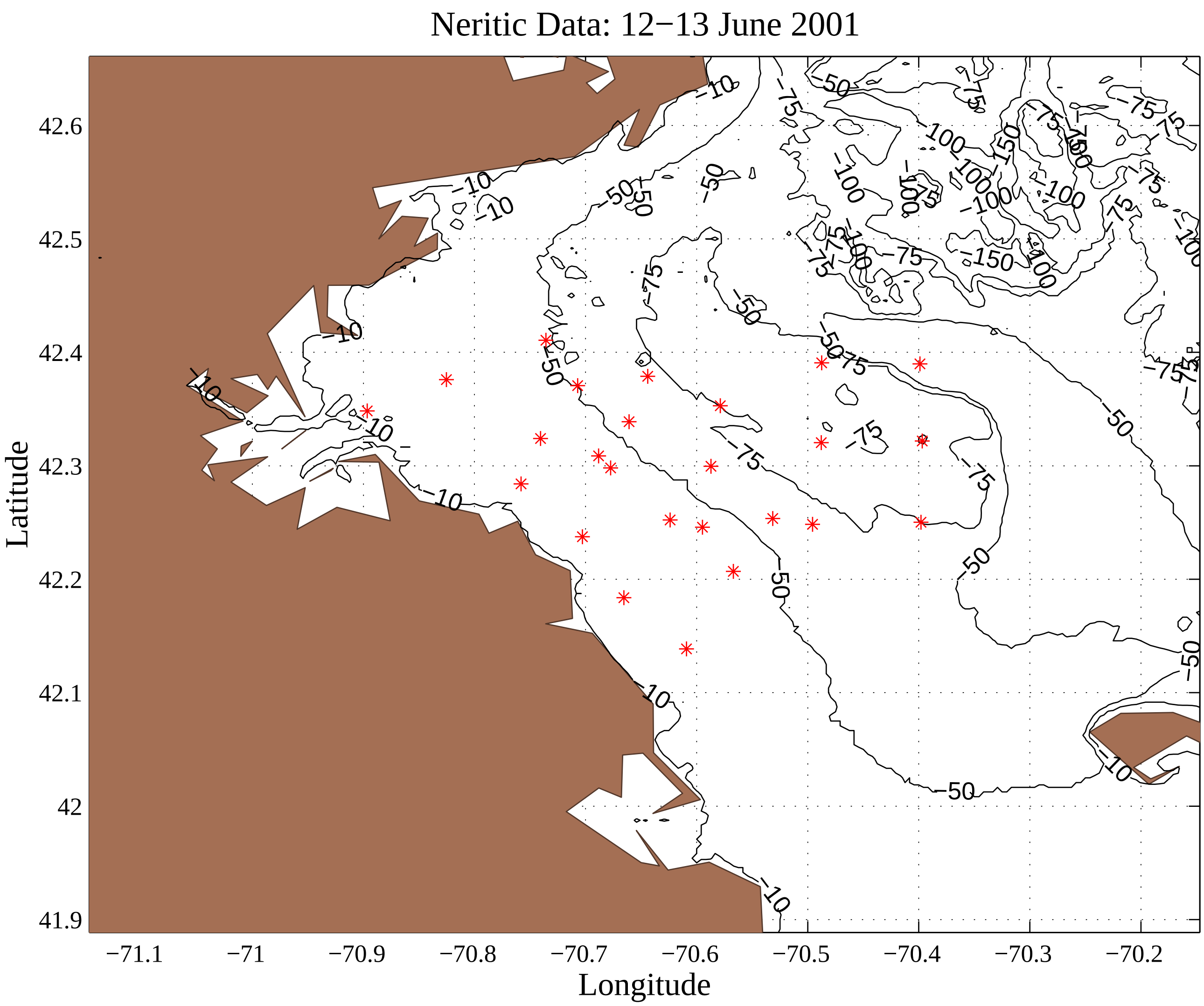
Neritic Data: 8−9 June 2001
Latitude
Longitude
42.7
42.6
42.5
42.4
42.3
42.2
42.1
−71
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3

Neritic Data: 8−9 June 2001



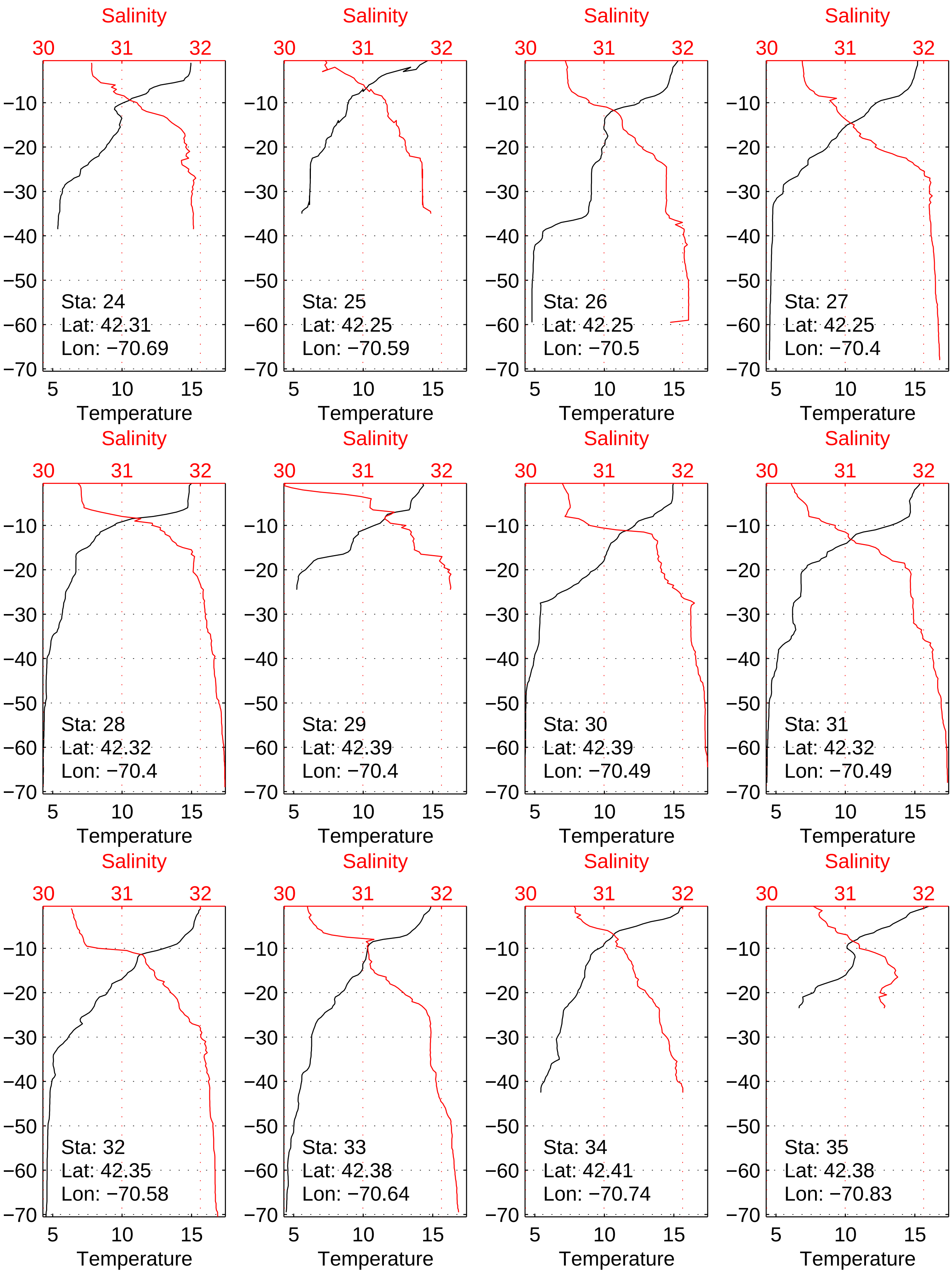
Neritic Data: 8−9 June 2001



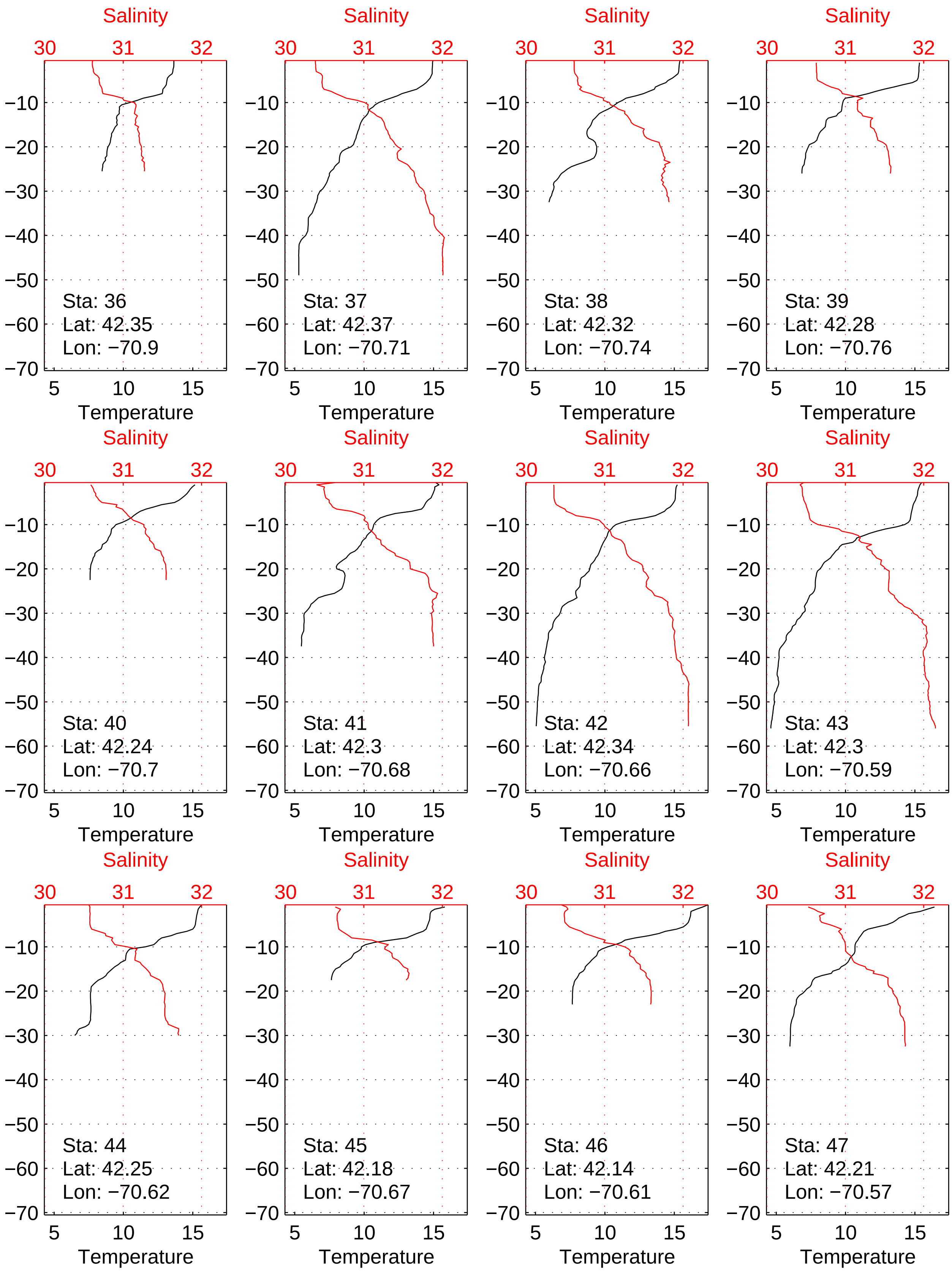


Neritic Data: 12−13 June 2001
Latitude
Longitude
42.6
42.5
42.4
42.3
42.2
42.1
42
41.9
−71.1
−71
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2

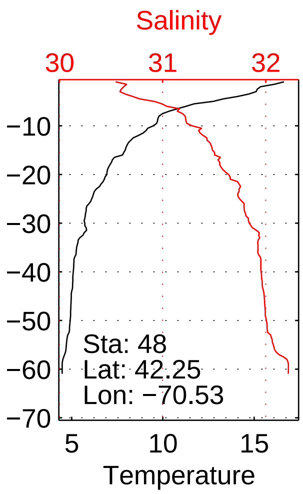
Neritic Data: 12−13 June 2001



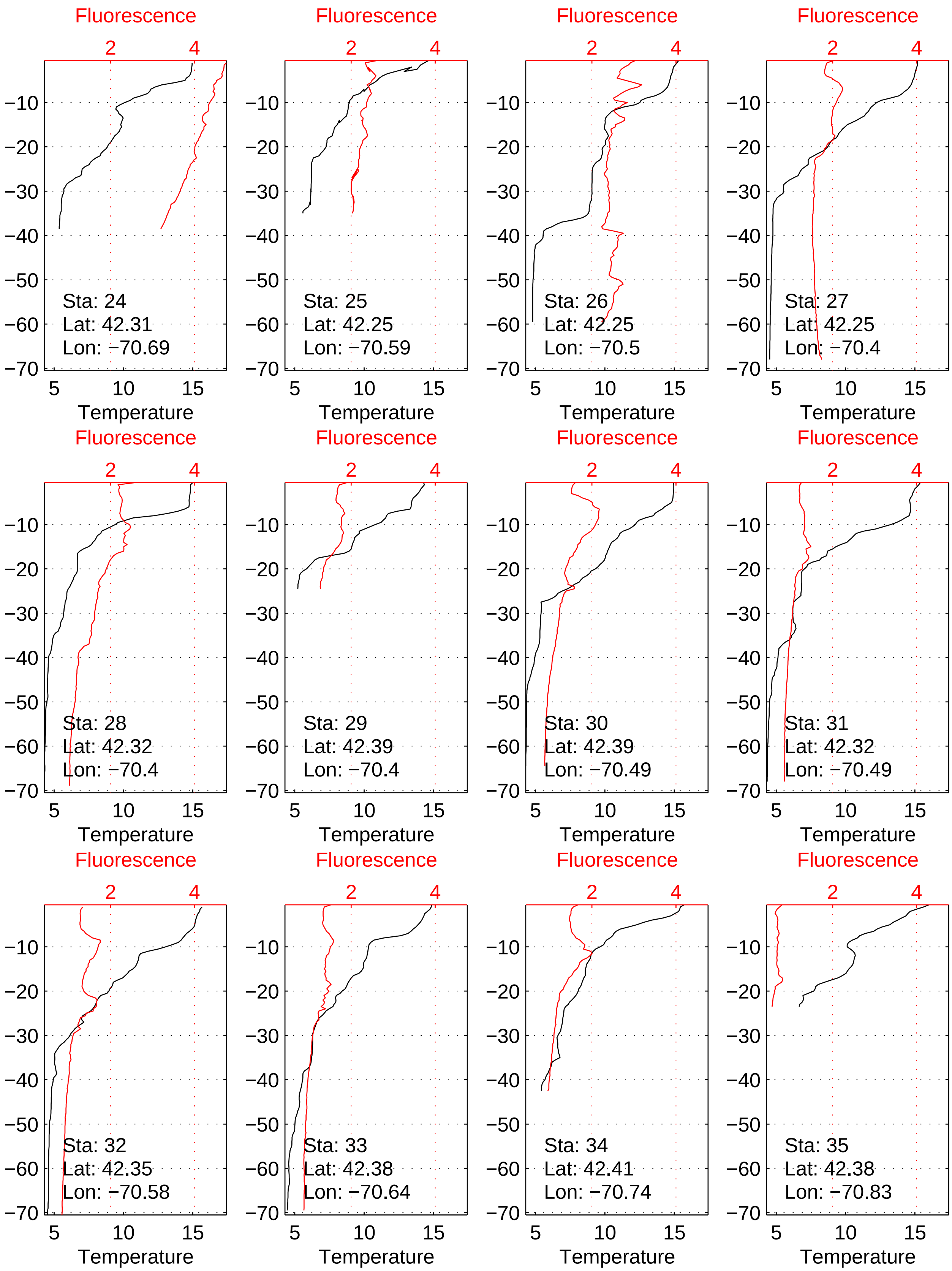
Neritic Data: 12−13 June 2001



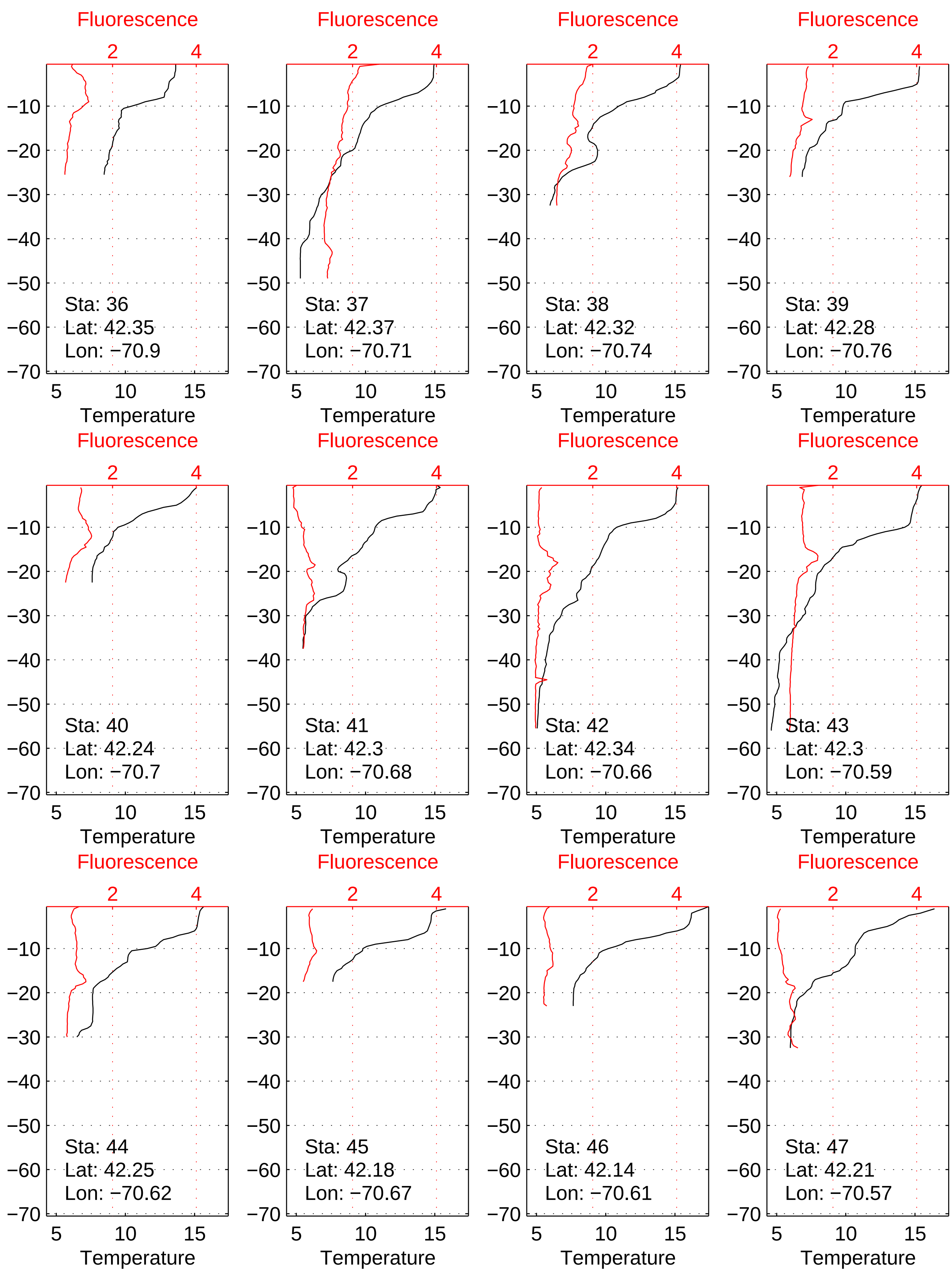
Neritic Data: 12−13 June 2001



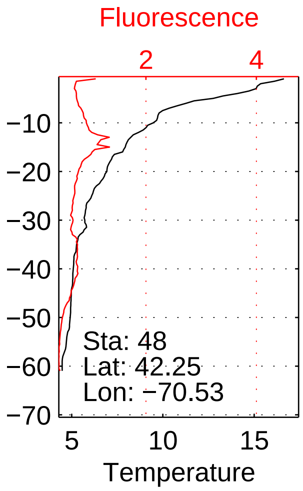
Neritic Data: 12−13 June 2001



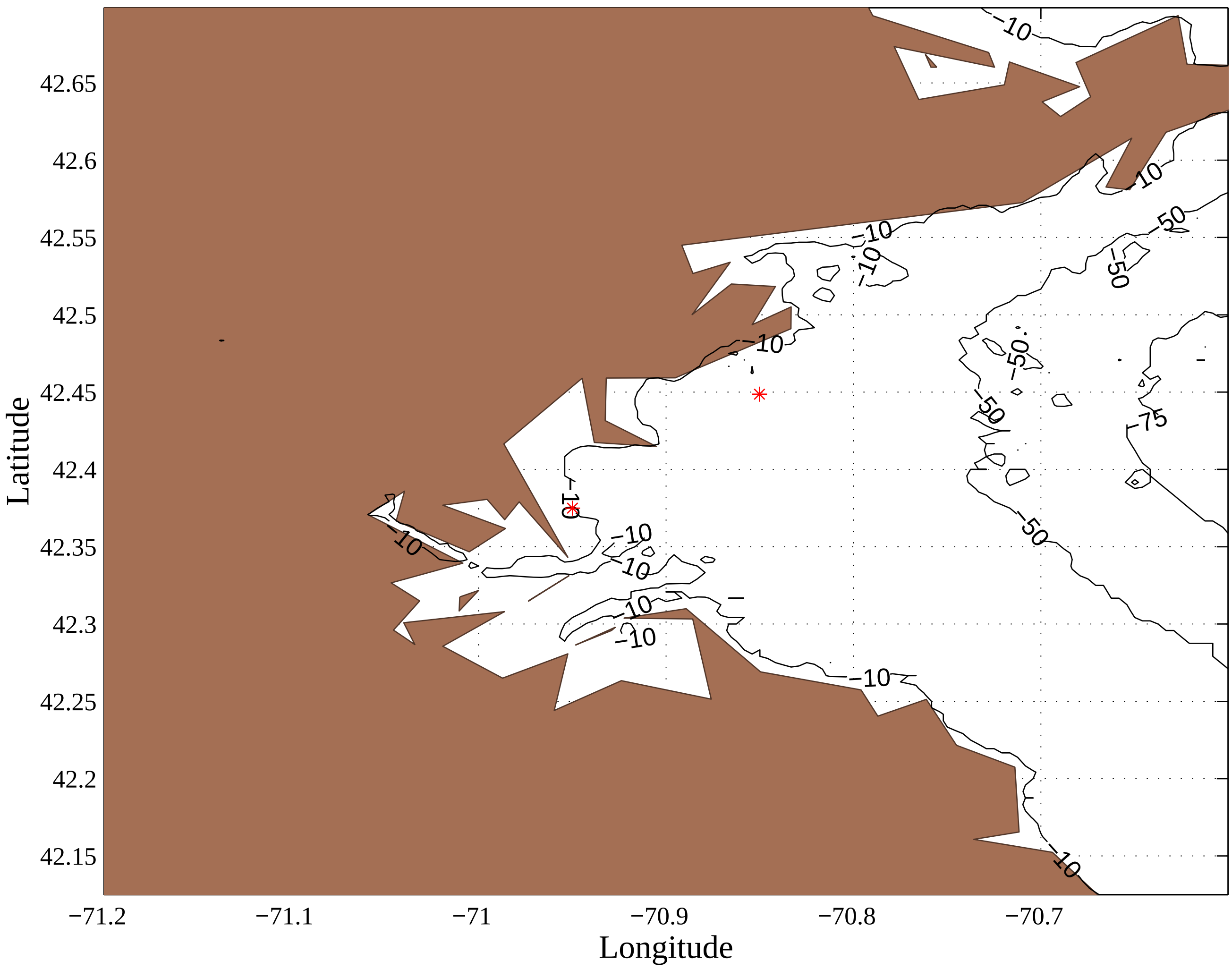
Neritic Data: 12−13 June 2001



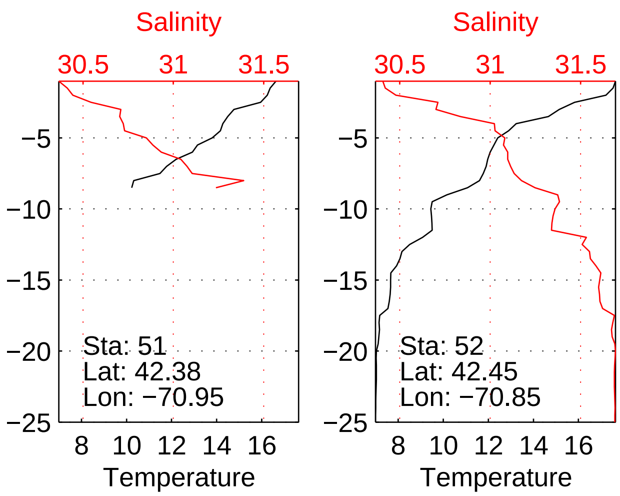
Neritic Data: 12−13 June 2001



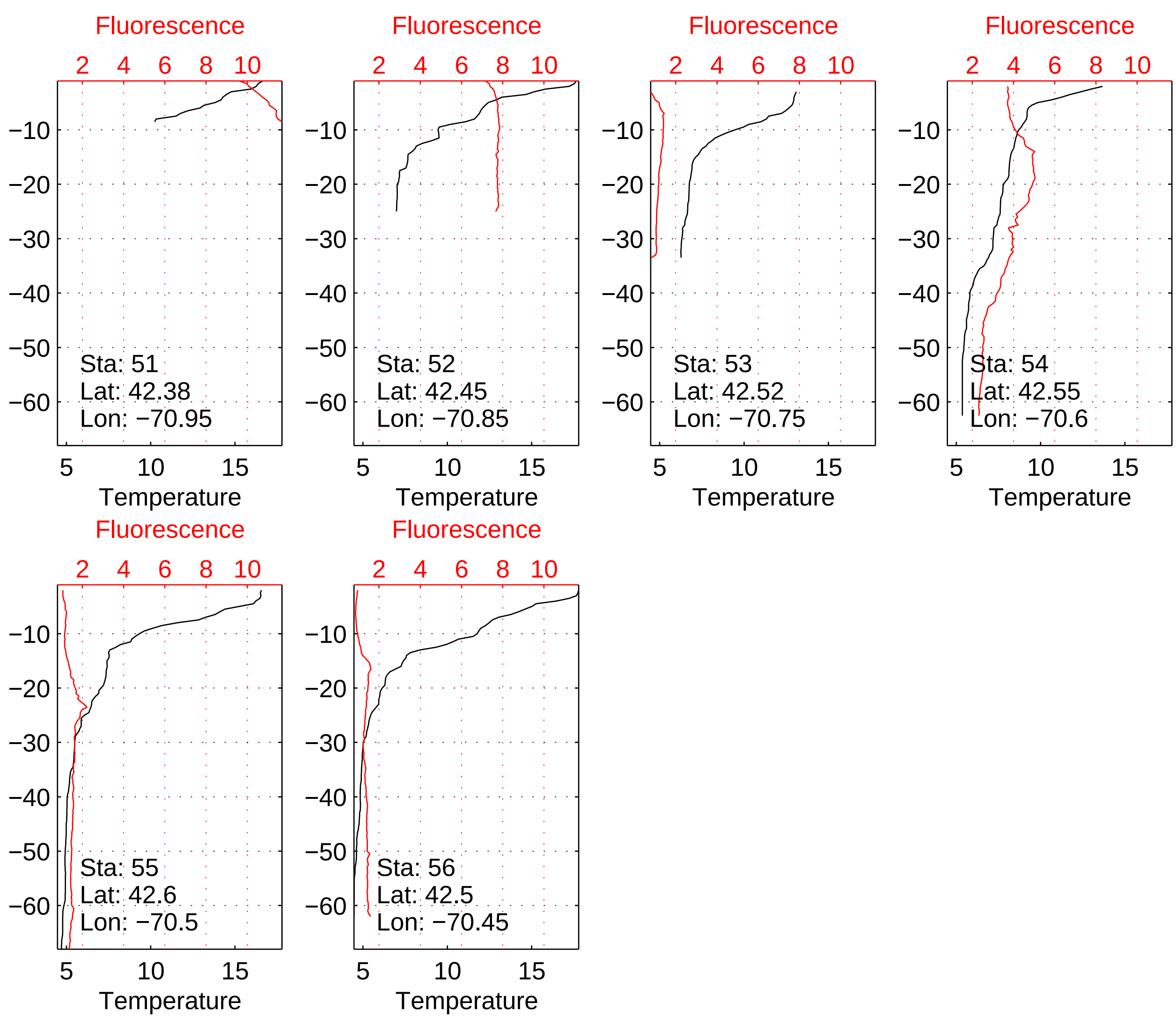
Neritic Data: 24−25 June 2001



Neritic Data: 24−25 June 2001



Neritic Data: 24−25 June 2001

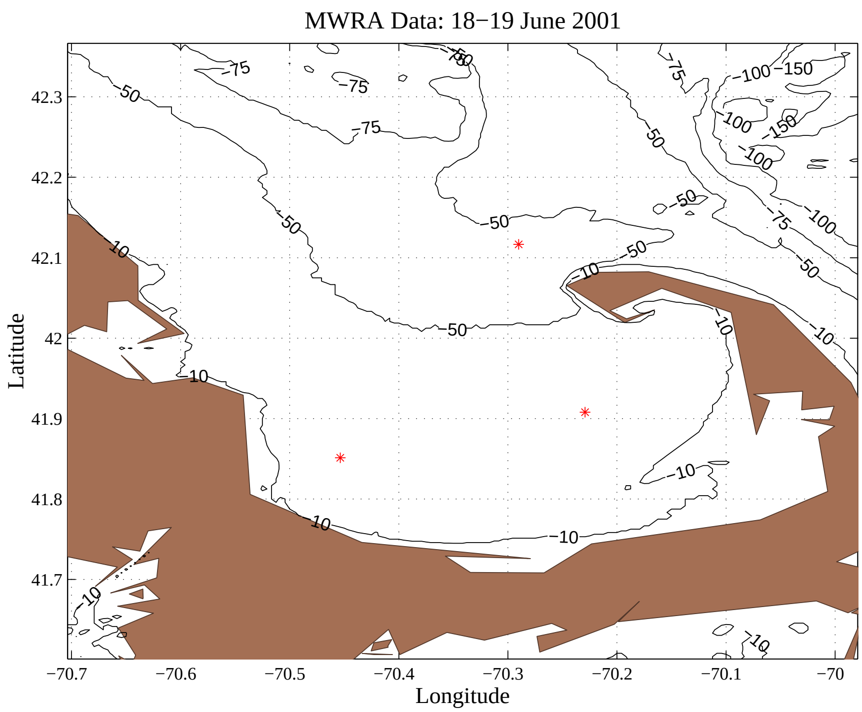


RV Aquamonitor - MWRA

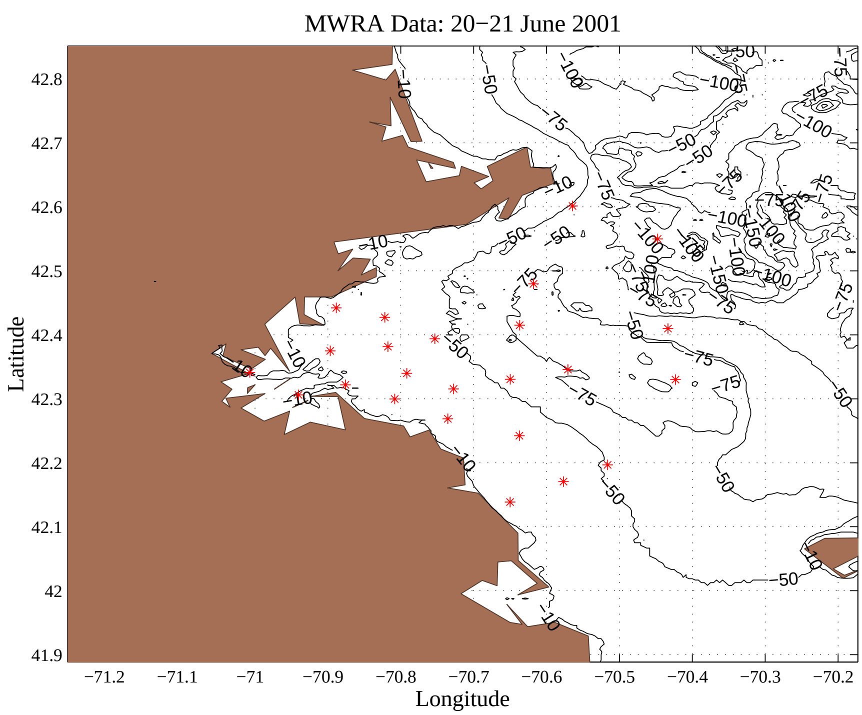
The Massachusetts Water Resources Authority (MWRA), aboard the RV Aquamonitor, collected 27 CTD stations over the period 19-21 June 2001 in Massachusetts Bay as part of an ongoing program of water quality monitoring. The data provided here is from survey WF017 and was transferred prior to undergoing the standard MWRA quality control procedures.

Station positions have been plotted for the standard two-day composites. Vertical profiles of temperature, salinity, and fluorescence are included for each station. Axes are uniform among the plots included in each two-day grouping but not from one grouping to the next.

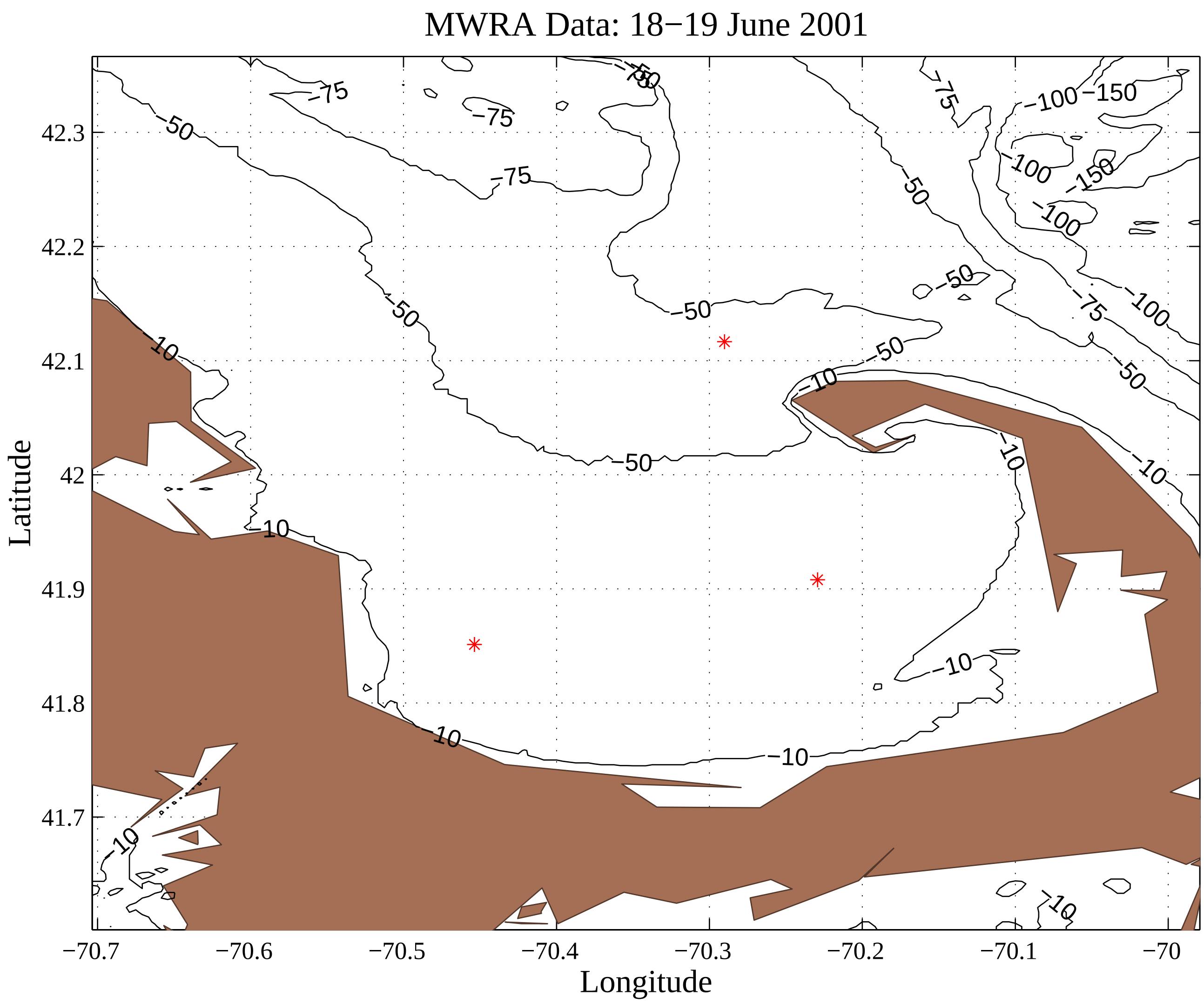
The fluorescence data from the individual vessels can not be compared directly. Calibration of this data is ongoing. Of most interest at this time is the profile structure, rather than the specific numbers.



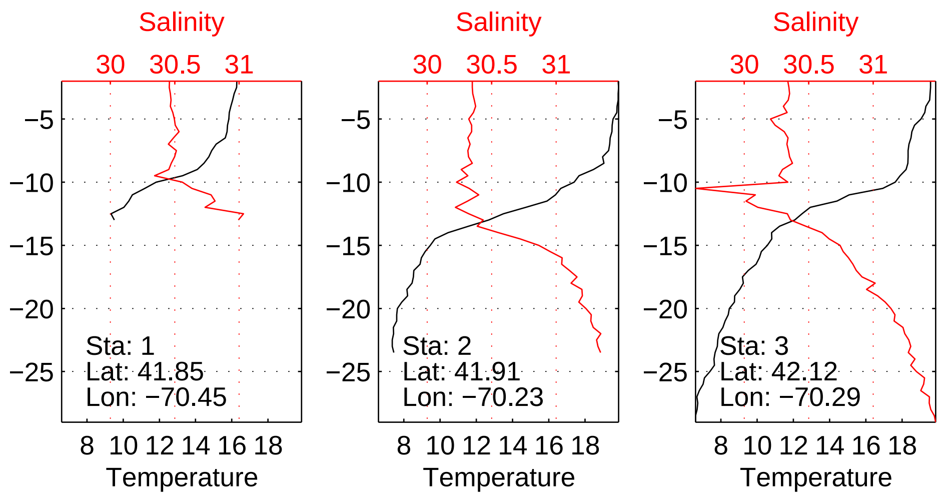
MWRA Data: 18−19 June 2001
Latitude
Longitude



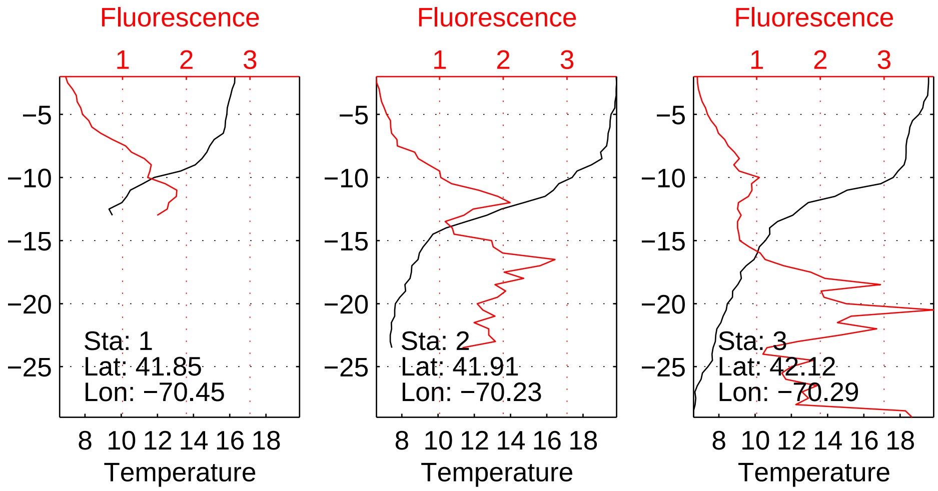
MWRA Data: 20−21 June 2001
Latitude
Longitude

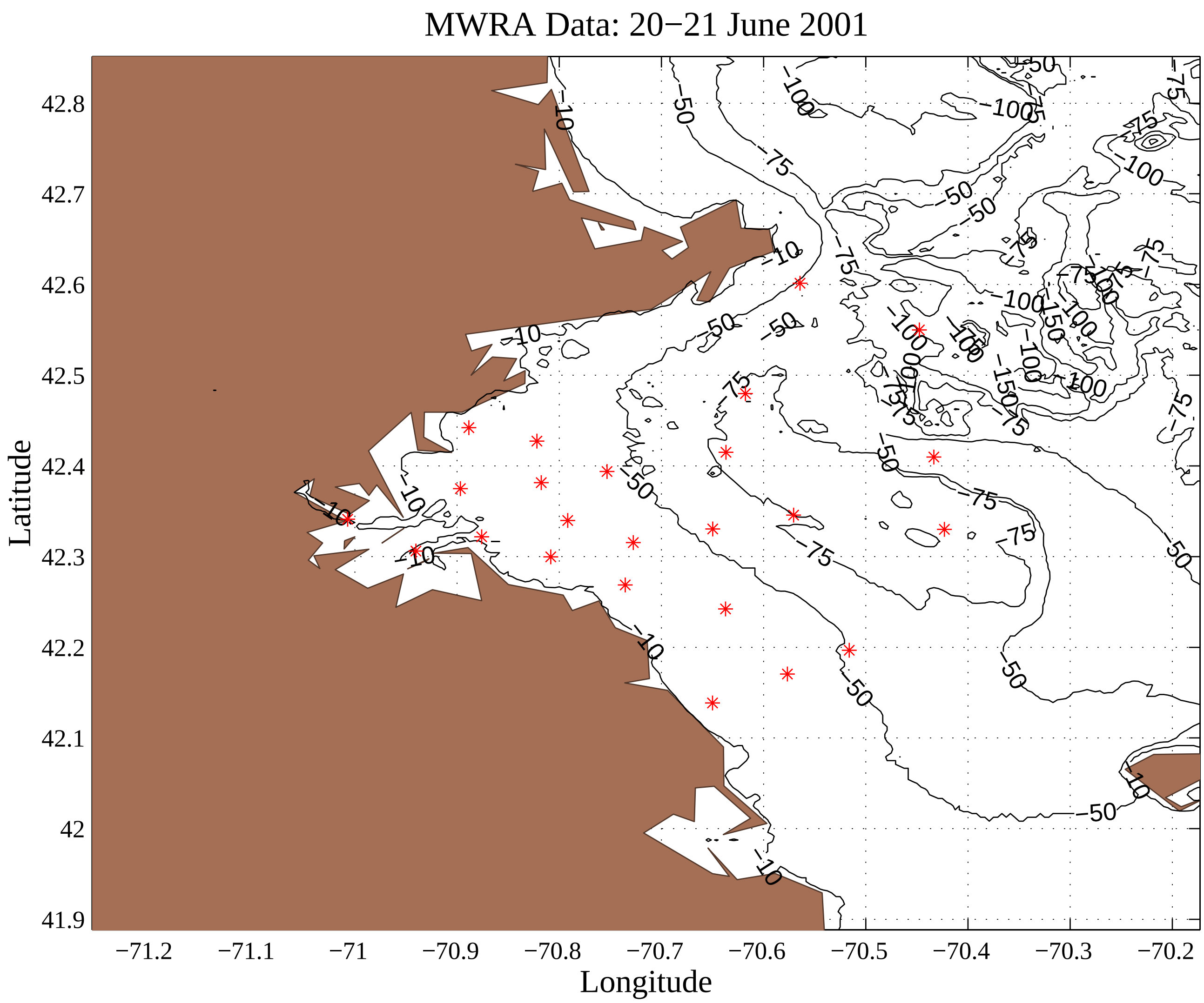

MWRA Data: 18−19 June 2001
Latitude
Longitude
42.3
42.2
42.1
42
41.9
41.8
41.7
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2
−70.1
−70
−10
−50
−75
−100
−150

MWRA Data: 18−19 June 2001



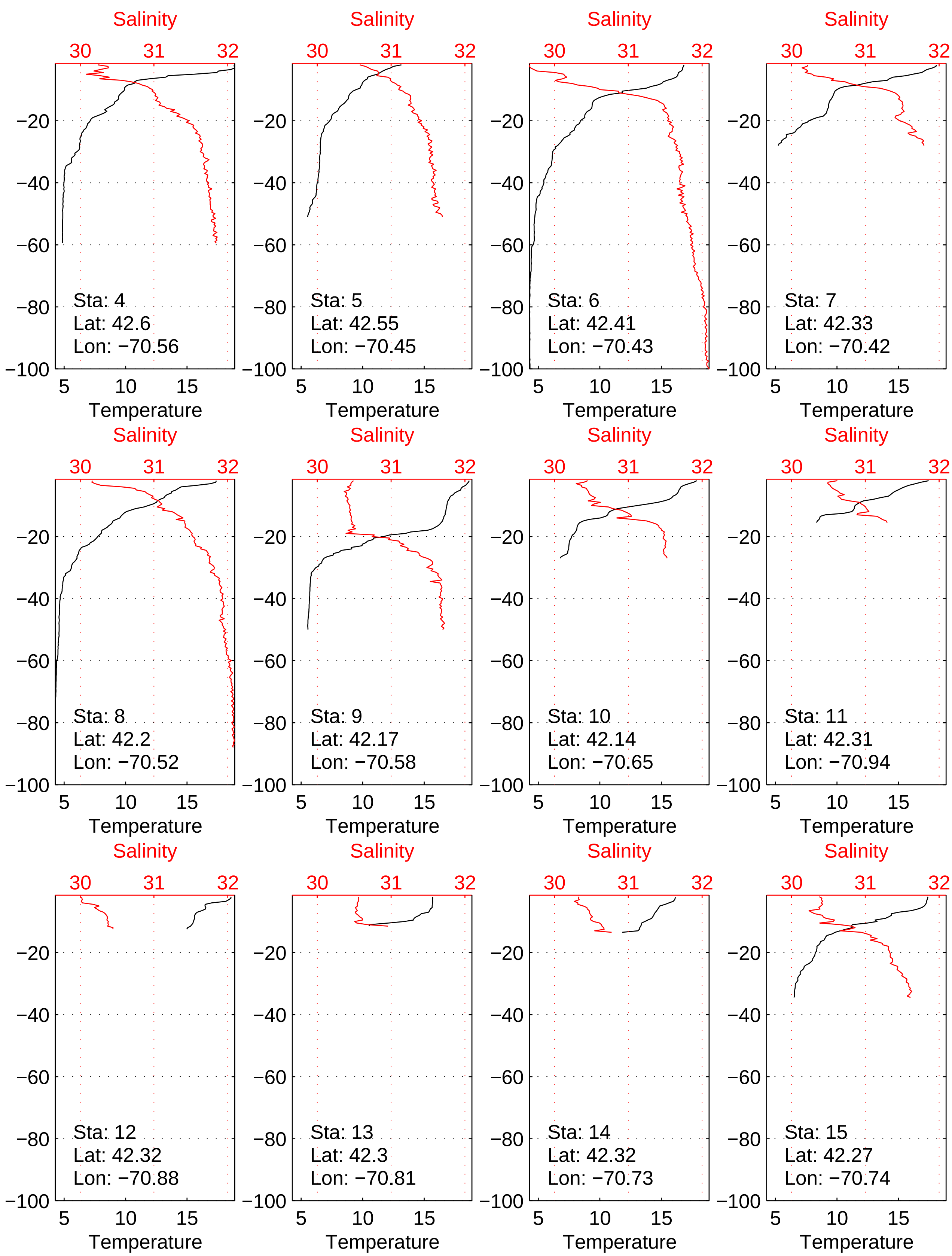
MWRA Data: 18−19 June 2001



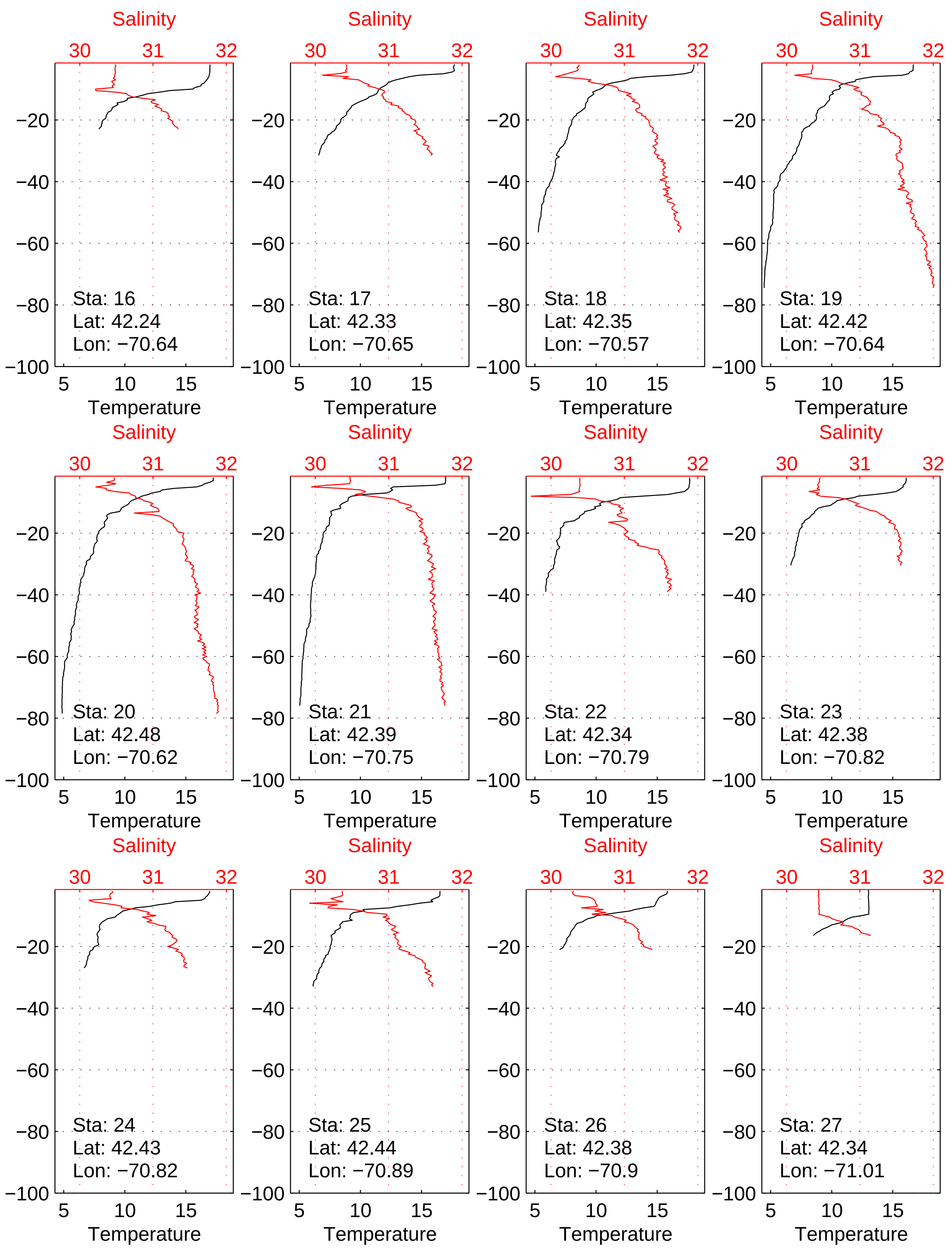


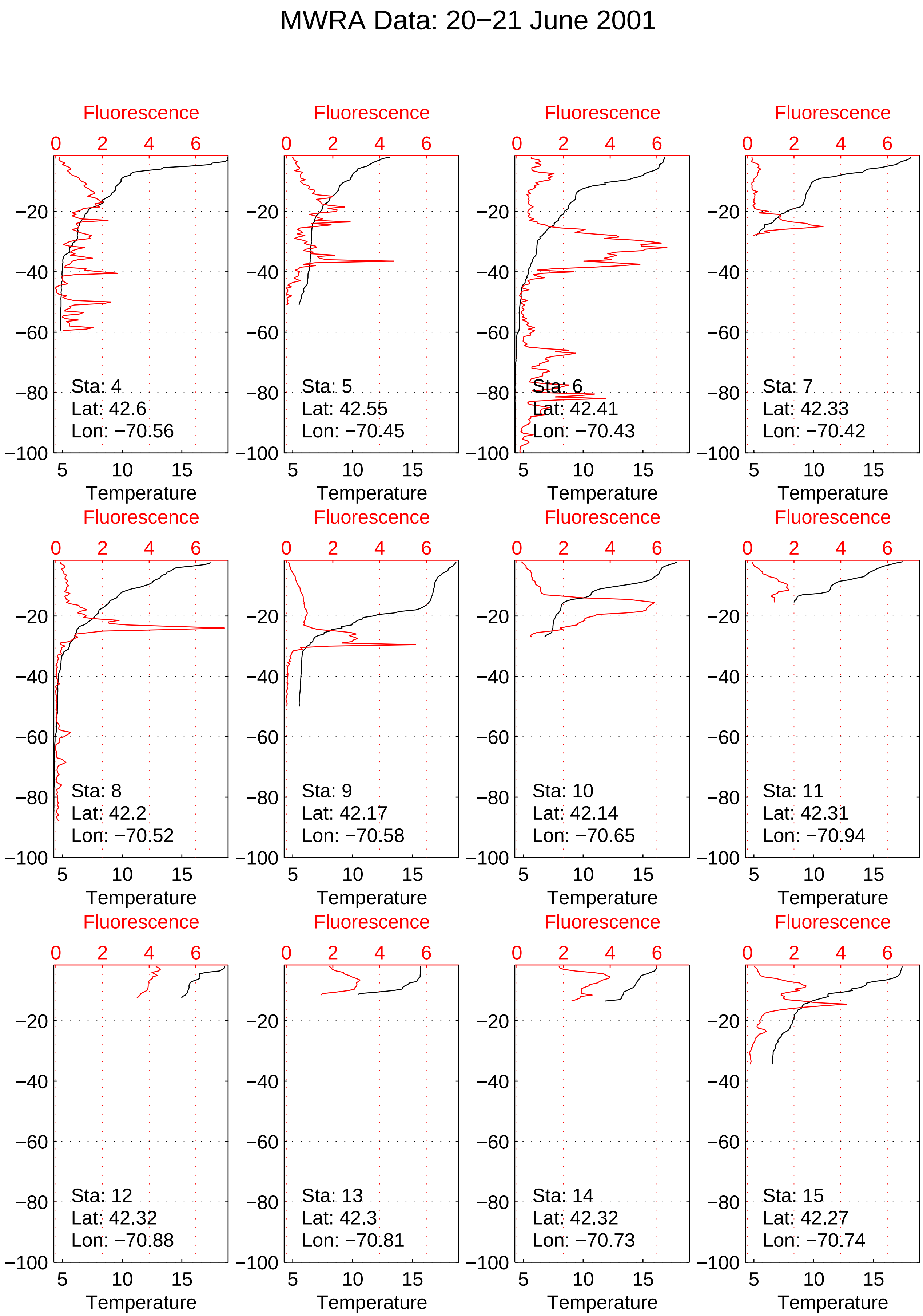
MWRA Data: 20−21 June 2001
Latitude
Longitude
42.8
42.7
42.6
42.5
42.4
42.3
42.2
42.1
42
41.9
−71.2
−71.1
−71
−70.9
−70.8
−70.7
−70.6
−70.5
−70.4
−70.3
−70.2

MWRA Data: 20−21 June 2001

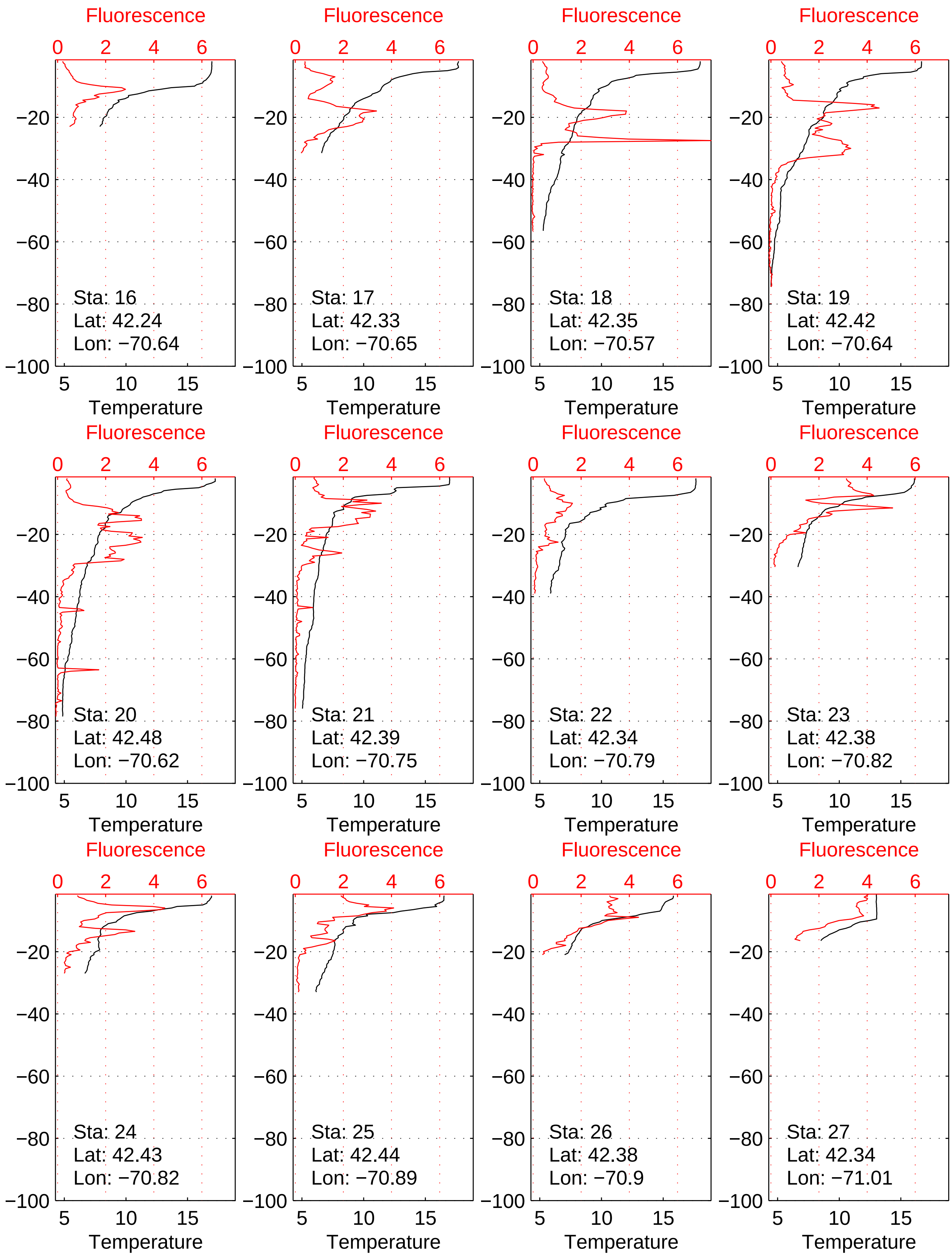


MWRA Data: 20−21 June 2001




MWRA Data: 20−21 June 2001
Fluorescence
0 2 4 6
Temperature
5 10 15
−20 −40 −60 −80 −100
Sta: 4
Lat: 42.6
Lon: −70.56
Sta: 5
Lat: 42.55
Lon: −70.45
Sta: 6
Lat: 42.41
Lon: −70.43
Sta: 7
Lat: 42.33
Lon: −70.42
Sta: 8
Lat: 42.2
Lon: −70.52
Sta: 9
Lat: 42.17
Lon: −70.58
Sta: 10
Lat: 42.14
Lon: −70.65
Sta: 11
Lat: 42.31
Lon: −70.94
Sta: 12
Lat: 42.32
Lon: −70.88
Sta: 13
Lat: 42.3
Lon: −70.81
Sta: 14
Lat: 42.32
Lon: −70.73
Sta: 15
Lat: 42.27
Lon: −70.74

MWRA Data: 20−21 June 2001

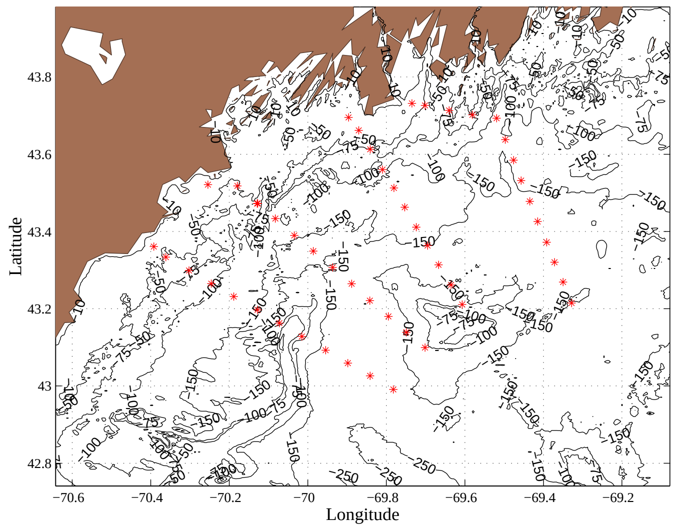


RV Oceanus

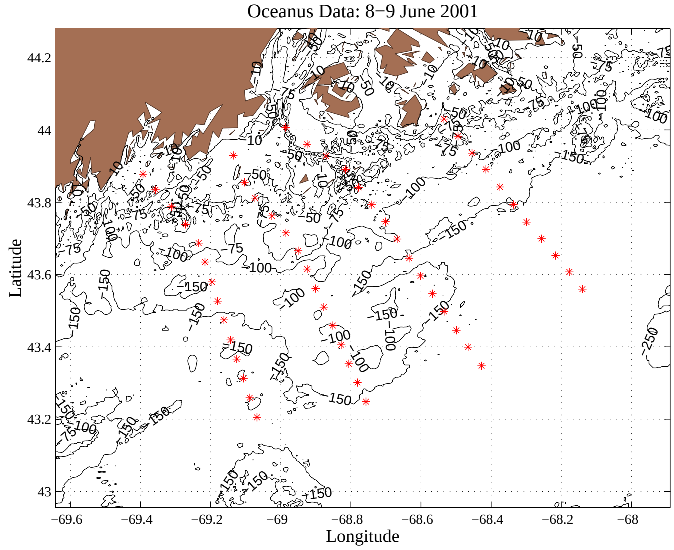
As part of the ECOHAB project, the RV Oceanus made a CTD survey on a dense station grid in the northern Gulf of Maine (OC366) during early June 2001. The profiles of temperature and salinity were made available to the ASCOT program in real time by chief scientist Jim Churchill. 121 CTD stations were performed over the period 6-11 June 2001 in the Gulf of Maine. Data were averaged over 1m depth intervals.

Station positions have been plotted first as the standard two-day composites and then as the complete cruise track. Vertical profiles of temperature and salinity are included for each station. Axes are uniform among the plots included in each two-day grouping but not from one grouping to the next.

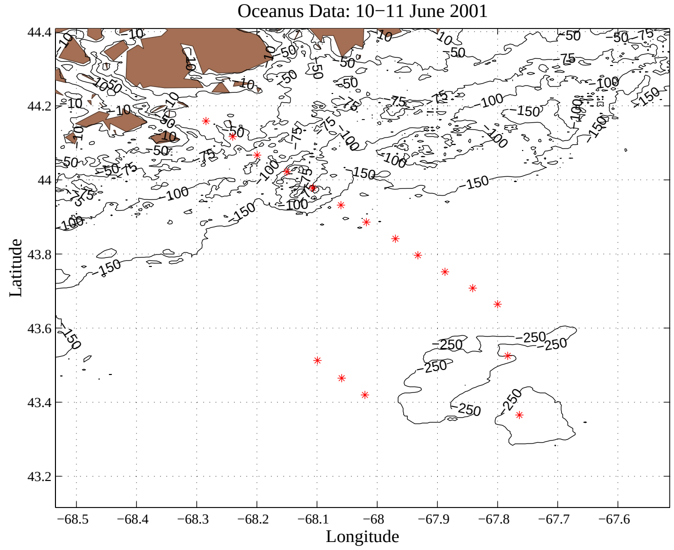
Oceanus Data: 6−7 June 2001



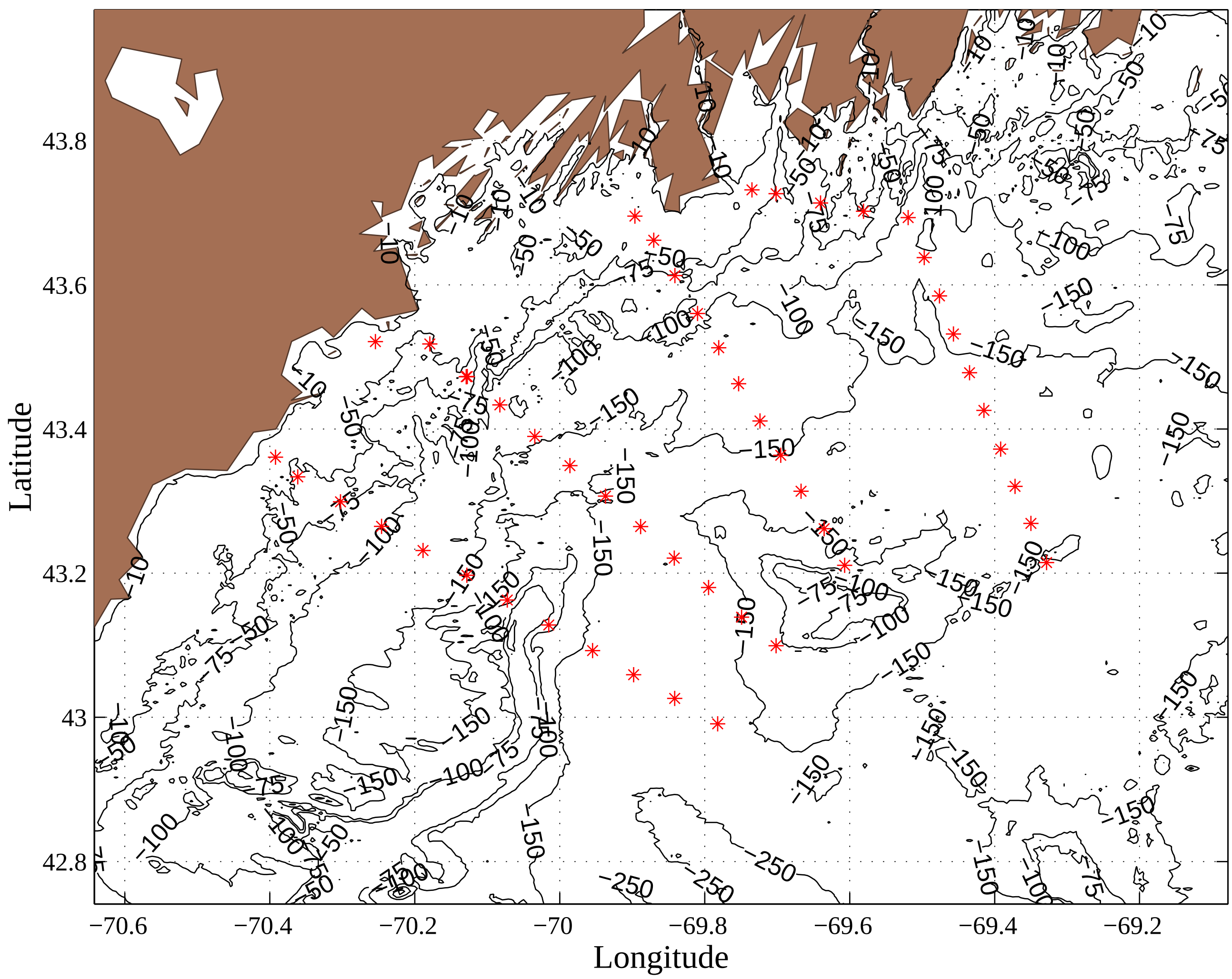
Oceanus Data: 8−9 June 2001



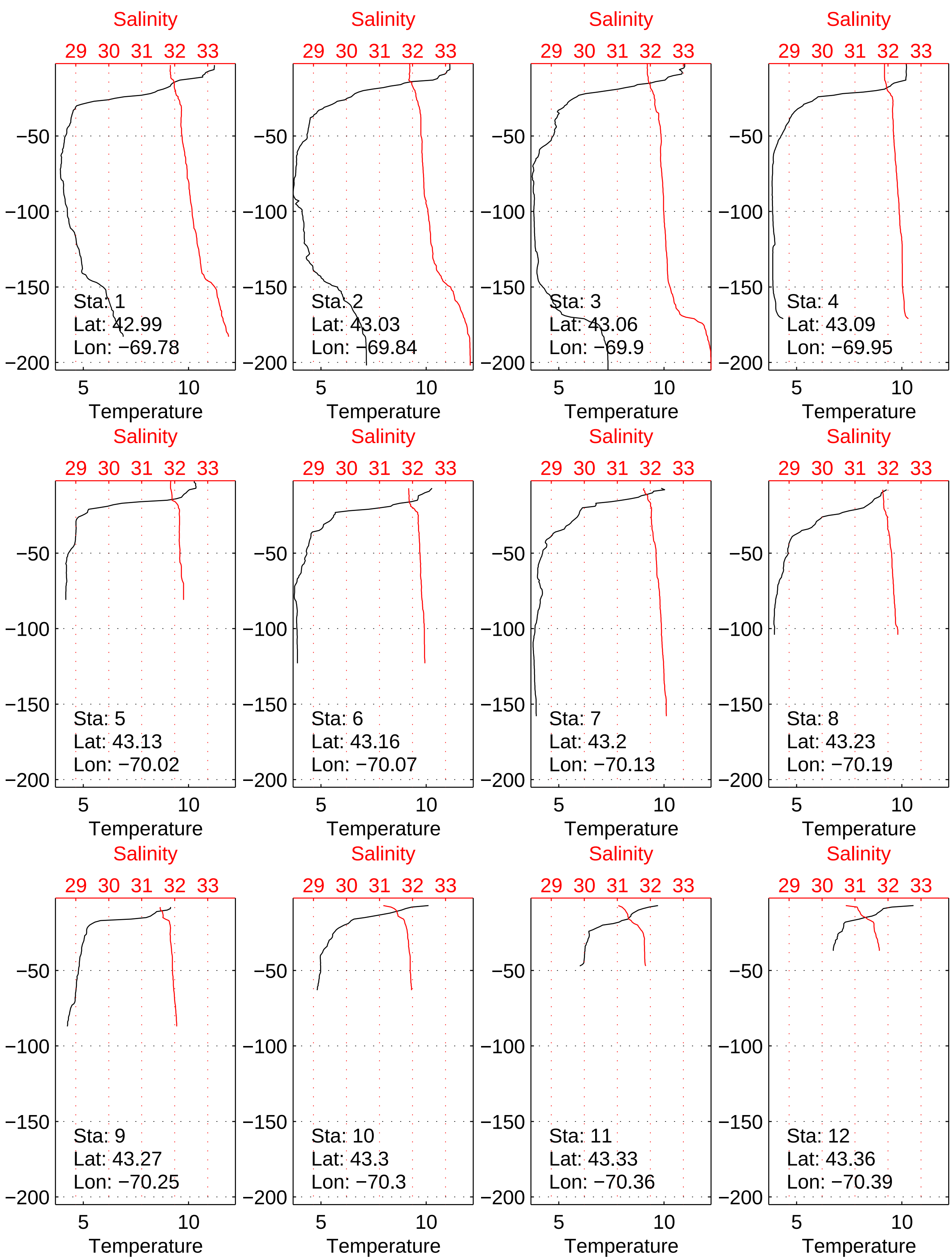
Oceanus Data: 10−11 June 2001



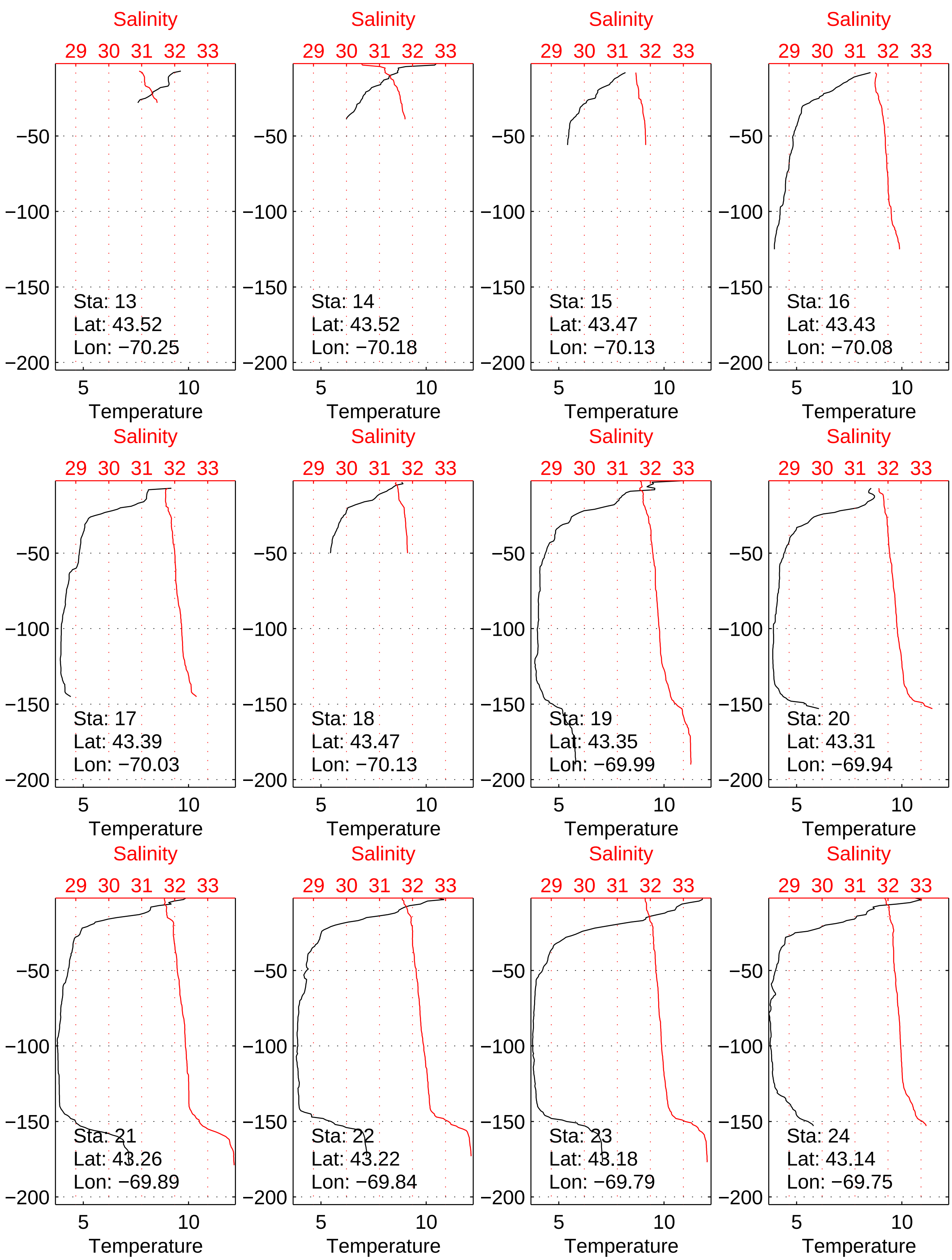
Oceanus Data: 6−7 June 2001



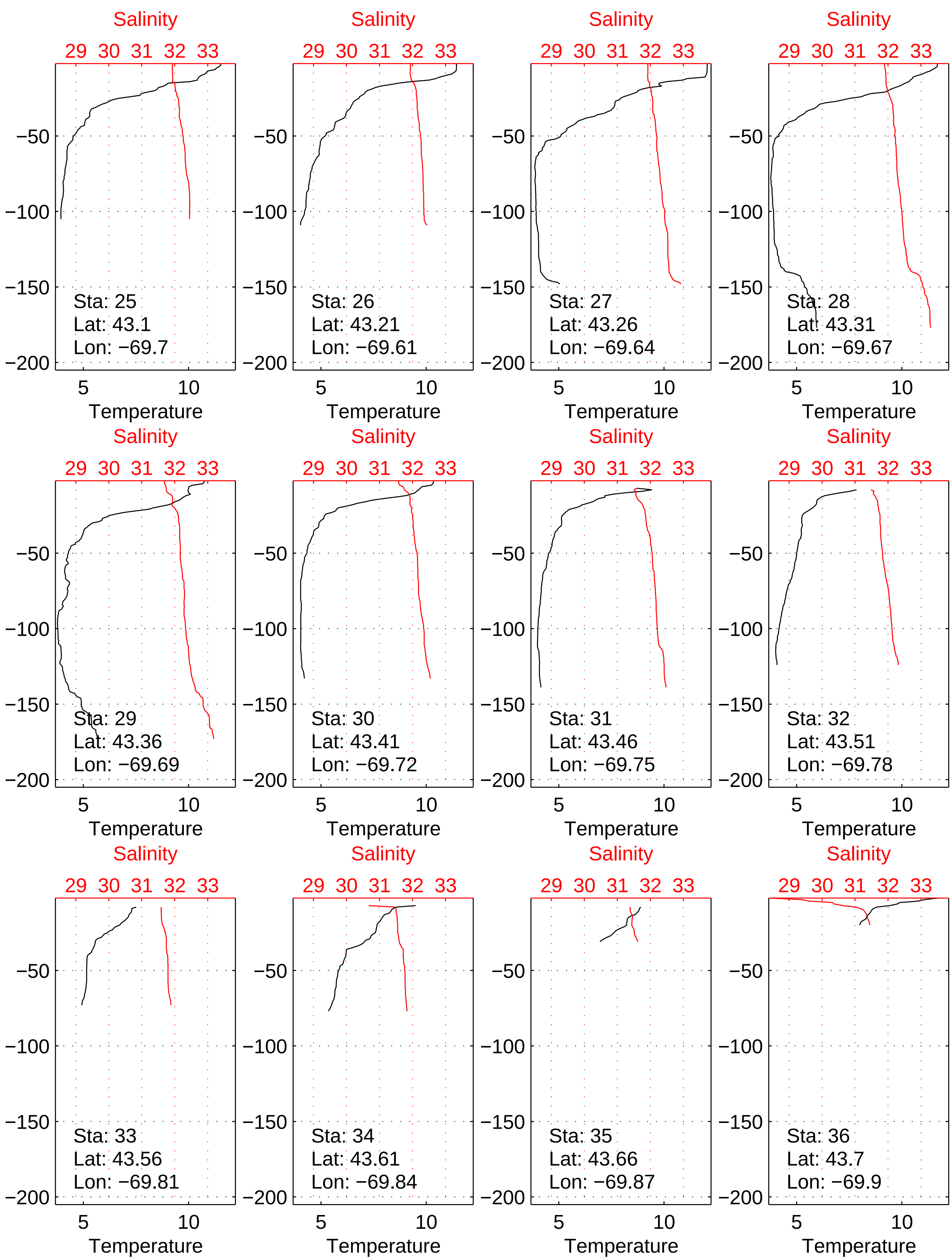
Oceanus Data: 6−7 June 2001



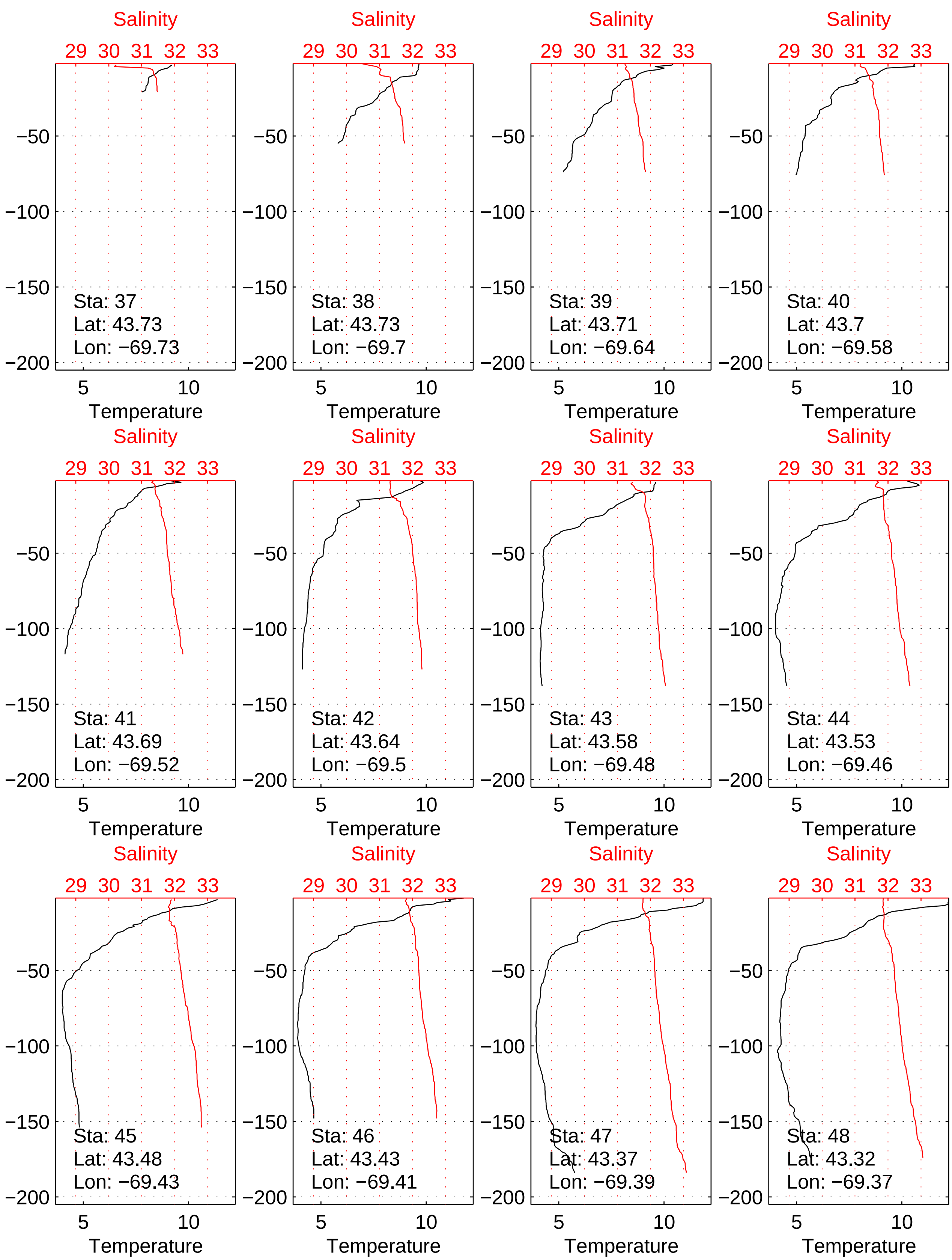
Oceanus Data: 6−7 June 2001



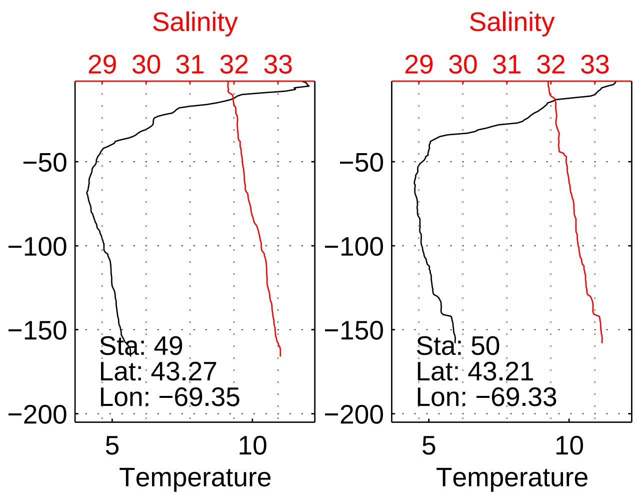
Oceanus Data: 6−7 June 2001

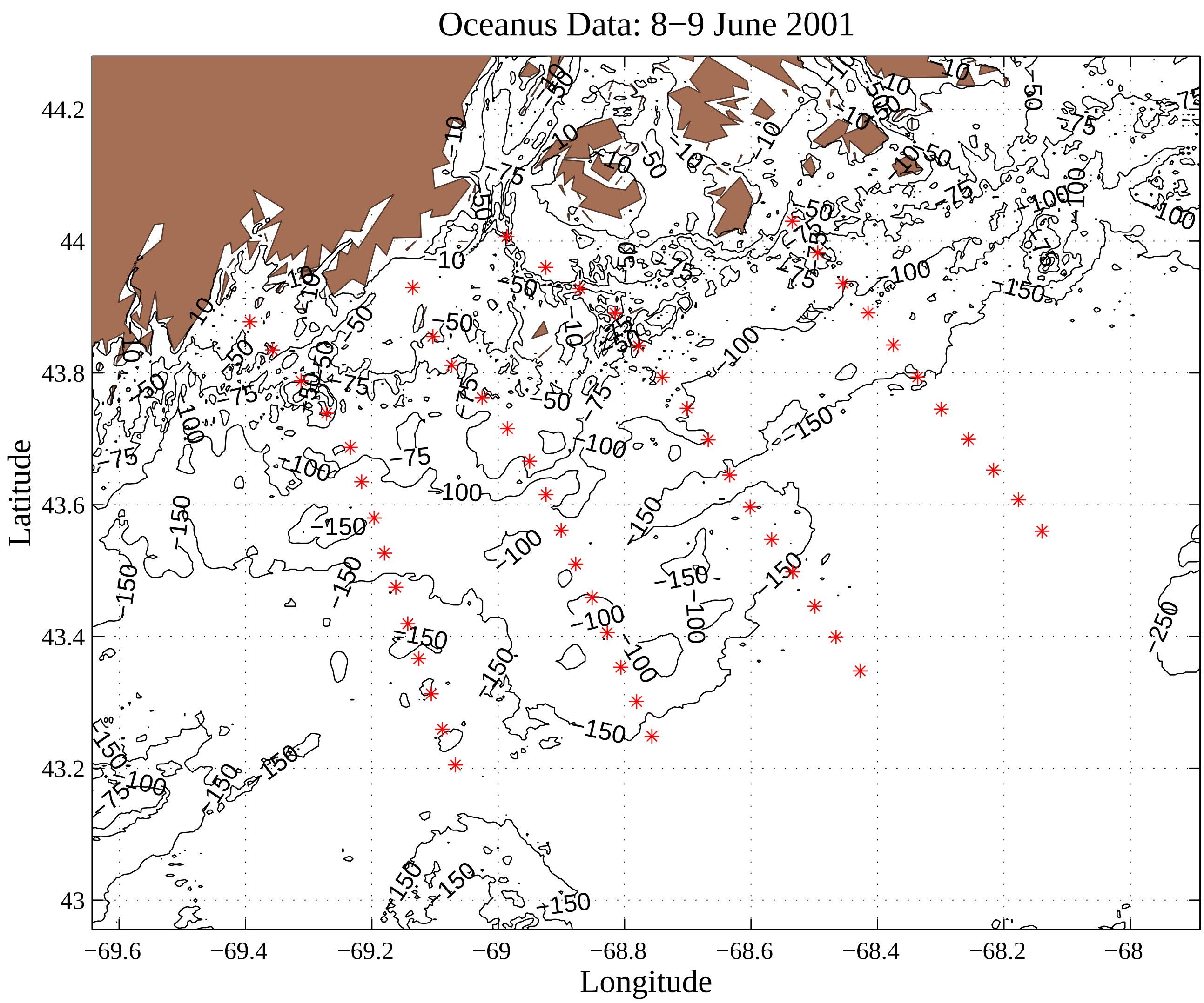


Oceanus Data: 6−7 June 2001



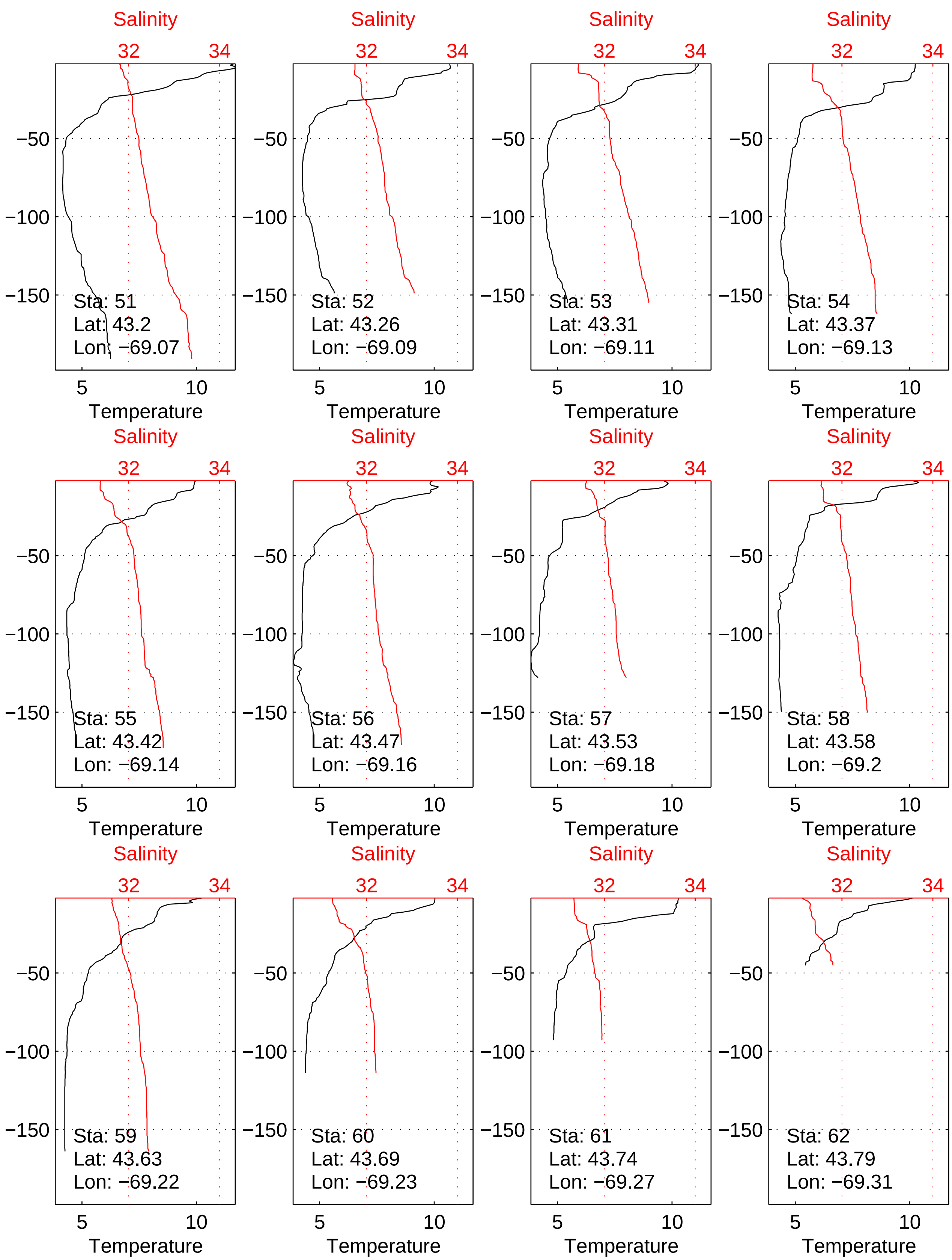
Oceanus Data: 6−7 June 2001



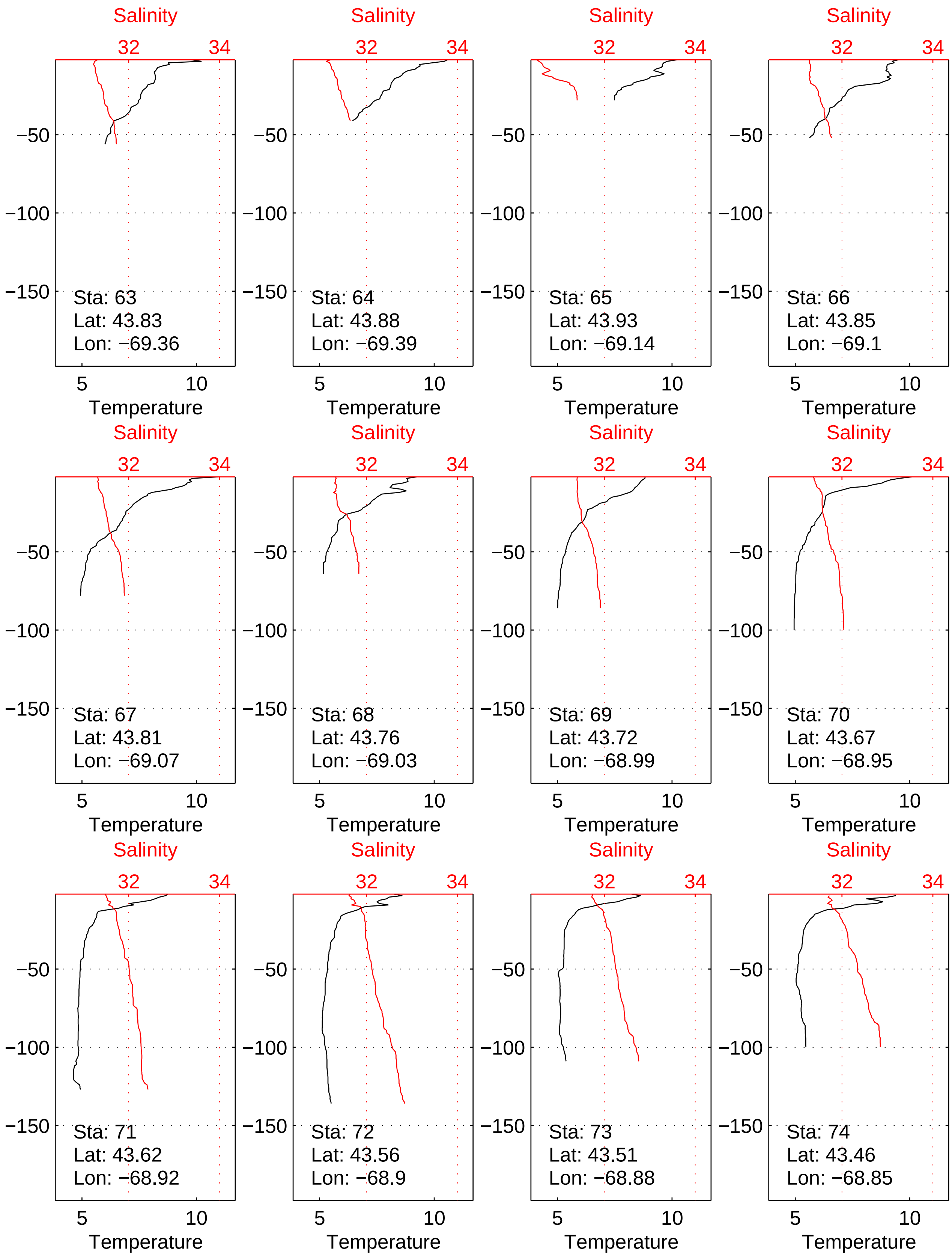


Oceanus Data: 8−9 June 2001
Latitude
Longitude
44.2
44
43.8
43.6
43.4
43.2
43
−69.6
−69.4
−69.2
−69
−68.8
−68.6
−68.4
−68.2
−68

