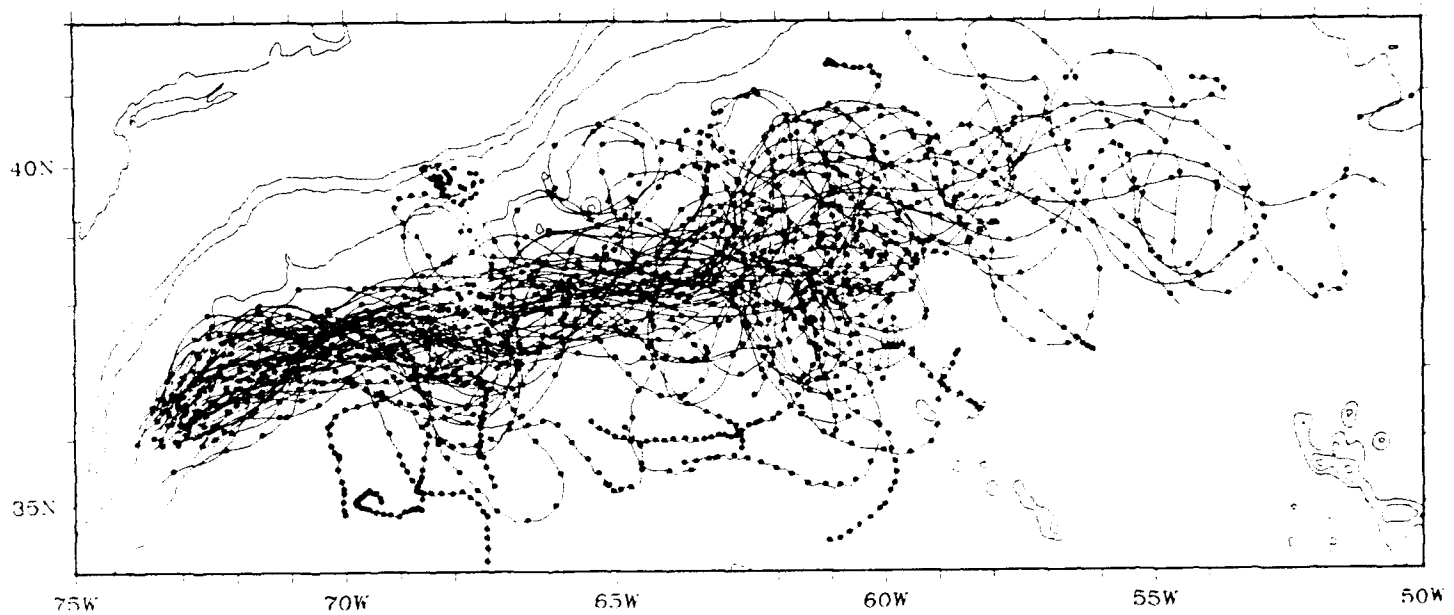
(2)

RAFOS Floats

in the SYNOP Experiment

1988-1990



Technical Report

Graduate School of Oceanography

University of Rhode Island

Narragansett, Rhode Island

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University of Rhode Island

RAFOS Floats in the SYNOP Experiment
1988 - 1990

by

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1. Introduction

This report presents all RAFOS float data collected during the period April 1988 through March 1990 as part of the SYNOP (SYNoptic Ocean Prediction) experiment. The main objective of the RAFOS program has been to study the spatial and temporal characteristics of the Gulf Stream east of Cape Hatteras, in particular to study the Lagrangian properties of fluid motion in the Gulf Stream using acoustically tracked floats. Specifically, through repeated seeding of floats in the center of the Stream, we can:

1. examine the spatial and temporal properties of the current,
2. examine the velocity and potential vorticity fields, and their evolution in relation to the time varying path structure,
3. compare the subsurface (float) and surface (IR) Stream paths to improve our understanding of the current's vertical structure,
4. continue earlier studies of pathways of fluid exchange with surrounding surrounding waters, and
5. use the data in comparative studies of numerical models.

RAFOS floats are neutrally buoyant isopycnal drifters, which are tracked acoustically by ranging to as many as five sound sources that have been moored at the depth of the permanent sound channel south of the Gulf Stream along a line between 73°W and 51°W. All sources transmit a precisely timed frequency modulated, continuous wave (CW) signal every eight hours. The floats, which are equipped with accurate timing, determine the times of arrival of the signals. These are saved in the float's microprocessor memory along with measurements of pressure and temperature. At the end of its mission, each float releases ballast, returns to the surface and starts its radio telemetry. The telemetered data are received by Systeme ARGOS, a French satellite-based data collection and platform location system. Once the data have been assembled in a computer, the trajectory of the float can be reconstructed from the time series of acoustic travel times. The RAFOS system has been

described in detail by Rossby et al. (1986). The data processing has been discussed in an earlier data report by Bower et al. (1986). The RAFOS float plots presented in this report include the trajectories and the pressure and temperature time series.

As in the RAFOS float pilot studies in the Gulf Stream summarized by Bower et al. (1986), floats were launched in the axis of the current, identified as the point at which the 15°C isotherm crosses 450m. The floats were launched between April 1988 and February 1990 by Capt. David Murphy of the H.O.S.*Bold Venture*, a commercial freighter operating between Norfolk, Virginia and Bermuda. The actual launch site is determined by a series of XBT's taken until the 15°C isotherm intersects 450m. The launch procedure is described in detail by Bower et al. (1986).

2. Technical Summary

Figure 1 shows the locations of the sound sources used for the acoustic navigation. The sound source mooring configuration is described in detail by Bower et al. (1986). Sound sources 1 through 5 were all launched in November 1987. Source 4 failed in July 1989 and source 2 failed in January 1990. Source 6 was launched south of Bermuda (25.01°S, 64.67°W) in October 1989 by Kevin Leaman of the University of Miami. While it was useful in tracking two of the floats launched toward the end of the experiment (211, 222), the source was too far south to provide a continuous travel time series for most of the floats and is not included on figure 1. The sound sources were transmitting every 8 hours starting at 00:30 GMT for sources 1 and 4, 01:00 GMT for sources 2 and (beginning 10/89) 6, and 01:30 GMT for sources 3 and 5.

Throughout the experiment the drift in transmission time for each sound source was monitored in Bermuda (Rossby et al., 1986), where a receiver was installed, essentially a shore-based RAFOS float. The measured drift was corrected for drift in the receiver's clock by comparing the receiver's clock time with that of the Naval Observatory clock (Universal Time). Later, independent calculations of drift compared closely with the Bermuda determinations. Floats which left the Gulf Stream to the south and continued to receive data

until surfacing, and would not have drifted much before telemetering the first surface message, were used in the sound source drift calculations. Correction of each float's clock drift is based on the actual transmission times of its radio messages compared to the expected times if the clock were not drifting. Since the distance between the sound source and the float at its first surface position is known, it is an easy calculation to determine the clock error in the sound source, and hence the drift in transmission time for each sound source (seconds/day), from the arrival times at the float just prior to surfacing. Table 1 lists these drifts along with the sound source locations (sound source 6–location only). Information from five to eight floats was used to obtain a calculated drift for each sound source, except for sound source 4 (three floats used) which failed about halfway through the experiment. The calculations were in good agreement (within 5 percent) with the drift determinations made by monitoring the Bermuda receiver. However, assuming linear drifts in the sound source transmission times throughout the length of the experiment, we feel more confident in using the calculated drifts in the float tracking due to technical difficulties with timing at the Bermuda monitoring station. The relatively high rates of drift (approximately 0.2 seconds/day) were due to a programming oversight in the sound sources: the temperature coefficients for the crystal oscillator were never downloaded.