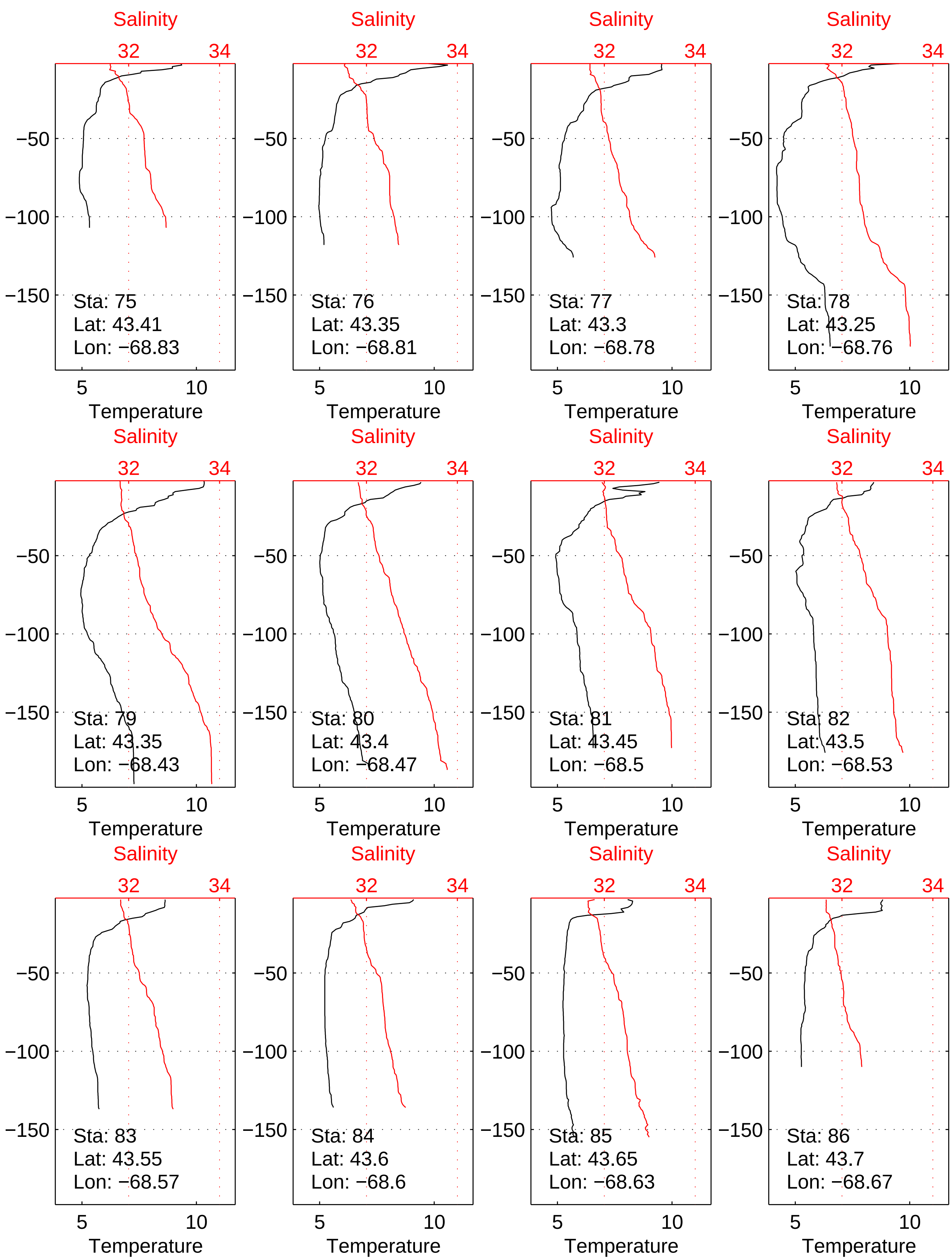
Oceanus Data: 8−9 June 2001



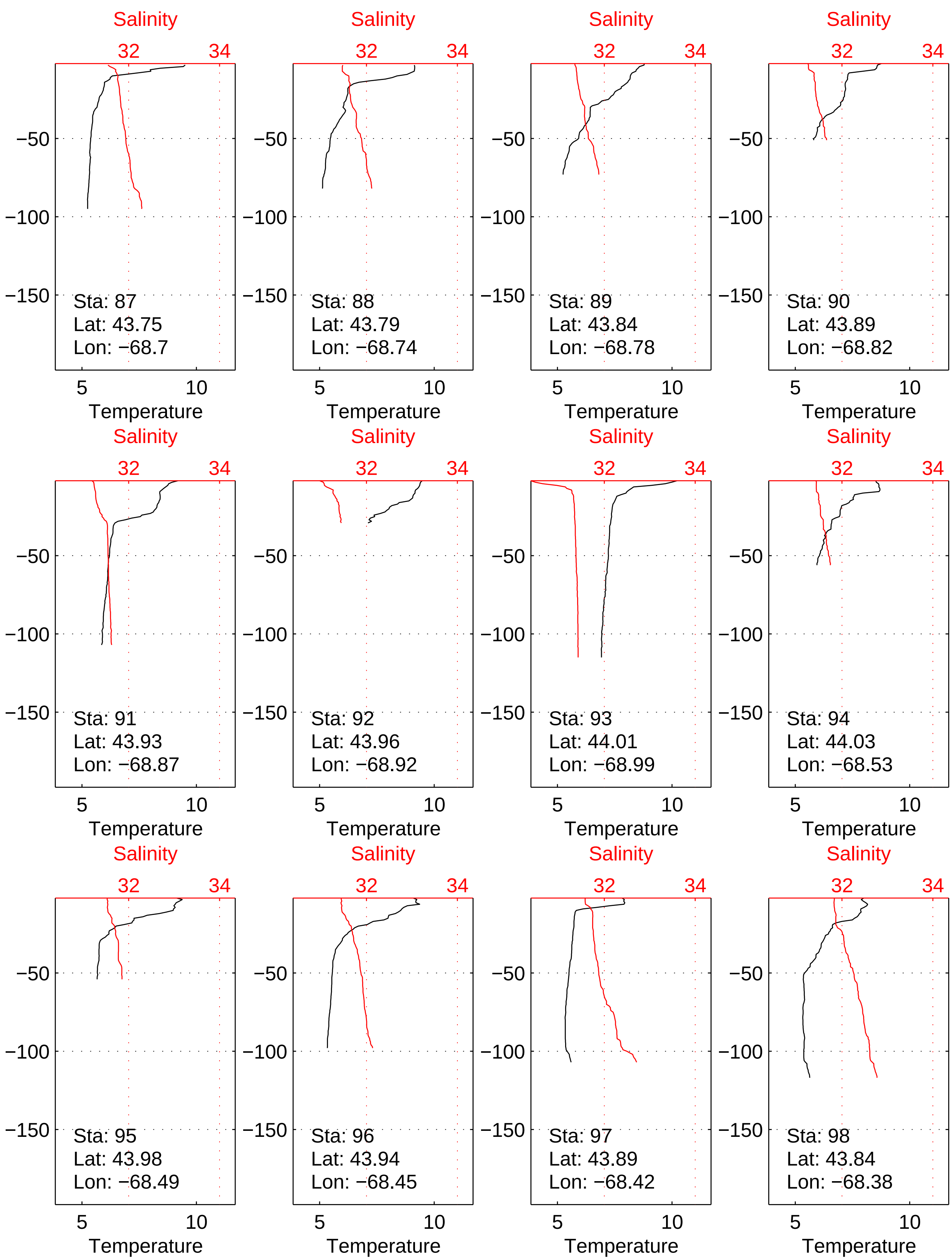
Oceanus Data: 8−9 June 2001



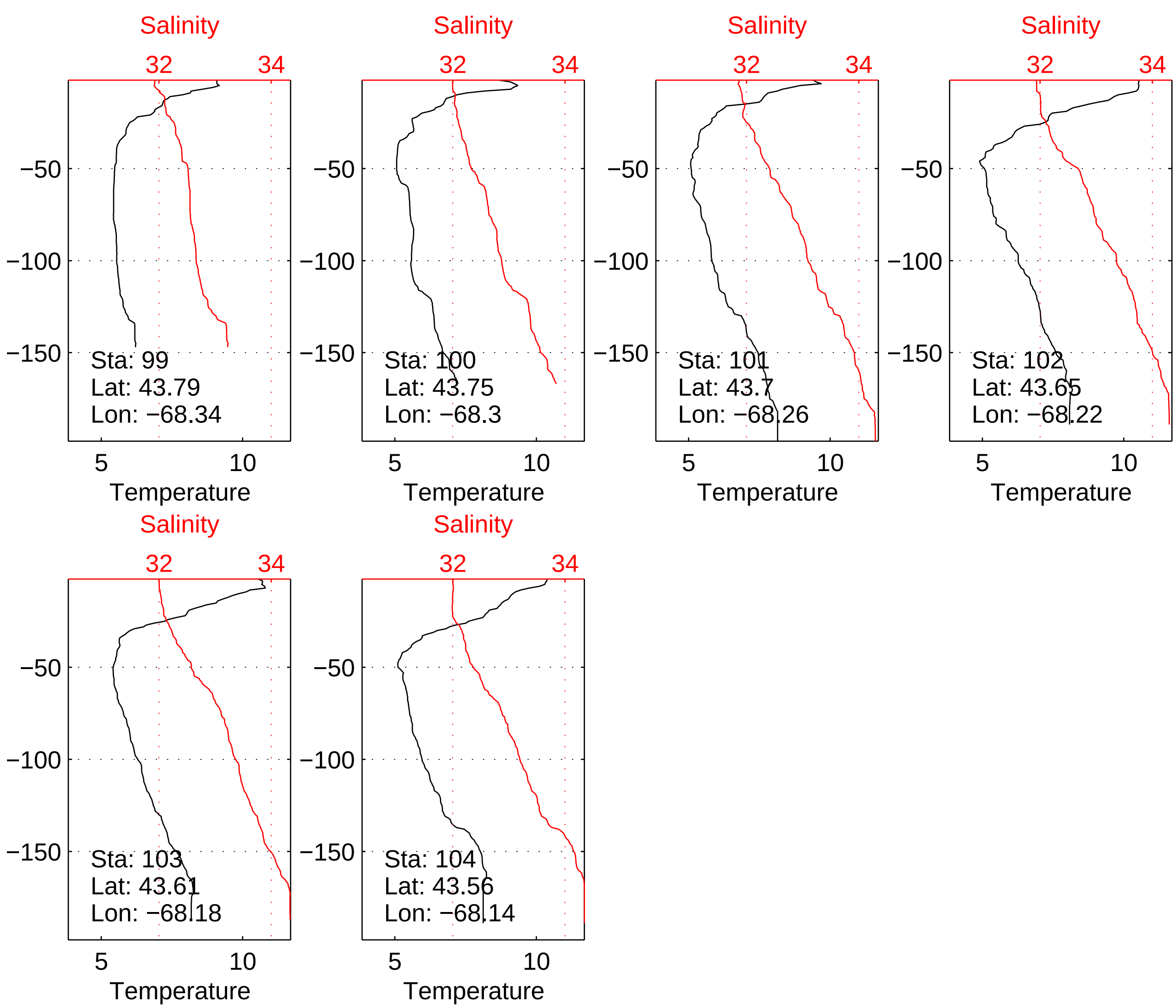
Oceanus Data: 8−9 June 2001

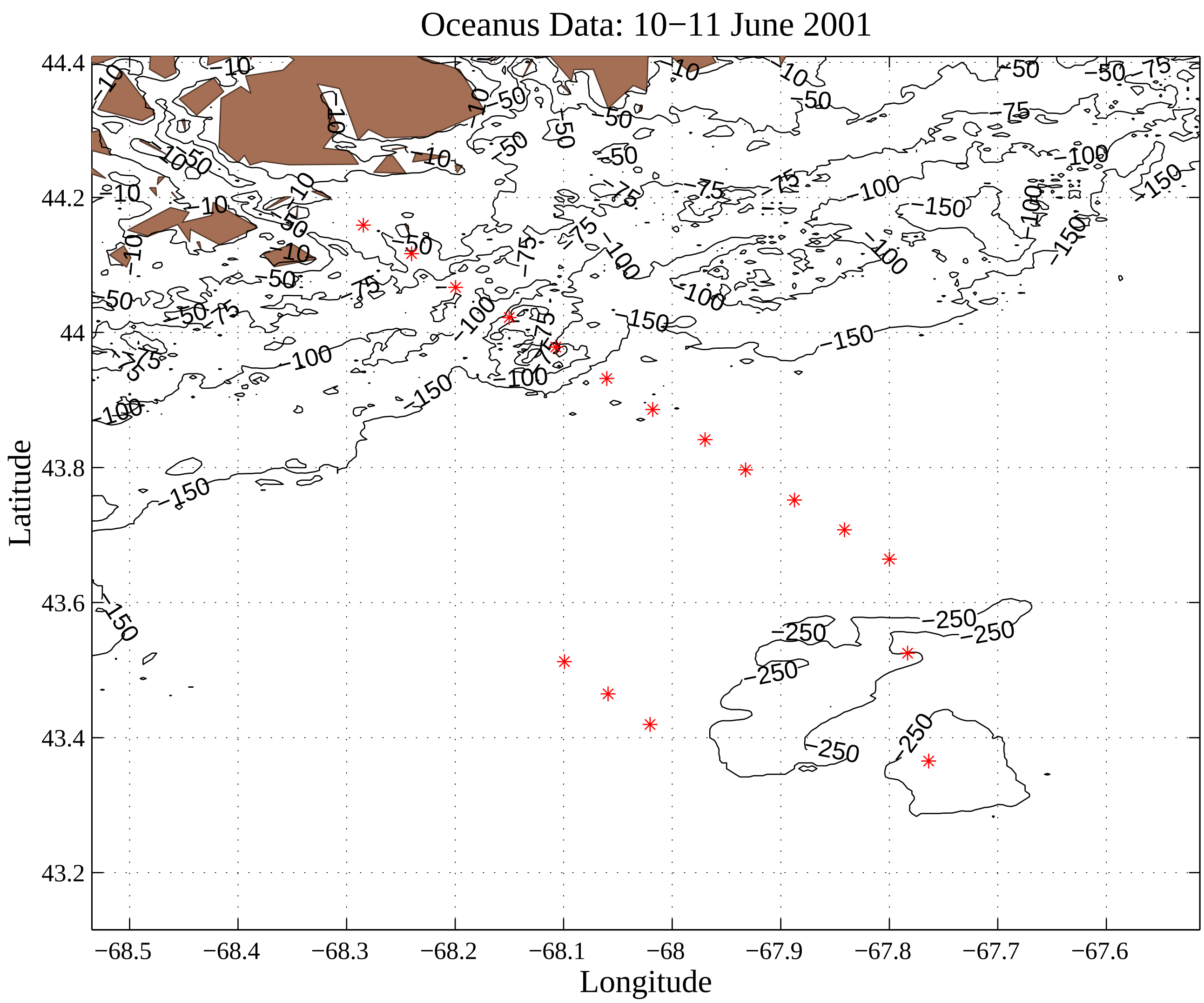


Oceanus Data: 8−9 June 2001



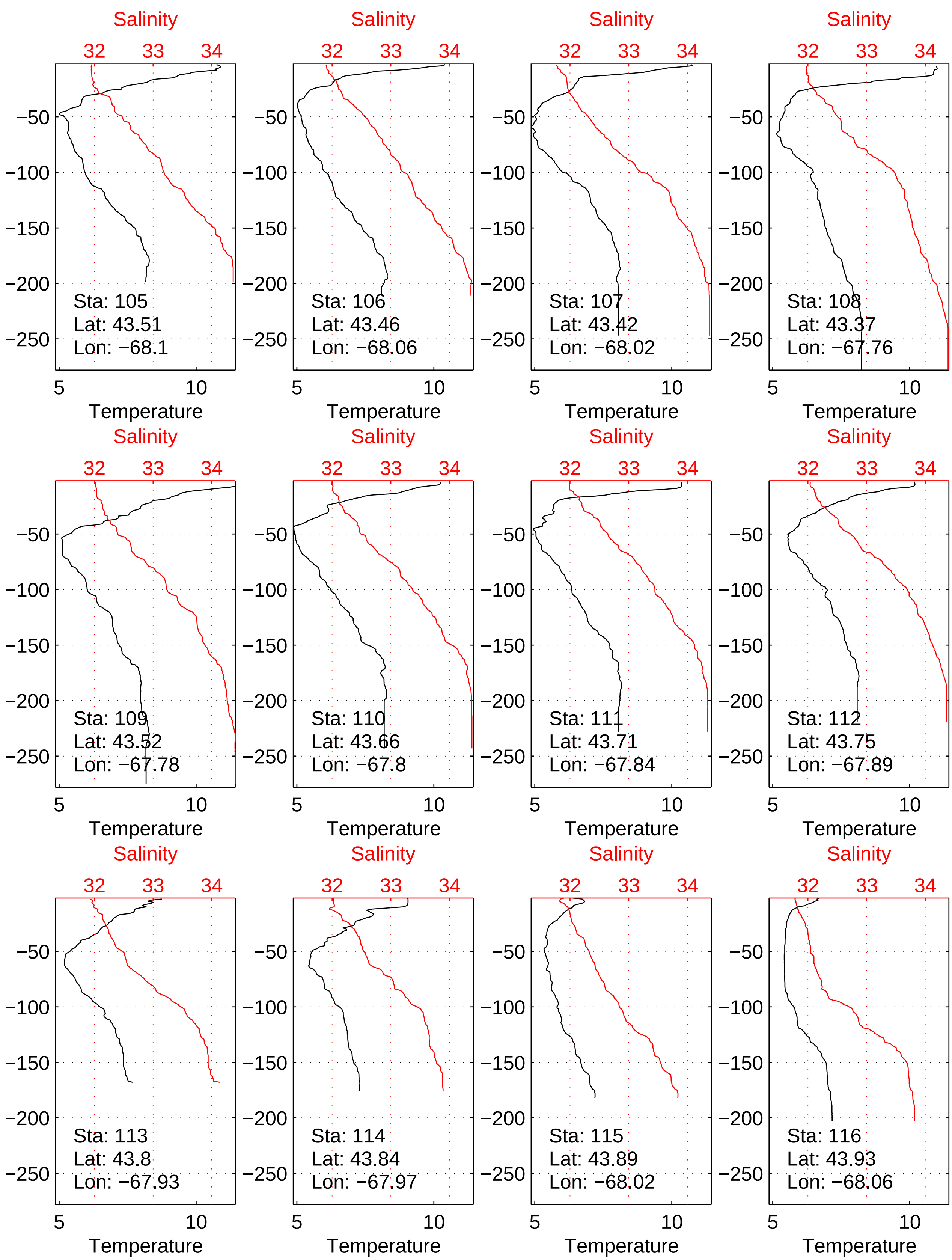
Oceanus Data: 8−9 June 2001



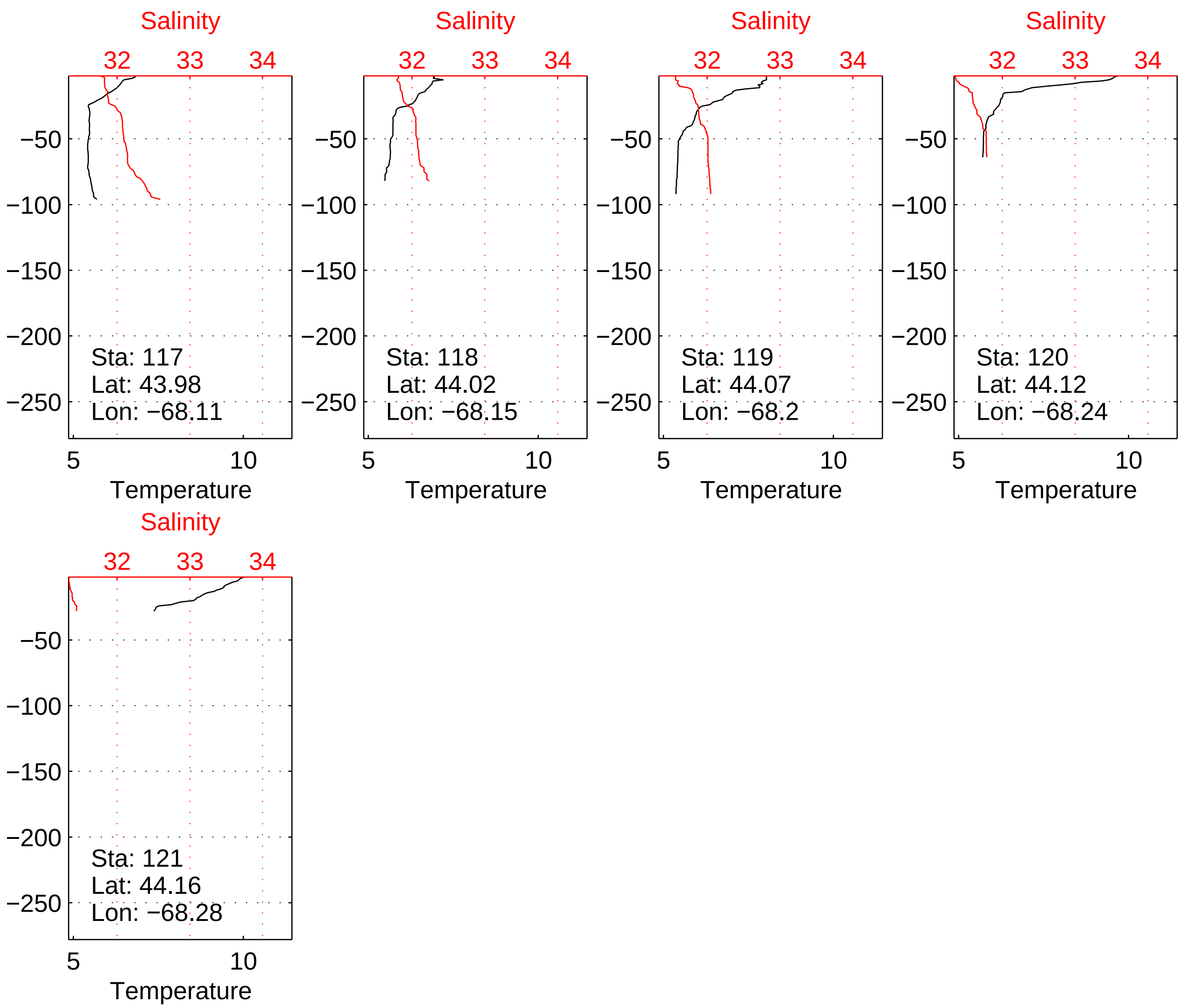


Oceanus Data: 10−11 June 2001
Latitude
Longitude
44.4
44.2
44
43.8
43.6
43.4
43.2
−68.5
−68.4
−68.3
−68.2
−68.1
−68
−67.9
−67.8
−67.7
−67.6

Oceanus Data: 10−11 June 2001



Oceanus Data: 10−11 June 2001



Along-track current measurements - NRV Alliance

The NRV Alliance is permanently equipped with a 37.5 kHz Acoustic Doppler Current Profiler (ADCP) which is installed behind a transparent plate at the bottom of the well. It measures the Doppler shift of sound, which is reflected from depth intervals (bins). The minimum standard bin length of 37.5 kHz systems is 8m. Attempts to use 4m bins in shallow water have not produced encouraging results.

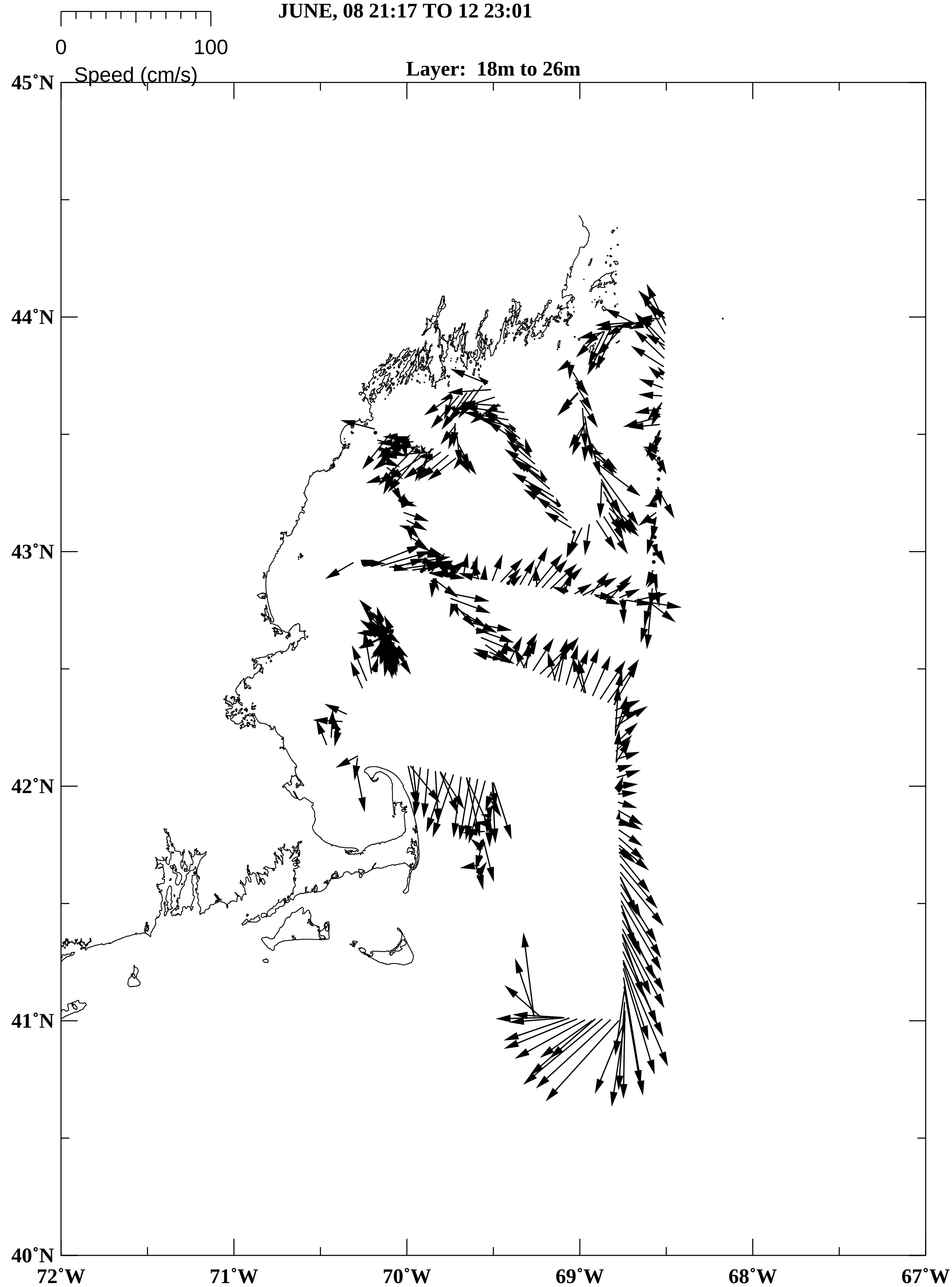
The ADCP data have been processed with the CODAS package. Resulting along-track currents are divided into the time periods: 8-12 June 2001, 12-16 June 2001, 16-18 June 2001 and 19-24 June 2001. For each time period there are plots for 9 different layers: 18-26m, 26-50m, 50-75m, 75-100m, 100-125m, 125-150m, 150-175m, 175-200m, and 200-240m. The ADCP data have not been corrected for tides.

ADCP Data – 8-12 June 2001

Thu Jun 14 14:04:32 2001

ASCOT01

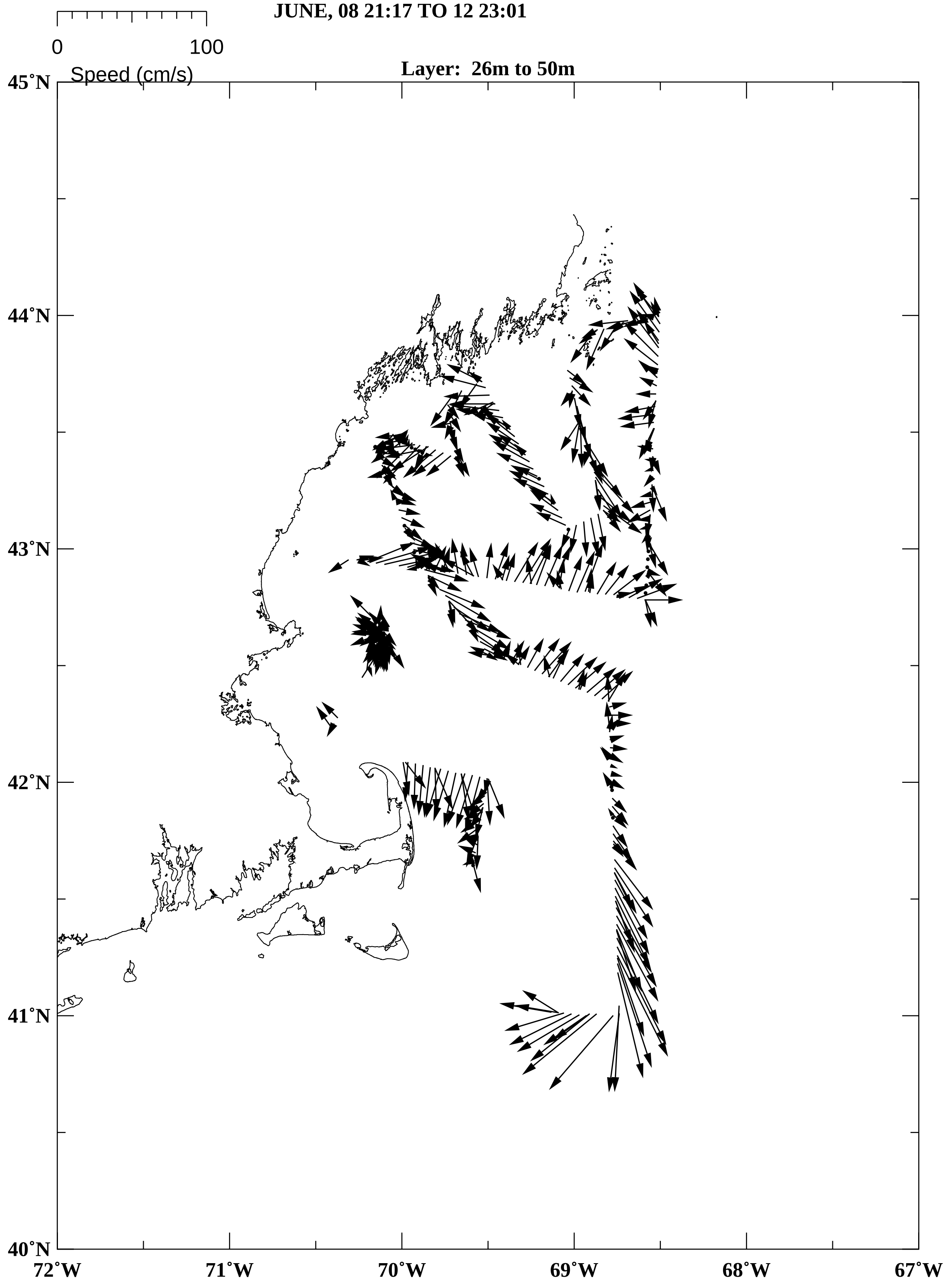
JUNE, 08 21:17 TO 12 23:01



ASCOT01

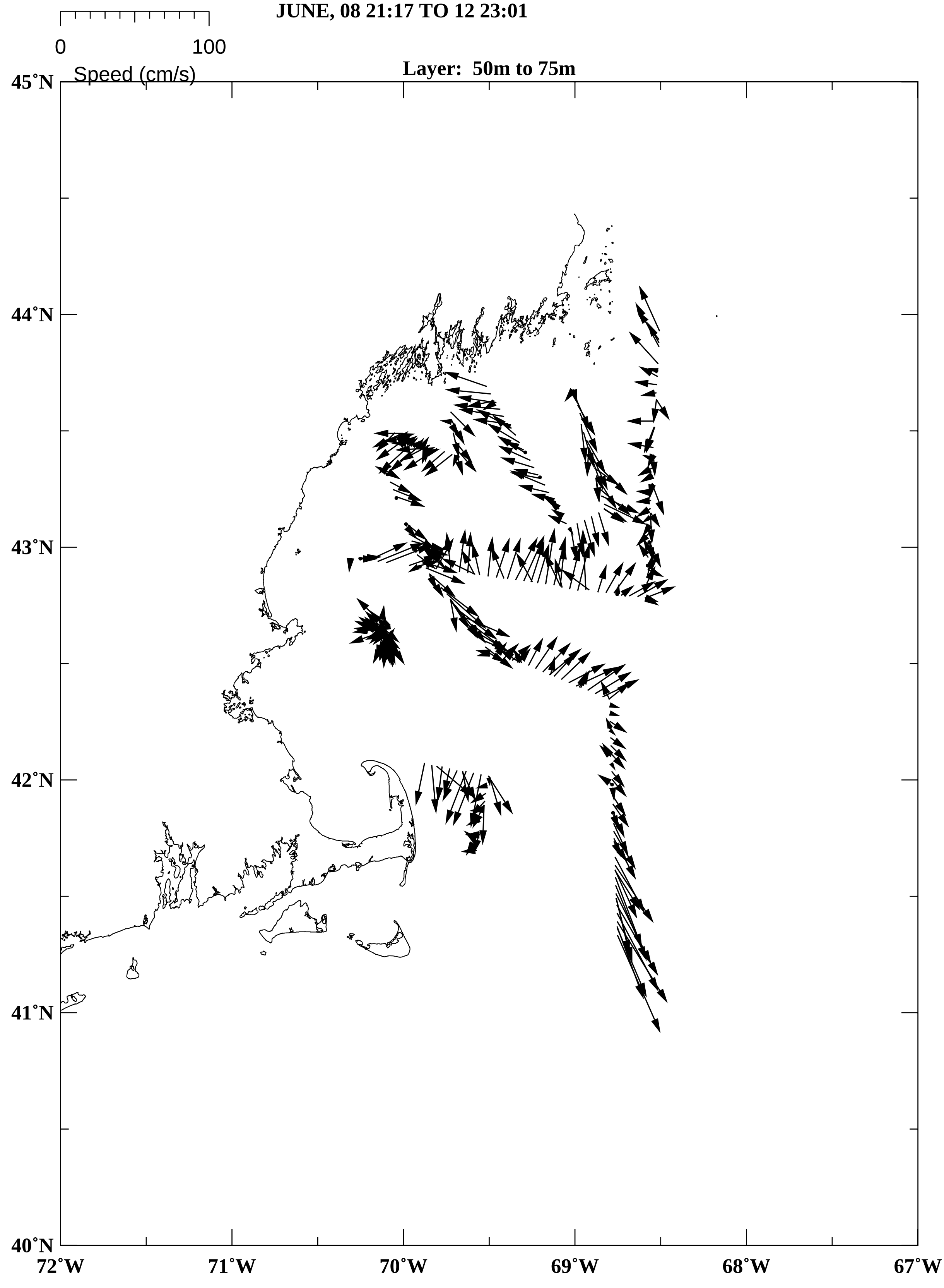
JUNE, 08 21:17 TO 12 23:01

Layer: 26m to 50m



ASCOT01

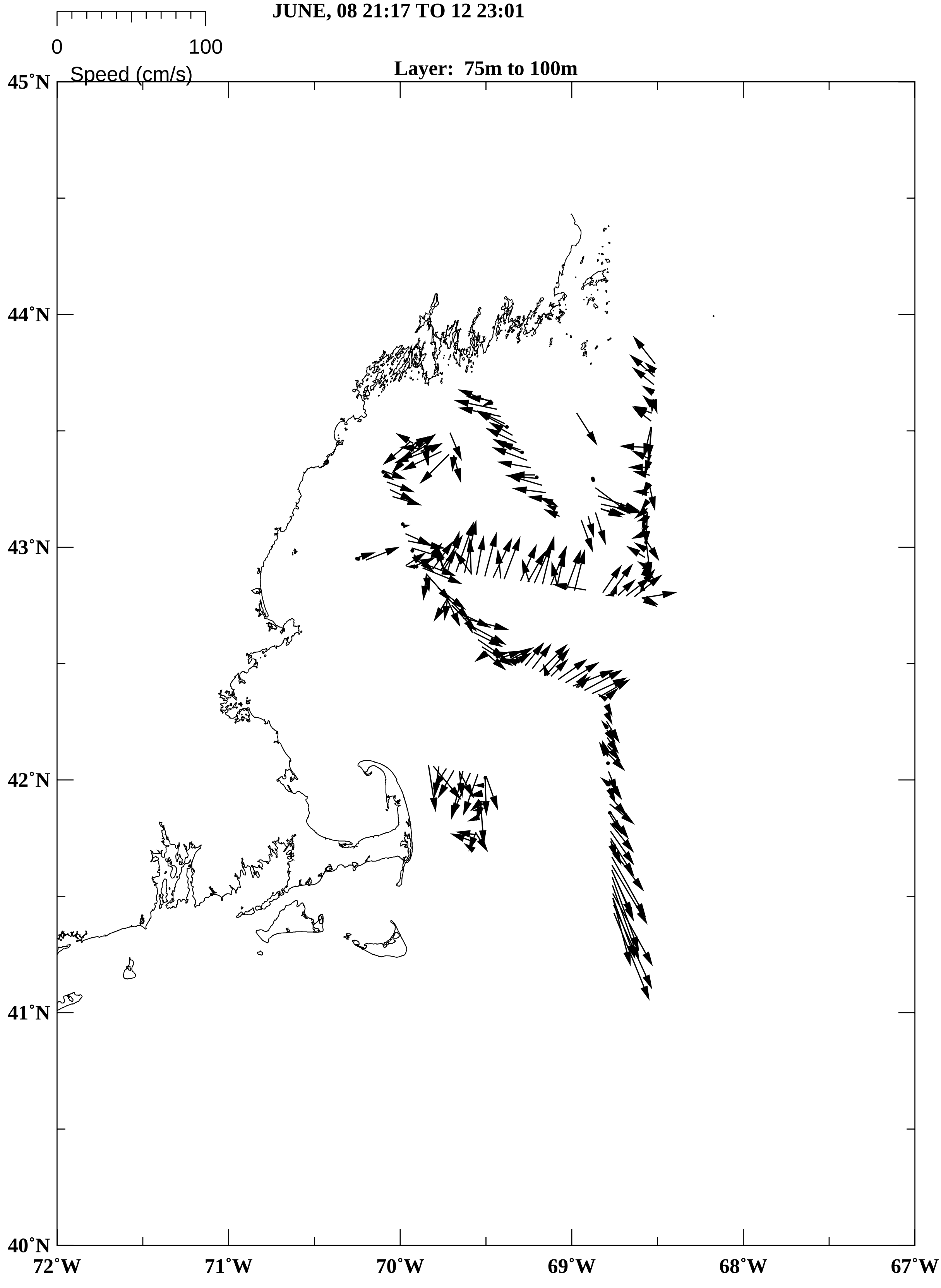
JUNE, 08 21:17 TO 12 23:01



Thu Jun 14 14:04:32 2001

ASCOT01

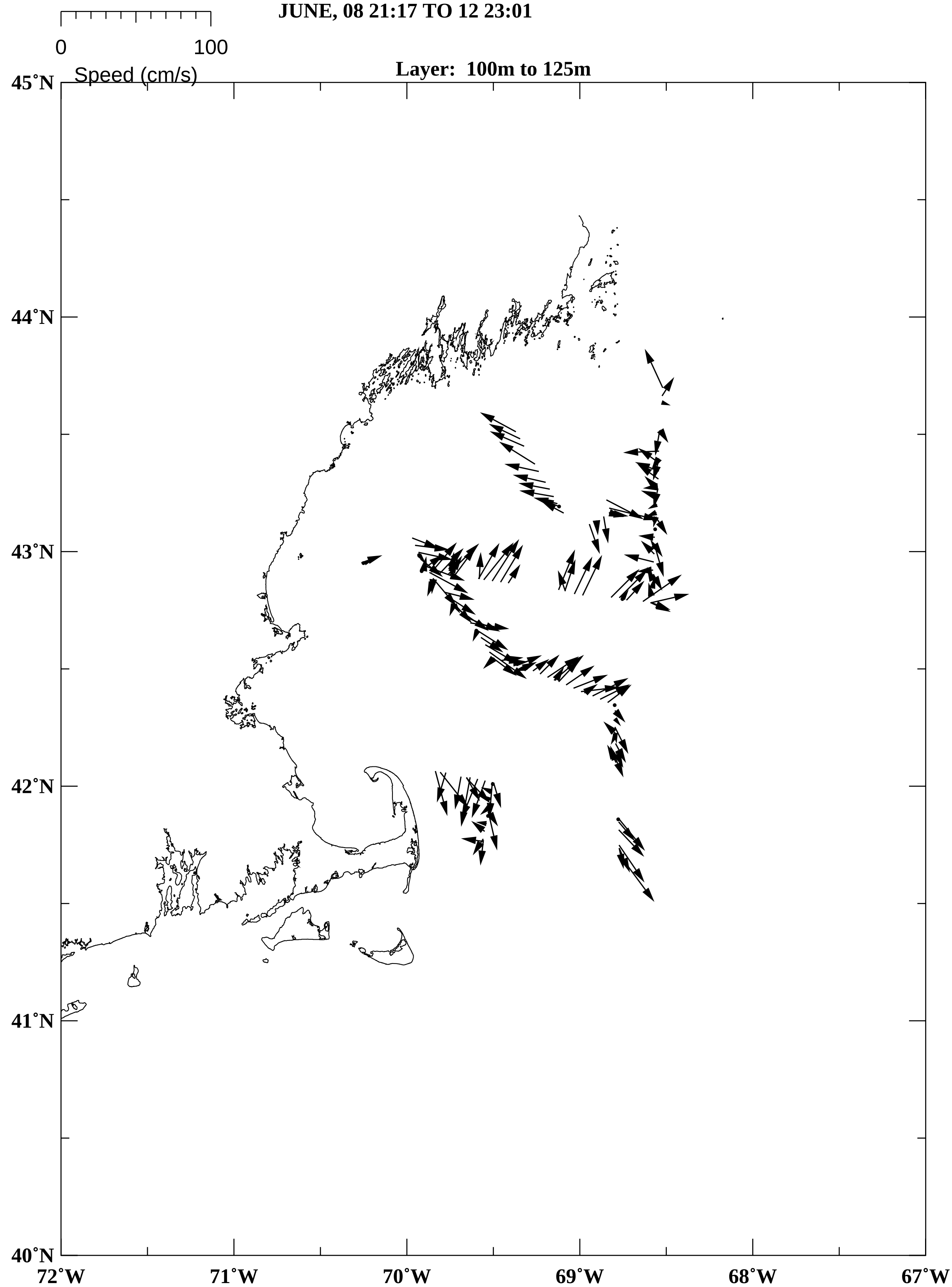
JUNE, 08 21:17 TO 12 23:01



Thu Jun 14 14:04:32 2001

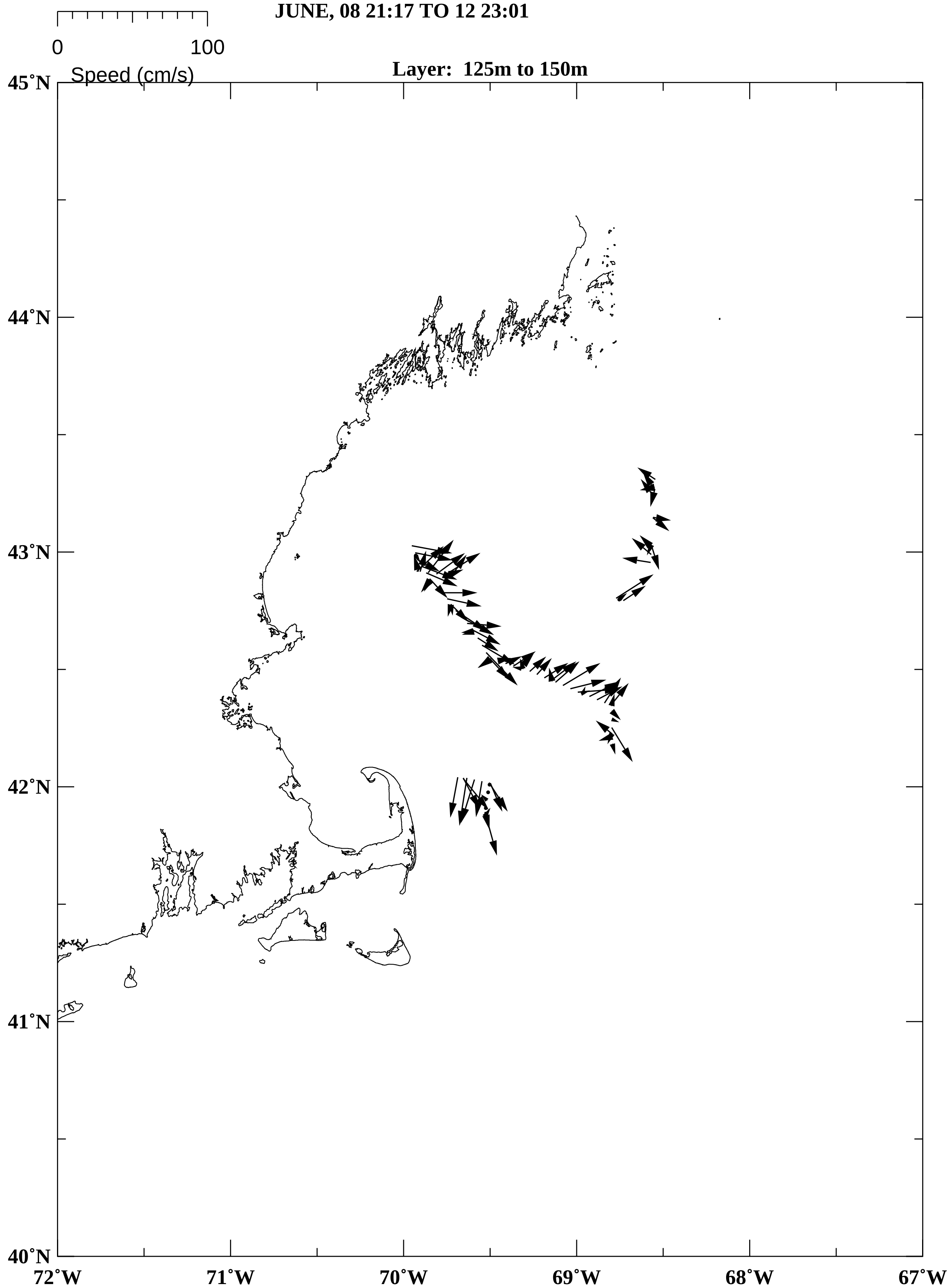
ASCOT01

JUNE, 08 21:17 TO 12 23:01



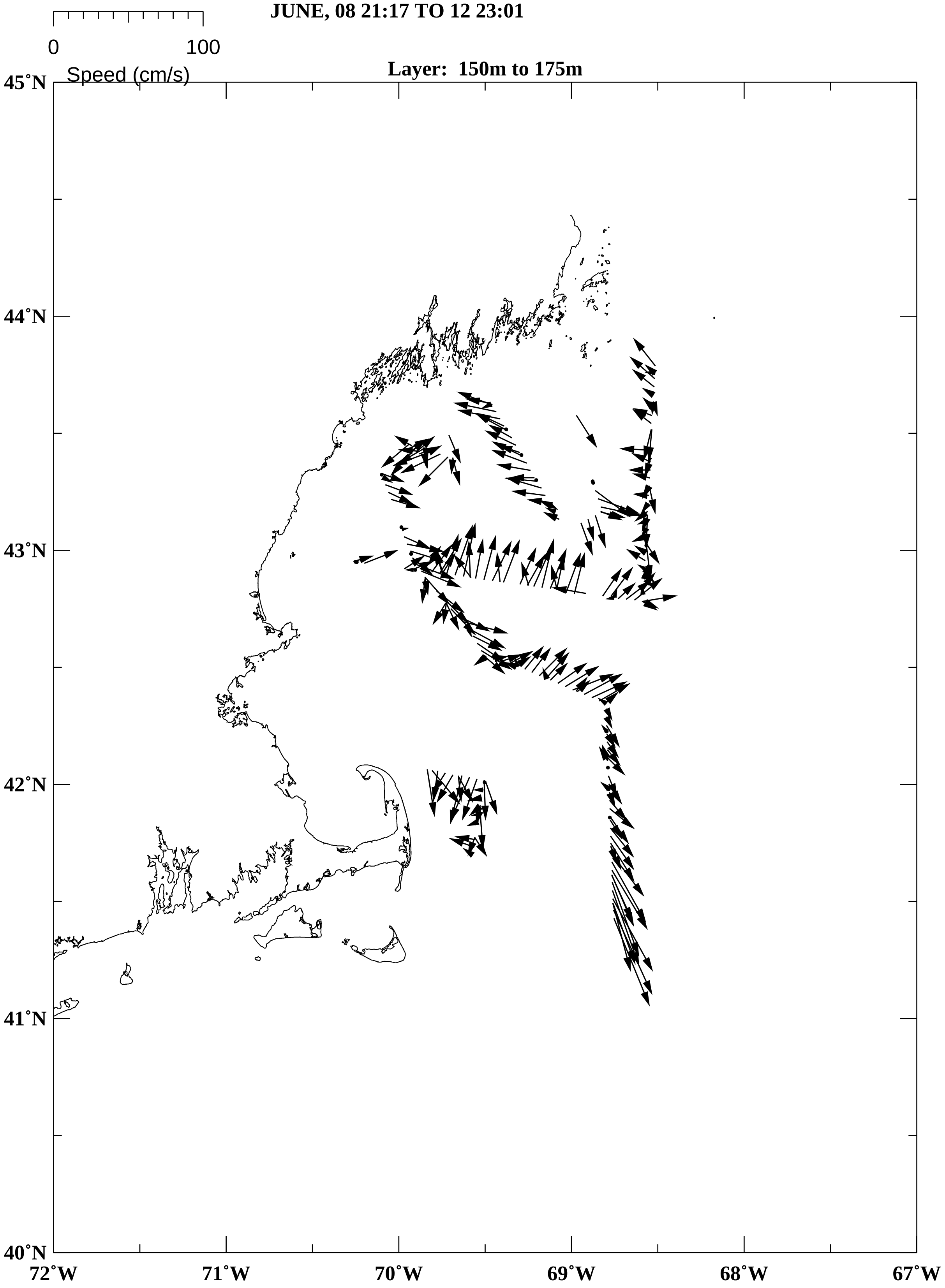
ASCOT01

JUNE, 08 21:17 TO 12 23:01



ASCOT01

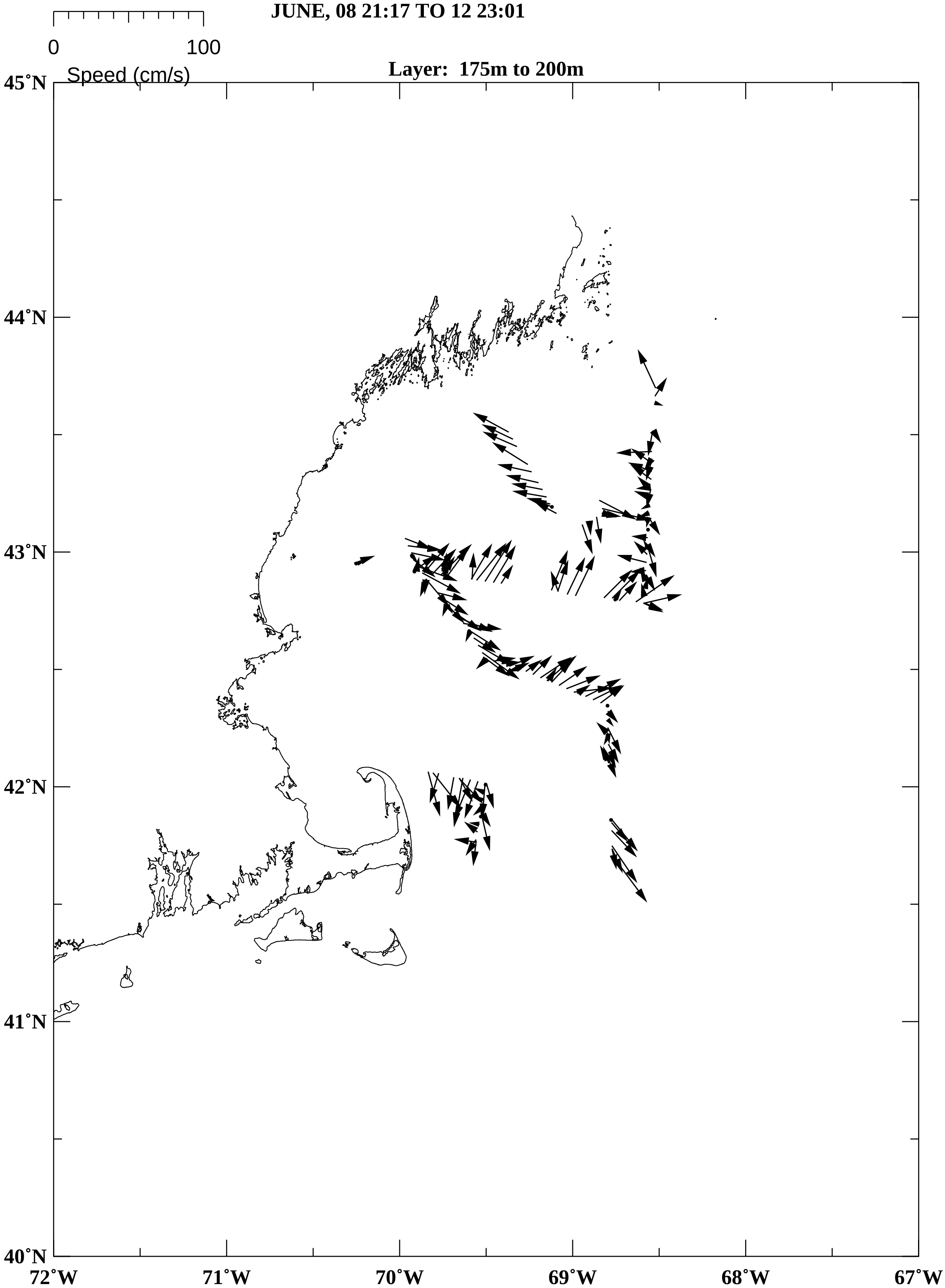
JUNE, 08 21:17 TO 12 23:01



Thu Jun 14 14:04:32 2001

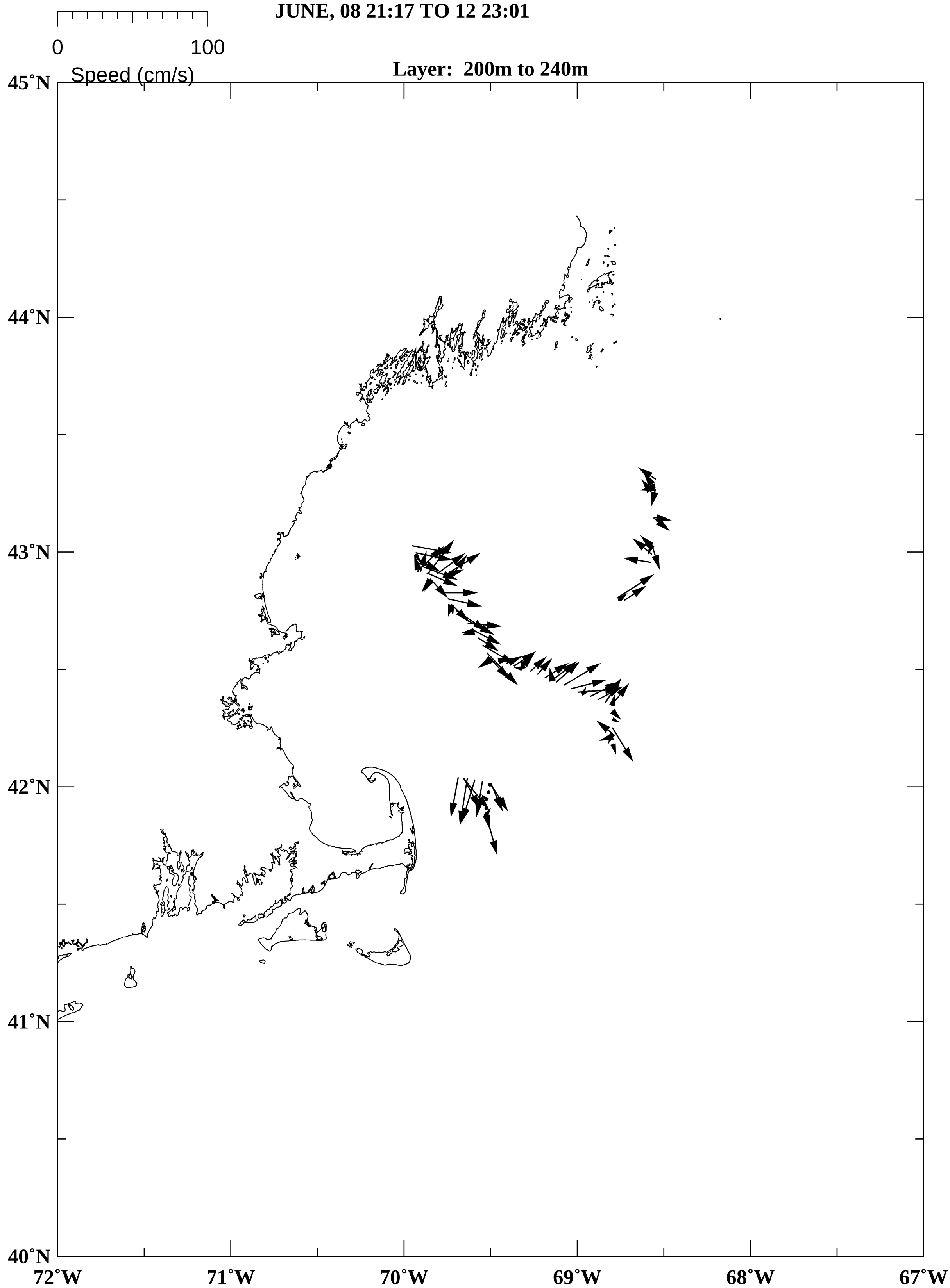
ASCOT01

JUNE, 08 21:17 TO 12 23:01



ASCOT01

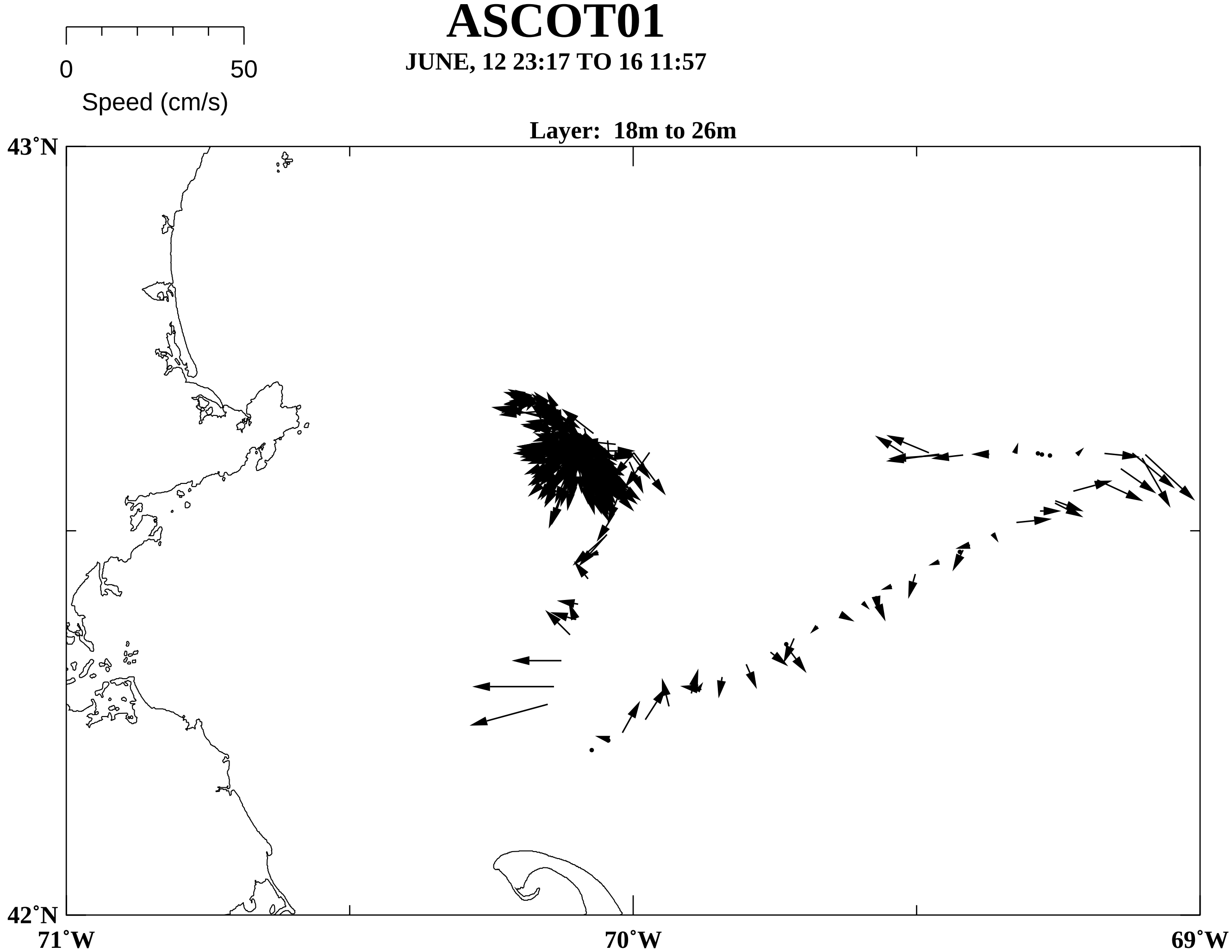
JUNE, 08 21:17 TO 12 23:01



ADCP Data – 12-16 June 2001

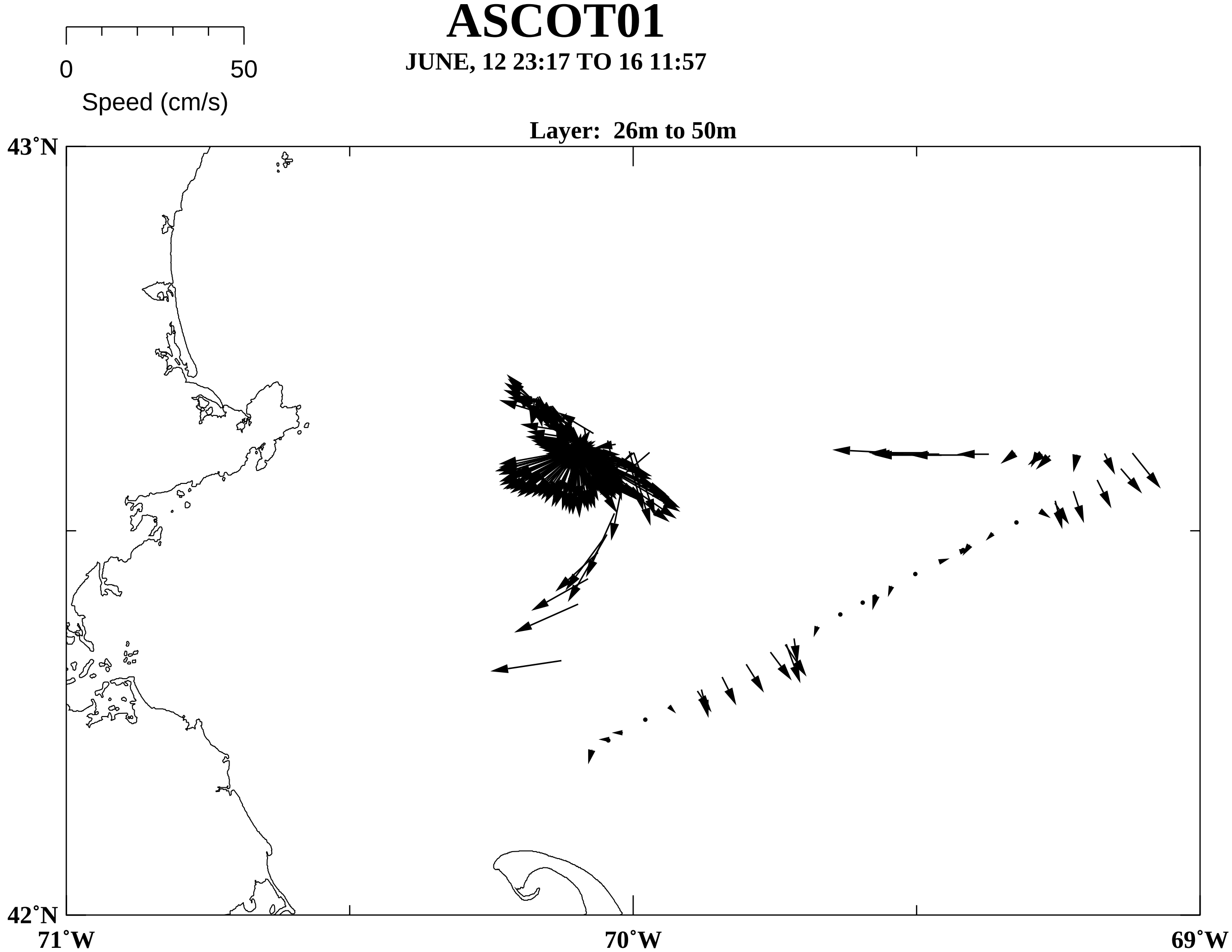
ASCOT01

JUNE, 12 23:17 TO 16 11:57



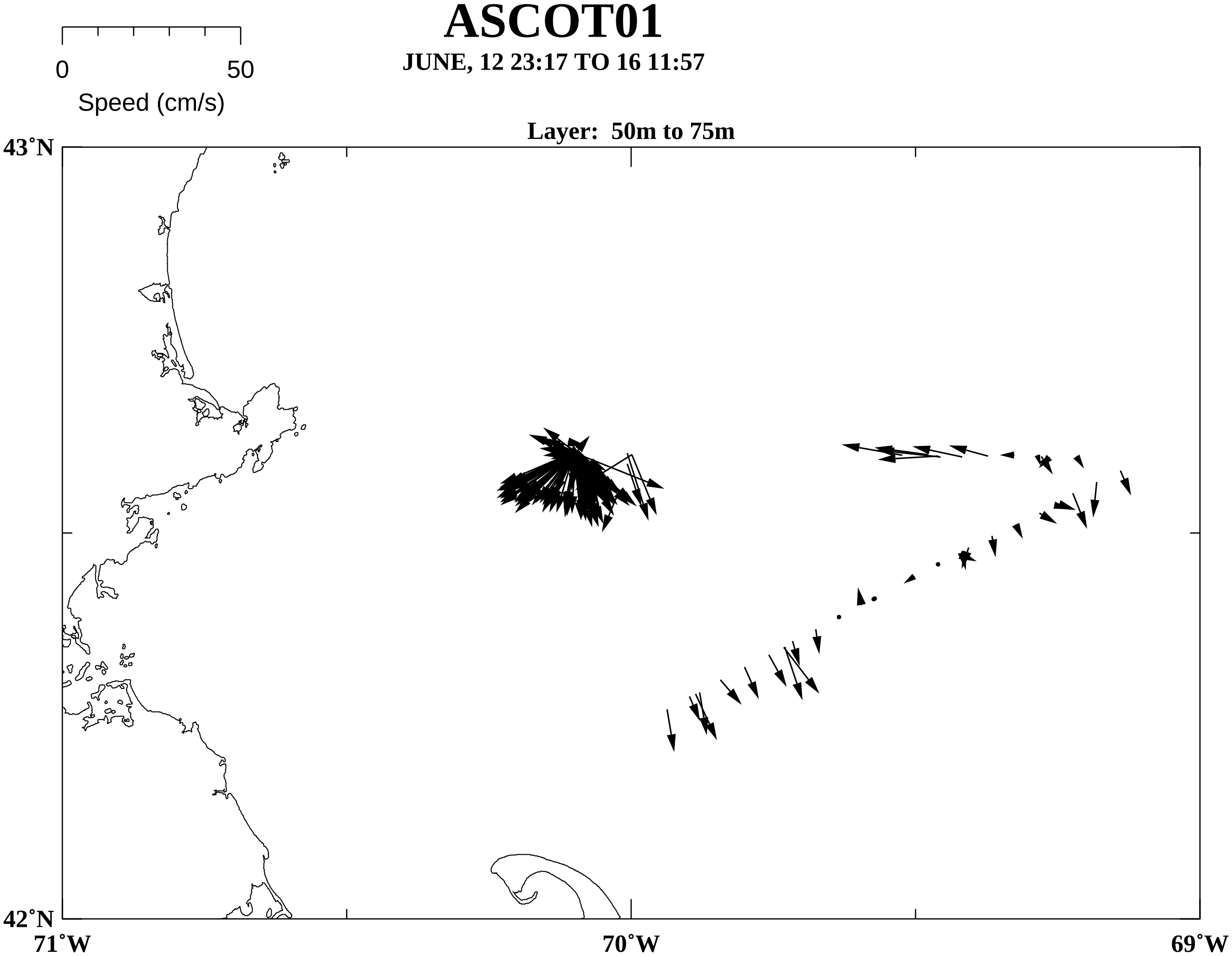
ASCOT01

JUNE, 12 23:17 TO 16 11:57



ASCOT01

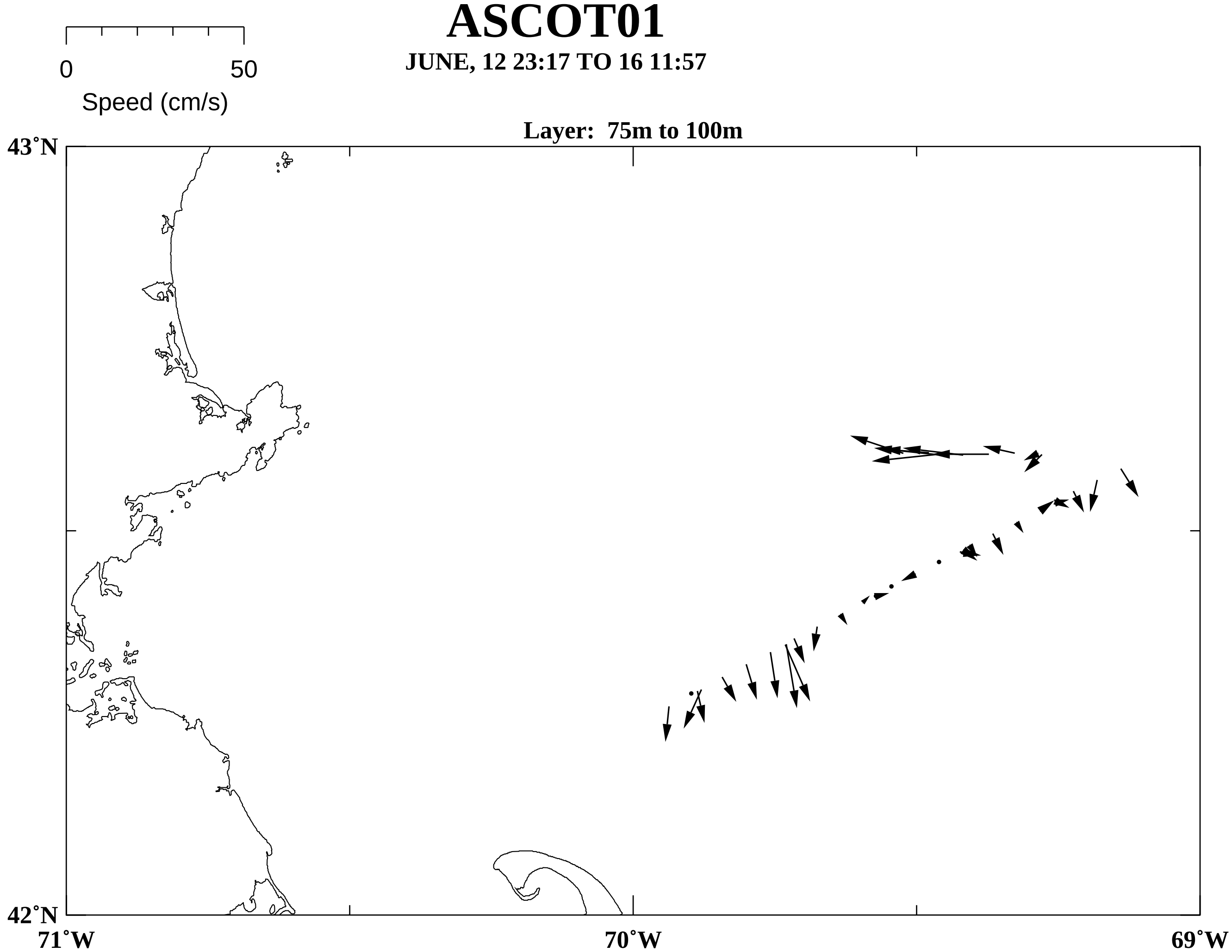
JUNE, 12 23:17 TO 16 11:57



Sun Jun 17 10:26:14 2001

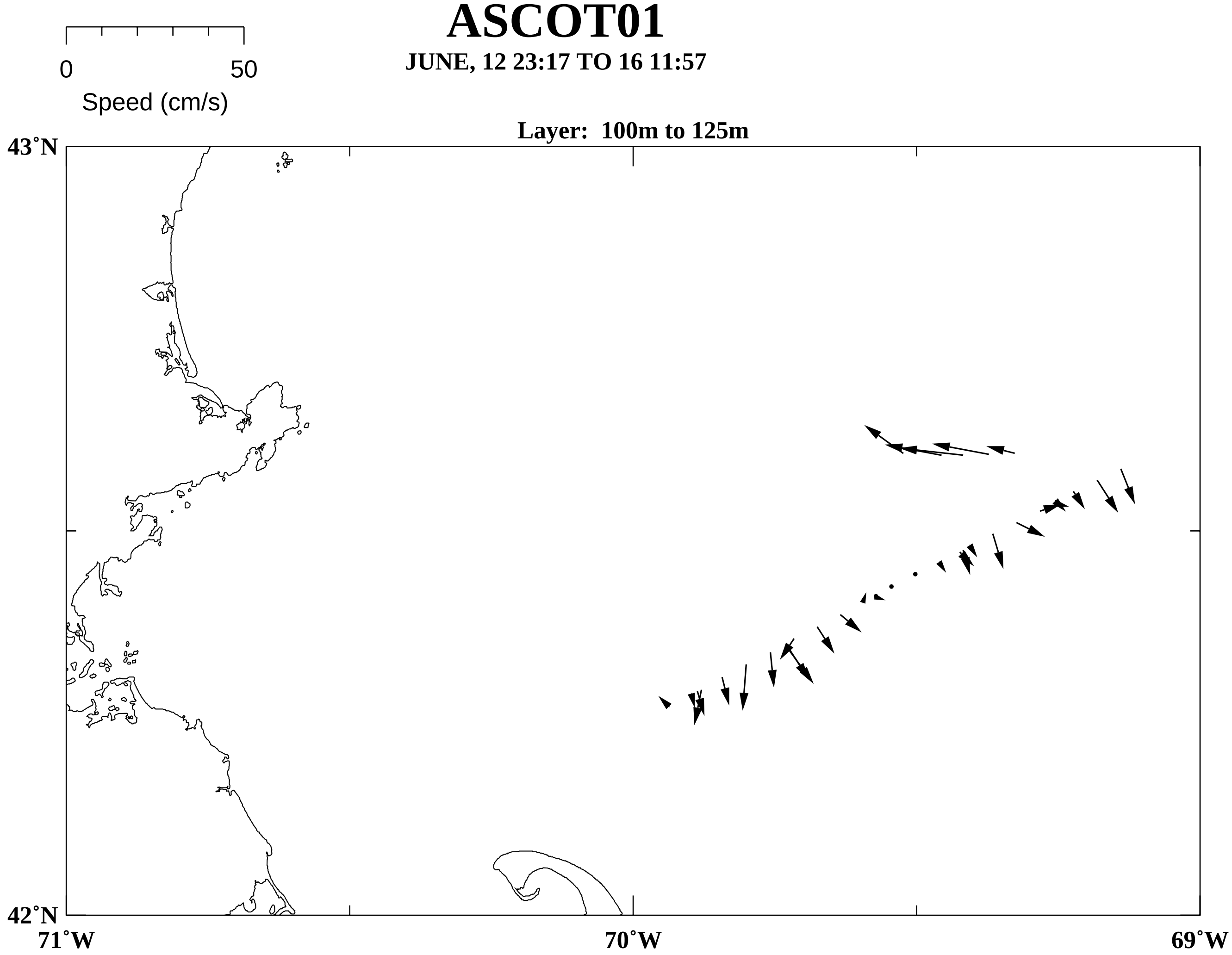
ASCOT01

JUNE, 12 23:17 TO 16 11:57



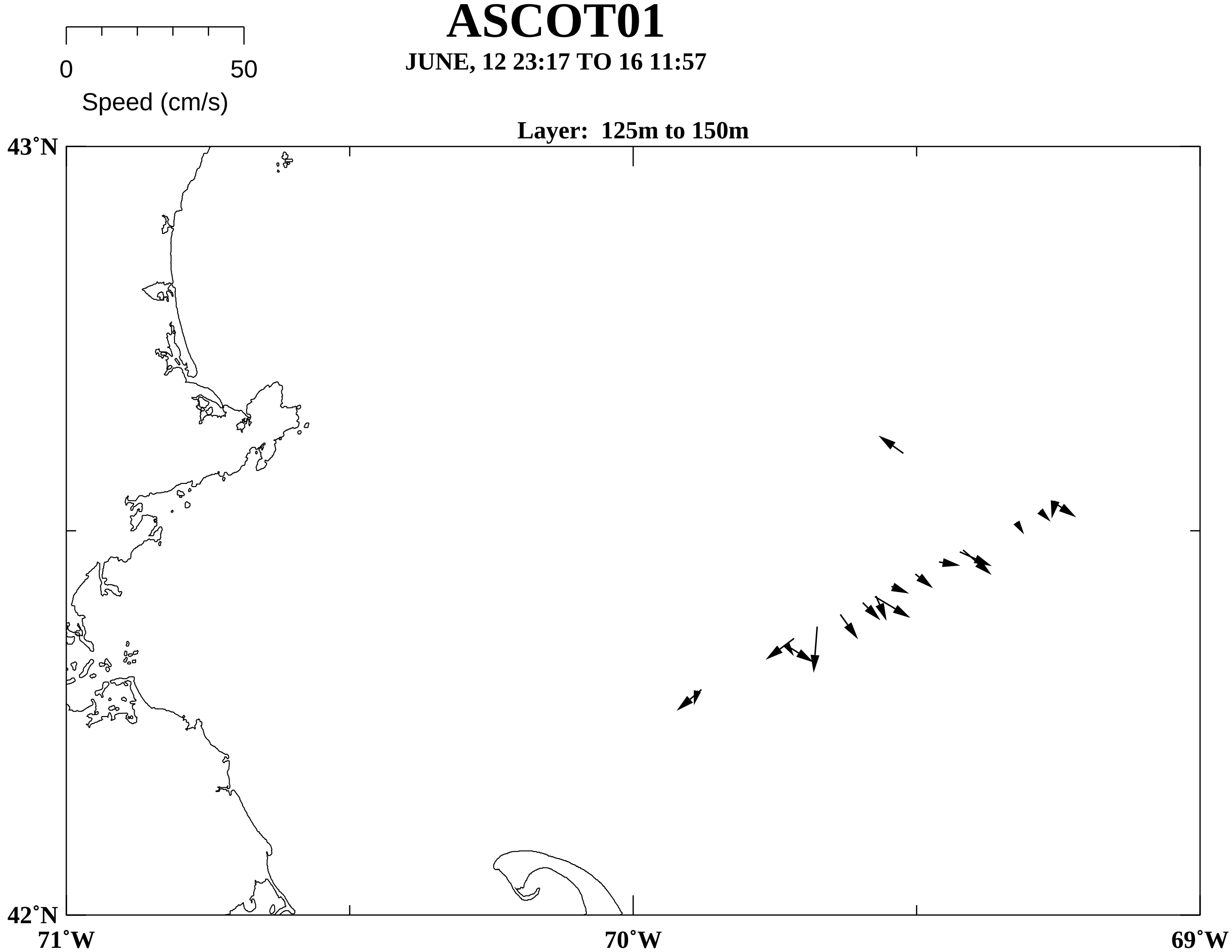
ASCOT01

JUNE, 12 23:17 TO 16 11:57



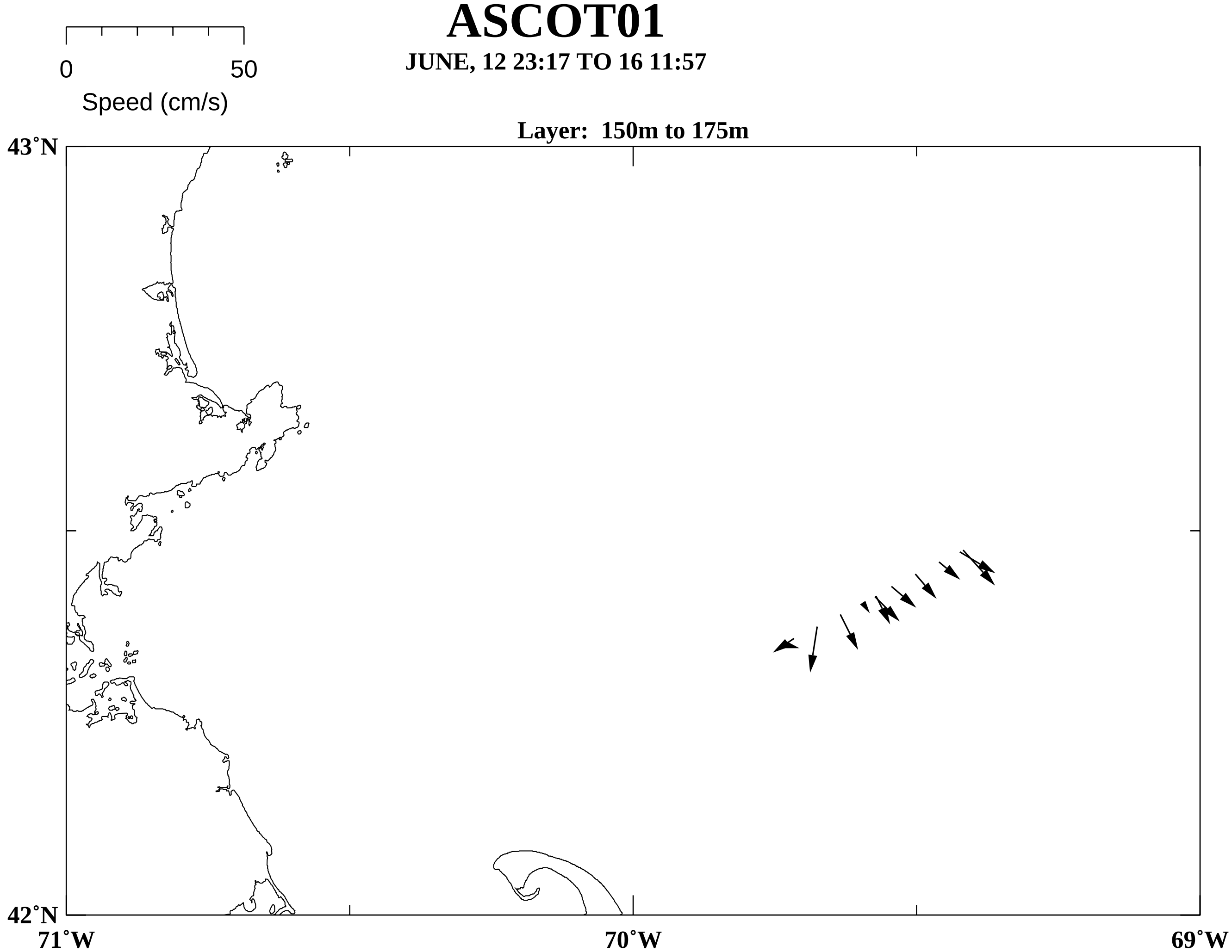
ASCOT01

JUNE, 12 23:17 TO 16 11:57



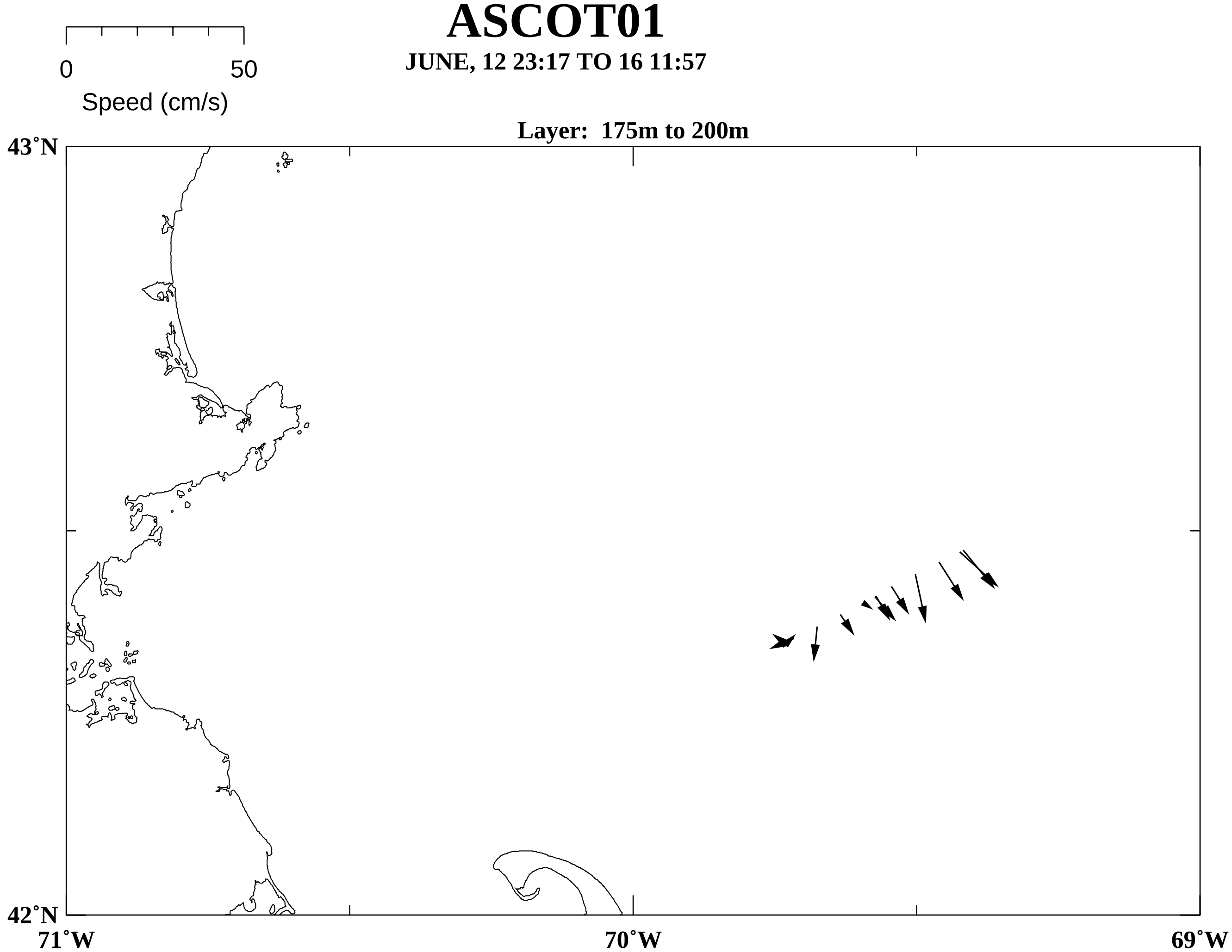
ASCOT01

JUNE, 12 23:17 TO 16 11:57



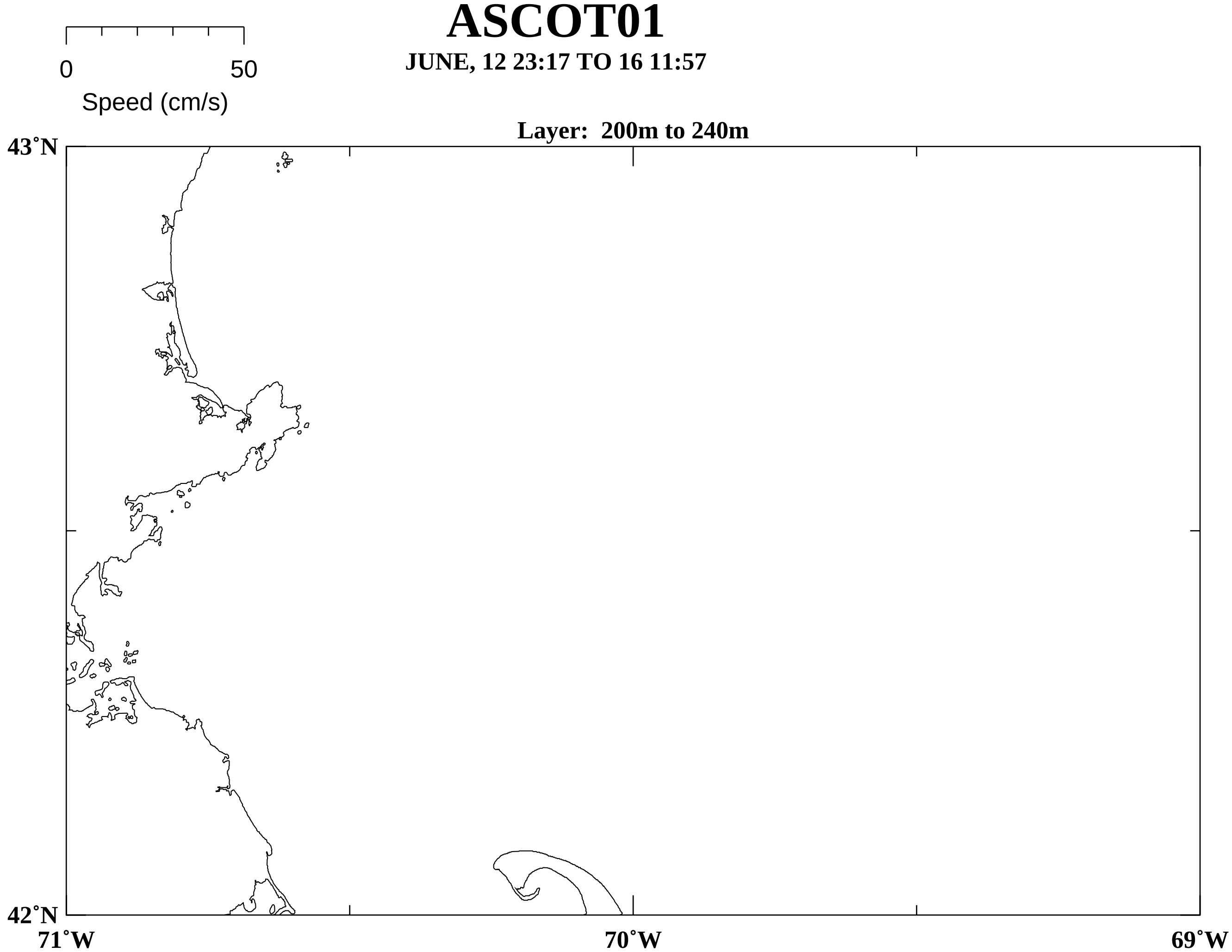
ASCOT01

JUNE, 12 23:17 TO 16 11:57



ASCOT01

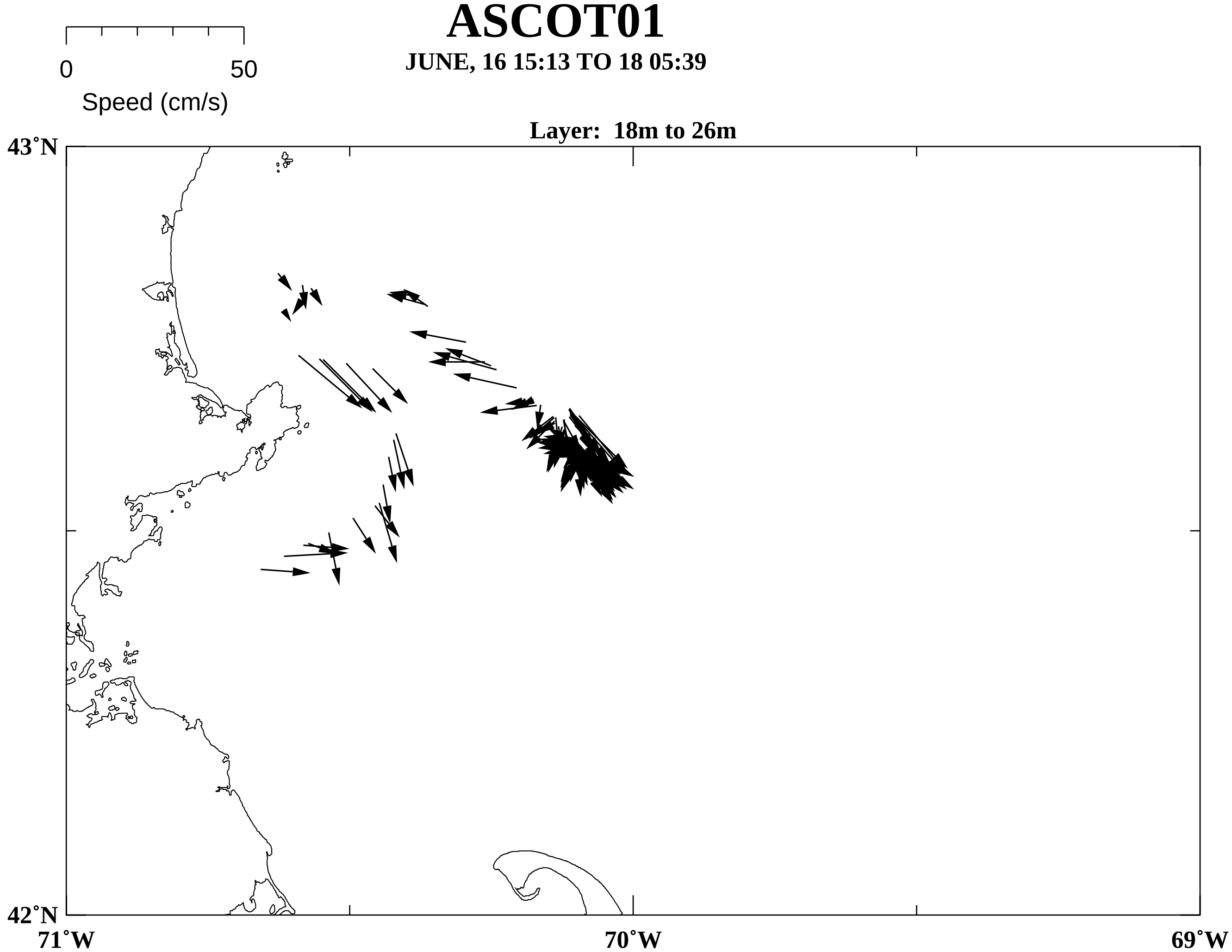
JUNE, 12 23:17 TO 16 11:57



ADCP Data – 16-18 June 2001

ASCOT01

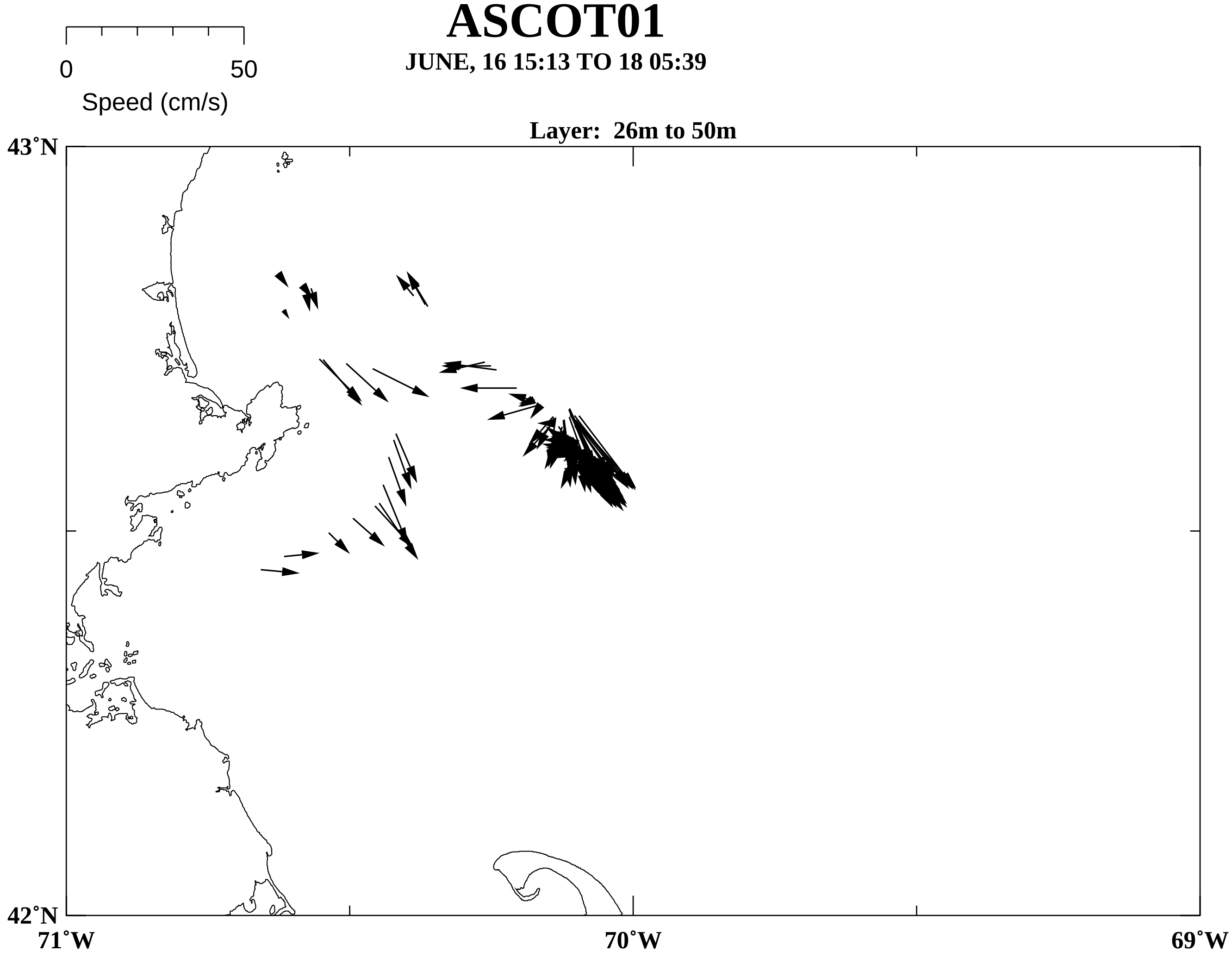
JUNE, 16 15:13 TO 18 05:39



Mon Jun 25 10:07:07 2001

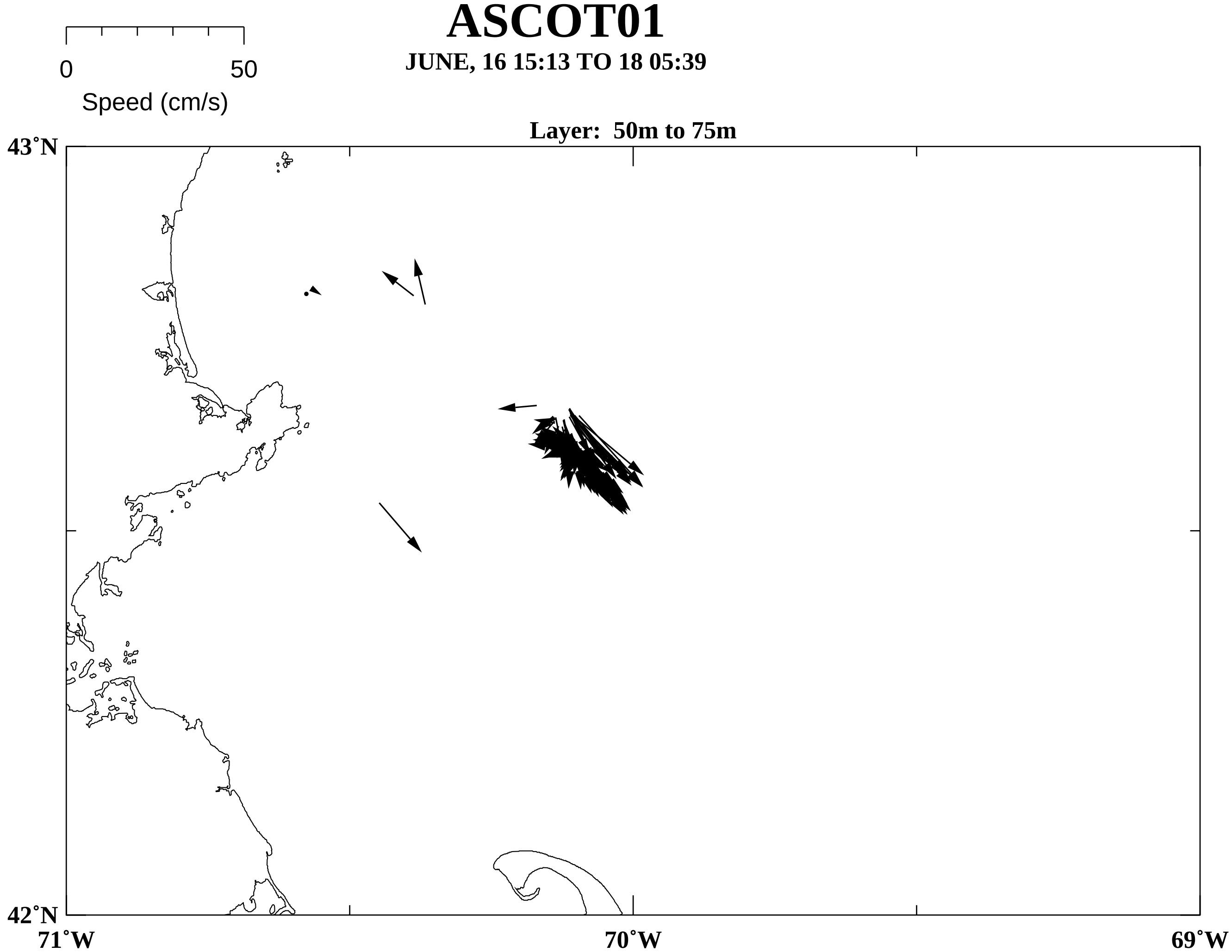
ASCOT01

JUNE, 16 15:13 TO 18 05:39



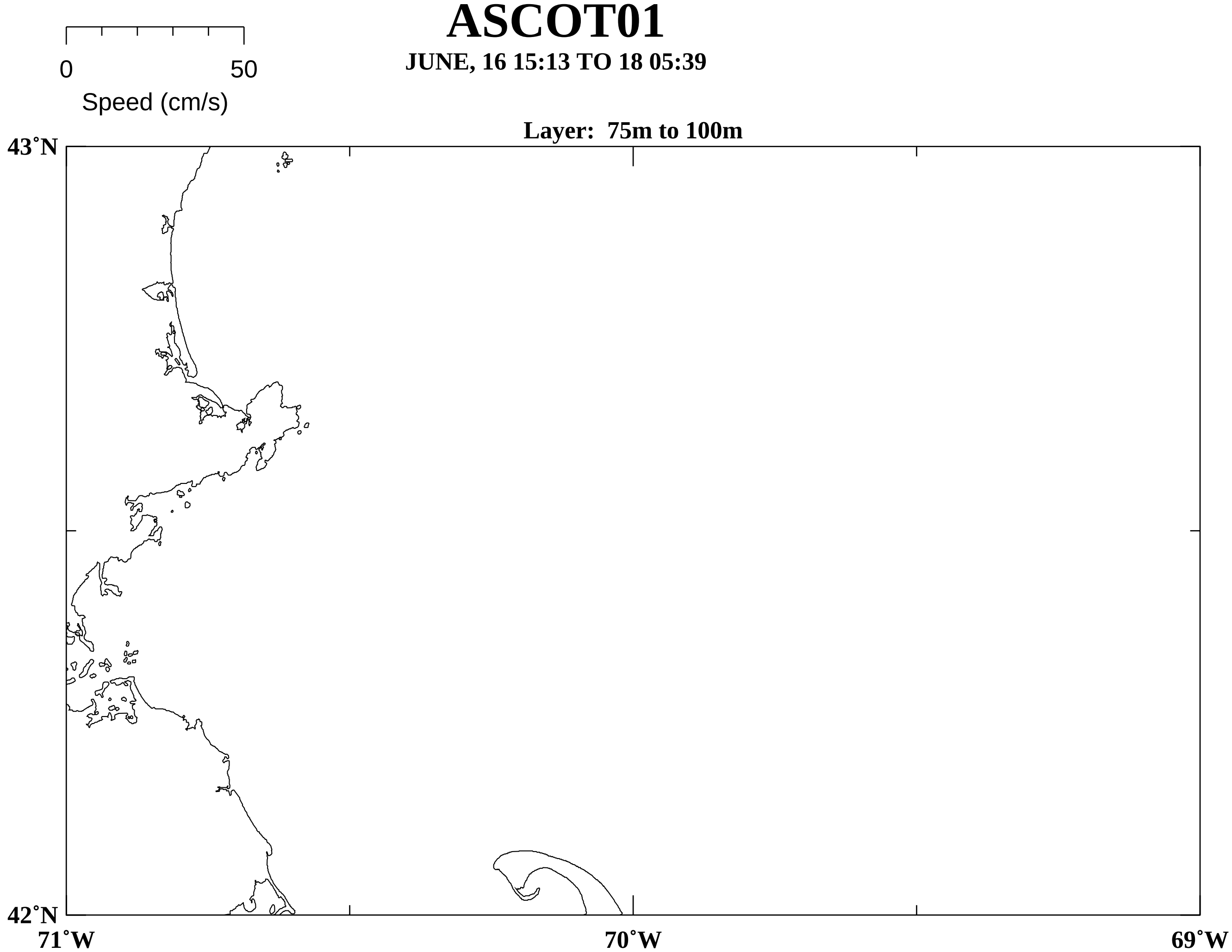
ASCOT01

JUNE, 16 15:13 TO 18 05:39



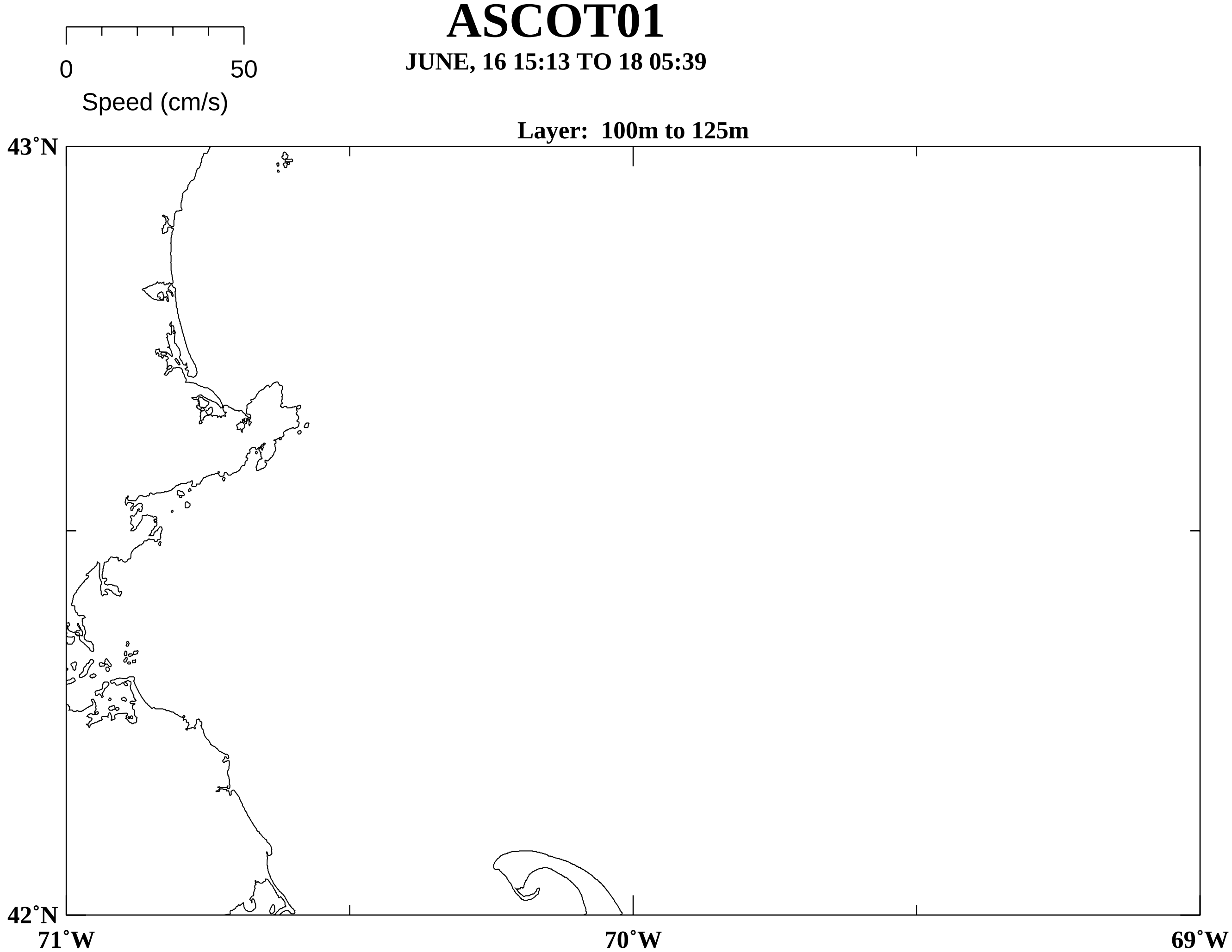
ASCOT01

JUNE, 16 15:13 TO 18 05:39



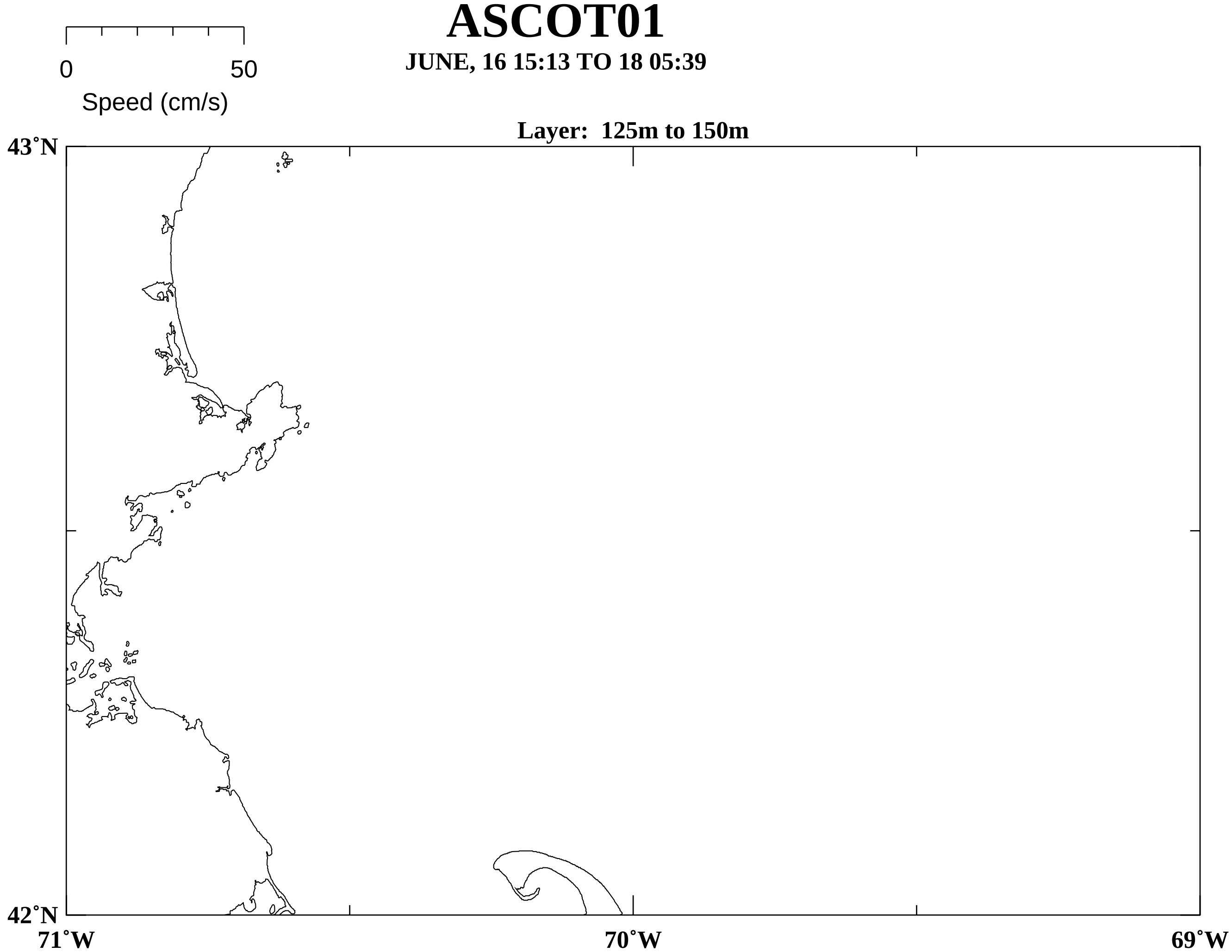
ASCOT01

JUNE, 16 15:13 TO 18 05:39



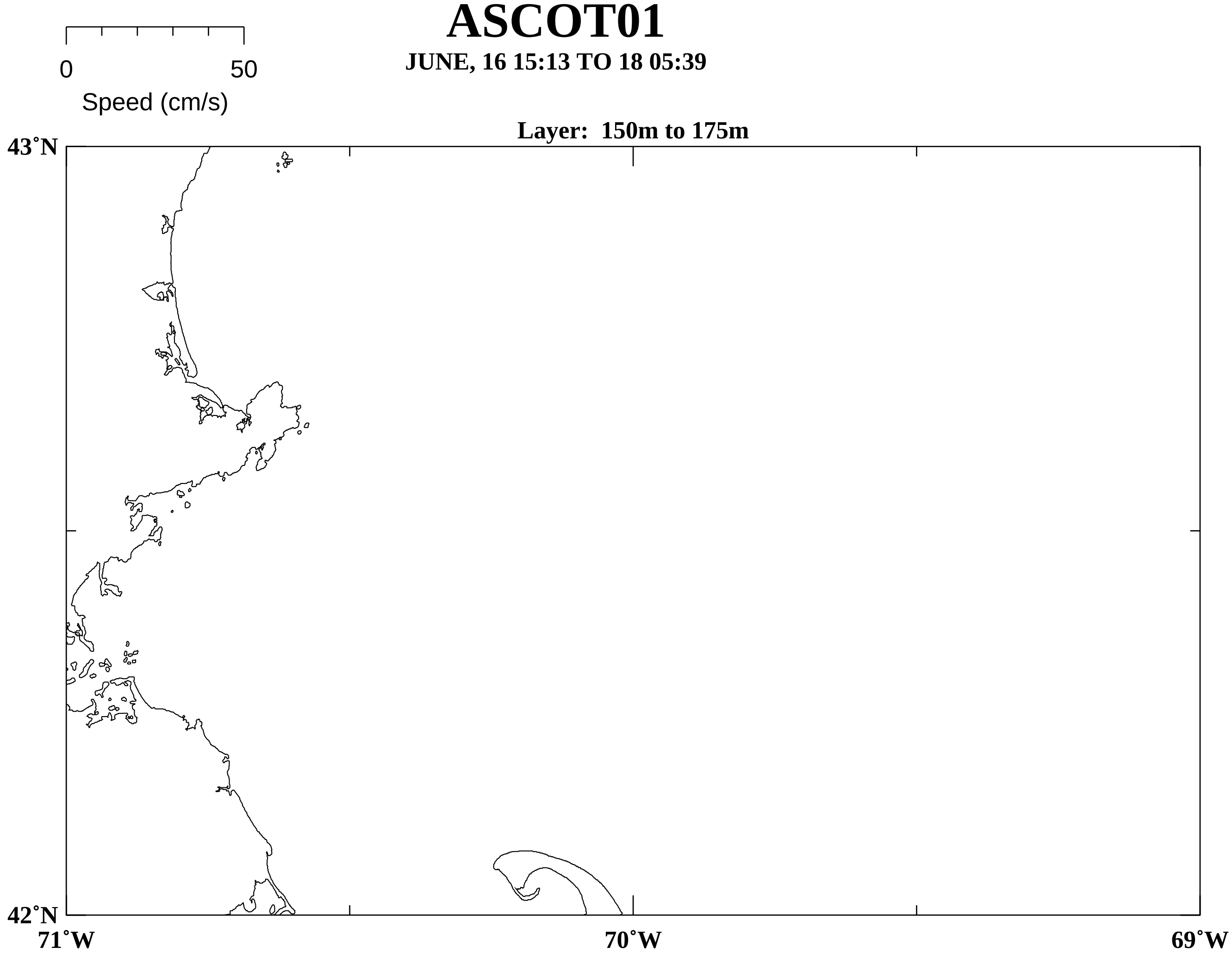
ASCOT01

JUNE, 16 15:13 TO 18 05:39



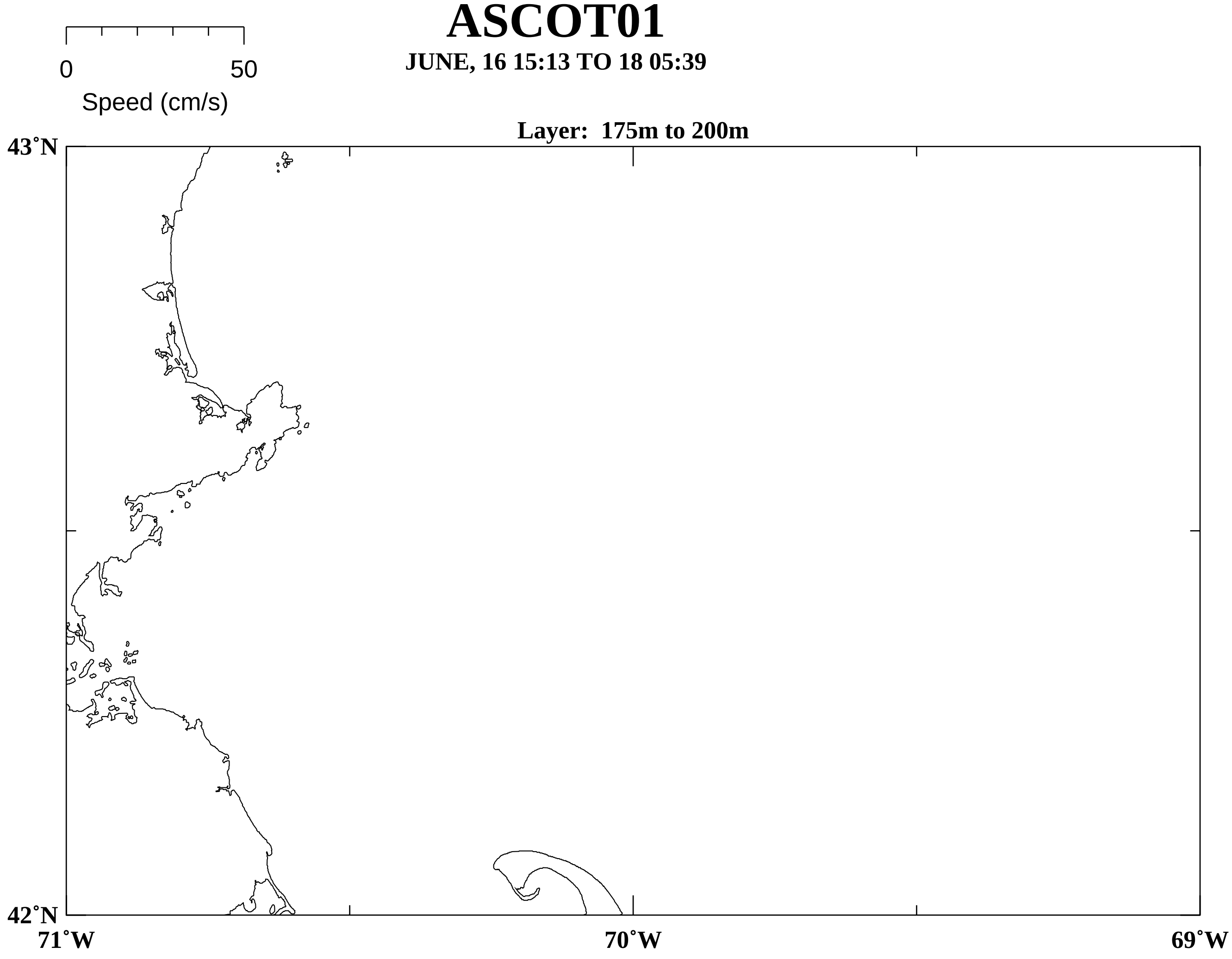
ASCOT01

JUNE, 16 15:13 TO 18 05:39



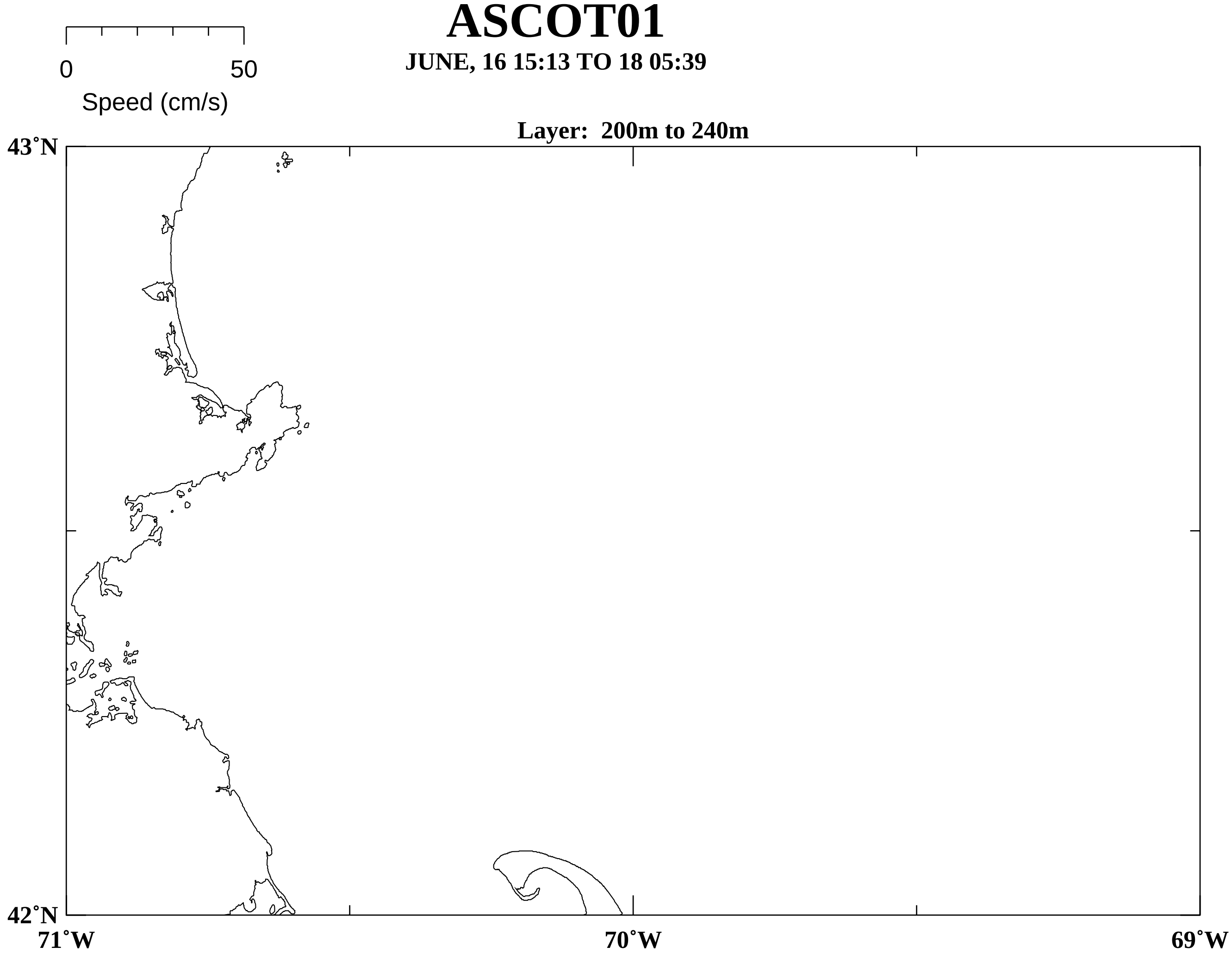
ASCOT01

JUNE, 16 15:13 TO 18 05:39



ASCOT01

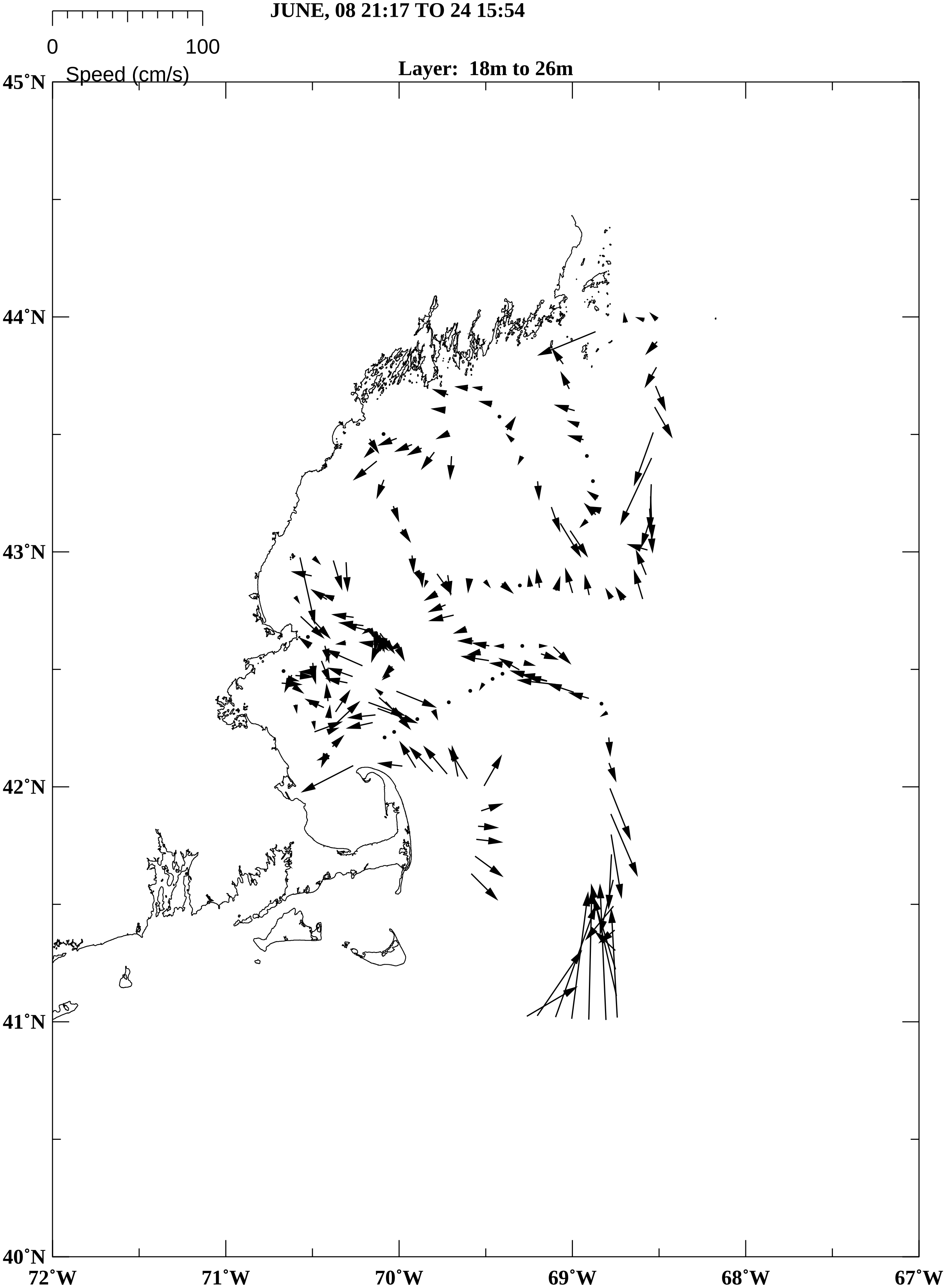
JUNE, 16 15:13 TO 18 05:39



ADCP Data – 19-24 June 2001

ASCOT01

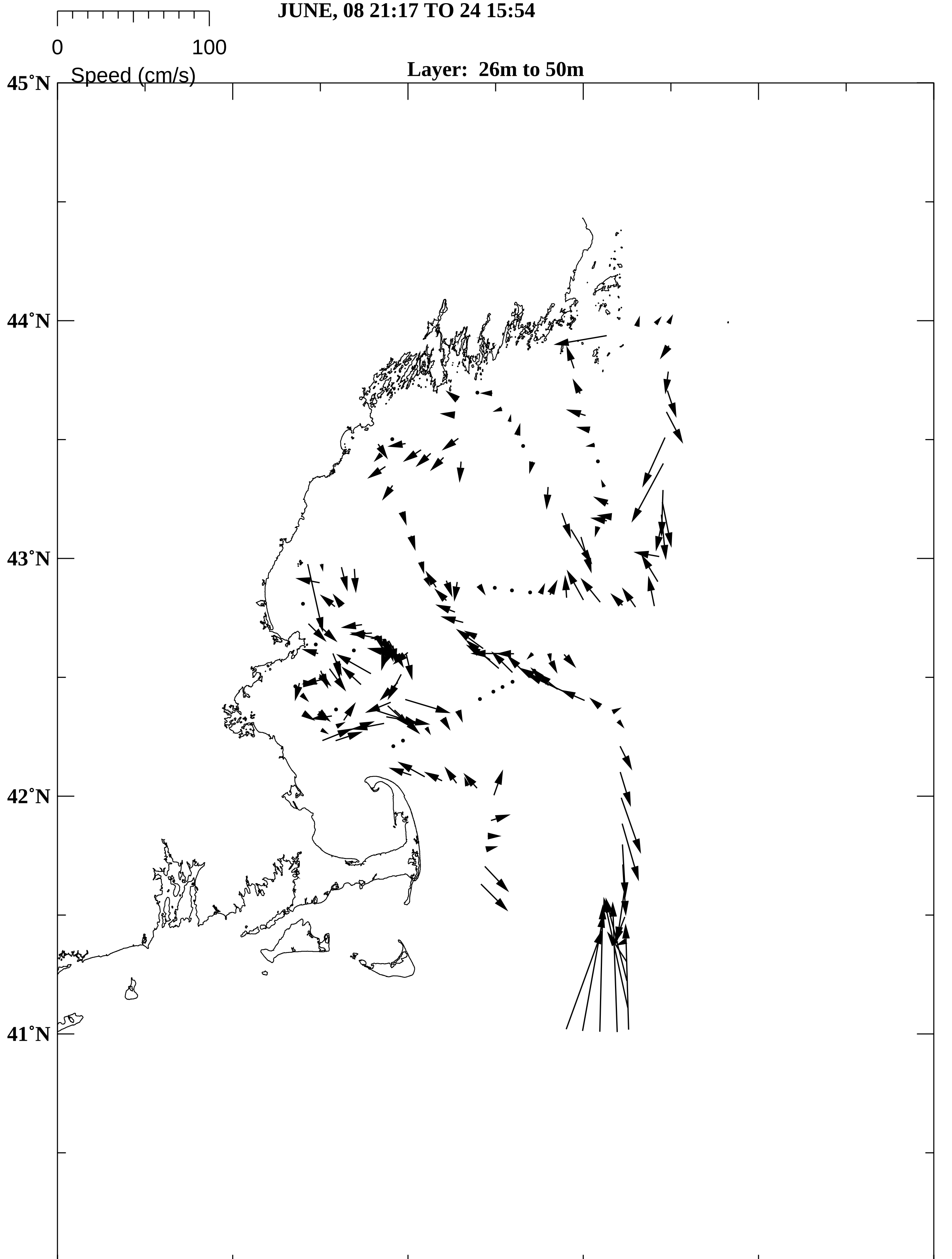
JUNE, 08 21:17 TO 24 15:54



Tue Jul 3 06:20:20 2001

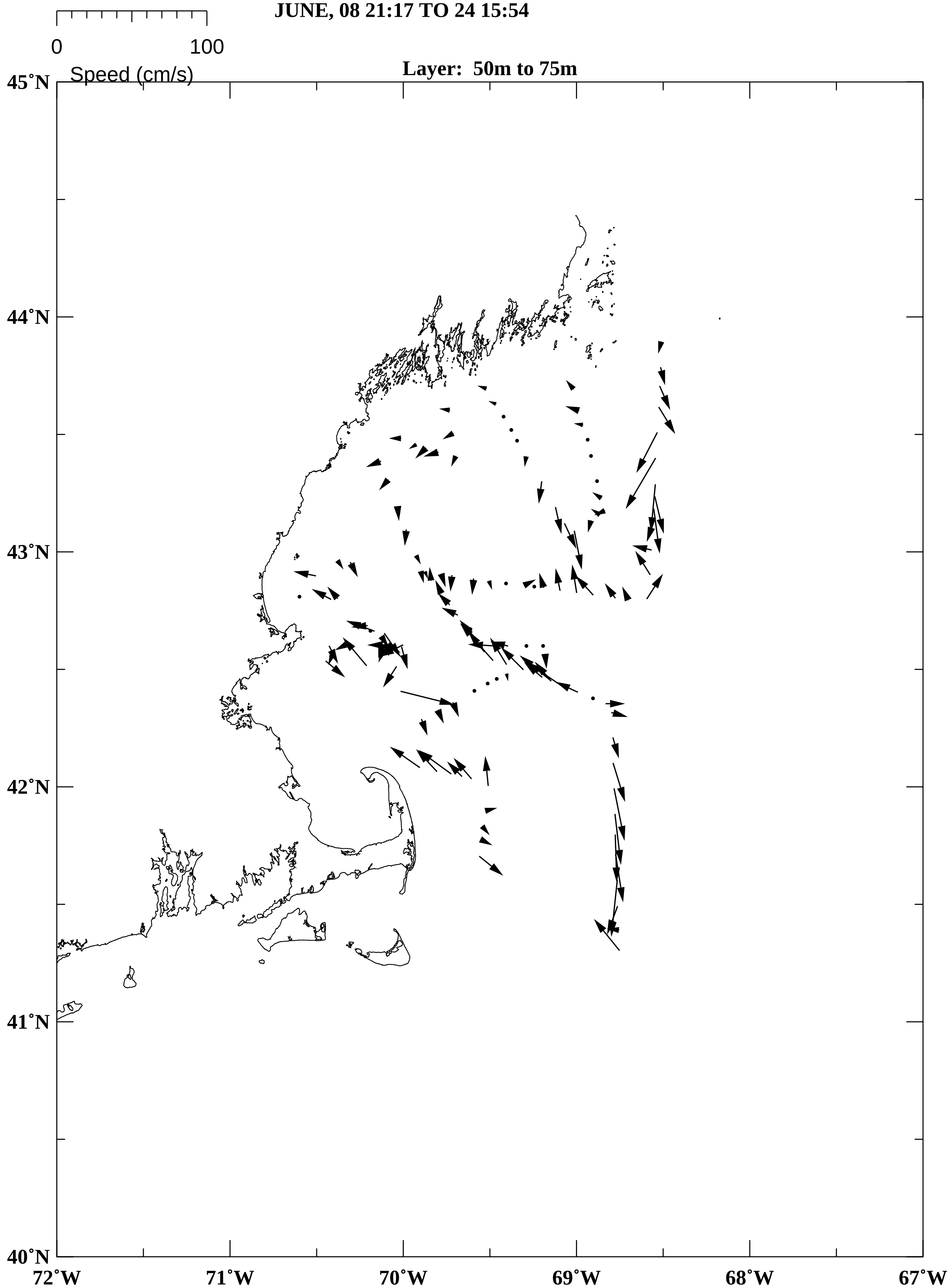
ASCOT01

JUNE, 08 21:17 TO 24 15:54



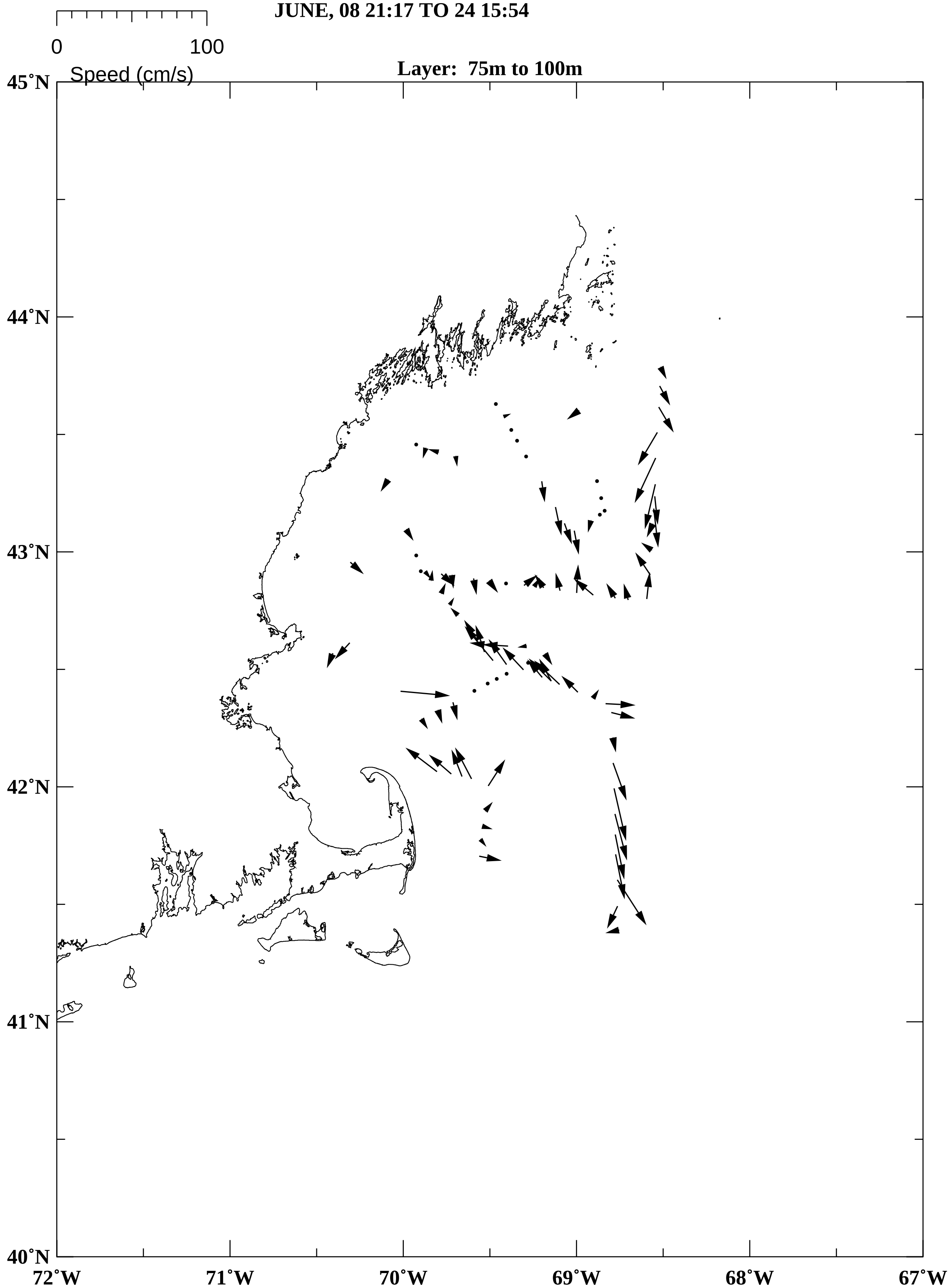
ASCOT01

JUNE, 08 21:17 TO 24 15:54



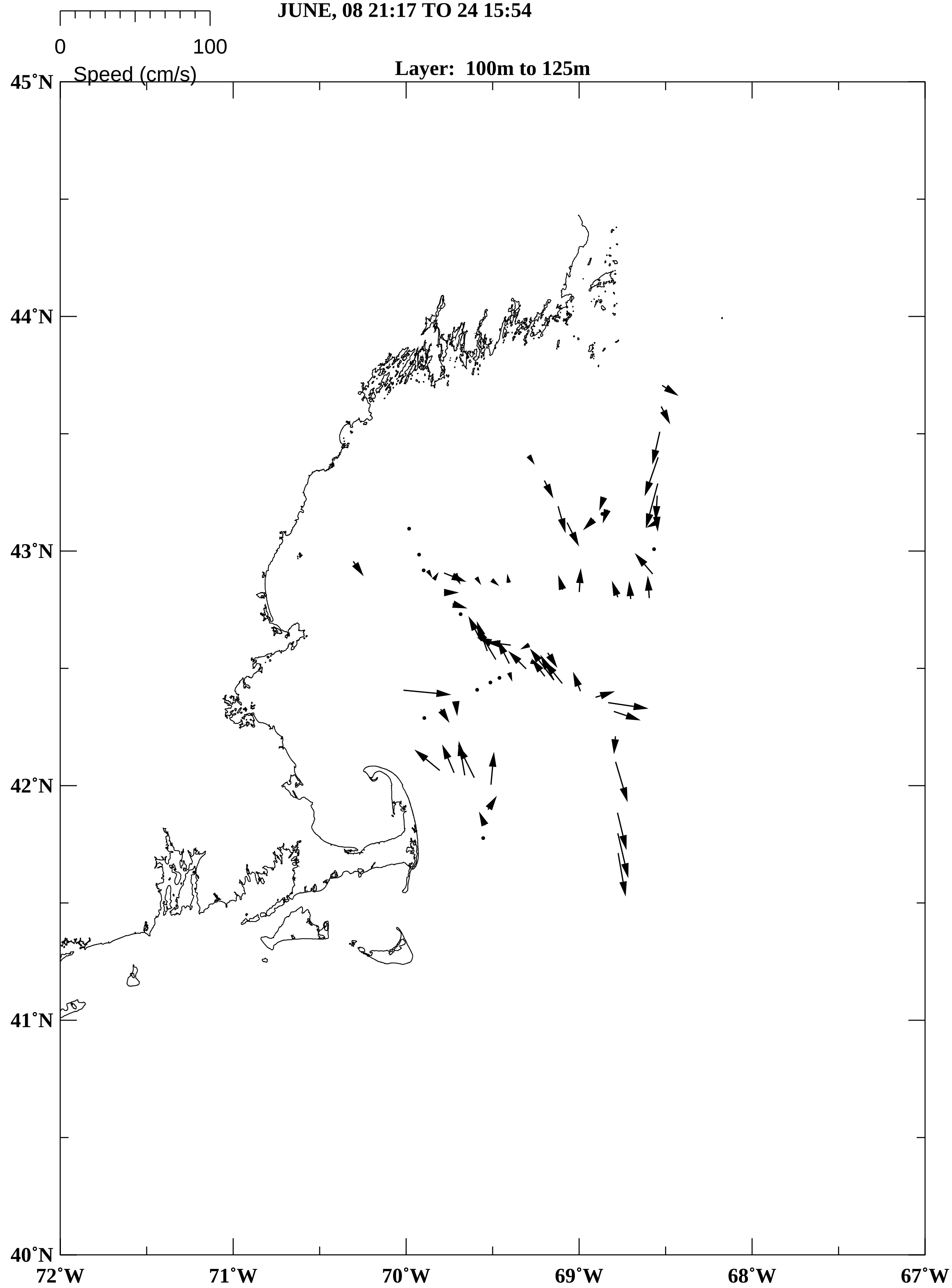
ASCOT01

JUNE, 08 21:17 TO 24 15:54



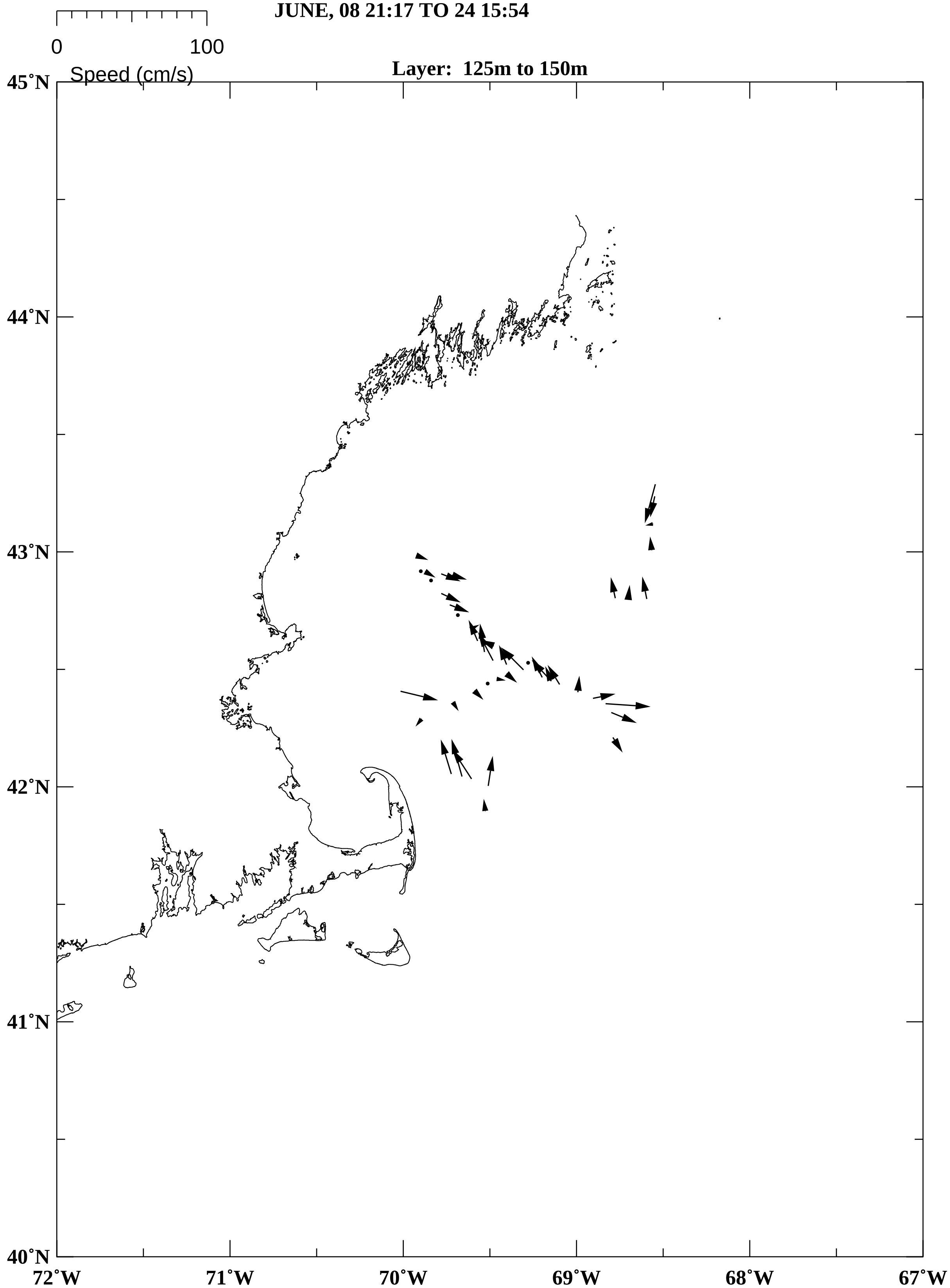
ASCOT01

JUNE, 08 21:17 TO 24 15:54



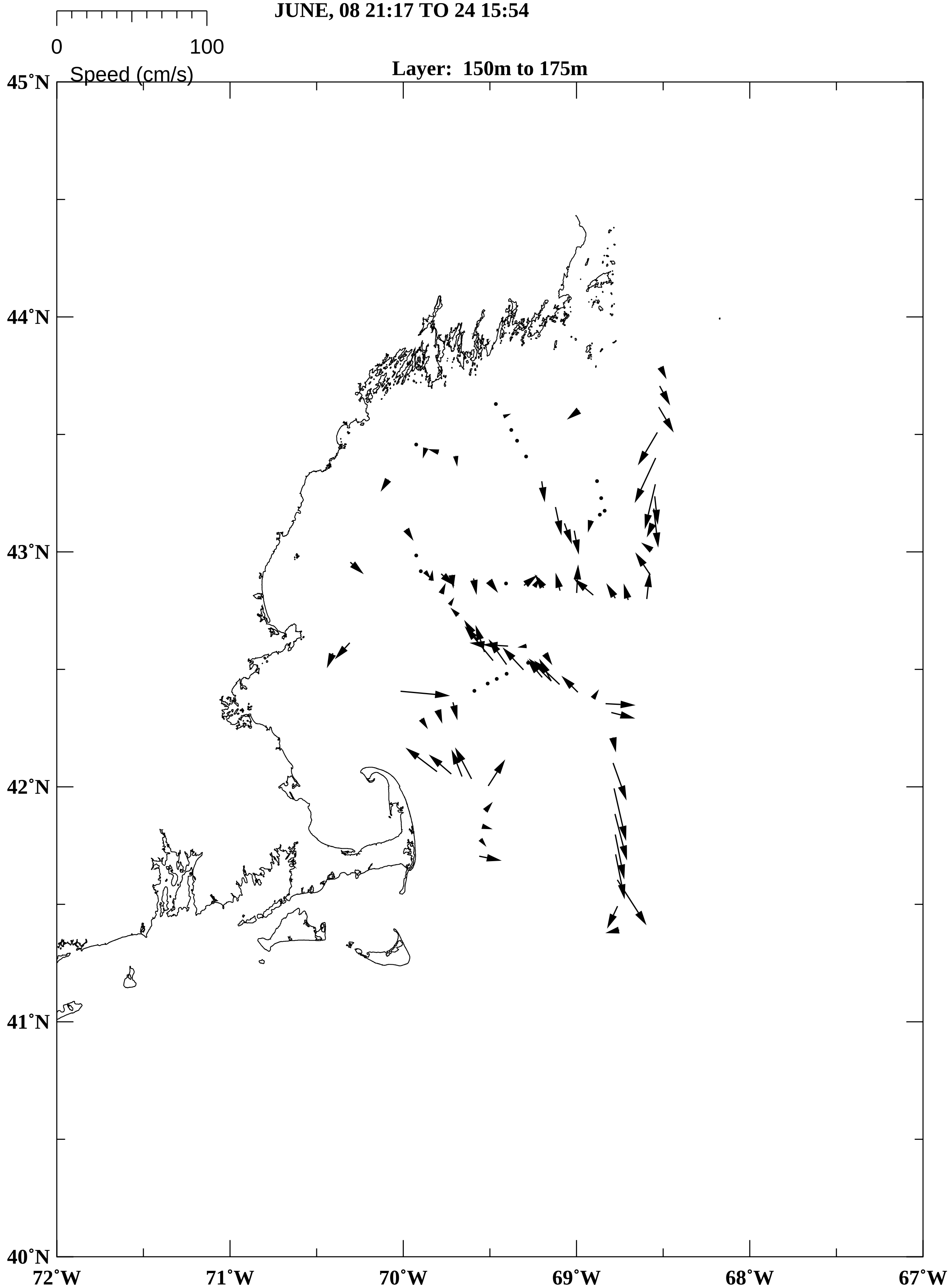
ASCOT01

JUNE, 08 21:17 TO 24 15:54



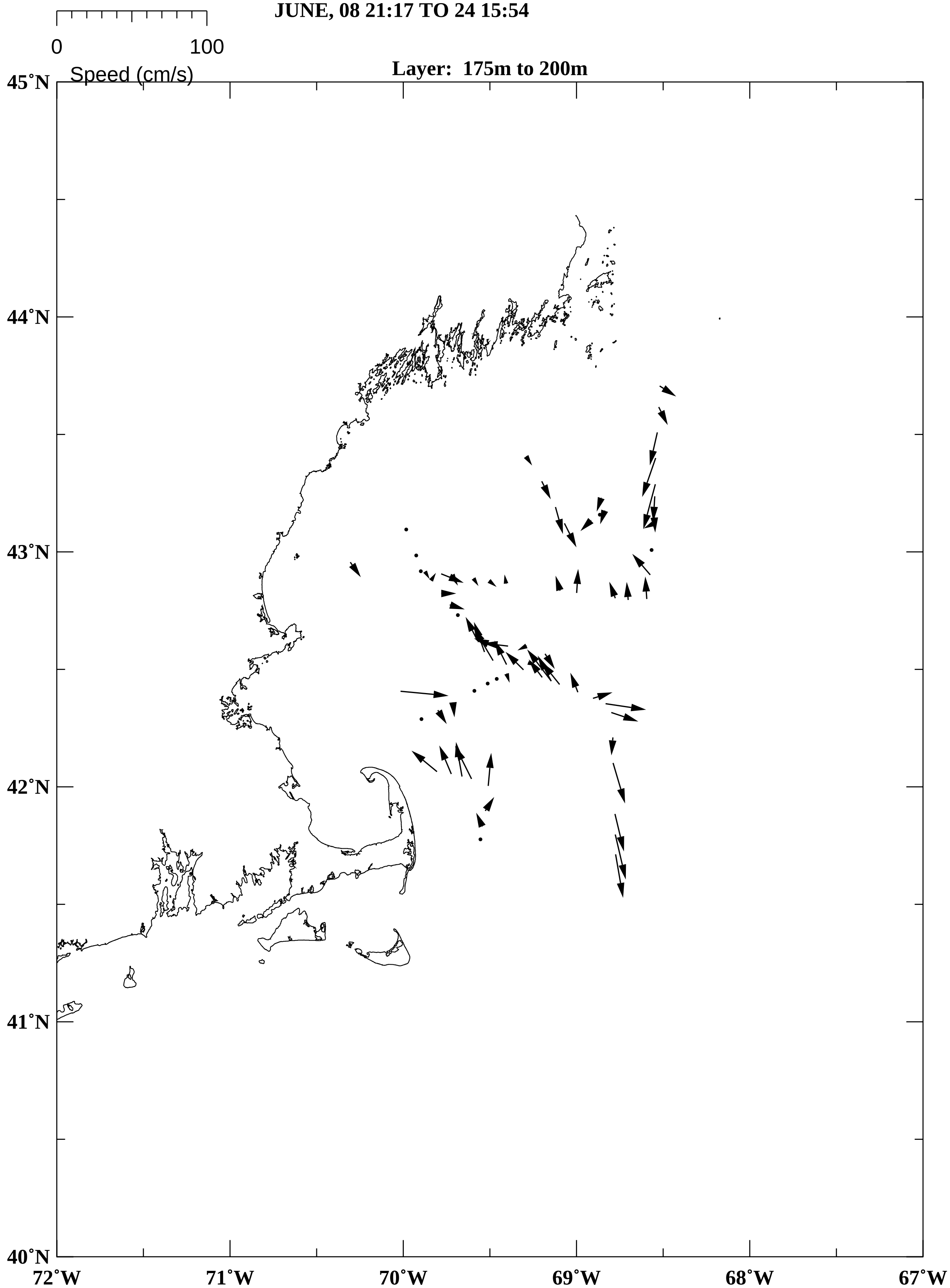
ASCOT01

JUNE, 08 21:17 TO 24 15:54



ASCOT01

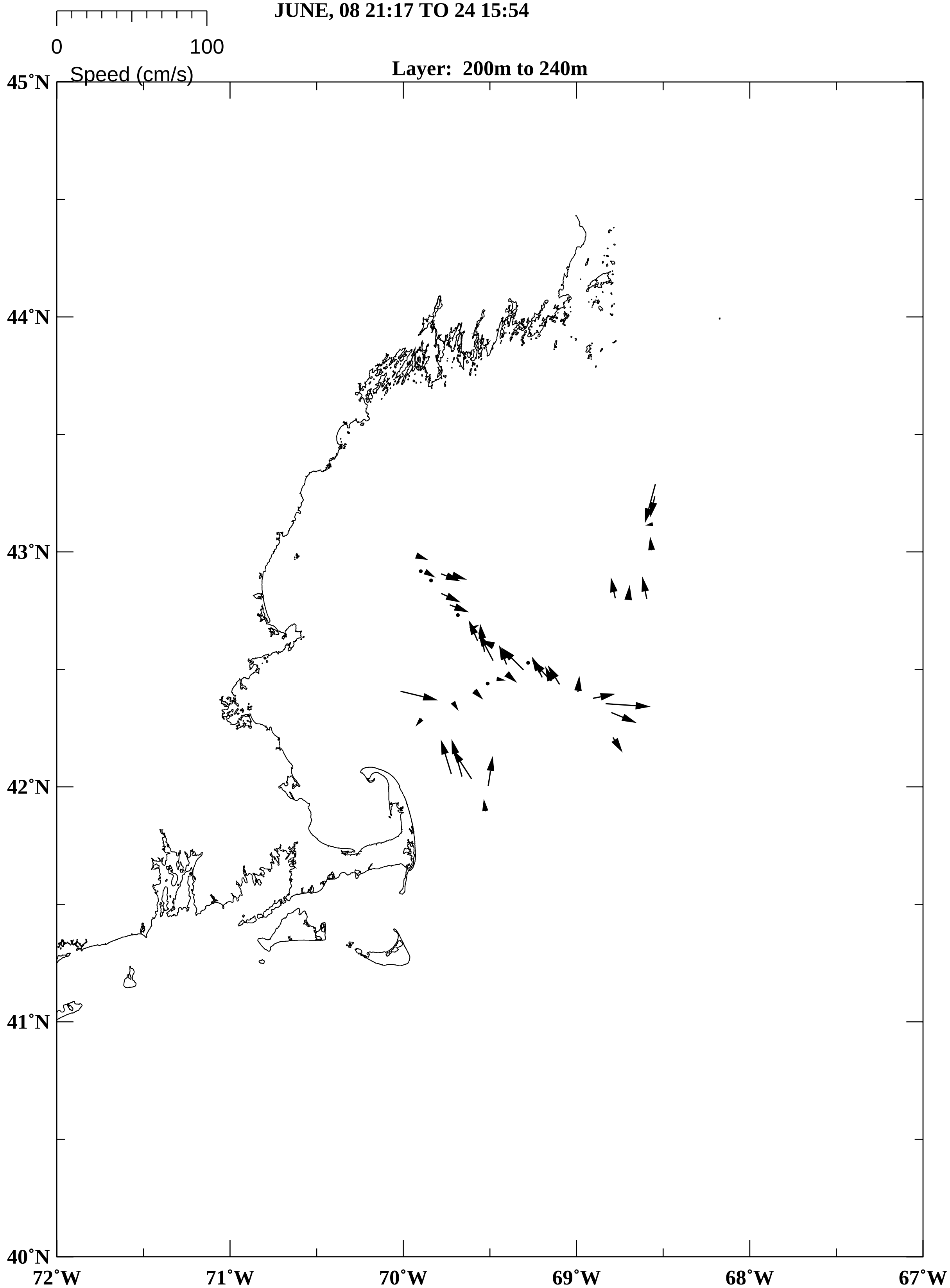
JUNE, 08 21:17 TO 24 15:54



ASCOT01

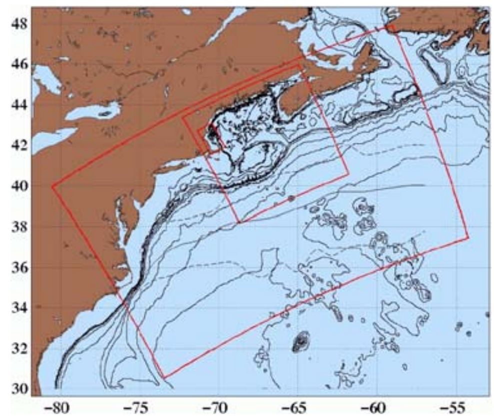
JUNE, 08 21:17 TO 24 15:54

Layer: 200m to 240m



Real-time Nowcasts and Forecasts – Table and Example Products

Data analysis, data assimilation and numerical simulations were carried out on a daily basis in real-time throughout the duration of the exercise. Data was analyzed, quality controlled and processed as it is received and made available for assimilation into the Harvard Ocean Prediction System (HOPS). Model simulations were carried out both aboard the Alliance and at Harvard. The operational forecasts were performed aboard the Alliance.



The ASCOT-01 simulation and operational system consisted of a set of three two-way nested domains: the Northwest Atlantic (NWA), the Gulf of Maine (GOM) and Massachusetts Bay (MB). The specifics of the individual domains are given in the table below and the domains are shown at right. In the operational context, there was two-way nesting between the NWA and GOM (NWA/GOM) domains and the GOM and MB (GOM/MB) domains. The NWA/GOM nested run provided boundary conditions for the GOM during the GOM/MB nested run. The coupled physical/biological simulations were run in a stand-alone Massachusetts Bay domain at Harvard.

Modeling Domains

DOMAIN	DESCRIPTION/ SPECIFICATION
Western North Atlantic	Resolution: 0.135 degrees (~15km) Size: 130x83x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 0 deg.; dely = 0 deg. Domain rotation: 25.5 degrees
Gulf of Maine	Resolution: 0.045 degrees (~5km) Size: 131x144 x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 1.2825 deg.; dely = 2.0475 deg. Domain rotation: 25.5 degrees
Massachusetts Bay	Resolution: 0.015 degrees (~5/3km) Size: 53x90x16 (nx x ny x nz) Transform center: 39.439250N, 67.1515W Domain offset: delx = -0.9675 deg. dely = 3.6975 deg. Domain rotation: 25.5 degrees

A two-way nested domain pair consists of a dynamical model defined in two domains, one with coarser resolution containing the other with finer resolution.

Information from the finer resolution domain is used to replace information in the coarser resolution domain areas that intersects with the finer resolution domain (up-scale). Information from the coarser resolution domain around the boundaries of the finer resolution domain is interpolated to improve boundary information in the finer resolution domain (down-scale).

Typical model forecasts lasted for seven model days. This duration allows for the assimilation of hydrographic and remotely sensed data, a nowcast and short (four day) forecast. Lengthier forecasts are possible but were not considered necessary for this operation. On a typical forecast day (Day 0) aboard the Alliance, the following protocol was followed:

1. Evaluate and interpret the physical forecast launched the previous day (Day -1) and also interpret the biological forecast received the previous night (Day -1) or the night before (Day -2).
2. Plan adaptive sampling for the subsequent two days and anticipate interesting sampling for the following day.
   * confirm operation of coastal vessels and furnish sampling plan for tomorrow
   * alert coastal vessels of impending use - determine scientific motivation (UFA) and general area of operations - allow time for coastal vessels to deal with logistical issues
3. Prepare and launch daily forecast
   * data management and quality control (2 hours)
   * objective analysis of observations and prepare initialization (2 hours)
   * launch forecast (approximately 1430)

Forecasts were available on a daily basis after the initialization survey in order to provide adaptive sampling patterns for the subsequent day's sampling. Products were available from the NRV Alliance via the experiment web site (http://people.deas.harvard.edu/~leslie/ASCOT01/index.html). The following pages include the table of forecasts and products available from the ASCOT-01 web site as well as a sub-set of products from each of the forecasts. The example products include (for both the Gulf of Maine and Massachusetts Bay modeling domains): synoptic analysis (nowcast) maps of temperature with superimposed velocity vectors for two levels of interest and a vertical section of temperature at an interesting location.

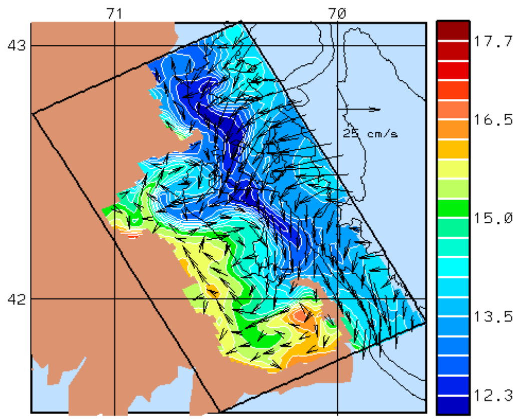
Real-time Nowcast and Forecast Products

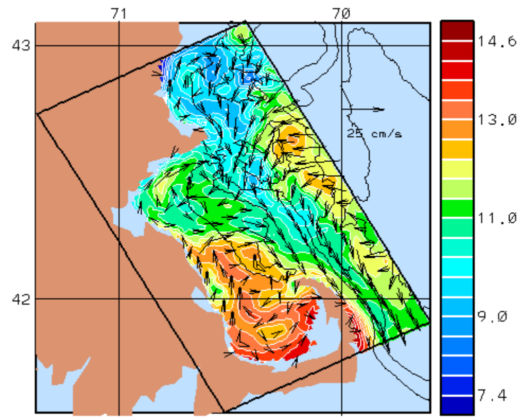
Nowcast and Forecast Products	Massachusetts Bay		Gulf of Maine
	Physics	Biology	Physics
09 June 2001	X		
10 June 2001	X		
11 June 2001	X		X
12 June 2001	X		X
13 June 2001	X	X	X
14 June 2001	X		X
16 June 2001	X	X	X
17 June 2001		X	
18 June 2001		X	
20 June 2001	X	X	X
21 June 2001	X	X	X
22 June 2001	X	X	X
23 June 2001	X	X	X
24 June 2001		X	
25 June 2001	X		X

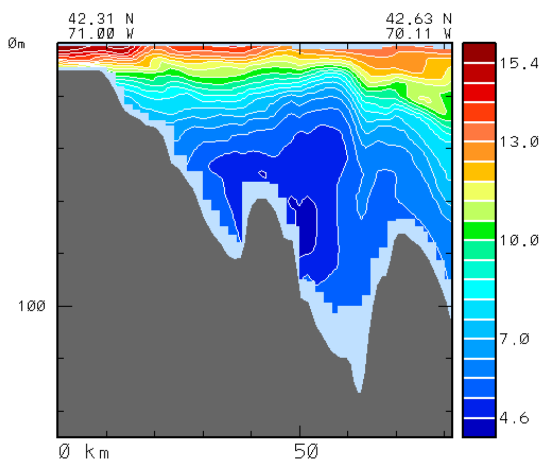
The real-time analyses and forecasts were produced by the Harvard Ocean Prediction System under the guidance of Prof. Allan R. Robinson. The forecasts of physics were carried out at sea on the NRV Alliance by Dr. Patrick J. Haley, Jr. The forecasts of biology were carried out at Harvard University by Dr. Pierre F.J. Lermusiaux. Data processing, analysis and web pages were the responsibility of Wayne G. Leslie

Nowcast Products for 9 June 2001

2m Temp., 10m Temp., Section from Scituate

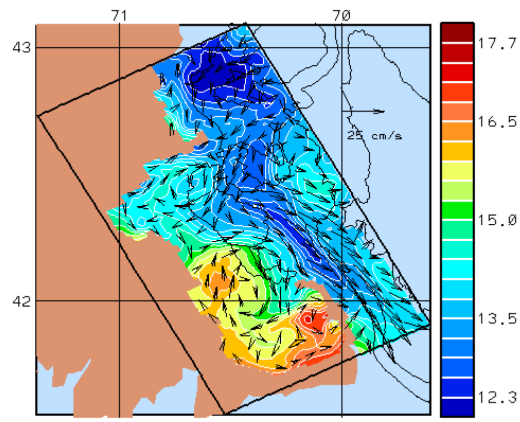


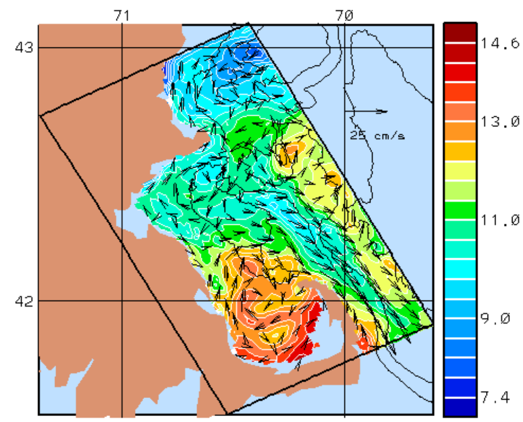


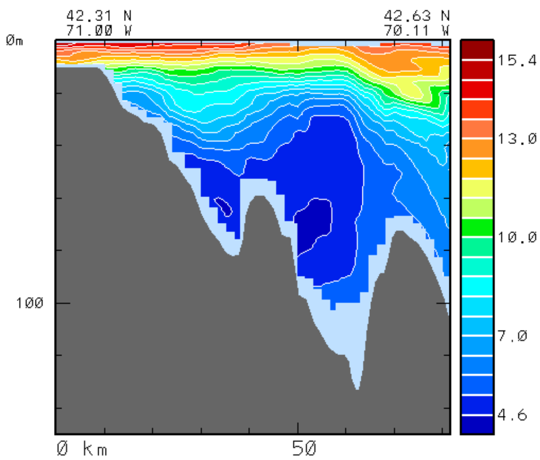


Nowcast Products for 10 June 2001

2m Temp., 10m Temp., Section from Scituate

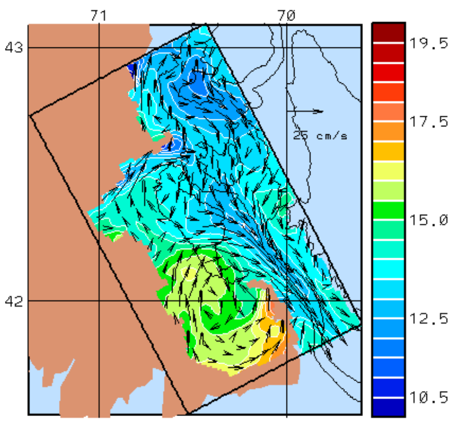


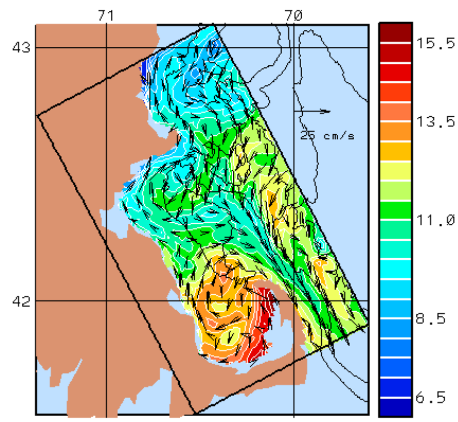


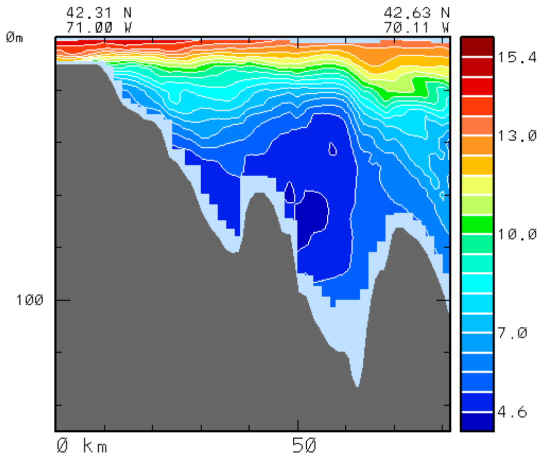


Nowcast Products for 11 June 2001

2m Temp., 10m Temp., Section from Scituate

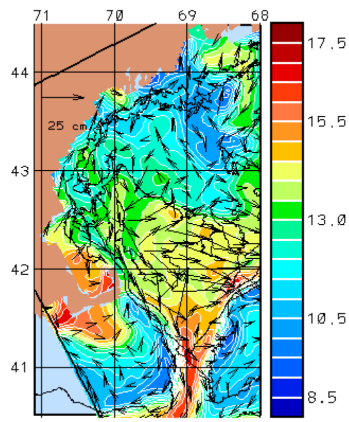


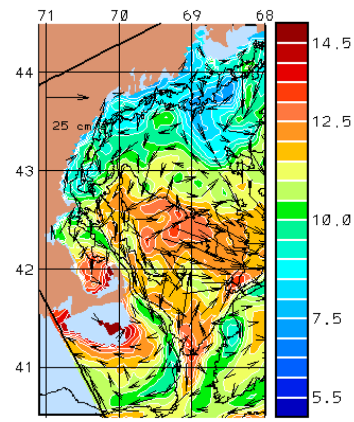


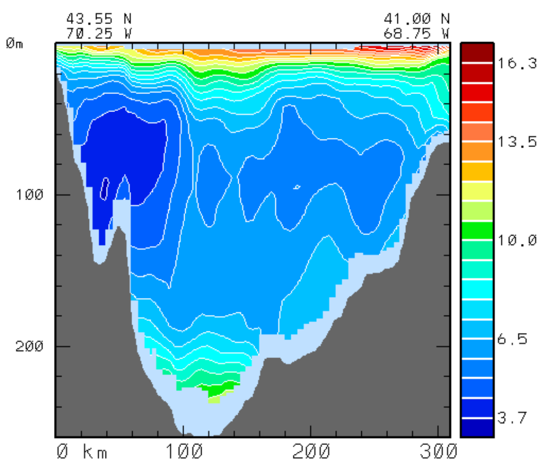


Nowcast Products for 11 June 2001

3m Temp., 25m Temp., Section from Portland

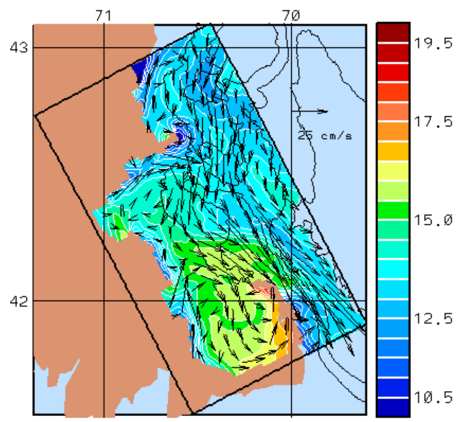


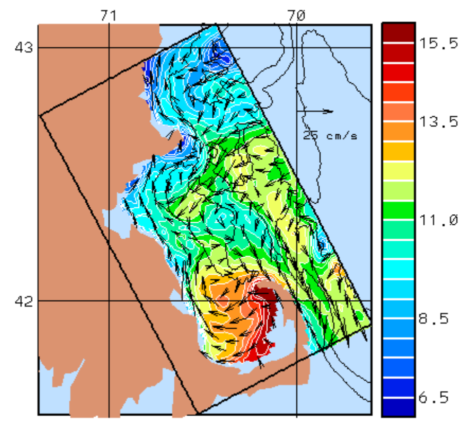


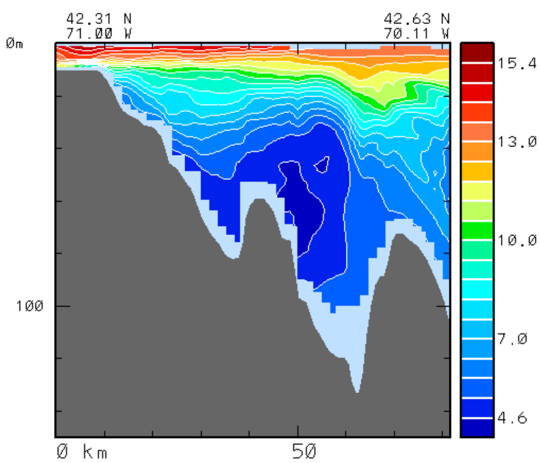


Nowcast Products for 12 June 2001

2m Temp., 10m Temp., Section from Scituate

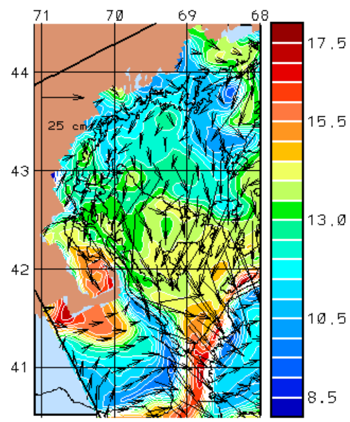


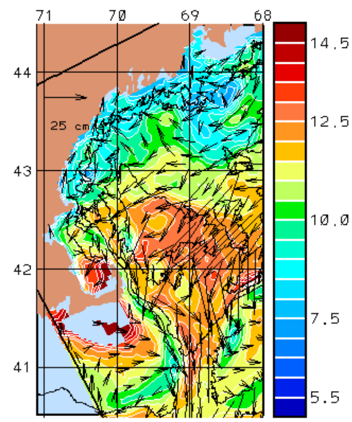


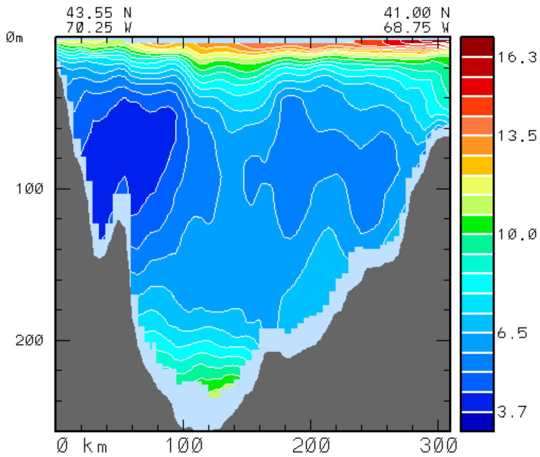


Nowcast Products for 12 June 2001

3m Temp., 25m Temp., Section from Portland







Nowcast Products for 13 June 2001

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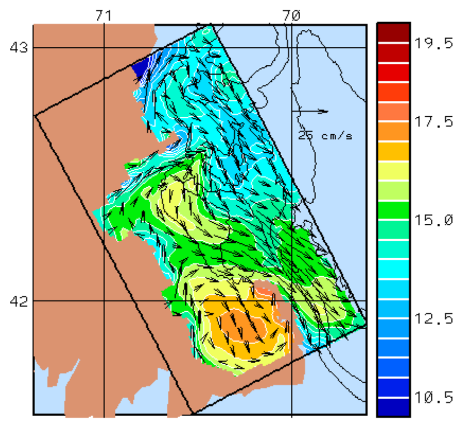
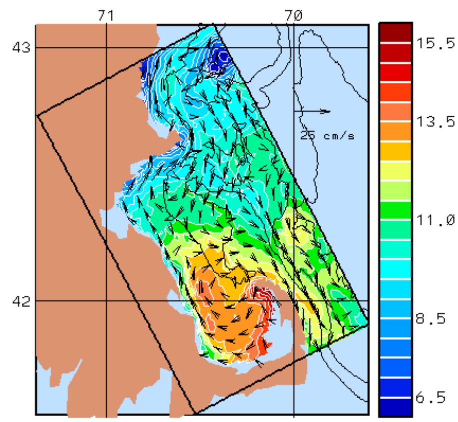
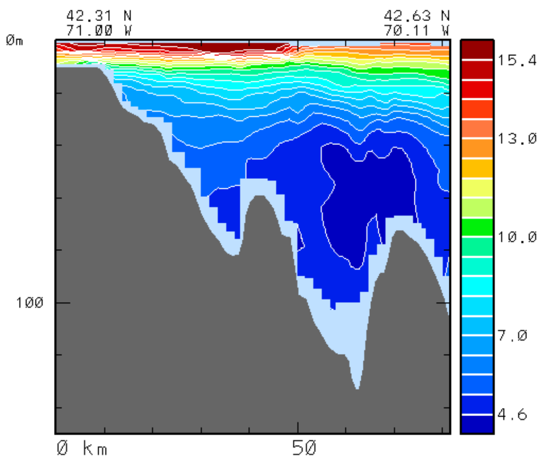
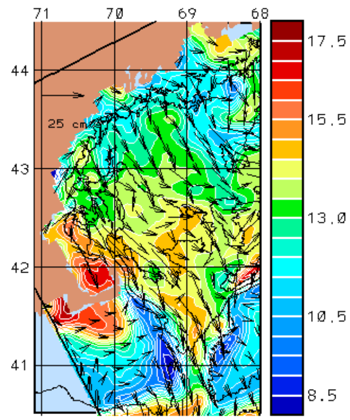


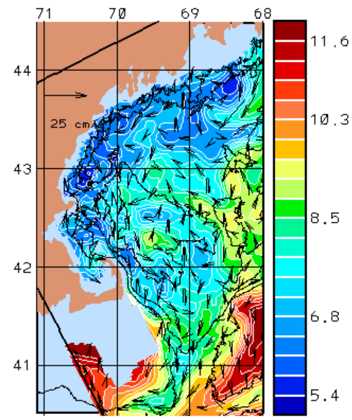


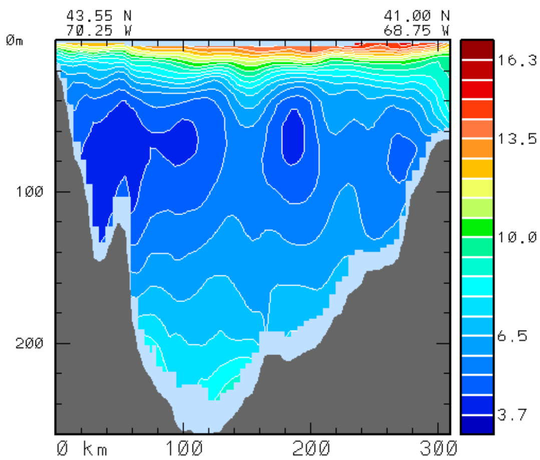


Nowcast Products for 13 June 2001

3m Temp., 25m Temp., Section from Portland

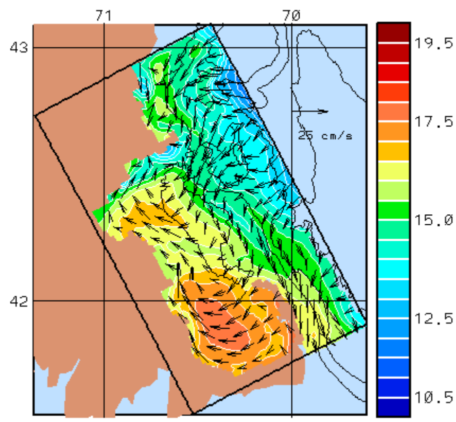


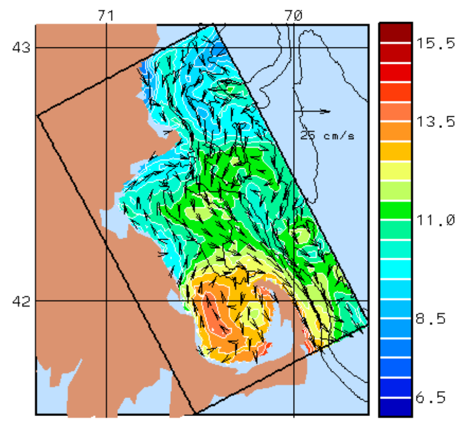


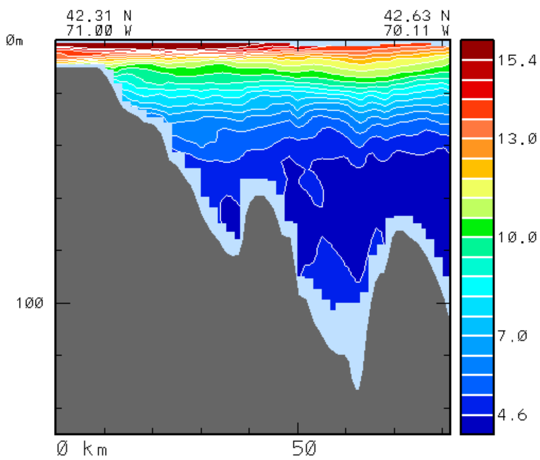


Nowcast Products for 14 June 2001

2m Temp., 10m Temp., Section from Scituate

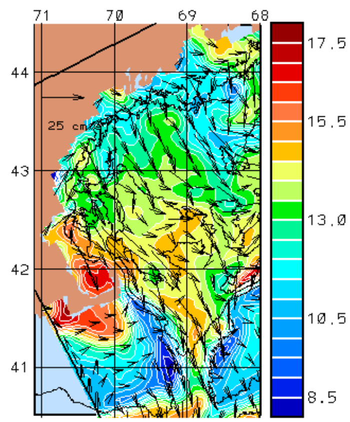


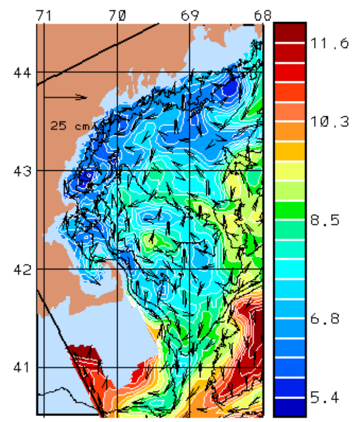


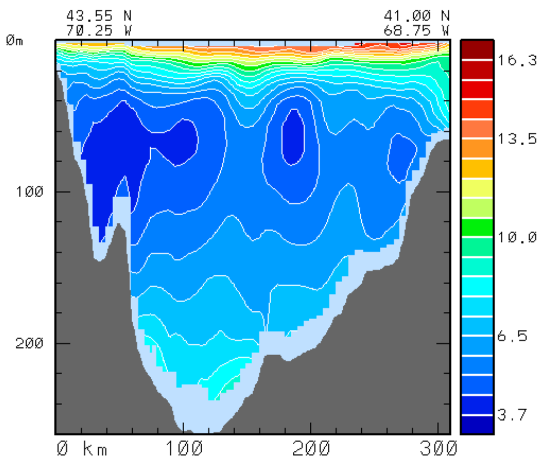


Nowcast Products for 14 June 2001

3m Temp., 25m Temp., Section from Portland

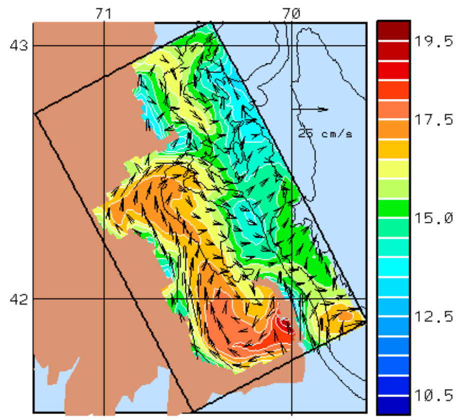


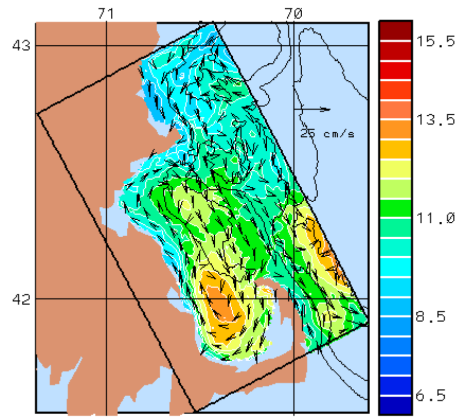


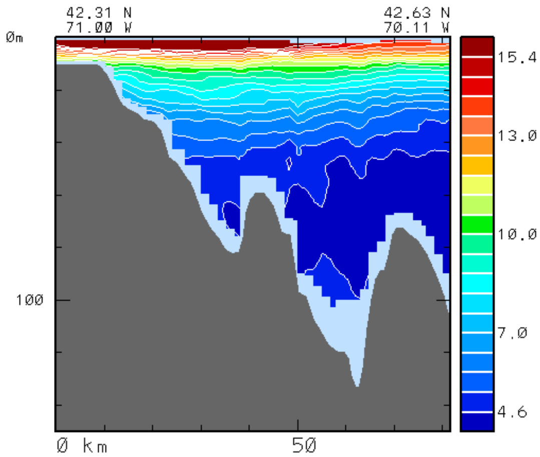


Nowcast Products for 16 June 2001

2m Temp., 10m Temp., Section from Scituate

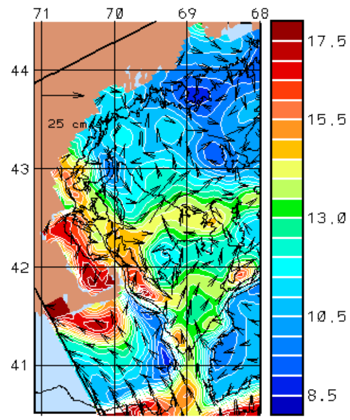


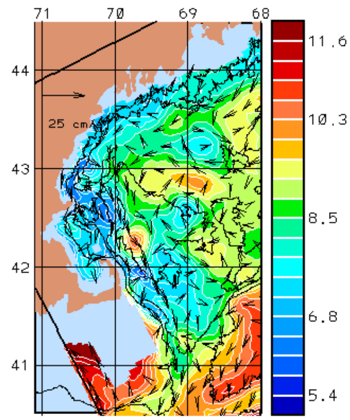


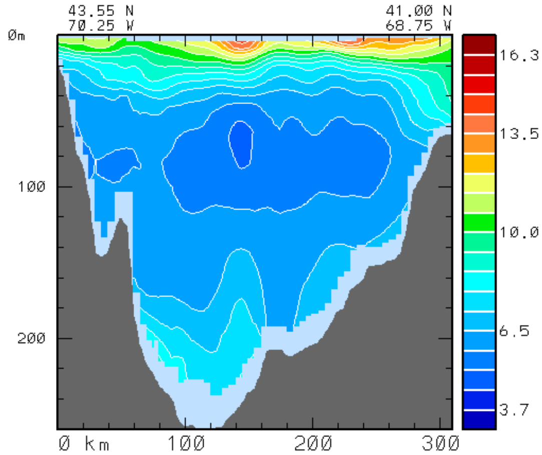


Nowcast Products for 16 June 2001

3m Temp., 25m Temp., Section from Portland

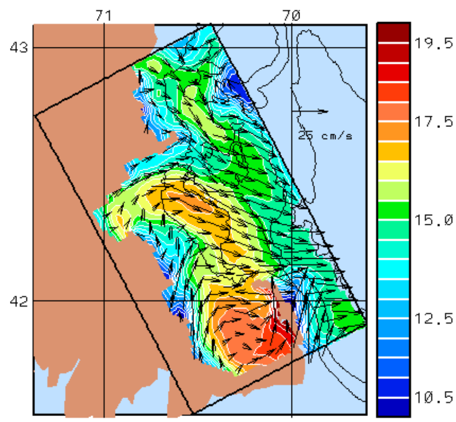


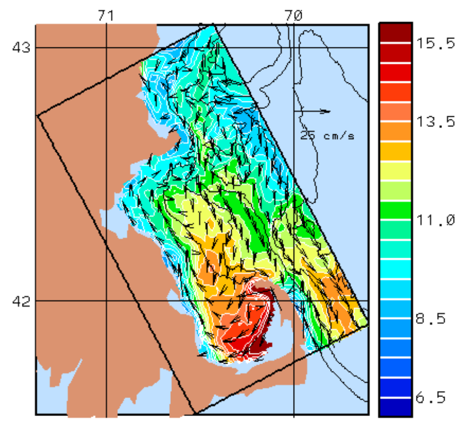


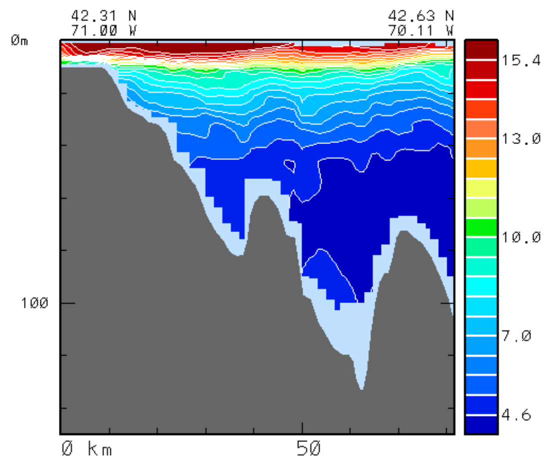


Nowcast Products for 20 June 2001

2m Temp., 10m Temp., Section from Scituate

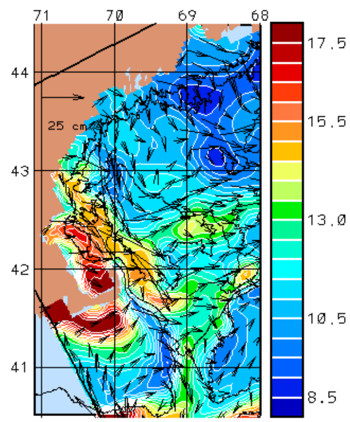


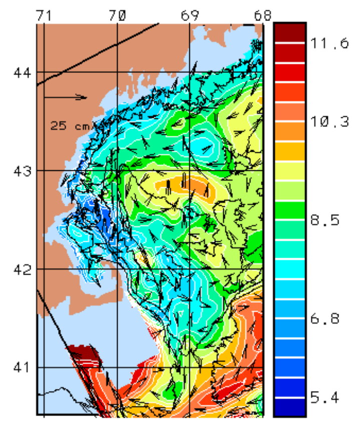


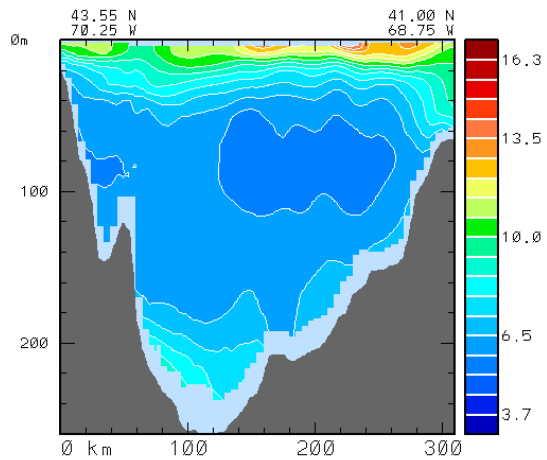


Nowcast Products for 20 June 2001

3m Temp., 25m Temp., Section from Portland

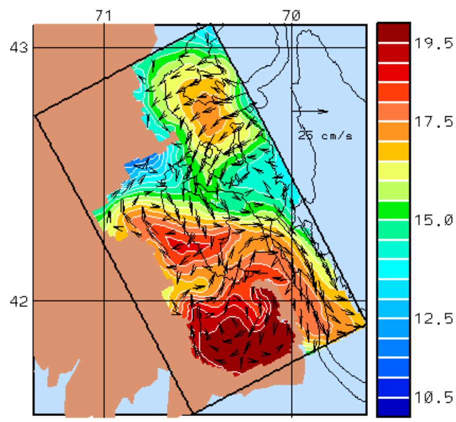


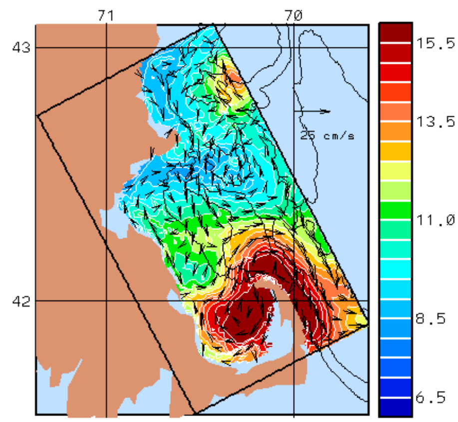


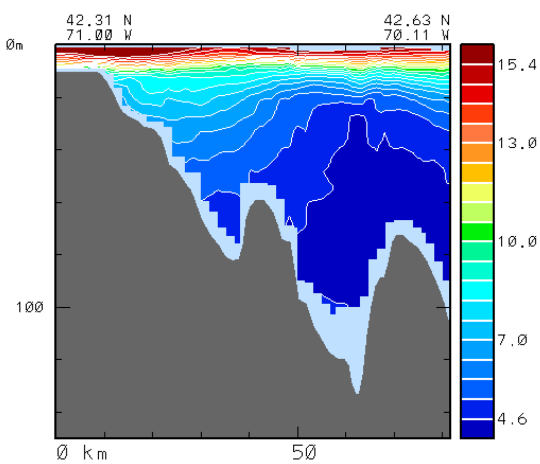


Nowcast Products for 21 June 2001

2m Temp., 10m Temp., Section from Scituate

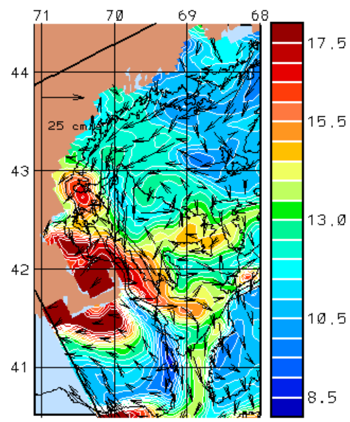


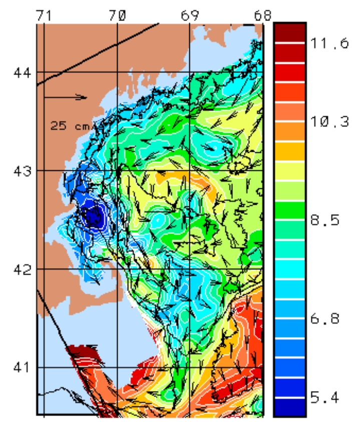


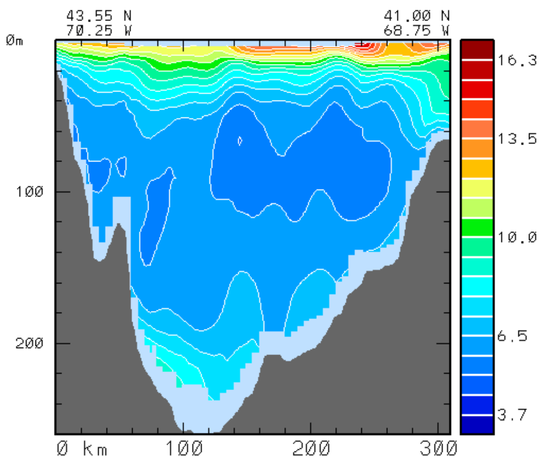


Nowcast Products for 21 June 2001

3m Temp., 25m Temp., Section from Portland

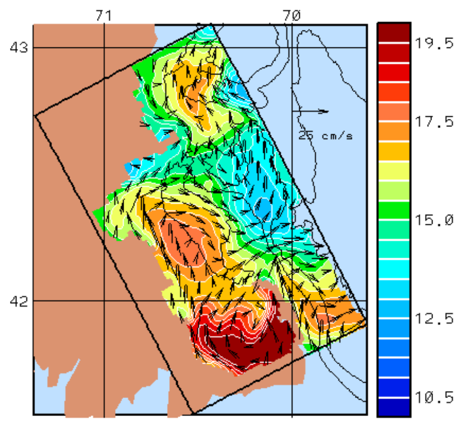


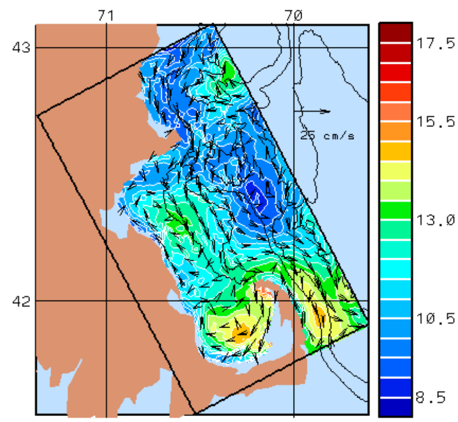


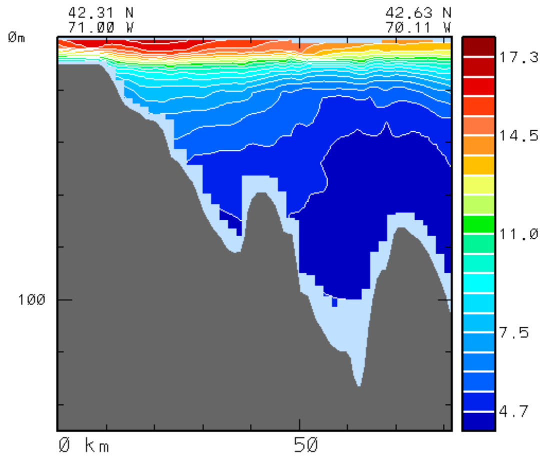


Nowcast Products for 22 June 2001

2m Temp., 10m Temp., Section from Scituate

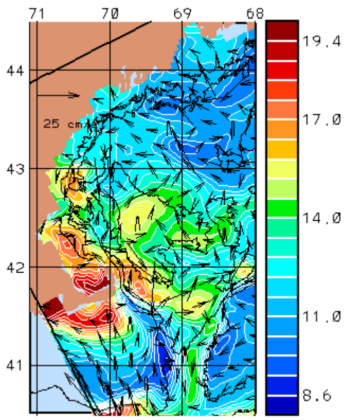


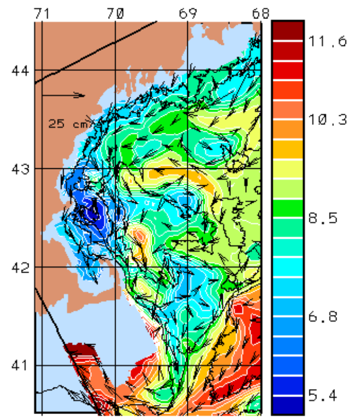


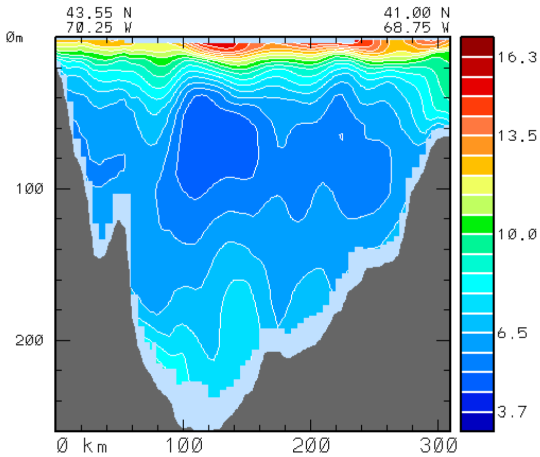


Nowcast Products for 22 June 2001

3m Temp., 25m Temp., Section from Portland







Nowcast Products for 23 June 2001

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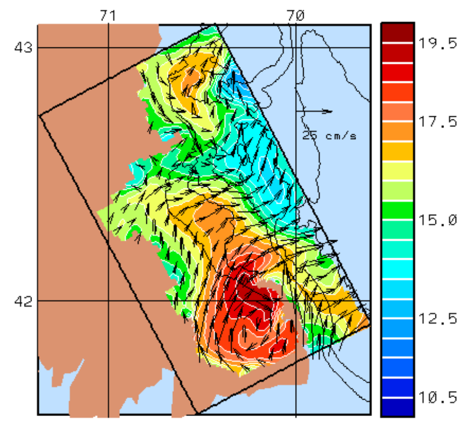
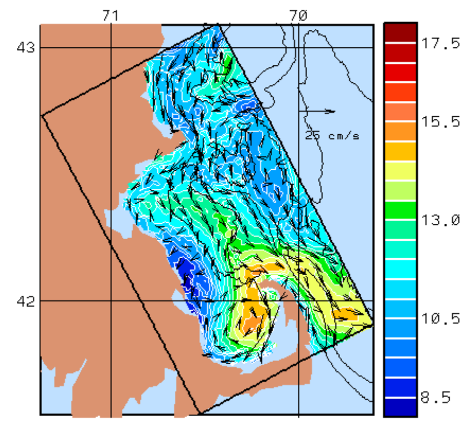
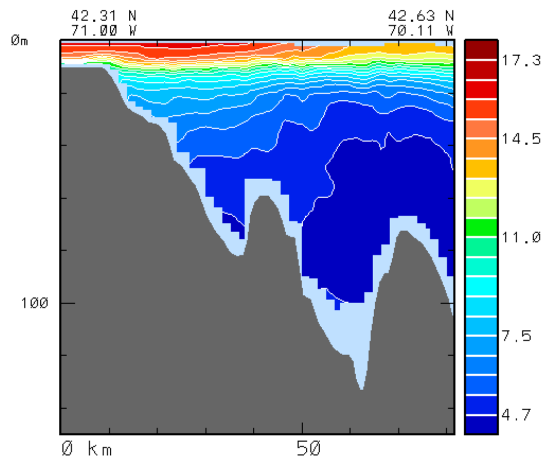
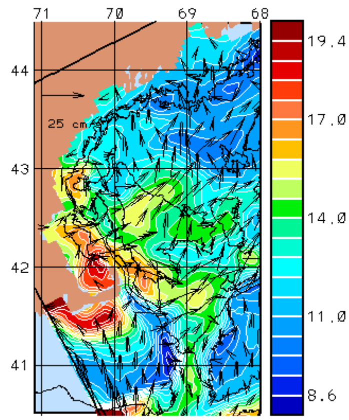


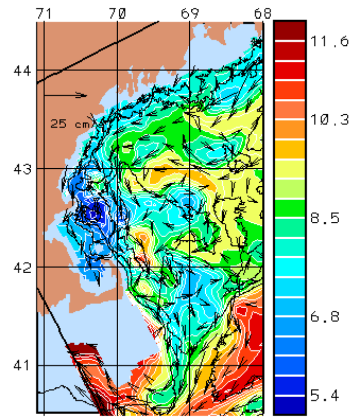


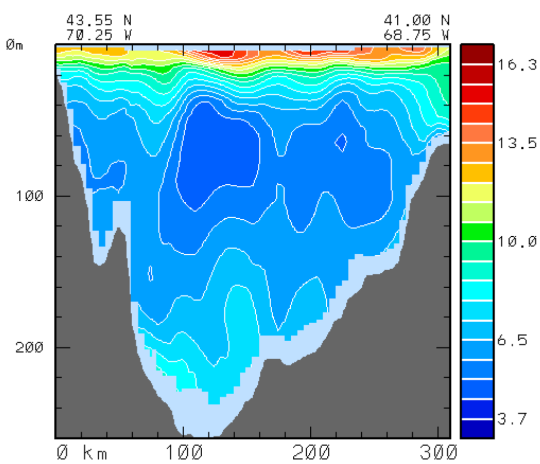


Nowcast Products for 23 June 2001

3m Temp., 25m Temp., Section from Portland

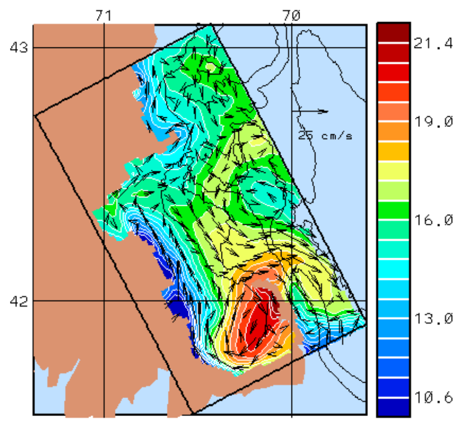


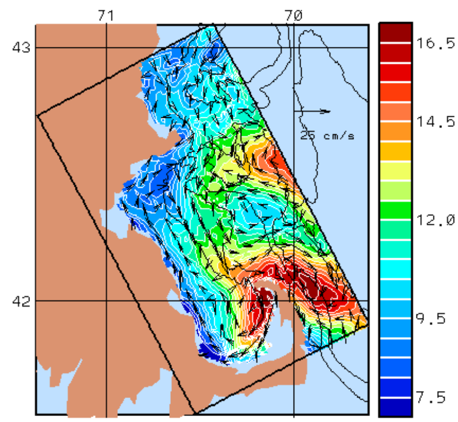


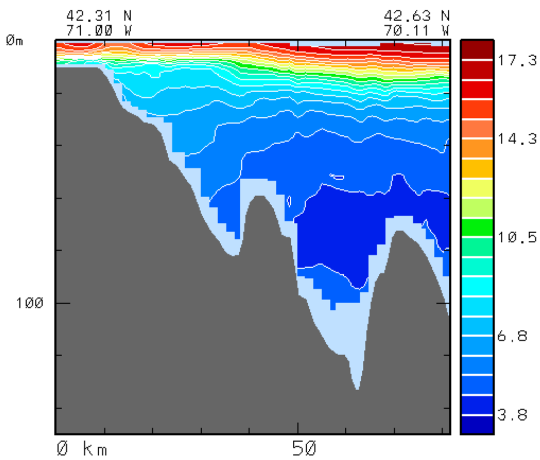


Nowcast Products for 25 June 2001

2m Temp., 10m Temp., Section from Scituate

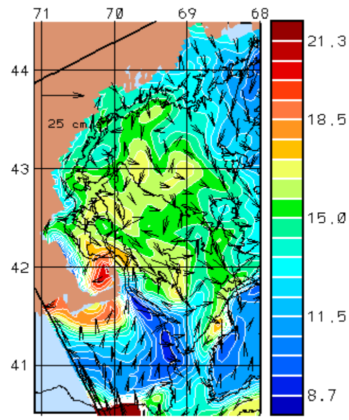


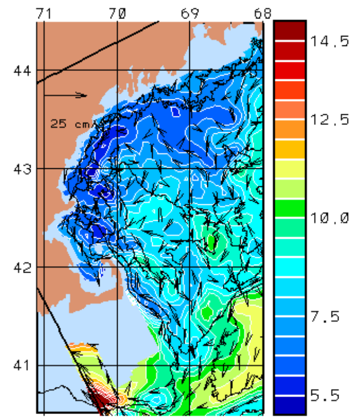


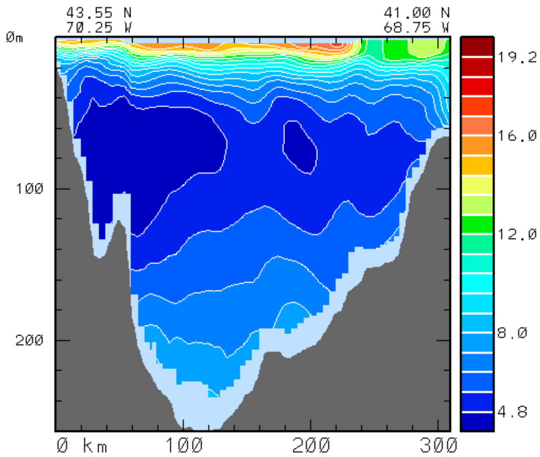


Nowcast Products for 25 June 2001

3m Temp., 25m Temp., Section from Portland







Forecast Skill Metrics

The skill of the operational forecasts is measured by using two metrics, a Root-Mean-Square Error (RMSE) and Pattern Correlation Coefficient (PCC), as defined below. These numbers are computed model level by model level (1 to 16), and as a volume average. The perfect values of the PCC and RMSE are, respectively, one and zero. Note, however, that in practice, these values are never realized.