Of the 75 floats launched during the experiment, 72 returned useful data. We were able to track all but one of these (137). That particular float was started an hour early so it recorded a coherent signal in one channel only, but provided a complete temperature and pressure record. A plot showing the launch and surface points for that float is included in the data section. The floats were ballasted to be neutrally bouyant along the density surface corresponding to approximately 15°C. Only two of the 72 floats (121 and 239) went too deep, possibly due to leaking compressees; the pressure transducer in one of these (239) apparently failed, so we only have the temperature time series for that float. Four floats surfaced early, three (177, 181, 189) in less than five days, and one (240) after 30 days of a 45 day mission. There were only three floats (139, 143, 195) out of the 75 launched which did not return any data, either because they never surfaced or because they never transmitted upon surfacing.

Floats were frequently able to receive well-defined signals from the sound sources at distances of 1500 km, although dropouts (missing signals) become more common at these distances.

3. Comments

The float trajectories and temperature and pressure time series are shown for all RAFOS floats that could be processed. Obviously bad data points were removed during the processing. In reconstructing the float trajectories, spline functions were used to interpolate over the resulting gaps where possible. Normally interpolation is not done over more than 6 consecutive times of arrival (2 days), but in a few cases it was necessary to interpolate over as many as 12 (4 days). In these few cases, there is almost always one nearly continuous travel time series to work with, and it was thought to be better to make a qualified estimate of the float's position as a function of time than to not use the available data at all. The archived data include a flag indicating where such interpolation has been done. In most cases the interpolation has resulted in a continuous track, but a few floats exhibit gaps where bad acoustic data span a longer period of time. For the temperature and pressure time series, obviously bad points were also removed. In some cases these have been replaced with simple linear interpolation.

The following plots show the float tracks superimposed on bathymetric contours. In addition to the coastline, the 1000m, 2000m, 3000m and 4000m contours are included. For consistency, the same geographic area is shown for each float. Only two floats (211 and 206) have tracks which extend slightly outside this region. Four other floats (175, 185, 191, 207) surfaced west of 50°W, but poor acoustic data prevented their complete tracking. In addition to those four floats, there were six others (178, 184, 211, 238, 240, 241) for which either the hydrophone or the acoustic receiver failed before the end of the mission, so the tracking is incomplete. Also, three floats (198, 200, 202) stopped telemetering from the surface early, so all data were not received. Fixes every eight hours are indicated along each track, with an asterisk representing the daily 00:00 GMT fix and labels (yeardays) every five days. Preceding the individual float plots (Fig. 2) is a composite, or "spaghetti", plot of all

floats with mean temperatures between 13.5 and 16°C which returned over five days of data. Table 2 lists all RAFOS floats launched, arranged in chronological order.

4. Acknowledgements

We wish to acknowledge Jim Fontaine for his excellent work building and testing the RAFOS floats. Thanks to his efforts the project enjoyed a very large data return. Capt. David Murphy of the *Bold Venture* is gratefully acknowledged for his support and cooperation in the launching of the floats. We thank Tudor Hills Labs in Bermuda for providing monitoring of the sound source array. Mr. Bill Hahn and Mr. Tom Orvosh were responsible for installing the array in November 1987. Their help and efforts are gratefully acknowledged. We also thank Dr. Everett Carter, Jr., for writing the program "redit", a user interactive program for maintaining information about each float, such as launch and surface time and location, mission length, calibration coefficients and other data needed by the various RAFOS processing programs. Finally, we wish to acknowledge Dr. Amy Bower, John Lillibridge, and Kathy Schultz-Tokos for their help in the initial stages of this project. Support for this project was provided by the Office of Naval Research under grants N00014-87-K-0235 and N00014-90-J-1602.

5. References

Bower, A., R. O'Gara and T. Rossby, 1986. RAFOS float pilot studies in the Gulf Stream 1984-1985. G.S.O. Univ. of Rhode Island Tech. Report 86-7, 110 pp.

Rossby, T., D. Dorson and J. Fontaine, 1986. The RAFOS system. J. Atmos. and Oceanic Tech., 3, 672-679.

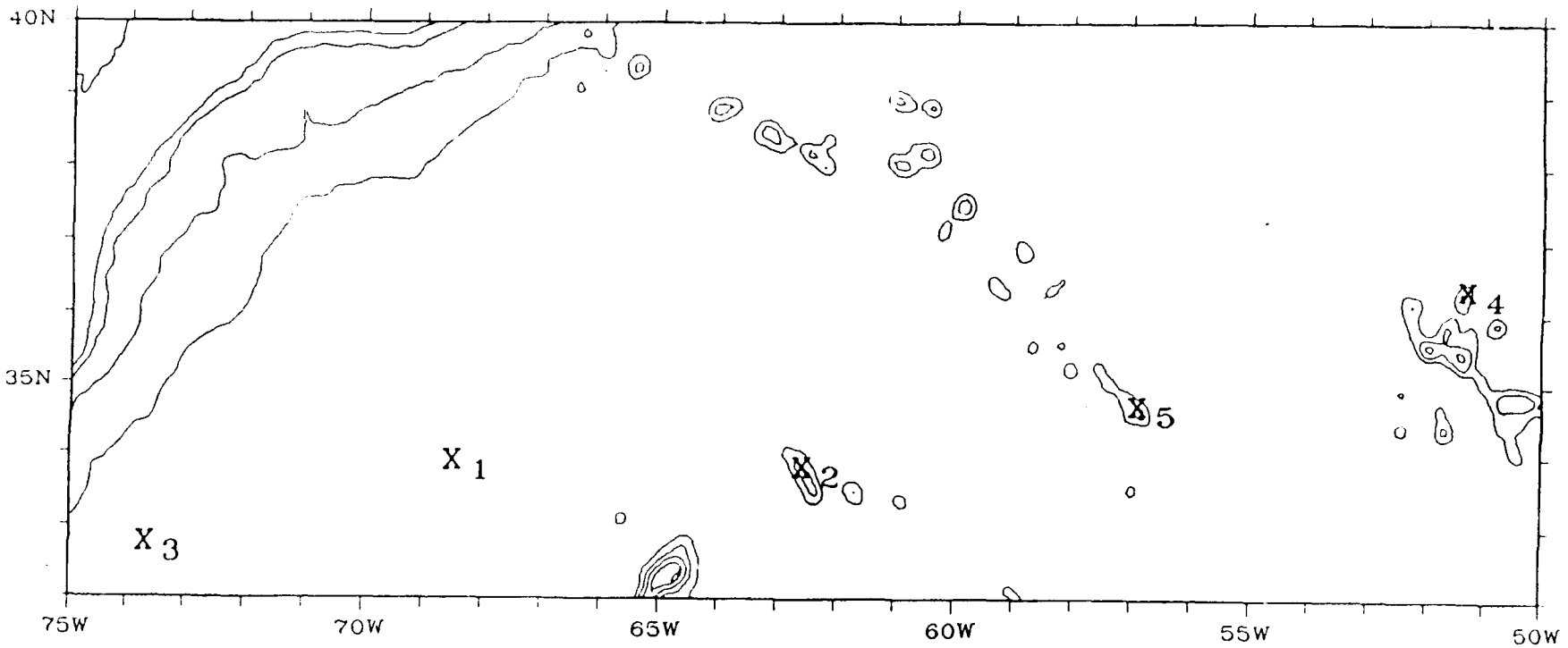


Fig. 1. Region of the western North Atlantic under study, showing the positions of the five moored sound sources (X's). The numbers on the map correspond to the source numbers in Table 1.

Table 1. SYNOP sound sources

Source	Lat(N)	Long(W)	Drift (sec/day)
1	33.868	68.505	0.217
2	33.787	62.579	0.246
3	32.733	73.692	0.178
4	36.331	51.334	0.198
5	34.645	56.923	0.271
6	25.010	64.673	0.0

Table 2. RAFOS float launch summary

Launch Date	Float#	Launch Position Lat(N)	Long(W)	Mission Length	Mean Temp	Comment
115/88	133	36.158	72.995	30	14.9	1
125/88	126	35.912	73.343	30	14.5	ok
134/88	138	35.985	73.128	30	16.1	1
142/88	120	35.987	73.010	30	15.4	1
157/88	122	36.003	73.355	30	14.4	ok
161/88	139	36.017	73.000	30	-	5
167/88	135	35.988	73.260	30	14.5	ok
174/88	121	35.982	73.113	30	4.0	2
181/88	123	36.112	73.333	30	15.2	ok
195/88	125	36.082	73.272	30	15.2	ok
202/88	140	36.073	73.262	30	14.1	ok
211/88	127	36.123	73.510	30	14.9	ok
223/88	124	36.235	73.638	30	14.0	ok
233/88	142	36.052	73.640	30	14.4	ok
245/88	129	36.182	73.725	30	14.2	ok
254/88	131	36.165	73.310	30	14.2	ok
261/88	134	36.065	73.335	30	15.6	ok
288/88	137	36.120	73.650	30	13.8	7
302/88	141	36.208	73.623	30	14.5	ok
313/88	130	36.162	73.760	30	14.7	ok
324/88	136	36.103	73.835	30	14.7	ok
344/88	128	36.017	73.522	30	13.5	ok
007/89	132	36.063	73.537	30	14.1	ok
014/89	175	35.925	73.800	30	14.9	1
025/89	176	36.013	73.368	30	14.0	ok
034/89	177	36.053	73.417	30	21.5	1,6
046/89	179	36.168	73.510	30	14.6	1
070/89	180	35.847	73.700	30	13.3	ok
083/89	178	36.203	73.562	30	13.9	1
097/89	181	36.135	73.625	30	19.9	1,6
102/89	182	35.828	73.613	30	13.8	ok
107/89	185	36.097	73.702	30	14.2	1
111/89	184	35.855	73.748	30	14.7	1
116/89	187	36.183	73.603	30	14.0	ok
120/89	186	36.217	73.683	30	13.8	ok
126/89	198	36.267	73.657	30	14.2	1
131/89	191	36.230	73.690	30	19.5	1,3
137/89	189	36.117	73.877	30	22.9	1,6
141/89	190	35.838	73.875	30	13.8	1
148/89	193	36.155	73.635	30	15.4	ok
152/89	192	35.858	73.967	30	14.7	ok
161/89	183	36.453	73.188	30	14.0	ok
165/89	195	35.790	73.827	30	-	5
175/89	197	36.107	73.475	30	14.0	ok
179/89	196	35.827	73.627	30	16.0	ok
189/89	143	35.943	73.043	30	-	5
193/89	200	35.955	73.215	45	14.4	1

202/89	202	36.067	73.088	45	14.0	1
207/89	203	35.750	73.667	45	13.6	ok
217/89	205	36.013	73.175	45	21.8	3
222/89	204	36.030	73.303	45	14.5	ok
230/89	206	35.910	72.880	45	13.9	ok
235/89	207	35.715	72.950	45	20.1	1,3
245/89	208	35.718	72.543	45	13.4	ok
250/89	209	35.628	73.020	45	14.4	1
269/89	210	35.320	73.625	45	14.1	ok
273/89	211	35.817	72.672	45	13.7	1
277/89	212	35.840	72.613	45	12.2	ok
284/89	213	35.817	72.787	45	13.6	ok
288/89	214	35.887	72.742	45	13.8	ok
300/89	215	34.967	74.508	45	13.3	1
309/89	194	35.740	73.378	30	14.6	ok
314/89	199	35.892	73.302	30	15.0	ok
319/89	201	35.820	73.417	45	14.9	ok
322/89	216	36.055	73.443	45	12.4	ok
335/89	217	35.880	73.298	45	14.3	1
346/89	220	35.990	73.307	45	8.4	ok
364/89	221	35.627	73.737	45	14.4	1
005/90	222	36.095	73.217	45	14.1	ok
012/90	223	34.808	74.510	45	13.2	ok
015/90	224	35.613	73.177	45	14.2	1
024/90	238	36.010	73.157	45	13.9	1
028/90	239	35.987	73.532	45	4.3	4,2
033/90	240	36.033	73.290	45	13.7	1,6
040/90	241	36.157	73.185	45	15.4	1

Units are as follows:
  Launch Date: yearday/year
  Mission Length: days
  Mean Temp: degrees Centigrade

Comments: 1 - some tracking missing, 2 - deep, 3 - shallow,
  4 - bad pressure data, 5 - no data, 6 - surfaced early,
  7 - no track

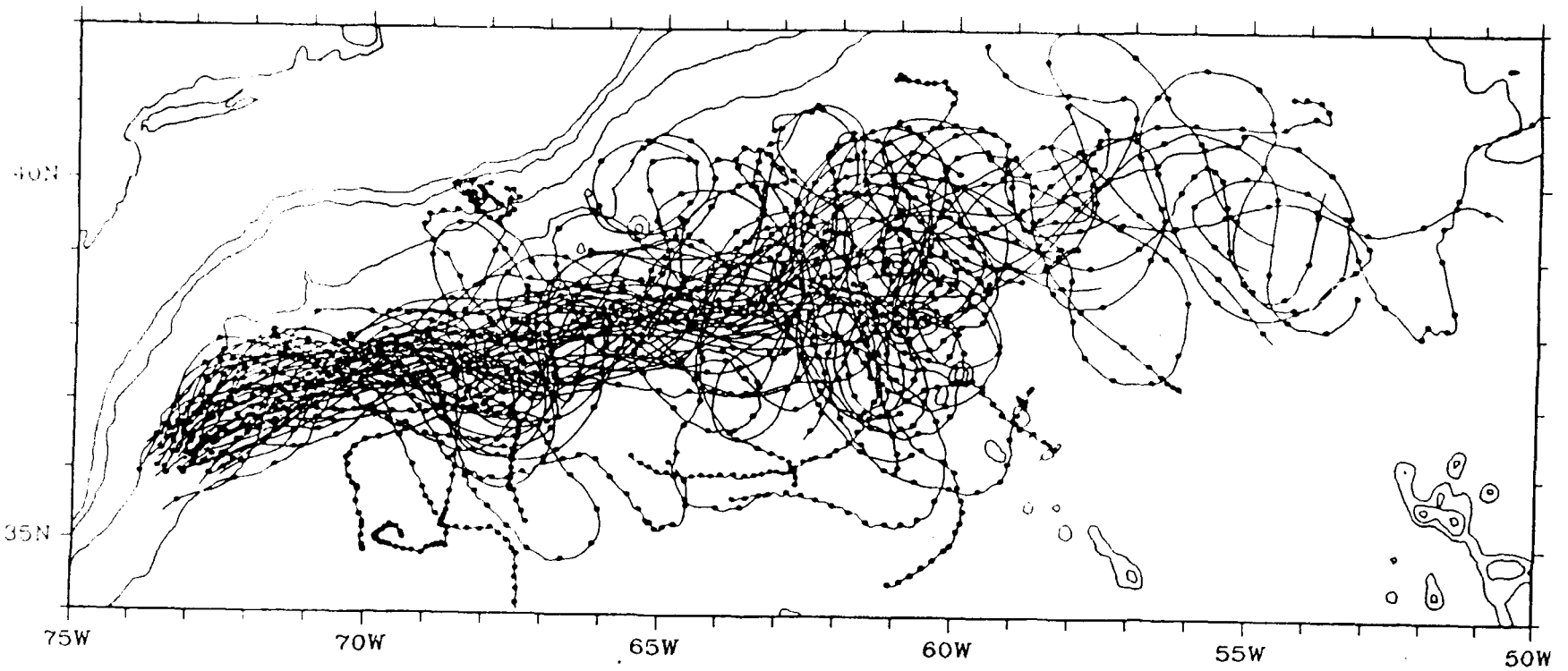
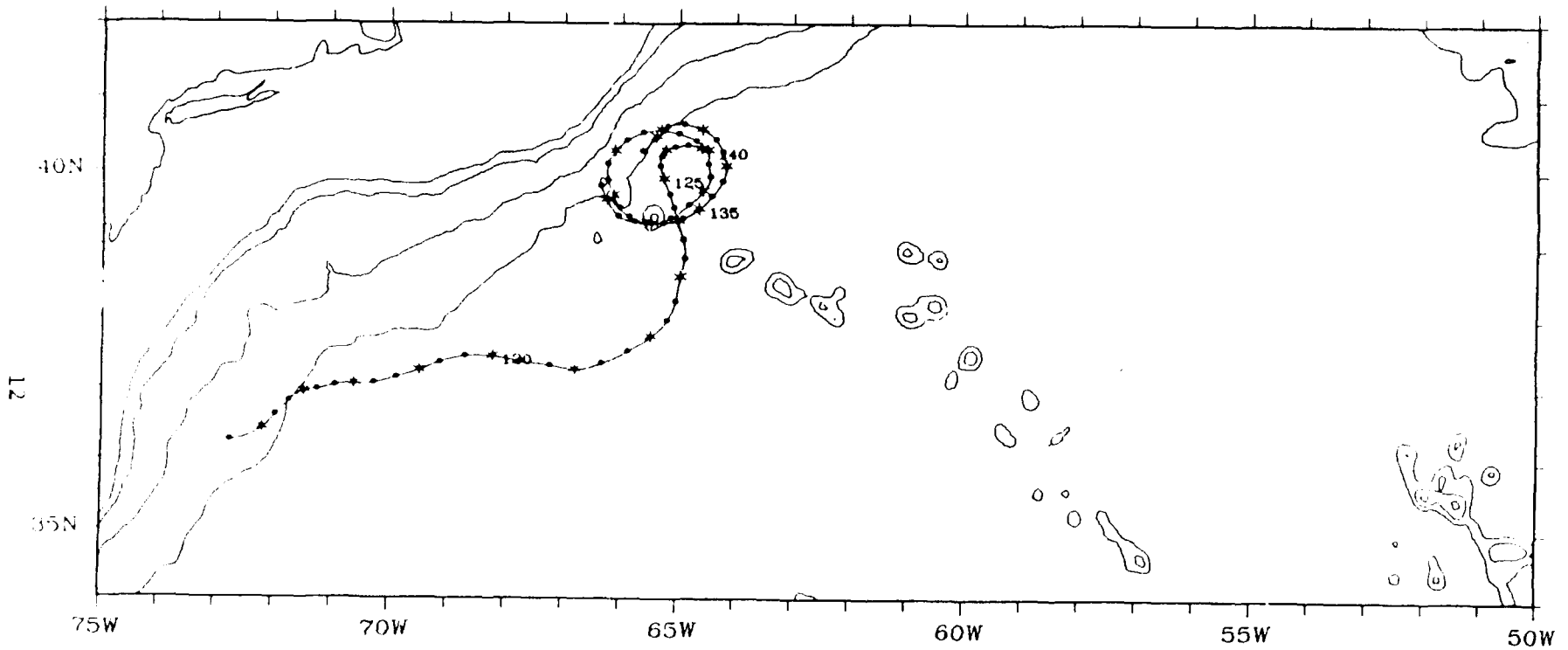