<u>Definitions:</u>

Loading the field values of a variable into a vector *T* whose dimension varies with the spatial extension of the field (e.g. model level or volume field), the field RSME and PCC are respectively defined by

$$\text{RMSE} \equiv \sqrt{(T^f - \hat{T})^T (T^f - \hat{T})} \equiv \left\| T^f - \hat{T} \right\|_2 ; \quad \text{PCC} \equiv \frac{(T^f - T^b)^T \; (\hat{T} - T^b)}{\left\| T^f - T^b \right\|_2 \left\| \hat{T} - T^b \right\|_2}$$

where $\hat{T}$ denotes the true ocean, T^f its forecast, T^b a background field vector (e.g. large-scale field, climatological field, etc.), and $\| \, . \, \|_2$ the vector $_2$ norm.

A classic measure of skill is to compare the RMS and PCC of the forecast with that of the initial conditions (IC) (persistence forecast, in short persistence). If the RMSE of the forecast is smaller than that of the IC, the forecast has RMS-skill or beats persistence. Similarly, if the PCC of the forecast is larger than that of the IC, the forecast has PCC-skill or has better patterns than persistence. These skill metrics compare model results with those data not utilized for the forecast due to collection after the initialization of the model run. Note, importantly, that on volume average, the forecasts have lower RMSE and greater PCC than persistence for every forecast for which skill metrics could be calculated.

The statistical summary for June 20 has been broken into "Upper Ocean" and "Deep Ocean" evaluations. As the deep ocean changes very little, the useful metrics compare the upper and deep ocean separately. The separation was chosen at the level where the change of the metrics from level to level is small. The numbers entered in the "Ave" row are hand-calculated averages over the set of levels. A modification is being made to the computation of the skill metrics to provide a level-by-level analysis.

Simulations were initialized with a synoptic field created from June 2000 CTD shelf data. The first simulation (issued 9 June) was begun on 4 June 2001 with Fleet Numerical Meteorology and Oceanography Center (FNMOC) atmospheric forcing and assimilated 6-7 June hydrographic data on the dates on which the observations occurred. Subsequent simulations were restarted from the last day of the previous simulation which was forced by FNMOC analysis data rather than forecast data.

Forecast Issued	Assimilated Hydrography	FNMOC Forcing
9 June 2001	6-7 June 2001	Analysis: 4 June – 0000Z 8 June 2001 Forecast: 1200Z 8 June 2001 and after
12 June 2001	6-11 June 2001	Analysis: thru 0000Z 11 June 2001 Forecast: 1200Z 12 June 2001 and after
13 June 2001	6-12 June 2001	Analysis: thru 0000Z 12 June 2001 Forecast: 1200Z 12 June 2001 and after
14 June 2001	6-12 June 2001	Analysis: thru 0000Z 13 June 2001 Forecast: 1200Z 13 June 2001 and after
20 June 2001	6-15 June 2001	Analysis: thru 0000Z 19 June 2001 Forecast: 1200Z 19 June 2001 and after

On the pages that follow, there are three basic categories of fields presented:

Analysis: the result of an objective analysis of the hydrographic data
Forecast: PE model prediction for the date/time of the analysis field
Persistence: the corresponding initialization fields for the forecast. For a restart simulation, persistence is defined as the last assimilation field from the prior simulation.

The skill fields which are presented are defined as:

Forecast/Persistence – Analysis: a point by point difference of the corresponding fields over areas of sufficiently small (<0.2) non-dimensional error of the analysis field. From the RMSE, this is $(T^f - \hat{T})$ or $(T^p - \hat{T})$.

Forecast/Persistence Anomaly: a smooth “background” (average) field is constructed from the indicated field. This smoothed field is then removed to construct the anomaly. From the PCC, this is $(T^f - T^b)$ or $(T^p - T^b)$.

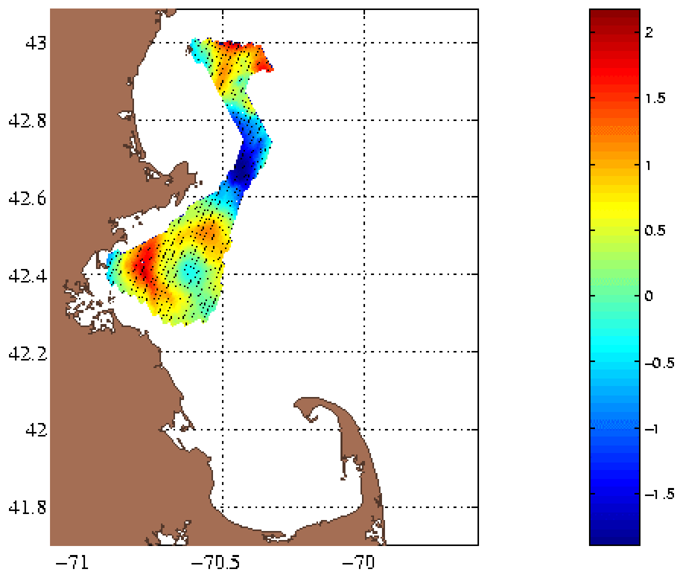
The units of the fields and the statistics are those of the quantity being evaluated. For temperature, the units are ^{o}C, and for salinity, PSU.

Forecast Skill Metrics - 9 June 2001 - Temperature

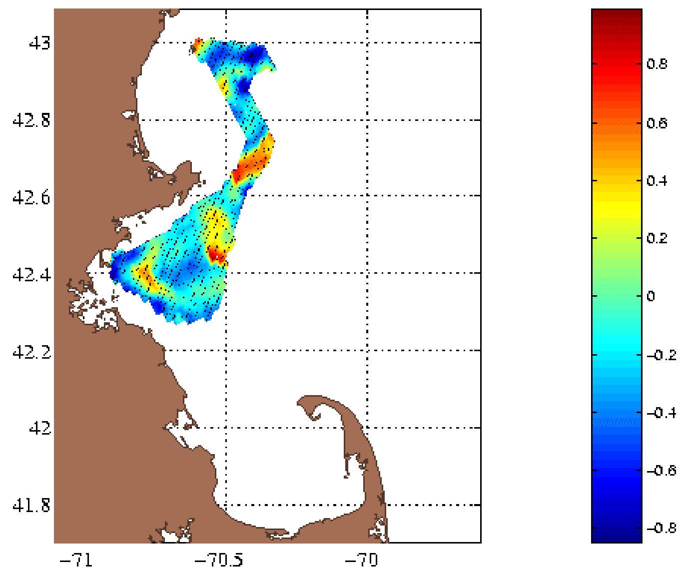
Statistical Summary

Level	RMS Error	PCC
1	1.173989	0.136915
2	1.203193	0.205639
3	0.990375	0.353393
4	0.702168	0.490772
5	0.870274	0.599074
6	0.999789	0.597056
7	0.988096	0.619488
8	0.859225	0.730054
9	0.766040	0.773867
10	0.766302	0.797963
11	0.776306	0.795008
12	0.761160	0.766555
13	0.717846	0.810406
14	0.814069	0.847316
15	0.832775	0.833507
16	0.800118	0.784855
Vol	0.888091	0.697431

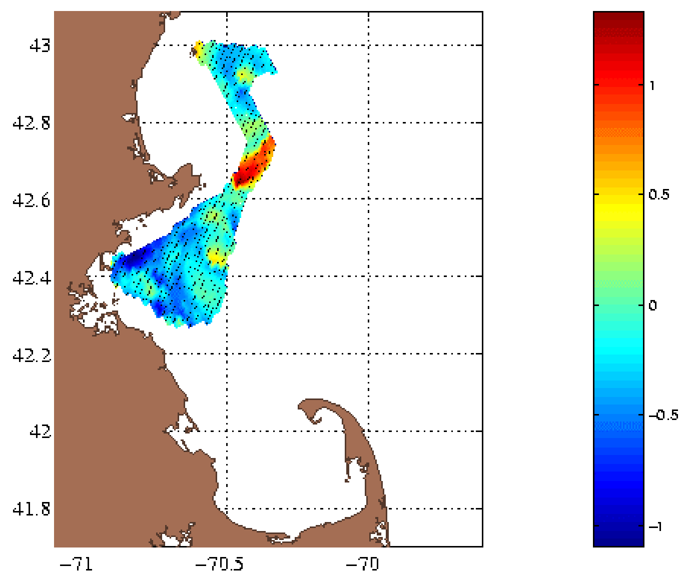
Forecast - Analysis



Forecast Anomaly



Analysis Anomaly

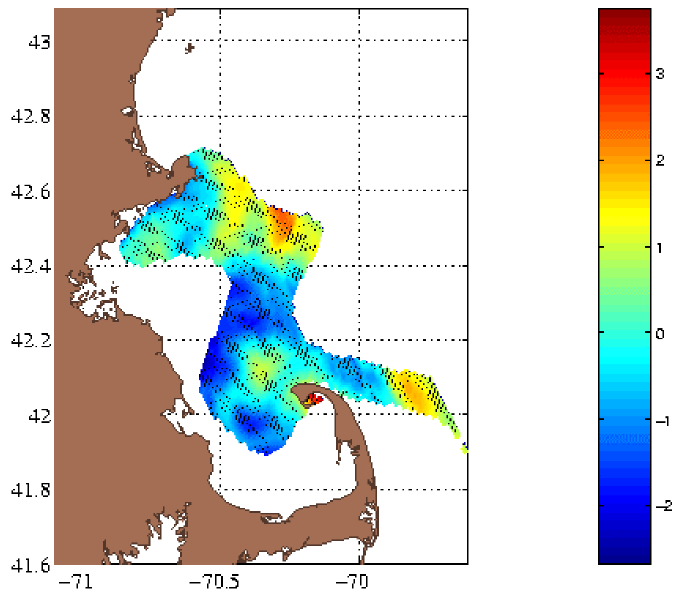


Forecast Skill Metrics - 12 June 2001 - Temperature

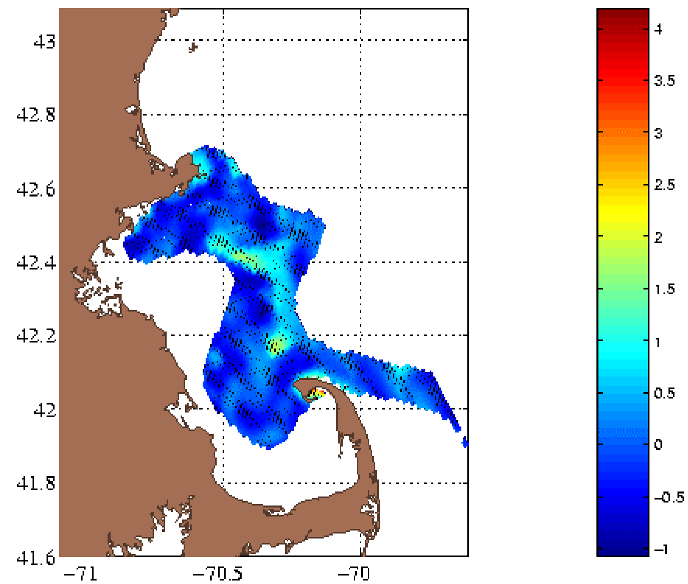
Statistical Summary

Level	RMS Error	PCC
1	1.154942	-0.146308
2	1.282186	-0.038826
3	1.321700	0.301205
4	1.423929	0.373749
5	1.386344	0.582297
6	1.212590	0.663519
7	1.177281	0.708132
8	1.123222	0.719809
9	1.207583	0.733216
10	1.168762	0.742671
11	1.142384	0.747263
12	1.043582	0.763440
13	0.952568	0.776363
14	0.931668	0.796973
15	0.929088	0.839647
16	1.121877	0.797721
Vol	1.181158	0.704737

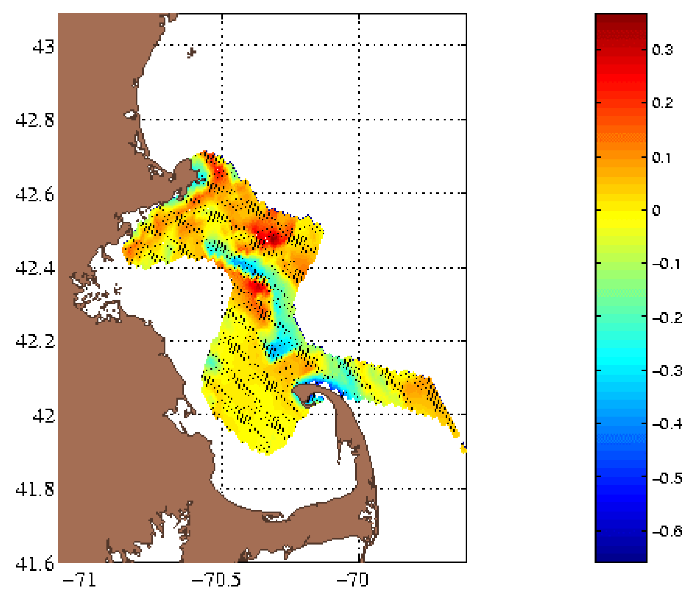
Forecast - Analysis



Forecast Anomaly



Analysis Anomaly

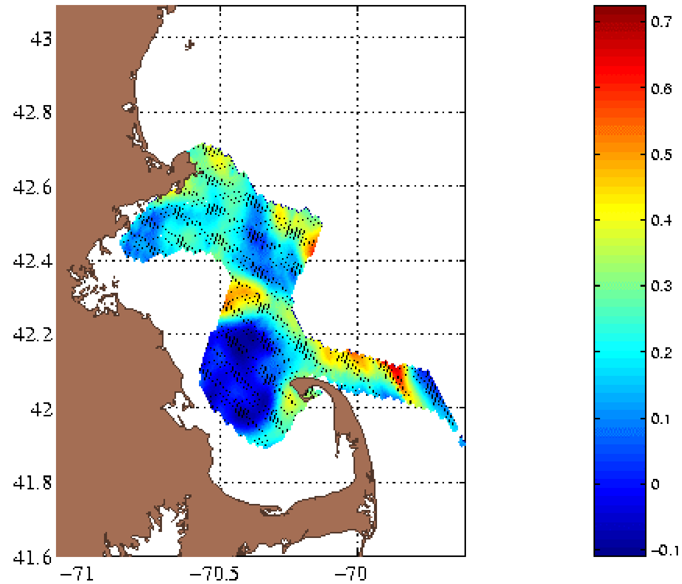


Forecast Skill Metrics - 12 June 2001 - Salinity

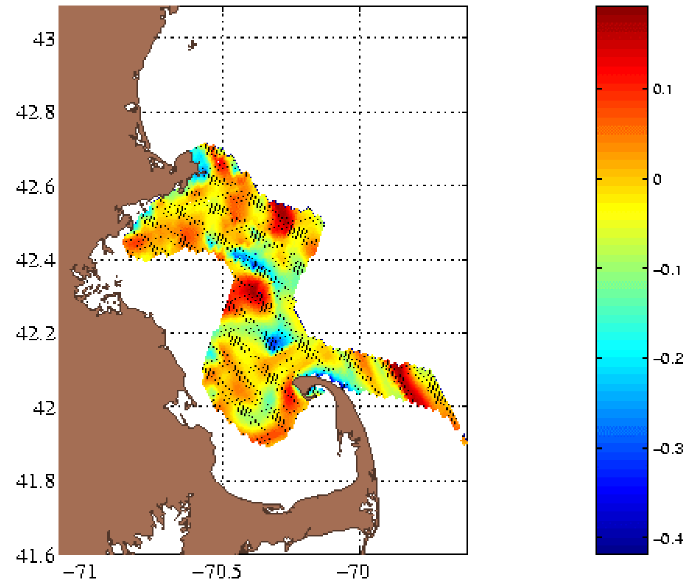
Statistical Summary

Level	RMS Error	PCC
1	0.943928	-0.025197
2	0.716641	0.057144
3	0.572141	0.096476
4	0.458260	0.335650
5	0.364118	0.391026
6	0.299123	0.519261
7	0.243192	0.687912
8	0.240455	0.706802
9	0.241255	0.721888
10	0.233795	0.743776
11	0.240229	0.737993
12	0.235167	0.734948
13	0.221139	0.742546
14	0.217183	0.760642
15	0.206177	0.777528
16	0.242875	0.754238
Vol	0.423405	0.637624

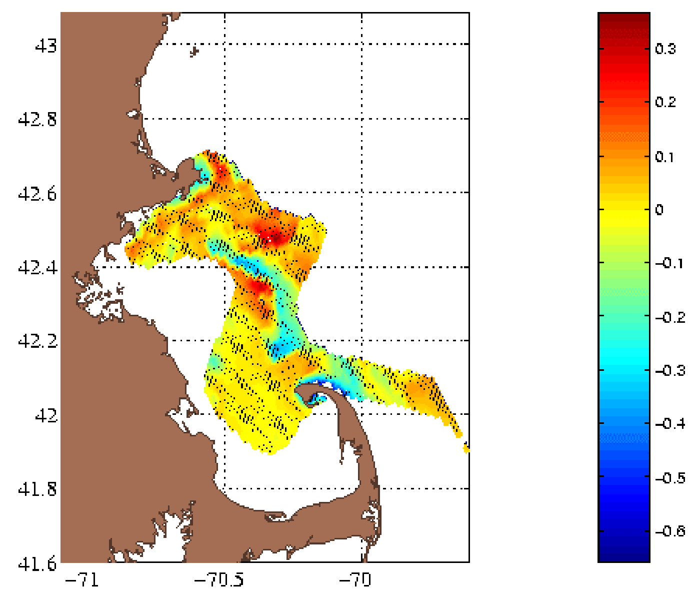
Forecast - Analysis



Forecast Anomaly



Analysis Anomaly



Forecast Skill Metrics - 13 June 2001 - Temperature

Statistical Summary

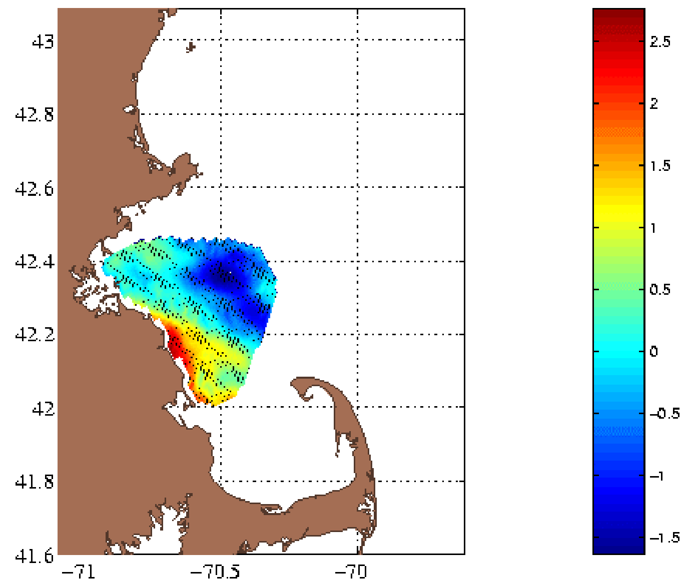
Persistence

Level	RMS Error	PCC
1	0.911388	0.145679
2	1.070723	0.258861
3	1.156427	0.173181
4	1.090295	0.561384
5	0.849721	0.661398
6	0.813391	0.758159
7	0.799762	0.818488
8	0.822009	0.821502
9	0.796034	0.808807
10	0.858534	0.802288
11	0.894565	0.787105
12	0.907039	0.766720
13	0.903162	0.756918
14	0.860311	0.763296
15	0.871539	0.701519
16	0.914378	0.617247
Vol	0.914591	0.734783

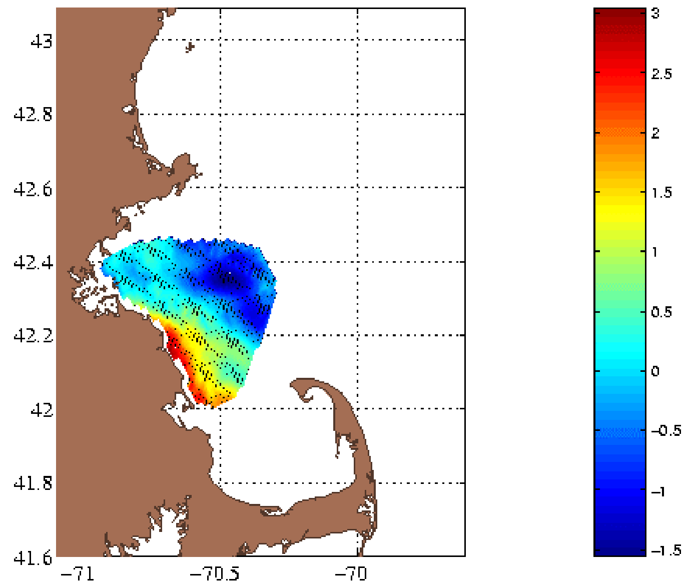
Forecast

Level	RMS Error	PCC
1	0.641896	0.162772
2	0.739893	0.278259
3	0.963876	0.342650
4	0.974327	0.650188
5	0.788529	0.783901
6	0.809799	0.828973
7	0.800880	0.856814
8	0.830561	0.838826
9	0.828020	0.819048
10	0.884964	0.799567
11	0.918250	0.775934
12	0.934659	0.752985
13	0.933475	0.744521
14	0.896841	0.755468
15	0.901234	0.699190
16	0.927552	0.608104
Vol	0.862388	0.755013

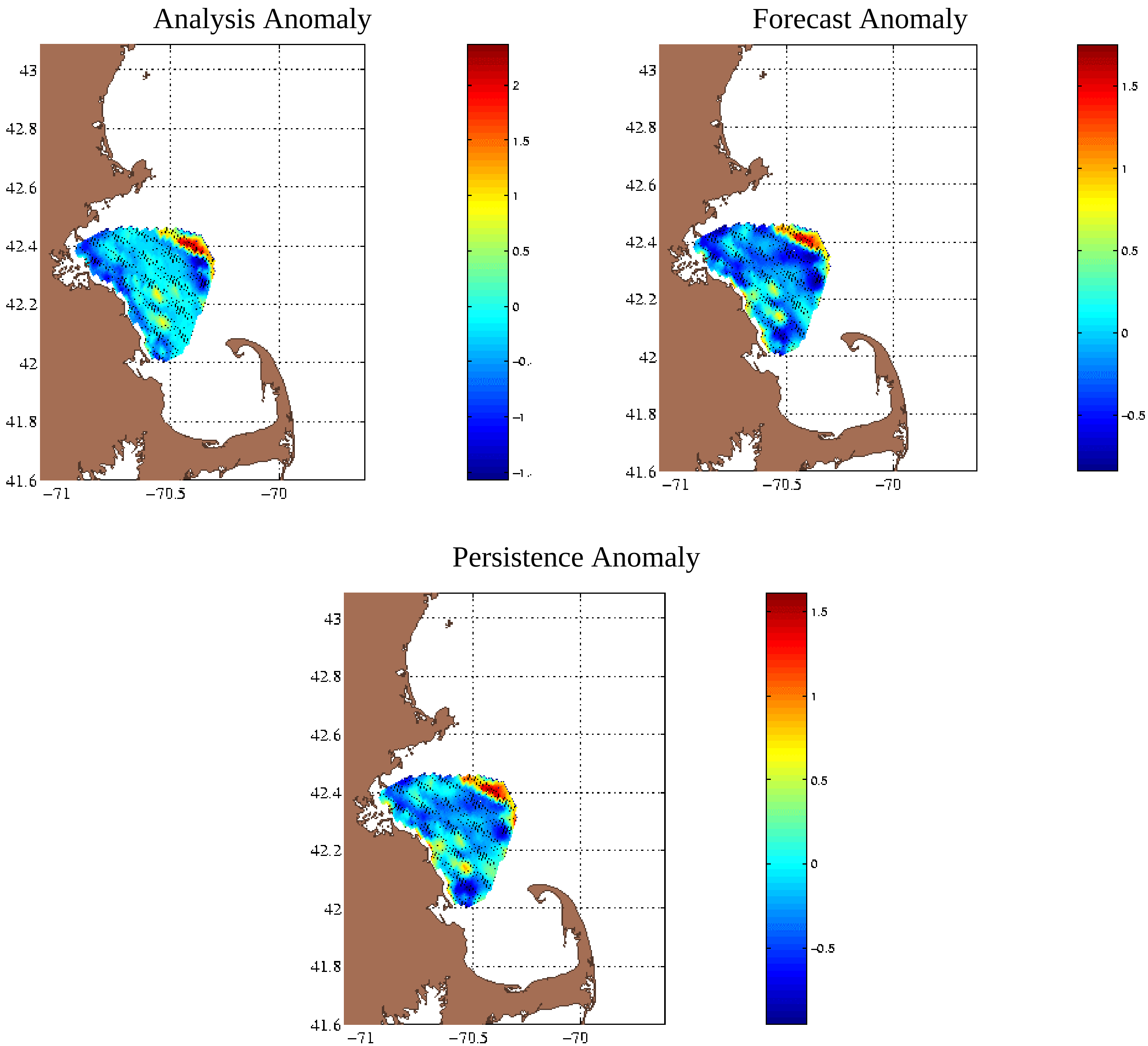
Persistence - Analysis



Forecast - Analysis



Forecast Skill Metrics - 13 June 2001 - Temperature



Forecast Skill Metrics - 13 June 2001 - Salinity

Statistical Summary

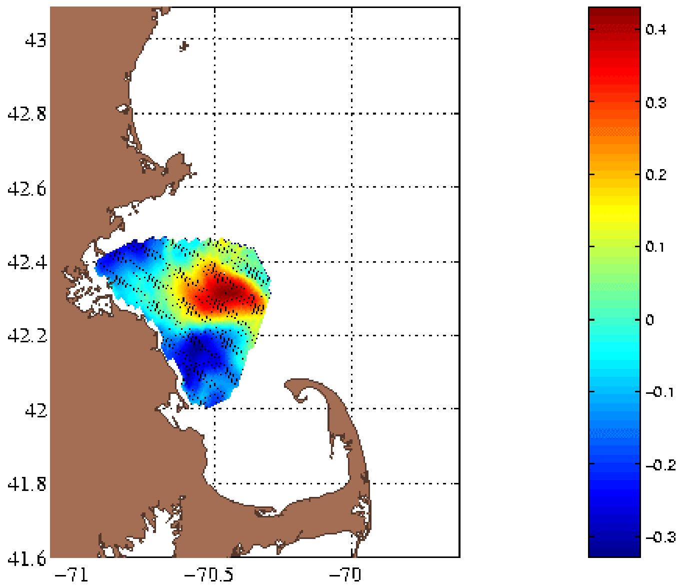
Persistence

Level	RMS Error	PCC
1	0.331894	0.328763
2	0.295804	0.231462
3	0.251015	0.342930
4	0.245195	0.563730
5	0.169699	0.558870
6	0.150673	0.702773
7	0.153185	0.823635
8	0.149049	0.798389
9	0.134840	0.741801
10	0.141143	0.747398
11	0.131020	0.753244
12	0.118382	0.770481
13	0.113018	0.732245
14	0.116089	0.690440
15	0.116355	0.648499
16	0.126118	0.689470
Vol	0.187189	0.689359

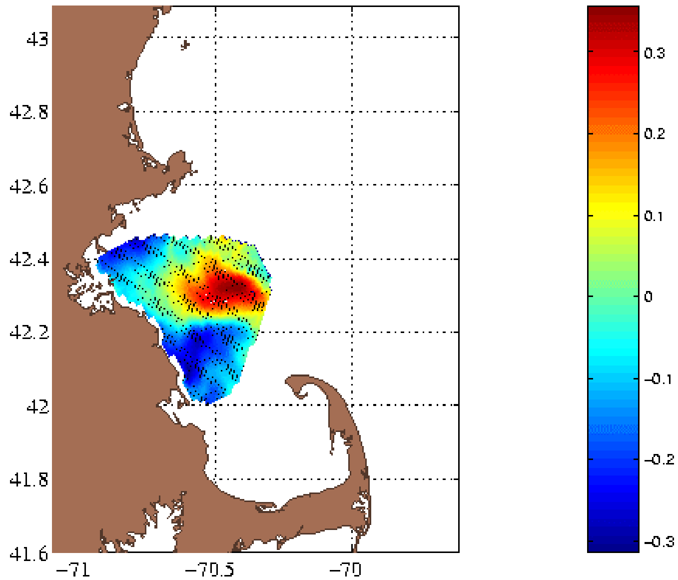
Forecast

Level	RMS Error	PCC
1	0.297511	0.235131
2	0.253348	0.157258
3	0.210388	0.344302
4	0.210730	0.570206
5	0.145843	0.652966
6	0.130478	0.776075
7	0.134601	0.854566
8	0.139218	0.798118
9	0.129193	0.738080
10	0.136117	0.736604
11	0.127801	0.735827
12	0.115988	0.754740
13	0.112627	0.716143
14	0.115253	0.675900
15	0.115222	0.636415
16	0.122224	0.682163
Vol	0.167417	0.699380

Persistence - Analysis

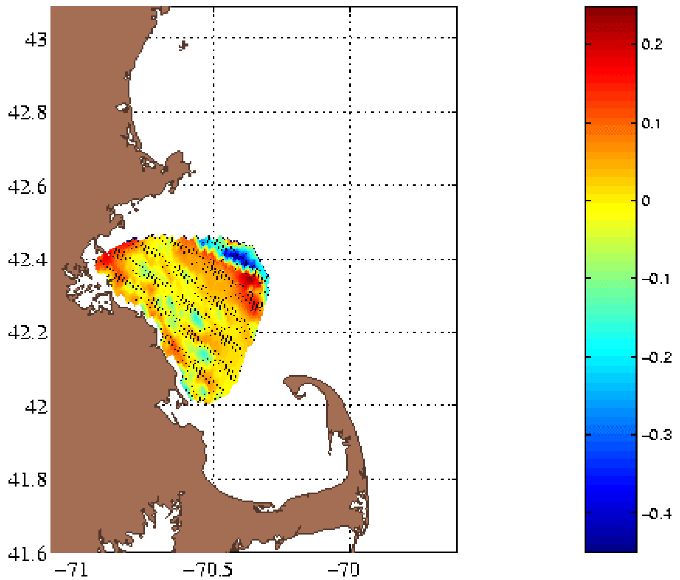


Forecast - Analysis

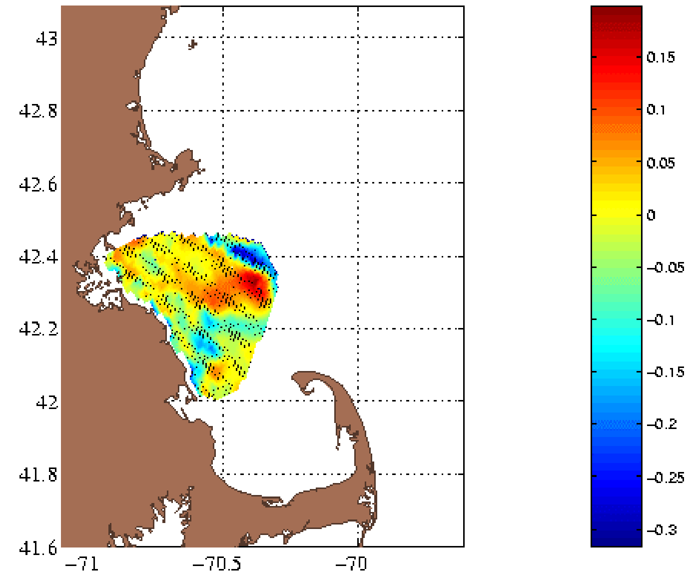


Forecast Skill Metrics - 13 June 2001 - Salinity

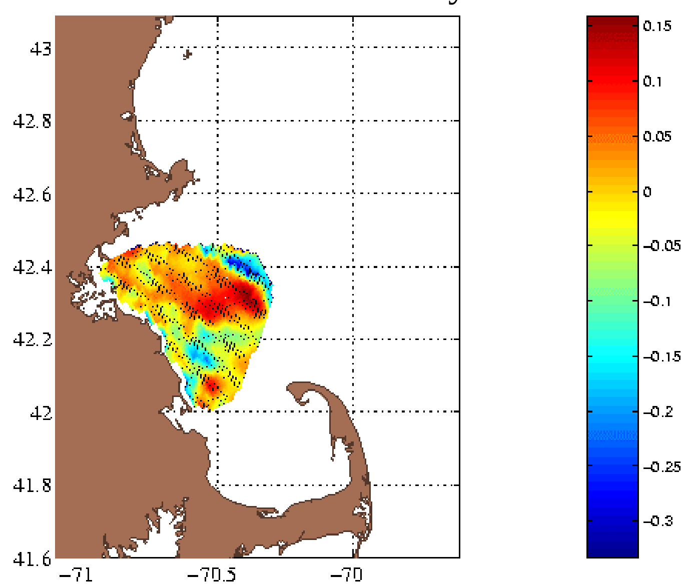
Analysis Anomaly



Forecast Anomaly



Persistence Anomaly



Forecast Skill Metrics - 14 June 2001 - Temperature

Statistical Summary

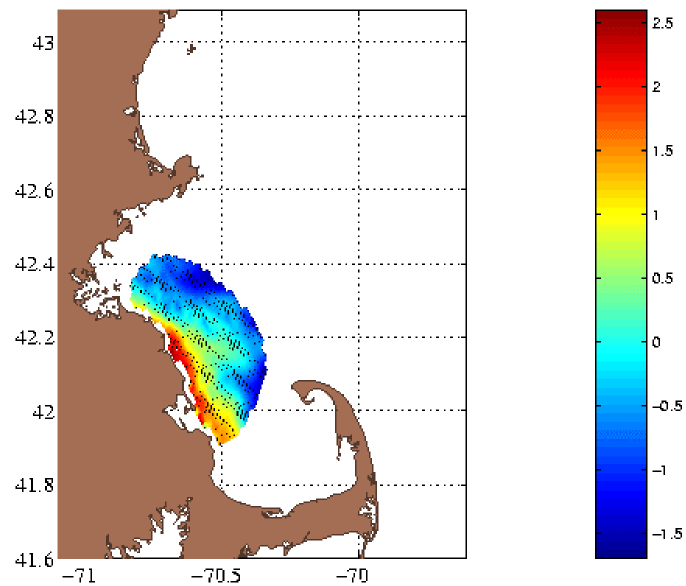
Persistence

Level	RMS Error	PCC
1	0.815273	0.232331
2	0.912290	0.379214
3	0.872152	0.455407
4	0.950404	0.533135
5	0.909241	0.640081
6	0.709430	0.780081
7	0.710515	0.814457
8	0.850635	0.802126
9	0.838592	0.730676
10	0.873373	0.725685
11	0.862809	0.751223
12	0.876305	0.758179
13	0.937703	0.758732
14	0.945108	0.786526
15	0.841761	0.798979
16	0.976978	0.728831
Vol	0.867810	0.741620

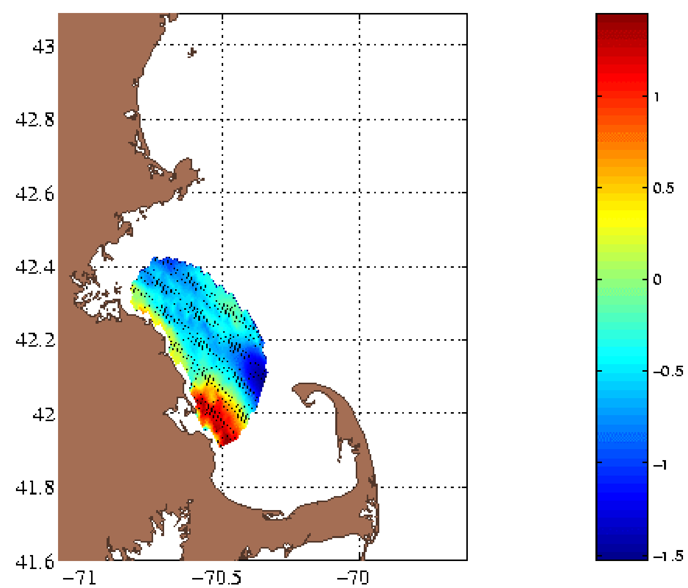
Forecast

Level	RMS Error	PCC
1	0.696960	0.212540
2	0.546307	0.171313
3	0.468540	0.297357
4	0.693212	0.502781
5	0.993318	0.607577
6	0.895307	0.679766
7	0.875765	0.708225
8	0.779077	0.816164
9	0.772045	0.738373
10	0.730467	0.760173
11	0.670881	0.783384
12	0.614023	0.802821
13	0.565922	0.803127
14	0.490681	0.798290
15	0.447485	0.771297
16	0.518493	0.779611
Vol	0.697978	0.756869

Persistence - Analysis

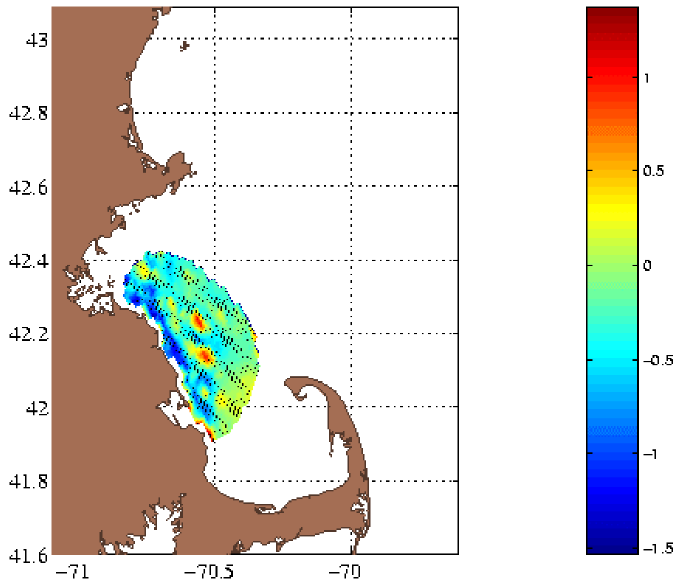


Forecast - Analysis

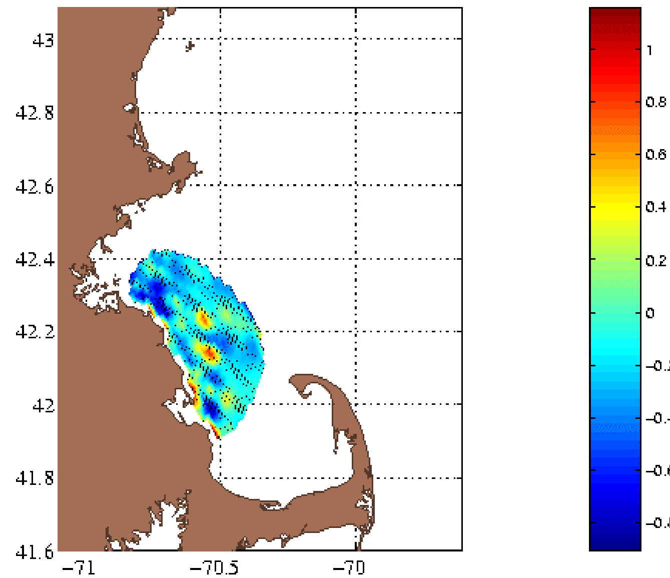


Forecast Skill Metrics - 14 June 2001 - Temperature

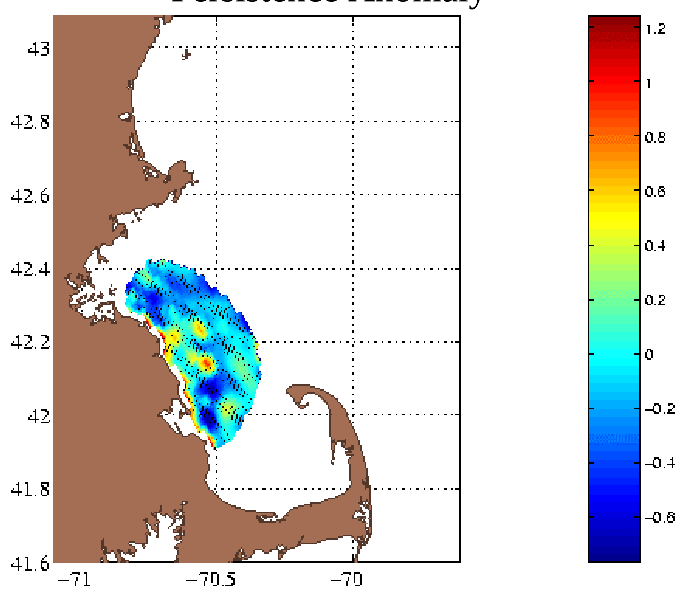
Analysis Anomaly



Forecast Anomaly



Persistence Anomaly



Forecast Skill Metrics - 14 June 2001 - Salinity

Statistical Summary

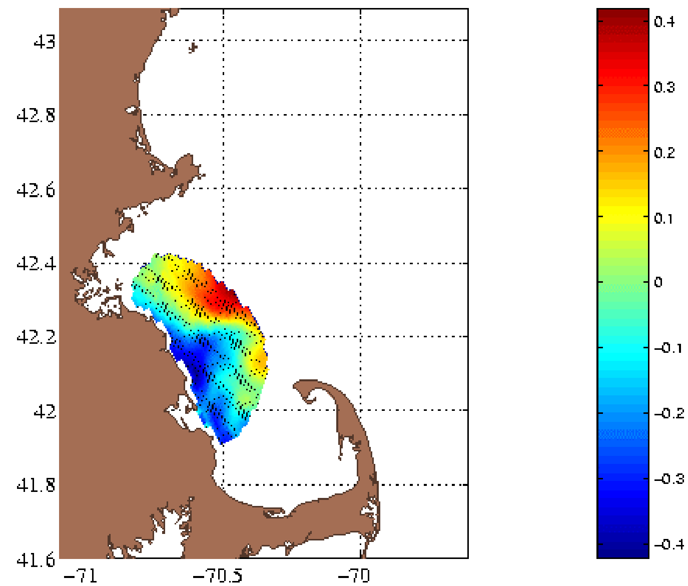
Persistence

Level	RMS Error	PCC
1	0.182385	0.271966
2	0.172869	0.284903
3	0.151382	0.419132
4	0.178537	0.404605
5	0.142527	0.394904
6	0.126708	0.556064
7	0.168225	0.633227
8	0.187825	0.644763
9	0.166504	0.656870
10	0.166585	0.659028
11	0.151482	0.698415
12	0.135918	0.741653
13	0.129040	0.757395
14	0.133992	0.762760
15	0.120664	0.764383
16	0.134593	0.784598
Vol	0.155523	0.671409

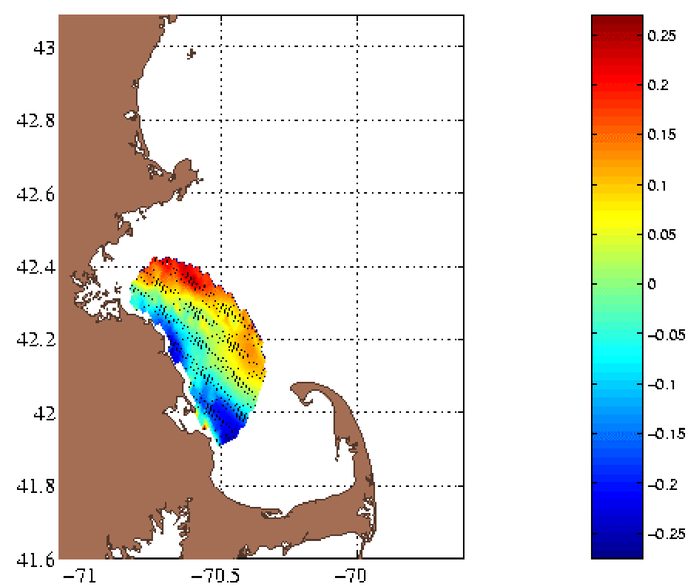
Forecast

Level	RMS Error	PCC
1	0.053036	0.401229
2	0.052097	0.419746
3	0.057904	0.363427
4	0.085165	0.406363
5	0.112039	0.702004
6	0.120278	0.755306
7	0.148397	0.723374
8	0.138993	0.774925
9	0.115149	0.758138
10	0.106593	0.779102
11	0.095339	0.806815
12	0.088906	0.809649
13	0.083868	0.815554
14	0.079953	0.797987
15	0.081493	0.701874
16	0.098210	0.711093
Vol	0.098965	0.764223

Persistence - Analysis

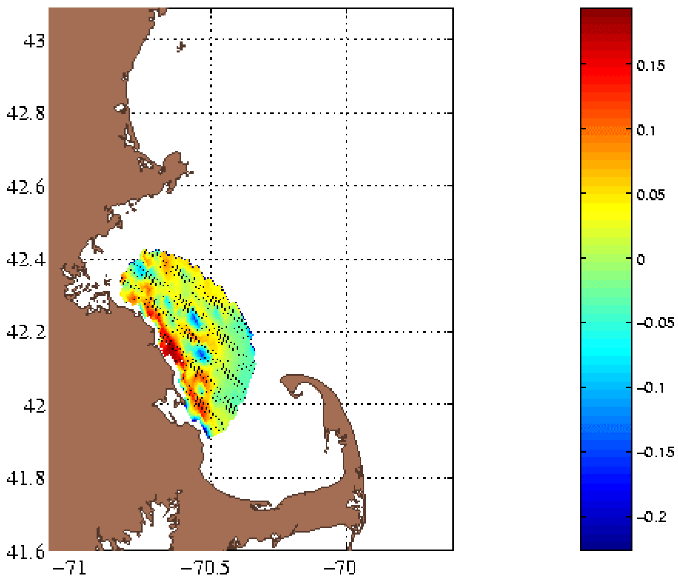


Forecast - Analysis

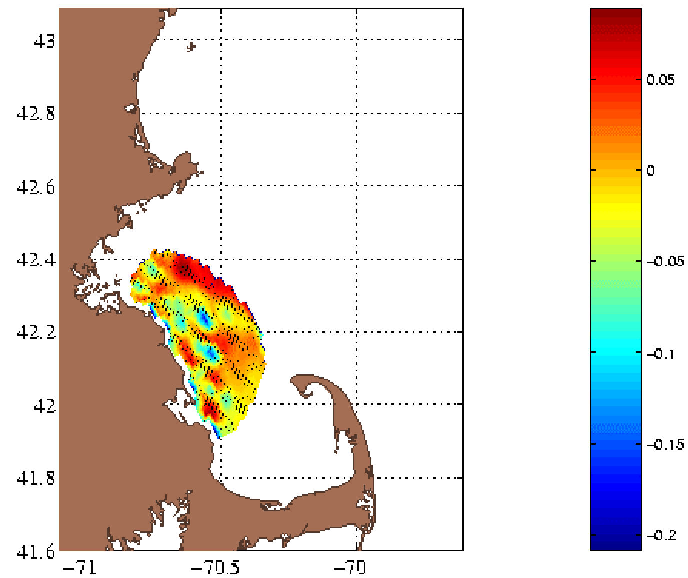


Forecast Skill Metrics - 14 June 2001 - Salinity

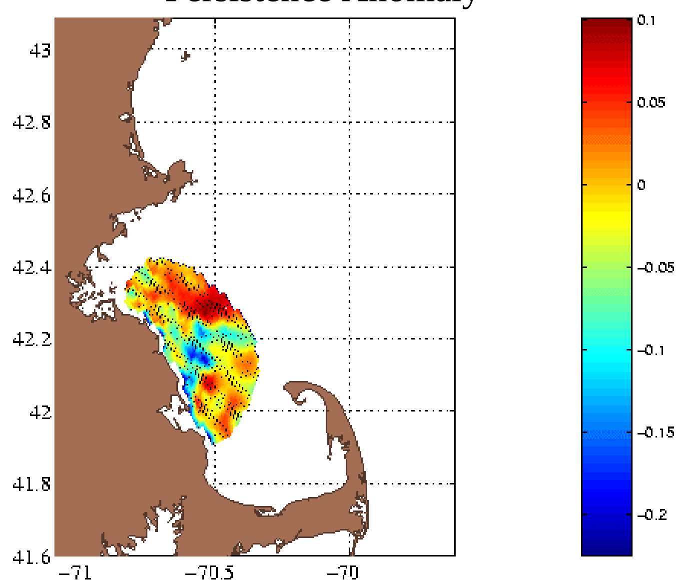
Analysis Anomaly



Forecast Anomaly



Persistence Anomaly



Forecast Skill Metrics - 20 June 2001 - Temperature

Statistical Summary

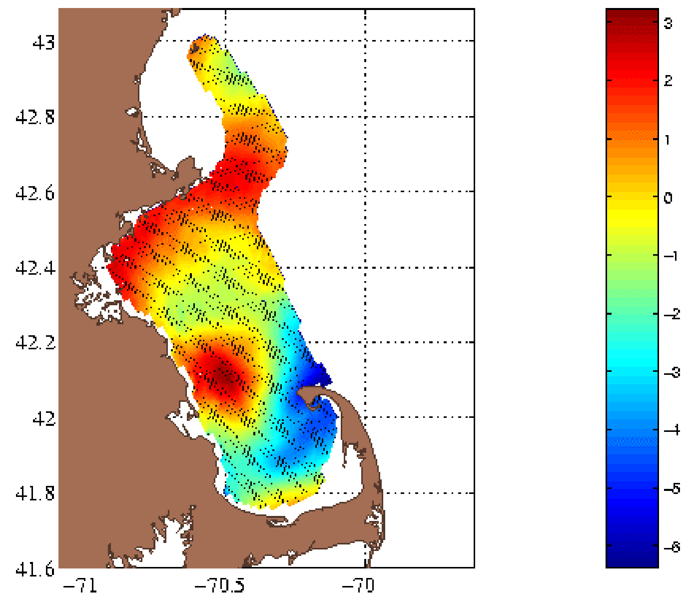
Upper Ocean - Persistence		
Level	**RMS Error**	**PCC**
1	3.253100	-0.16869
2	3.508632	-0.07545
3	3.397050	0.294989
4	2.991333	0.516914
5	2.782008	0.618315
6	2.733145	0.685836
Ave	3.1	0.31

Upper Ocean - Forecast		
Level	**RMS Error**	**PCC**
1	1.313215	0.292803
2	1.539824	0.313643
3	1.788853	0.414753
4	1.965819	0.627213
5	2.119816	0.680522
6	2.307601	0.693586
Ave	1.8	0.50

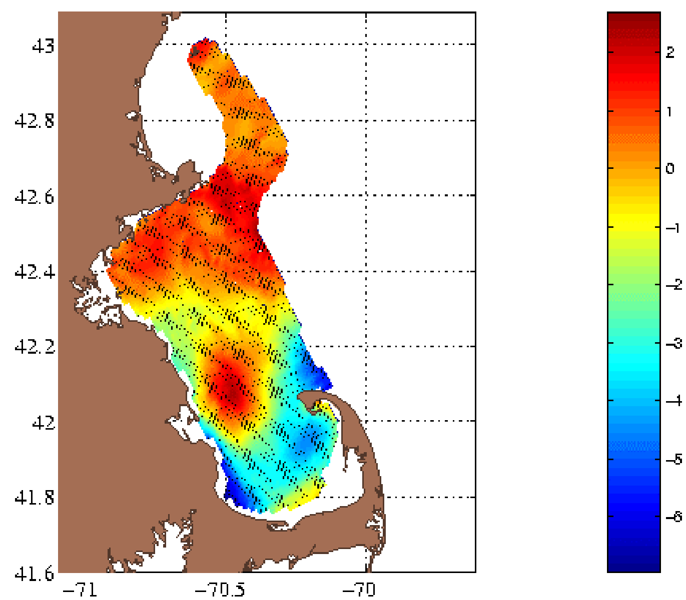
Deep Ocean - Persistence		
Level	**RMS Error**	**PCC**
7	2.480385	0.715284
8	1.966225	0.722239
9	1.699704	0.737278
10	1.607497	0.734268
11	1.518190	0.735786
12	1.437734	0.730796
13	1.375223	0.716012
14	1.322239	0.711341
15	1.301060	0.708643
16	1.410897	0.711943
Ave	1.6	0.72

Deep Ocean - Forecast		
Level	**RMS Error**	**PCC**
7	2.377179	0.713381
8	2.112112	0.713665
9	1.991455	0.706533
10	1.839084	0.725024
11	1.737139	0.740148
12	1.674553	0.736510
13	1.594693	0.739332
14	1.563719	0.724920
15	1.531955	0.721695
16	1.675865	0.760974
Ave	1.8	0.73

Persistence - Analysis

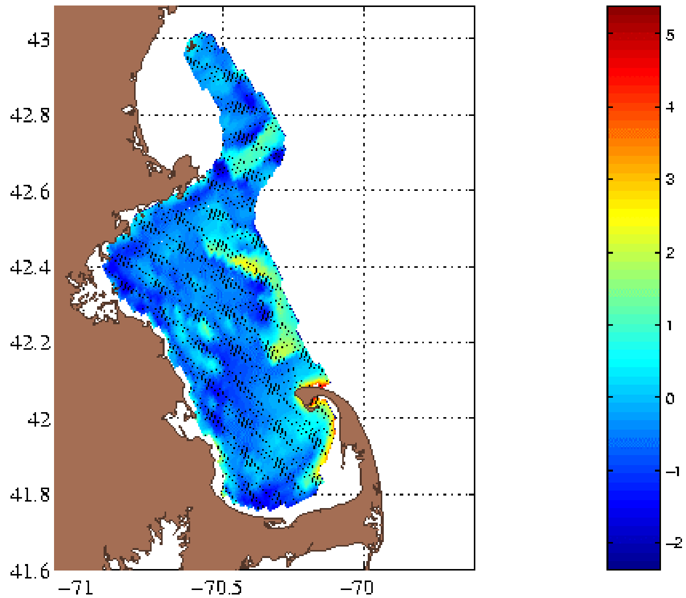


Forecast - Analysis

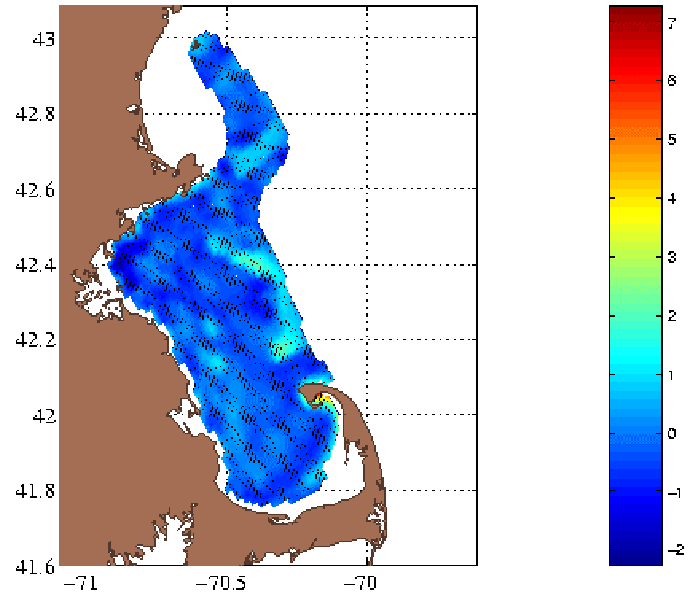


Forecast Skill Metrics - 20 June 2001 - Temperature

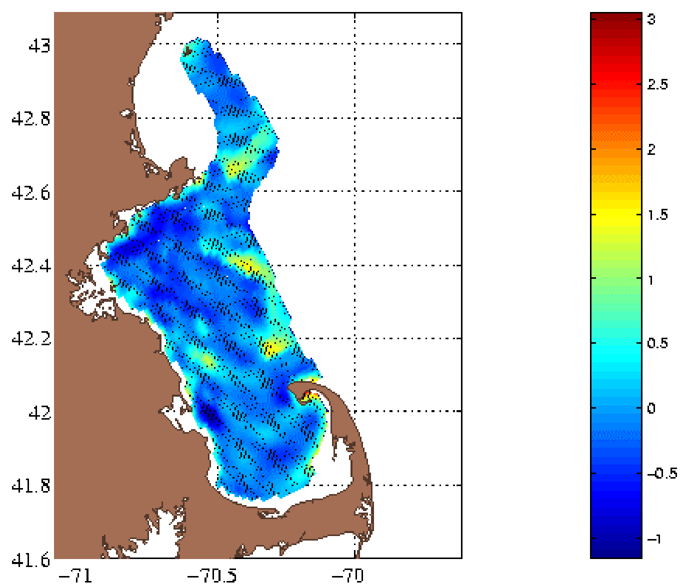
Analysis Anomaly



Forecast Anomaly



Persistence Anomaly



Forecast Skill Metrics - 20 June 2001 - Salinity

Statistical Summary

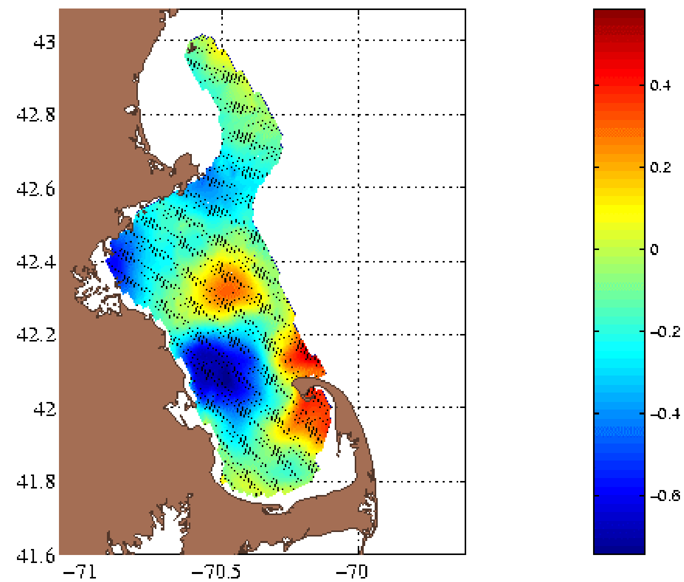
Upper Ocean - Persistence		
Level	RMS Error	PCC
1	0.459882	0.057665
2	0.458611	0.174117
3	0.366556	0.221260
4	0.250838	0.315784
5	0.216988	0.367705
6	0.243154	0.520999
Ave	0.33	0.28

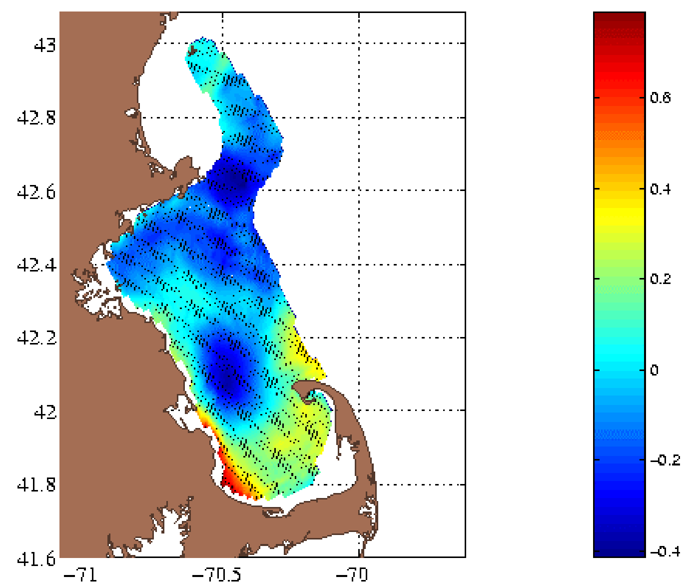
Upper Ocean - Forecast		
Level	RMS Error	PCC
1	0.429710	0.255510
2	0.402585	0.266107
3	0.296349	0.382001
4	0.223768	0.559778
5	0.198463	0.619634
6	0.191854	0.673589
Ave	0.29	0.46

Deep Ocean - Persistence		
Level	RMS Error	PCC
7	0.254896	0.661753
8	0.241360	0.704597
9	0.229075	0.705659
10	0.226148	0.721792
11	0.212078	0.759650
12	0.198268	0.777583
13	0.188378	0.775310
14	0.183682	0.766849
15	0.178101	0.779102
16	0.204246	0.778209
Ave	0.21	0.74

Deep Ocean - Forecast		
Level	RMS Error	PCC
7	0.191031	0.723818
8	0.194150	0.763057
9	0.211200	0.732903
10	0.201165	0.744526
11	0.199053	0.757445
12	0.199047	0.767310
13	0.197271	0.757771
14	0.206985	0.752178
15	0.215385	0.765185
16	0.252147	0.770697
Ave	0.21	0.75

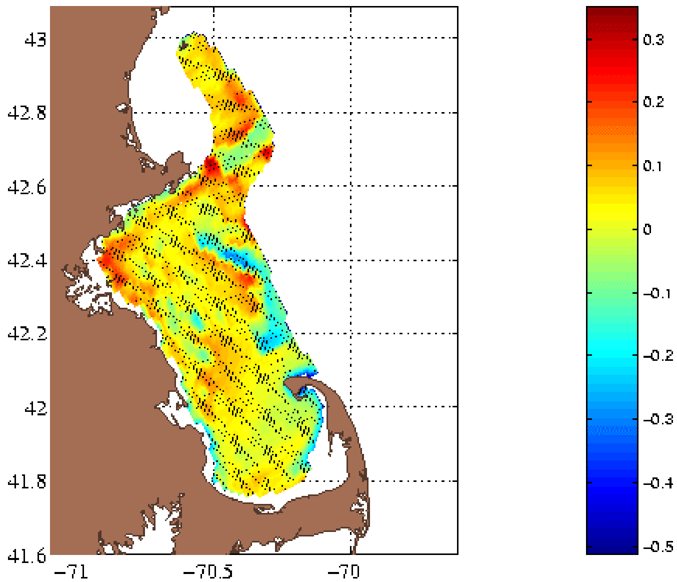
Persistence - Analysis



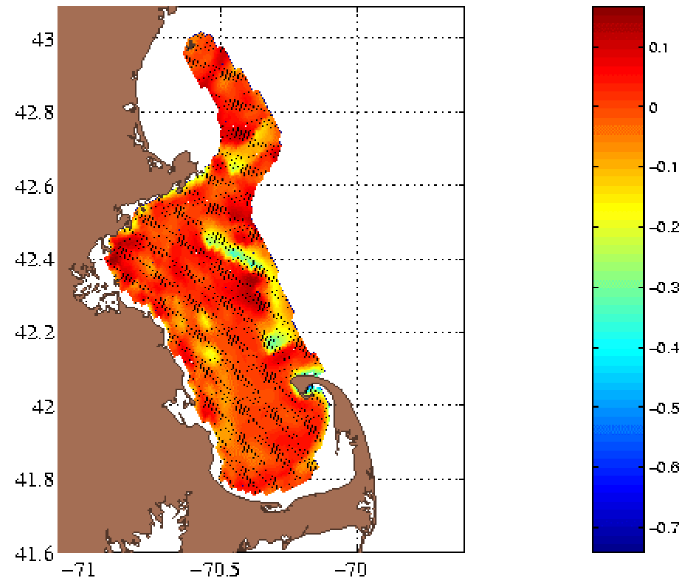


Forecast Skill Metrics - 20 June 2001 - Salinity

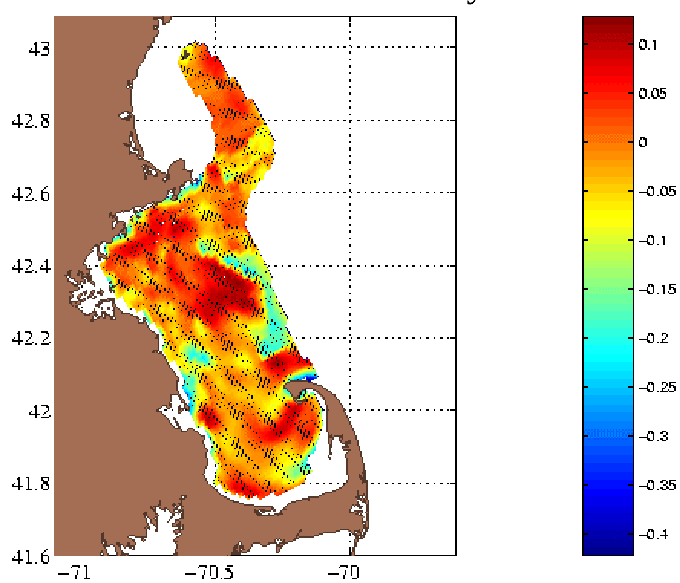
Analysis Anomaly



Forecast Anomaly



Persistence Anomaly



Real-time Biological Nowcasts and Forecasts – Example Products

Physical and biological data collected during the period 6-21 June 2001 was combined with historical Massachusetts Bay data to provide an estimate for the synoptic conditions. This estimate of synoptic conditions provides initialization conditions for the Harvard Ocean Prediction System (HOPS) model simulations.

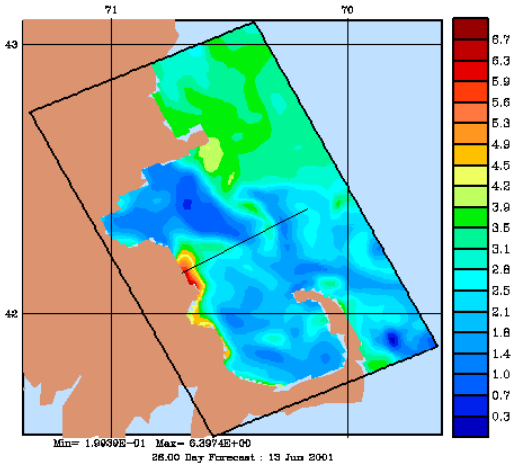
The ASCOT-01 simulation and operational system consists of a set of three two-way nested domains: the Northwest Atlantic (NWA), the Gulf of Maine (GOM) and Massachusetts Bay (MB). The specifics of the individual domains are given elsewhere. The coupled biological/physical simulations were only run in the MB domain in a stand-alone mode.

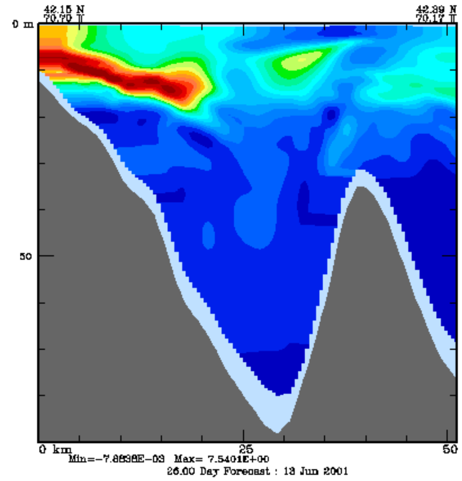
The quantities included in the real-time forecast products from the web included: maps of chlorophyll-a, zooplankton, and detritus (all at 5, 10, 15 and 20 meters), as well as maps of NO_3 (nitrate), and NH_4 (ammonium) at 15 and 20 meters. In addition, a vertical section of chlorophyll-a across Massachusetts Bay, and an animated version of this section (for 22-24 June), was included. Values of the quantities are millimoles nitrogen per meter^3, with the exception of chlorophyll, which are milligrams per meter^3.

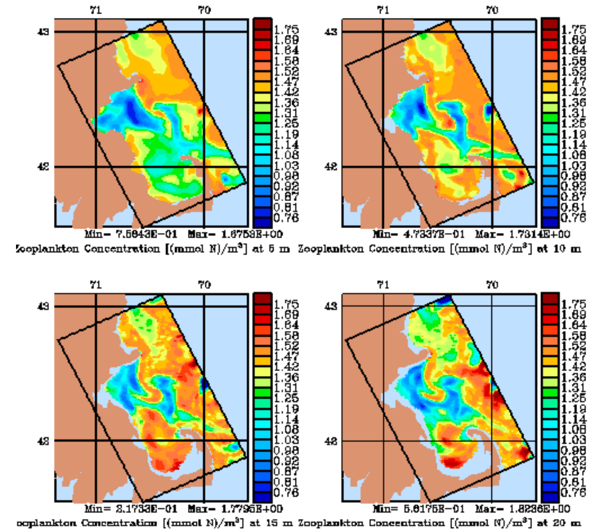
The example products contained here include nowcasts (only) of: chlorophyll-a at 5m, the chlorophyll-a vertical section, zooplankton at 4 levels, nitrate at 20m and ammonium at 20m. Additional levels and quantities can be viewed via the web.

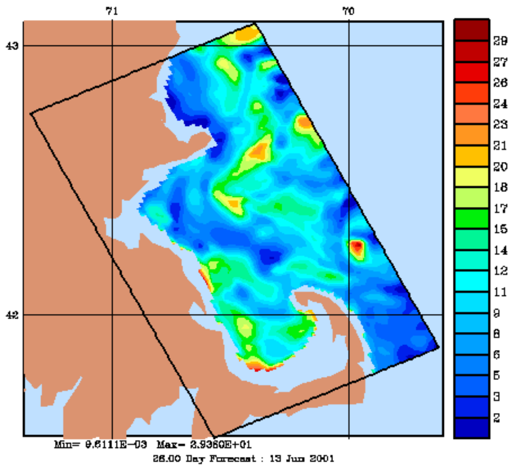
Nowcast Biological Products for 13 June 2001

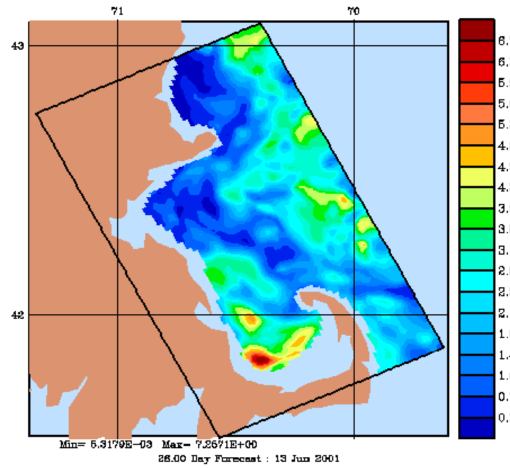
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton, Nitrate (20m), Ammonium (20m)





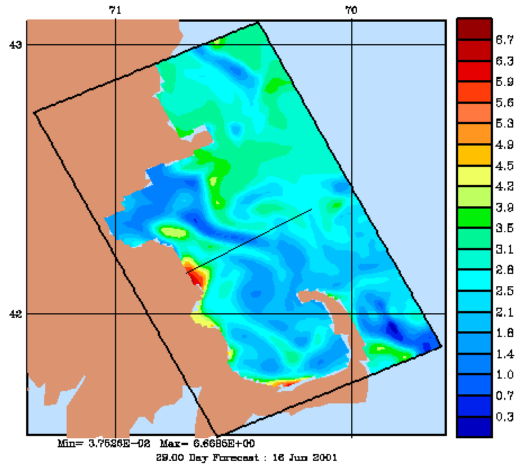


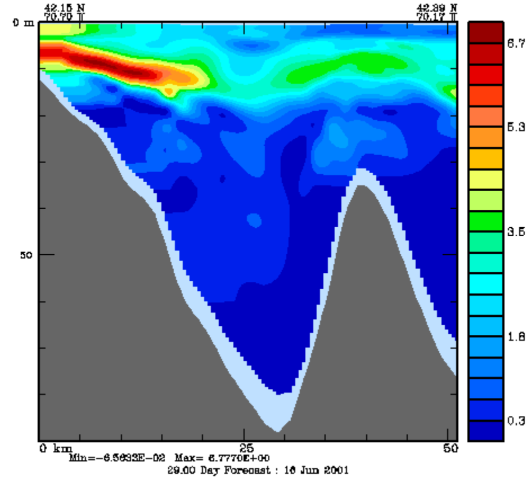


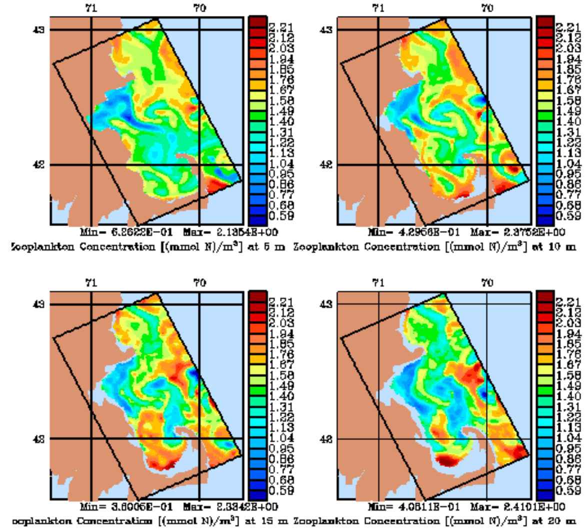


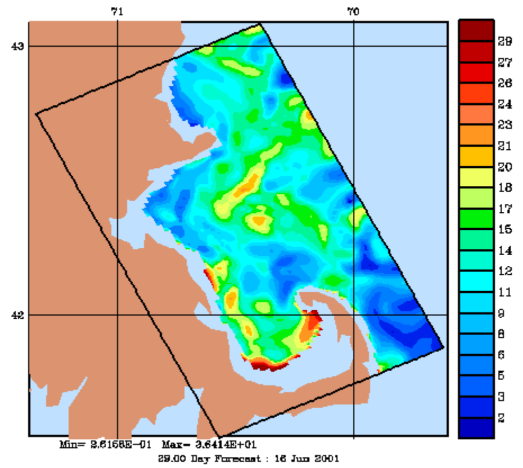
Nowcast Biological Products for 16 June 2001

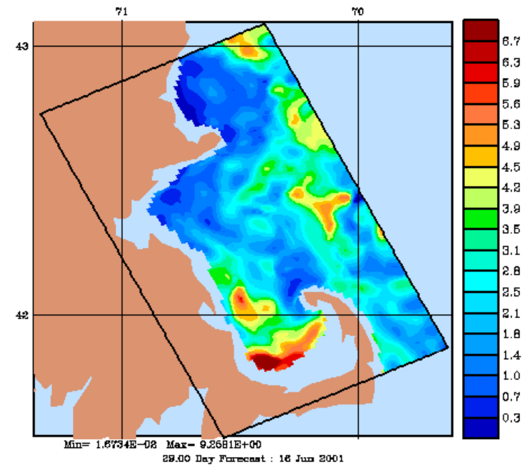
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

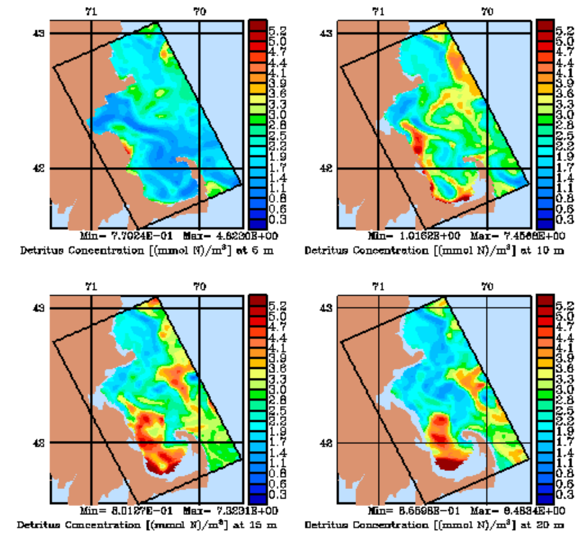






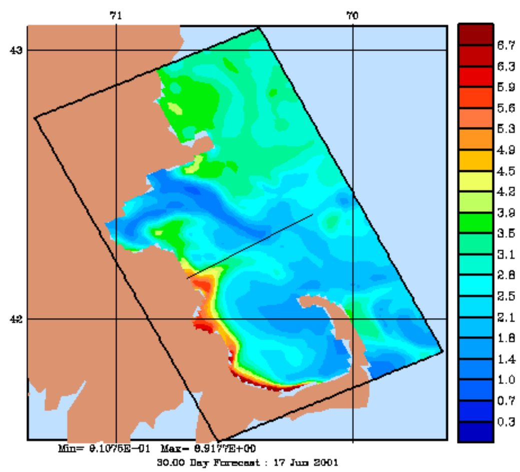


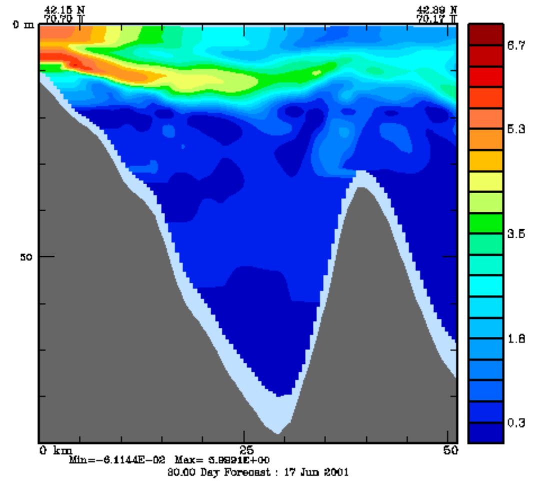


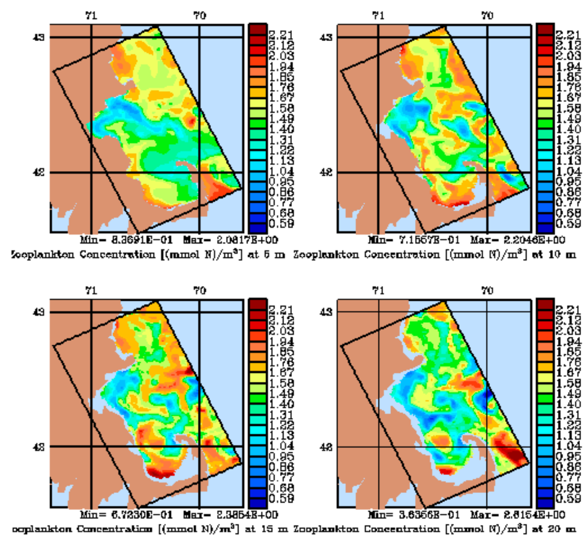


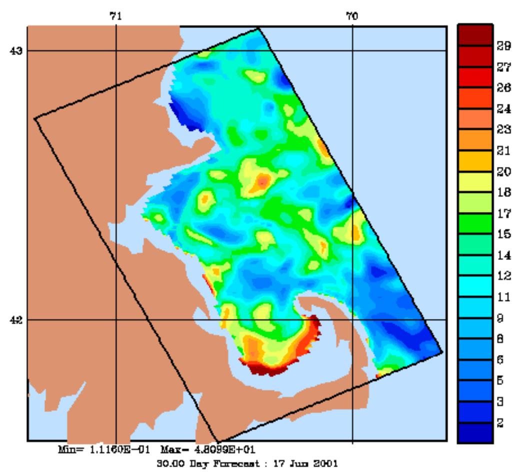
Nowcast Biological Products for 17 June 2001

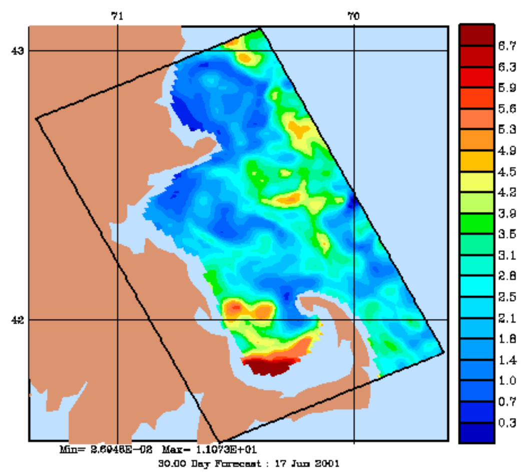
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

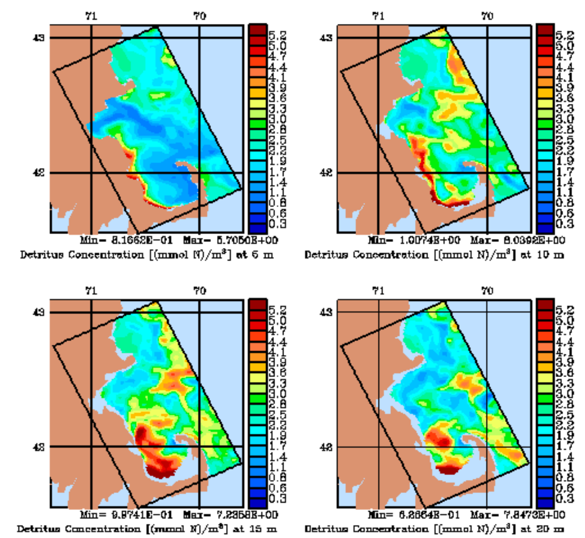






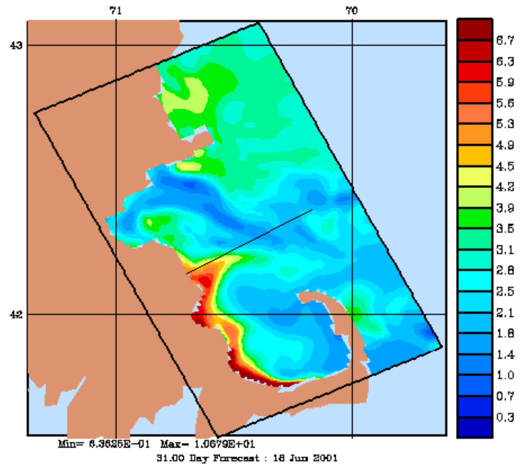


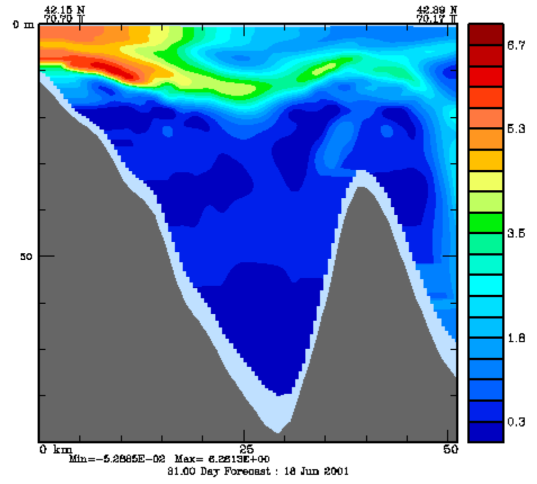


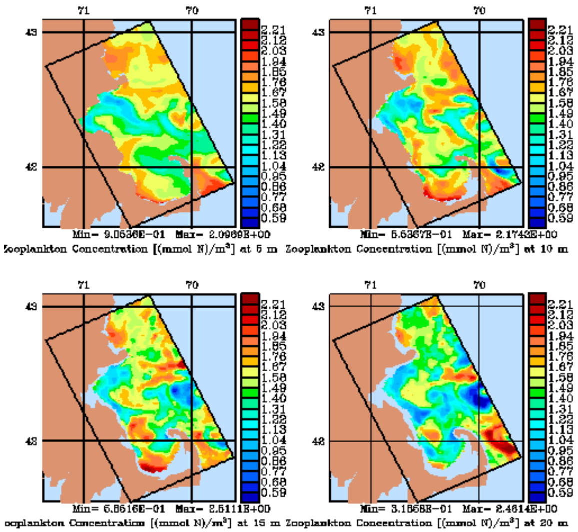


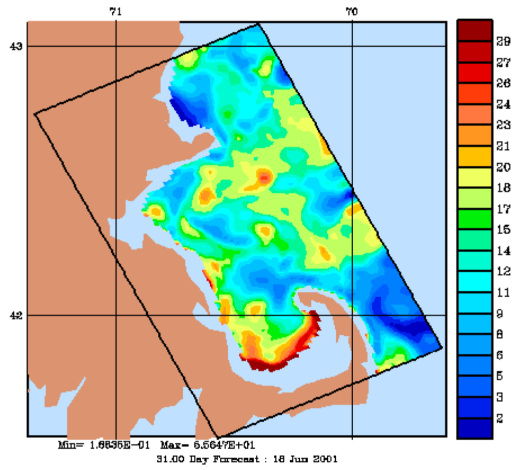
Nowcast Biological Products for 18 June 2001

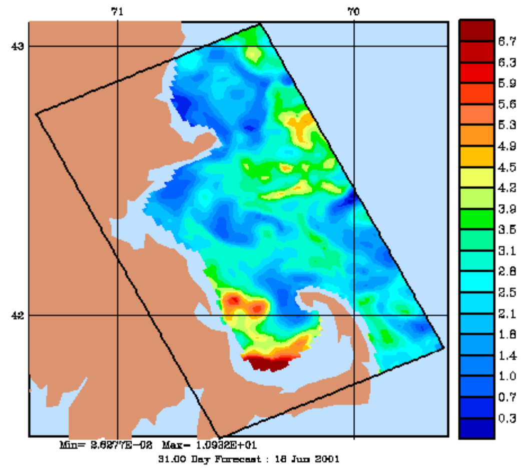
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

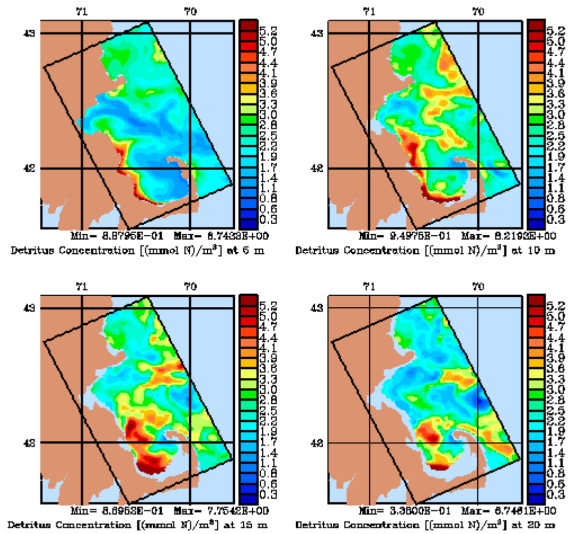






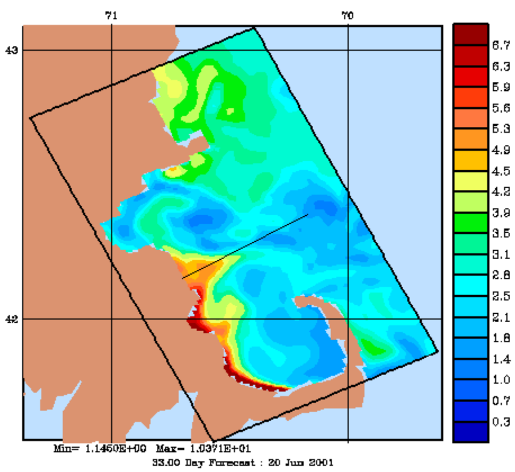


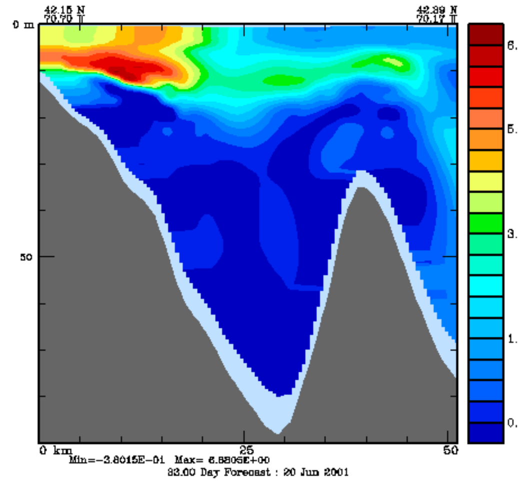


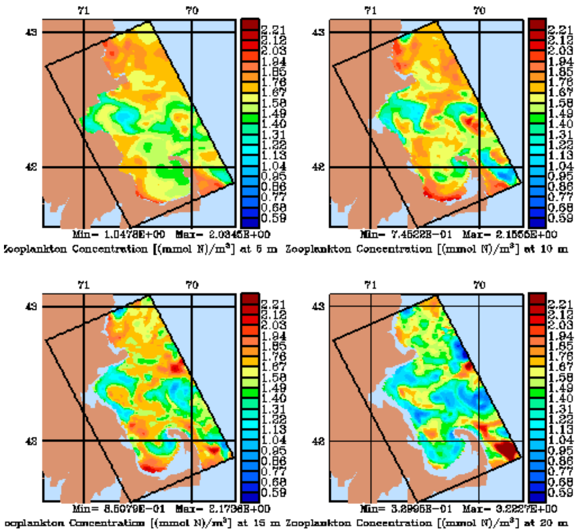


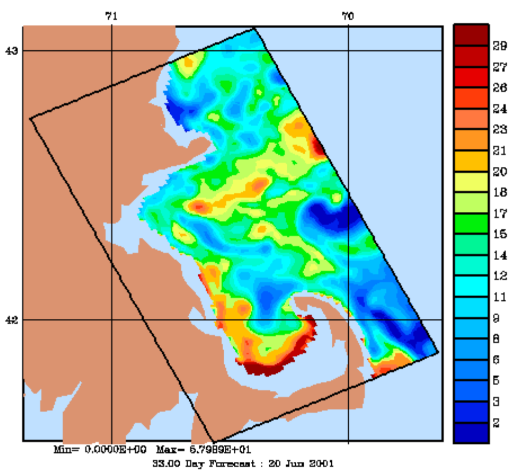
Nowcast Biological Products for 20 June 2001

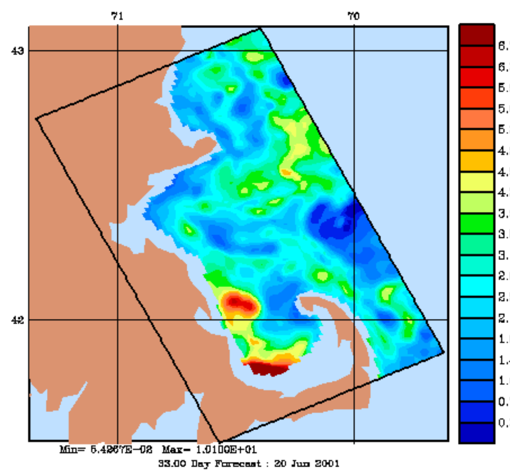
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

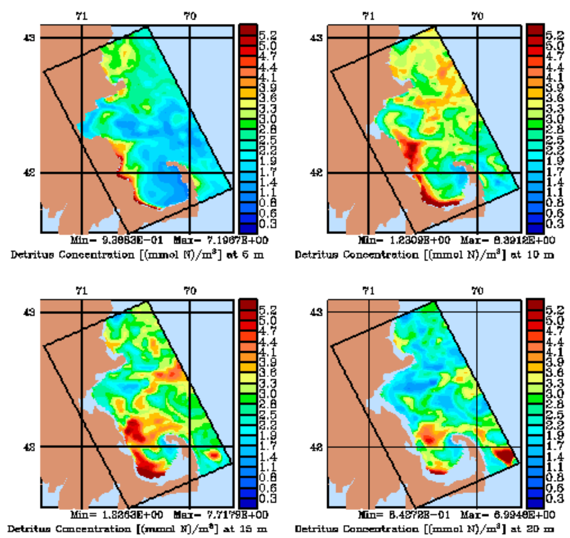






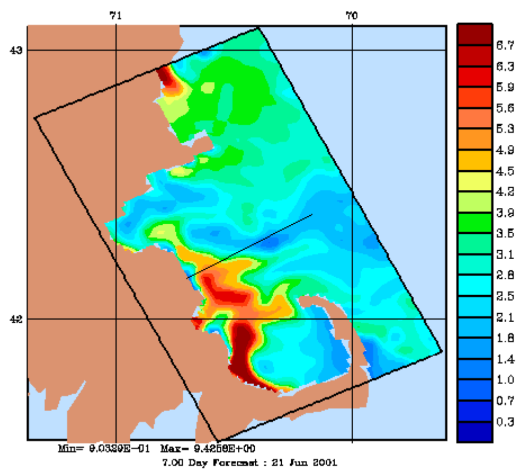


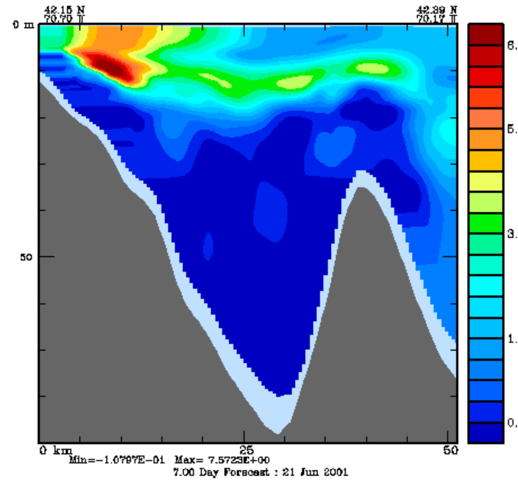


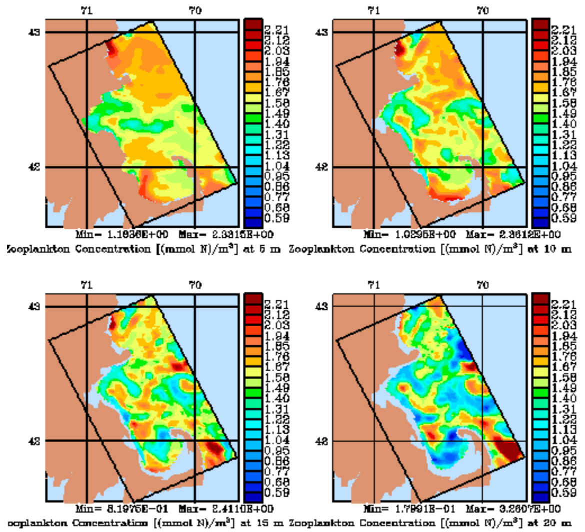


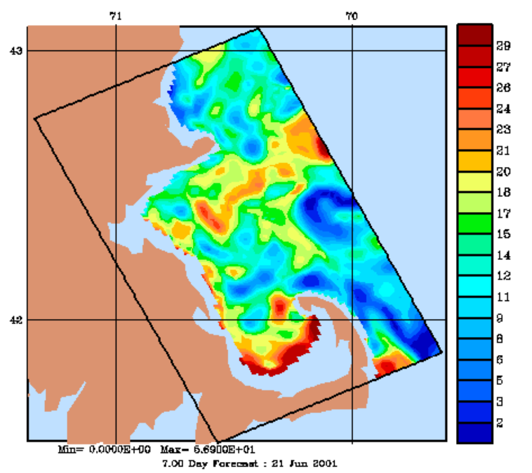
Nowcast Biological Products for 21 June 2001

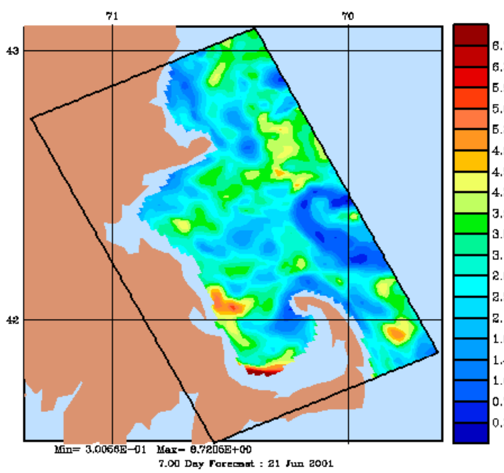
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

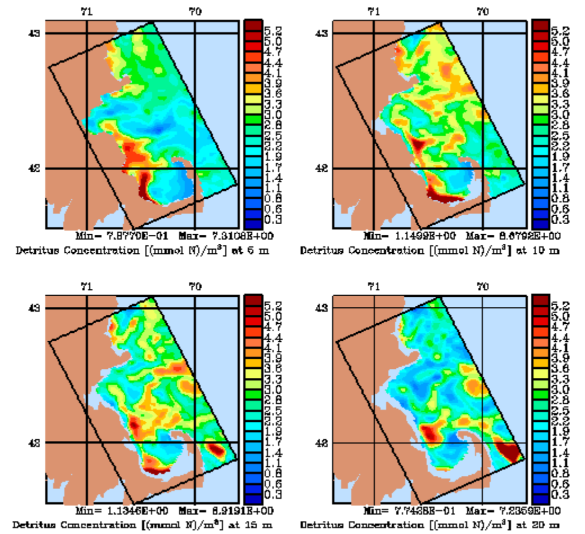






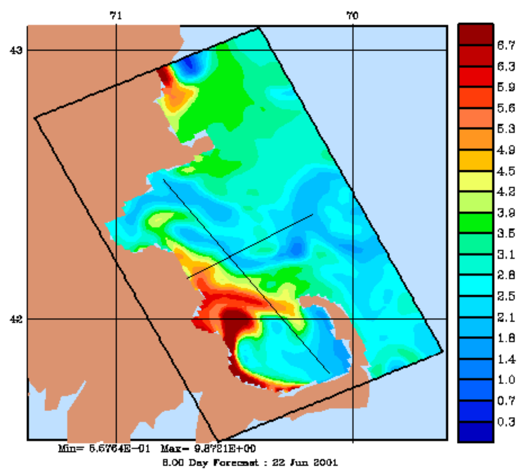


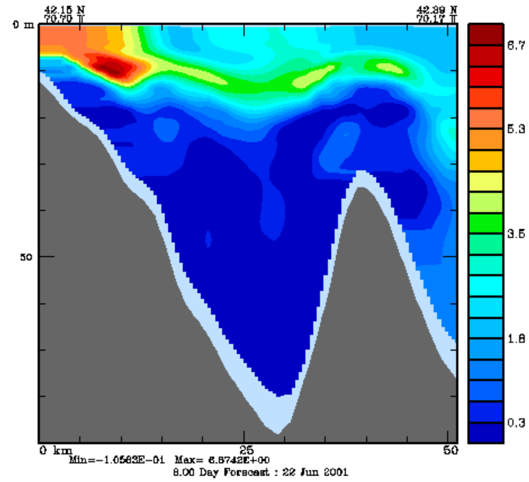


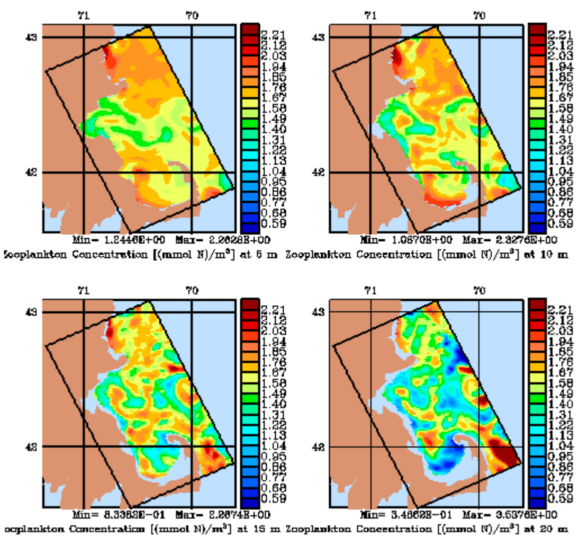


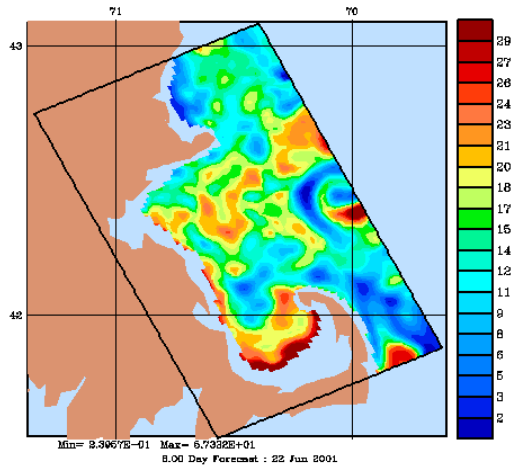
Nowcast Biological Products for 22 June 2001

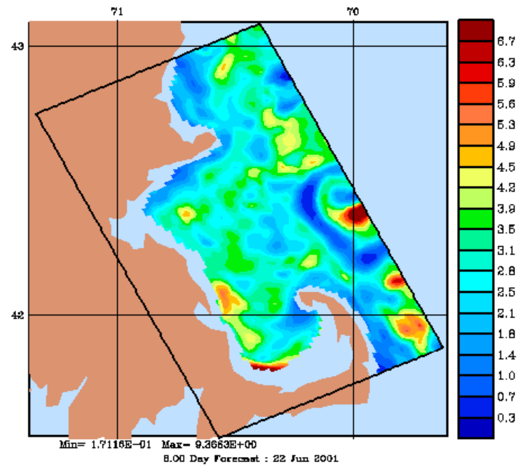
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

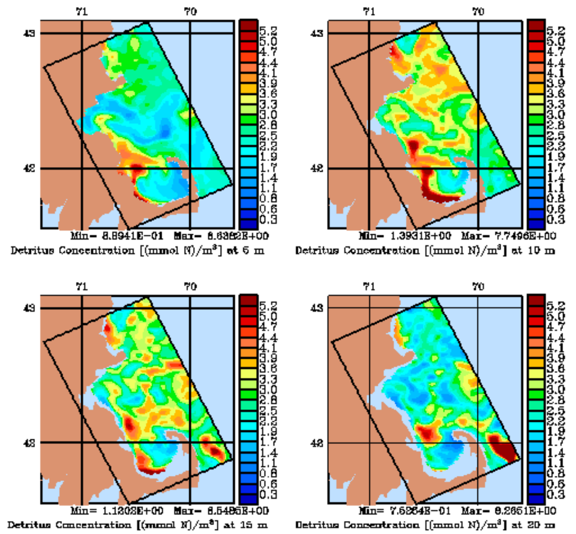






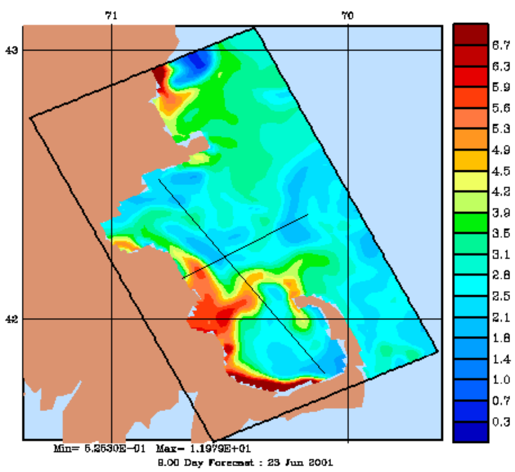


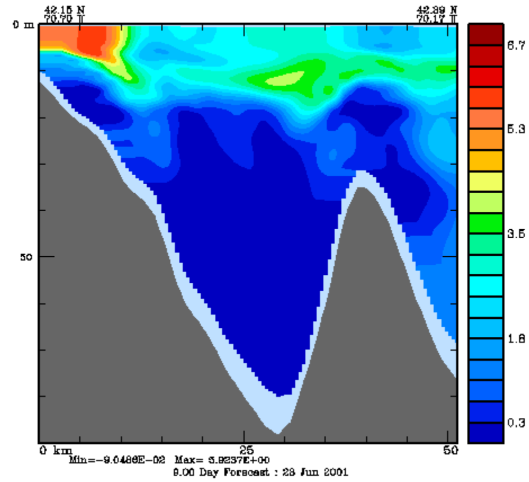


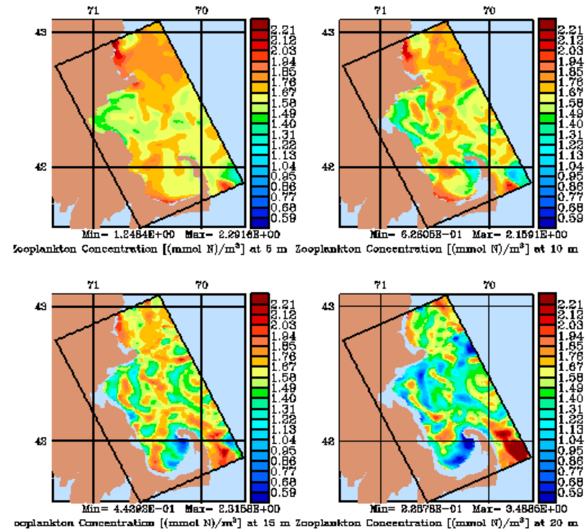


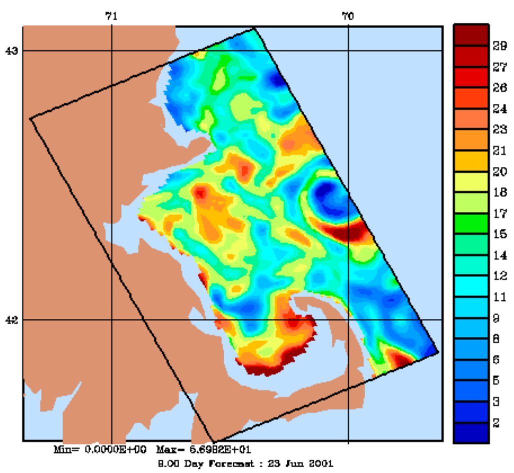
Nowcast Biological Products for 23 June 2001

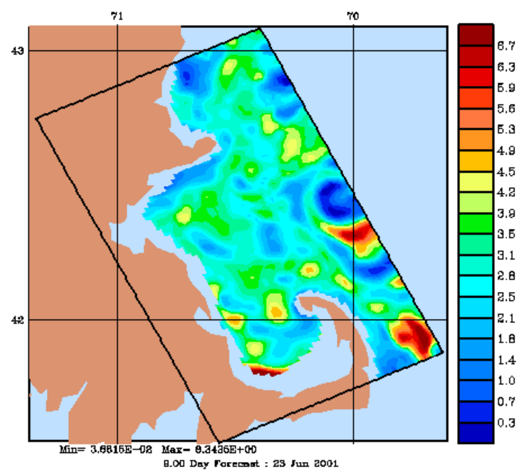
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

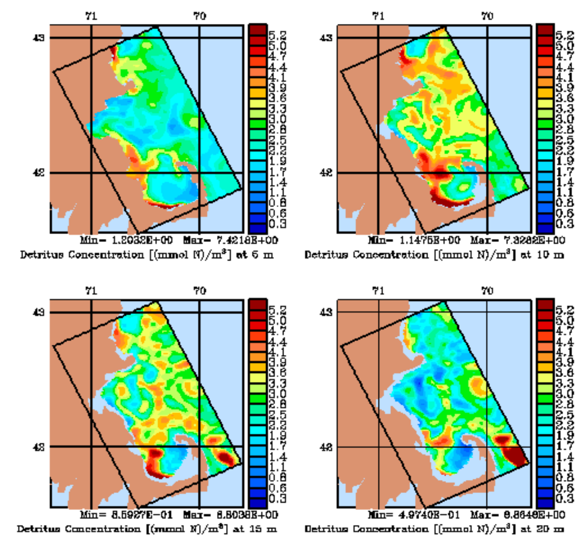






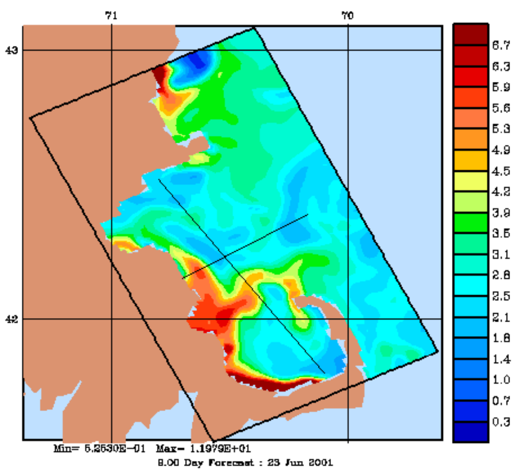


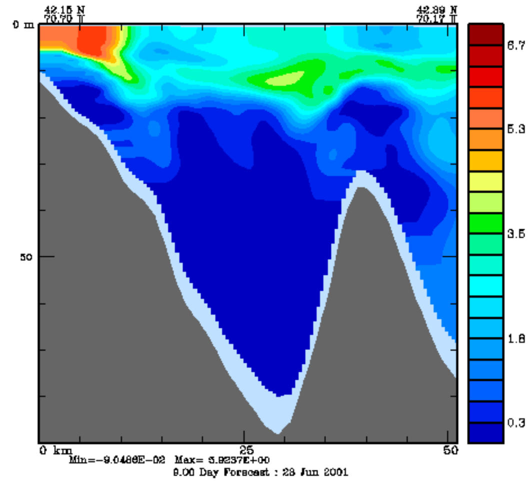


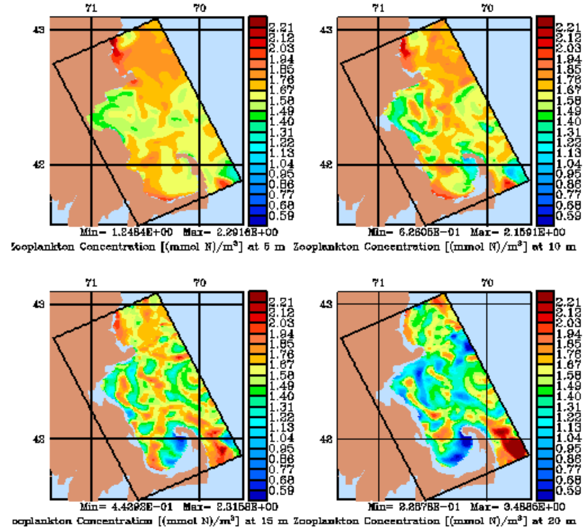


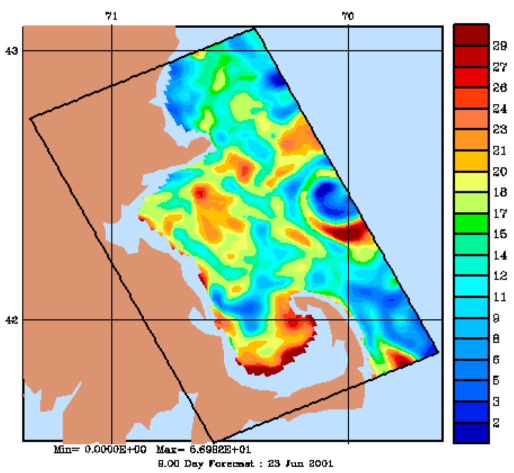
Nowcast Biological Products for 24 June 2001

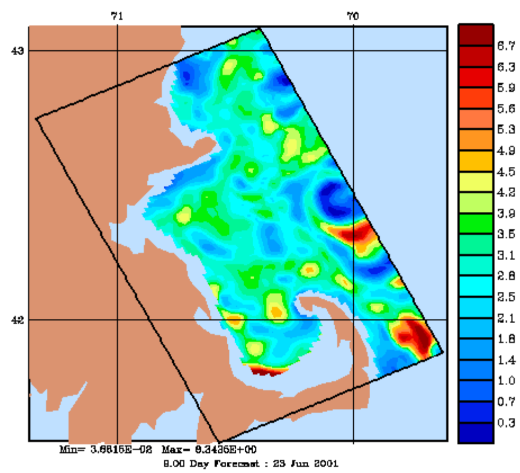
Chlorophyll-a (5m), Chlorophyll-a Section, Zooplankton,
Nitrate (20m), Ammonium (20m), Detritus

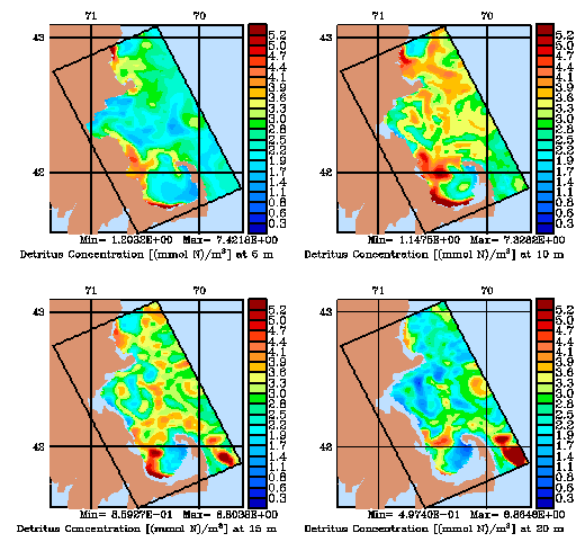












Fleet Numerical Meteorology and Oceanography Center Forcing

Atmospheric forcing for the Harvard Ocean Prediction System (HOPS) was acquired from the US Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC). The products, including 00Z and 12Z nowcasts and forecasts for up to 144 hours on a 1-degree or 2-degree resolution grid, were downloaded via the internet. The model and analysis fields were generally produced on a one-degree grid, with the exception of relative humidity and cloud cover. FNMOC fields include surface pressure, air temperature, 12-hour forecast precipitation, surface winds, relative humidity, cloud cover, sea surface temperature and mixed layer depth. These gridded fields were interpolated in space and time onto the model grids by HOPS and used to compute fluxes that drive the HOPS models at the surface. Flux analyses were used whenever possible and forecast fluxes replaced by the analyses as those analyses became available.