Fig. 2. Spaghetti diagram of RAFOS floats with mean temperatures between 13.5 and 16°C which returned over five days of data. Dots along each track correspond to the daily 00:00 GMT satellite fixes.

6. RAFOS Float Data



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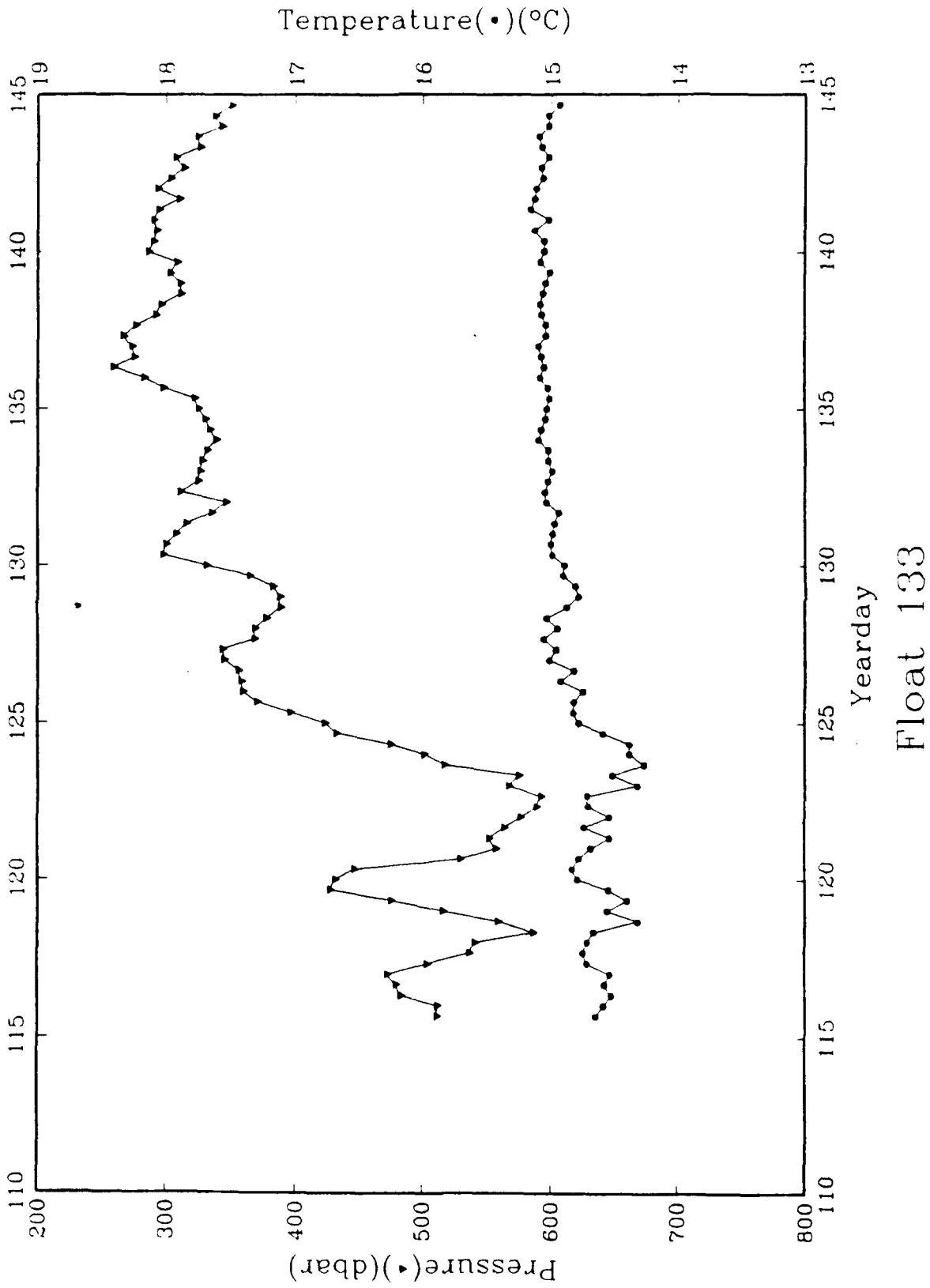
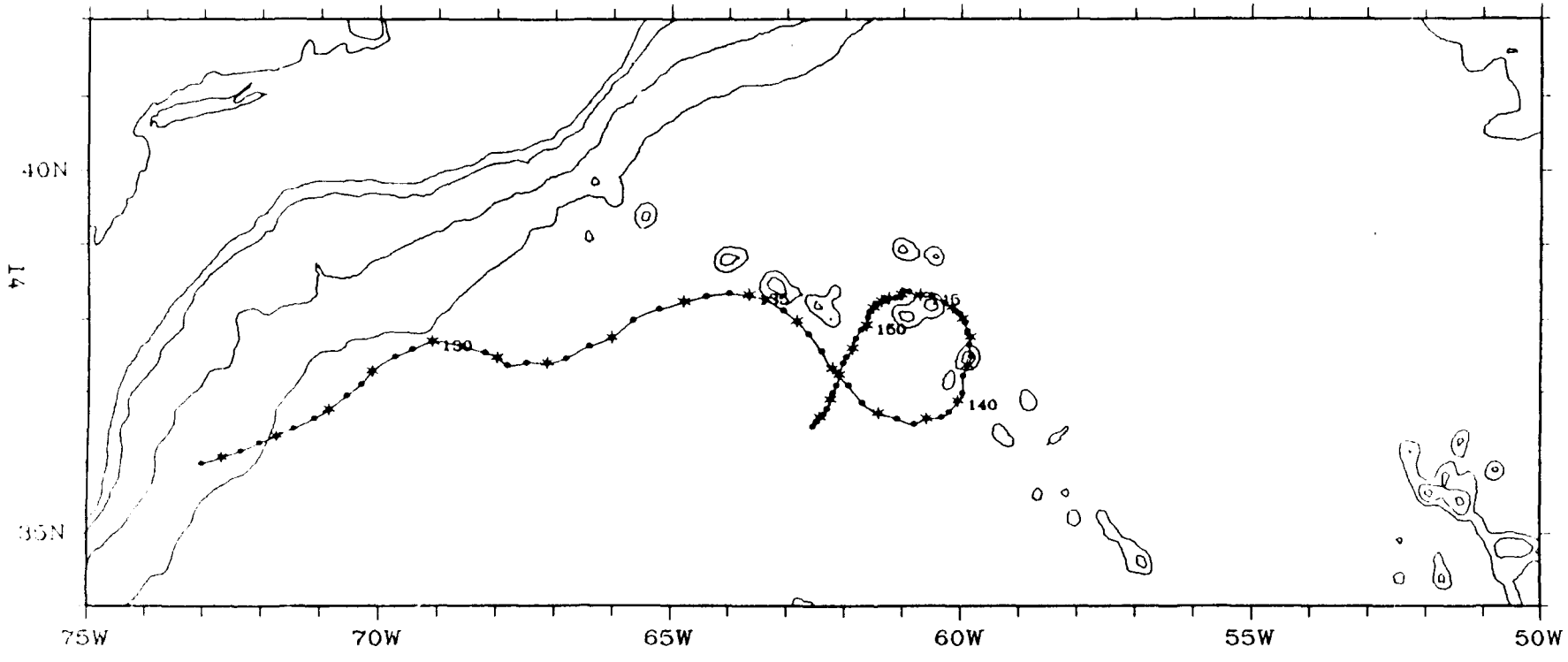