The following sections contain daily analyses of three of the main forcing fields for the HOPS forecasts: wind stress, surface heat flux and shortwave radiation. The fields have been plotted for the Massachusetts Bay domain only.

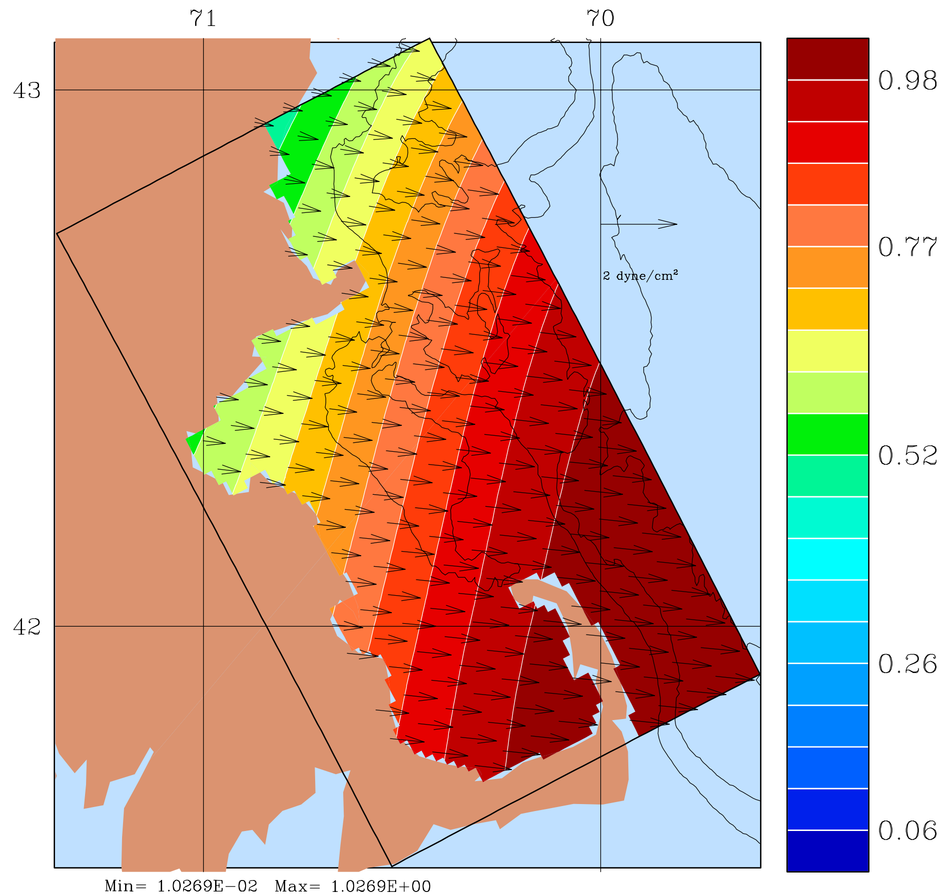
FNMOC Wind Stress

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 6 Jun 2001

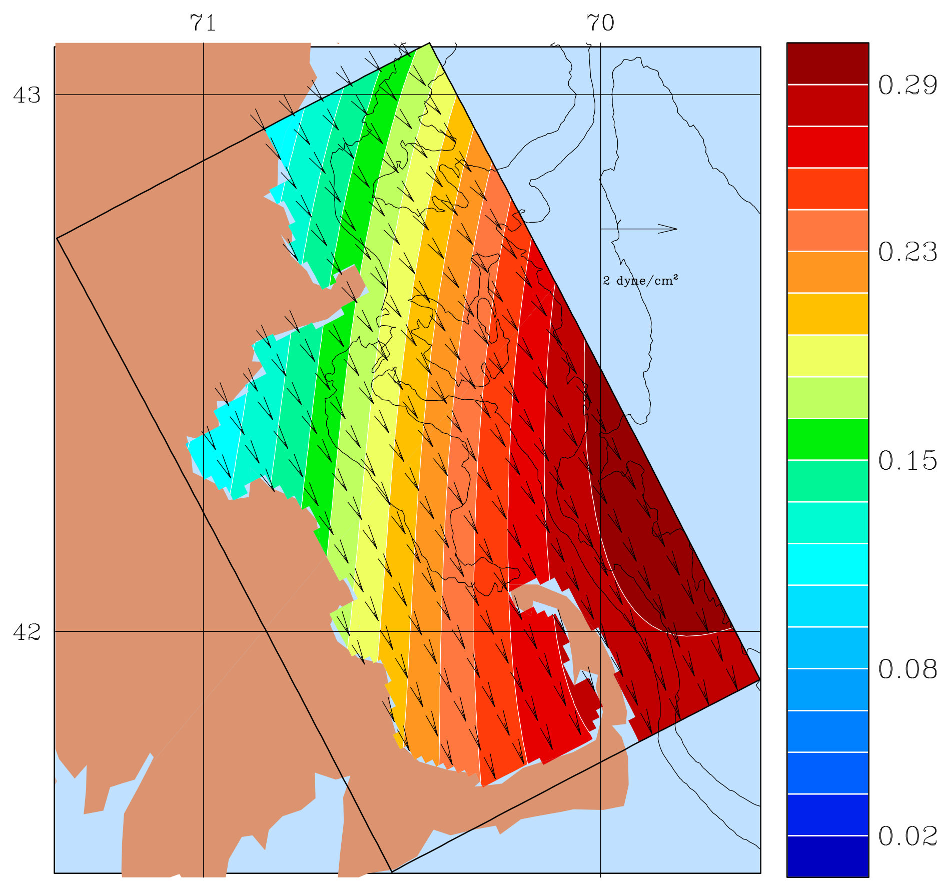
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 3.0392E−03 Max= 3.0392E−01

Nowcast : 7 Jun 2001

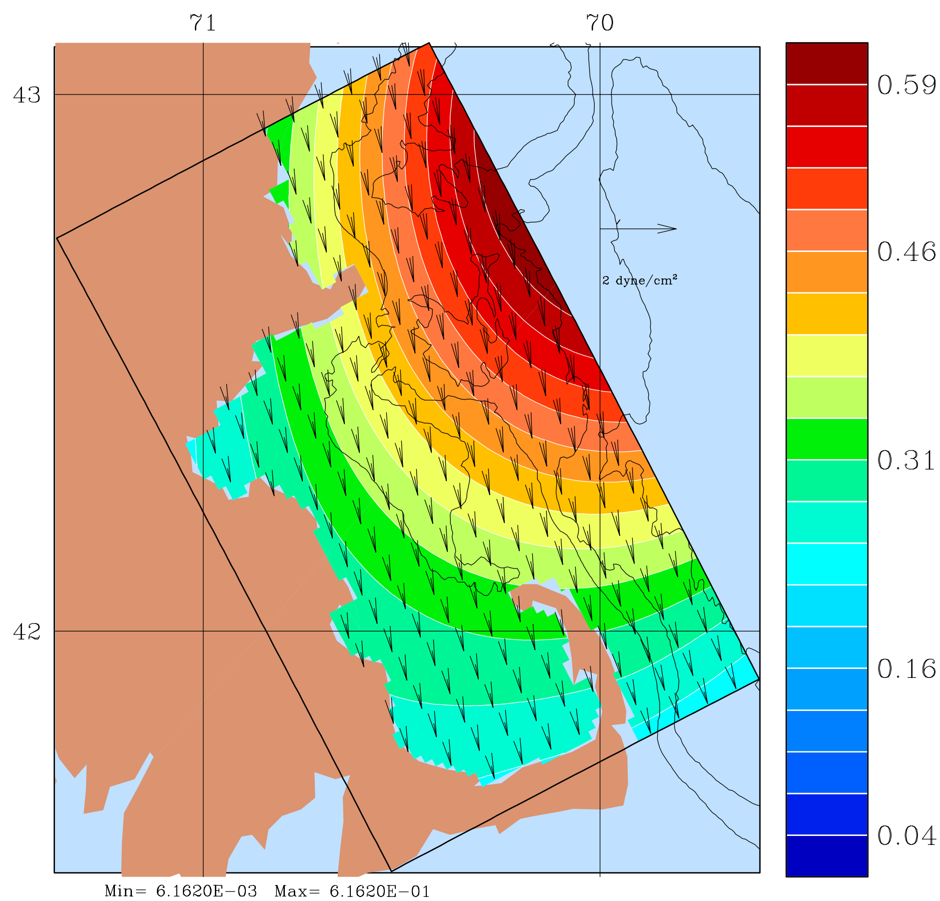
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 8 Jun 2001

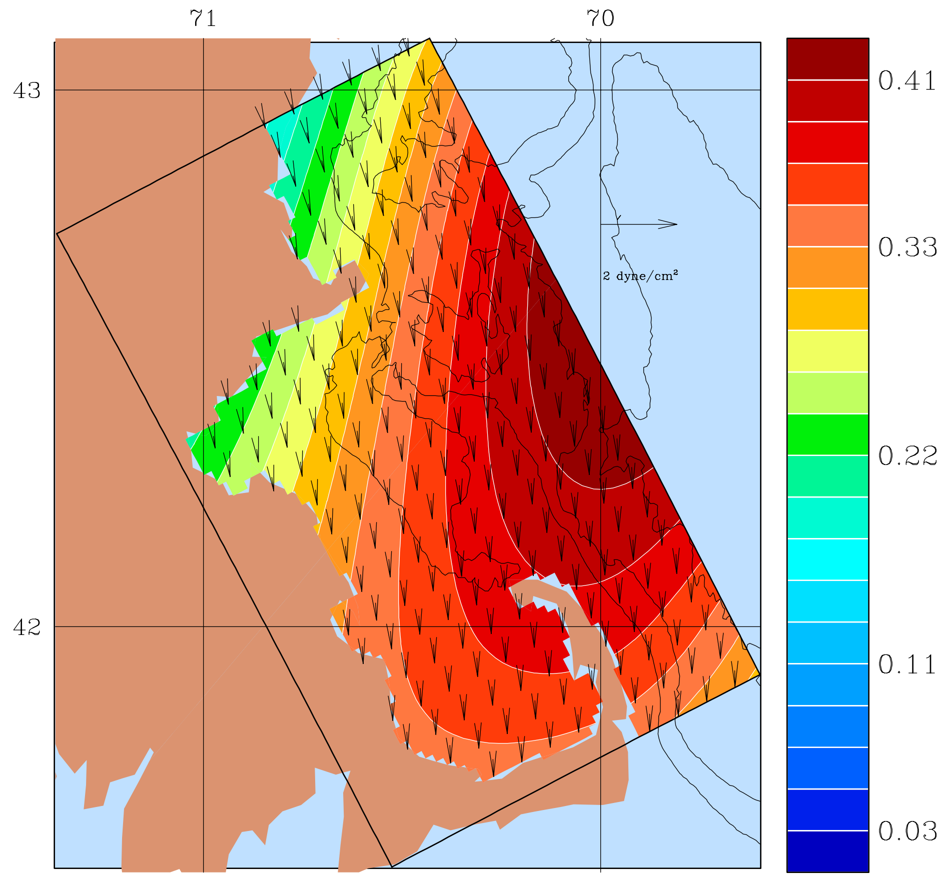
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 4.3196E−03 Max= 4.3196E−01

Nowcast : 9 Jun 2001

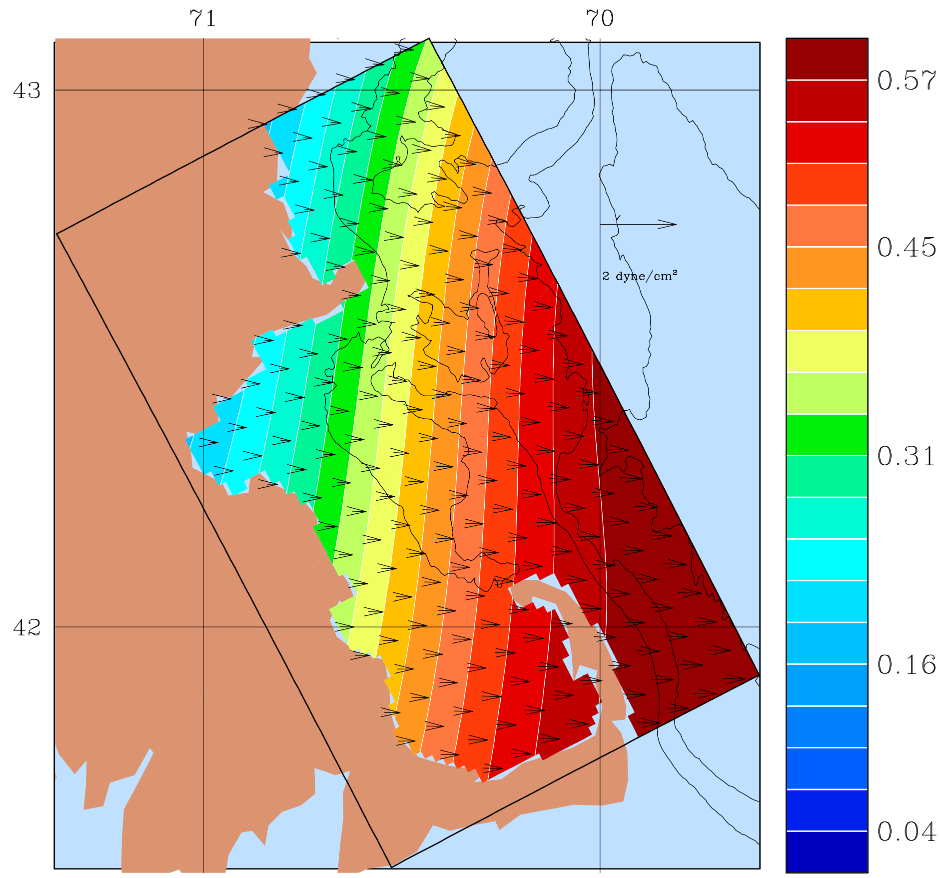
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 10 Jun 2001

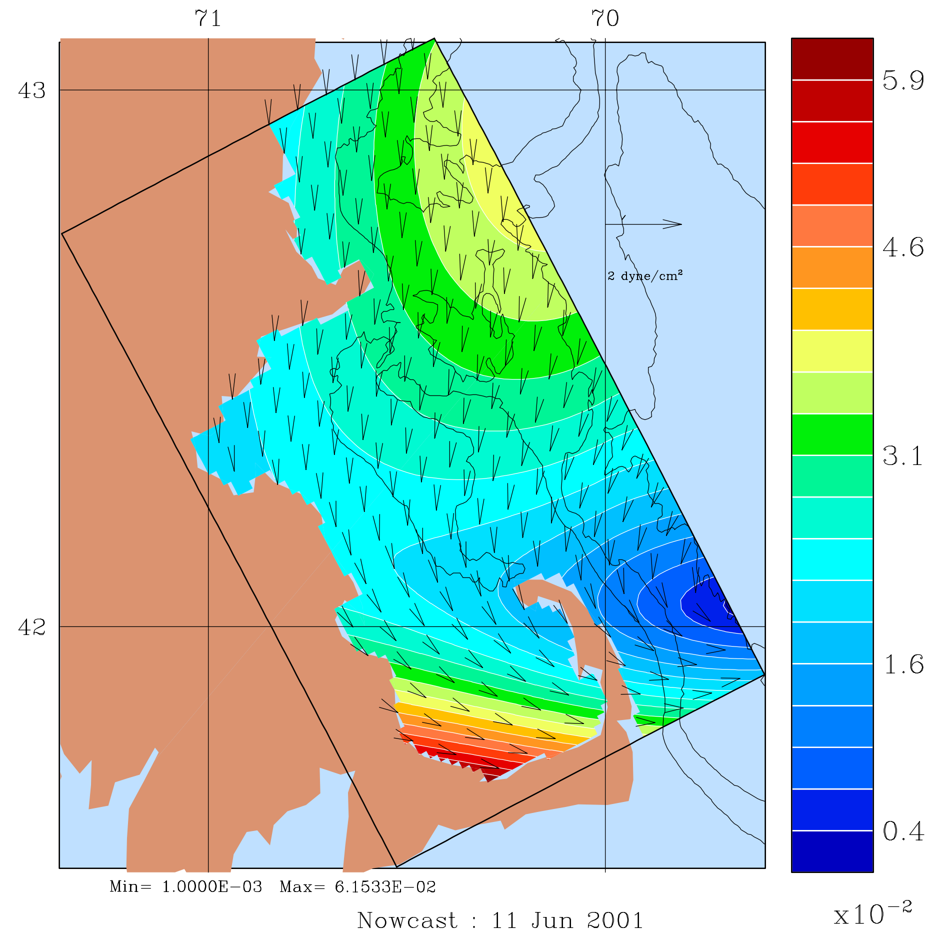
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



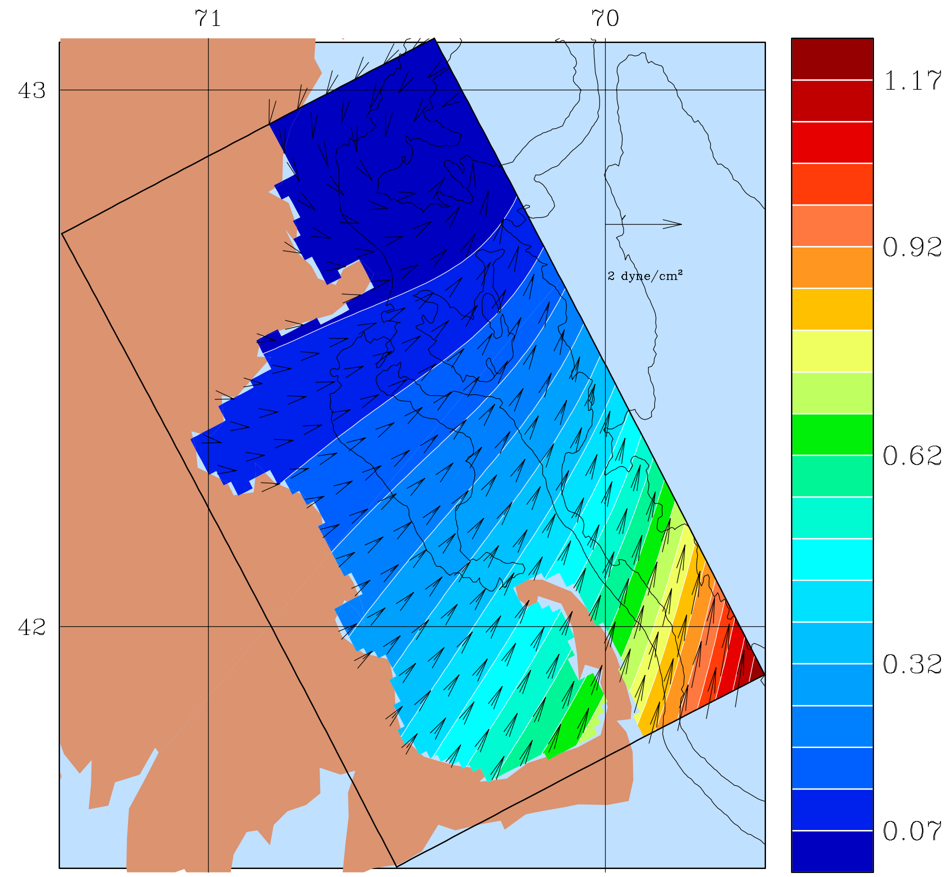
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 12 Jun 2001

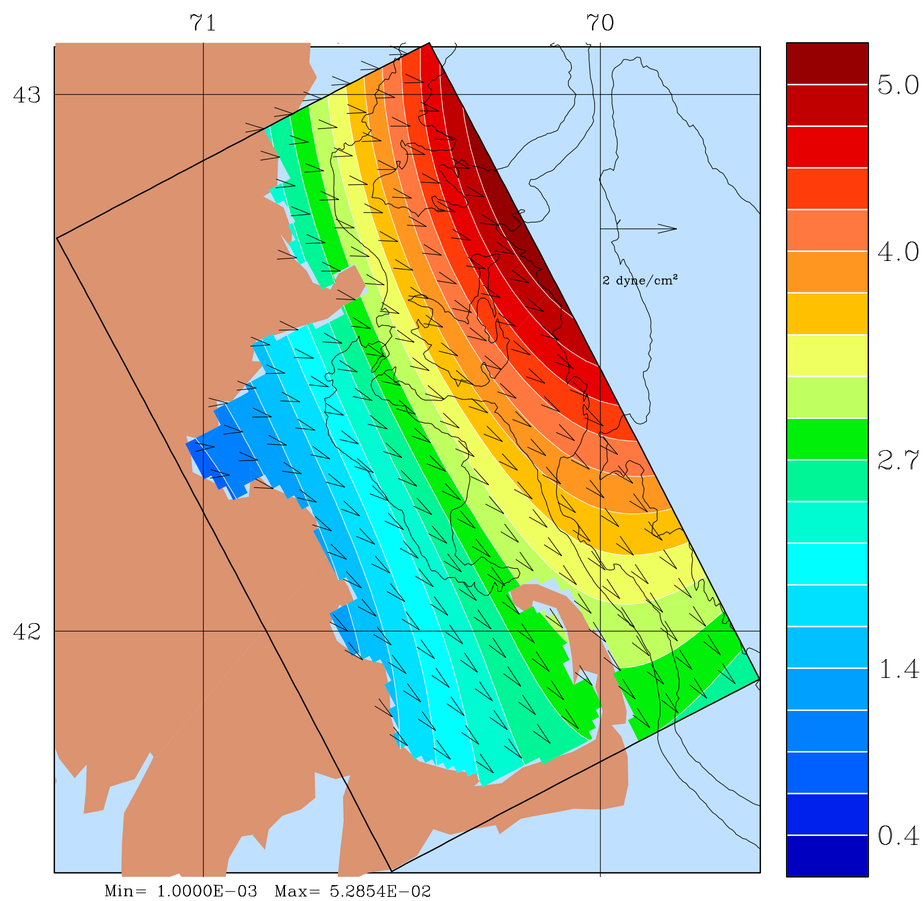
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 13 Jun 2001

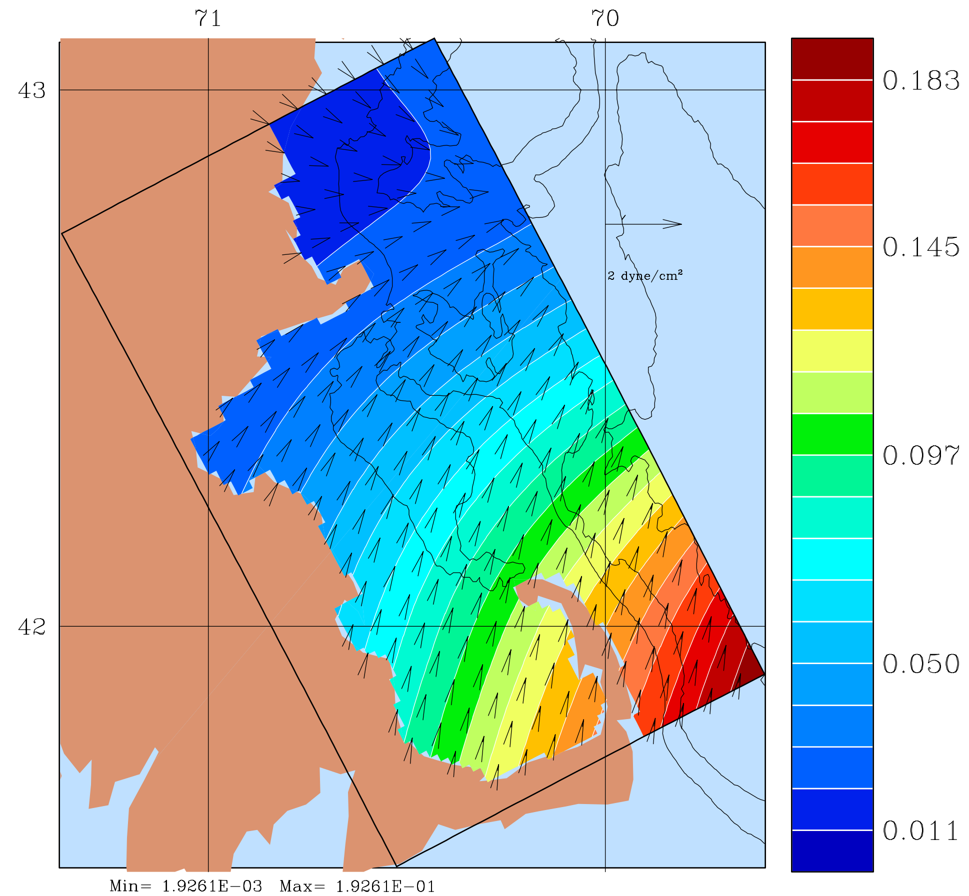
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 14 Jun 2001

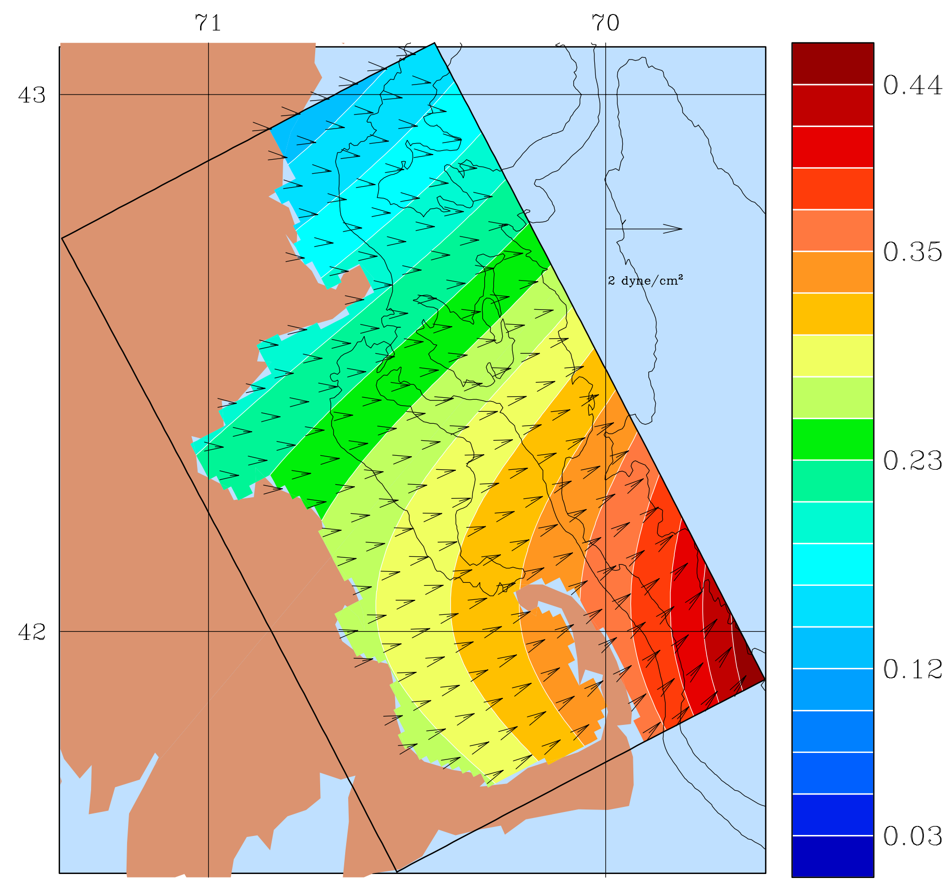
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 15 Jun 2001

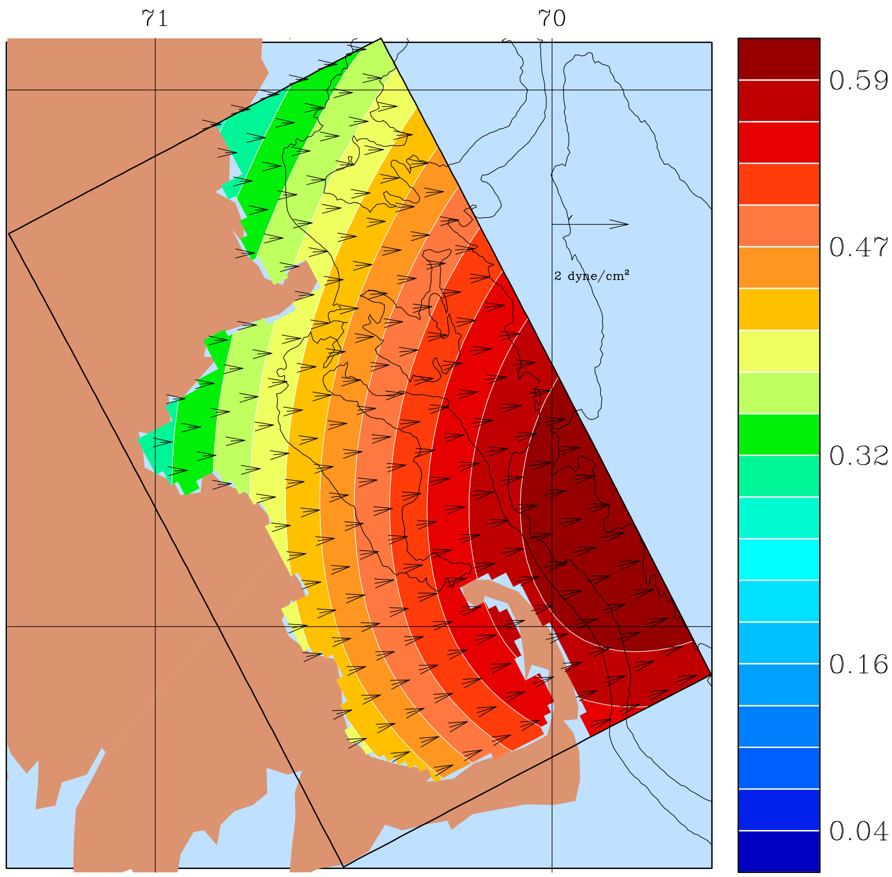
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 6.2401E−03 Max= 6.2401E−01

Nowcast : 16 Jun 2001

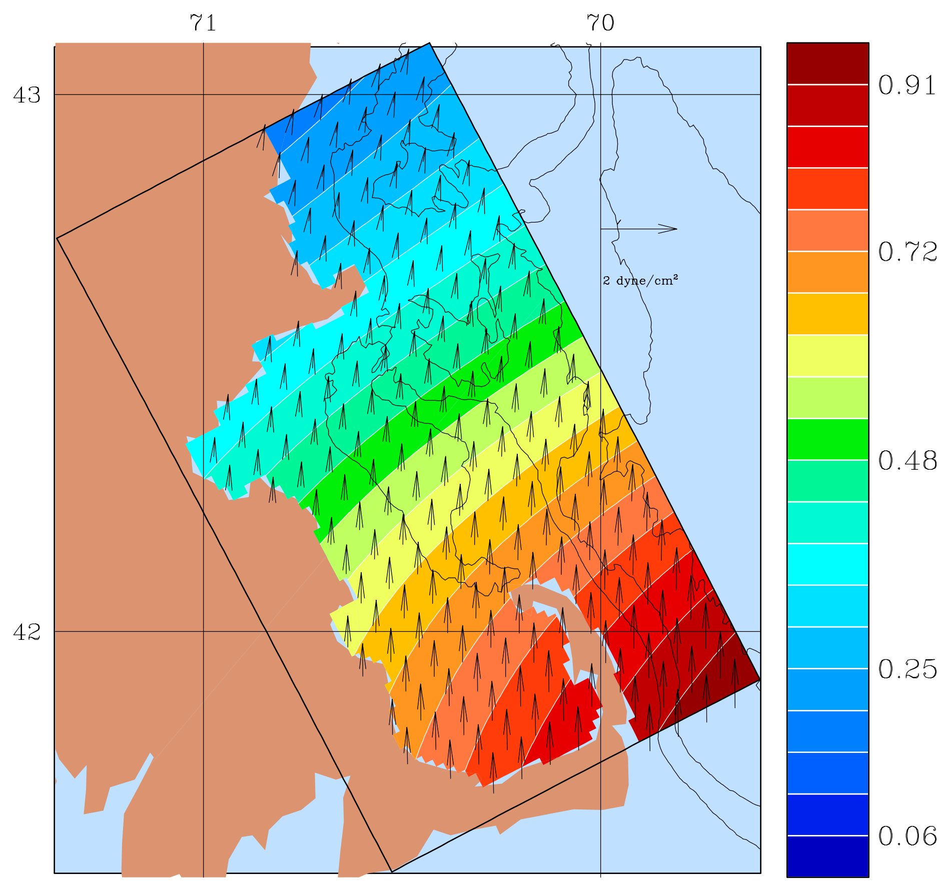
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 9.5897E−03 Max= 9.5897E−01

Nowcast : 17 Jun 2001

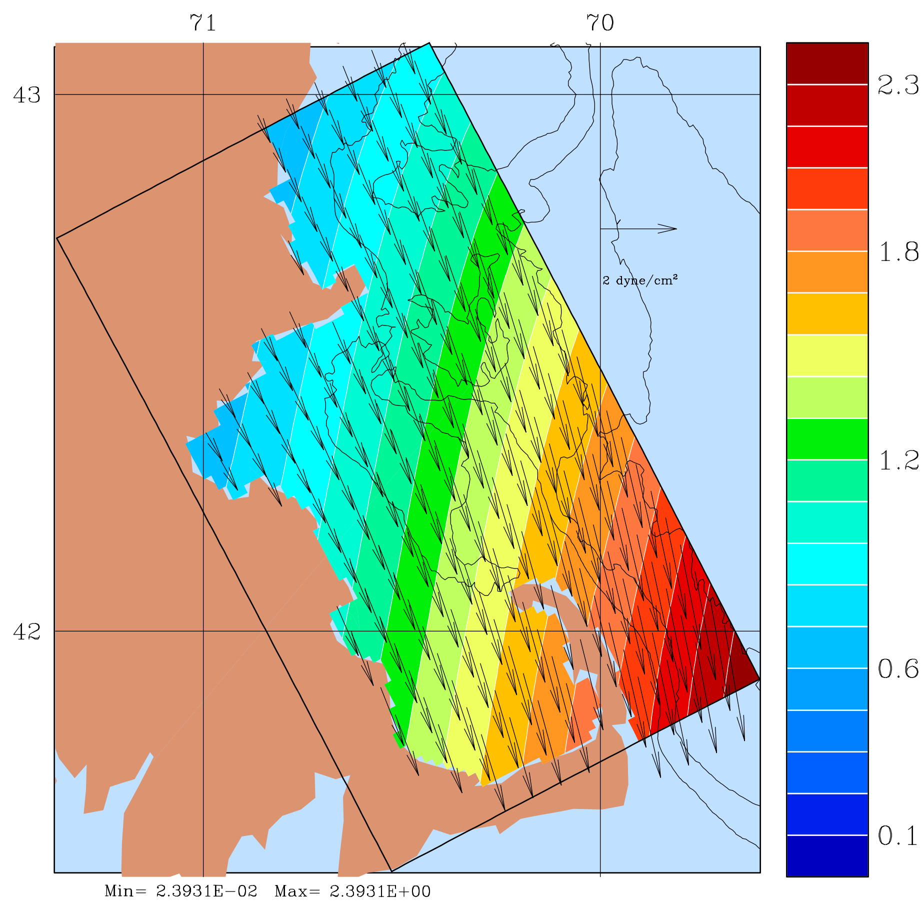
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 18 Jun 2001

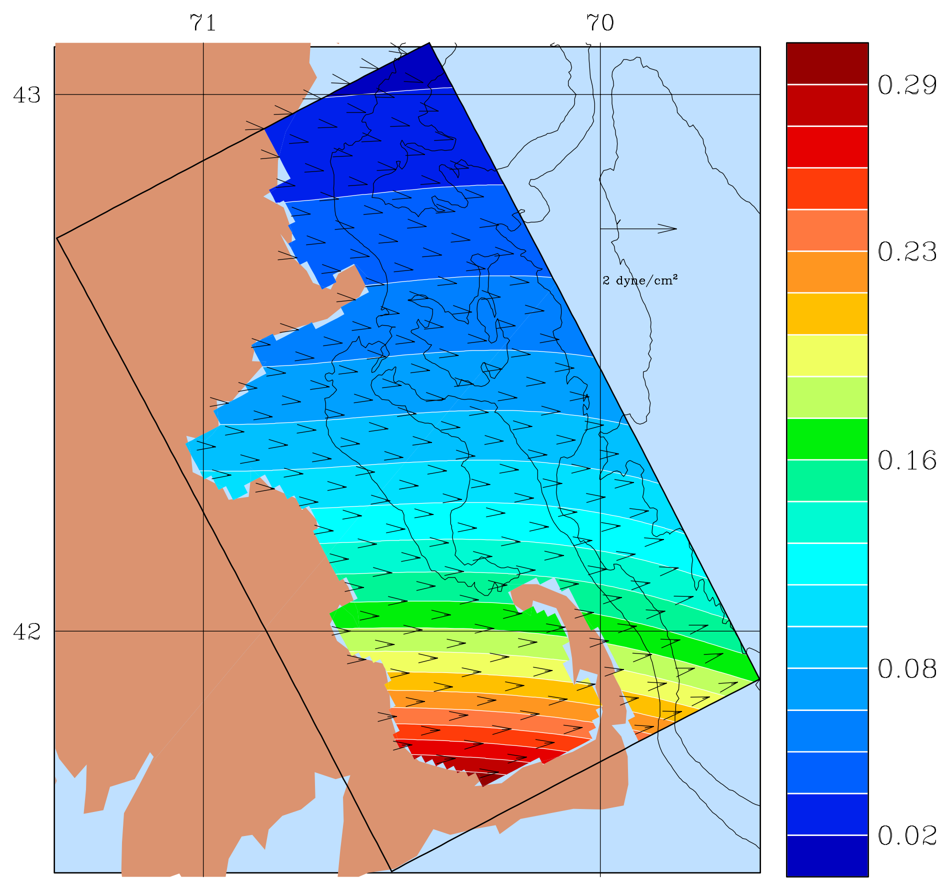
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 19 Jun 2001

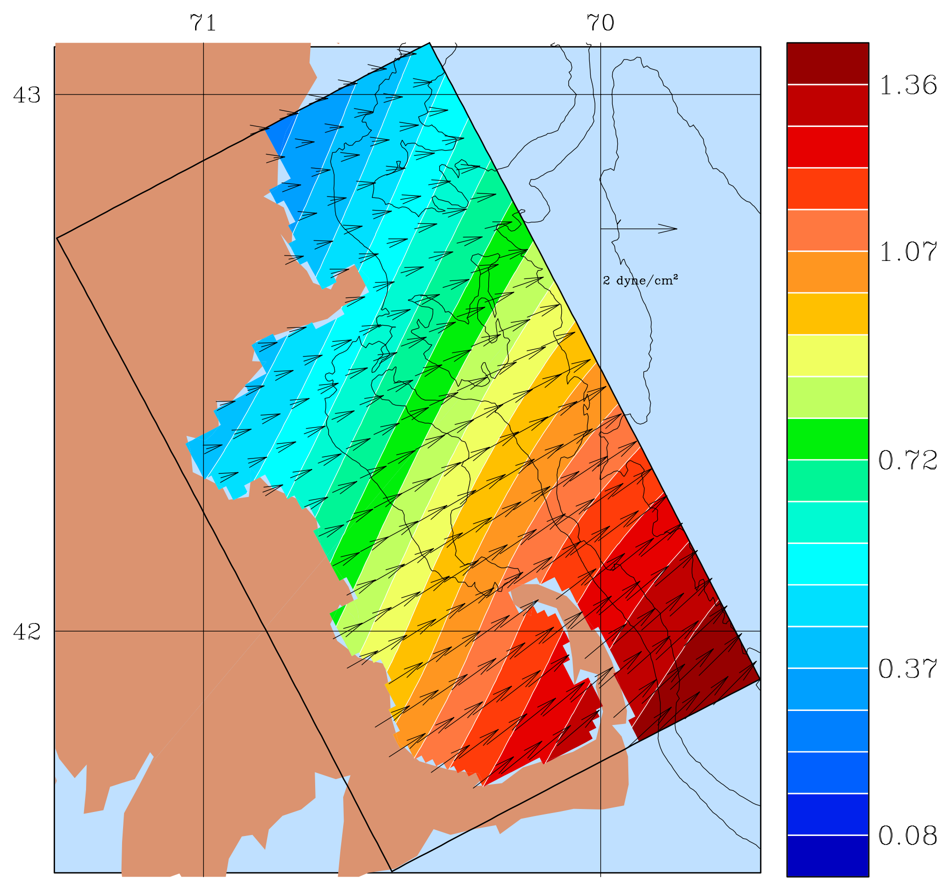
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 1.4260E−02 Max= 1.4260E+00

Nowcast : 20 Jun 2001

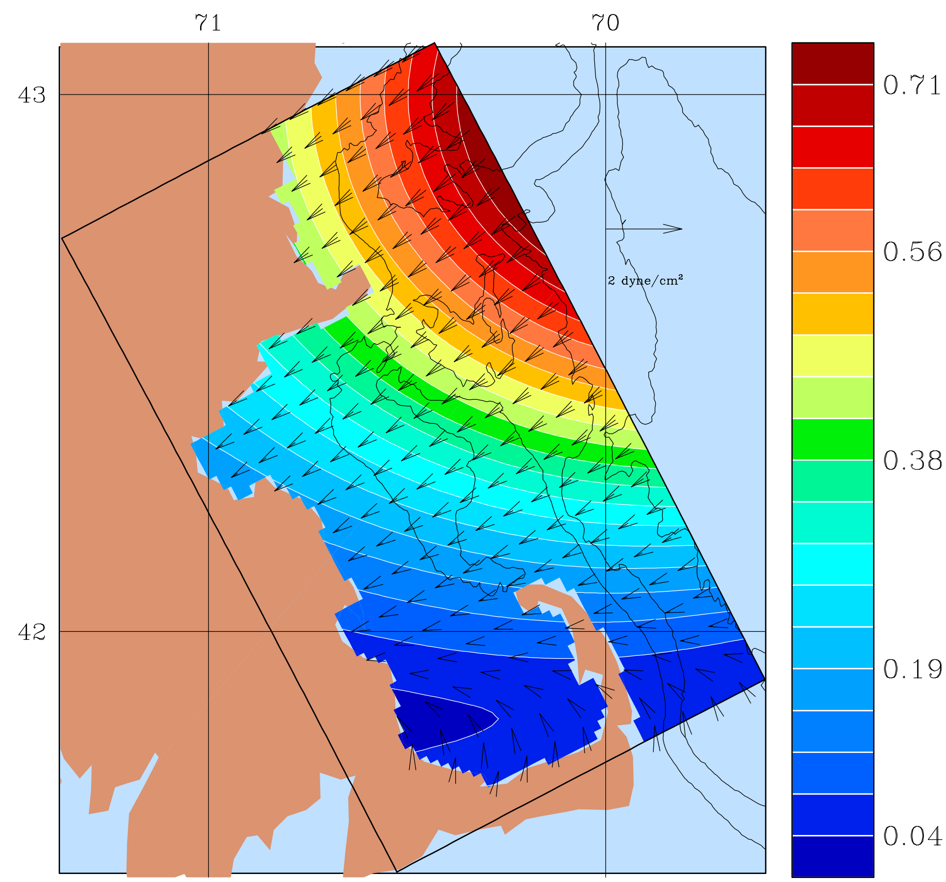
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 21 Jun 2001

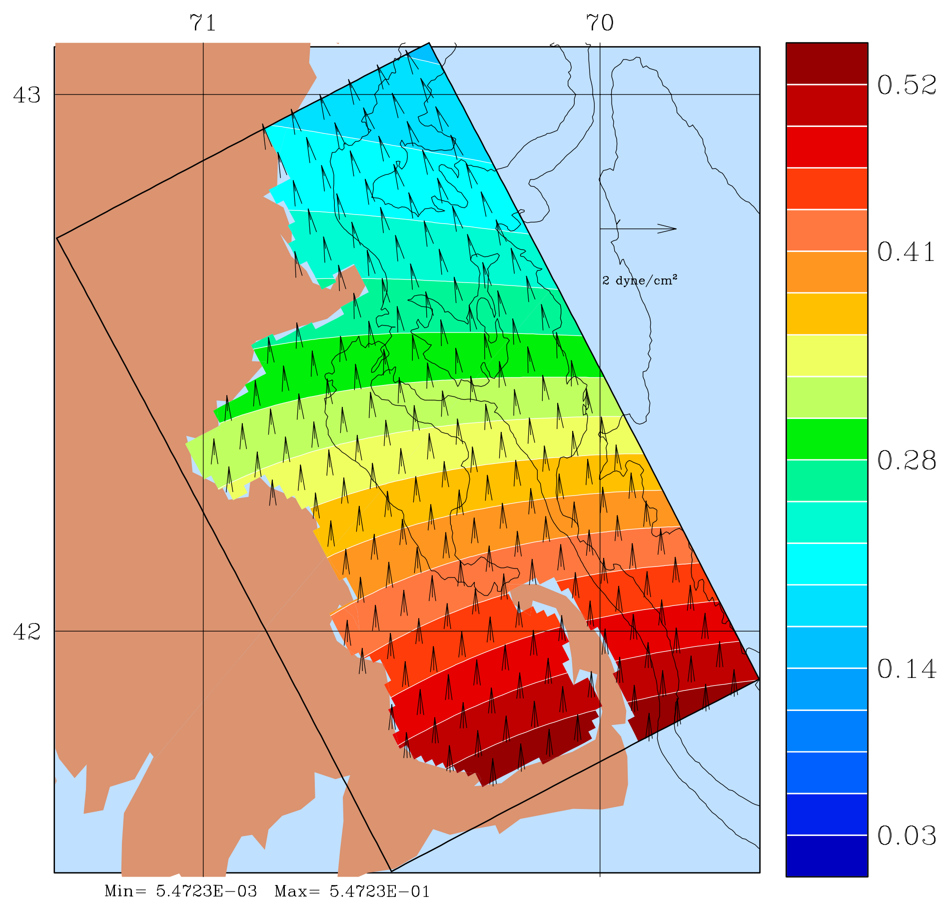
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 22 Jun 2001

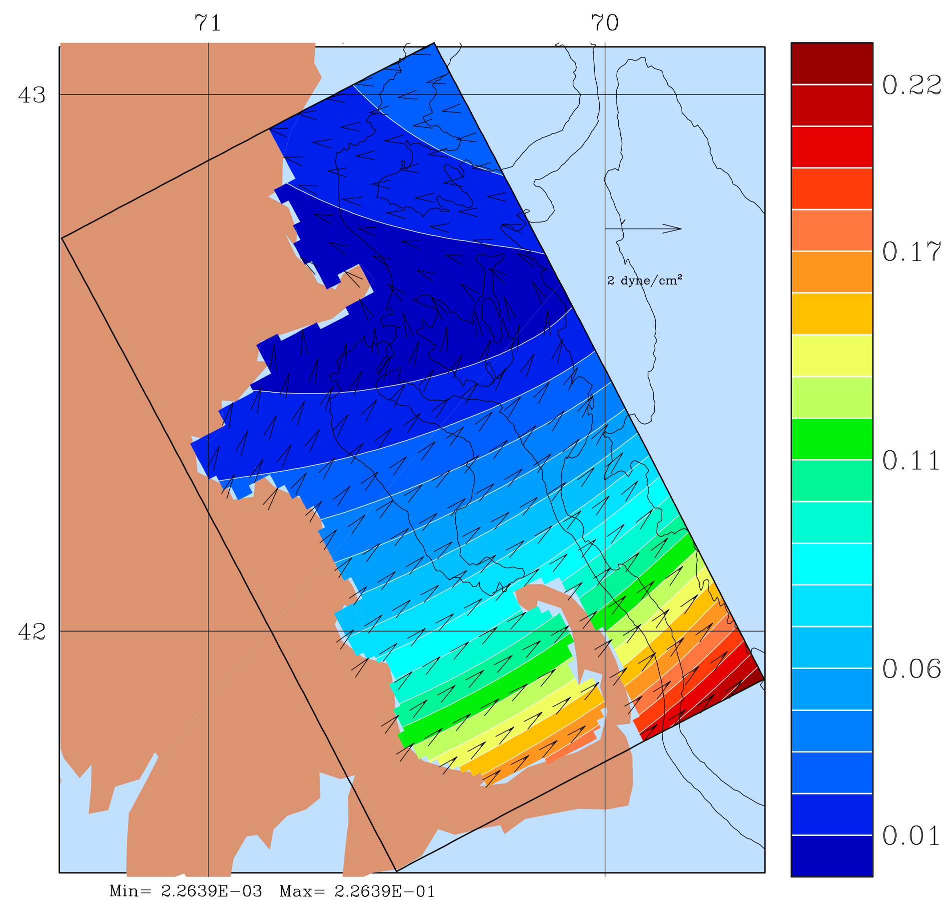
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 23 Jun 2001

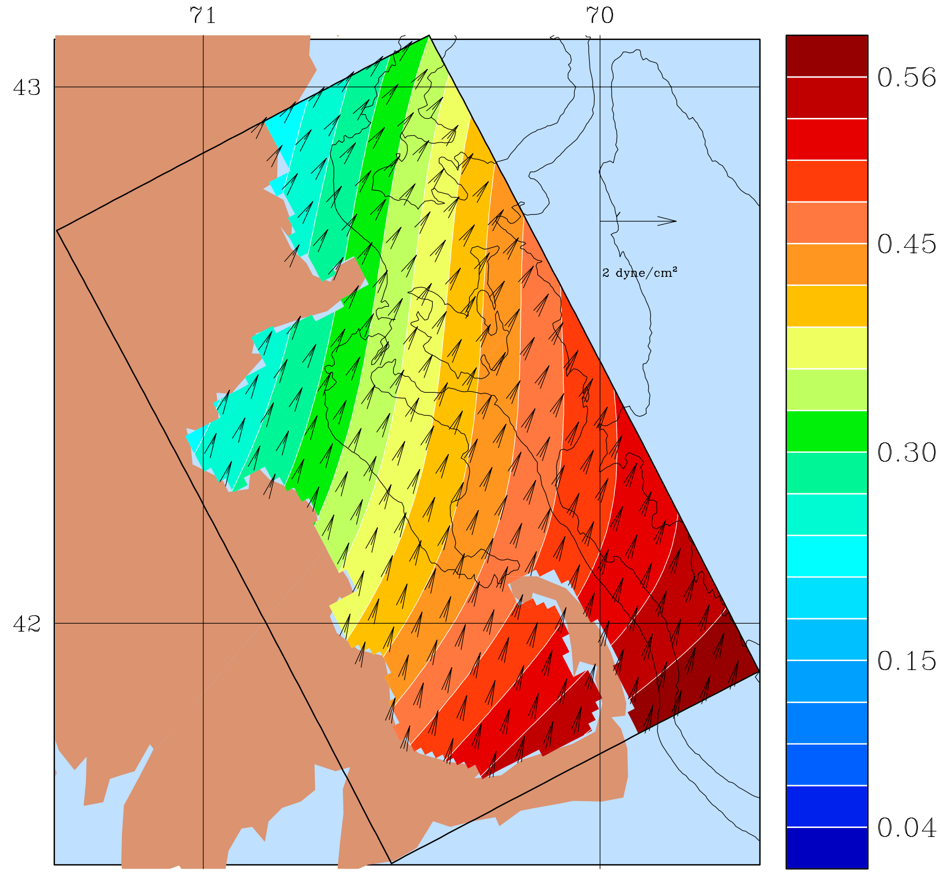
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 24 Jun 2001

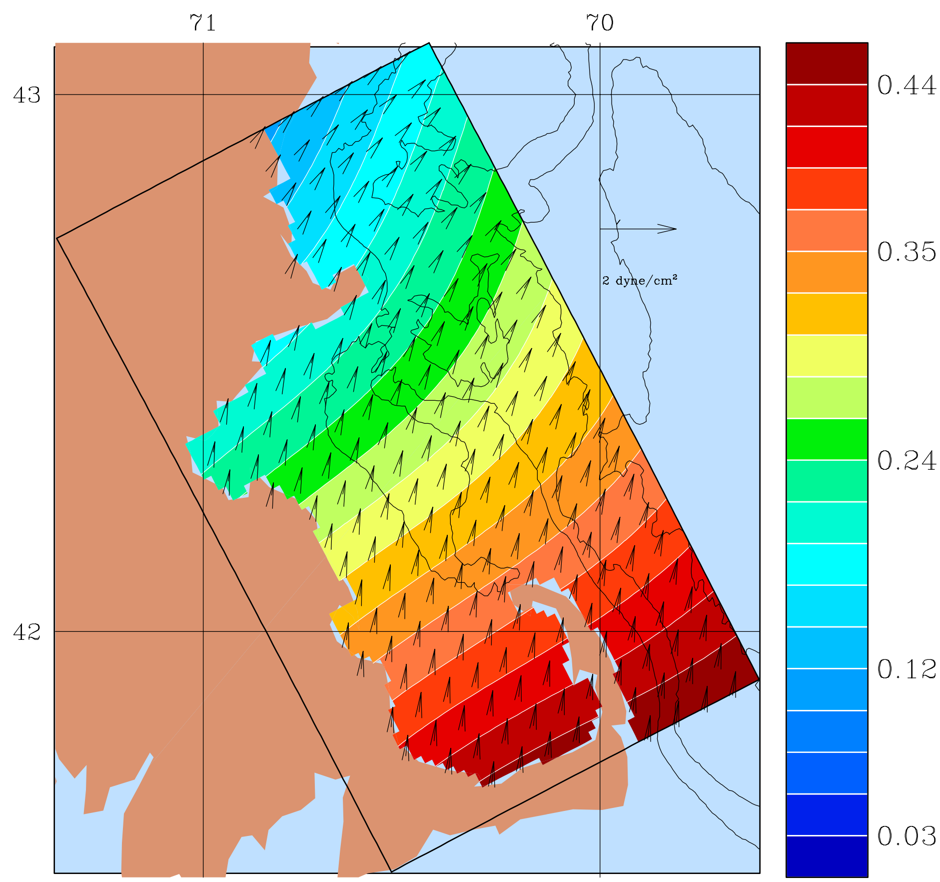
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Min= 4.6757E−03 Max= 4.6757E−01

Nowcast : 25 Jun 2001

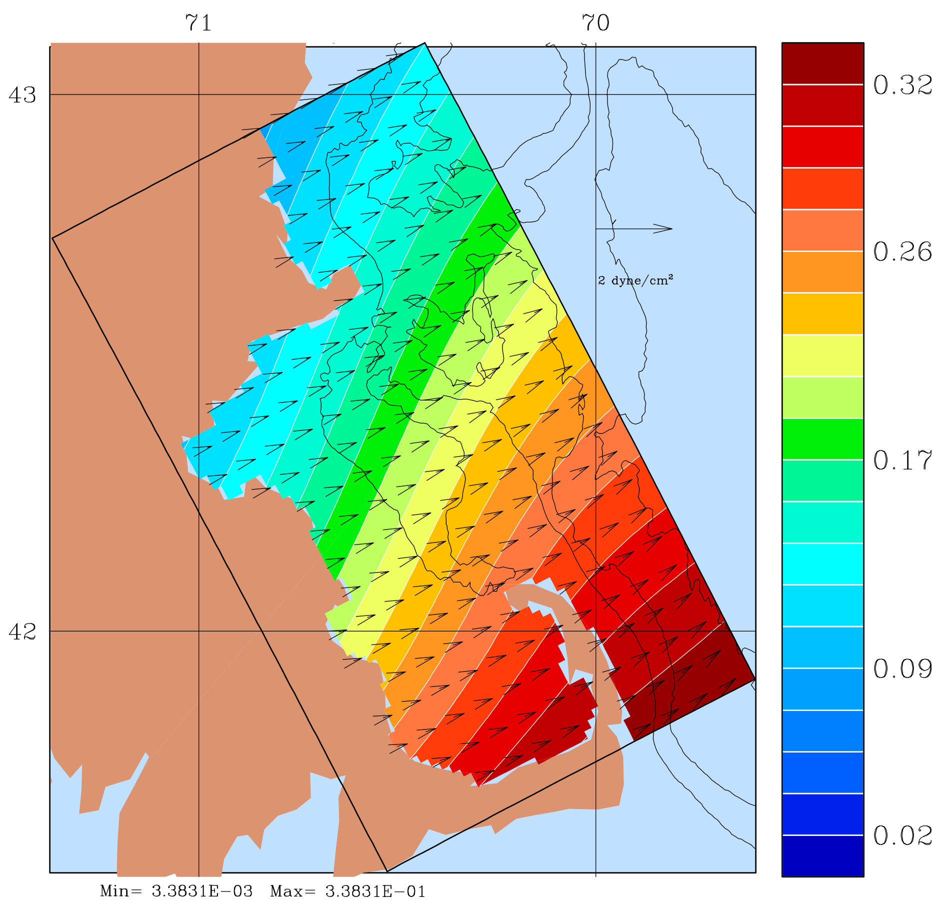
Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Wind Stress (dyne/cm^2)



Nowcast : 26 Jun 2001

Tuesday - October 26, 2004 - 10:36:36 am
pe_frc_mbay.nc

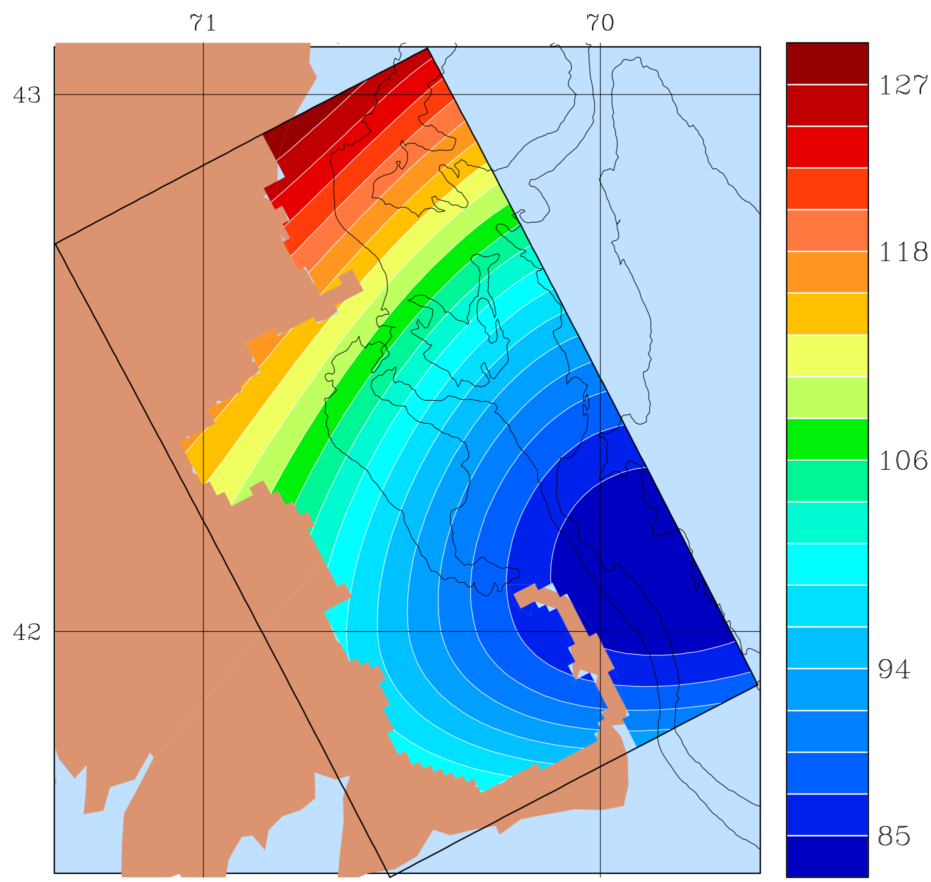
FNMOC Surface Heat Flux

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 6 Jun 2001

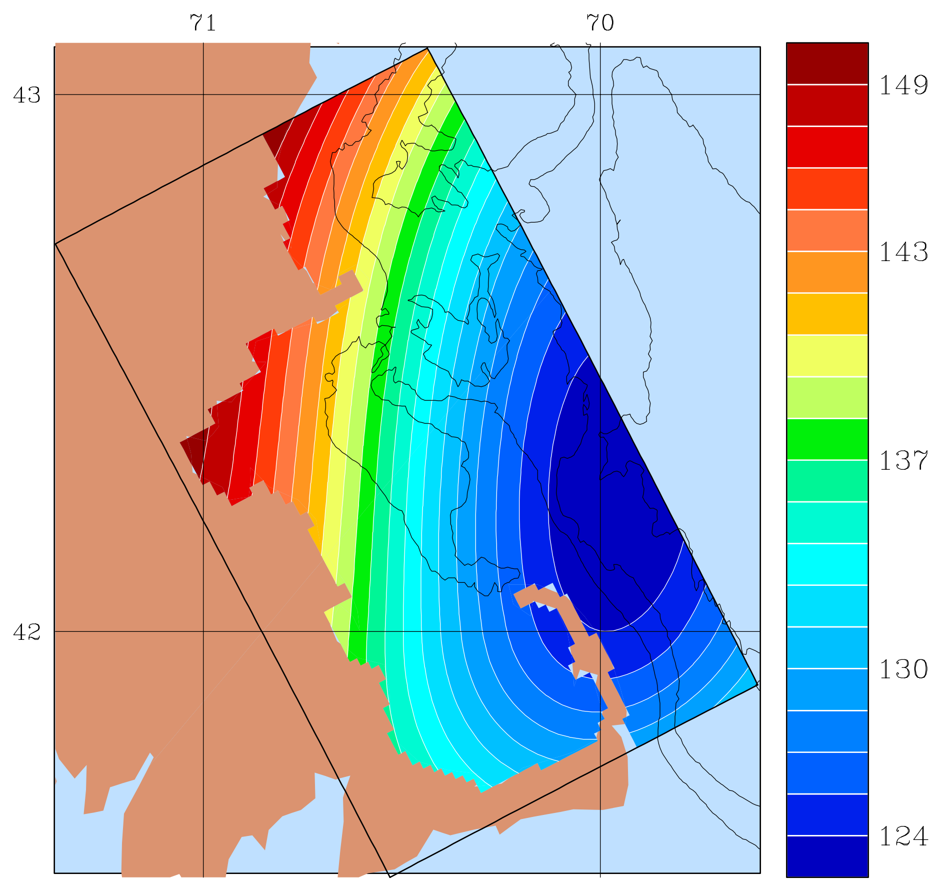
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 1.2273E+02 Max= 1.5029E+02

Nowcast : 7 Jun 2001

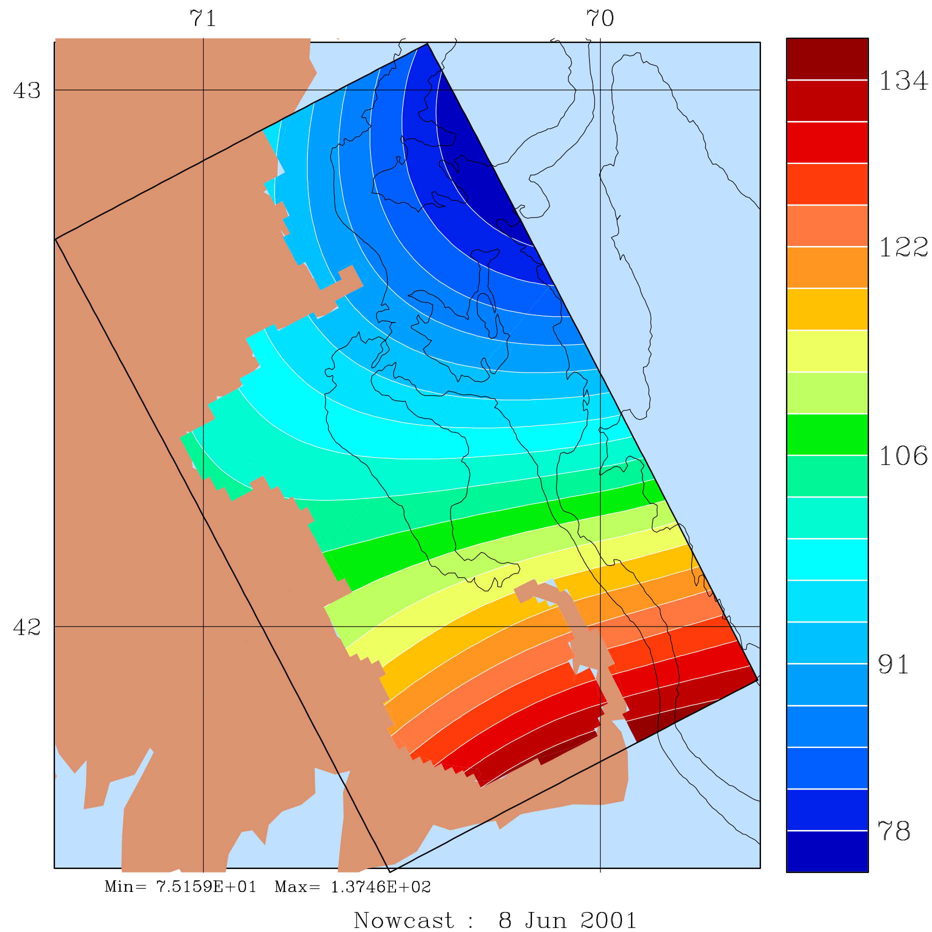
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



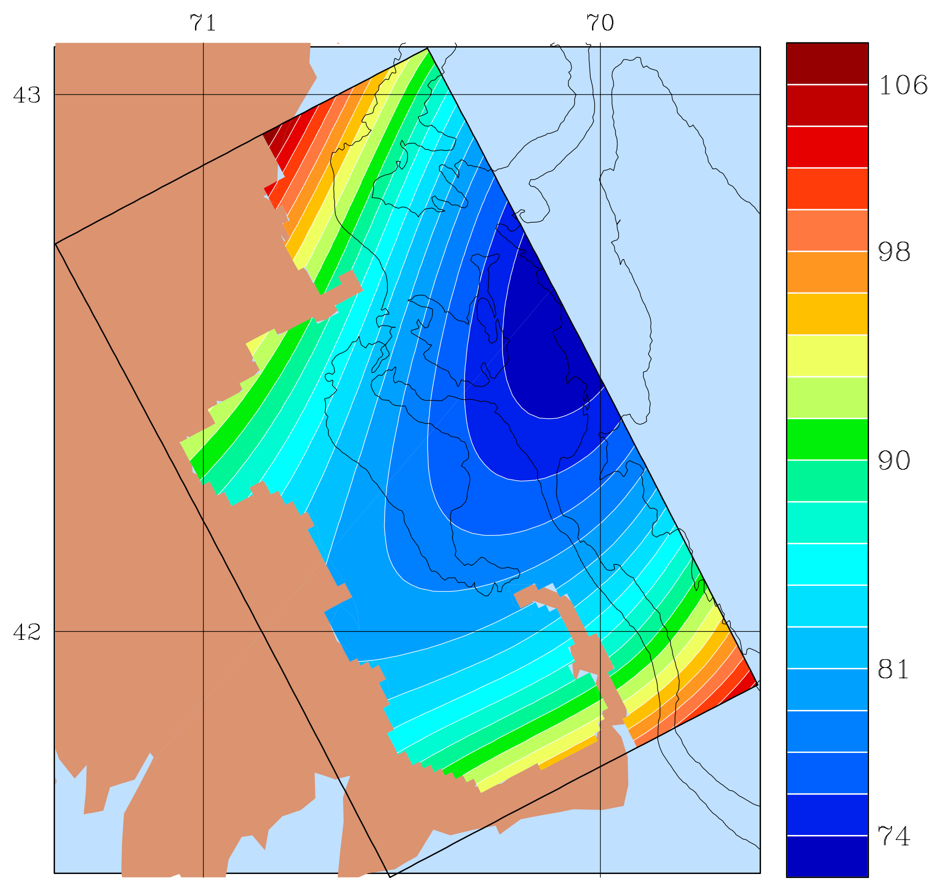
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 9 Jun 2001

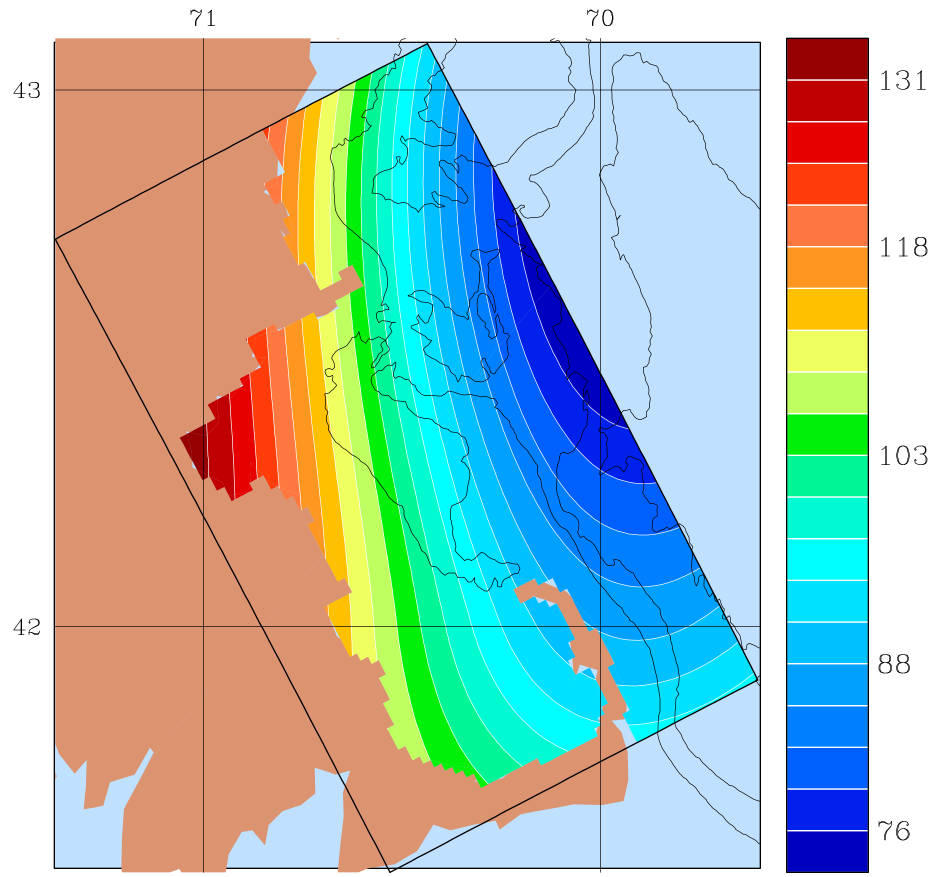
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 7.2761E+01 Max= 1.3356E+02

Nowcast : 10 Jun 2001

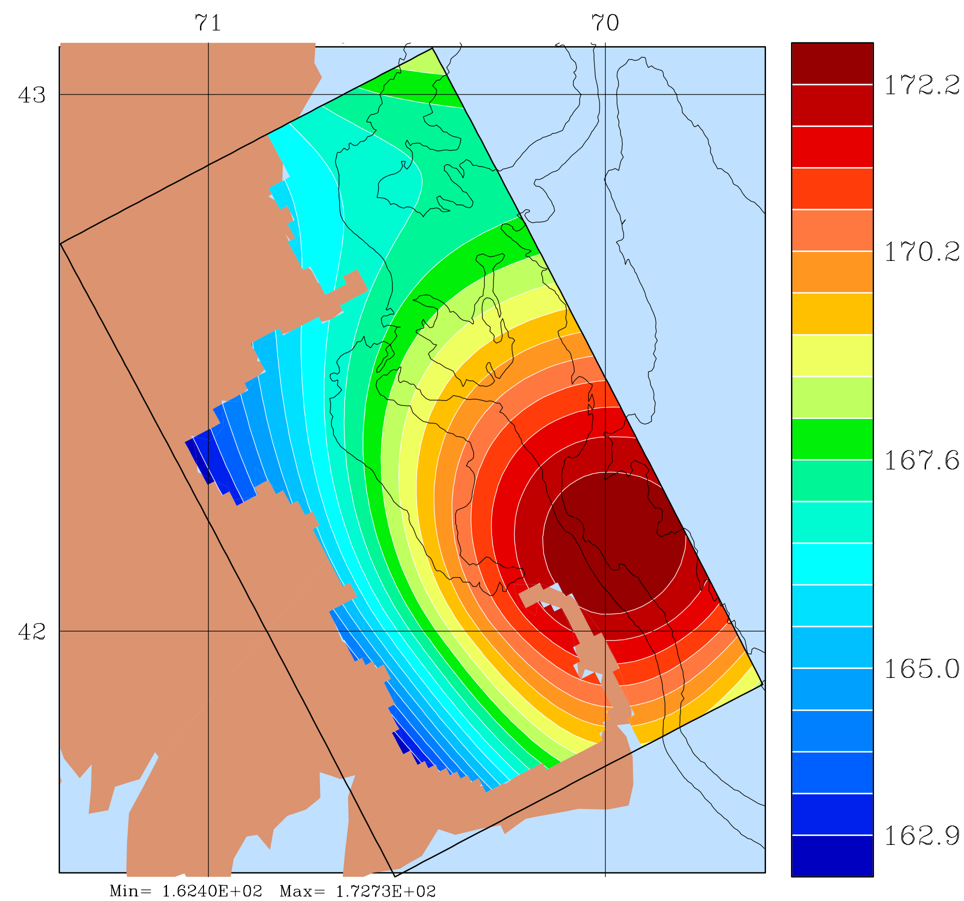
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 11 Jun 2001

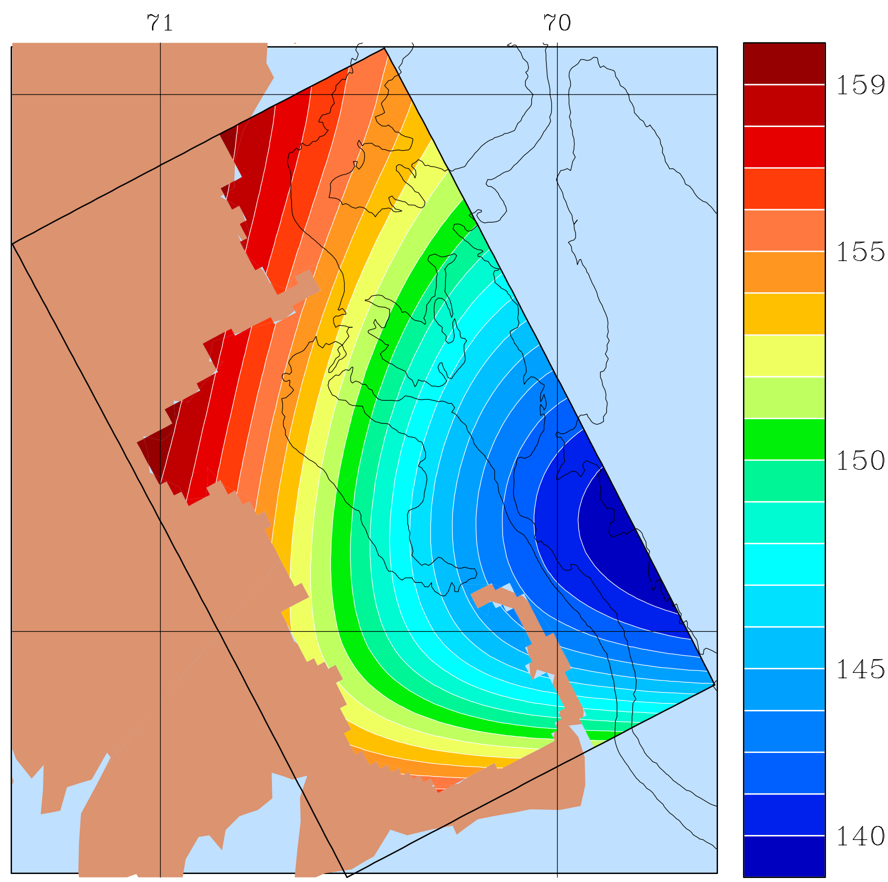
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 1.3924E+02 Max= 1.6030E+02

Nowcast : 12 Jun 2001

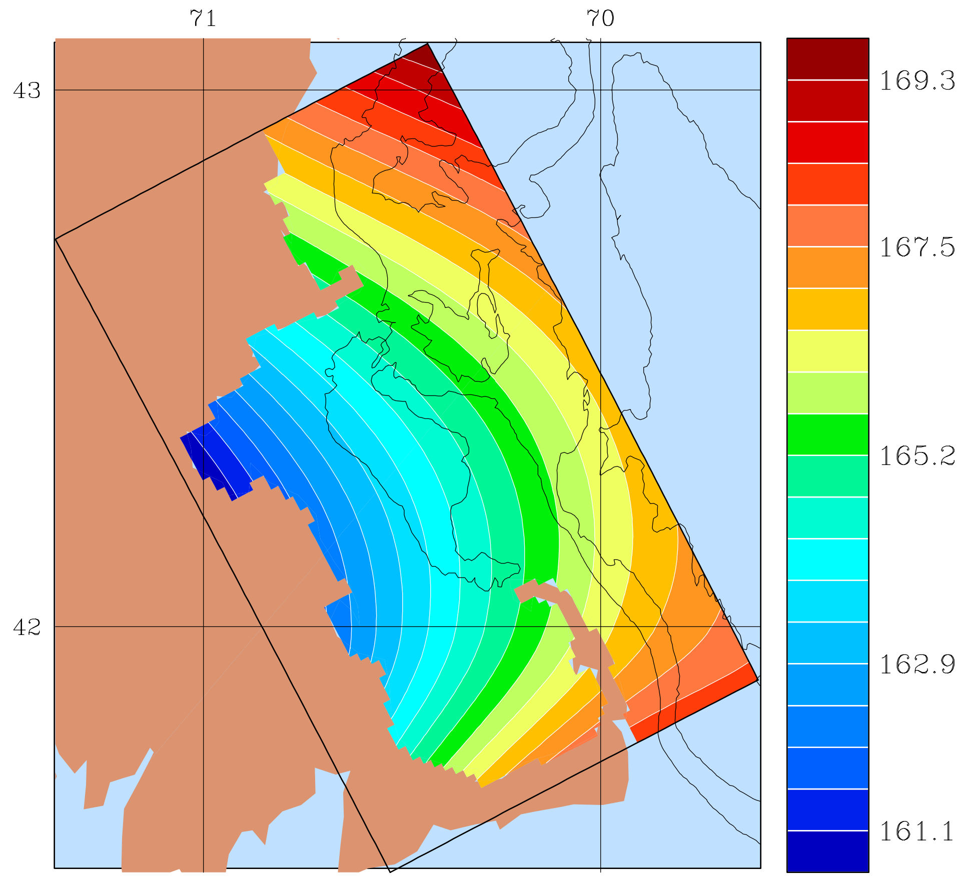
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 1.6067E+02 Max= 1.6979E+02

Nowcast : 13 Jun 2001

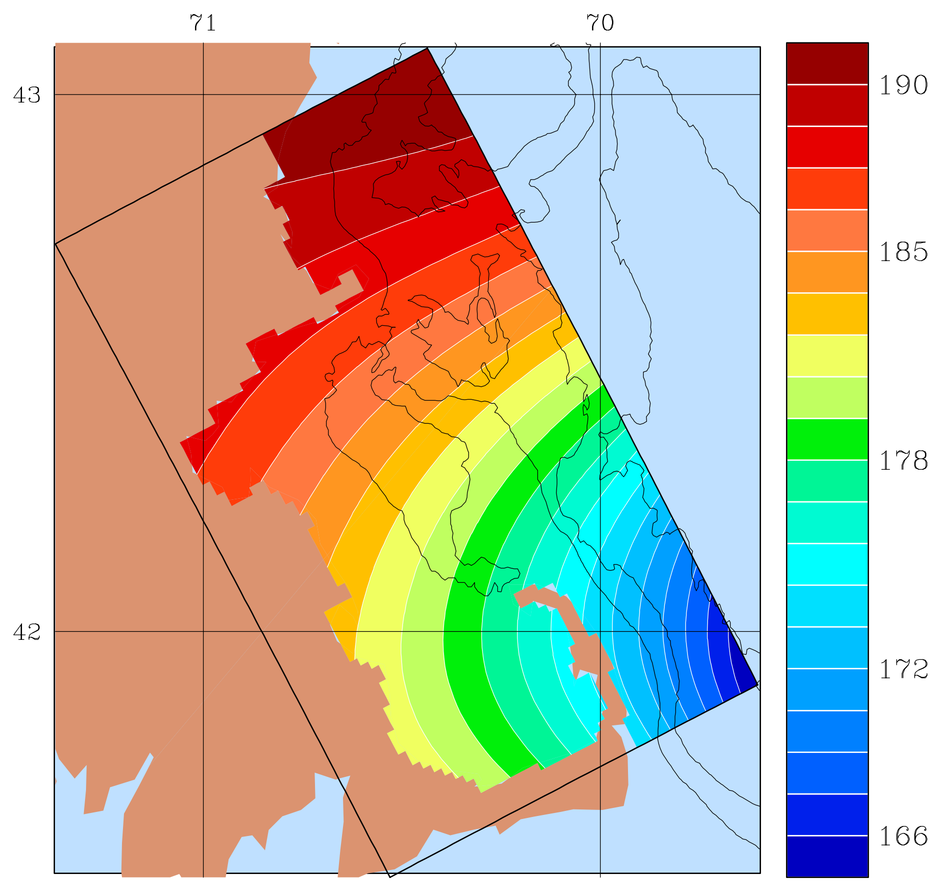
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 14 Jun 2001

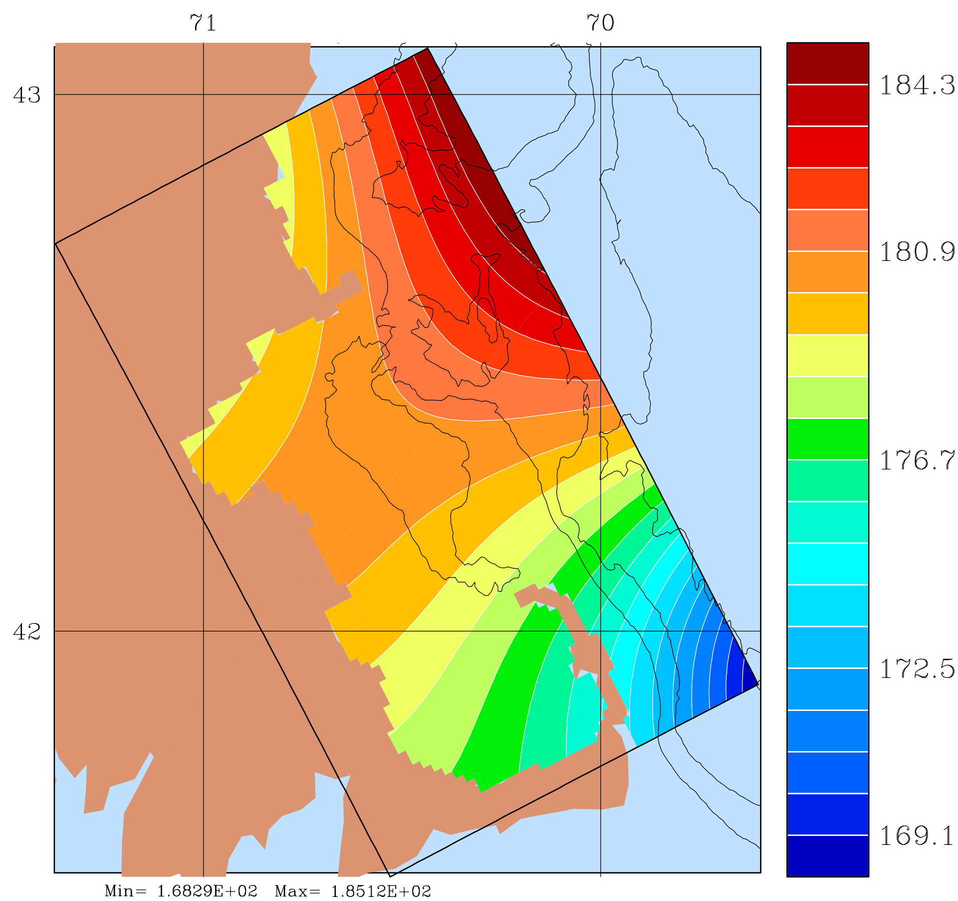
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 15 Jun 2001

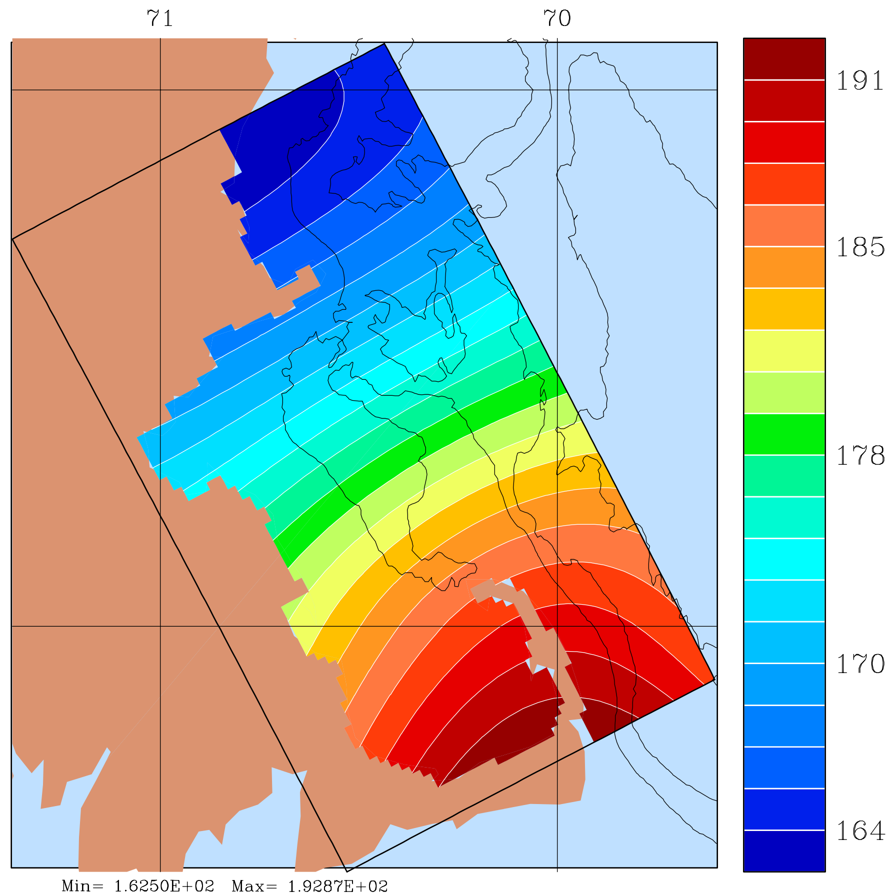
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 16 Jun 2001

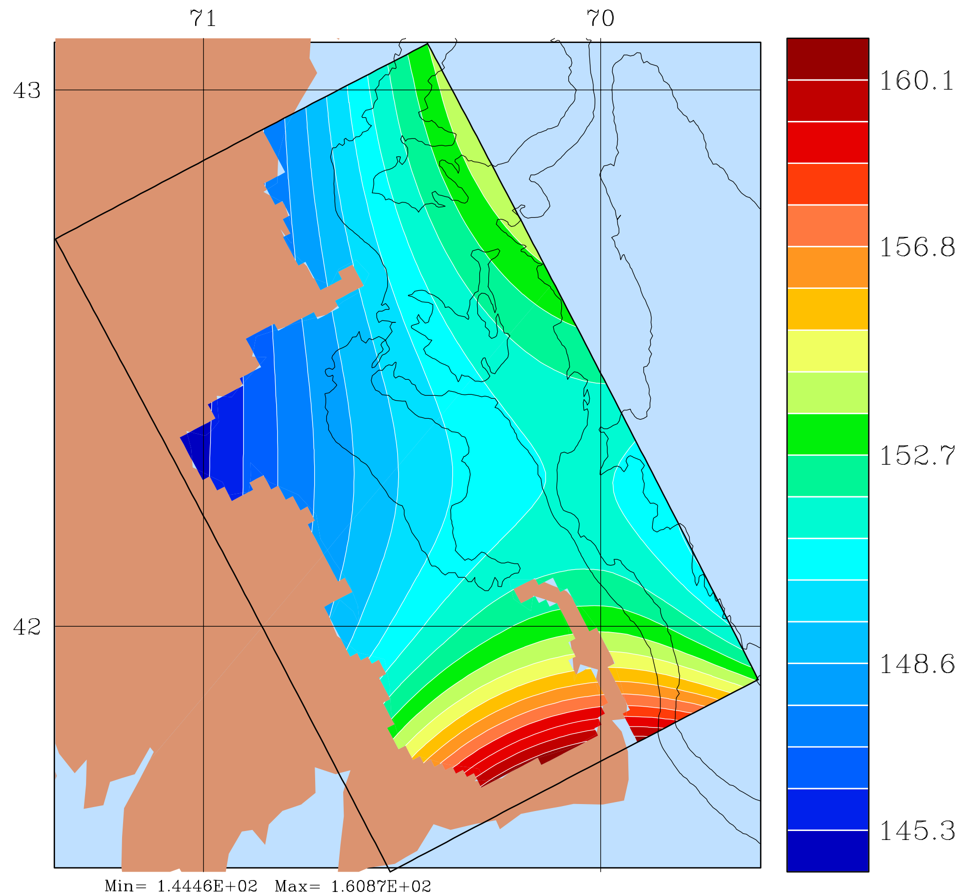
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 17 Jun 2001

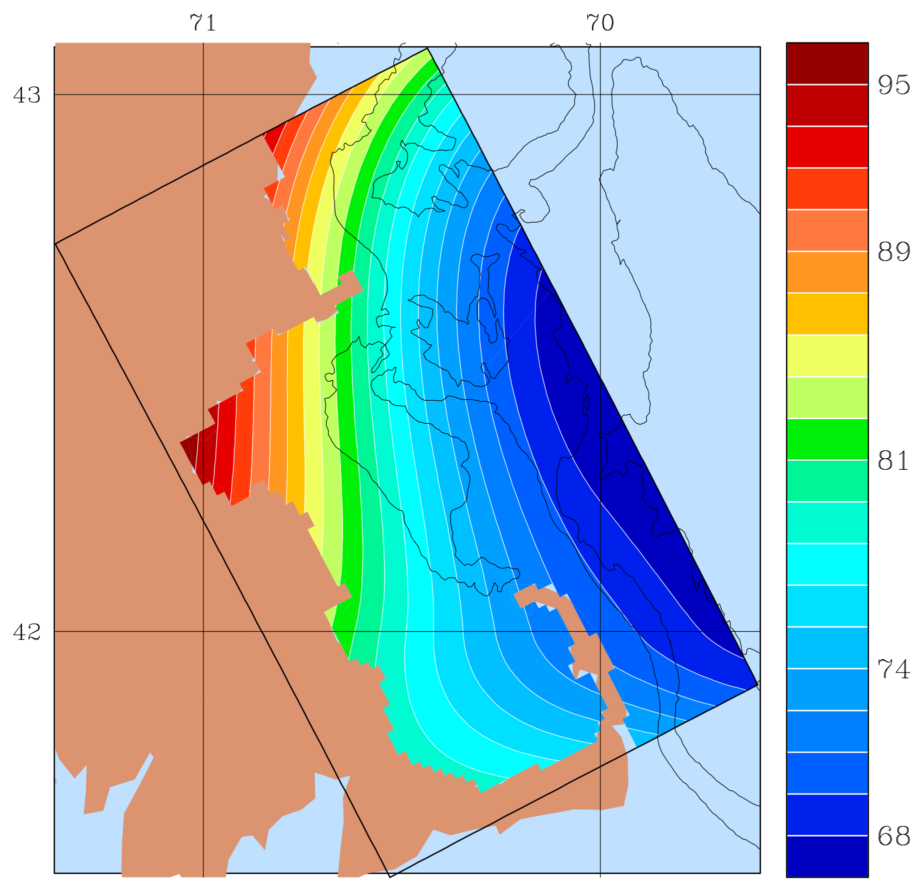
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 18 Jun 2001

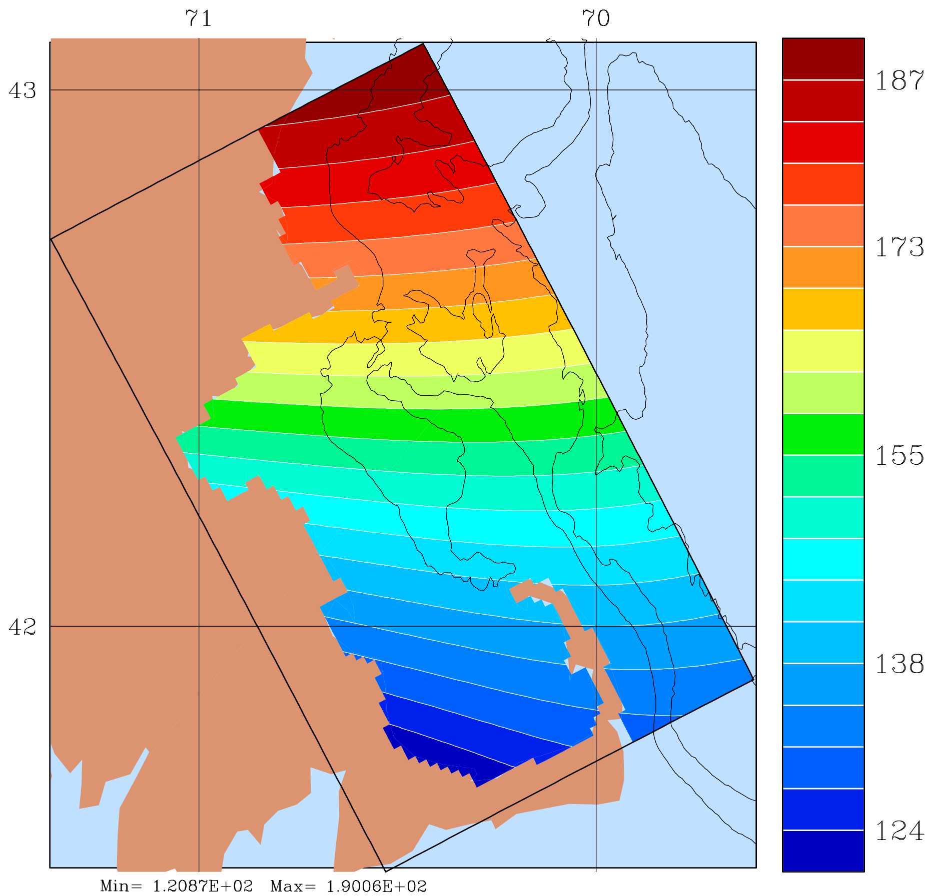
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 19 Jun 2001

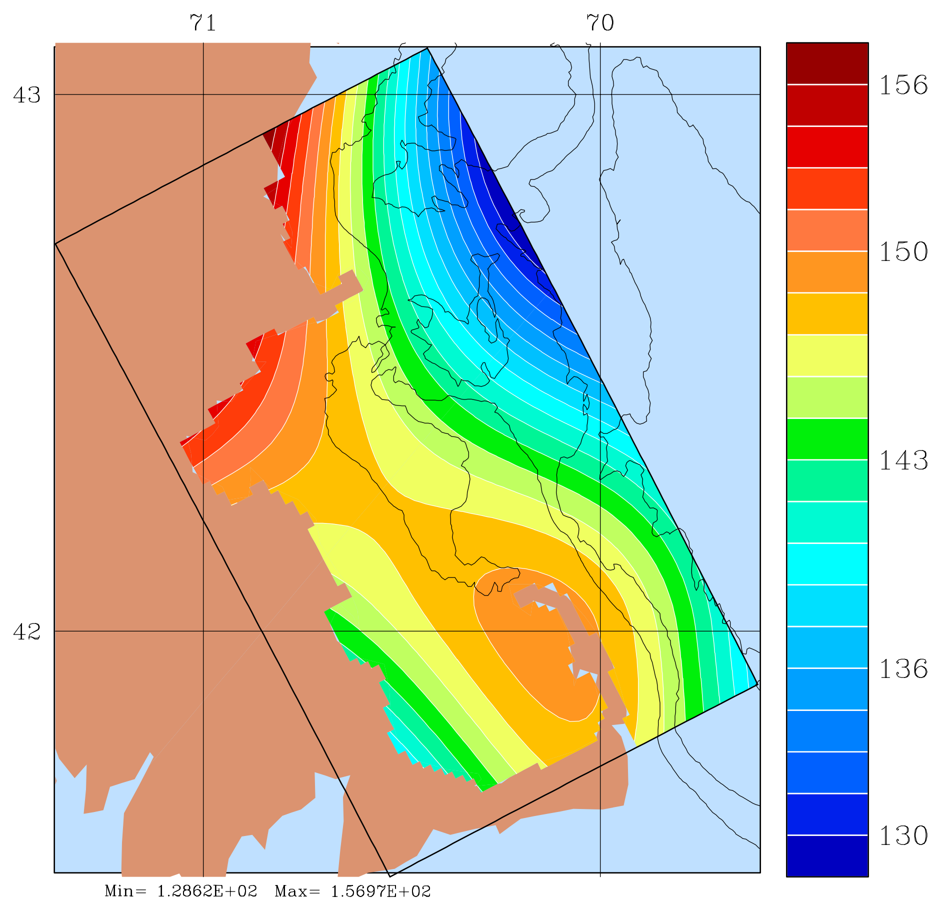
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 20 Jun 2001

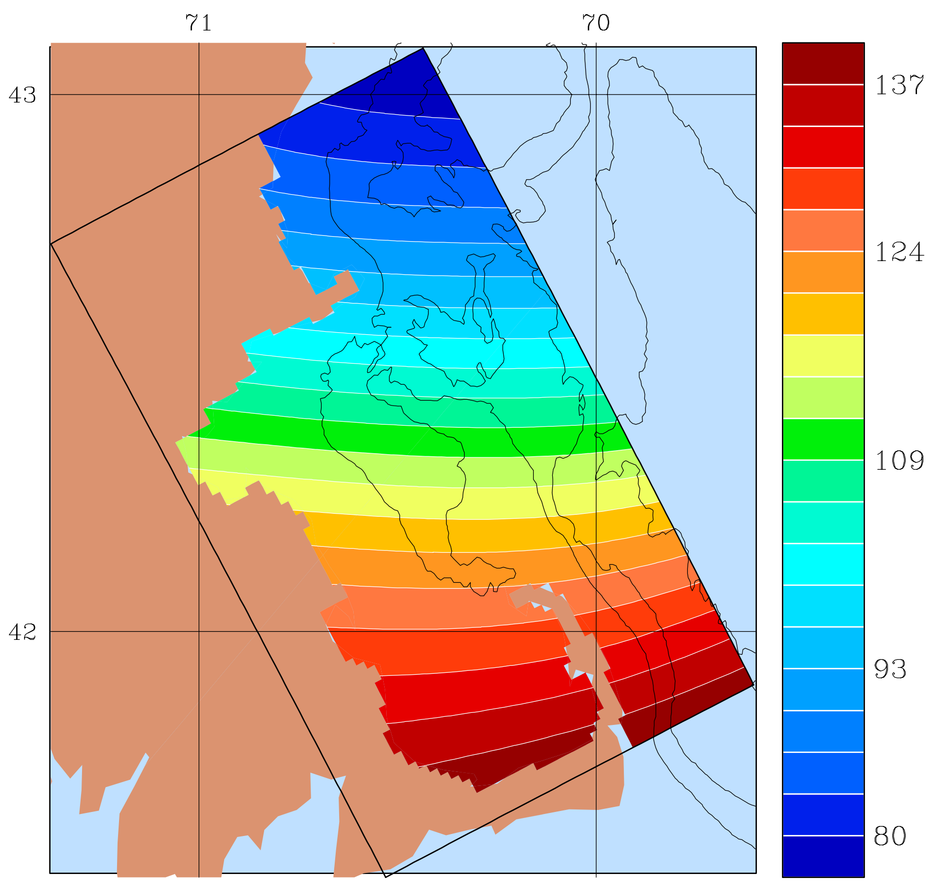
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 7.7109E+01 Max= 1.4012E+02

Nowcast : 21 Jun 2001

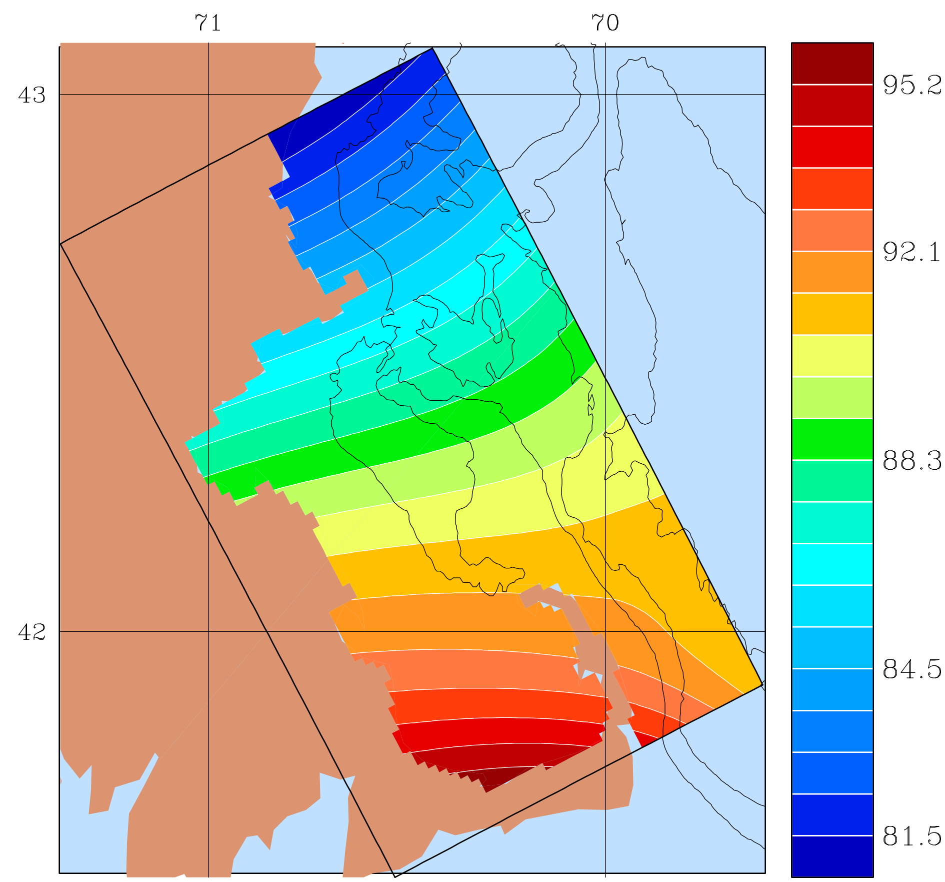
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 22 Jun 2001

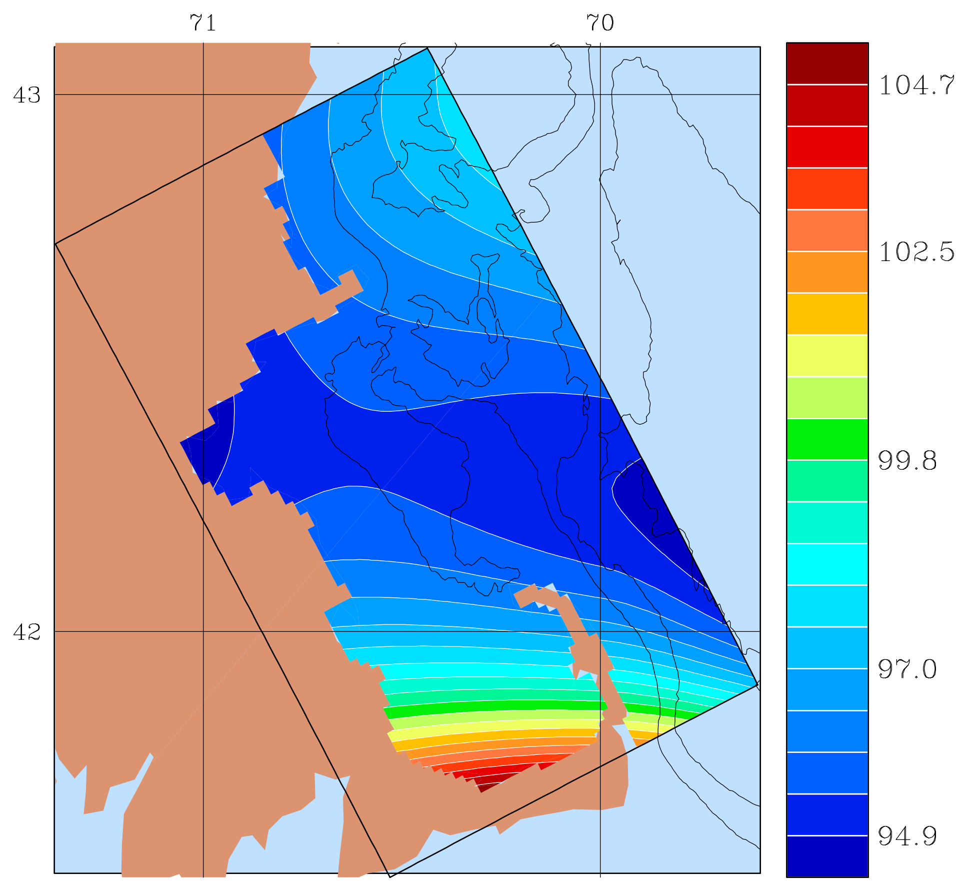
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Nowcast : 23 Jun 2001

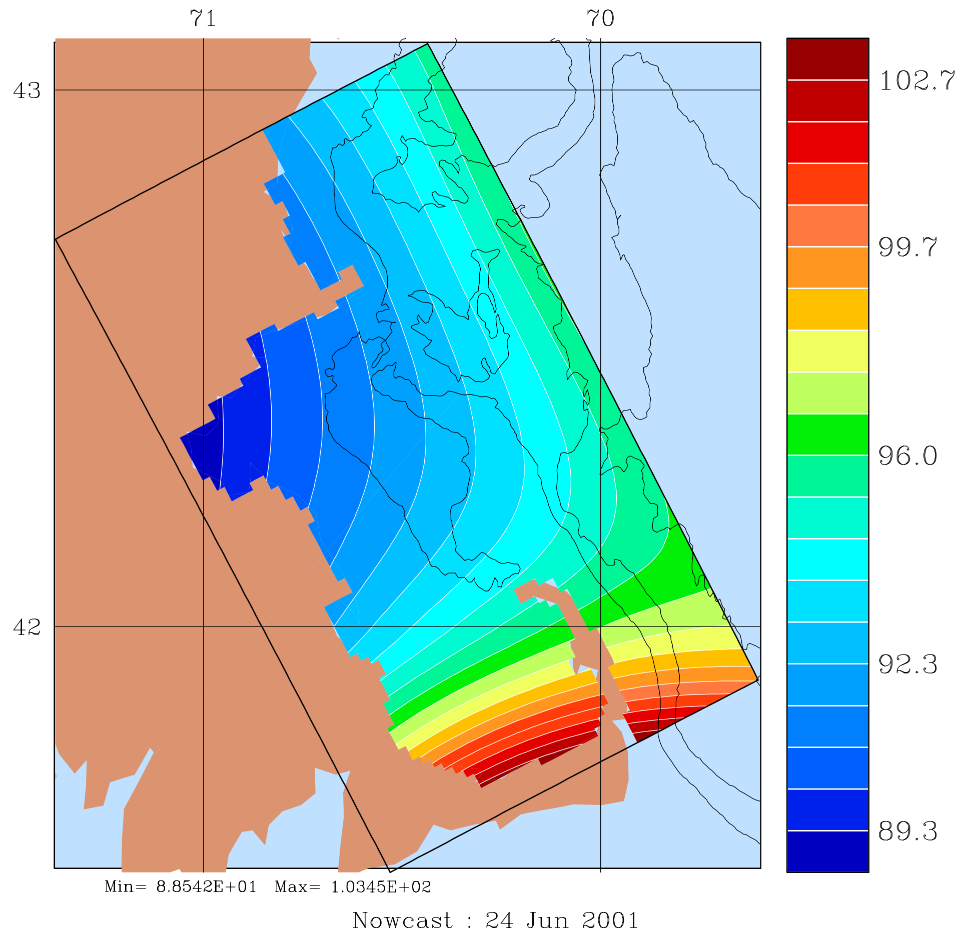
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



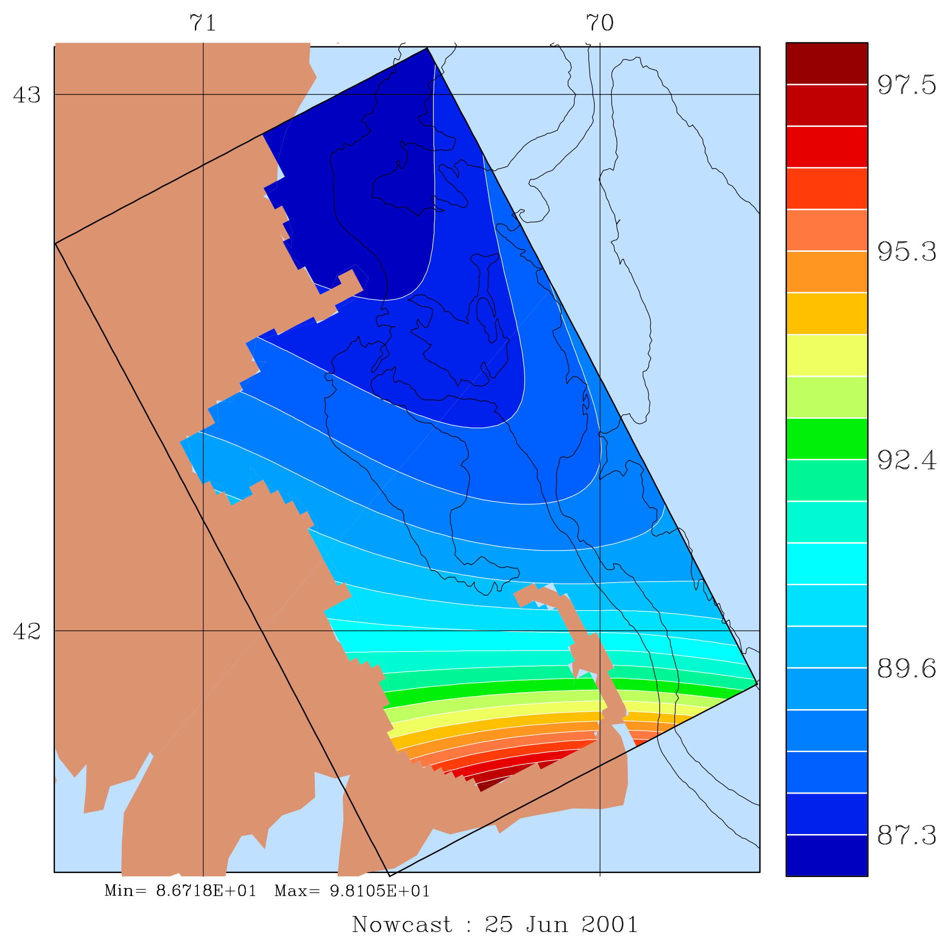
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



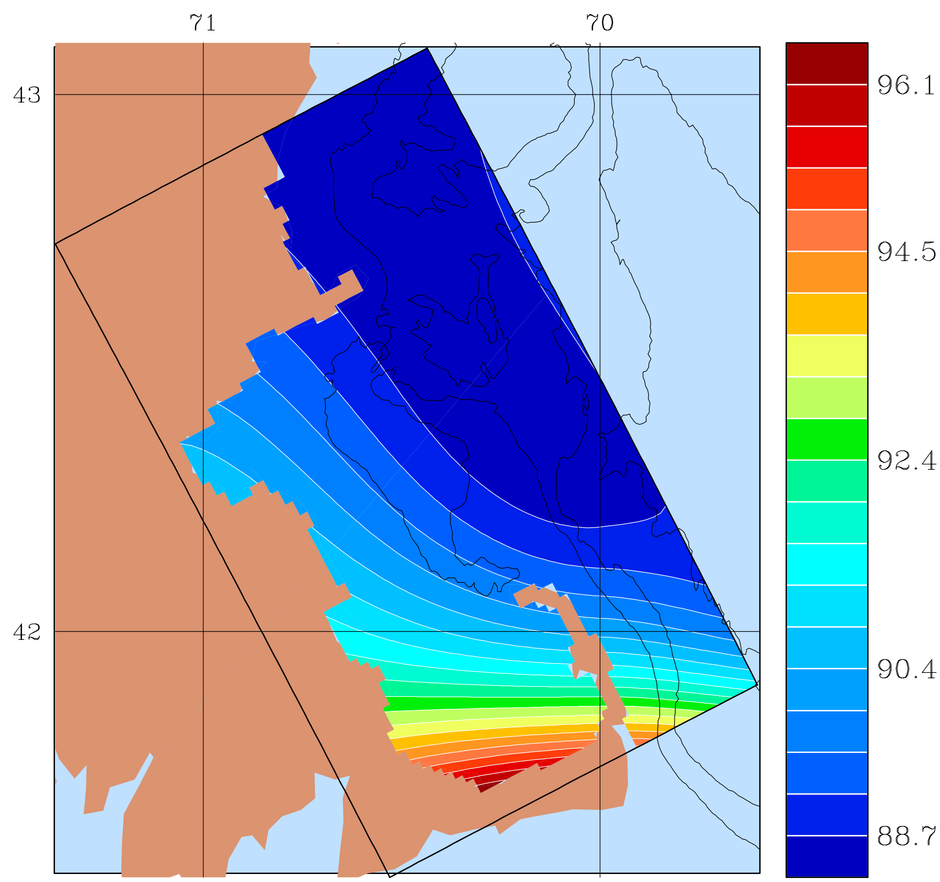
Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Surface Heat Flux



Min= 8.8323E+01 Max= 9.6522E+01

Nowcast : 26 Jun 2001

Tuesday - October 26, 2004 - 10:34:56 am
pe_frc_mbay.nc

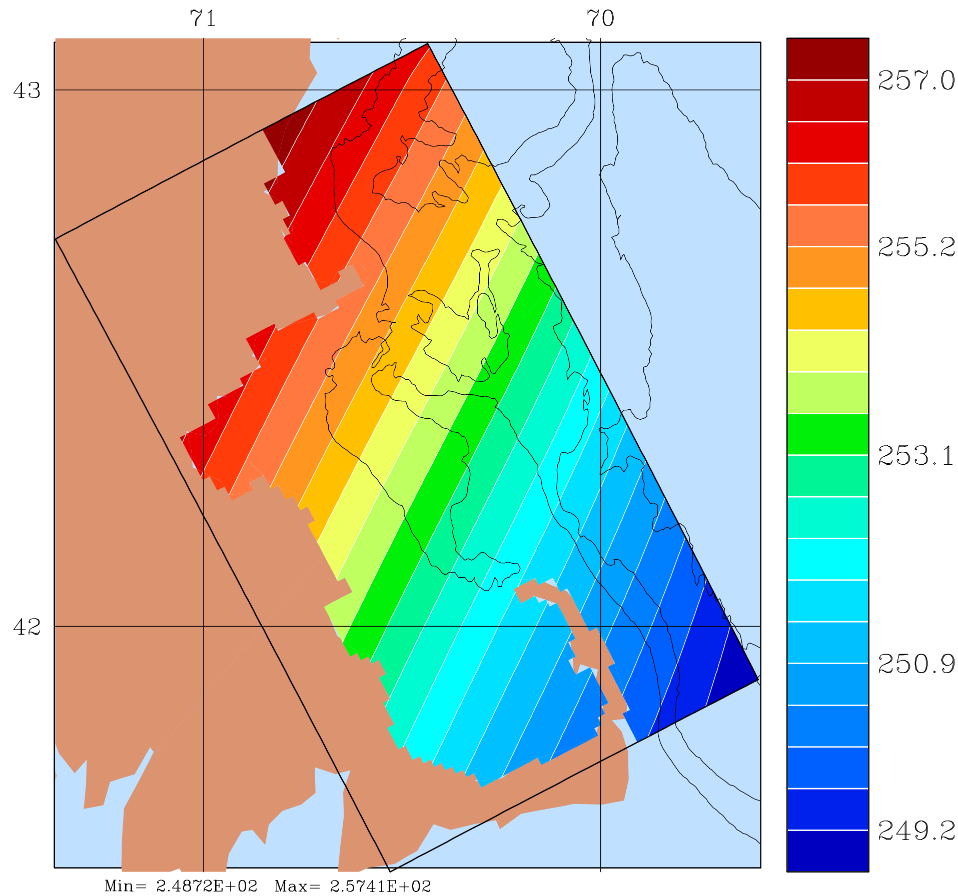
FNMOC Shortwave Radiation

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 6 Jun 2001

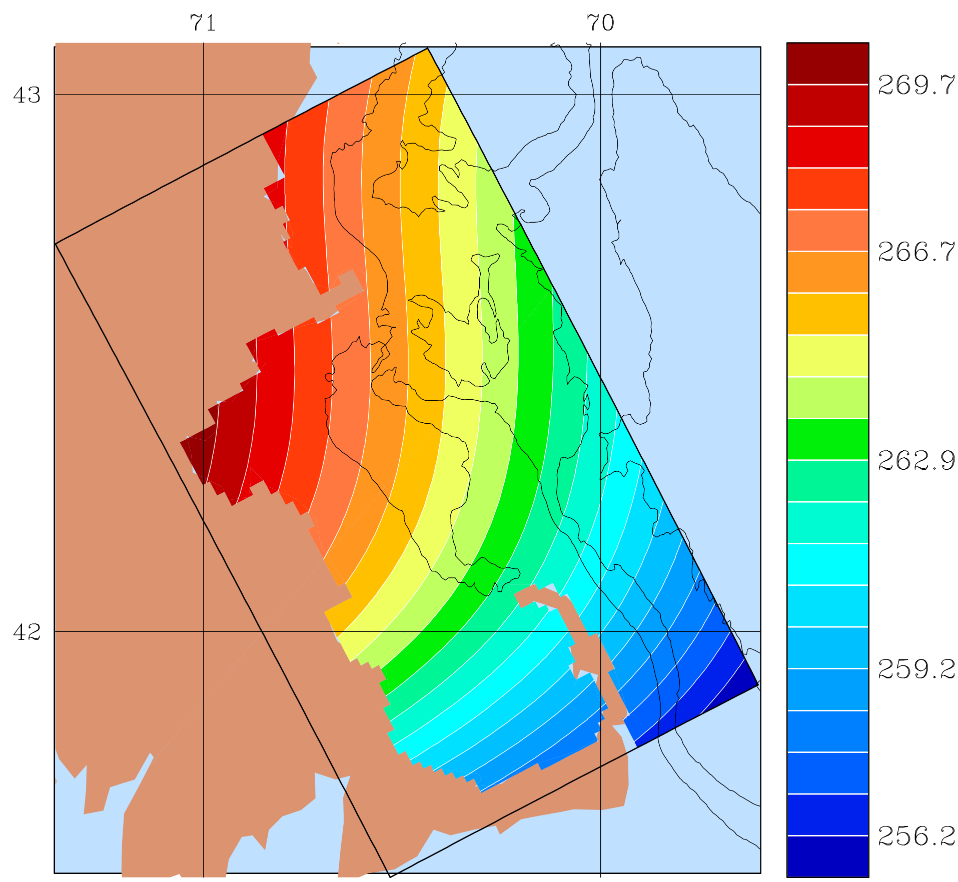
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 2.5548E+02 Max= 2.7040E+02

Nowcast : 7 Jun 2001

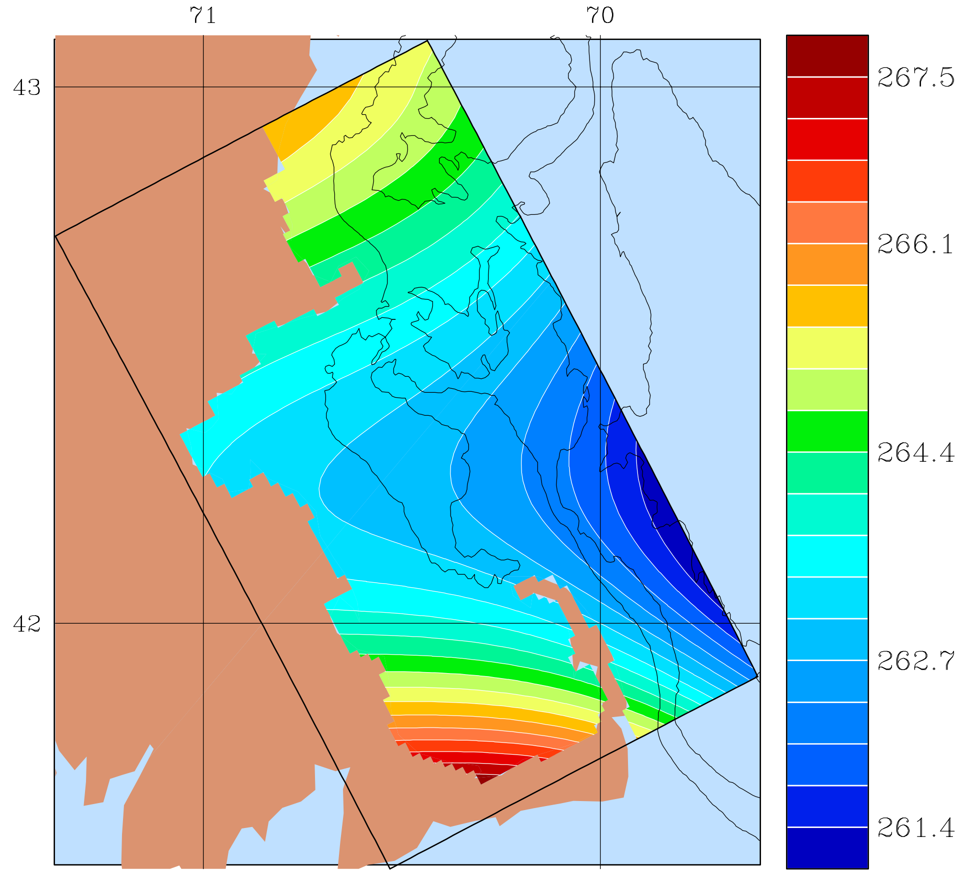
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 8 Jun 2001

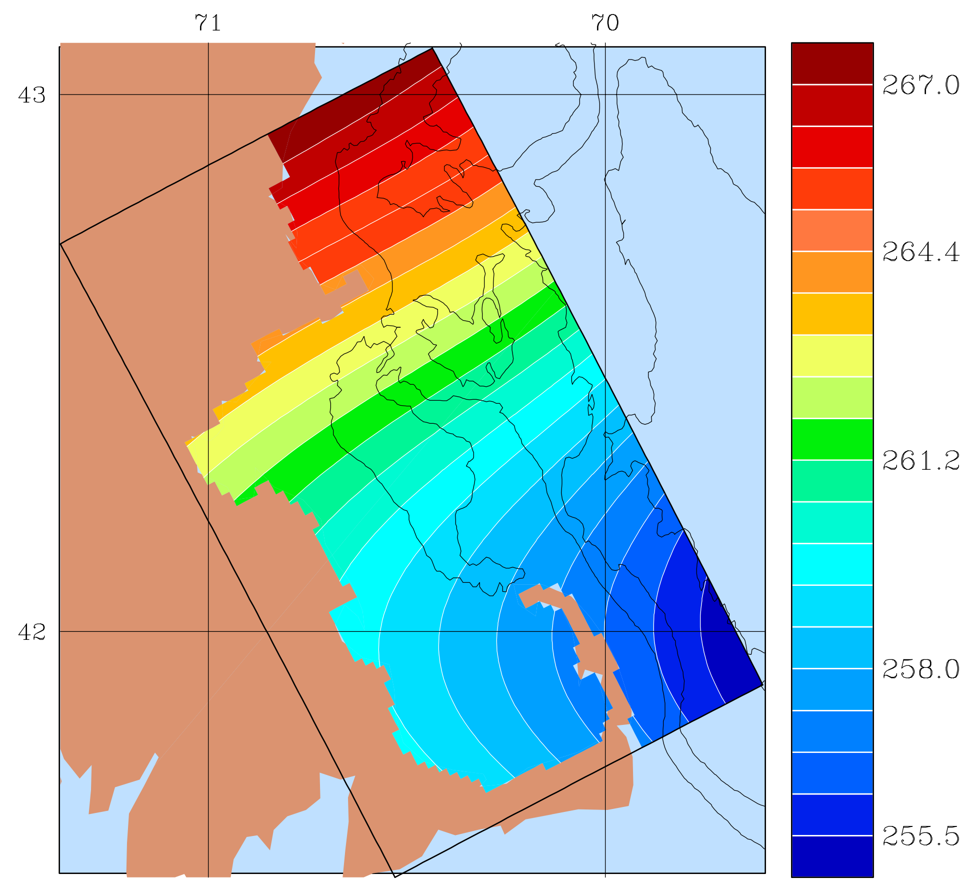
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 9 Jun 2001

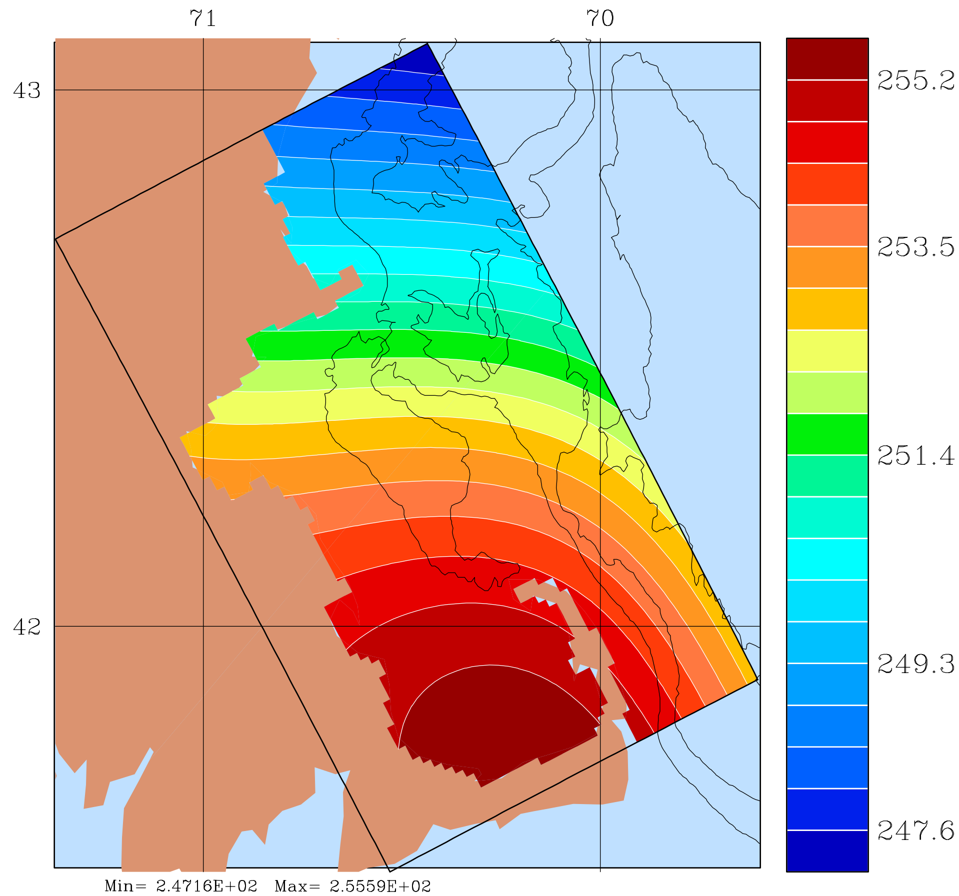
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 10 Jun 2001

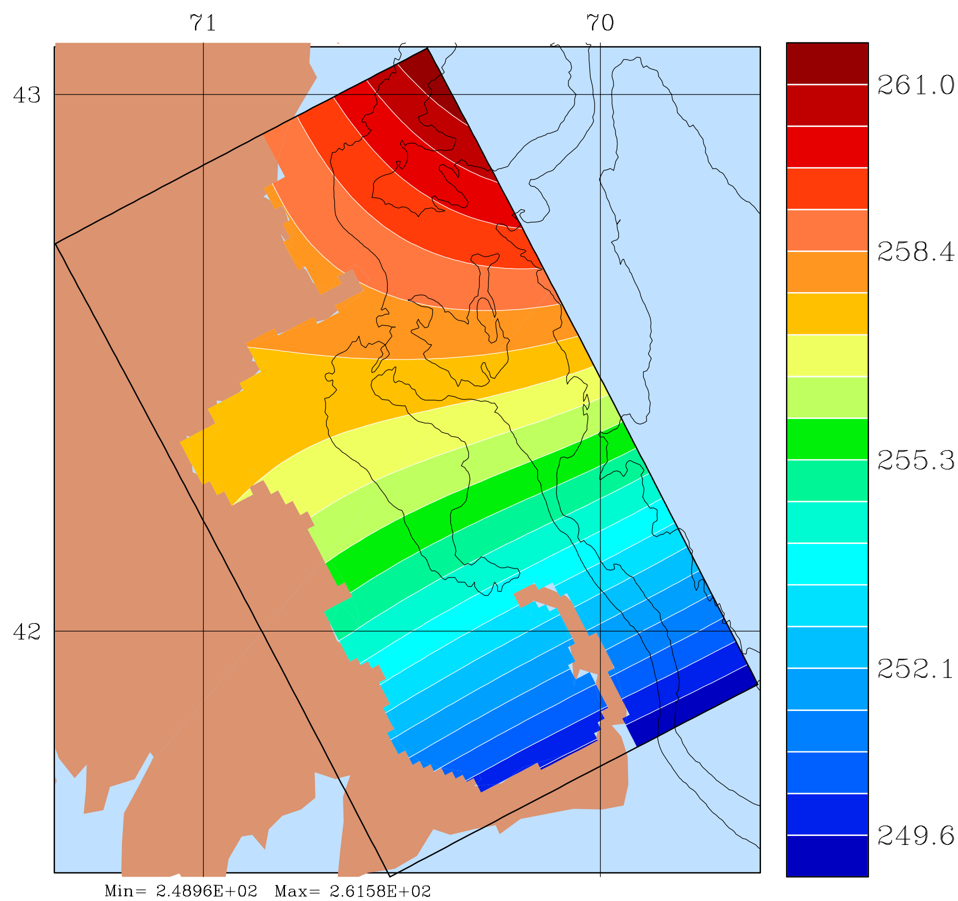
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 11 Jun 2001

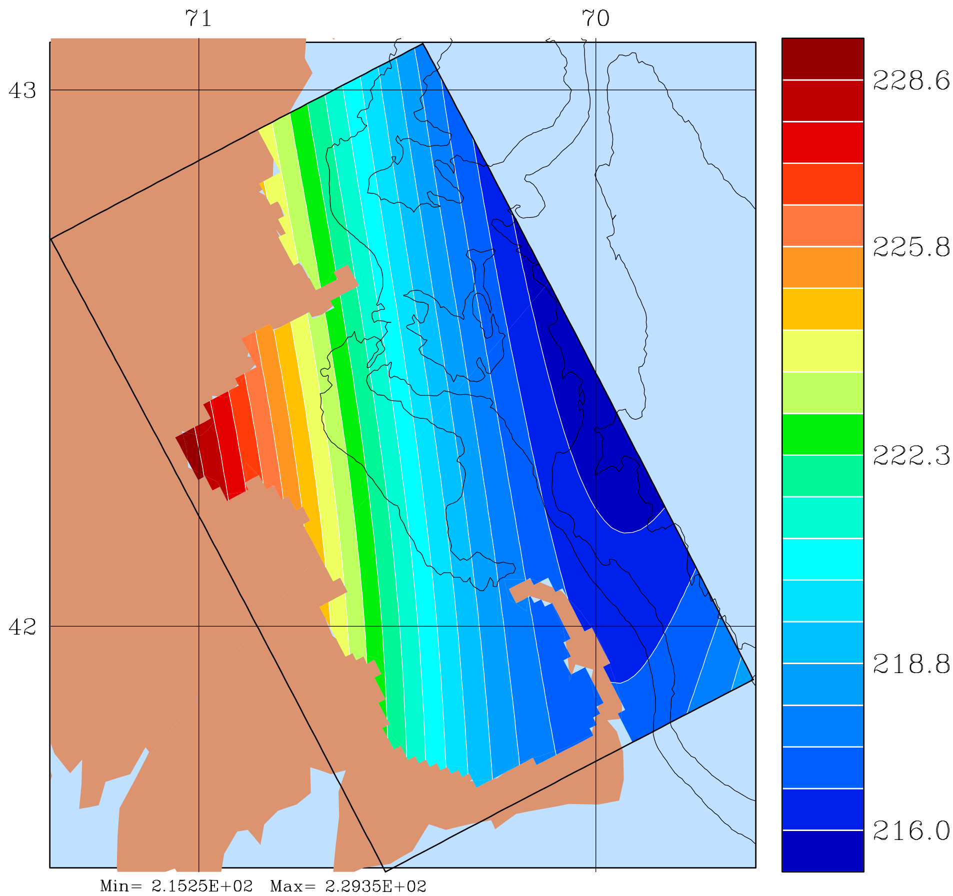
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 12 Jun 2001

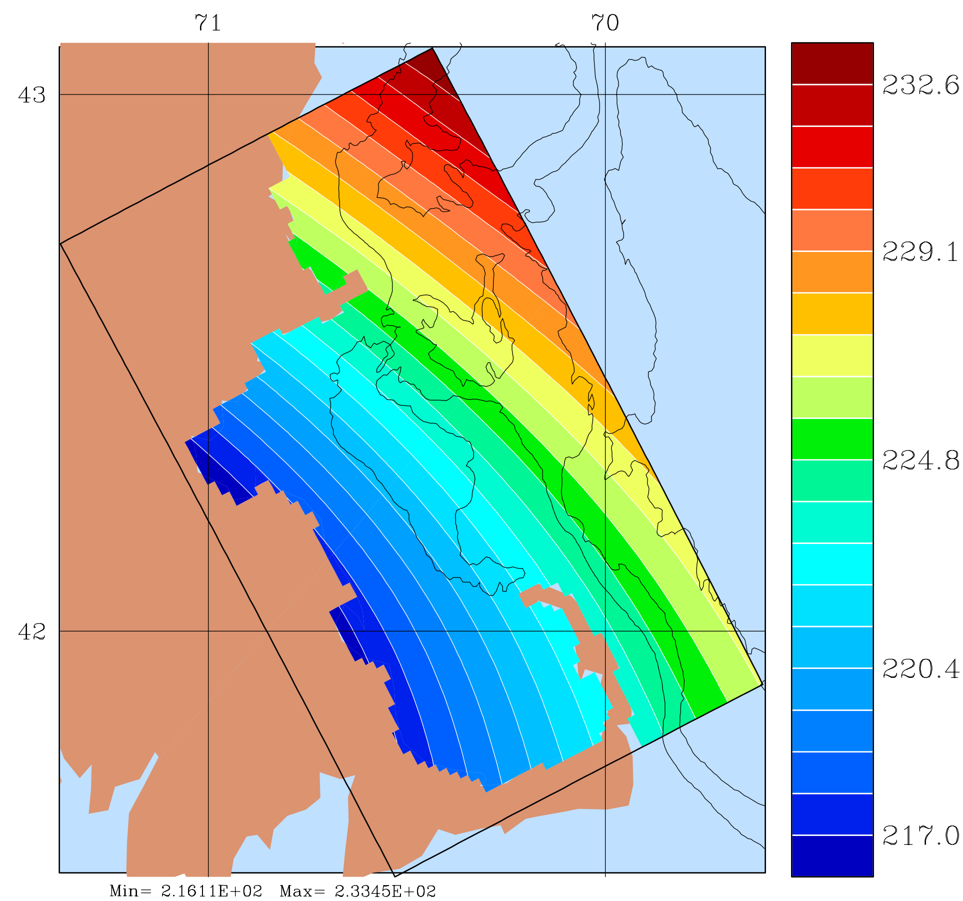
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 13 Jun 2001

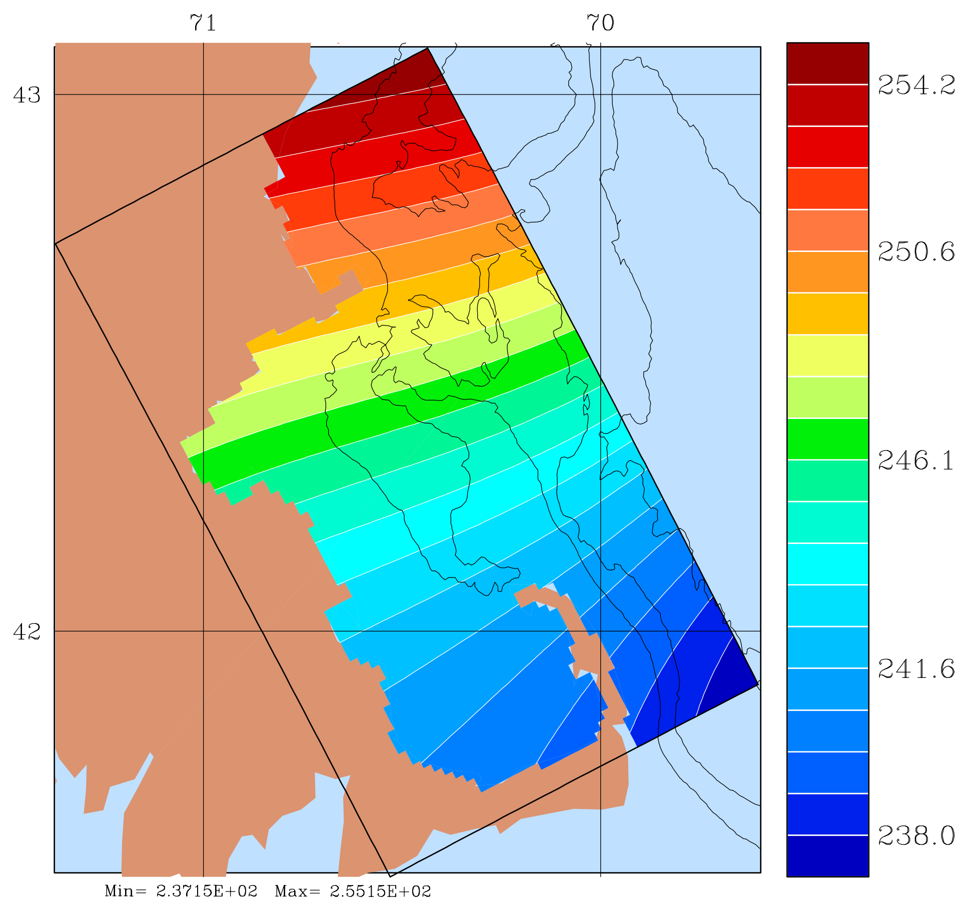
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 14 Jun 2001

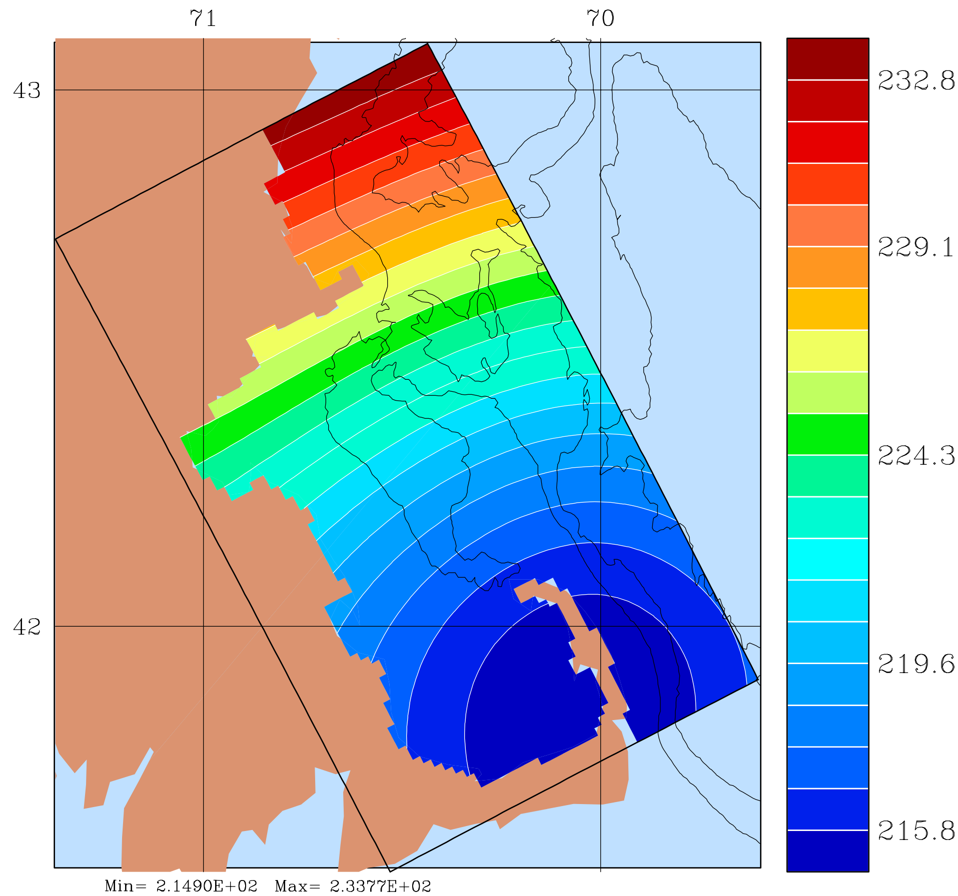
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 15 Jun 2001

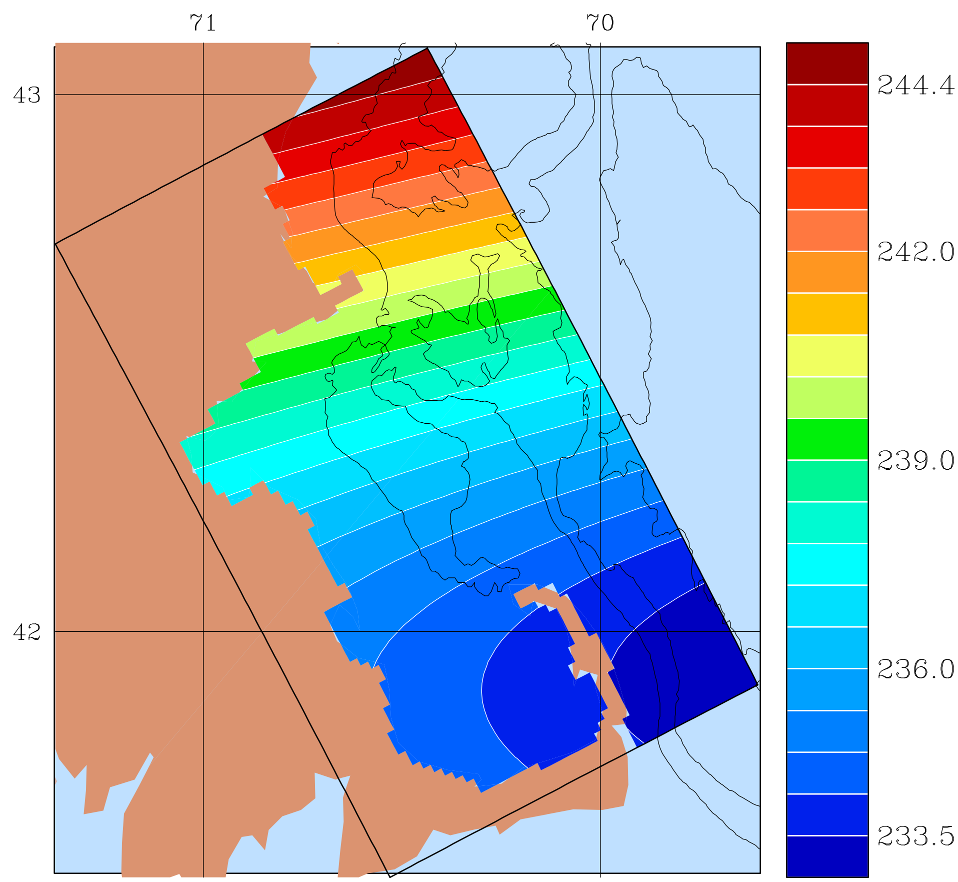
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 2.3294E+02 Max= 2.4502E+02

Nowcast : 16 Jun 2001

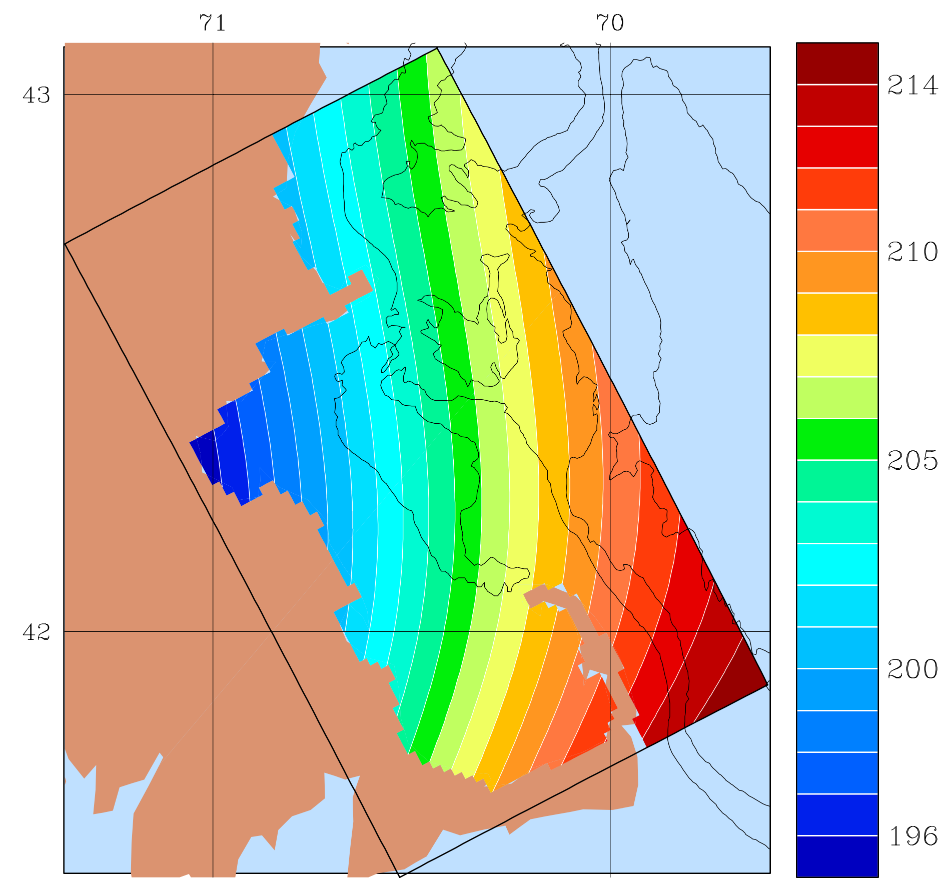
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 1.9467E+02 Max= 2.1544E+02

Nowcast : 17 Jun 2001

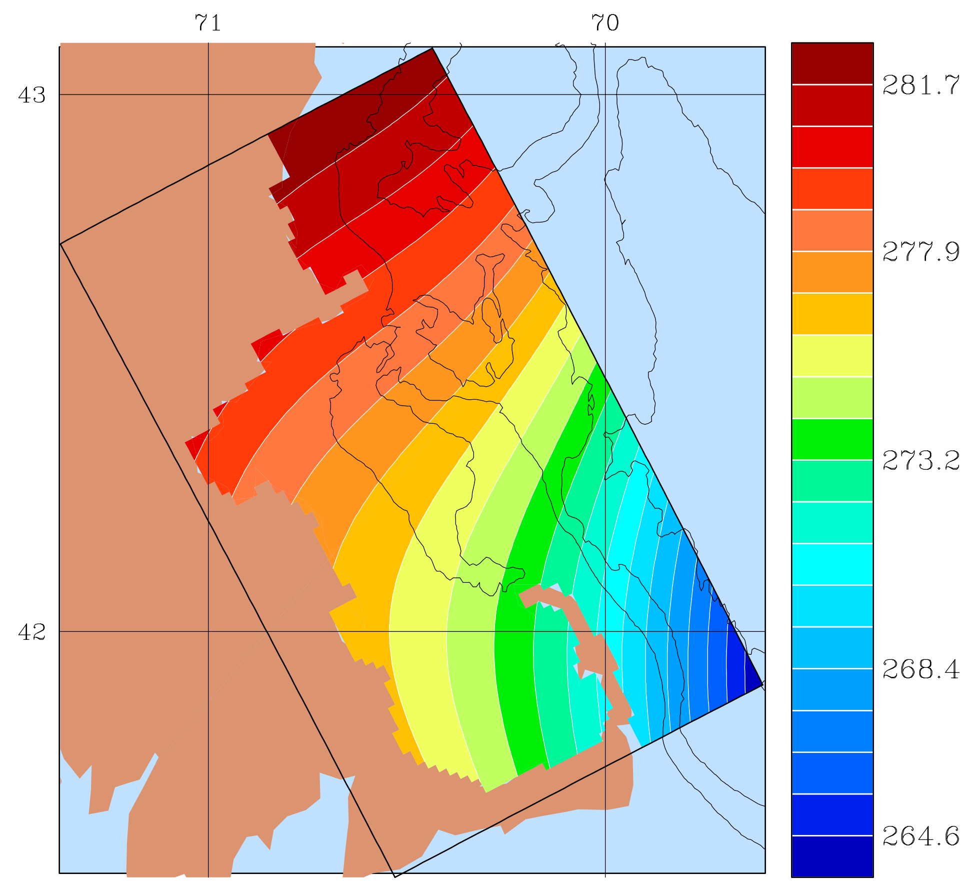
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 18 Jun 2001

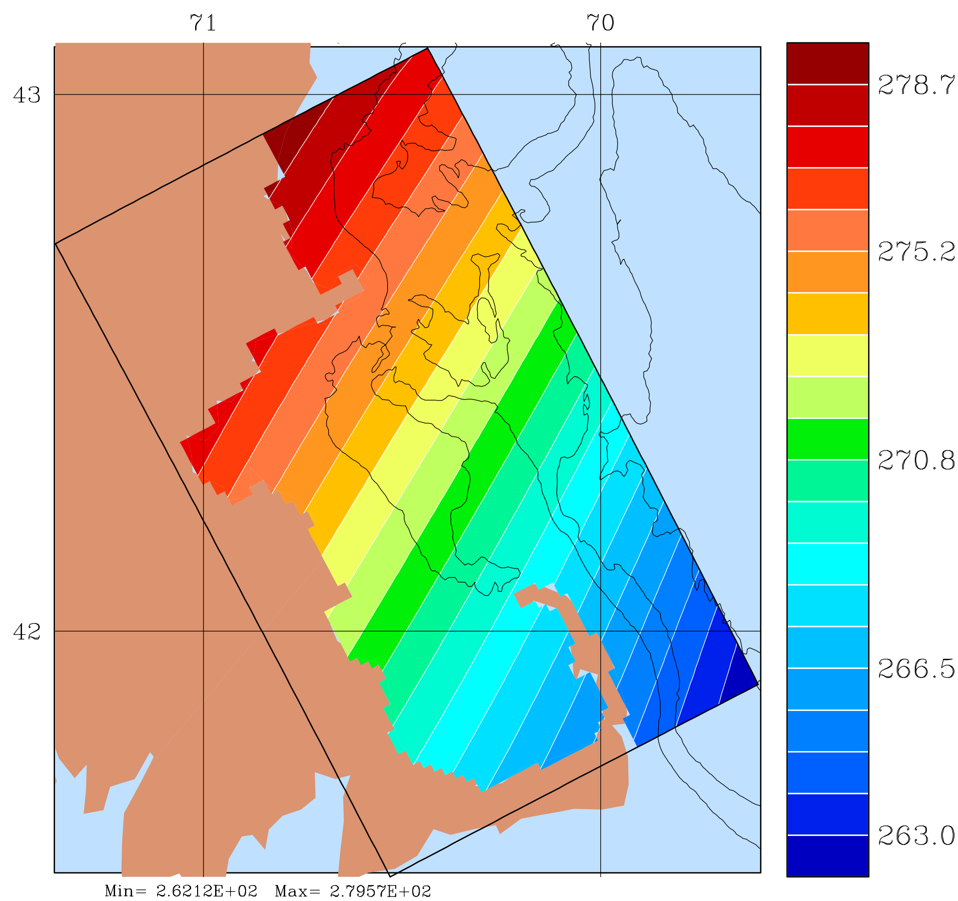
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 19 Jun 2001

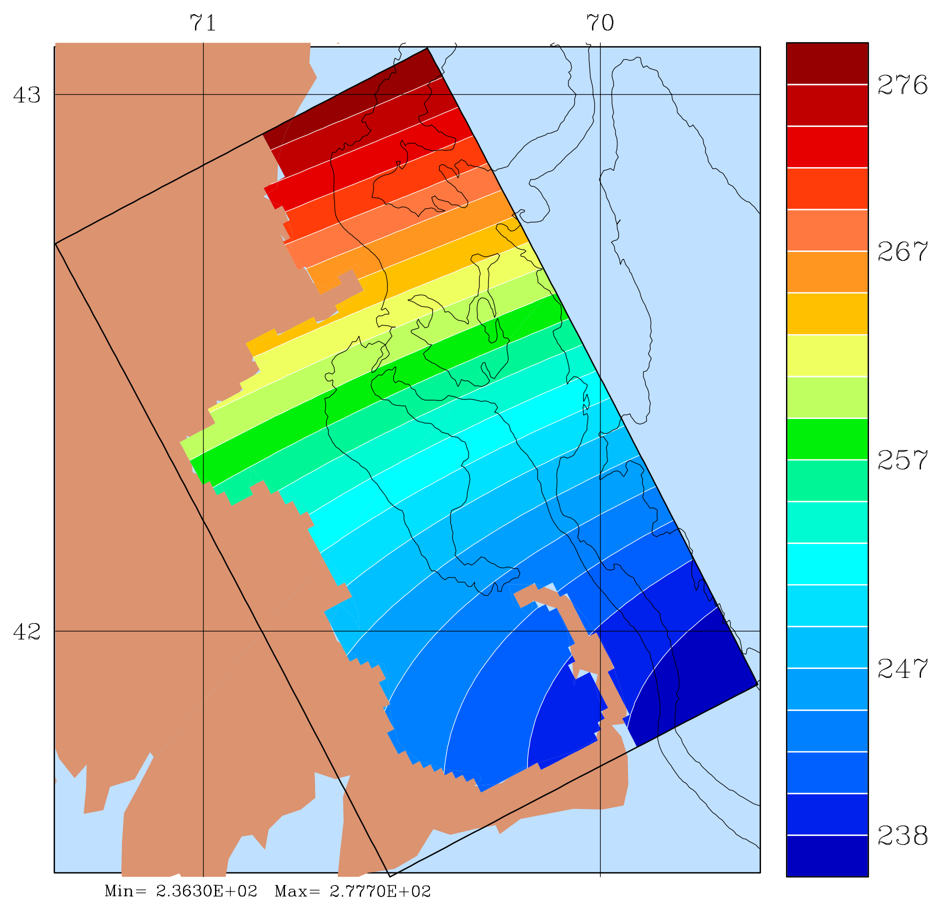
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 20 Jun 2001

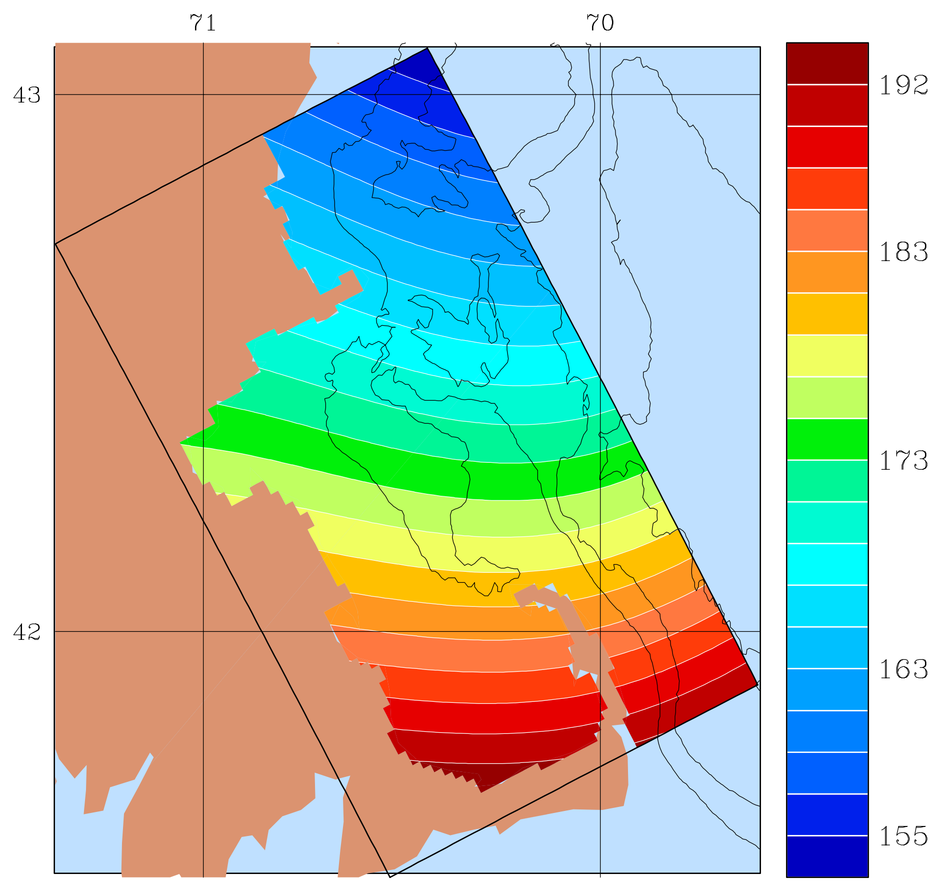
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 1.5281E+02 Max= 1.9356E+02

Nowcast : 21 Jun 2001

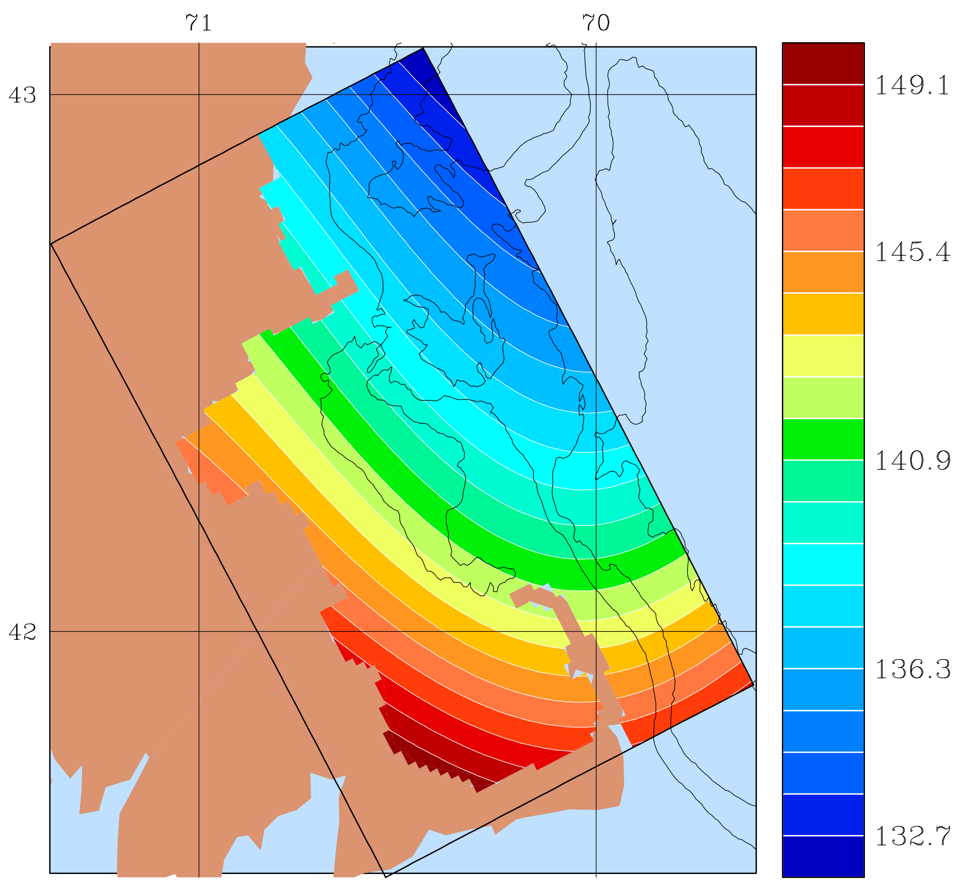
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 1.3178E+02 Max= 1.4998E+02

Nowcast : 22 Jun 2001

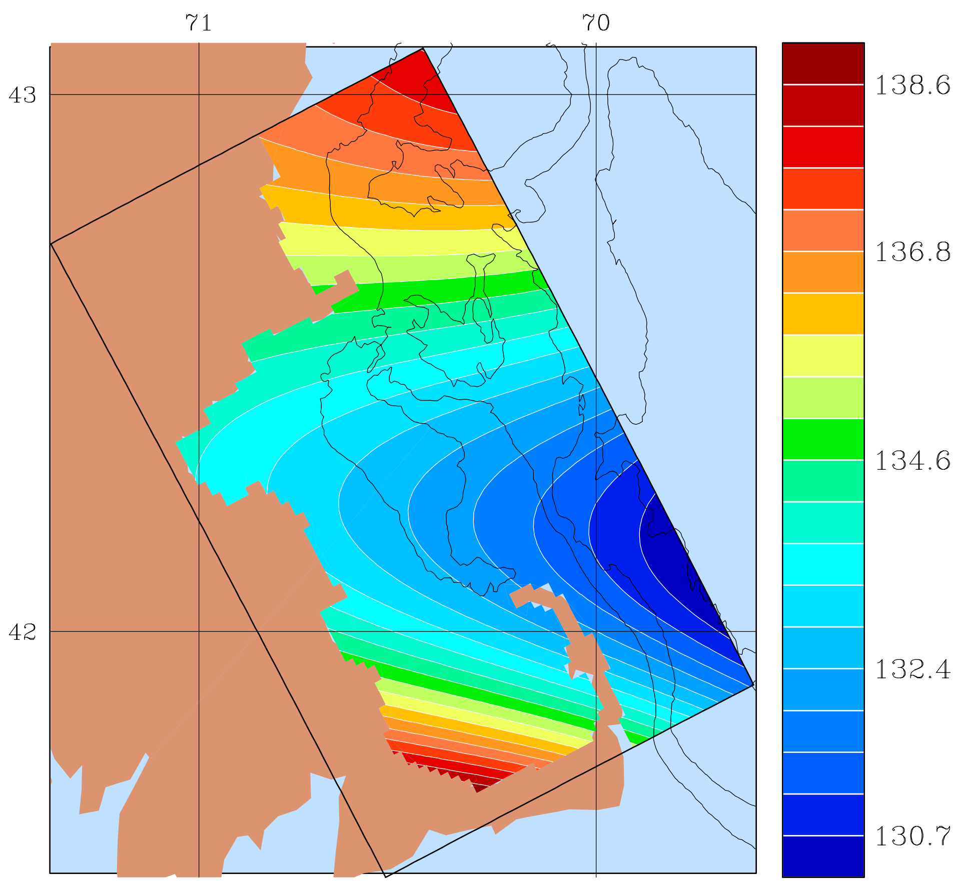
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Min= 1.3022E+02 Max= 1.3905E+02

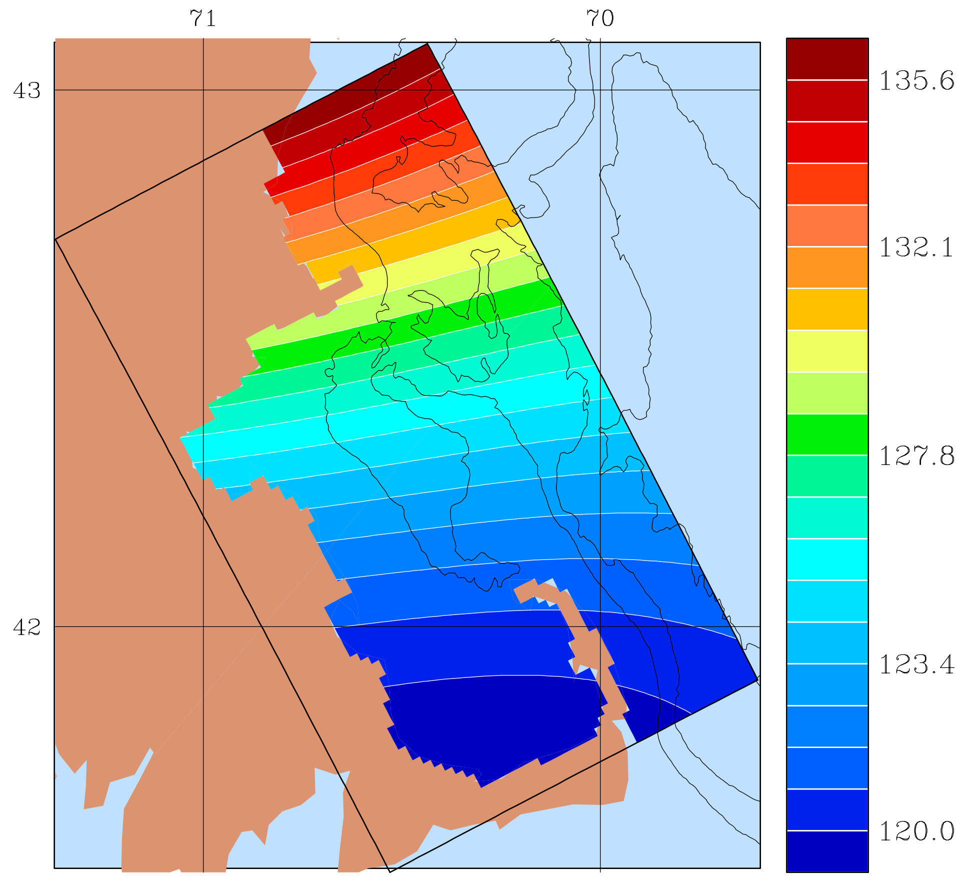
Nowcast : 23 Jun 2001

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 24 Jun 2001

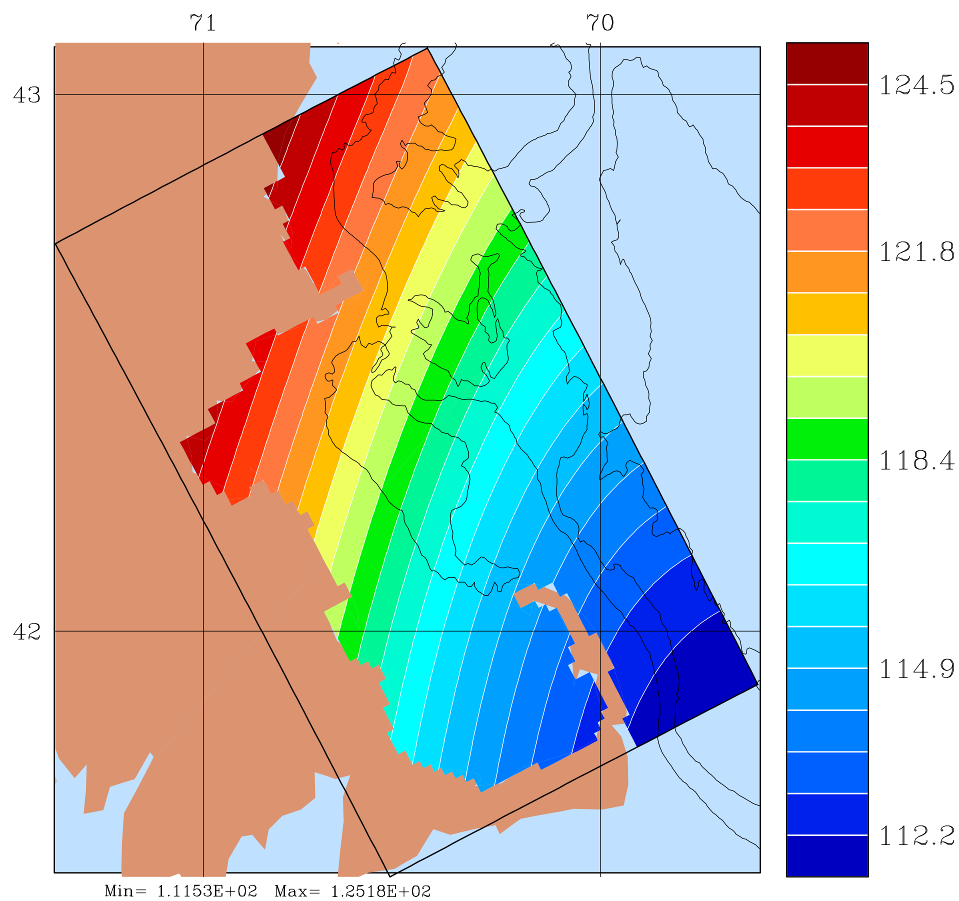
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT−01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 25 Jun 2001

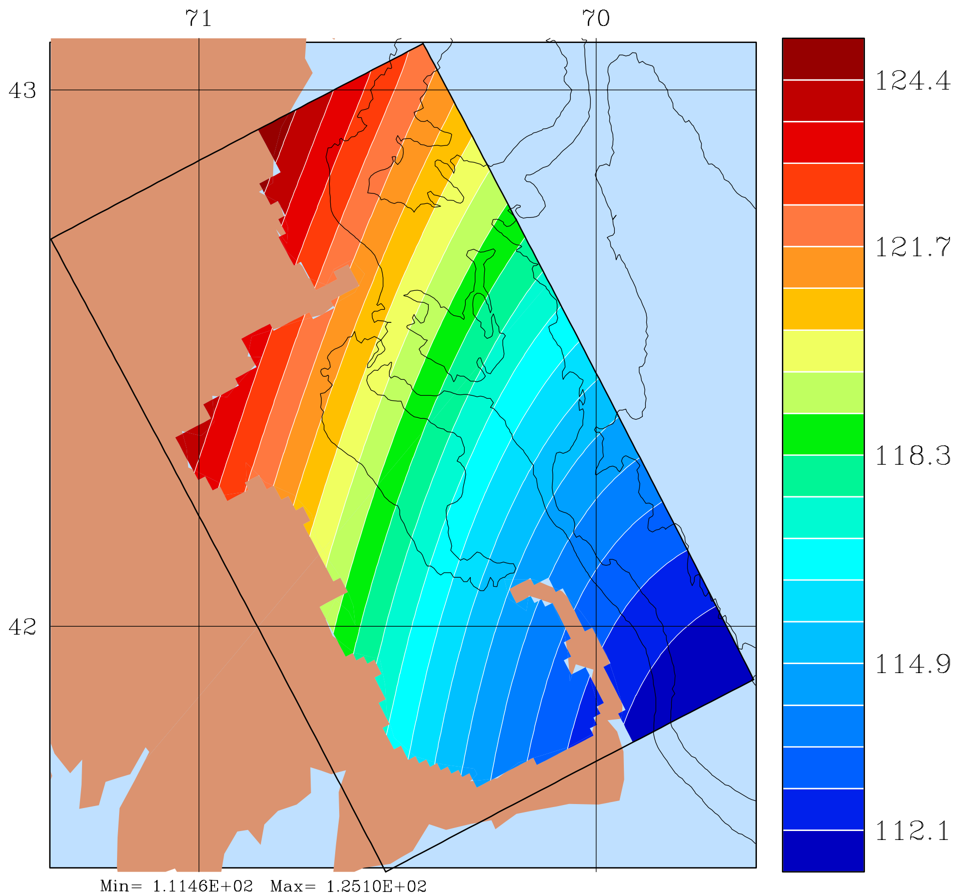
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

ASCOT-01

June 2001 FNMOC: Received June 21

Derived Surface Fluxes

Shortwave Radiation



Nowcast : 26 Jun 2001

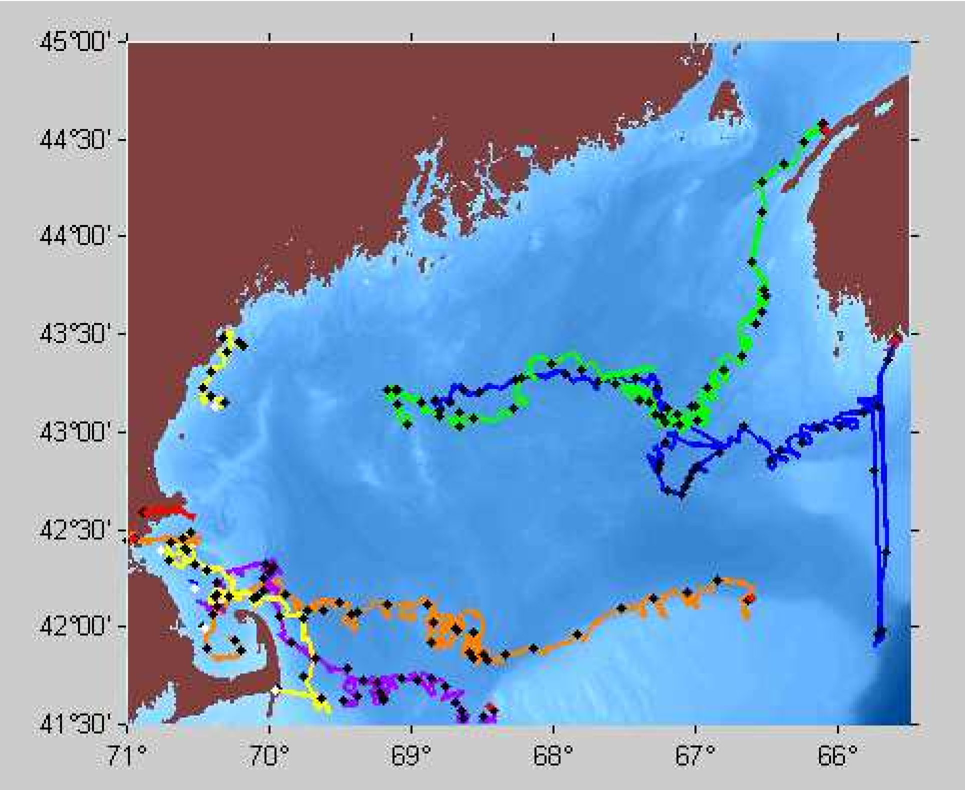
Tuesday - October 26, 2004 - 10:35:41 am
pe_frc_mbay.nc

Surface Drifters

The following pages contain plots of the trajectories of surface drifters released in Gulf of Maine and Massachusetts Bay from the NRV Alliance. The pages are direct printouts of the web pages found on the SACLANTCEN ASCOT-01 CDROM.

ASCOT01

Drifters in the Gulf of Maine



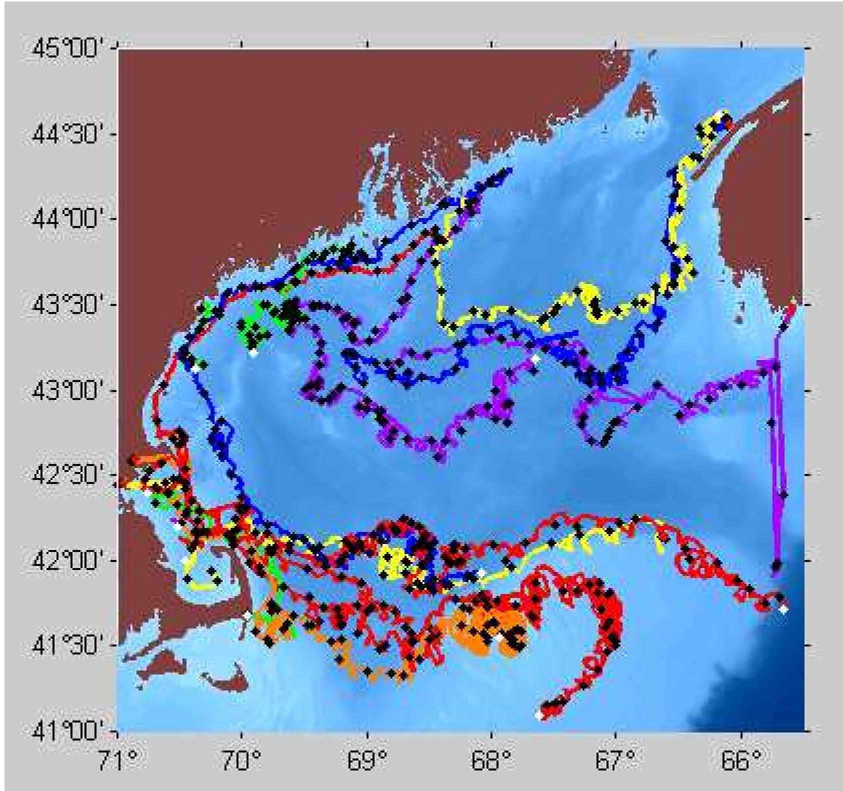
Status in the early morning of 19 July 2001

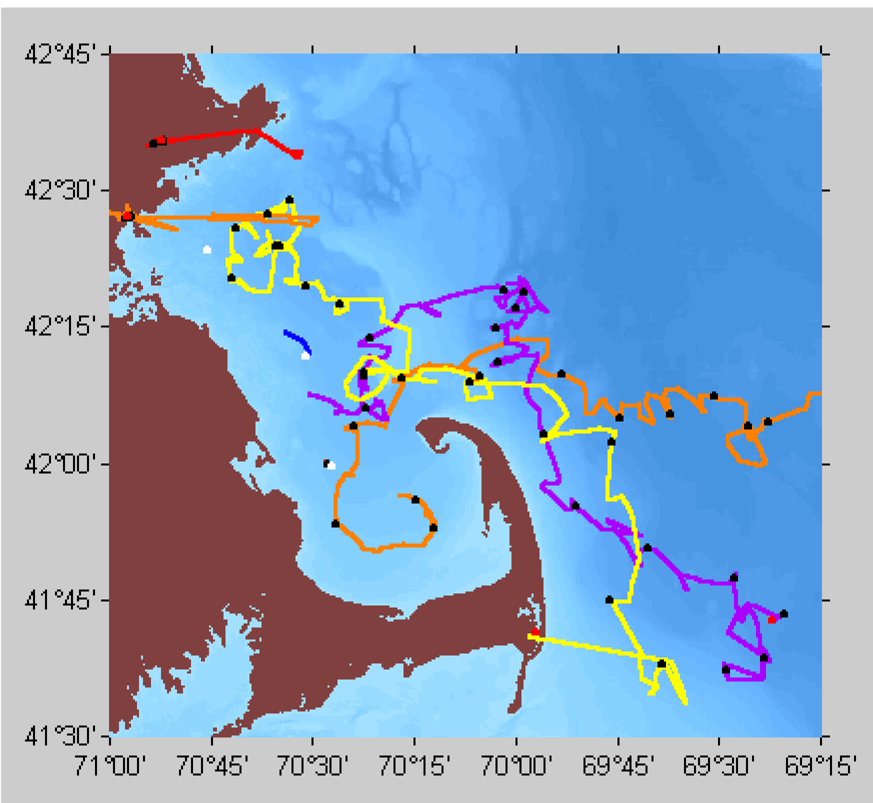
The first surface drifters were released by *NRV Alliance* around midnight (UTC) on 10 June at about 43° N 69° W. One was obviously caught by a slow boat, before it could escape to the deep Atlantic Ocean. The next drifter deployed in the afternoon of 10 June close to 43° 30' N 70° 30' W, ceased transmitting after few days. More drifters were released in Massachusetts Bay (see below). Two of them made it to Georgias Bank, where they go with the anticyclonic current at the bank edge.

Red points at the end of the curves mark the last received location. If however no updates were received during the last 3 days, the head is printed in white. Black markers along drifter tracks denote midnight positions.

Woods Hole Oceanographic Institute had deployed drifters in May. Their tracks are displayed on the right together with those of the SACLANTCEN drifters. The most recent positions are from 15 July, therefore the worm heads are displayed in white.

The two most striking phenomena are the coastal currents, by which drifters are captured for a long time, and the general westward surface drift. Also on Georgias Bank, drifters are pushed into shallow water rathern than left in the main current on the slope.





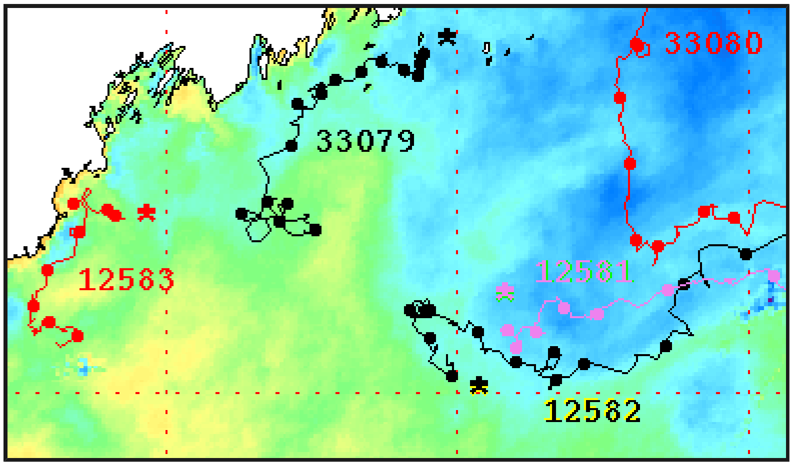
Massachusetts Bay experiment

Eight surface drifters were released by *NRV Alliance* in Massachusetts Bay during the special survey in the night from 19 to 20 June. Three of them have died after less than one day and two were brought ashore almost immediately, so that only three drifters were left over. One was captured in the anticyclonic eddy in the northern Massachusetts Bay for a week, before it went towards Cape Cod and followed the other, who escaped towards SE, until on 4 July it was also caught by a boat and brought ashore.

In this image, red dots (snake heads) indicate the positions on 5 July, while black dots are midnight positions.

Gulf of Maine Drifters with Merged SST Imagery

Drifter tracks through June 24 were overlain on SST imagery from June 20-22 to the relationship

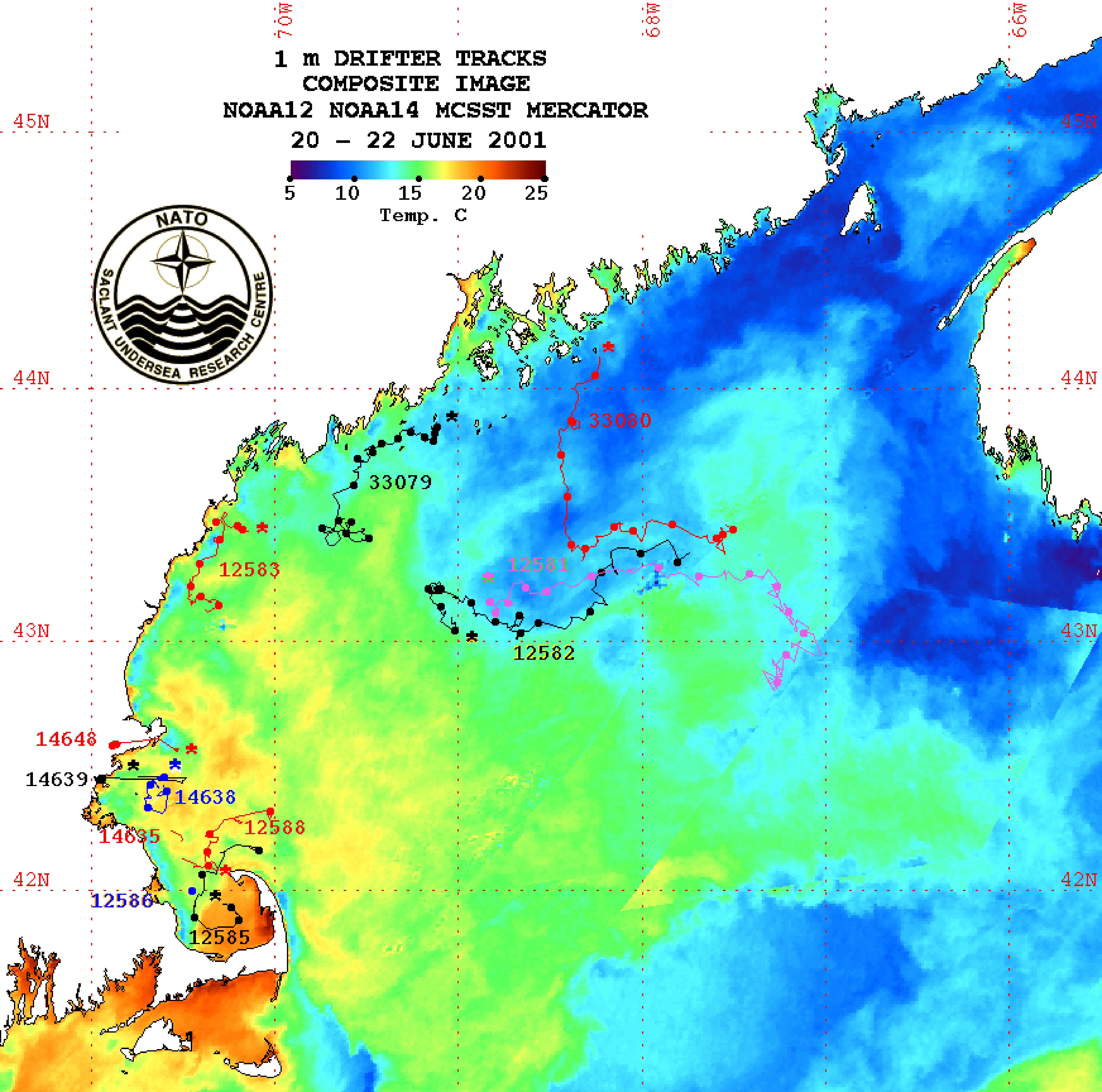


Click here or above for full image!

between these 1 m surface drifters and sea surface temperature features. The dominant SST features of the Gulf are evident: cold water exists over Georges Bank, east of Cape Cod, west of Nova Scotia and in the Bay of Fundy due to strong tidal mixing. Cold water moves southwestward from the entrance to the Bay of Fundy, forming the Eastern Maine Coastal Current, and then branches offshore east of Penobscot Bay.

Most of this image is from June 20, except for small region west of Nova Scotia that was obscured by clouds and replaced by images from June 21 and June 22. Crosses indicate release locations, and dots indicate noon locations.

Last Update: 19 Jul 2001, 13:43



1 m DRIFTER TRACKS
COMPOSITE IMAGE
NOAA12 NOAA14 MCSST MERCATOR
20 – 22 JUNE 2001
5
10
15
20
25
Temp. C
NATO
SACLANT UNDERSEA RESEARCH CENTRE
70W
68W
66W
45N
44N
43N
42N
33080
33079
12583
12581
12582
14648
14639
14638
12588
14635
12586
12585

Remotely Sensed Data

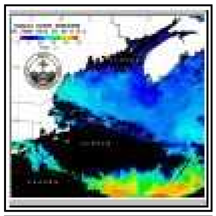
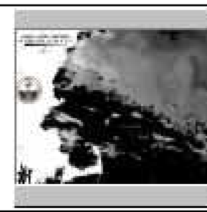
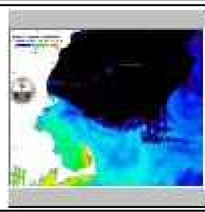
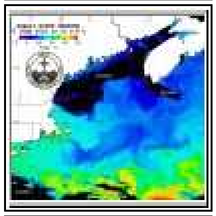
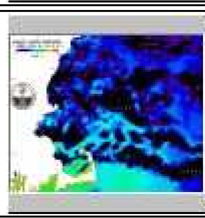
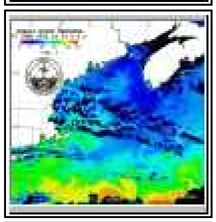
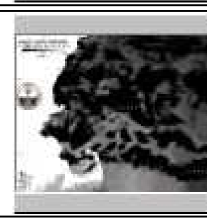
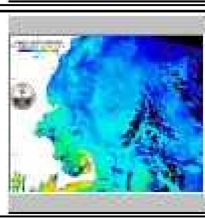
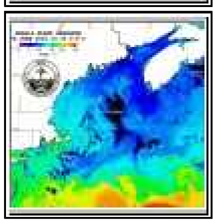
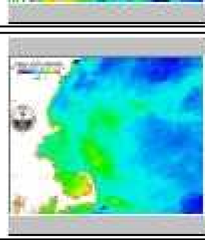
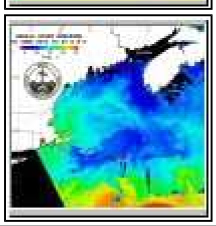
During the ASCOT-01 exercise, SACLANTCEN collected a number of images of sea surface temperature, chlorophyll-a, and transparency. These were measured by NOAA-12 and NOAA-14 (for SST) and SeaWiFS (for chlorophyll and transparency) satellites. The following pages are printed directly from the SACLANTCEN ASCOT-01 CDROM and provide thumbnail or small versions of the images that are available on the CDROM. In all cases, the images are available in both color and gray-scale versions.