Temperature(•)(°C)
19
18
17
16
15
14
13
145
140
135
130
125
120
115
110
Yearday
Float 133
Pressure(•)(dbar)
200
300
400
500
600
700
800



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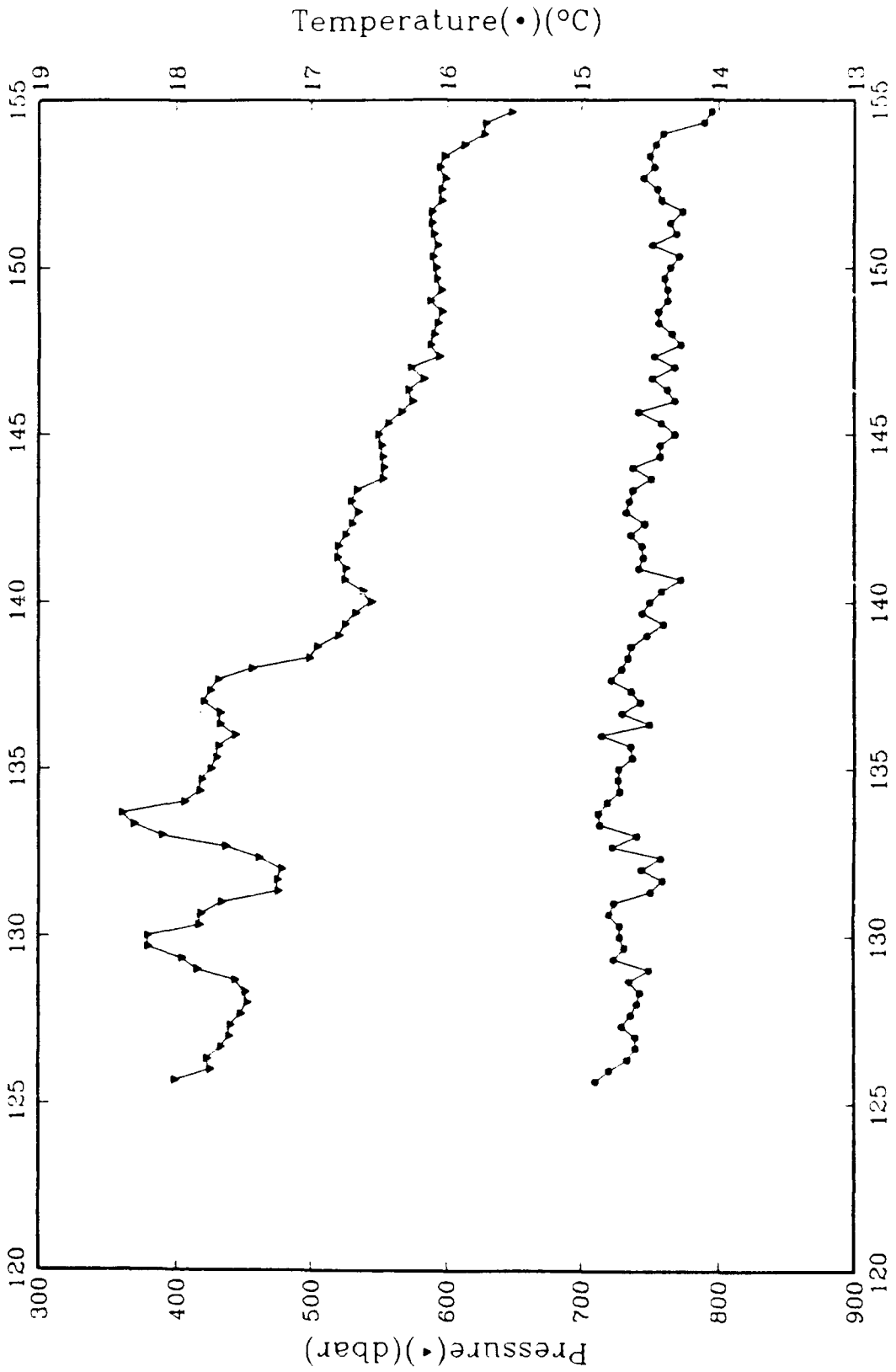
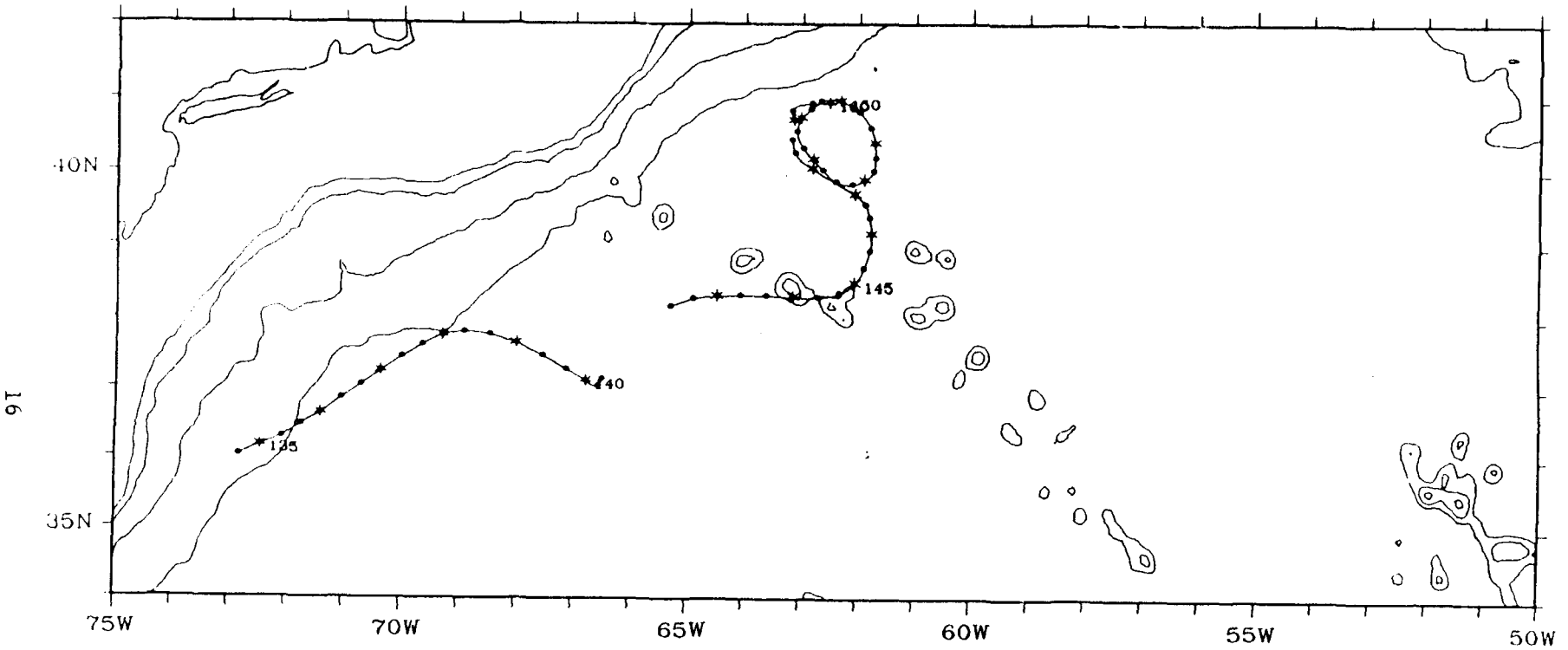