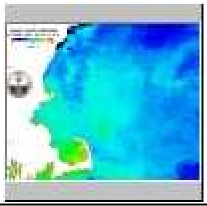
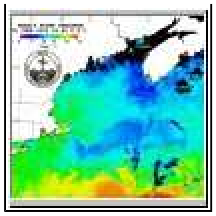
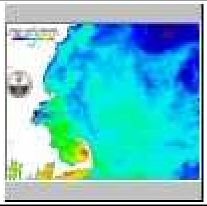
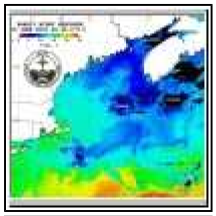
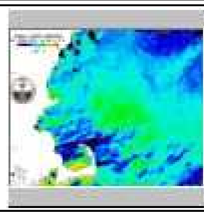
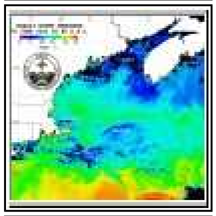
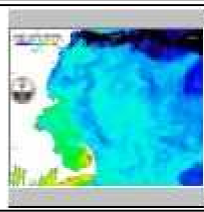
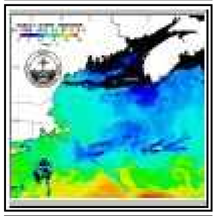
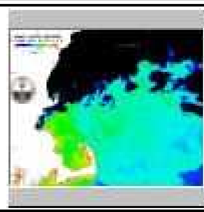
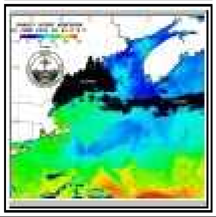
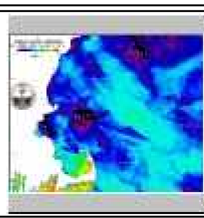
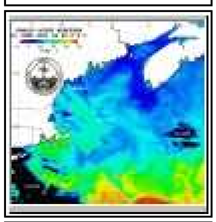
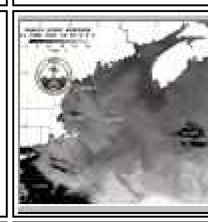
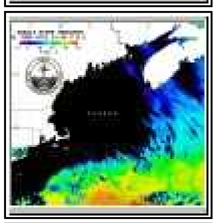
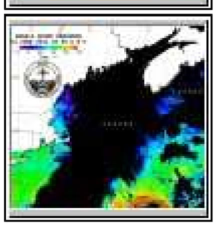
ASCOT01

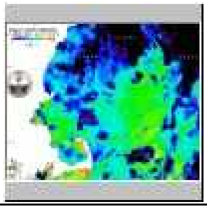
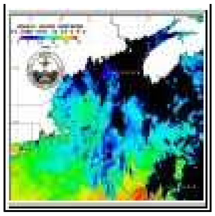
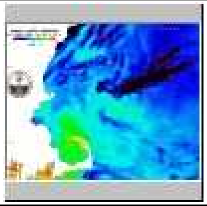
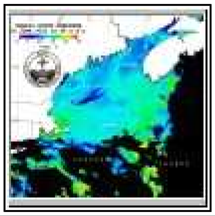
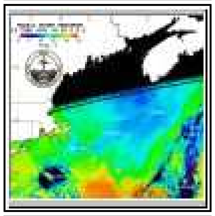
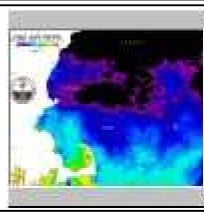
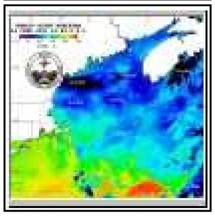
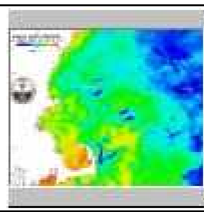
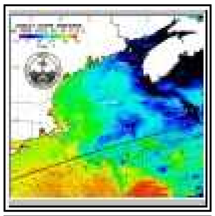
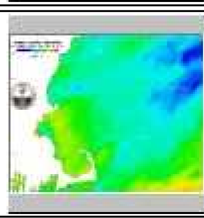
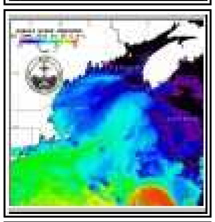
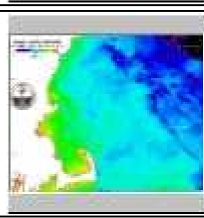
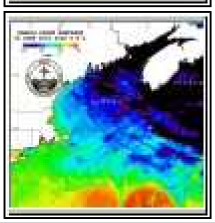
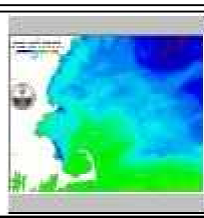
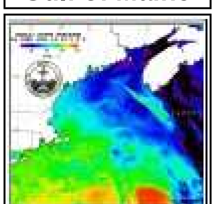
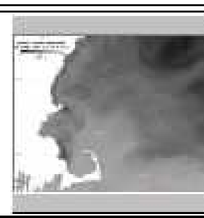
AVHRR

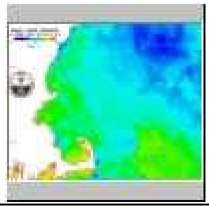
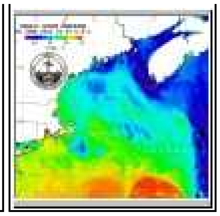
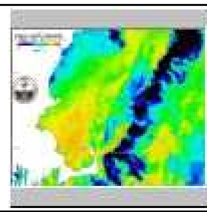
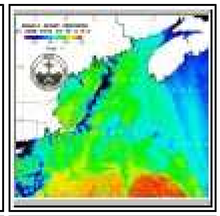
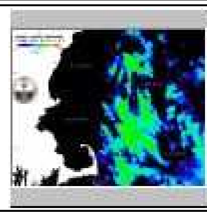
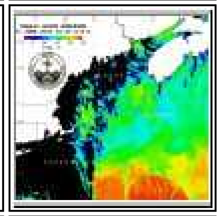
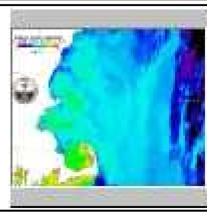
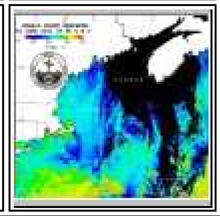
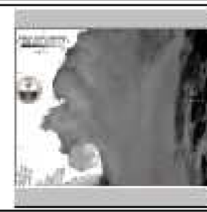
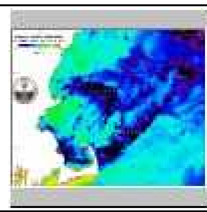
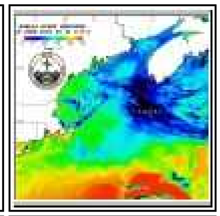
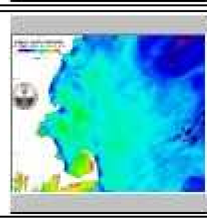
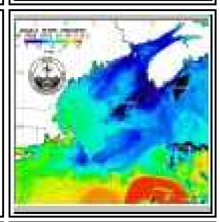
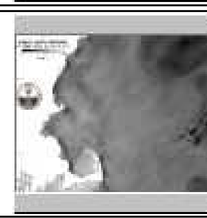
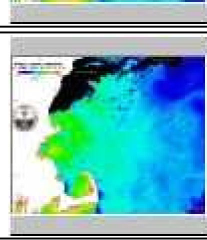
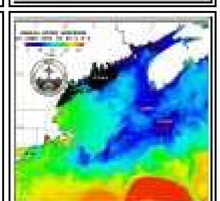
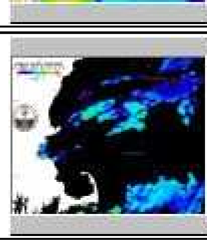
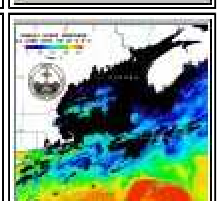
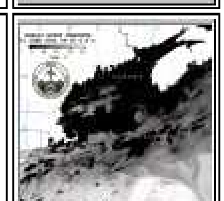
HOME DATA CHLOROPHYLLE TRANSPARENCY

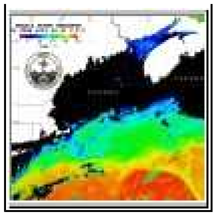
The folder AVHRR contains satellite sea surface temperature images in graphics interchange format (gif). Measurement platforms are NOAA12 and NOAA14 satellites. Temperatures are corrected by standard formulae using multiple channel information. Whenever there were areas of cloud free sea surface, images were processed and stored in separate subdirectories for colored and grey-scale images. With a click on a thumbnail image in the table below, a full size image will be displayed.

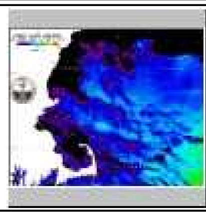
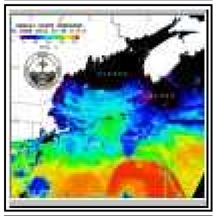
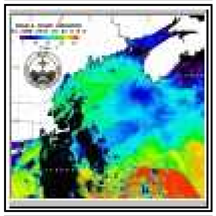
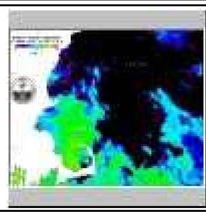
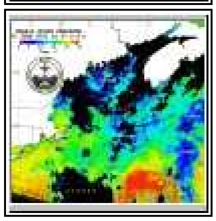
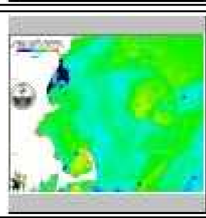
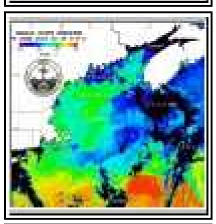
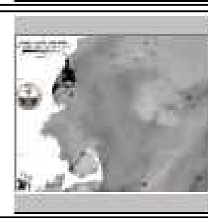
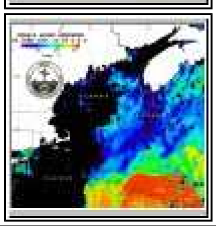
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA14	06-Jun	20:26				
NOAA12	07-Jun	10:11				
NOAA12	07-Jun	21:33				
NOAA14	08-Jun	10:16				
NOAA14	08-Jun	20:03				
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA14	08-Jun	21:43				

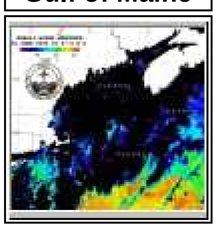
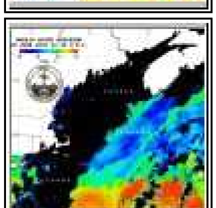
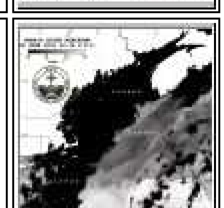
						
NOAA12	09-Jun	09:25				
NOAA12	09-Jun	20:46				
NOAA12	10-Jun	10:41				
NOAA12	10-Jun	20:23				
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA14	11-Jun	09:40				
NOAA14	11-Jun	21:07				
NOAA12	12-Jun	09:54				
NOAA12	12-Jun	21:17				

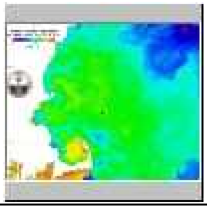
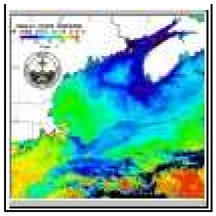
						
NOAA14	13-Jun	10:57				
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA14	13-Jun	20:52				
NOAA14	14-Jun	10:44				
NOAA14	14-Jun	20:25				
NOAA14	15-Jun	10:26				
NOAA14	15-Jun	20:18				
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA12	16-Jun	10:02				

NOAA12	16-Jun	21:24				
NOAA12	17-Jun	09:39				
NOAA12	17-Jun	21:00				
NOAA14	18-Jun	09:56				
Satellite	Date	Time	**Massachusetts Bay**	**Gulf of Maine**	**Massachusetts Bay**	**Gulf of Maine**
NOAA14	19-Jun	10:49				
NOAA12	20-Jun	10:08				
NOAA14	20-Jun	21:00				
NOAA14	21-Jun	09:20				
NOAA14	21-Jun	20:48				

Satellite	Date	Time	Massachusetts Bay	Gulf of Maine	Massachusetts Bay	Gulf of Maine
NOAA14	22-Jun	10:49				
NOAA12	22-Jun	20:44				
NOAA14	23-Jun	10:38				
NOAA14	23-Jun	20:24				
NOAA14	24-Jun	10:26				

Satellite	Date	Time	Massachusetts Bay	Gulf of Maine	Massachusetts Bay	Gulf of Maine
NOAA14	24-Jun	21:38				
NOAA14	25-Jun	10:15				

NOAA14	26-Jun	10:02				

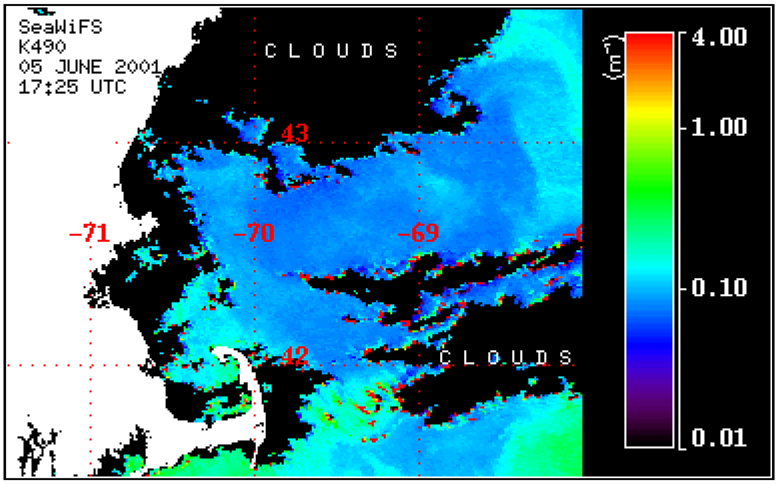
Last Update: 19 Jul 2001, 10:44

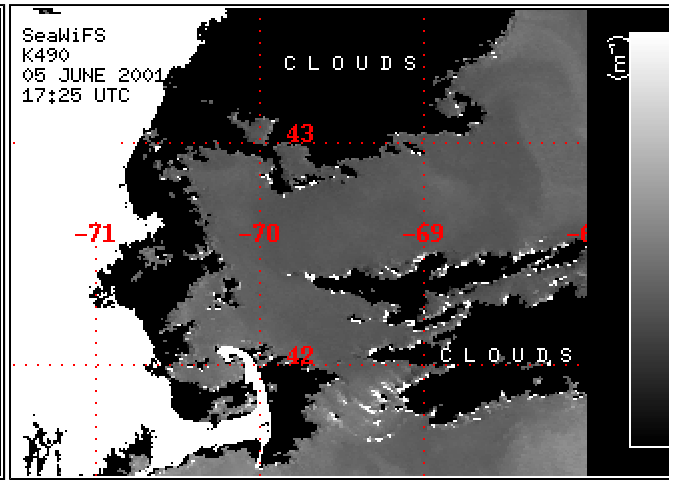
ASCOT01

TRANSPARENCY

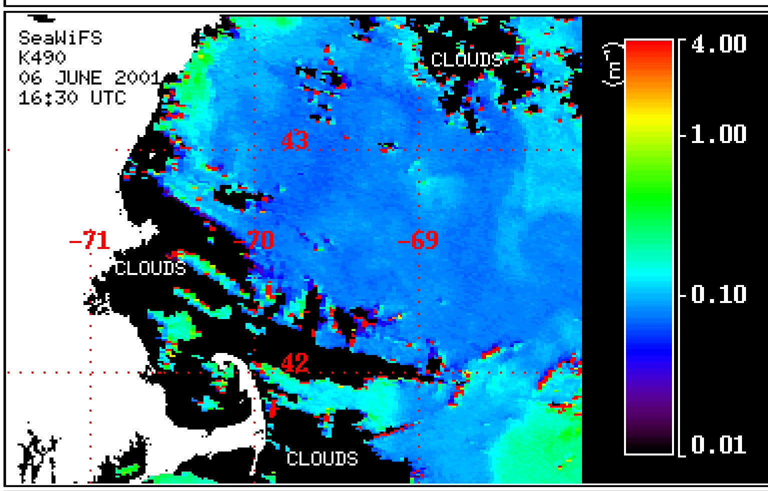
The folder SEAWIFS contains satellite sea transparency images in graphics interchange format (gif). Measurement platform is the **SeaWiFS** satellite. Whenever there were areas of cloud free sea surface, images were processed and stored in separate subdirectories for colored and grey-scale images.

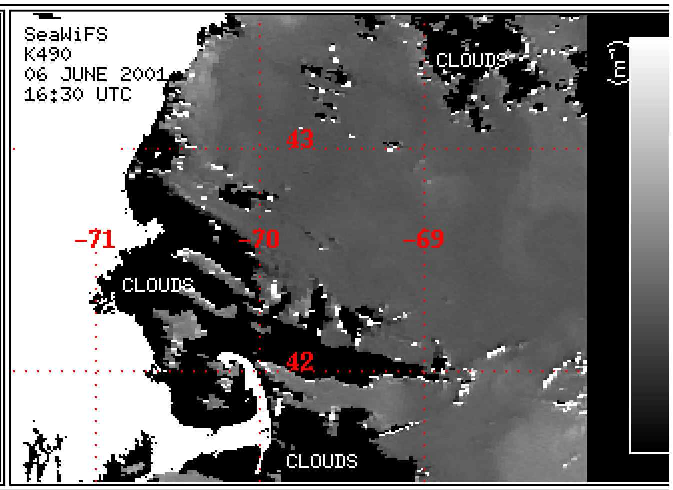
Gulf of Maine



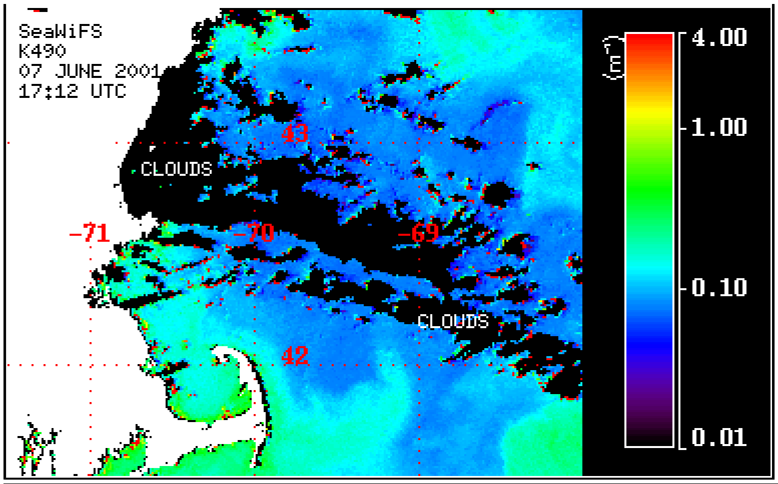


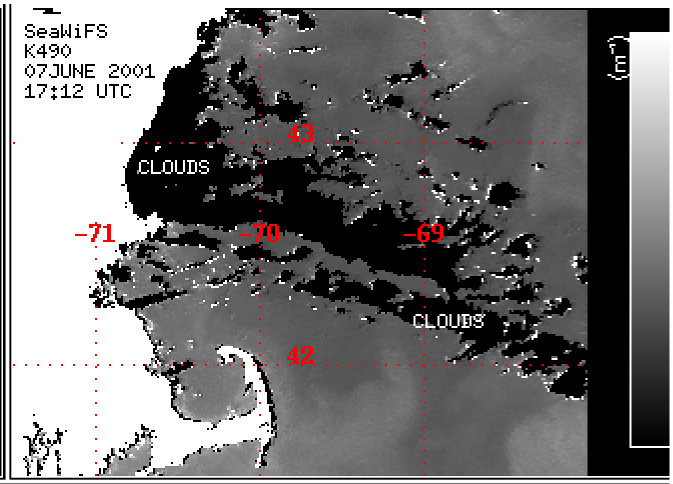
05-June 17:25 UTC



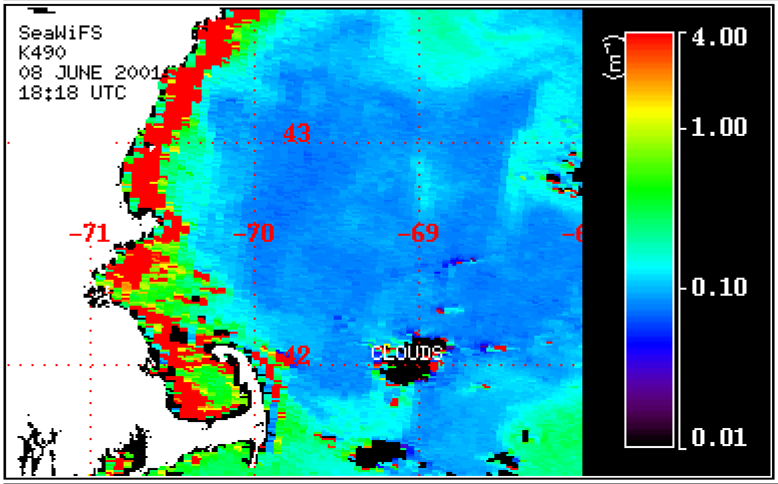


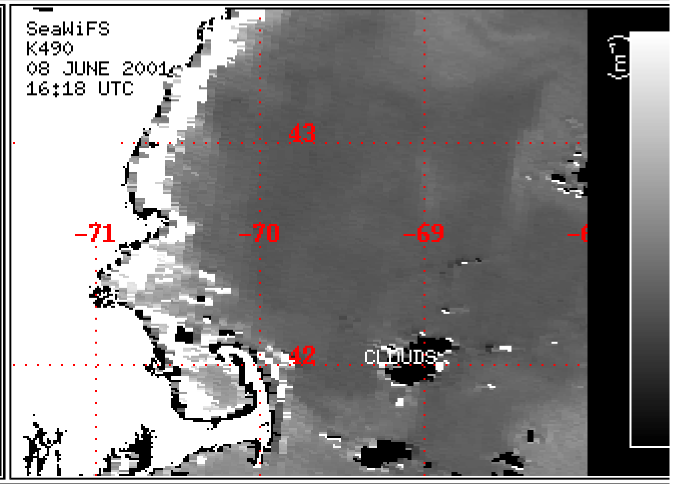
06-June 16:30 UTC





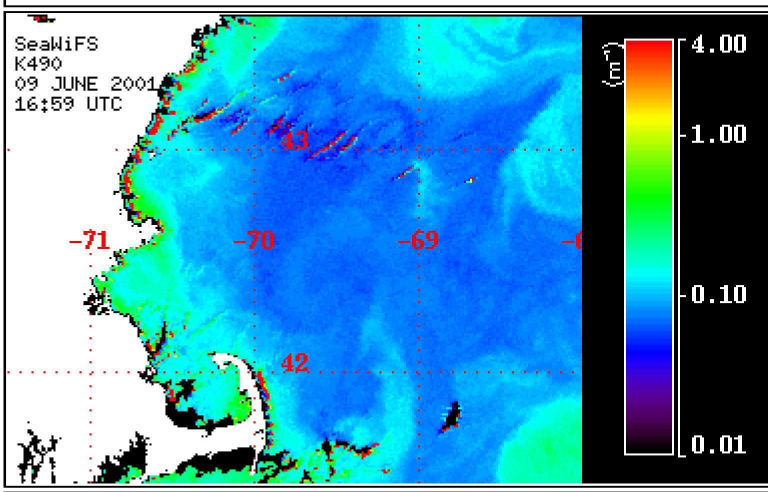
07-June 17:12 UTC

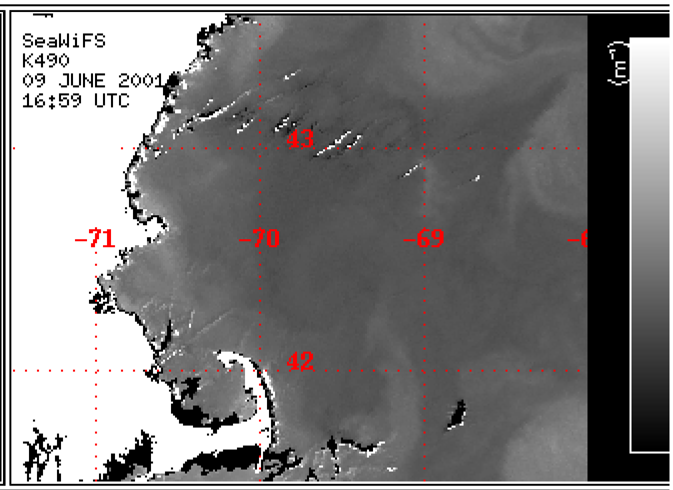




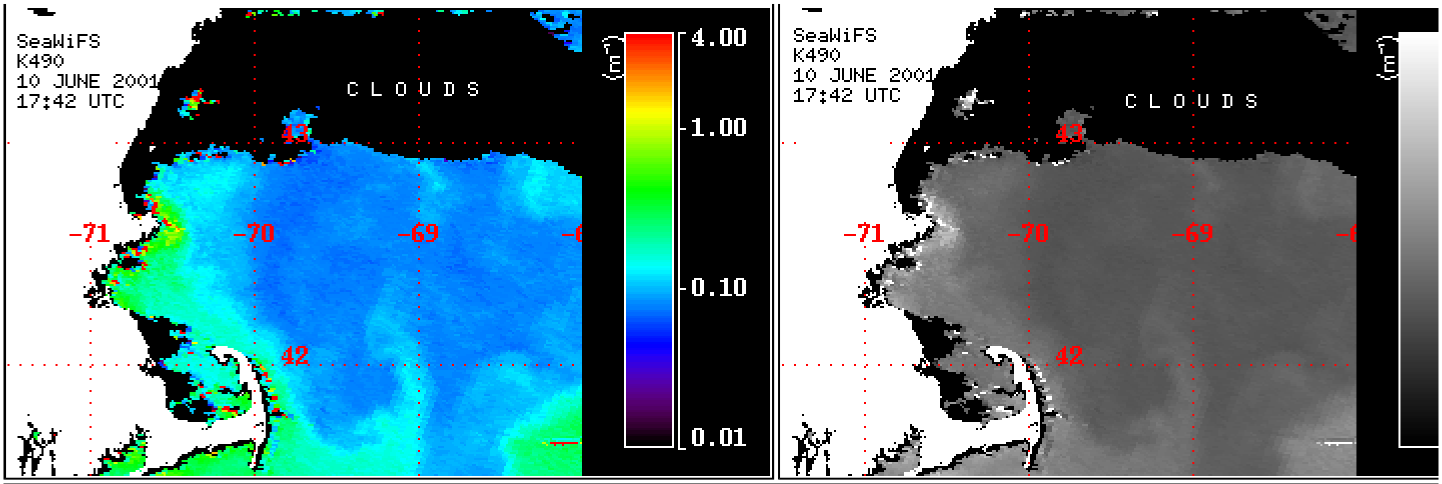
08-June 16:18 UTC

Gulf of Maine

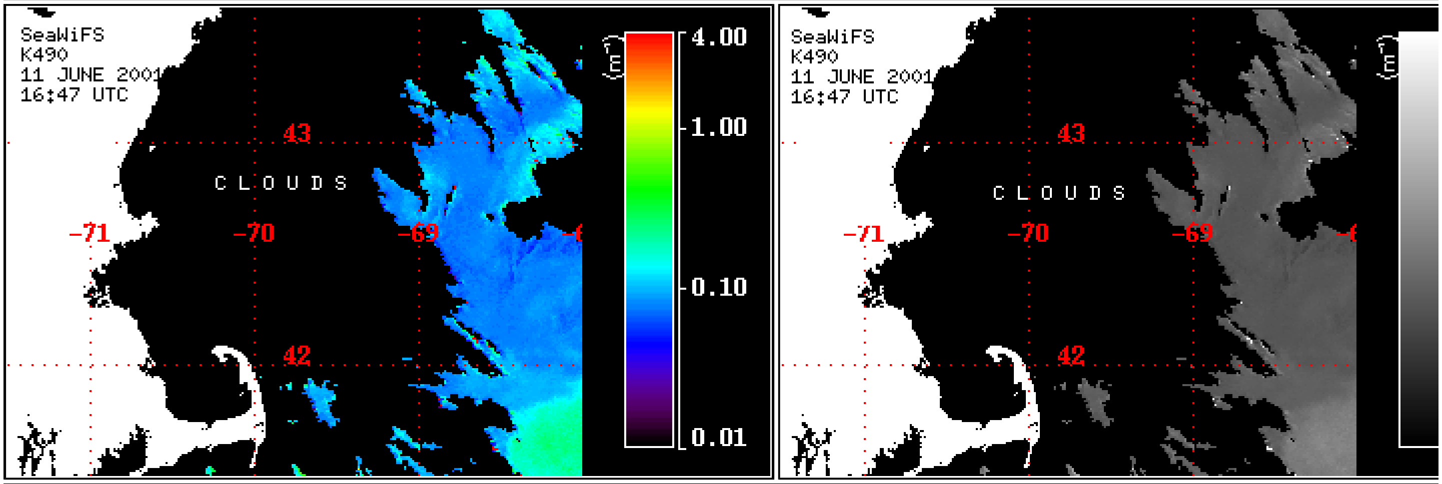




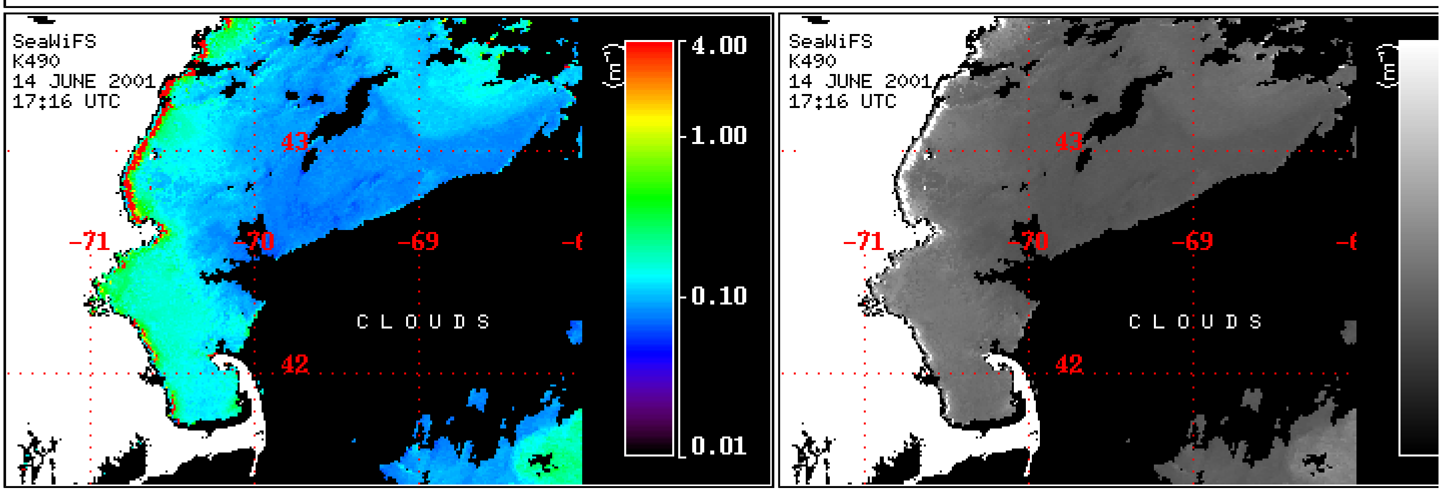
09-June 16:59 UTC



10-June 17:42 UTC

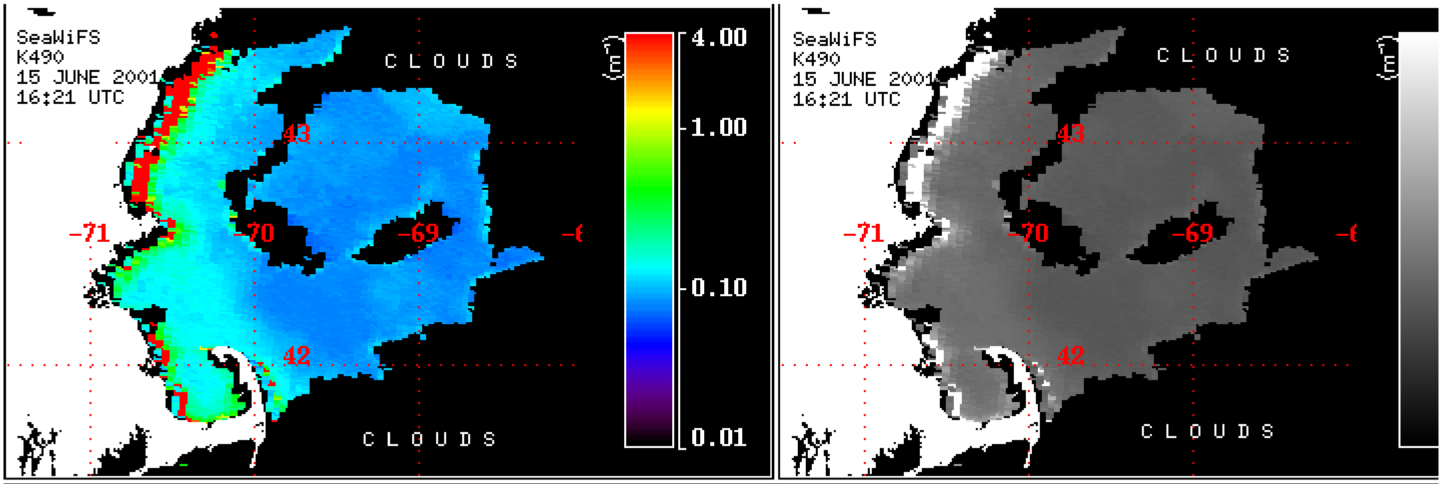


11-June 16:47 UTC

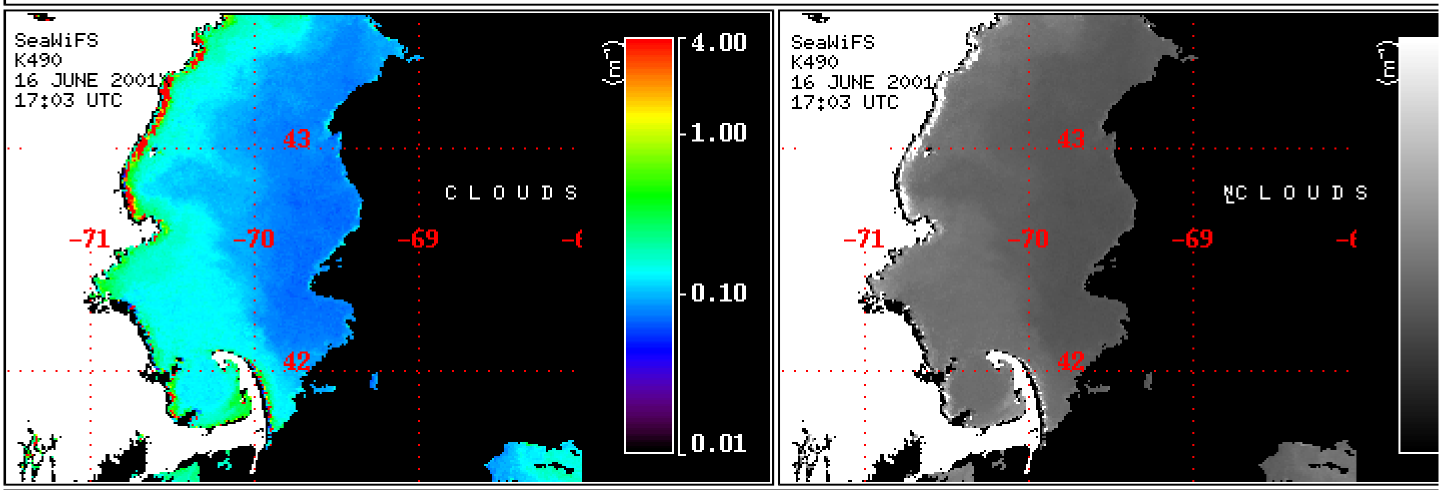


14-June 17:16 UTC

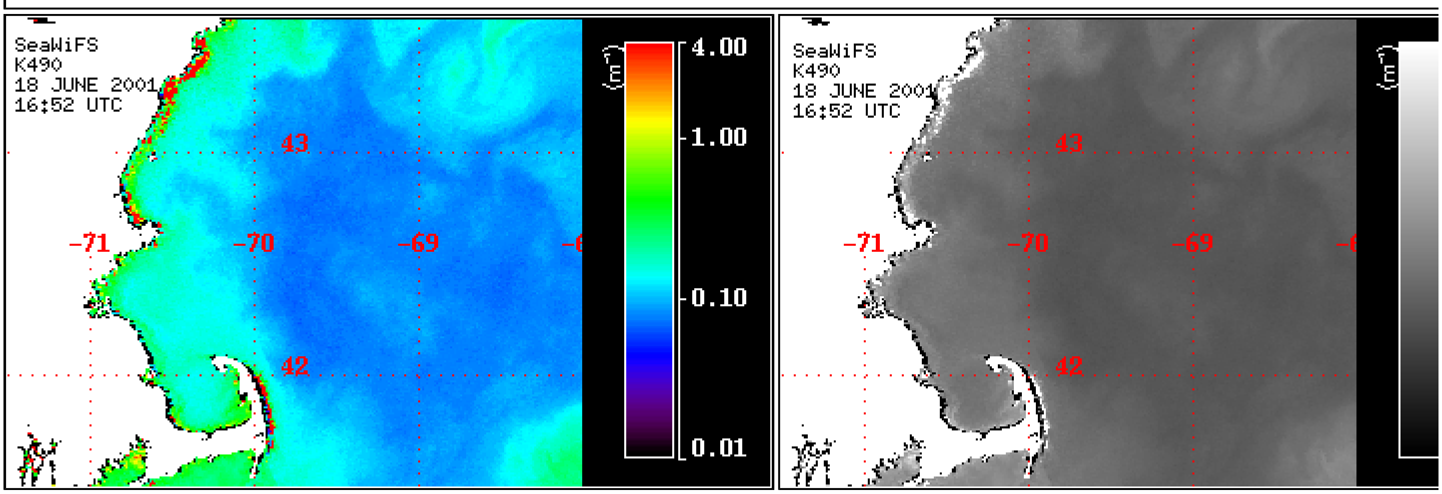
Gulf of Maine



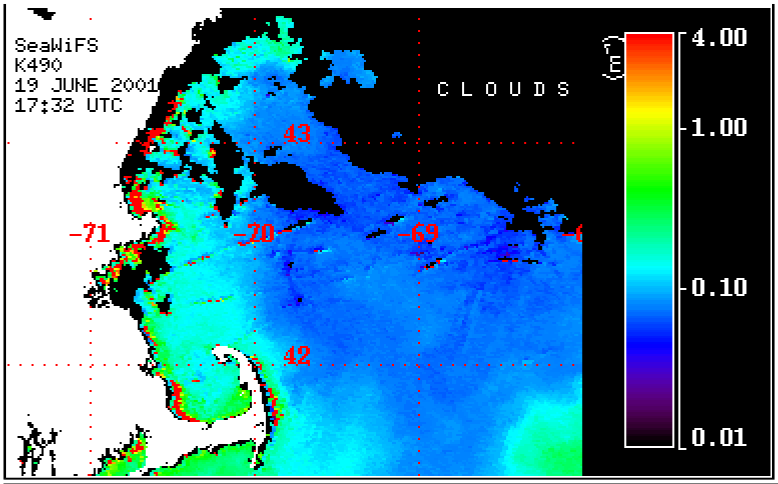
15-June 16:21 UTC

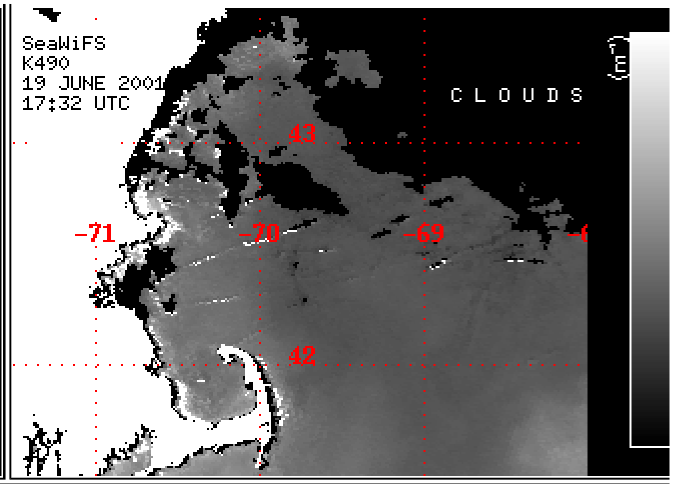


16-June 17:03 UTC



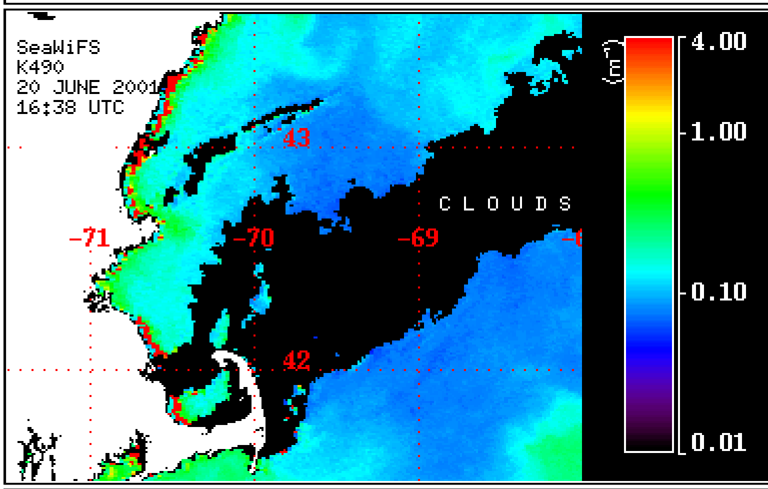
18-June 16:52 UTC

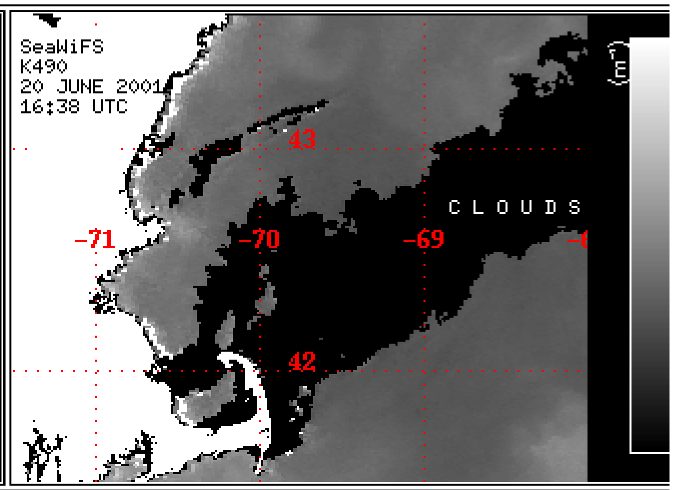




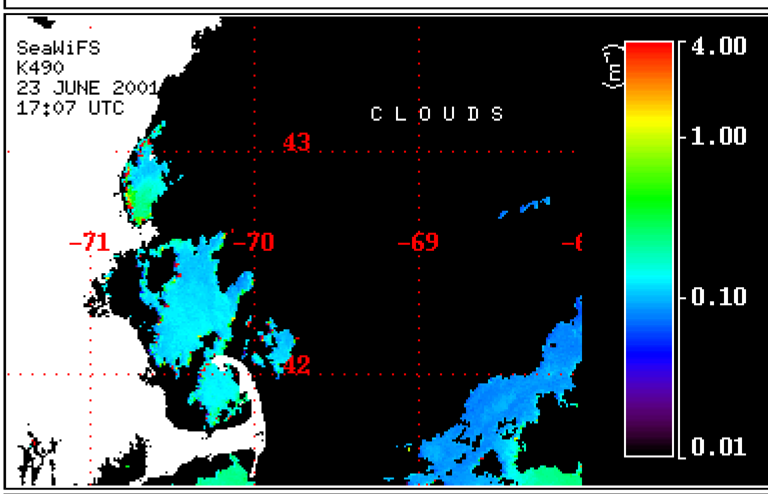
19-June 17:32 UTC

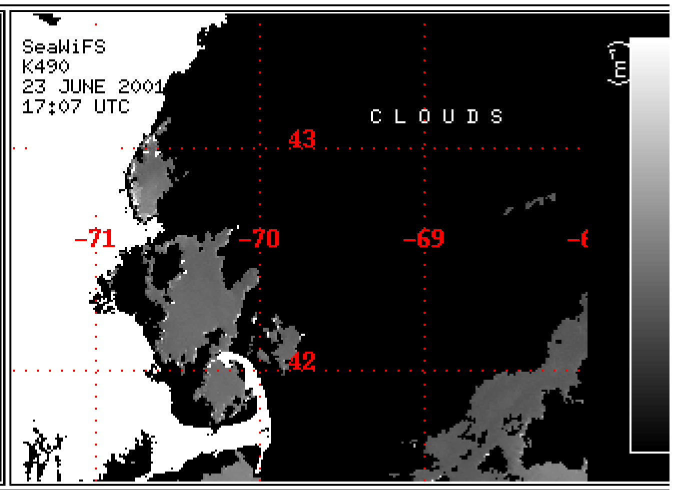
Gulf of Maine



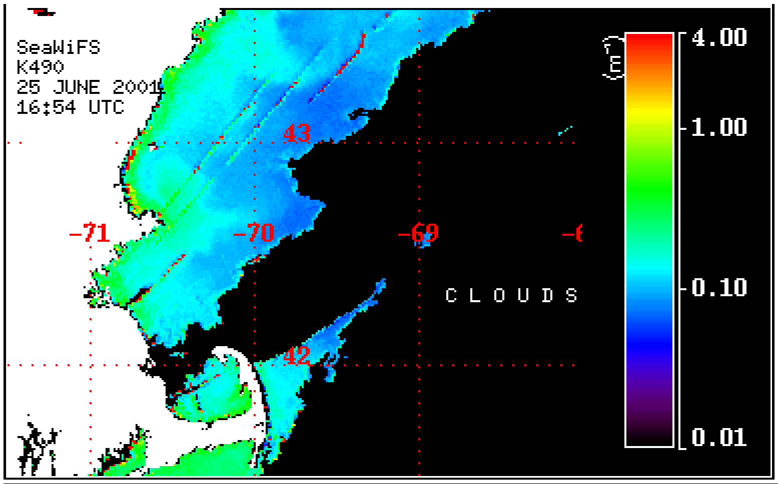


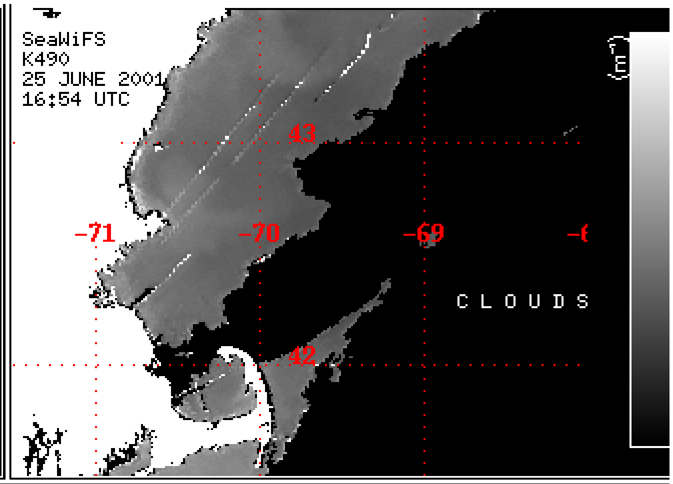
20-June 16:38 UTC



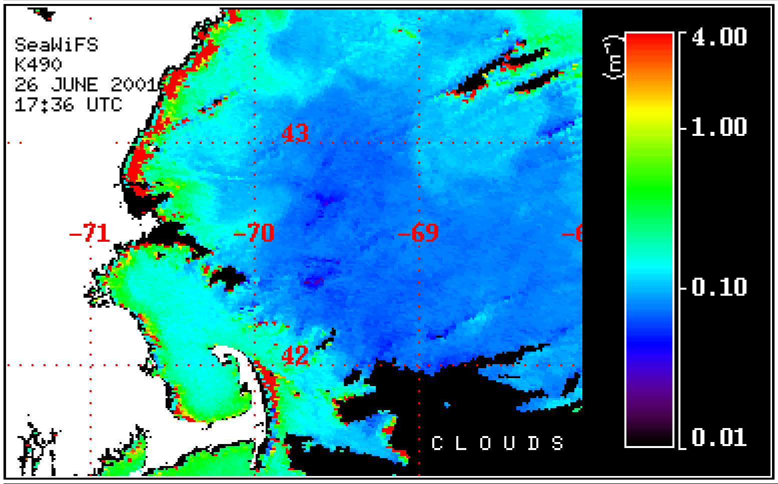


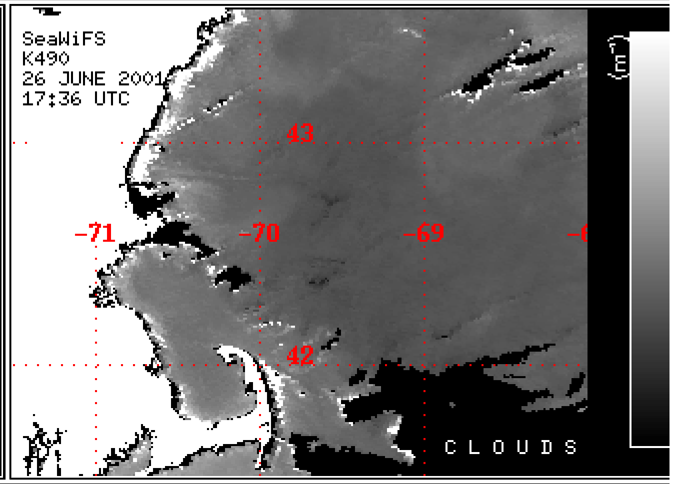
23-June 17:07 UTC





25-June 16:54 UTC





26-June 17:36 UTC

HOME TOP

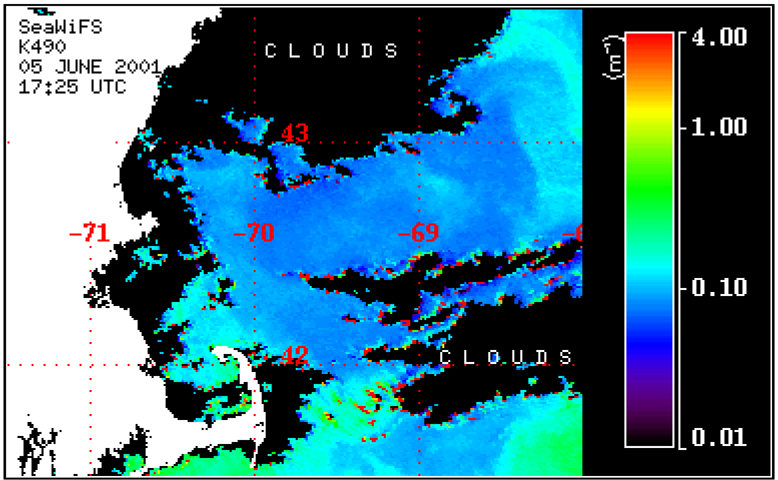
Last Update: 20 July 2001, 14:00

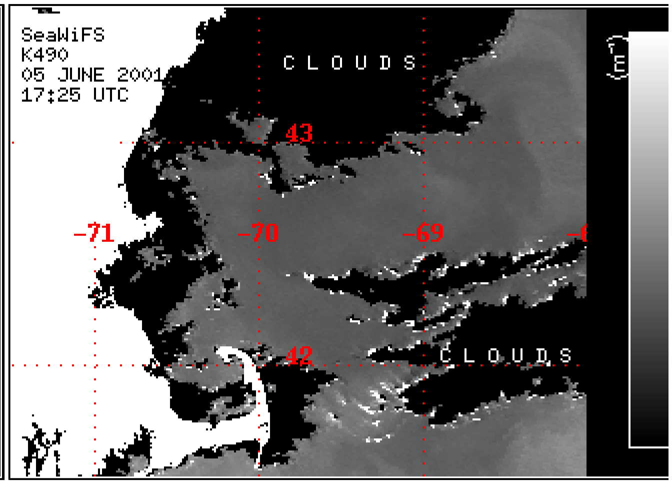
ASCOT01

TRANSPARENCY

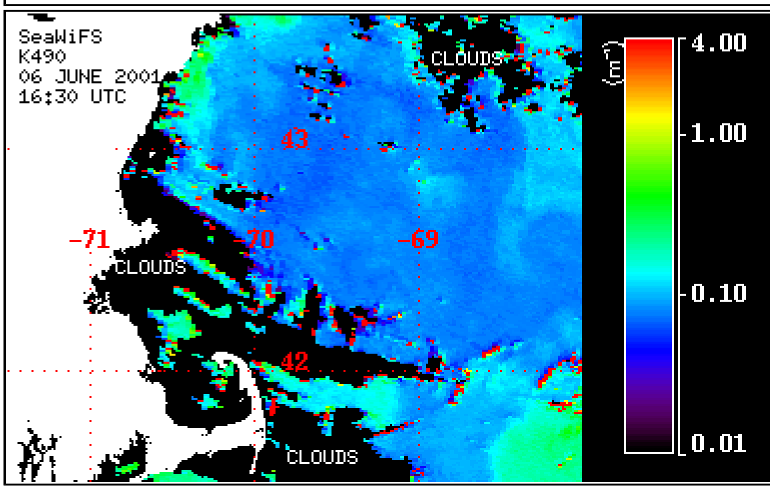
The folder SEAWIFS contains satellite sea transparency images in graphics interchange format (gif). Measurement platform is the **SeaWiFS** satellite. Whenever there were areas of cloud free sea surface, images were processed and stored in separate subdirectories for colored and grey-scale images.

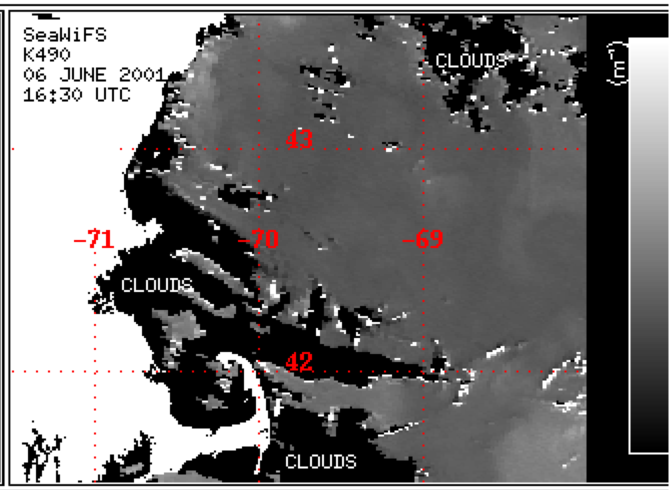
Gulf of Maine



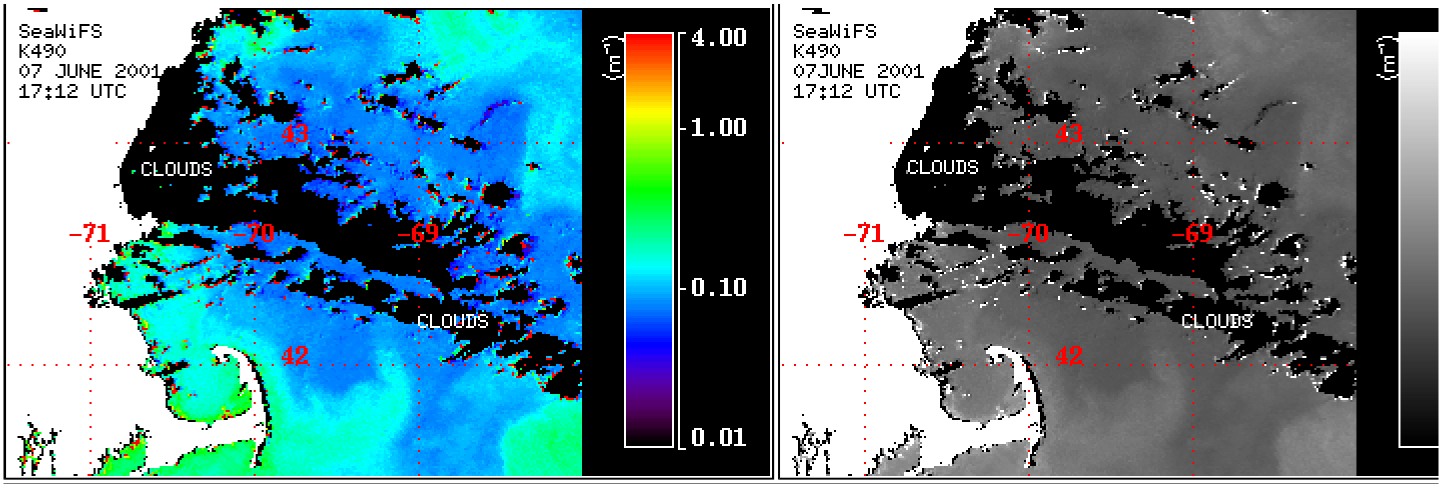


05-June 17:25 UTC

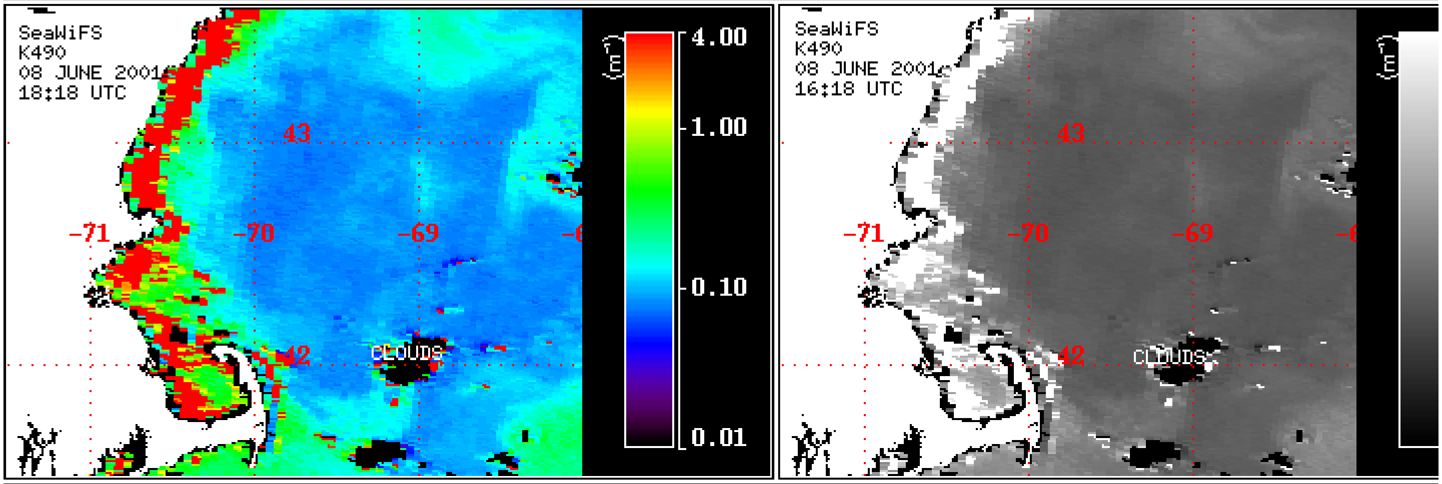




06-June 16:30 UTC

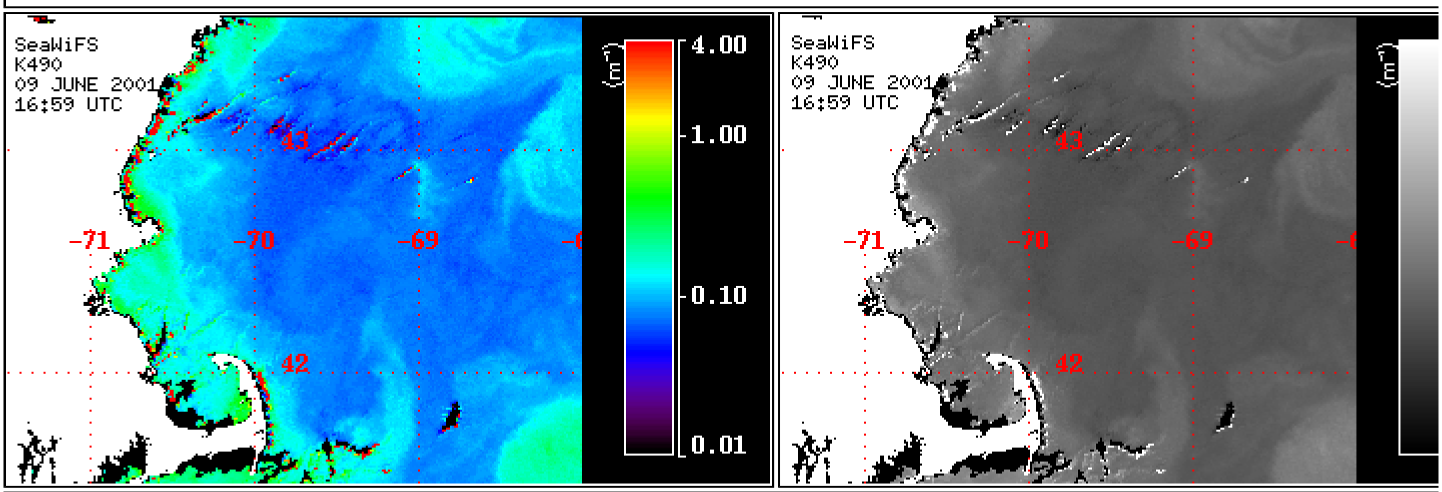


07-June 17:12 UTC

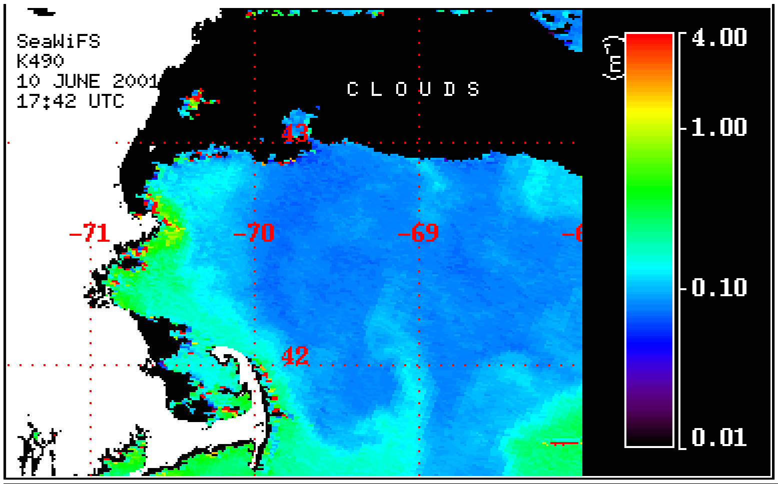


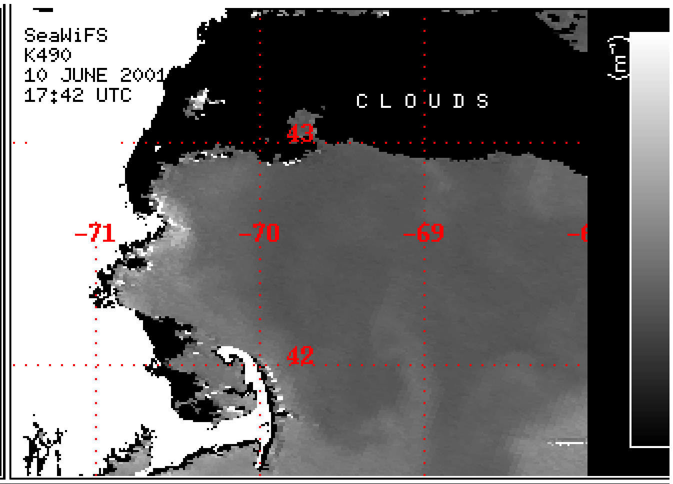
08-June 16:18 UTC

Gulf of Maine

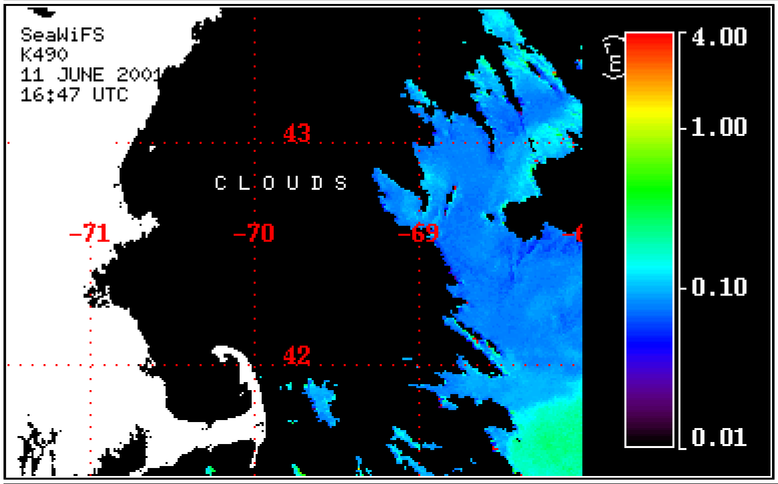


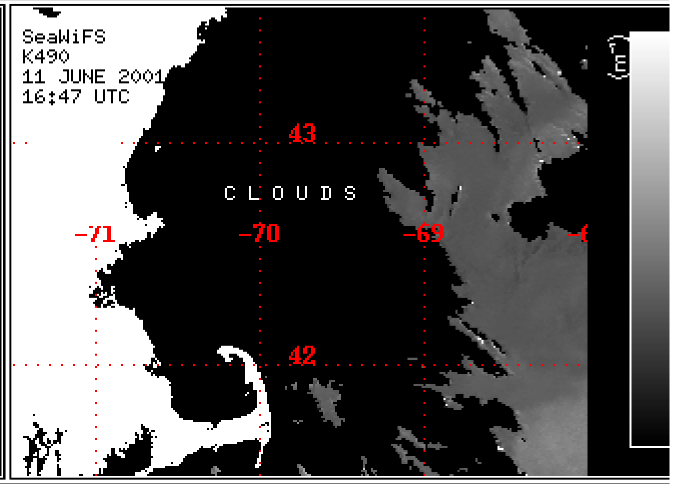
09-June 16:59 UTC





10-June 17:42 UTC





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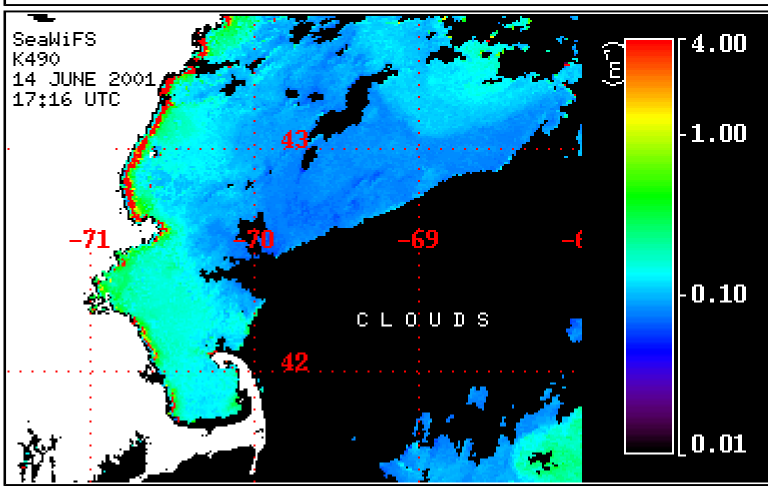
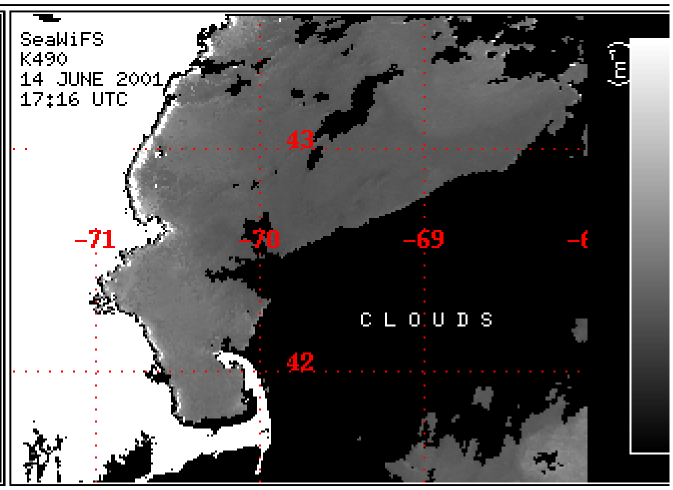
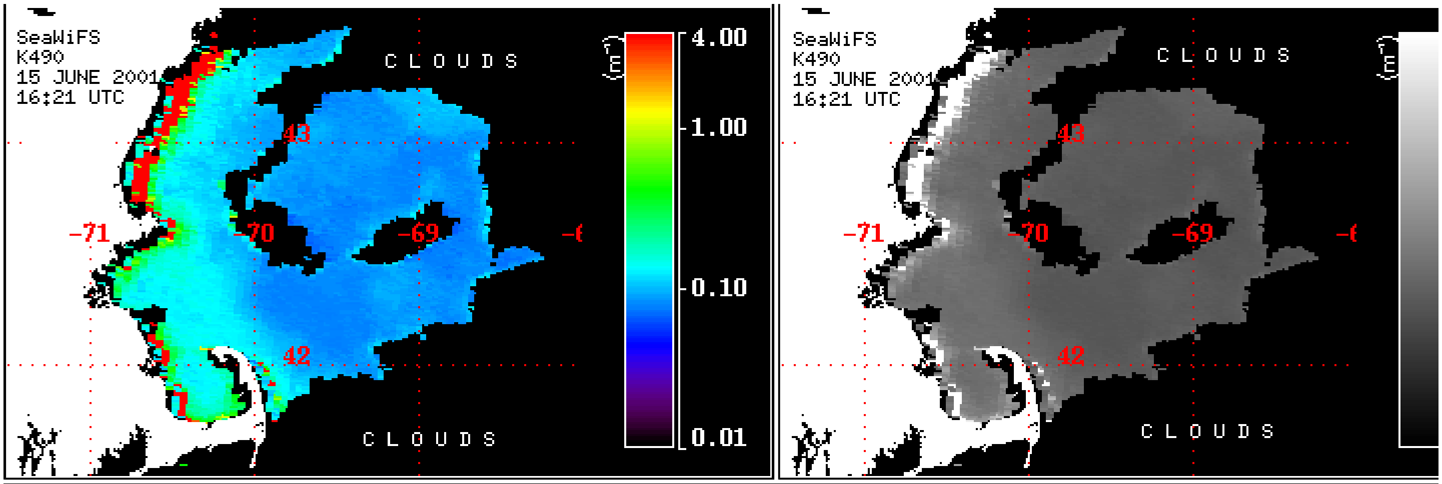




14-June 17:16 UTC

Gulf of Maine



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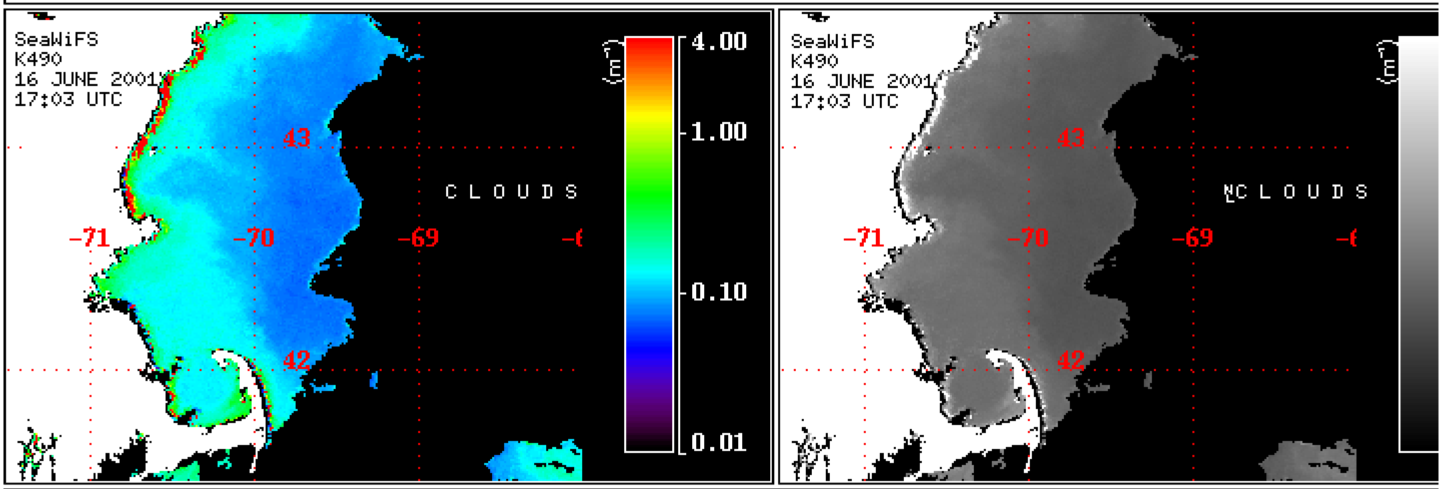

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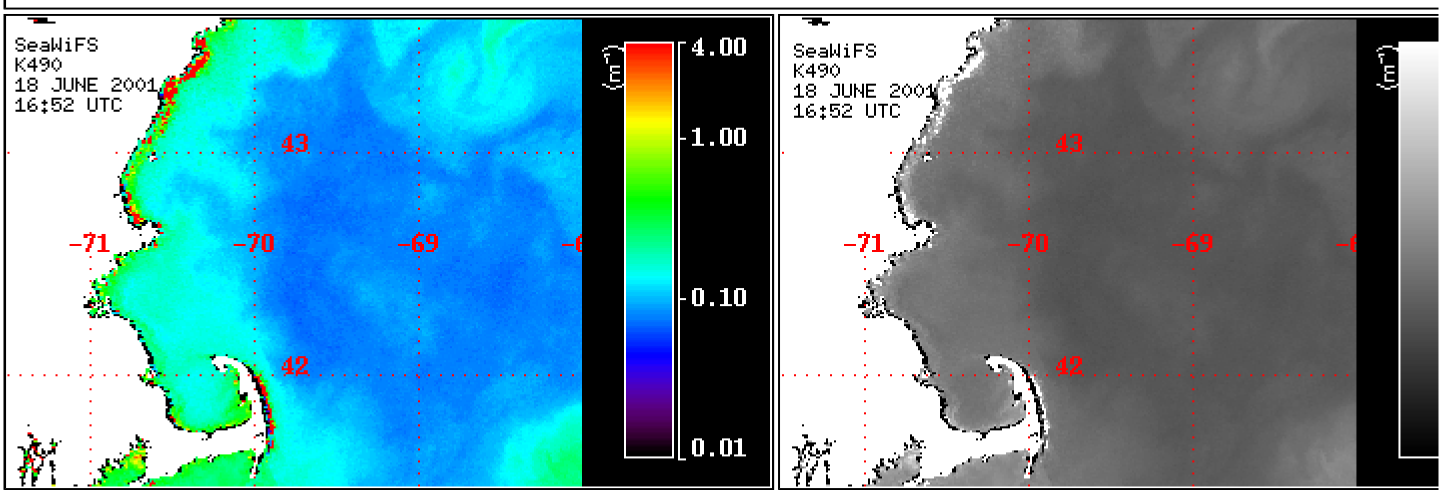
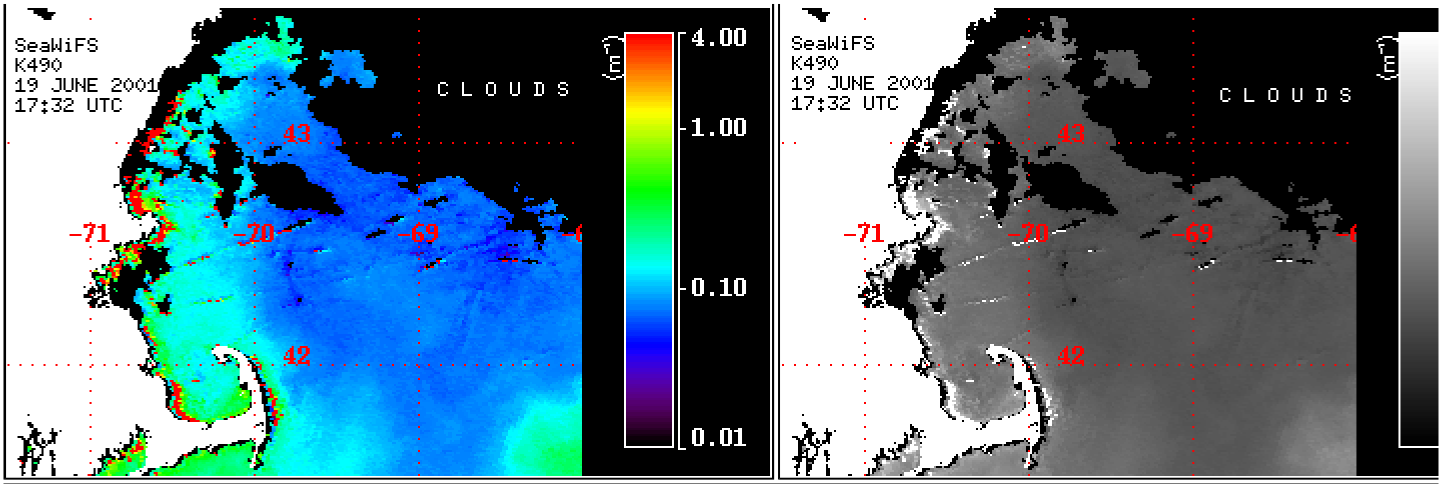
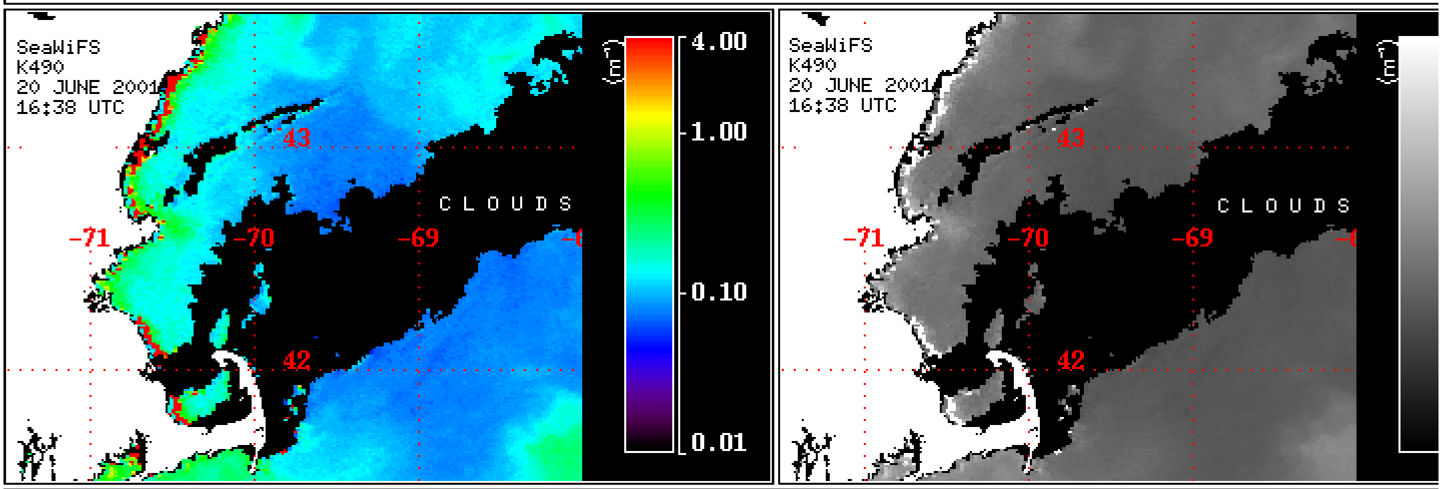


18-June 16:52 UTC

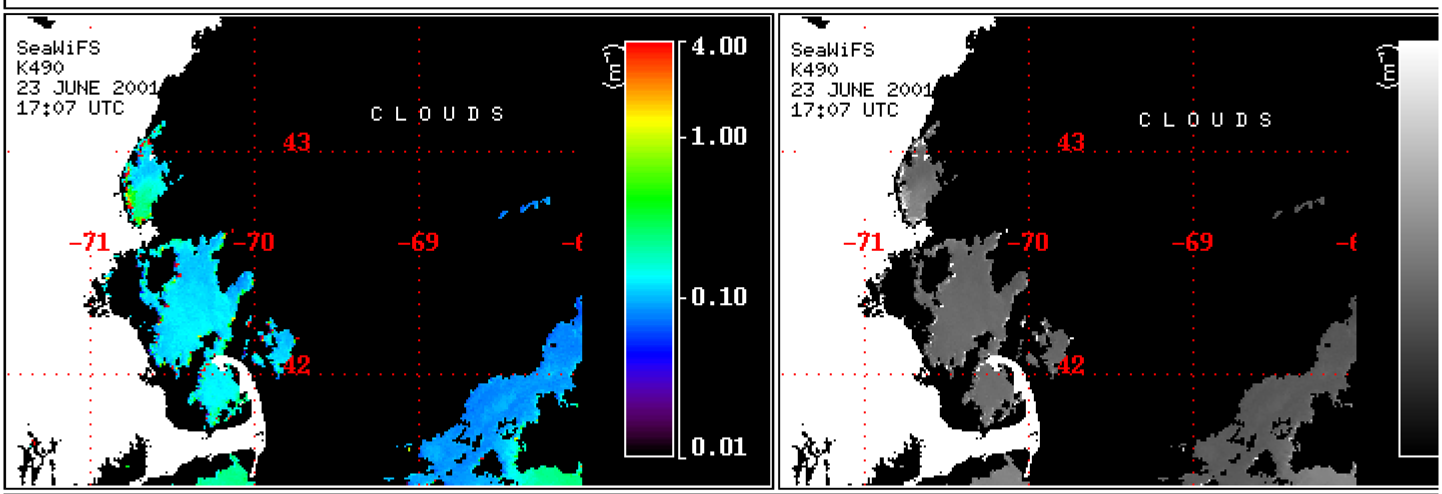


19-June 17:32 UTC

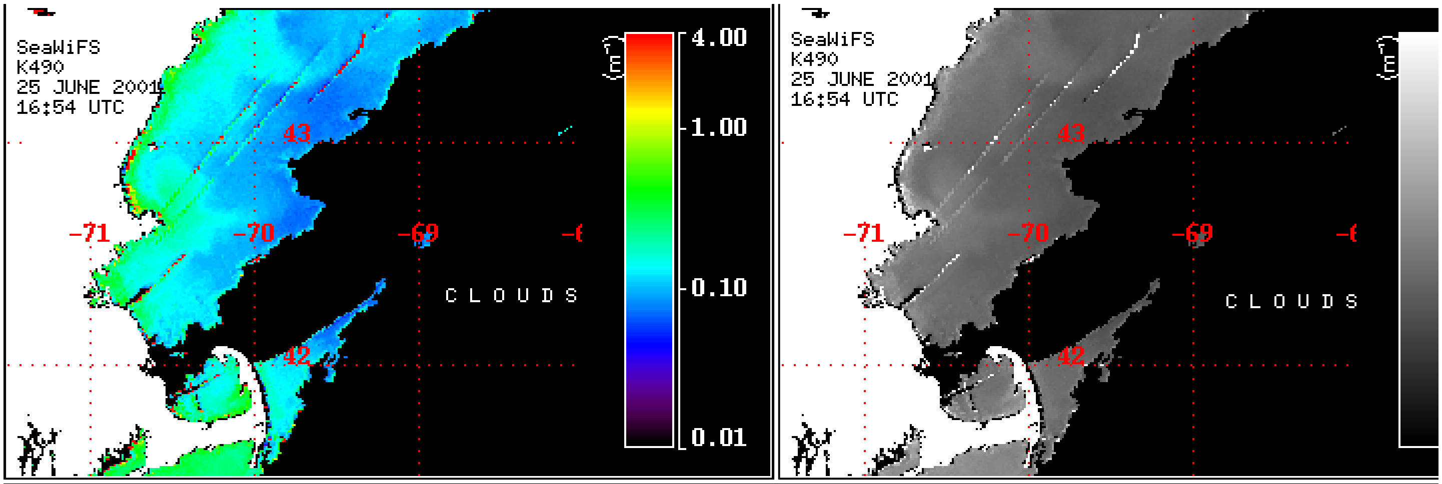
Gulf of Maine



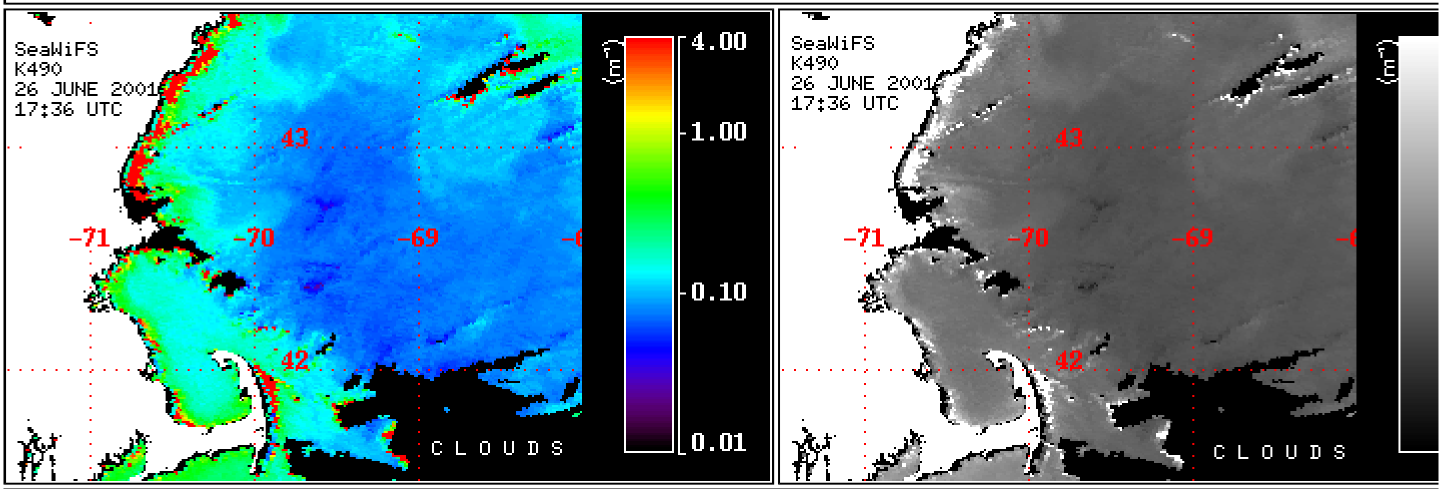
20-June 16:38 UTC



23-June 17:07 UTC



25-June 16:54 UTC



26-June 17:36 UTC

HOME TOP

Last Update: 20 July 2001, 14:00

SACLANTCEN CDROM

A CDROM is available from the NATO SACLANT Undersea Research Centre (CD-49) which contains all of the *in situ* data collected during ASCOT-01 as well as considerable additional information. To acquire this CDROM, contact the Centre via the mail address:

Mr. Arthur Green
Information Service Branch
NATO SACLANT Undersea Research Centre
Viale S. Bartolomeo, 400
19138, La Spezia, Italy

or via fax (39-187-527-700).

The next two pages are a printout of the index.html page from the CDROM.

ASCOT01

Assessment of Skill for Coastal Ocean Transients

2 - 26 June 2001 - Gulf of Maine

NRV Alliance

Data acquired on NRV Alliance

- Navigation log
- Bathymetry
- Meteo observations
- CTD profiles
- CTDchain (raw data)
- On-track temperature and salinity
- On-track currents
- Acoustics

Complementary ship measurements

- **GULF CHALLENGER**
- **LUCKY LADY**
- **NERITIC**
- **OCEANUS**

Moored and drifting platforms

- Acoustic Doppler Current Profilers
- Thermistor strings
- Meteo buoy at the acoustic experiment site
- Wave rider buoy
- Surface drifters

Satellite observations

- Sea Surface Temperature
- Chlorophyll A
- Transparency

Ocean modelling

- Harvard Group (copy from their site http://www.deas.harvard.edu/~leslie/ASCOT01/)
- SACLANTCEN
- Calculation of tides

Cruise Participants

- Persons embarked on Alliance
- Institutions

Plans and documentation

- Cruise plan
- SIC's log (html version)
- Other documents

Software Tools

- DOS, Windows and Linux
- Matlab

Related Internet sites

Remotely sensed and *in situ* data

PI and SIC

Participating institutions

SACLANTCEN	NATO SACLANT Undersea Research Centre
Harvard	Harvard University, Department of Earth & Planetary Science
UMass Dartmouth	University of Massachusetts, Dartmouth
UMass Boston	University of Massachusetts, Boston

Last Update: 19 Jul 2001, 14:16

Scientist-in-Charge (SIC) Log

Aboard the NRV Alliance, the SIC (Dr. Jurgen Sellschopp) maintained an event log for the duration of the experiment. This log details all significant events for the period 2-26 June 2001. The complete log is reproduced here.

SICs log **ASCOT01**

Eastern Daylight Saving Time = UTC-4

Sat	2	June	16.30	Embarkation of most participants for the oceanographic cruise, while the last staff from the previous cruise leaves.
Sun	3	June	16.00	Open house and refreshment, invitation of US oceanographers.
Mon	4	June	14.00	Pre-cruise hazard identification safety meeting with master and SMO. The interpretation of the mammals mitigation policy needs clarification to be requested from the responsible program officer.
			16.00	Visit of the Harvard Museum of Natural History.
			17.00	Reception at Harvard University.
Tue	5	June	13.30	Mail from Centre with clarification of the mammals policy.
			15.00	Loading and installation of Harvard computers.
Wed	6	June	6.00	Leave port Boston. Transit to Cape Ann.
			7.30	Muster.
			8.15	At 50-m ADCP position take a grab sample. Coarse material.
			8.40	Deploy 600 kHz ADCP.
			9.10	First CTD station close to Cape Ann.
			11.05	At 70-m ADCP position take a grab sample. Silty clay.
			11.20	Deploy 300 kHz ADCP. Continue with CTD survey N of Cape Ann.
			15.00	File transfer via the satellite link is not working properly. Later even e-mail, http and telnet are not functioning for a couple of hours because of a shore based technical problem.
			20.00	Last CTD station of the pattern in the inflow to Massachusetts Bay.
			20.10	Deploy CTD chain to 50 m for tow through Massachusetts Bay.
			20.30	Start chain acquisition on track.
			21.00	Failure of CTD chain, most likely in the deck unit. Recover chain. Plan for CTD stations over night.
			21.20	Open connector detected, unplugged by chain tension.
			21.40	After CTD cast, redeploy CTD chain and continue track.
			22.35	File transfer problem over satellite solved by reduction of the packet size from 1500 to 576.
Thu	7	June	9.45	Arrive at northern end of the deepest tow track. A packet of high amplitude internal waves has just been detected, not as spectacular though as one during night. By unknown reasons, data were corrupted by bad electrical signals during two periods of only few minutes, cured by adjustment of the supply current.
			9.55	Reduce chain length to 30 m for the next track, which is closer to shore. Weather conditions are as excellent as the day before.
			21.00	At tip of Cape Codd reduce CTD chain length to 15 m.
Fri	8	June	9.00	SIC received a corrupted e-mail message during night with an executable attachment (msnmig.exe), which smells like a virus. The satellite link has been down for quite a while again. The problem seems to be with connections on land rather than with the satellite.
			10.20	CTD station at the end of the chain track. Recover the (15 m rest of) the CTD chain. The first station of the CTD survey is at Cape Ann,

				15 miles from the present position. Engines are cleaned on the high speed passage.
			11.50	CTD survey starts.
			19.00	The more or less random distribution of computers on two different networks creates unnecessary and time consuming effort to bridge the air gap. It is recommended to connect all computers, which do not carry classified information, to the unclassified network.
			22.30	After several hours of missing connection to the Centre, the line is up again.
			22.45	The IMS log writes at time 23:59:59 the date of the new day.
Sat	9	June	13.40	Due to hazardous navigation in the northern part of the track, one station was cancelled and another shifted.
			17.00	Because of optimal weather conditions it is possible to extend the track by another zigzag through the coastal current.
			19.30	For verification of the modelled NE current on this position, a drifter is launched at 43° 9.7' N, 68° 49.8' W.
			20.40	Second drifter at 43° 05' N, 69° 02' W.
			22.00	The satellite data communication has been very unreliable all the time. The reason is a desastrous storm in Houston, the place of the ground station.
			22.15	First modeling results offered on the Internet at address http://www.deas.harvard.edu/~leslie/ASCOT01.
Sun	10	June	7.00	Last CTD station in front of Portland. Stand by.
			11.15	Participants for the acoustic experiments have arrived by boat from Portland. Staff for the Gulf Challenger (De Maggiora, Zanasca, Trangeled) left by the same Taxi-boat. Continue CTD survey.
			12.35	Deploy third drifter on the way south.
			14.30	Technical meeting for discussion of the deployments on Tuesday.
Mon	11	June	8.00	Extension of CTD track to include a loop into Cape Codd Bay.
			10.30	Meeting with Master and First Officer for discussion of tomorrow's deployments.
Tue	12	June	5.15	Last station of the CTD track at the position of the later source tower deployment. During night, wind had increased to 30 kn with gusts 35 kn. Now it is calming down.
			6.15	Deployed wave rider buoy at 42° 36.762' N, 70° 5.845' W, 106 m water depth. Swath bathymetry along track to 5-km VLA position.
			6.32	Also at VLA position 107 m depth.
			6.55	Deploy meteorological buoy at 42° 38.721' N, 70° 6.115' W, 119 m.
			7.15	Depth at ADCP position is 123 m, that is 15 m more than indicated in the high-accuracy map.
			7.55	ADCP deployed at 42° 38.611' N, 70° 7.370' W, 123 m.
			9.40	Vertical Hydrophone Line array (VLA) is prepared. Deployment postponed because of low visibility. The wind has calmed down to less than 15 kn.
			11.00	Gulf Chalenger has arrived on site after a challenging ride from Portsmouth.
			11.05	First thermistor string (10 s sampling interval) deployed at 42° 38.848' N, 70° 8.359' W, 116.3 m.
			11.40	Second thermistor string (10 s sampling interval) deployed at 42°

		37.844' N, 70° 7.279' W, 104.1 m. Break for lunch.
	13.15	Third thermistor string (1 minute sampling interval) deployed at 42° 39.039' N, 70° 6.648' W, depth 111.8 m.
	14.00	The spread spectrum radio connection with Gulf Challenger works perfectly. For connection between computers by http, ftp and telnet is totally transparent.
	14.25	VLA deployed and radio buoy 42° 38.300' N, 70° 8.181' W on 102.5 m water. Prepare CTD chain.
	14.55	Position fix of VLA by EG&G pinger and releaser results in a VLA position of 42° 38.352' N, 70° 8.214' W.
	15.35	Releaser (finally) remotely switched to stand-by mode.
	16.15	CTD chain deployed with float, marker buoy and ballast for recovery by Gulf Challenger.
	16.25	Gulf Challenger comes alongside for the Trangeled / Stoner change.
	16.30	Proceed to source tower position.
	17.15	Grab sample taken at the source tower position again results in sand and small stones. Break for dinner.
	19.08	Start visual and audio whale watch.
	19.25	Acquisition on Gulf Challenger has started. GPS data are, but chain data are not visible from Alliance, because the backup channel was not started properly.
	19.30	The source tower was deployed to the bottom at 42° 36.325' N, 70° 5.776' W, 98.5 m. The connecting cable is slowly payed out.
	20.20	Signals from the CTD chain on Gulf Challenger get interrupted when she tows at faster speed, a broken conductor in the towing cable being the suggested reason. Data acquisition will hopefully be maintained at low speed towing.
	20.45	The source tower cable is taken from the winch, held in the crane and connected. Equipment test and ramp-up sequence.
	21.05	Equipment test finished. Switch off and connect more permanently.
	21.20	Continue transmitting with 160 dB source level and increase slowly.
	23.20	Start acquisition of low and medium frequency signals. Source level is 187 dB.
Wed 13 June	5.00	Amplifyer for the medium frequency signals overheated. Loss of transmissions for about one hour.
	11.20	Finish low and medium frequency signals. Start high frequency transmissions.
	14.32	Discontinue recording. Switch of signal power, disconnect from source and deploy cable end with a surface buoy.
	14.52	Transit to VLA-5-km location, where Gulf Challenger also waits for hand-over of the CTD chain.
	15.15	Workboat transfer between Gulf Challenger and Alliance. The end of the CTD chain towing cabel is deployed into the water together with a buoy attached to it. It is picked up by the work boat and brought to the Alliance.
	15.35	The float and the very upper end of the CTD chain are lifted up and put on deck. The towing cable is replaced by a spare.
	16.00	The CTD chain is brought back to the Gulf Challenger. Recover VLA at 5-km-position.

	16.30	Start of CTD chain acquisition on Gulf Challenger. The backup on a second computer running under windows is now working. Data files are loaded to Alliance through spread spectrum radio. Data quality is good.
	17.20	Deploy VLA at 2 km distance from the source on position 42° 37.104' N, 70° 6.612' W.
	17.50	Back at source towert position. Use EG&G pinger for accurate localisation. Break for lunch.
	19.00	Start whale watch. The EG&G pinger is not working. Source tower localisation is postponed again. Pick up the source cable tail and buoy.
	19.50	Cable fixed and connected. Start ramp-up sequence.
	20.45	Start data acquisition on 2 km range with low and medium frequencies.
Thu 14 June	7.30	Gulf Challenger data are obtained via ftp. Data quality is very good. Ocean variability is mainly due to internal waves and far from statistically homogeneous. Tow speed was mostly 3 kn.
	8.30	Gulf Challenger has approached the position of the Alliance. CTD chain data acquisition is discontinued. The chain is disconnected and handed over to Alliance for recovery. Leslie leaves for Portland, Stoner comes back to the Alliance.
	9.00	Transfer and recovery finished. Transmission of low and medium frequency signals is discontinued. Switch to high frequency.
	9.25	Start acoustic data acqusition.
	12.15	Finish data acquisition. Disconnect from Source tower and deploy the cable attached to a moored surface buoy.
	13.00	Accurate localisation of the tower position by EG&G pinger at 42° 36.325' N, 70° 5.769' W,.
	13.15	Recover VLA.
	14.00	VLA recovered. CTD station.
	14.30	Recover both fast thermistor strings.
	15.00	CTD survey on a triangle with first leg to E, last leg back from S.
Fri 15 June	7.30	Finished CTD survey at the 10 km VLA position. Because of the poor visibility, the VLA deployment is postponed.
	9.15	Re-deploy thermistorstring 1 at 42° 38.850' N, 70° 8.390' W, 117.4 m.
	9.45	Re-deploy thermistorstring 2 at 42° 37.845' N, 70° 7.266' W, 104.9 m.
	11.20	Gulf Challenger arrives at the k10 position. Start deployment of the CTD chain.
	11.25	Gulf Challenger comes alongside and takes Stoner.
	11.40	CTD chain, float and towing cable with a ball at its tail are deployed to be picked up by Gulf Challenger.
	13.00	Wind has increasesto 15 to 20 knots, no swell. Visibility improved. Start deployment of the VLA.
	13.45	Radio buoy at 42° 40.134' N, 70° 10.503' W, 96 m.
	14.00	Received 30 minutes of CTD chain data via radio link. After elimination of a few erroneous (and redundant) pressure sensors, data are of good quality.