Temperature(•)(°C)
19
18
17
16
15
14
13
155
150
145
140
135
130
125
120
300
400
500
600
700
800
900
Pressure(◂)(dbar)
Yearday
Float 126



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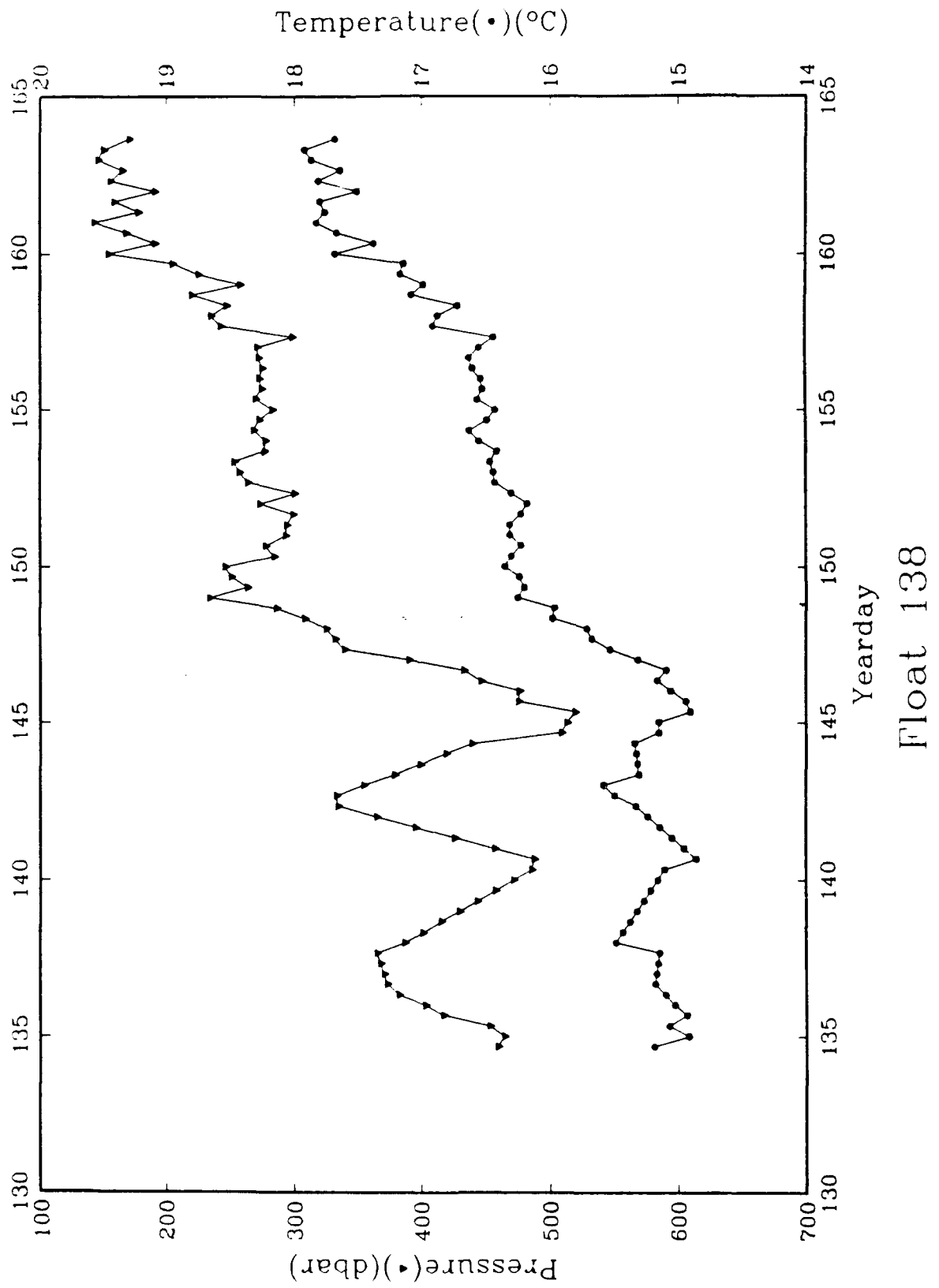
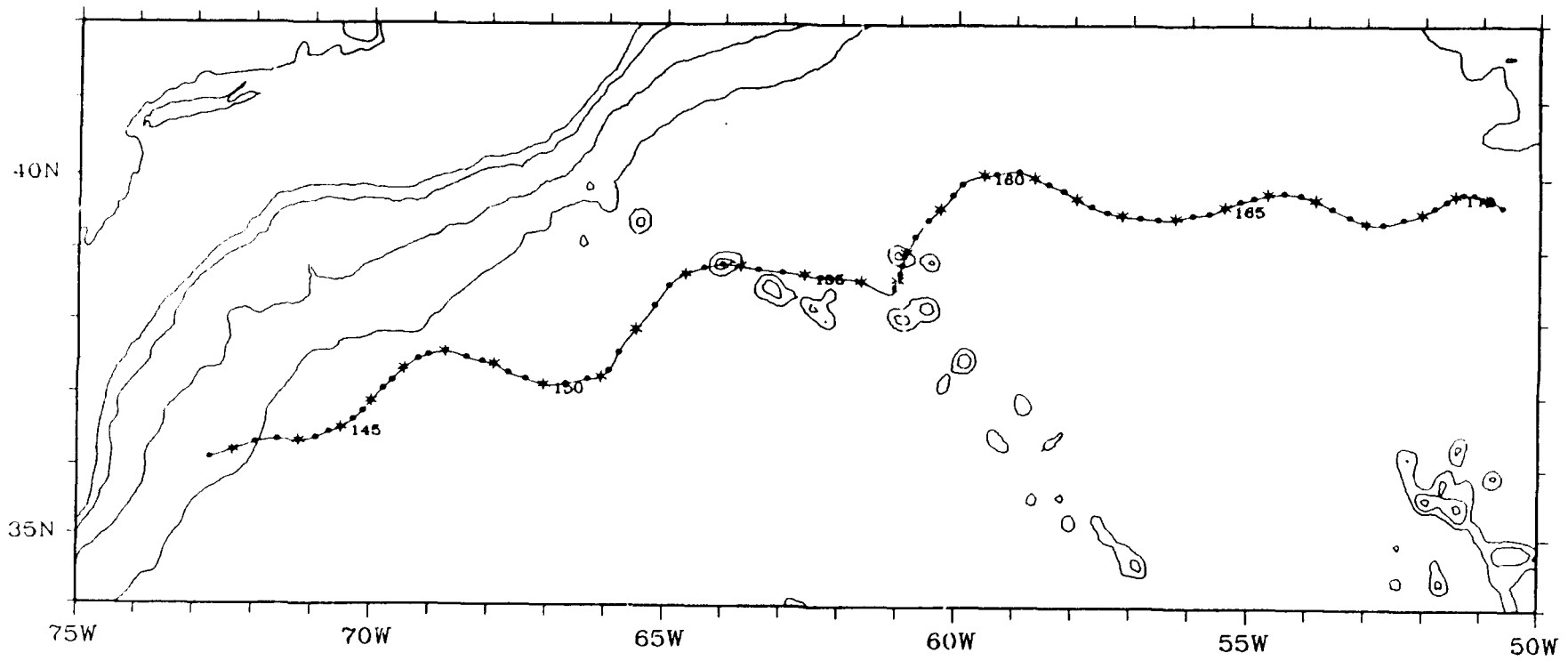