			14.25	VLA localised at 42° 40.142' N, 70° 10.688' W
			15.00	Workboat transfer of Della Maggiora back to Alliance.
			15.20	Start whale watch.
			15.30	Re-connect to the source tower.
			16.00	Ramp-up and test sequence.
			17.40	Start high frequency data acquisition.
			20.00	Switch to low and medium frequencies.
Sat	16	June	8.00	More transmissions at high frequencies.
			13.00	Discontinue transmissions. Disconnect from source tower. Localisation with EG&G pinger results in position 42° 36.324' N, 70° 5.768' W.
			14.05	Localisation of the VLA 10k, 42° 40.143' N, 70° 10.689' W.
			14.20	Recover VLA.
			15.40	Re-deploy VLA approximately 750 m from the source.
			16.30	Recover wave rider buoy, which otherwise would have a potential for interference with the VLA.
			17.15	Re-deploy wave rider buoy at 42° 37.140' N, 70° 6.502' W. VLA localisation with EG&G pinger results in the location 42° 36.621' N, 70° 6.174' W.
			18.05	CTD station. Start whale watch. Connect to the acoustic source.
			19.05	Start ramp-up and test phase.
			19.30	Start acquisition of high frequency standard signals. Switch to the usual other signals in the course of the night.
Sun	17	June	6.05	Discontinue acoustic run and disconnect cable from amplifyer. Dense fog and calm sea.
			7.00	Recover source tower.
			8.15	Receive from Gulf Challenger and recover CTD chain.
			8.50	Gulf Challenger leaves for Portsmouth with Stoner and Zanasca on board, who will bring the equipment back to Alliance tomorrow.
			9.35	Recover radio buoy and vertical array.
			10.35	Recover wave rider buoy. Calm sea and dense fog as before.
			11.30	Recover meteorology buoy.
			13.00	During lunch time the visibility has largely improved.
			13.25	Recover the slow thermistor string T3.
			14.00	Recover ADCP in the center position between the thermistor strings.
			14.25	Recover northernmost thermistor string T1.
			15.10	Recover southern thermistor string T2. Proceed with CTD stations towards north of Cape Ann and zig-zagging back to Boston Bay.
			17.35	Shipborne ADCP affected by lightning in thunderstorm.
			19.15	The attempt to update the data server at SACLANTCEN fails again. The reliability of the satellite connection during the past ASCOT cruise period is not satisfactory.
Mon	18	June	2.00	Last CTD station before port call.
			6.00	Pilot for Boston embarks.
			8.00	Enter Constitution Marina to find birth next to the historical ship Constitution.
			10.00	Stoner and Zanasca arrive with equipment from Gulf Challenger.
Tue	19	June	7.30	Participants of the acoustic experiments disembark for their return flights to Italy.

			8.00	Leave port Boston.
			9.25	First CTD station of a Massachusetts Bay survey.
			17.00	At 8 CTD positions, drifters will be deployed between now and Wednesday morning.
Wed	20	June	8.00	Finished special survey of Massachusetts Bay close to Cape Ann. Start verification survey in Gulf of Maine with the same CTD station pattern as for initialization.
			16.00	Fouling in the pumps of the condictivity cells cause erronious salinities and densities in the surface layer of some stations close to shore. The pumps will be cleaned more frequently in future.
Thu	21	June	8.00	Argos has not sent the positions of half of the drifters, which were deployed more than 24 hours ago. They promised to check.
			21.05	While the ADCP acquisition PC lost approximately 5 seconds per day for most of this cruise (the same as in GOATS 2000), there are 15 seconds missing between yesterday night and now. Since it is very unlikely, that the computer clock is unstable (it was checked in the laboratory without negative result), it is assumed that in a certain stage the acquisition program prevents timer interrupts to be processed.
Fri	22	June	8.00	For verification that drifter data in Massachusetts Bay have been received, we were sent example positions yesterday afternoon. This morning, there are still most drifters missing in the e-mail from Argos.
			10.00	The reliability of the satellite connection has remarkably improved, since the threshold for re-appearing signals was increased.
			16.30	The soundings from 15 June 22:50 on are fixed at 103.6 m. This was only noticed on 17 June 13:33 after Alliance left her fixed position. The IMS acquisition is missing between 12:36 and 22:39 on 17 June. The NINAS backup acquisition is used to recover navigation data. A sounding track along the 10 km acoustic range must however be repeated.
			21.45	SE corner of the CTD repeat survey.
Sat	23	June	11.30	The current CTD survey is extended by tracks crossing Stellwagen Bank.
			22.30	At the position of the acoustic experiments, the 10 km range is covered by three side by side with swath mapping laps.
Sun	24	June	1.00	Bathymetric survey finished. Continue CTD stations.
			8.00	At the entrance to Boston, Prof. Robinson disembarks by taxi boat.
			9.30	Recover 600 kHz ADCP (Barny)
			9.40	Transit.
			10.20	The 600 kHz has stopped recording at the moment when it was deployed.
			10.30	Recover 300 kHz ADCP (Sentinel)
			10.45	Deploy the CTD chain (37 m) with 20 sensors made in 2000. In the upper part of the chain there are more data errors than usual. The wave form of the sensor signal is challenging. Moreover the result from laboratory calibtration is verified, which means that lower conductivities below the surface mixed layer cannot be measured with these sensors. The acquired data file has wrong date (17 June)

				and time (21.00).
			13.00	Recover the short chain and deploy the 80 m chain to 51 m into the water. Increase speed to 5 knots.
			13.30	Start chain data acquisition on track.
			14.50	The chain must have encountered a drifting obstacle. The depressor came up by 5 m, the wire was vibrating. One more sensor does not respond after this happened.
Mon	25	June	2.00	At the northern turning point shorten CTD chain to 35 m length in the water.
			4.15	For a short time the chain gets entangled with something unknown, and the depressor comes up almost to the surface.
			12.45	The chain has been pulled up by 2 or 3 meters because of a potential interference with the bottom. After a while no more signal is received by the deck unit. When the CTD chain is recovered, a marker buoy and ball appear togethether with the central part of the chain. Several damages are detected in the insulation of the tow cable, the largest even of one square centimetre size.
			13.30	After fast repair the chain is redeployed to 20 m length in the water. After restart of the acquisition the data are of normal good quality.
Tue	26	June	1.40	Endpoint of the tow track. Final CTD station.
			1.45	Recover CTD chain.
			2.00	Speed up in order to clean the engine on extended transit to Boston.
			8.00	Arrive in port next to the historical vessel Constitution.
			15.30	Disembarkation of last cruise participants prior to the departure of Alliance to Canada.

Harvard Science Plan

In preparation for the ASCOT-01 experiment, Harvard scientists produced a science plan which introduces the experiment, defines the goals and objectives, describes the geographic and oceanographic context, specifies the modeling domains and schedule and generally provides a significant amount of overview information. That science plan follows.

Assessment of Skill for Coastal Ocean Transients
ASCOT-01

Massachusetts Bay / Gulf of Maine
June 2001

An Experiment for Ocean Coastal Prediction and NATO Rapid Environmental Assessment Skills Evaluation

A.R. Robinson, J. Sellschopp, W. G. Leslie

Harvard University
NATO SACLANT Undersea Research Centre

SCIENCE PLAN
August 2000

1. Introduction

Coastal Predictive Skill Experimentation (CPSE) measures the ability of a forecast system to combine model results and observations in coastal domains or regimes and to accurately define the present state and predict the future state. Rapid Environmental Assessment (REA) is defined in the military environment as "the acquisition, compilation and release of tactically relevant environmental information in a tactically relevant time frame". Ocean forecasting is essential for effective and efficient REA operations. A REA CPSE must be designed to determine forecast skill on the basis of minimal and covertly attainable observations and thus may be most efficiently carried out in the context of the definitive over-sampling provided by a CPSE.

Environmental observations are a necessity for initialization and updating of ocean forecasts. Numerical ocean forecast capabilities in general consist of observational networks, data assimilation schemes and dynamic forecast models. Since observations are the most expensive part of the forecast and are often difficult to achieve, methods that would reduce the requirements are highly desirable. Knowledge of features, structures and the dynamics which evolves them is necessary for successful forecasting. Adaptive sampling of the observations of greatest impact increases efficiency and can drastically reduce the observational requirements, i.e. by one or two orders of magnitude. This project will develop methodology for ocean forecasting using minimum input.

The Assessment of Skill for Coastal Ocean Transients (ASCOT) project is a series of real-time CPSE/REA experiments and simulations focussed on quantitative skill evaluation and cost-effective forecast system development. ASCOT-01, to be carried out in Massachusetts Bay/Gulf of Maine in June 2001, is the first such experiment. ASCOT-02 is planned for somewhere in the Mediterranean Sea in 2002.

2. Goals and Objectives

ASCOT Overall Goal: to enhance the efficiency, improve the accuracy and extend the scope of nowcasting and forecasting of oceanic fields for Coastal Predictive Skill Experimentation and for Rapid Environmental Assessment in the coastal ocean and to quantify such CPSE and REA capabilities.

ASCOT General Objectives:

- obtain data sets adequate for: 1) definitive real-time verification of regional coastal ocean predictive skills, with and without REA constraints; 2) CPSE and REA Observational System Simulation Experiments (OSSEs), both for ASCOT design and more generally; and, 3) definitive knowledge of dynamics
- define useful skill metrics and real-time forecast validation and verification procedures for REA
- assemble, calibrate, exercise in real-time, evaluate and improve a generic, portable, scalable advanced ocean forecast system (dynamical models and data analysis, management and

assimilation schemes) applicable for CPSE in general and NATO REA in particular.

ASCOT-01 Objectives:

- carry out and quantitatively evaluate in Massachusetts Bay (MB) and the Gulf of Maine (GOM) a coupled multiscale interdisciplinary real-time forecast experiment
- obtain a data set adequate to define coupled dynamical processes (submeso-, meso-, bay-, gulf- scales) that govern the formation and evolution of structures and events, including generic processes and the coupling of wind-forced events and buoyancy currents
- obtain an intensive data set adequate for definitive quantitative skill assessment and suitable for the design of minimal data requirements for both REA and for an efficient regional monitoring and prediction system.

REA requires multiscale capabilities for different kinds of warfare (e.g. anti-submarine (ASW), mine warfare (MW), etc.). An experiment which is to assess the predictive skill of a forecast system must therefore measure and evaluate on multiple scales. Knowledge of the multiscale dynamics is essential. For ASCOT-01, the coupling extends from Massachusetts Bay, through the Gulf of Maine, out to the northwest Atlantic. Skill metrics will be designed to take the coupling of scales into account. All coastal regions require both generic and regional-specific metrics for the dominant variabilities. For example, upwelling is a generic process, however, the location and time of occurrence of upwelling is specific to the region.

As a predictive skill experiment, ASCOT-01 will include oversampling, in order that sources of error can be tracked. During the verification survey a significant fraction of the initialization survey will be repeated. Adaptive sampling survey patterns will be designed to address: 1) the interactions of Massachusetts Bay and the Gulf of Maine (inflow updates, exchanges, etc.); 2) response to storms or air-sea exchanges (upwelling, structures of currents and gyres, bifurcation structures in the Gulf of Maine, etc.); coupling of wind-response and buoyancy currents; reduction of multi-variate forecast errors; and, update of information for feature model parameters. Such scenarios will be designed in advance through OSSEs.

This document details the central stand-alone physics aspects of ASCOT-01. In addition to the acoustics experiment to take place during the experiment, it is hoped that additional collaborators will add other interdisciplinary aspects to the overall program.

3. Geographic and Oceanographic Context

ASCOT-01 will take place in Massachusetts Bay and the Gulf of Maine. Massachusetts Bay (including Cape Cod Bay) forms a semi-enclosed embayment adjacent to the Gulf of Maine. The dimensions of the system are approximately 100km by 50km; bounded by Cape Ann to the north, Cape Cod to the south, the coastline of Massachusetts to the west and Stellwagen Bank to the east. Stellwagen Bank rises to within 30m of the sea surface. There are channels to the north and south of Stellwagen Bank which connect with the Gulf of Maine. The North Passage has a sill depth of 60m and the South Passage has a sill depth of 50m. The deepest part of

Massachusetts Bay is Stellwagen Basin, just to the west of Stellwagen Bank, with depths of 80m-100m. The average depth of Massachusetts Bay is approximately 35m.

Historically, the mean circulation in Massachusetts Bay has been characterized as a cyclonic, southward flow. Water enters the bay flowing southwest as it passes Cape Ann. It then flows southward along the Massachusetts coastline, circulates through Cape Cod Bay and exits to the northeast by Race Point on Cape Cod. This flow is driven by both remote forcing from the Gulf of Maine and by wind stress. In addition to the mean circulation, tidal fluctuations, and upwelling and downwelling events play important roles in the circulation of Massachusetts Bay.

Figure 1, from model results with data assimilation, exemplifies the variability of the general multiscale circulation. Dynamically, much more variability than previously described has recently been found in the circulation structures. Strong wind events can control the qualitative structures of the buoyancy flow. The Gulf of Maine current can have three branches: the Massachusetts Bay coastal current, one which enters the Bay (but not Cape Cod Bay) and then exits at Race Point, and one which flows along Stellwagen Bank without entering Massachusetts Bay. A Cape Cod Bay gyre can be cyclonic, anti-cyclonic or absent. For several days following a wind event, the structure of the buoyancy current is maintained by a combination of inertia, topography, coastal geometry and internal dynamics. Sub-mesoscale vortices form between branches and filaments of the buoyancy Gulf of Maine current and/or mesoscale gyres.

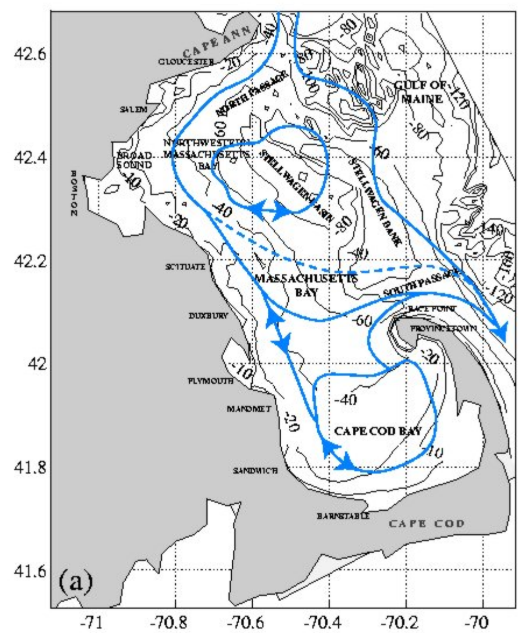


Figure 1 - Schematic of the buoyancy-driven circulation in Massachusetts Bay.

The Gulf of Maine is a semi-enclosed basin which has its natural large-scale circulation influenced by buoyancy driven inflow and outflow conditions, atmospheric forcing, topography, tides, river inflow and basin-wide pressure gradients. The Gulf of Maine is bounded on the north and west by the continental United States and on the east by Nova Scotia and the Bay of Fundy. To the south the Gulf of Maine is partially isolated from the Atlantic Ocean by Georges Bank, which in some areas rises to within a few meters of the sea surface. Exchanges between waters of the Gulf and the coastal Atlantic Ocean are confined mostly to the Scotian Shelf, the Northeast Channel and the Great South Channel. Inside the Gulf are three principal basins, separated at the 200m depth, but connected by sills. Jordan and Wilkinson Basins have maximum depths of about 270m, but Georges Basin, which forms the inner terminus of the Northeast Channel, contains the greatest depth, approximately 380m. A major part of the Gulf of Maine region is affected by the Gulf Stream System and the warm core rings generated by its large-amplitude meandering and growth events. These rings also influence the slope circulation to the south of the Gulf of Maine and Georges Bank ecosystem. The position and transport of the Gulf also plays a role in affecting the variability of the water-mass dynamics in the shelf/slope system.

The Gulf of Maine regional circulation is characterized by five important sets of circulation features: i) a buoyance driven coastal current; ii) tidal fronts fronts around Georges Bank, giving rise to the anti-cyclonic circulation pattern around the Bank; iii) cyclonic gyres centered around the basins in the deeper waters of the Gulf of Maine; iv) inflow and outflow regions of the basin; and, v) the cold pool. The major features of the region are listed in Table 1. The Gulf of Maine has a distinct inflow region through the Northeast Channel (NEC) and an outflow region through the Great South Channel (GSC). A major feature is the narrow Maine Coastal Current with its bifurcating and trifurcating regions. The deep basin regions are dominated by a topographically controlled cyclonic gyre system, named after the basins, i.e., the Georges Basin gyre, the Jordan Basin gyre and the Wilkinson Basin gyre. The circulation in the Gulf of Maine during the summer season is schematized in Figure 2.

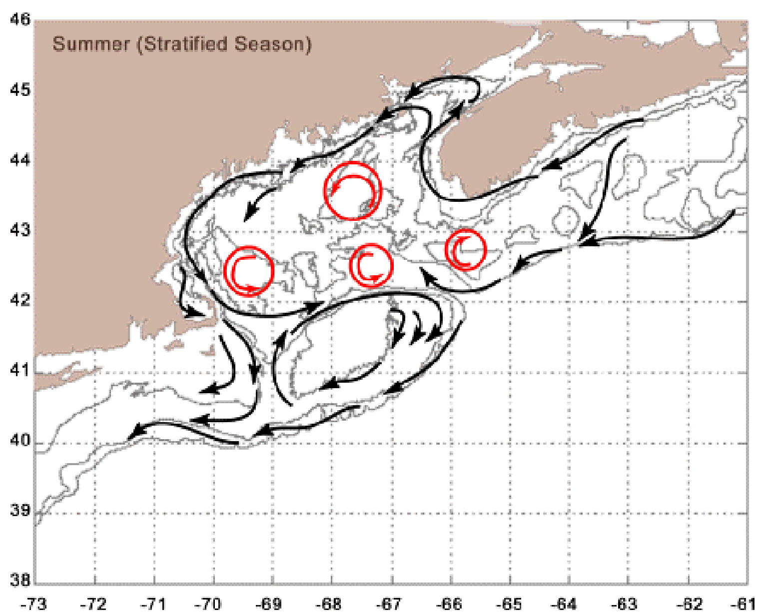


Figure 2 - Schematic of the summer circulation in the Gulf of Maine.

Table 1. List of GOMGB features and selected studies

Features	Selected Studies
Maine Coastal Current	Smith, 1989; Smith et al., 1989; Mountain and Manning, 1994; Beardsley et al, 1985; Brooks, 1987; Chapman and Beardsley, 1989; Bisagni et al., 1996; Brooks and Townsend, 1989; Mavor and Huq, 1996. Lynch et al, Lynch and Naimi, Naimi
NEC Inflow	Ramp et al., 1985
Gyre Circulation	Brooks, 1985; Brown and Irish, 1992; Mountain and Jessen, 1987; Brooks, 1990. Wright et al., 1986; Beardsley et al, 1997
GSC Outflow	Beardsley et al., 1985
Gorges Bank Anticyclonic circulation	Flagg, 1987; Butman and Beardsley, 1987; Butman et al., 1987
Jordan Basin Gyre	Pettiggrew et al, 1996
Wilkinson Basin Gyre	Brown et al, 1998 more….
Geroges basin Gyre	Pettigrew et al, 1996
Cold Pool	Bisagni et al, 1996
NEC Eddy	Bisagni and Smith
NEC Washover	Bisagni and Smith, 1998

4. Nested Modeling Domains

The ASCOT-01 simulation and operational system will consist of a set of three two-way nested domains: the Northwest Atlantic (NWA), the Gulf of Maine (GOM) and Massachusetts Bay (MB). The specifics of the individual domains are given in Table 2 and the domains are shown in the figure below. In the operational context, there will be two-way nesting between the NWA and GOM (NWA/GOM) domains and the GOM and MB (GOM/MB) domains. The NWA/GOM nested run will provide boundary conditions for the GOM during the GOM/MB nested run.

A two-way nested domain pair consists of a dynamical model defined in two domains, one with coarser resolution containing the other with finer resolution. Information from the finer resolution domain is used to replace information in the coarser resolution domain areas which intersects with the finer resolution domain (up-scale). Information from the coarser resolution domain around the boundaries of the finer resolution domain is interpolated to improve boundary information in the finer resolution domain (down-scale).

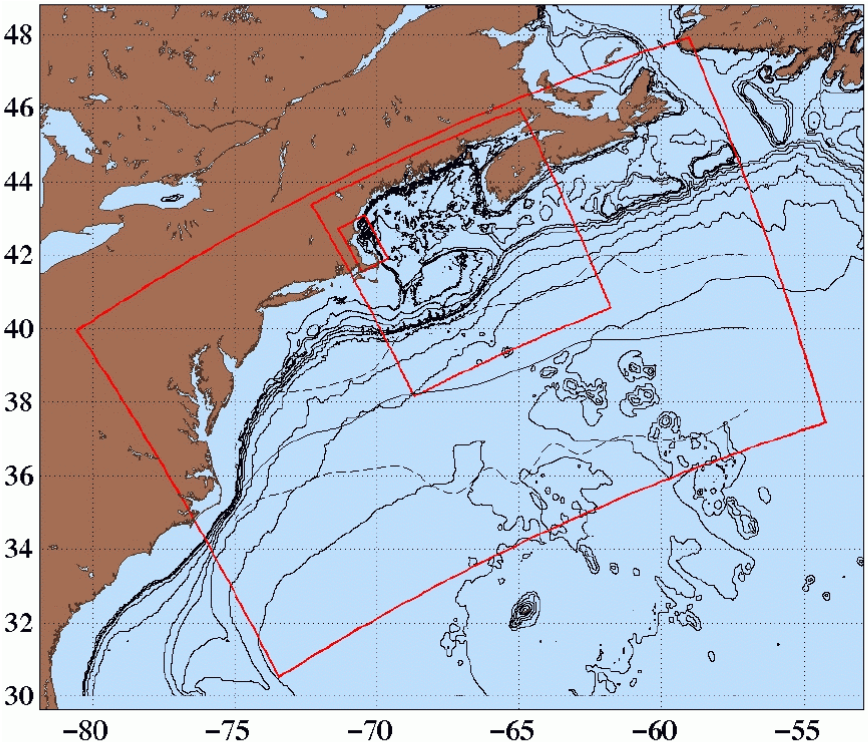


Figure 3 - Nested modeling domains

Table 2. Modeling Domains

DOMAIN	DESCRIPTION/ SPECIFICATION
Western North Atlantic	Resolution: 0.135 degrees (~15km) Size: 130x83x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 0 deg.; dely = 0 deg. Domain rotation: 25.5 degrees
Gulf of Maine	Resolution: 0.045 degrees (~5km) Size: 131x144 x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 1.2825 deg.; dely = 2.0475 deg. Domain rotation: 25.5 degrees
Massachusetts Bay	Resolution: 0.015 degrees (~5/3km) Size: 53x90x16 (nx x ny x nz) Transform center: 39.439250N, 67.1515W Domain offset: delx = -0.9675 deg. dely = 3.6975 deg. Domain rotation: 25.5 degrees

5. Ship requirements and instrumentation

The ASCOT-01 operational center will be aboard the NRV Alliance. The scientist in charge of ocean observations and the principle investigator for ocean modeling will embark with their groups. At least one additional ship is required for the experiment relating ocean variability to acoustic variability and coherence. In order to assure the presence and faithful operation of all systems for four days of the acoustic trial, the second ship is required for a period of seven days, optionally divided into 48-hour periods. Additional assets such as (coastal) ships and autonomous underwater vehicles are desired for fine-scale resolution of bay features, extended measurements in the Gulf of Maine, coupled and interdisciplinary experimentation (biogeochemical/ecosystem dynamics, acoustical dynamics, etc.).

Main instrumentation on Alliance consists of:

- Navigation
  - Integrated navigation system
  - Differential GPS

- Moorings
  - 600 kHz ADCP (Barny)
  - Two 300 kHz ADCPs (Sentinel)
  - Two real-time ADCP and profiling systems (SEPTR)
  - Wave rider buoy
  - Vertical hydrophone line array
  - Bottom mounted sound source (tower)

- Vertical profiles
  - Seabird CTD
  - Niskin Bottles

- Towed instruments
  - CTD chain

- Remote sensing
  - Sea Surface Temperature (AVHRR) satellite receiving and processing system
  - Ocean Color Scanner (SeaWiFS) receiving and processing system

- Data communications
  - Spread spectrum radio connection to tow ship
  - High bandwidth link with SACLANTCEN
  - Inmarsat B

- Computing
  - Processing systems for all acquired data

- Powerful workstations for ocean modeling

See the appendix for additional information on the NRV Alliance or visit the Alliance web site at: www.saclantc.nato.int/ships/alliance.html.

6. Schedule and sample tracks

The ASCOT-01 cruise of NRV Alliance is flanked in time by two cruises to the American East Coast. Passage of the NRV Alliance across the Atlantic Ocean will be in April and July. Port calls between cruises will be in Boston, each of two days duration.

Local time = Eastern Daylight Time (EDT)

Jun 04	0900	Alliance enters port of Boston
		Embark oceanographic groups, install equipment
Jun 06	0600	Alliance leave port
		Deploy ADCPs near Plymouth, near Race Point and near Cape Ann
	1800	Begin multiscale towed initialization survey of Massachusetts Bay (Fig. 4)
		Deploy CTD chain for towing on 70m water depth
Jun 07	0600	Shorten chain to 30 m
	1600	Shorten chain to 15 m
Jun 08	0600	Recover CTD chain north of Boston harbor.
		Begin Gulf of Maine CTD initialization survey (Fig. 4)
Jun 12	0600	Deployment of wave rider buoy, hydrophone vertical line array, source tower and CTD chain, the latter to be picked up by another survey ship
	1500	1st fixed range acoustic experiment on temporal and spatial variability
Jun 13	0800	Rearrangement of the acoustic track
	1400	2nd fixed range acoustic experiment on temporal and spatial variability
Jun 14	0600	Recover wave rider, acoustic source and receiver
		Adaptive Sampling CTD stations
Jun 15	0800	Deploy wave rider, acoustic source and receiver
	1500	3rd fixed range acoustic experiment on temporal and spatial variability
Jun 16	0800	Rearrangement of the acoustic track
	1400	4th fixed range acoustic experiment on temporal and spatial variability
Jun 17	0600	Recover wave rider, acoustic source and receiver, pick up CTD chain from second ship
		Adaptive Sampling CTD stations
Jun 18	0800	Port call Boston, disembark acoustics team
Jun 19	0800	Alliance leaves port of Boston
		Adaptive Sampling CTD stations
Jun 20	0900	Begin multiscale towed verification survey of Massachusetts Bay
		Deploy CTD chain for towing on 70 m water depth
	2200	Shorten chain to 30 m

Jun 21	0800	Shorten chain to 15 m
	2000	Recover CTD chain north of Boston harbor.
	2200	Begin Gulf of Maine CTD verification survey (see map and table)
Jun 25	1200	Interrupt CTD survey for ADCP recovery
Jun 26	0800	Alliance enter port Boston
		Disembark oceanographic groups

The towed CTD chain survey will precede the Gulf of Maine CTD survey. The towed CTD chain survey is designed to follow isobaths within Massachusetts Bay, thereby minimizing the number of manipulations (raising and lowering) of the CTD chain. The ship will survey inflow conditions first. The Gulf of Maine survey will begin subsequent to the completion of the Massachusetts Bay survey.

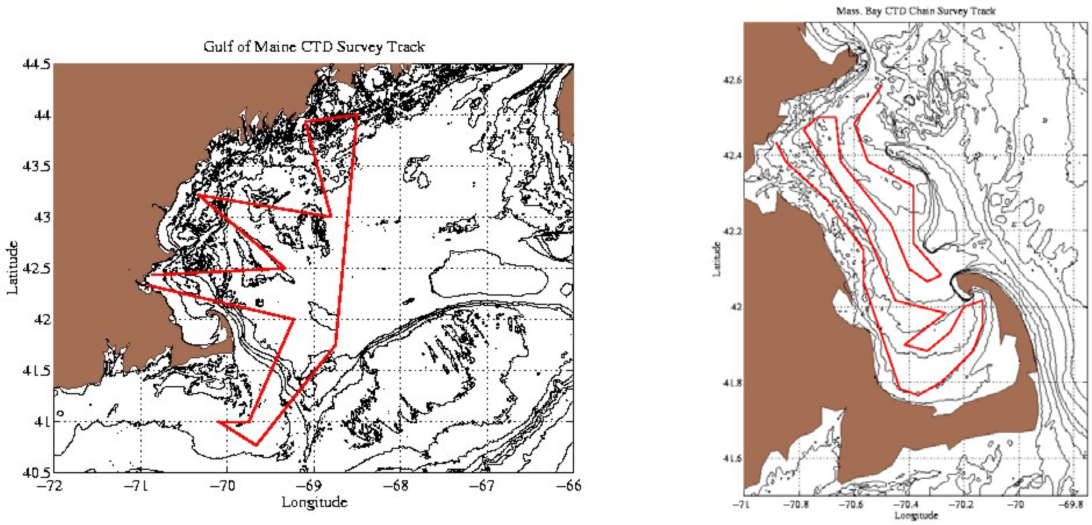


Figure 4 - Potential cruise tracks. Left - Gulf of Maine CTD survey. Right - Massachusetts Bay Towed CTD Chain survey.

7. Logistics

When NRV Alliance arrives in Boston, she will have all equipment on board except for the workstations of the Harvard group. Two days in port will be used for rearrangements in the laboratory.

An acquisition system for the CTD chain and spread spectrum radio communications must be installed on the second ship prior to the acoustic experiment. Under favorable weather conditions this might be possible at sea, an installation in port is preferred however. For the transfer of equipment between Alliance and the other ship, a van is required during the first and second port call in Boston. The CTD chain and communications systems on the second ship should be operated with the assistance of two SACLANTCEN technicians.

Ocean modeling carried out on NRV Alliance requires input from the outside such as atmospheric forcing fields. Since another group of modelers will be located elsewhere and the other group's model fields are required for nesting or comparison and vice versa, the data communications requirements exceed those of previous REA experiments. A satellite communication system will be installed on Alliance prior to the cruise by which transmission costs will be drastically reduced as compared with Inmarsat B.

8. Forecasting and Real-Time Products

Data analysis, data assimilation and numerical simulations will be carried out on a daily basis in real-time throughout the duration of the exercise. *In situ* data will be acquired by the NRV Alliance as well as by other chartered vessels or ships of opportunity. Remotely sensed data will be available via SACLANTCEN or other sites. Data will be analyzed, quality controlled and processed as it is received and made available for assimilation into the Harvard Ocean Prediction System (HOPS).

It is desirable to have the forecasts carried out in two modes: in Predictive Skill Assessment mode - i.e. using all data as acquired in order to most accurately predict future states; and in REA mode - i.e. using a reduced data set in order to mimic REA conditions and demonstrate the ability to utilize minimal data. This goal will be met if conditions and assets allow for separate forecast teams.

Forecasts will be available on a daily basis after the initialization survey in order to provide adaptive sampling patterns for the subsequent day's sampling. Products will be available via the experiment web site. Example products might include (for both the Gulf of Maine and Massachusetts Bay modeling domains): synoptic maps and forecasts of temperature or salinity with superimposed velocity vectors for levels of interest, vertical sections of chosen quantities at locations of interest, profiles of temperature or sound speed at locations of interest, etc.

9. Potential for Collaborations

The scientific plan presented here is for a self-consistent ASCOT-01 physical dynamical and forecast experiment. However, the core ASCOT-01 experiment provides an exceptional opportunity for extended physical experimentation and additional coupled interdisciplinary research in acoustics and biogeochemical/ecosystem dynamics and processes. The ASCOT-01 scientists welcome collaborations both of mutual interest and that would extend the impact or utility of the core experiment.

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Appendix - Alliance Characteristics

Length overall	93 m
Length between perpendiculars	82 m
Moulded beam	15.20 m
Depth, moulded	8.70 m
Draught, full load	5.2 m
Displacement, loaded	2,920 t
Gross tonnage	3,180 t
Net tonnage	960 t
Fuel capacity	315 cubic m
Fresh water	100 t
Shaft power (max. continuous)	2970 kw
Sustained sea speed	16.3 knots (Clean Hull)
Effective range at 11.5 knots	7200 n.mi
Endurance port to port	26 days
Main Masthead height	33.3 m (top of radar antenna)
Secondary Mast height	23.9 m (top of radar antenna)
Fore Mast	15.4 m (Railing top)

The vessel is equipped with twin (outward turning) screws, twin rudders, bow thruster and diesel/gas turbine electric propulsion machinery.

The vessel is designed for unmanned machinery and one-man bridge operation (daylight hours) for 24 hours a day when in a steady steaming condition.

Harvard Operational Logistics Plan

Shortly prior to the ASCOT-01 experiment, Harvard scientists produced an operational logistics plan which gives much more detailed information on the actual operational logistics of the real-time experiment. The document presents an operational timeline as well as sampling protocol. That logistics plan follows.

Assessment of Skill for Coastal Ocean Transients
ASCOT-01

Massachusetts Bay / Gulf of Maine
June 2001

An Experiment for Ocean Coastal Prediction and NATO Rapid Environmental Assessment Skills Evaluation

NATO NRV Alliance

Science and Operational Plan

A.R. Robinson, J. Sellschopp, J.J. McCarthy, W. G. Leslie

Harvard University
NATO SACLANT Undersea Research Centre

5 June 2001

This is the science and operational plan for the physical predictive skill experiment and the associated interdisciplinary dynamical process and coupled forecasting experiment and is a supplement to two prior documents which discuss goals, objectives, details of the predictive physical experiment and the scientific context of the interdisciplinary experiment.

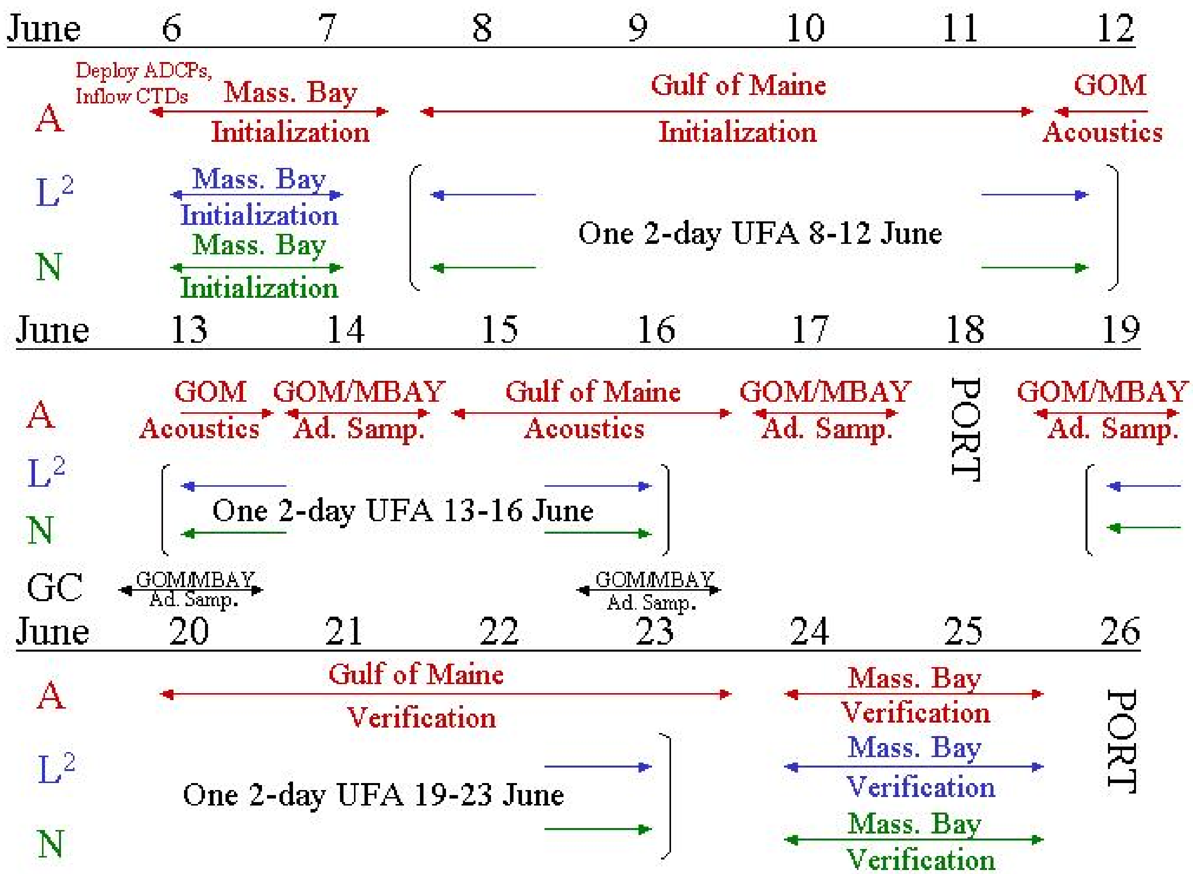
The specific objectives of the interdisciplinary measurements to be made from the R/V Lucky Lady and R/V Neritic (UMass-Dartmouth and UMass-Boston, respectively) have been focussed on: 1) the study of wind-driven episodic upwelling events; 2) the investigation of selected features and structures of the flow in Massachusetts Bay, including inflow from the Gulf of Maine, bifurcation points, etc.; and, 3) the attainment of coupled physical/biological data for assimilation in order to maintain a high-resolution three-dimensional time series of the physics and biology from 6-25 June. To accomplish the latter, the Massachusetts Bay verification survey has been shifted in time to follow the Gulf of Maine verification survey.

The Lucky Lady and Neritic will work together for five (5) 2-day long, daytime periods. The first and last of these are initialization and verification surveys. The three (3) additional 2-day experiments are designated on the timeline that follows as **UFA** (**U**pwelling/**F**eature/**A**ssimilation) studies. Note that each such **UFA** is scheduled to occur within a four-day window. The specific objectives and adaptive sampling for each **UFA** will be guided by weather forecasts and Harvard Ocean Prediction System (HOPS) forecasts of circulation and associated biological features. 2-3 days prior notification of the need for surveys will be attempted.

In addition to CTD's and fluorometry from the R/V Lucky Lady basic measurements of biological and chemical fields will include nutrients, chlorophyll and a full suite of plant pigments on selected stations, samples collected but not immediately processed for phytoplankton microscopic counts, zooplankton net collections and microscopic counts, and nitrogen turn-over times. In addition to CTD's and fluorometry from the R/V Neritic, water samples for a suite of organic chemistry analyses, including caffeine, dissolved organics and optics will be accomplished. Calibration stations (stations nearly simultaneous in space and time) for hydrographic and biological measurements are to be carried out.

R/V Neritic scientists will include: Profs. Bernie Gardner and Bob Chen and assistants (UMass-Boston). R/V Lucky Lady scientists will include: Prof. Avijit Gangopadhyay and assistants (UMass-Dartmouth), and Dr. J.F Bertrand and Ms. Patricia Moreno (Harvard). During ASCOT-01, the R/V Neritic will operate out of its home port. The R/V Lucky Lady will operate out of Sandwich and Dorchester (Quincy) - Marina Bay Marina. The Lucky Lady crew will overnight locally as necessary but can return home when possible.

Operational timeline



Data Logistics

NRV Alliance: data collected from the Alliance will be available on an ongoing routine daily basis shortly (within a few hours). Data collected overnight will likely be ready by 1030. It is expected that observations from CTDs, the CTD chain and XBTs will be made by the Alliance. Any hydrographic data collected aboard the *RV Gulf Challenger* will be transferred to and processed by the Alliance.

RV Neritic: CTD data collected aboard the Neritic will be emailed to leslie@pacific.deas.harvard.edu as soon as possible after the daily cruise is completed. The CTD data must undergo preliminary processing by the data collector to convert the raw data into ".cnv" or equivalent ascii files prior to file transfer.

RV Lucky Lady: CTD data collected aboard the Lucky Lady will be emailed to leslie@pacific.deas.harvard.edu as soon as possible after the daily cruise is completed. The CTD data must undergo preliminary processing by the data collector to convert the raw data into ".cnv" or equivalent ascii files prior to file transfer.

Hydrographic and fluorescence data collected during ASCOT-01 by all vessels will be converted into the standard Harvard "mods" format by Wayne Leslie and made available to Harvard-based forecasters immediately upon completion of data quality control.

Atmospheric forcing: data files from the Fleet Numerical Meteorology and Oceanography Center (FNMOC) are transferred from UMass.-Dartmouth (SMAST) to Harvard on a daily basis during the night. Those files will be processed by Oleg Logoutov as his initial daily responsibility (by 0900). The resulting processed files will be ftp'd by those aboard the Alliance to use in model simulations.

Sea Surface Temperature (SST): sea surface temperature from NOAA AVHRR is currently gathered in three ways: a) data files from Glenn Strout at UMass-Dartmouth (SMAST); b) images from UMaine via the Web; and, c) images from JHU/APL via the Web. Wayne Leslie will acquire all web-based images as an initial daily responsibility. Pat Haley will utilize Matlab scripts to process these images into gridded observations. The data files from Glenn Strout are generally available on a daily basis after being ftp'd to Harvard. These will be ftp'd to Alliance to incorporate when possible.

Sea Surface Color (SSC): sea surface color (chlorophyll) from SeaWiFS is available on a delayed basis in two ways: a) data files from Glenn Strout at UMass.-Dartmouth (SMAST); and, b) images from UMaine via the Web. Wayne Leslie will acquire all web-based images as an initial daily responsibility. The potential of use of the Maine images has not yet been completely explored. The data files from Glenn Strout are generally available on a daily basis after being ftp'd to Harvard. These will be ftp'd to Alliance to incorporate when possible.

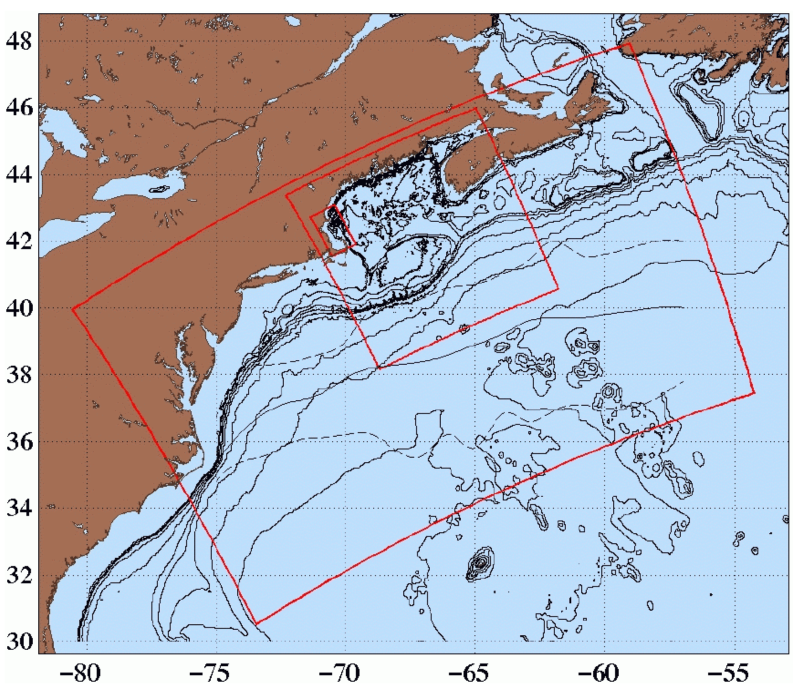
All files generated aboard the Alliance will be made available via the Web or via ftp to Harvard-based researchers.

Forecast Protocol

Model simulations will be carried out both aboard the Alliance and at Harvard. The operational forecasts will generally be performed aboard the Alliance. Product releases will be from the Alliance via the Web. Error Subspace Statistical Estimation (ESSE) forecasts will be completed at Harvard.

The ASCOT-01 simulation and operational system will consist of a set of three two-way nested domains: the Northwest Atlantic (NWA), the Gulf of Maine (GOM) and Massachusetts Bay (MB). The specifics of the individual domains are given in the table and the domains are shown below. In the operational context, there will be two-way nesting between the NWA and GOM (NWA/GOM) domains and the GOM and MB (GOM/MB) domains. The NWA/GOM nested run will provide boundary conditions for the GOM during the GOM/MB nested run.

A two-way nested domain pair consists of a dynamical model defined in two domains, one with coarser resolution containing the other with finer resolution. Information from the finer resolution domain is used to replace information in the coarser resolution domain areas which intersects with the finer resolution domain (up-scale). Information from the coarser resolution domain around the boundaries of the finer resolution domain is interpolated to improve boundary information in the finer resolution domain (down-scale).



Nested modeling domains
(The Gulf of Maine domain has been since expanded southward;
the table on the next page accurately reflects the domain specifications.)

Modeling Domains

DOMAIN	DESCRIPTION/ SPECIFICATION
Western North Atlantic	Resolution: 0.135 degrees (~15km) Size: 130x83x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 0 deg.; dely = 0 deg. Domain rotation: 25.5 degrees
Gulf of Maine	Resolution: 0.045 degrees (~5km) Size: 131x144 x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 1.2825 deg.; dely = 2.0475 deg. Domain rotation: 25.5 degrees
Massachusetts Bay	Resolution: 0.015 degrees (~5/3km) Size: 53x90x16 (nx x ny x nz) Transform center: 39.439250N, 67.1515W Domain offset: delx = -0.9675 deg. dely = 3.6975 deg. Domain rotation: 25.5 degrees

Typical model simulations will last for seven model days. This duration allows for the assimilation of hydrographic and remotely sensed data, a nowcast and short (four day) forecast. Lengthier forecasts are possible but are not considered necessary at this time. Forecasts products may include, but are not limited to, maps of temperature, salinity, sub-tidal velocity, chlorophyll and various forecast predictive skill metrics. Given the current modeling domain configuration, in a triple-nested mode, a single seven-day long simulation requires approximately twelve hours of clock time to complete. Individual domains in stand-alone mode can be forecast in a shorter time period (~2 hours for the Massachusetts Bay domain).

On a typical forecast day (Day 0) aboard the Alliance, the following protocol will be followed:

1. Evaluate and interpret the physical forecast launched the previous day (Day -1) and also interpret the biological forecast received the previous night (Day -1) or the night before (Day -2).
2. Plan adaptive sampling for the subsequent two days and anticipate interesting sampling for the following day.
   * confirm operation of coastal vessels and furnish sampling plan for tomorrow
   * alert coastal vessels of impending use - determine scientific motivation (UFA) and general area of operations - allow time for coastal vessels to deal with logistical issues
3. Prepare and launch daily forecast
   * data management and quality control (2 hours)
   * objective analysis of observations and prepare initialization (2 hours)
   * launch forecast (approximately 1430)

At Harvard, the coupled physical/biological simulations will be run in a stand-alone Massachusetts Bay domain. In general, with the exception of 7-8 June, the simulations will be performed on an every-other day basis. This will make biological fields available for interpretation on the mornings of 8, 9, 11 June, etc.

ESSE estimates from the coupled physical/biological ESSE will be made for (tentatively) 13-14 June, 20-21 June and 25-26 June in order to be of value and provide guidance to the periods of time available for adaptive sampling.

Contact Information

Prof. Allan R. Robinson	robinson@pacific.deas.harvard.edu	617-495-2819 (Office) 617-267-4359 (Home) 617-512-6437 (Cell)
Prof. James J. McCarthy	jmccarthy@oeb.harvard.edu	617-495-2330 (Office) 617-492-3076 (Home) 617-699-7649 (Cell)
Dr. Mike Mickelson	mike.mickelson@mwra.state.ma.us	617-788-4746 (Office)
Prof. Bernie Gardner	bernie.gardner@umb.edu	617-287-7451 (Office) 781-883-8140 (Cell)
Dr. Carlton Hunt	huntc@battelle.org	781-934-0571 (Office)
Prof. Avijit Gangopadhyay	agangopadhya@uassd.edu	508-910-6330 (SMAST) 508-999-8493 (Physics) 508-984-7384 (Home)
Wayne Leslie	leslie@pacific.deas.harvard.edu wgleslie@aol.com	617-495-4569 (Office) 781-665-5170 (Home) 617-495-5192 (Fax) 781-718-1856 (Cell)
J.F. Bertrand	jfbertrand@oeb.harvard.edu	617-495-5600 (Office)
Pat Haley	haley@pacific.deas.harvard.edu	617-495-2827 (Office)
Pierre Lermusiaux	pierrel@pacific.deas.harvard.edu	617-495-0378 (Office)
Oleg Logoutov	oleg@pacific.deas.harvard.edu	617-496-4939 (Office)
Patricia Moreno	pmoreno@pacific.deas.harvard.edu	617-495-8051 (Office)
Gioia Sweetland	gioia@pacific.deas.harvard.edu	617-495-2919 (Office)
Ray Rock (Lucky Lady skipper)	rrocksr@aol.com	508-994-8390 (Home) 508-326-3075 (Cell)
Peter Edwards (Neritic skipper)		617-908-9256 (Cell)
Jeff Turner	jturner@umassd.edu	508-910-6332 (SMAST) 508-999-8229 (Office)
NRV Alliance	INMARSAT calls are extremely expensive - use only in an emergency.	00871-321-811-010 (INMARSAT B Voice) 00871-321-811-012 (INMARSAT B Fax)

Station Protocol for ASCOT-1 survey aboard the R/V Lucky Lady

Order of events
In the AM contact Battelle to arrange drop off of samples when return time is known.

Arrive on station

Record station id, start(when CTD is lowered to lowest point), time lat, long,(degrees & minutes to 2 decimals) depth (meters)

- Time should be in UTC (DST plus 4).

Lower, retrieve CTD, determine thermocline

6. The CTD is a SeaBird SBE-19 which measures pressure, temperature, conductivity and fluorescence (chlorophyll-alpha) at 2 Hz (2 samples/second). The Seabird software calculates salinity.
7. I'll bring calibration sheets and instrument specs.
8. I'll also loan you a PC to remain on the LL for the duration.
9. It will be necessary to create an operational instruction sheet (from cast to analysis)
10. Obviously, we will have to upload data after every cast. This will take 10 minutes or less to upload and display results.
11. We'll need to determine
    (1) Rate to lower CTD (1 ft/sec = 10 m/min. 60 samples/min = 6 samples/m)
    (2) Distance from bottom to stop CTD. Depends on vessel fathometer accuracy and how much near-bottom info is desired.

Determine Secchi depth

Lower retrieve Niskin bottle for 1st DIN/Chlor sample (1-3 meters below thermocline)
Lower retrieve Niskin bottle for 2nd DIN sample (3-5 meters above bottom)
Lower retrieve Niskin bottle for 2nd Chlor sample and 3rd DIN sample (1-3 meters below surface
HPLC samples? (√ w/ JJM)
Record data for each sample (see log)

- The order of these samples will change depending on the particular survey (see attached "STUDY ORDER)
- I suggest we sample all three depths at once. We have three 2.5 l Niskin bottles which we can place on line at specified depths and close all at once.
- We do not have messengers—hopefully the Lucky Lady has some.
- Remember - this depends on how much water you'll need for CHL-A and DIN
- If you don't need to find the exact thermocline positions each time, we can add Niskin bottles during CTD cast (eg – 2 m from cast bottom (right above CTD, at estimated thermocline (this will be a range depending on the current state of theocean) and 2 m below the surface.

Tow zooplankton net
Transfer zooplankton to pretreated specimen bottle, label, log
Record end station lat long depth

- As above – normally it is a safer practice to log positions of each sample (for instance, you will have to accurately reconstruct time in water and distance traveled if you want to determine zooplankton density during the tow).

Filter, label, log, freeze DIN 40ml samples in 60ml bottles (syringe filtered through nucleopore d47mm 0.4 µm-membrane-fiber filter)
Filter 400 ml Chlor samples onto Whatman 42.5mm GF/C $MgCO_3$ treated glass fiber filters, fold, wrap in aluminium foil, label, log, freeze

Proceed to next station

CTD must be lowered and retrieved first since sampling depths will depend on thermocline

There should be two to three Niskin sampling events (this will probably be the most time consuming procedure while on station.)

Sample treatment can be done while towing plankton net, and on the way to the next station

A paper log, including COC forms, will be kept in a binder for all stations and samples.

JF and Patricia will transport samples to Battelle in the evening

STUDY ORDER (for samples)

INITIALIZATION SURVEY (6 AND 7 JUNE)

R/V Neritic - DIN samples
 8 stations @ 4/day (√ w/ Wayne Leslie for station location)
 3 samples/station (middle of mixed layer, 3-5 m below thermocline, 3-5 m above bottom
 8 x 3 = 24 DIN samples

R/V Lucky Lady - DIN samples
 8 stations @ 4/day (√ w/ Wayne Leslie for station location)
 3 samples/station (middle of mixed layer, 3-5 m below thermocline, 3-5 m above bottom
 8 x 3 = 24 DIN samples (DIN Total 48)

R/V Lucky Lady - Chlor. Samples
 8 stations @ 4/day (same as DIN stations)
 2 samples/station (middle of mixed layer, 3-5 m below thermocline)
 8 x 2 = 16 Chlor samples

R/V Lucky Lady - Zooplankton samples
 8 stations @ 4/day (same as DIN stations
 1 fifteen minute tow (Verify procedure w/ Ray Rock)
 8 Zoo. samples

UFA - INFLOW EXPERIMENT (date to be determined)

R/V Lucky Lady - DIN samples
 10 stations @ 5/day (locations TBD)
 2 samples/station (3-5 m below thermocline, 3-5 m above bottom)
 10 x 2 = 20 DIN samples (DIN Total 68)

R/V Lucky Lady - Chlor Samples
 10 stations @ 5/day (same as DIN stations))
 2 samples/station (middle of mixed layer, 3-5 m below thermocline)
 8 x 2 = 16 Chlor samples (Chlor Total 32)

R/V Lucky Lady - Zooplankton samples
 10 stations @ 5/day (same as DIN stations
 1 fifteen minute tow (Verify procedure w/ Ray Rock)
 10 Zoo. Samples (Zoo Total 18)

UFA - UPWELLING EXPERIMENT (X 2) (dates to be determined)

R/V Lucky Lady - DIN samples
 12 stations (locations TBD)
  2 samples/station (3-5 m below thermocline, 3-5 m above bottom)
 6 stations (locations TBD)
  3 samples/station (middle of mixed layer, 3-5 m below themocline, 3-5 m above bottom)
 (12 x 2) + (6 x 3) =42 times 2 = 84 (DIN Total 152)

R/V Lucky Lady - Chlor samples
- 9 stations/day
- 12 stations (same as DIN stations)
  - 2 samples/station (middle of mixed layer, 3-5 m below thermocline)
- 6 stations (locations TBD)
  - 3 samples/station (two samples distributed in mixed layer, one sample 3 -5 m below thermocline)

(12 x 2) + (6 x 3) =42 times 2 = 84 (Chlor Total 116)

R/V Lucky Lady - Zooplankton samples
- 18 stations @ 9/day (same as DIN stations
- 1 fifteen minute tow (Verify procedure w/ Ray Rock)
- *18 Zoo. Times 2 = 36 (ZooTotal 54)*

VERIFICATION SURVEY (24 AND 25 JUNE)

R/V Neritic - DIN samples
- 8 stations @ 4/day (√ w/ Wayne Leslie for station location)
- 3 samples/station (middle of mixed layer, 3-5 m below thermocline, 3-5 m above bottom
- *8 x 3 = 24 DIN samples (DIN Total 176)*

R/V Lucky Lady - DIN samples
- 8 stations @ 4/day (√ w/ Wayne Leslie for station location)
- 3 samples/station (middle of mixed layer, 3-5 m below thermocline, 3-5 m above bottom

8 x 3 = 24 DIN samples (DIN Total 200)

R/V Lucky Lady - Chlor. Samples
- 8 stations @ 4/day (same as DIN stations)
- 2 samples/station (middle of mixed layer, 3-5 m below thermocline)
- *8 x 2 = 16 Chlor samples (Chlor Total 132)*

R/V Lucky Lady - Zooplankton samples
- 8 stations @ 4/day (same as DIN stations
- 1 fifteen minute tow (Verify procedure w/ Ray Rock)
- *8 Zoo. Samples (Zoo Total 62)*

SACLANTCEN Trials Plan

In preparation for the ASCOT-01 experiment, SACLANTCEN scientists produced a “trials” plan which introduces the experiment, defines the goals and objectives, describes the geographic and oceanographic context, specifies the modeling domains and schedule, documents the specifics of the experiment which are not included within the Harvard context, and provides information required by the SACLANTCEN administration and protocols. That trials plan follows.

SACLANT UNDERSEA RESEARCH CENTRE

TRIALS PLAN
25 February 2001

TITLE:	**ASCOT 01**
PROJECTS:	**01A, 01B**
PERIOD COVERED:	**2 - 26 June 2001**
RESEARCH SHIP	**ALLIANCE**
GEOGRAPHIC AREA:	Gulf of Maine
SCIENTIST-IN-CHARGE:	J. Sellschopp
PRINCIPLE INVESTIGATOR:	A.R. Robinson
ACOUSTIC TESTS DIRECTOR:	M. Siderius
ENGINEERING COORDINATOR:	R. Stoner
DATA ACQUISITION COORDINATOR:	A. Cavanna

Assessment of Skill for Coastal Ocean Transients ASCOT-01

An Experiment for Coastal Ocean Prediction and NATO Rapid Environmental Assessment Skills Evaluation

1. PURPOSE

1.1 Introduction

Coastal Predictive Skill Experimentation (CPSE) measures the ability of a forecast system to combine model results and observations in coastal domains or regimes and to accurately define the present state and predict the future state. Rapid Environmental Assessment (REA) is defined in the military environment as "the acquisition, compilation and release of tactically relevant environmental information in a tactically relevant time frame". Ocean forecasting is essential for effective and efficient REA operations. A REA CPSE must be designed to determine forecast skill on the basis of minimal and covertly attainable observations and thus may be most efficiently carried out in the context of the definitive over-sampling provided by a CPSE.

Environmental observations are a necessity for initialization and updating of ocean forecasts. Numerical ocean forecast capabilities in general consist of observational networks, data assimilation schemes and dynamic forecast models. Since observations are the most expensive part of the forecast and are often difficult to achieve, methods that would reduce the requirements are highly desirable. Knowledge of features, structures and the dynamics which evolves them is necessary for successful forecasting. Adaptive sampling of the observations of greatest impact increases efficiency and can drastically reduce the observational requirements, i.e. by one or two orders of magnitude. This project will develop methodology for ocean forecasting using minimum input.

The Assessment of Skill for Coastal Ocean Transients (ASCOT) project is a series of real-time CPSE/REA experiments and simulations focussed on quantitative skill evaluation and cost-effective forecast system development. ASCOT-01, to be carried out in Massachusetts Bay/Gulf of Maine in June 2001, is the first such experiment. ASCOT-02 is planned for somewhere in the Mediterranean Sea in 2002.

1.2 Goals and Objectives

ASCOT Overall Goal: to enhance the efficiency, improve the accuracy and extend the scope of nowcasting and forecasting of oceanic fields for Coastal Predictive Skill Experimentation and for Rapid Environmental Assessment in the coastal ocean and to quantify such CPSE and REA capabilities.

ASCOT General Objectives:

- obtain data sets adequate for: 1) definitive real-time verification of regional coastal ocean predictive skills, with and without REA constraints; 2) CPSE and REA Observational System Simulation Experiments (OSSEs), both for ASCOT design and more generally; and, 3) definitive knowledge of dynamics
- define useful skill metrics and real-time forecast validation and verification procedures for

REA

- assemble, calibrate, exercise in real-time, evaluate and improve a generic, portable, scalable advanced ocean forecast system (dynamical models and data analysis, management and assimilation schemes) applicable for CPSE in general and NATO REA in particular.

ASCOT-01 Objectives:

- carry out and quantitatively evaluate in Massachusetts Bay (MB) and the Gulf of Maine (GOM) a coupled multiscale interdisciplinary real-time forecast experiment
- obtain a data set adequate to define multiscale dynamical processes (submeso-, meso-, bay-, gulf- scales) that govern the formation and evolution of structures and events, including generic processes and the coupling of wind-forced events and buoyancy currents
- obtain an intensive data set capable of providing a context for interdisciplinary forecasting, maintaining a continuous synoptic description of Mass. Bay with mesoscale resolution throughout and sub-mesoscale resolution as dynamically necessary, adequate for definitive quantitative skill assessment and suitable for the design of minimal data requirements for both REA and for an efficient regional monitoring and prediction system.

REA requires multiscale capabilities for different kinds of warfare (e.g. anti-submarine (ASW), mine warfare (MW), etc.). An experiment which is to assess the predictive skill of a forecast system must therefore measure and evaluate on multiple scales. Knowledge of the multiscale dynamics is essential. For ASCOT-01, the coupling extends from Massachusetts Bay, through the Gulf of Maine, out to the northwest Atlantic. Skill metrics will be designed to take the coupling of scales into account. All coastal regions require both generic and regional-specific metrics for the dominant variabilities. For example, upwelling is a generic process, however, the location and time of occurrence of upwelling is specific to the region.

As a predictive skill experiment, ASCOT-01 will include oversampling, in order that sources of error can be tracked. During the verification survey a significant fraction of the initialization survey will be repeated. Adaptive sampling survey patterns will be designed to address: 1) the interactions of Massachusetts Bay and the Gulf of Maine (inflow updates, exchanges, etc.); 2) response to storms or air-sea exchanges (upwelling, structures of currents and gyres, bifurcation structures in the Gulf of Maine, etc.); coupling of wind-response and buoyancy currents; reduction of multi-variate forecast errors; and, update of information for feature model parameters. Such scenarios will be designed in advance through OSSEs.

This document details the central stand-alone physics aspects of ASCOT-01. An addendum (McCarthy, 2000) describes the biological component of ASCOT-01. In addition to an acoustics experiment to take place during the experiment, it is hoped that additional collaborators will add other interdisciplinary aspects to the overall program. The primary platform from which data will be collected will be the NRV Alliance. Additional vessels will be utilized for: interdisciplinary studies, acoustics, adaptive sampling and the maintenance of a synoptic description of Massachusetts Bay; as was done in the LOOPS Massachusetts Bay Sea Trial 1998 experiment (Robinson *et al*., 1999; Besiktepe *et al*., 1999).

Acoustic experiments objectives

To better understand how the oceanographic processes influence acoustic signals the OCD and ACD departments will combine their expertise in the ASCOT-01 joint oceanographic and acoustic sea-trial. These experiments will provide a basic data set to measure the temporal coherence of acoustic signals and to better understand the dominant mechanisms on acoustics in shallow water. Broad-band (150—5000 Hz) acoustic signals from a bottom-moored source will be transmitted over fixed paths and received on a moored vertical hydrophone array. During the transmissions extensive environmental measurements (e.g. sound speed, current, sea-surface wave height etc.) will be made to correlate the time-varying environmental and acoustic data. The purpose of these experiments is to provide data for analysis in the ASW (04) and REA (01) thrust areas. The details of the ASW and REA research with the ASCOT-01 data are described below:

Thrust 01- REA (Geo-acoustic inversion)

Acoustic data measured in the ocean fluctuates due to the complex time varying properties of the channel. When measured data is used for model-based, geo-acoustic inversion, how do acoustic fluctuations impact estimates for the seabed properties? Developing an operational, rapid environmental assessment (REA) capability requires the method to be tested for robustness to oceanographic conditions. To accomplish this, data will be collected with a fixed sound projector and vertical array over a three-day period. This data will be used to quantify some of the limitations on the inversion techniques caused by: ocean time variability, ocean spatial variability, seabed spatial variability, acoustic aperture size and signal bandwidth. These experiments will be used for comparison with modeling shallow water acoustic propagation and to determine the impact on inversion for seabed properties.

Thrust 04- ASW (Performance Prediction)

ASW sonar systems operate in a time-varying ocean environment, which affects acoustic propagation and therefore sonar system performance. Prediction systems (e.g., tactical decision aids or mission planning tools) traditionally characterize the ocean environment as constant, resulting in inaccuracies that limit their utility. Sophisticated oceanographic and acoustic propagation models exist and can be used to characterize the uncertainty of the acoustic fields and the subsequent effect on sonar system performance. However, testing the predictive capabilities of these models requires careful analysis of simultaneously measured oceanographic and acoustic data. These measurements are planned for the ASCOT-01 experiments. This unique data set will be used to characterize the uncertainty in acoustic propagation and relate it to variations in oceanographic conditions. The results of this analysis will determine the dominant oceanographic conditions producing uncertainty and provide a paragon for any models that are developed to predict uncertainty in acoustic propagation. This can be accomplished as follows:

1. Use measured transmission loss (TL) to empirically characterize the observed variability in terms of a probability density function (PDF) and relate the uncertainty to any potentially causal oceanographic conditions. Such a statistical characterization is easily used to modify the sonar equation to provide a more accurate prediction of probability of detection and other relevant performance measures.

2. Test the hypothesis that sound velocity profiles (SVP) and wave-height time variability explain sufficiently the statistical variability in the TL. This will be accomplished by comparing the measured variability in TL with that obtained from a range-dependent acoustic propagation model using measured SVP's (collected using data from a towed, vertical CTD chain) and measured wave-heights (using Wave-Rider buoys). Such a relationship implies that the statistical variability in TL can be predicted from measured CTD chain and wave-height data.

3. Given successful testing of the previous hypothesis, evaluate the statistical variability of TL for a wide variety of test sites and seasons using available CTD chain data.

1.3 Geographic and Oceanographic Context

ASCOT-01 will take place in Massachusetts Bay and the Gulf of Maine. Massachusetts Bay (including Cape Cod Bay) forms a semi-enclosed embayment adjacent to the Gulf of Maine. The dimensions of the system are approximately 100km by 50km; bounded by Cape Ann to the north, Cape Cod to the south, the coastline of Massachusetts to the west and Stellwagen Bank to the east. Stellwagen Bank rises to within 30m of the sea surface. There are channels to the north and south of Stellwagen Bank which connect with the Gulf of Maine. The North Passage has a sill depth of 60m and the South Passage has a sill depth of 50m. The deepest part of Massachusetts Bay is Stellwagen Basin, just to the west of Stellwagen Bank, with depths of 80m-100m. The average depth of Massachusetts Bay is approximately 35m.

Historically, the mean circulation in Massachusetts Bay has been characterized as a cyclonic, southward flow. Water enters the bay flowing southwest as it passes Cape Ann. It then flows southward along the Massachusetts coastline, circulates through Cape Cod Bay and exits to the northeast by Race Point on Cape Cod. This flow is driven by both remote forcing from the Gulf of Maine and by wind stress. In addition to the mean circulation, tidal fluctuations, and upwelling and downwelling events play important roles in the circulation of Massachusetts Bay.

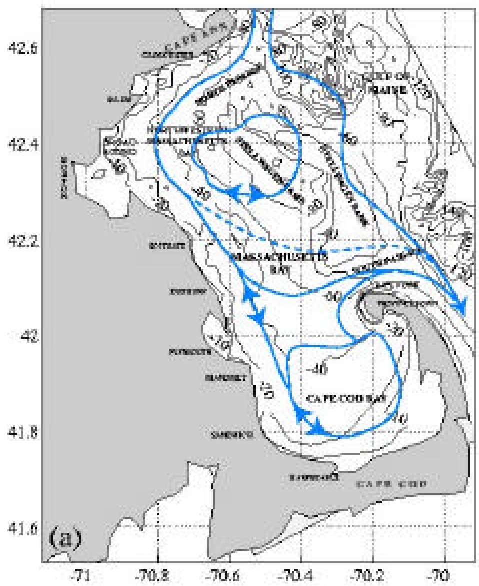


Figure 1 - Schematic of the buoyancy-driven circulation in Massachusetts Bay.

Figure 1, from model results with data assimilation, exemplifies the variability of the general multiscale circulation. Dynamically, much more variability than previously described has recently been found in the circulation structures. Strong wind events can control the qualitative structures of the buoyancy flow. The Gulf of Maine current can have three branches: the Massachusetts Bay coastal current, one which enters the Bay (but not Cape Cod Bay) and then exits at Race Point, and one which flows along Stellwagen Bank without entering Massachusetts Bay. A Cape Cod Bay gyre can be cyclonic, anti-cyclonic or absent. For several days following a wind event, the structure of the buoyancy current is maintained by a combination of inertia, topography, coastal geometry and internal dynamics. Sub-mesoscale vortices form between branches and filaments of the buoyancy Gulf of Maine current and/or mesoscale gyres.

The Gulf of Maine is a semi-enclosed basin which has its natural large-scale circulation influenced by buoyancy driven inflow and outflow conditions, atmospheric forcing, topography, tides, river inflow and basin-wide pressure gradients. The Gulf of Maine is bounded on the north and west by the continental United States and on the east by Nova Scotia and the Bay of Fundy. To the south the Gulf of Maine is partially isolated from the Atlantic Ocean by Georges Bank, which in some areas rises to within a few meters of the sea surface. Exchanges between waters of the Gulf and the coastal Atlantic Ocean are confined mostly to the Scotian Shelf, the Northeast Channel and the Great South Channel. Inside the Gulf are three principal basins, separated at the 200m depth, but connected by sills. Jordan and Wilkinson Basins have maximum depths of about 270m, but Georges Basin, which forms the inner terminus of the Northeast Channel, contains the greatest depth, approximately 380m. A major part of the Gulf of Maine region is affected by the Gulf Stream System and the warm core rings generated by its large-amplitude meandering and growth events. These rings also influence the slope circulation to the south of the Gulf of Maine and Georges Bank ecosystem. The position and transport of the Gulf also plays a role in affecting the variability of the water-mass dynamics in the shelf/slope system.

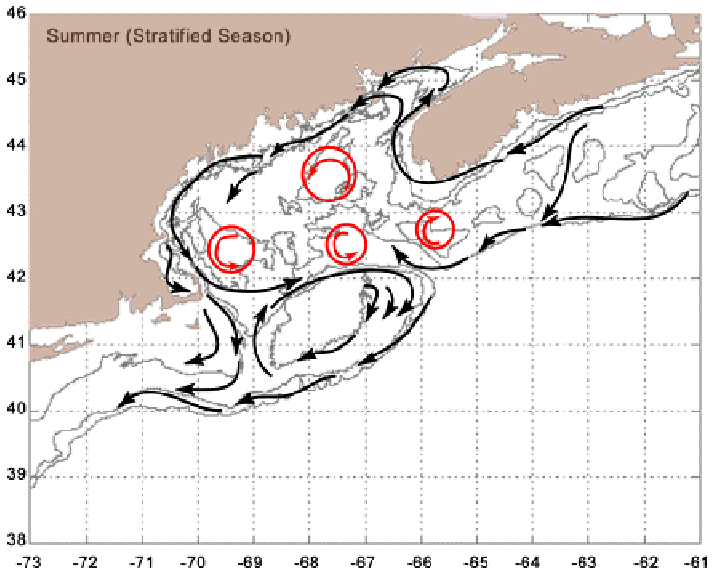


Figure 2 - Schematic of the summer circulation in the Gulf of Maine.

The Gulf of Maine regional circulation is characterized by five important sets of circulation features: i) a buoyancy driven coastal current; ii) tidal fronts around Georges Bank, giving rise to the anti-cyclonic circulation pattern around the Bank; iii) cyclonic gyres centered around the basins in the deeper waters of the Gulf of Maine; iv) inflow and outflow regions of the basin; and, v) the cold pool. The major features of the region are listed in Table I. The Gulf of Maine has a distinct inflow region through the Northeast Channel (NEC) and an outflow region through the Great South Channel (GSC). A major feature is the narrow Maine Coastal Current with its bifurcating and trifurcating regions. The deep basin regions are dominated by a topographically controlled cyclonic gyre system, named after the basins, i.e., the Georges Basin gyre, the Jordan Basin gyre and the Wilkinson Basin gyre. The circulation in the Gulf of Maine during the summer season is schematized in Figure 2.

Table I. List of GOMGB features and selected studies

Features	Selected Studies
Maine Coastal Current (including Great South Channel Outflow)	Beardsley et al., 1985; Bisagni et al., 1996; Brooks, 1987,1990,1994; Brooks and Townsend, 1989; Chapman and Beardsley, 1989; Holboke and Lynch, 1995; Mavor and Huq, 1996; Mountain and Manning, 1994; Lynch et al., 1992,1996; Lynch, 1999; Naimie et al., 1994; Naimie, 1995,1996; Smith, 1989
Georges Bank Anticyclonic circulation, Tidal fronts	Loder *et al.*, 1992; Butman and Beardsley, 1987a,b; Butman *et al.*, 1987; Bisagni *et al.*, 1996; Flagg, 1987; Houghton *et al.*, 1982
Jordan Basin Gyre	Brooks, 1987; Pettiggrew *et al.*, 1998; Wright *et al.*, 1986; Beardsley *et al.*, 1997
Wilkinson Basin Circulation	Brown and Beardsley, 1978; Brown and Irish, 1992, 1993; Brown, 1998; Mountain and Jessen, 1987
Georges Basin Gyre	Brooks, 1985; Wright *et al.*, 1986; Beardsley *et al.*, 1997; Pettigrew *et al.*, 1998, Xue *et al.*, 2000
North East Channel Inflow	Brooks, 1987; Ramp *et al.*, 1985; Bisagni and Smith, 1998

1.4 Acoustic test range

Acoustic experiments will be carried out outside Massachusetts Bay east of the Stellwagen Bank mammals sanctuary. Extensive information of Stellwagen Bank can be found on the Internet, see e.g. http://www.coreresearch.org/stelljeff.html or Fig. 3.

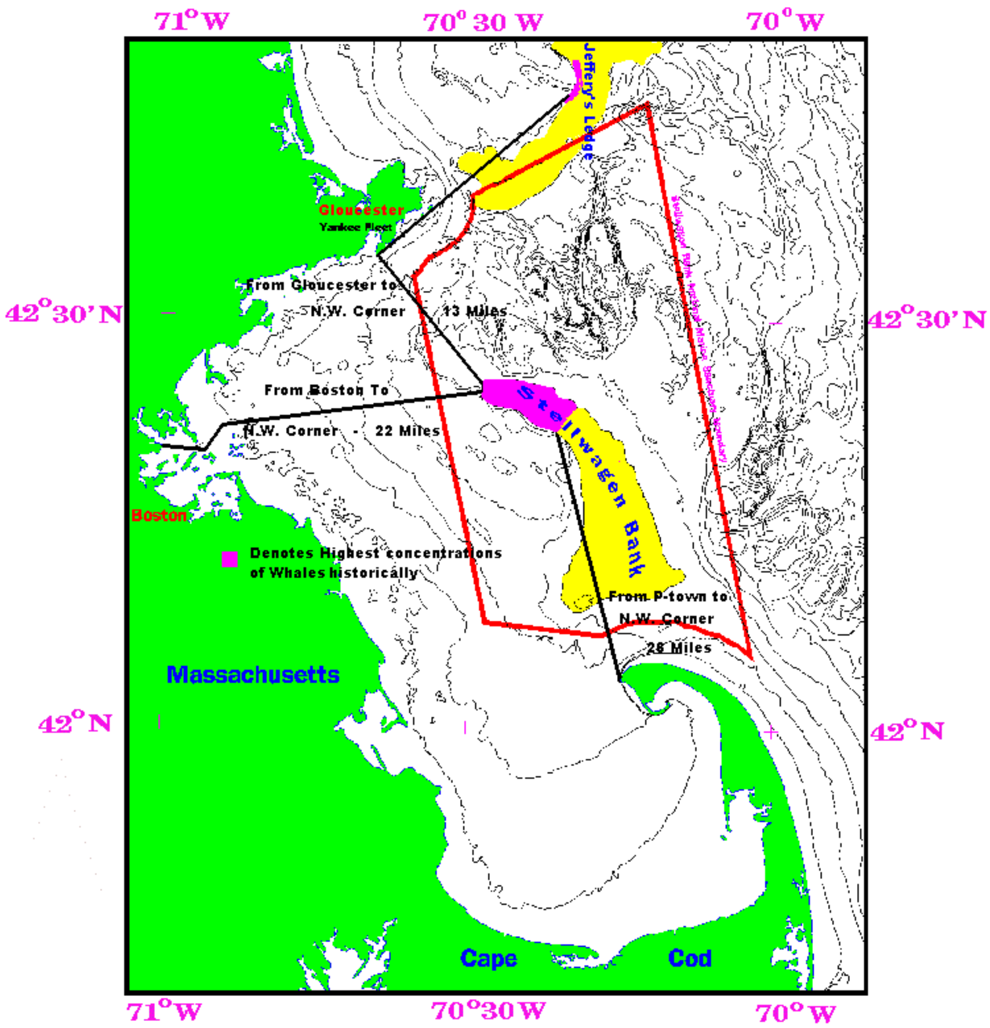


Figure 3 – Stellwagen Bank mammals sanctuary

1.5 Nested Modeling Domains

The ASCOT-01 simulation and operational system will consist of a set of three two-way nested domains: the Northwest Atlantic (NWA), the Gulf of Maine (GOM) and Massachusetts Bay (MB). The specifics of the individual domains are given in Table II and the domains are shown in Figure 4 below. In the operational context, there will be two-way nesting between the NWA and GOM (NWA/GOM) domains and the GOM and MB (GOM/MB) domains. The NWA/GOM nested run will provide boundary conditions for the GOM during the GOM/MB nested run.

A two-way nested domain pair consists of a dynamical model defined in two domains, one with coarser resolution containing the other with finer resolution. Information from the finer resolution domain is used to replace information in the coarser resolution domain areas which intersects with the finer resolution domain (up-scale). Information from the coarser resolution domain around the boundaries of the finer resolution domain is interpolated to improve boundary information in the finer resolution domain (down-scale).

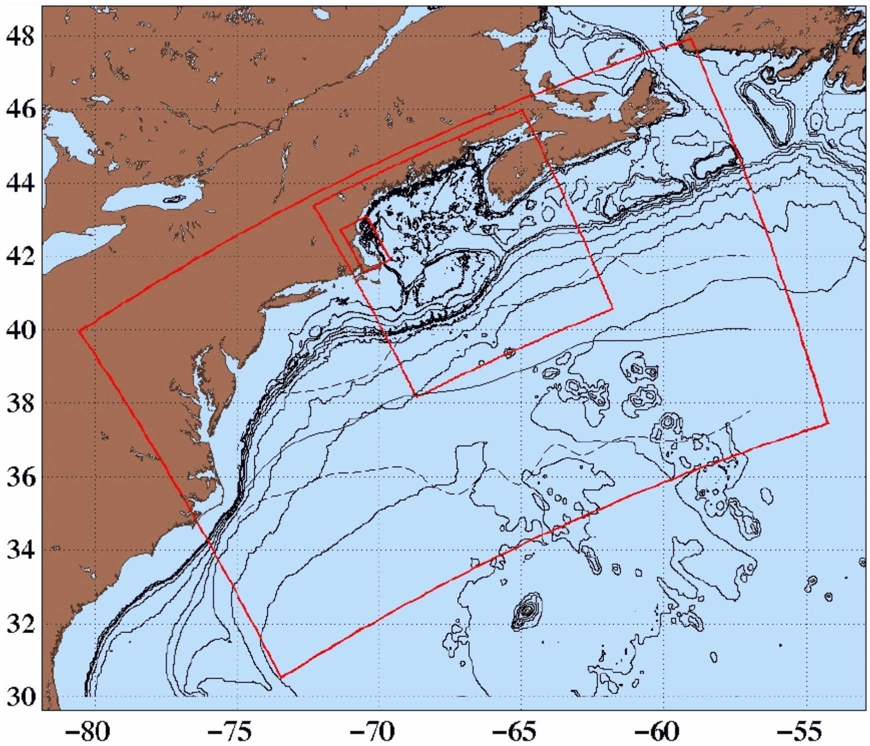


Figure 4 - Nested modeling domains

Table II: Modeling Domains

DOMAIN	DESCRIPTION/ SPECIFICATION
Western North Atlantic	Resolution: 0.135 degrees (~15km) Size: 130x83x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 0 deg.; dely = 0 deg. Domain rotation: 25.5 degrees
Gulf of Maine	Resolution: 0.045 degrees (~5km) Size: 131x132x16 (nx x ny x nz) Transform center: 39.439352N, 67.1515W Domain offset: delx = 1.2825 deg.; dely = 2.3175 deg. Domain rotation: 25.5 degrees
Massachusetts Bay	Resolution: 0.015 degrees (~5/3km) Size: 53x90x16 (nx x ny x nz) Transform center: 39.439250N, 67.1515W Domain offset: delx = -0.9675 deg. dely = 3.6975 deg. Domain rotation: 25.5 degrees

2. DESCRIPTION OF OPERATIONS

2.1	**Vessels**	**NRV ALLIANCE**	
		Gulf Challenger	from 11 to 17 June
2.2	**Area**	Massachusetts Bay including Cape Cod Bay Gulf of Maine	
		Territorial waters of	USA
		Economic zone of	USA
		Continental shelves of	USA

2.3 Tasks of RV Alliance

The ASCOT-01 operational center will be aboard *NRV Alliance*. The scientist in charge of ocean observations and the principle investigator for ocean modeling will embark with their groups for the whole cruise period, while the acoustic tests director and his group will stay only for the acoustic trials period from 10 to 18 June. The *Gulf Challenger* will be used for the high resolution oceanographic measurements accompanying the experiment relating ocean variability to acoustic variability and coherence. Additional assets such as (coastal) ships and autonomous underwater vehicles will be utilized for fine-scale resolution of bay features, extended measurements in the Gulf of Maine, coupled and interdisciplinary experimentation (biogeochemical/ecosystem dynamics, acoustical dynamics, etc.) and maintenance of a synoptic picture of Massachusetts Bay.

NRV Alliance will be on duty for oceanographic and acoustic measurements essentially 24 hours a day. She will

- Deploy and recover 3 ADCPs of the barnacle type
- Deploy and tow for the period of 2 days the CTD chain with different deployment depths directly from the stern
- Lower CTD probe at designated stations and times
- Release XBTs at designated stations and times
- Continuously record current profiles with the ship-borne ADCP
- While steaming, continuously acquire high precision navigation data including water depth
- Continuously record weather data

- Deploy and finally recover the CTD chain with surface float and marker buoy to be picked-up by *Gulf Challenger* for towing.
- Receive, by telemetry, CTD chain data from *Gulf Challenger*
- Deploy moored thermistor chains, wave rider and met buoy

- Repeatedly deploy and locate a vertical hydrophone array
- Deploy and locate the acoustic source tower
- Stay moored while transmitting from moored source
- Receive, by telemetry, the acoustic data from vertical array and wave rider data

2.4 Tasks of Gulf Challenger

- Stay in the experiment area few miles east of Stellwagen Bank for the period of the acoustic trials
- Pick up CTD chain deployed by *Alliance*. The chain is held at the surface by a float. At the connector end for the deck unit, the towing cable will be equipped with a maker buoy and anchor.
- Tow CTD chain (75 m long) along acoustic experiment track for periods of 42 hours continuously (day and night). Tow speed 3-7 knots
- When not used for chain towing, deploy CTD package and XBTs at designated stations and times
- Provide laboratory space and at least 3 kW, 220 V for laboratory equipment
- Accommodation for 3 persons

2.5 Sequence of events

The ASCOT-01 cruise of NRV Alliance is flanked in time by two cruises to the American East Coast. Passage of the NRV Alliance across the Atlantic Ocean will be in April and July. Port calls between cruises will be in Boston, each of two days duration.

Local time = Eastern Daylight Time (EDT) = UTC - 4

Jun 02	0900	*Alliance* enters port of Boston Embark oceanographic groups, install equipment on *Gulf Challenger*, prepare laboratory and modeling facilities on *Alliance*
Jun 06	0600	*Alliance* leave port, Deploy ADCPs near Plymouth, near Race Point and near Cape Ann
	1800	Begin multiscale towed initialization survey of Massachusetts Bay (Fig. 4). Deploy CTD chain for towing on 70m water depth
Jun 07	0600	Shorten chain to 30 m
	1600	Shorten chain to 15 m
Jun 08	0600	Recover CTD chain north of Boston harbor. Begin Gulf of Maine CTD initialization survey (Fig. 5)
Jun 10	0800	Embark by work boat the acoustic team for the joint oc/ac experiment
Jun 12	0600	Deployment of thermistor strings, ADCP, wave rider buoy, hydrophone vertical line array, source tower and CTD chain, the latter to be picked up by the *Gulf Challenger*
	1500	1st fixed range acoustic experiment on temporal and spatial variability
Jun 13	0800	Rearrangement of the acoustic track
	1400	2nd fixed range acoustic experiment on temporal and spatial variability
Jun 14	0600	Recover wave rider, acoustic source and receiver. Adaptive Sampling CTD stations

Jun 15	0800	Deploy wave rider, acoustic source and receiver
	1500	3rd fixed range acoustic experiment on temporal and spatial variability
Jun 16	0800	Rearrangement of the acoustic track
	1400	4th fixed range acoustic experiment on temporal and spatial variability
Jun 17	0600	Recover wave rider, ADCP, thermistor strings, acoustic source and receiver, pick up CTD chain from second ship. Adaptive sampling, CTD stations
Jun 18	0800	Port call Boston, disembark acoustics team
Jun 19	0800	*Alliance* leaves port of Boston Adaptive sampling, CTD stations
Jun 20	0900	Begin multiscale towed verification survey of Massachusetts Bay, deploy CTD chain for towing on 70 m water depth
	2200	Shorten chain to 30 m
Jun 21	0800	Shorten chain to 15 m
	2000	Recover CTD chain north of Boston harbor.
	2200	Begin Gulf of Maine CTD verification survey (see map and table)
Jun 25	1200	Interrupt CTD survey for ADCP recovery
Jun 26	0800	*Alliance* enter port Boston. Disembark oceanographic groups

The towed CTD chain survey will precede the Gulf of Maine CTD survey. The towed CTD chain survey is designed to follow isobaths within Massachusetts Bay, thereby minimizing the number of manipulations (raising and lowering) of the CTD chain. The ship will survey inflow conditions first. The Gulf of Maine survey will begin subsequent to the completion of the Massachusetts Bay survey.

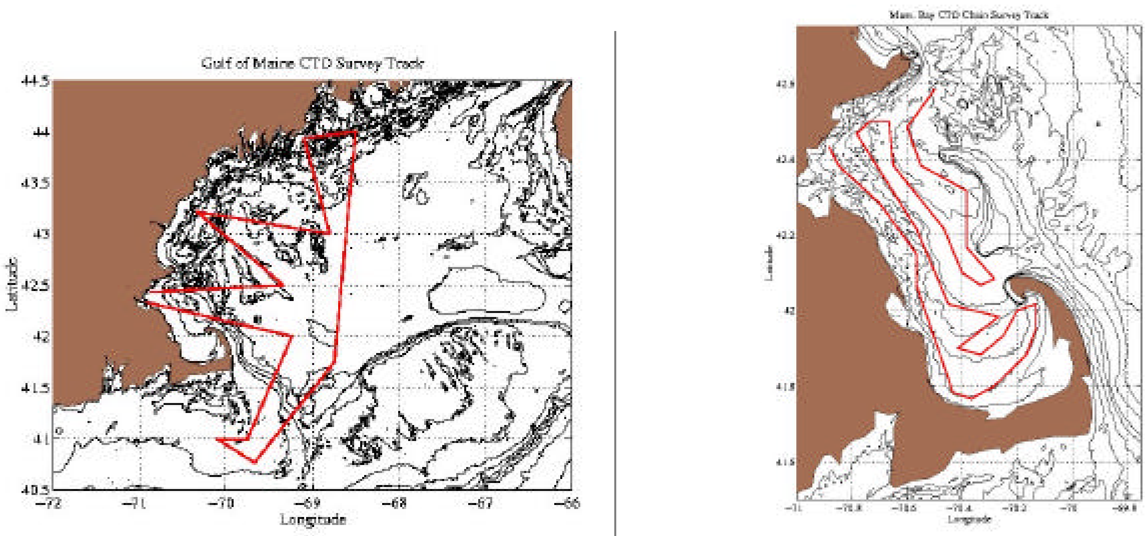


Figure 5 - Potential cruise tracks. Left - Gulf of Maine CTD survey. Right - Massachusetts Bay Towed CTD Chain survey.

2.6 Special Operations

Alliance must stay on anchor during the acoustic experiments and be connected to the source, which is mounted on a tower standing on the sea bottom. Water depth will be between 80 and 100 m.

2.7 Port Calls

The cruise starts and ends in Boston and has another port call in Boston on 18 June. *Alliance* will approach an appropriate place in Maine for embarkation of the acoustics team and make the transfer by work boat.

2.8 Coordination

All research activities on board *Alliance* and on the *Gulf Challenger* are coordinated by the Scientist In Charge on *Alliance*. Coordination between other potentially participating ships by mutual agreement between the Scientist in Charge, the Principle Investigator and external participants.

The challenge of everybody's office computer being available on board *Alliance* during four consecutive cruises is to be resolved by coordination between SICs and ADP coordinators and specialists.

2.9 Communications

NRV Alliance will be equipped with a permanent high speed digital satellite link, which guarantees access to Internet services and data transfer from and to any collaborating institutions.

Conventional communication channels are

- Standard ship-shore frequencies
- Inmarsat B voice: 00871 321 811 010 fax: 00871 321 811 012 (to be confirmed)
- Globalstar GSM satellite telephone (voice)
  - Bridge : 0039 (0)563 520 2915
  - MainLab: 0039 (0)563 520 1983

3. EQUIPMENT REQUIREMENTS

3.1 NRV Alliance

- DGPS Navigation, soundings and wind permanently available as digital string
- Thermosalinograph (Seabird) with deck unit and registration
- Ship-borne ADCP
- Meteo recording unit with 2 redundant sensor packages
- Handling gear as required for deployments described in paragraph 2.3

- Winch on the foredeck with 500 m single conductor cable as backup for CTD operations

3.2 Gulf Challenger
- David for the recovery of CTD chain marker buoy and anchor
- Winch with single conductor cable for CTD operation
- 220 V power supply

3.3 ETD for Gulf Challenger
- Voltage converter (if Gulf Challenger has no 220 V supply)
- CTD chain deck unit, PC and oscilloscopes
- GPS receiver and registration unit
- Spread spectrum radio for real-time data transmission
- Seabird CTD with deck unit
- Hand held XBT launcher

3.4 ETD Oceanographic equipment
- Moorings
  - 600 kHz ADCP (Barny)
  - Two 300 kHz ADCPs (Sentinel)
  - Two thermistor chains
  - Wave rider buoy
- Vertical profiles
  - Seabird CTD
  - Niskin Bottles
  - Reversible thermometers
- Towed instruments
  - CTD chain
  - OD-0 float for CTD chain, when towed by *Gulf Challenger*
- Remote sensing
  - Sea Surface Temperature (AVHRR) satellite receiving and processing system
  - Ocean Color Scanner (SeaWiFS) receiving system

3.5 ETD Acoustic equipment
- Sources
  - Frame (tower) for bottom deployment of acoustic source (min. 5 m from seabed)
  - MOD30, MOD40 and ITC + power amplifiers + cables to Alliance
  - Reference hydrophone pole mounted on source tower
  - Digital waveform generator for programmable signals
  - GPS clock/trigger (all transmissions triggered by GPS clock)
- Receivers
  - 2 Vertical line arrays (VLA) bottom moored (plan to use the 62 m with 94 m as backup) with modification of extra hydrophones (3 or 4) near the bottom
  - Telemetry link for VLA
  - Moorings for multiple deployments of VLA (~5 deployments) in 75-95 m depth

- Receiving equipment for arrays including VLDS tape drive and tapes
- GPS clock/trigger (all receptions triggered by GPS clock)
- Monitoring equipment for received signals (oscilloscopes and spectrum analyzers)

3.6 OCD/ACD computers for data processing

- 3 Alpha stations to be shared by 4 scientists
- HP workstations
  - 2 HP real time systems for acquisition of vertical array and reference channel
  - 1 HP real time systems for backup
- 5 PCs

3.7 Data communications

- Spread spectrum radio connection to tow ship (RIAB)
- Internet and e-mail services

3.8 ITO

- Color printer
- Laser printers
- Supplies
  - Paper, ink and pens for all printers and plotters
  - Floppy disks
  - Jazz disks (10 1 Gbyte and 10 2 Gbyte)
  - Zip disks (10)
  - 50 re-writable magneto-optical disks 5.2 Gbyte for acoustic data
  - 150 tapes for VLDS

3.9 Other

- Digital camera: 2 memory cards, rechargeable batteries, battery charger, USB cable, software for PC & MAC
- Digital videocam: 2 mini DV cassettes with IC memory, battery charger and spare battery, cable for video and monitor

4. DATA COLLECTION

Essentially all data are digitally stored on electronic media (hard disk, magneto-optical disk, magtape). Most data will be processed in near real-time for immediate use by ocean modelers and archiving on CD-ROM at the end of the cruise.

4.1 Seabird CTD

The data acquisition deck unit is connected to a personal computer (PC). Raw data are stored in binary format. They are transferred to another PC for post-processing with manufacturer provided software (SeaSoft).

4.2 XBT, XCTD

XCTD and XBT probes will only be used when it is impossible to lower a CTD probe, e.g. during very bad weather or extremely tight schedule. A manufacturer provided acquisition board and software is installed in a dedicated PC. The data files are transferred for postprocessing and reformatting.

4.3 CTD chain

The deck unit is controlled by a PC which also stores the data to hard disk. The data acquisition PC is able to send the original data to the communications port of another computer. While the chain is towed by the *Gulf Challenger*, the secondary files can be read from *Alliance* using the spread spectrum telemetry system. Subsamples and averaged profiles can be written to diskettes without disruption of the data acquisition. The data acquisition program also has a mode (undocumented) for spike removal and error correction during post-processing.

4.4 Ship-borne ADCP

Current velocity profiles with 8 m vertical resolution will be continuously recorded on a PC in 5 minutes intervals. Data will be transferred to the Codas3 system and processed during the cruise.

4.5 Moored BBADCP

Currents will be internally averaged over 10 minute periods and stored into solid state memory. After recovery late in the cruise, data will be read out and processed.

4.6 Navigation Data

Ship positions and echo sounder depths will be recorded in an ASCII text file every second.

4.7 Meteorological observations

Standard meteorological observations in 3 hour intervals will be made by the ship's officers. Paper copies are archived as scanned images for later conversion into ASCII text files. The Meteo system automatically stores 5 minute averaged meteorological data as ASCII strings.

4.8 Surface temperature and salinity

A Seabird 911 system is used as a thermo-salinograph. On track, conductivity is affected by micro-bubbles. During the ADRIA01 cruise the best results were obtained when data were acquired with the highest sample rate of 24 Hz and maximum readings within a 1 or 6 second time interval used rather than averages. Only the reduced data set will be permanently saved.

4.9 Wave rider and thermistor string data

Data are stored in their autonomous systems and processed off-line.

4.10 Vertical line array (VLA)

The vertical array acoustic data will be recorded continuously by radio telemetry while transmitting acoustic signals. All transmissions will be triggered by GPS clock and recorded with a time stamp. The data will be recorded on VLDS tape and HP acquisition systems. The HP data will be stored on 5.2 Gbyte optical disc. Two sets of batteries should be available to provide up to 24 hours of operations on 3 consecutive days. The vertical array should be modified to include 3 or 4 extra hydrophones (closer to the seabed) with the deepest phone about 3 m from the bottom.

Precise vertical array positions must be determined using pinging technique just after deployment and just before recover.

4.11 Reference hydrophone

The reference hydrophone near the acoustic projector will be acquired on one of the vertical array channels. Hydrophone calibration data is required.

5. Forecasting and Real-Time Products

Data analysis, data assimilation and numerical simulations will be carried out on a daily basis in real-time throughout the duration of the exercise. *In situ* data will be acquired by the NRV Alliance as well as by other chartered vessels or ships of opportunity. Remotely sensed data will be available via SACLANTCEN or other sites. Data will be analyzed, quality controlled and processed as it is received and made available for assimilation into the Harvard Ocean Prediction System (HOPS).

It is desirable to have the forecasts carried out in two modes: in Predictive Skill Assessment mode - i.e. using all data as acquired in order to most accurately predict future states; and in REA mode - i.e. using a reduced data set in order to mimic REA conditions and demonstrate the ability to utilize minimal data. This goal will be met if conditions and assets allow for separate forecast teams.

Forecasts will be available on a daily basis after the initialization survey in order to provide adaptive sampling patterns for the subsequent day's sampling. Products will be available via the experiment web site. Example products might include (for both the Gulf of Maine and Massachusetts Bay modeling domains): synoptic maps and forecasts of temperature or salinity with superimposed velocity vectors for levels of interest, vertical sections of chosen quantities at locations of interest, profiles of temperature or sound speed at locations of interest, etc.

6. PERSONNEL REQUIREMENTS

OCD	Jürgen Sellschopp		Scientist in charge
	Reiner Onken		Ocean modeling
	Richard Signell		Ocean modeling
	Elvio Nacini		Satellite images
	Andrea Cavanna		ADP coordinator
	Alex Trangeled		Web server and communications
	Gisella Baldasserini		CTD, XBT, ADCP data processing
	Pietro Zanasca	□	Oceanographic instruments
	Adolf Legner	■	Acoustic trials documentation
ACD	Martin Siderius	■	Acoustic trials director
	Peter Nielsen	■	Acoustic data assessment
	Domenico Galletti		System and hardware maintenance
ETD	Richard Stoner	□	Engineering coordinator
	Roberto Della Maggiora	□	Oceanographic instrumentation
	Per Arne Sletner	■	Acoustic instrumentation
	Piero Boni	■	Acoustic data acquisition
	O. Chiappini	■	Acoustic transmission and data acquisition
	P. Mandaliti	■	Wet end instrumentation
	Alessandro Brogini		Moorings, CTD chain, hardware
Harvard	Allan R. Robinson		Principle investigator
	Wayne Leslie		Ocean modeling
	Carlos Lozano		Ocean modeling
	Patrick Haley		Ocean modeling

■ Embarked on *Alliance* from 10 to 18 June
□ Embarked on *Gulf Challenger* from 12 to 18 June, otherwise on *Alliance*

7. RISK ASSESSMENT AND HAZARD AWARENESS

The rules of good seamanship will always be observed.

All operations will be conducted according to SACLANTCEN safety procedures.

The captain of ALLIANCE is responsible for the safety of the ship, the crew and embarked persons. Everybody will conform to his orders.

7.1 Marine mammal interference avoidance

This experiment will follow the Centre's mammal environmental policy and designated procedures will be followed throughout the acoustic measurements. This can be found in SACLANTCEN INSTRUCTION No. 77-98, Human Diver and Marine Mammal Environmental Policy and Risk Mitigation Rules.

For the acoustic experiments in ASCOT-01, three acoustic sources will be mounted on a single steel frame tower and moored on the sea floor. Signal transmissions types are summarized in the following table:

Source type	Signal Type	Frequency band	Duration	Source level
MOD40	LFM	150-800 Hz	1 second	195 dB
MOD40	Tones	200-700 Hz	5 seconds	195 dB
MOD30	LFM	800-1600 Hz	1 second	195 dB
MOD30	Tones	800-1600 Hz	5 seconds	195 dB
ITC 1000	LFM	2000-4000 Hz	1 second	195 dB
ITC 1000	QPSK	2000-4000 Hz	10 seconds	195 dB
ITC 1000	M-sequence	2000-4000 Hz	10 seconds	195 dB

Each of these signals will be transmitted one time in a sequence of 2 minutes and this sequence will be repeated over 24-hour periods on 3 consecutive days. Acoustic modeling has been performed to predict acoustic levels up to 2-km ranges. The source levels used in these experiments will reach the marine mammal safe level of 160 dB at ranges of approximately 100 meters from the sound source. To insure marine mammal safety, a ramp-up procedure is used whereby 30 minutes prior to the experiments transmissions begin at 160 dB levels. This is accompanied by a marine mammal observation period that begins 1 hour before the ramp-up sequence and is maintained during transmissions. Observations include both a visual and acoustic watches and a log is kept to record any marine mammal sightings. If no marine mammals are detected, the source levels are increased to 195 dB (after the ramp-up period) where they remain while there are no mammal sightings.

8. ADMINISTRATIVE

8.1 Travel

Air travel to and from USA is required for all Centre participants. Respective projects causing the travel will be charged for the expenses. For cruise participants, who embark for more than one cruise period, costs will be shared by the requesting projects.

01-A

- 8 return flights to Boston (Sellschopp, Onken, Signell, Nacini, Cavanna, Stoner, Della

Maggiora, Brogini)
- 2 home flights from Boston (Baldasserini, Zanasca). This travel is shared with **04-C**
- 1/3 of 2 return flights (Galletti, Trangeled,). This travel is shared with **04-C** and **03-H**

01-B
- 7 return flights to Boston (Siderius, Nielsen, Sletner, Boni, Chiarabini, Mandaliti, Legner)
- 3 times 3 per diem (Stoner, Della Maggiora, Zanasca) for embarkation on Gulf Challenger

8.2 Local Transportation

The equipment to be installed on the Gulf challenger will be transferred by rental van. Harvard University is responsible for embarkation of their computers.

8.3 Communication with the Centre

Daily situation reports will be sent by Master Alliance. Cruise participants will receive and send e-mail under their normal saclantc address. For voice and fax connection see 2.9.

As far as required, even large volumes of data will be transmitted to and from the Centre via the permanent satellite link. Inmarsat B is available as a backup.

8.4 Freight

All equipment should travel with Alliance rather than be sent by air freight.

8.5 Customs Clearance

Instruments are temporarily taken from board in order to be transferred to the US vessel *Gulf Challenger*. Harvard computers are temporarily embarked on *Alliance* in Boston.

8.6 Overtime

Overtime is provisionally requested for installations on Gulf Challenger

8.7 Allowances

All A technical grade, B and C grade personnel will receive a sea-going allowance in accordance with Centre Staff Instruction no. 42-92. A grade scientific personnel will receive holiday compensation in accordance with the Director's memorandum dated 31 May 1989.

8.8 Victualling

Non-Centre personnel will be charged 20.000 per day for victualling.

9. Potential for Collaborations

The scientific plan presented in this document is for a self-consistent ASCOT-01 physical dynamical and forecast experiment. However, the core ASCOT-01 experiment provides an exceptional opportunity for extended physical experimentation and additional coupled interdisciplinary research in acoustics and biogeochemical/ecosystem dynamics and processes. The ASCOT-01 scientists welcome collaborations both of mutual interest and that would extend the impact or utility of the core experiment.

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