Temperature(•)(°C)
20
19
18
17
16
15
14
Pressure(◂)(dbar)
100
200
300
400
500
600
700
130
135
140
145
150
155
160
165
Yearday
Float 138



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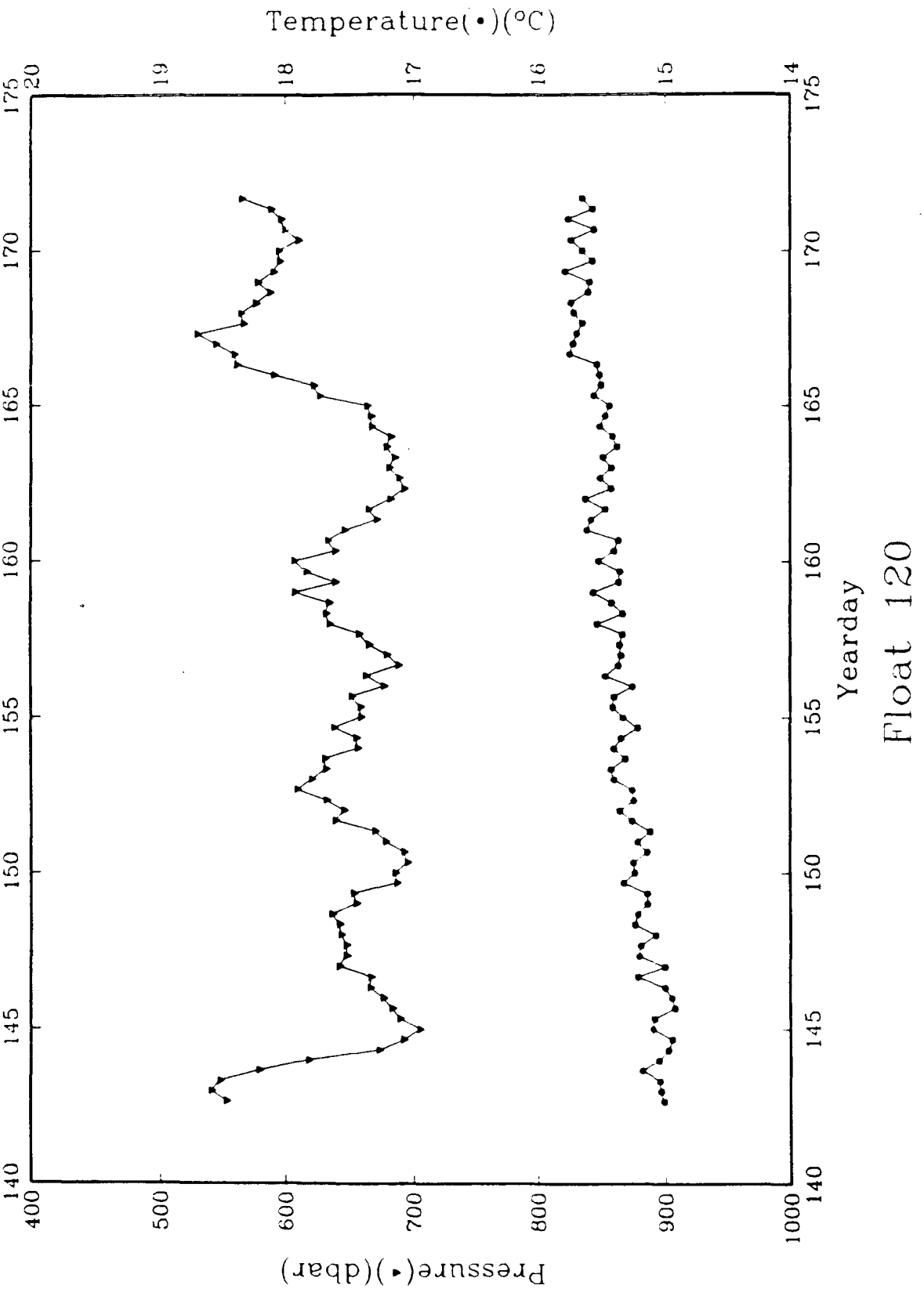
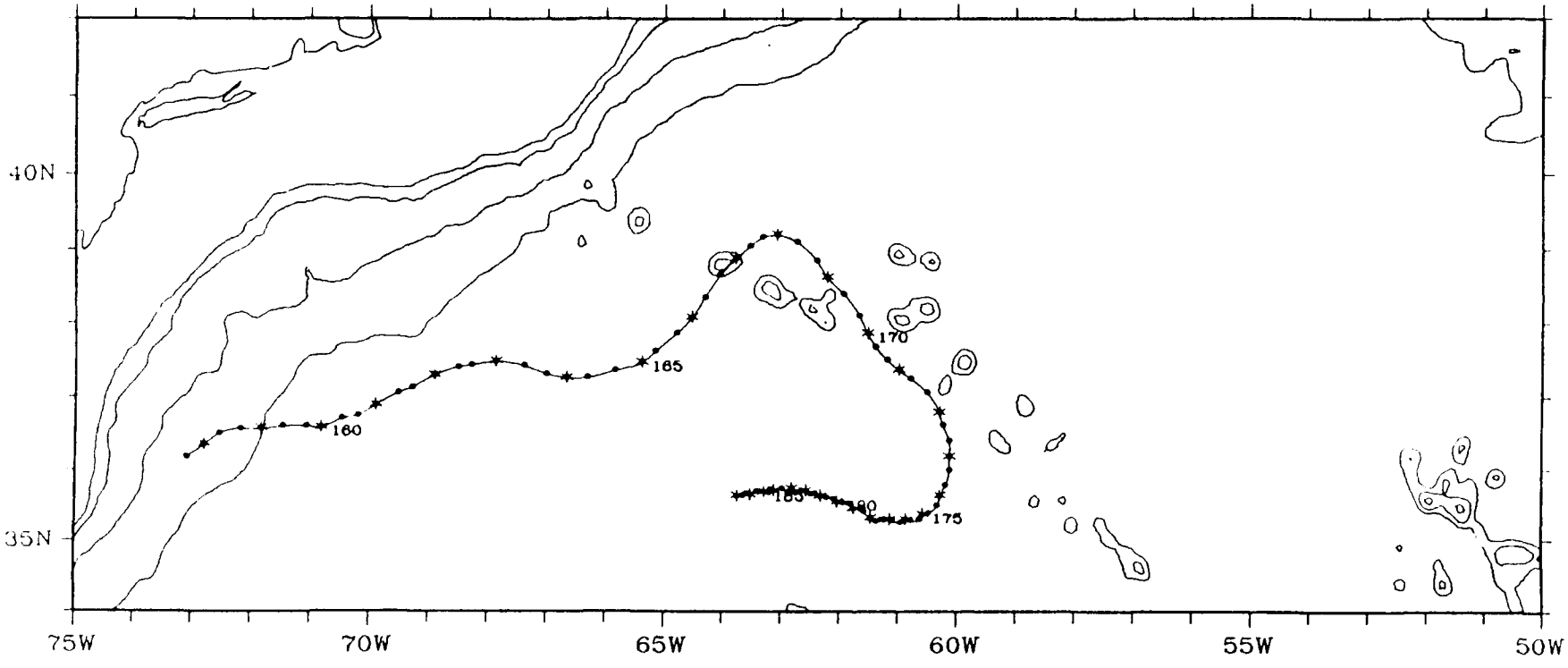

Temperature(•)(°C)
20
19
18
17
16
15
14
175
170
165
160
155
150
145
140
Yearday
Pressure(◂)(dbar)
400
500
600
700
800
900
1000
Float 120



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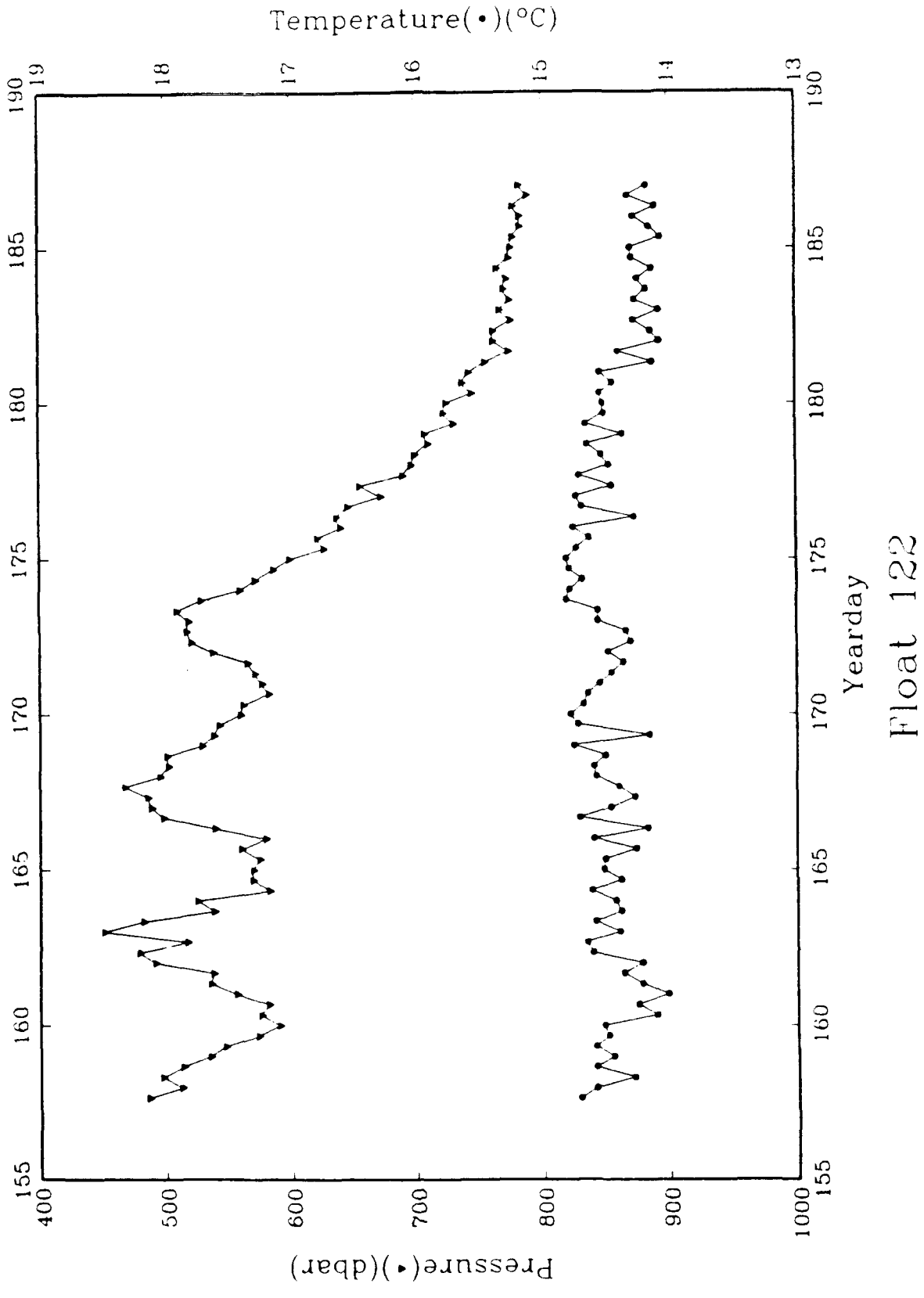
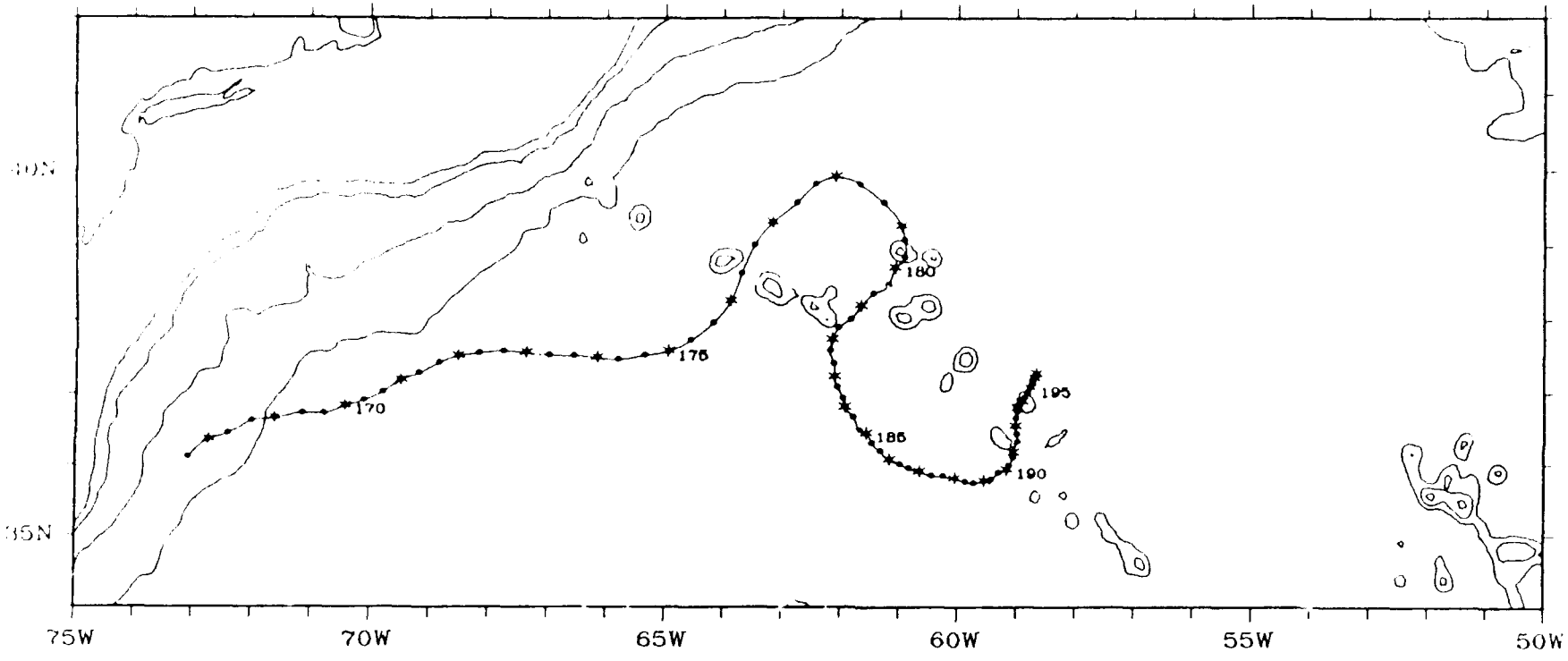

Temperature(•)(°C)
19
18
17
16
15
14
13
190
185
180
175
170
165
160
155
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000
Float 122



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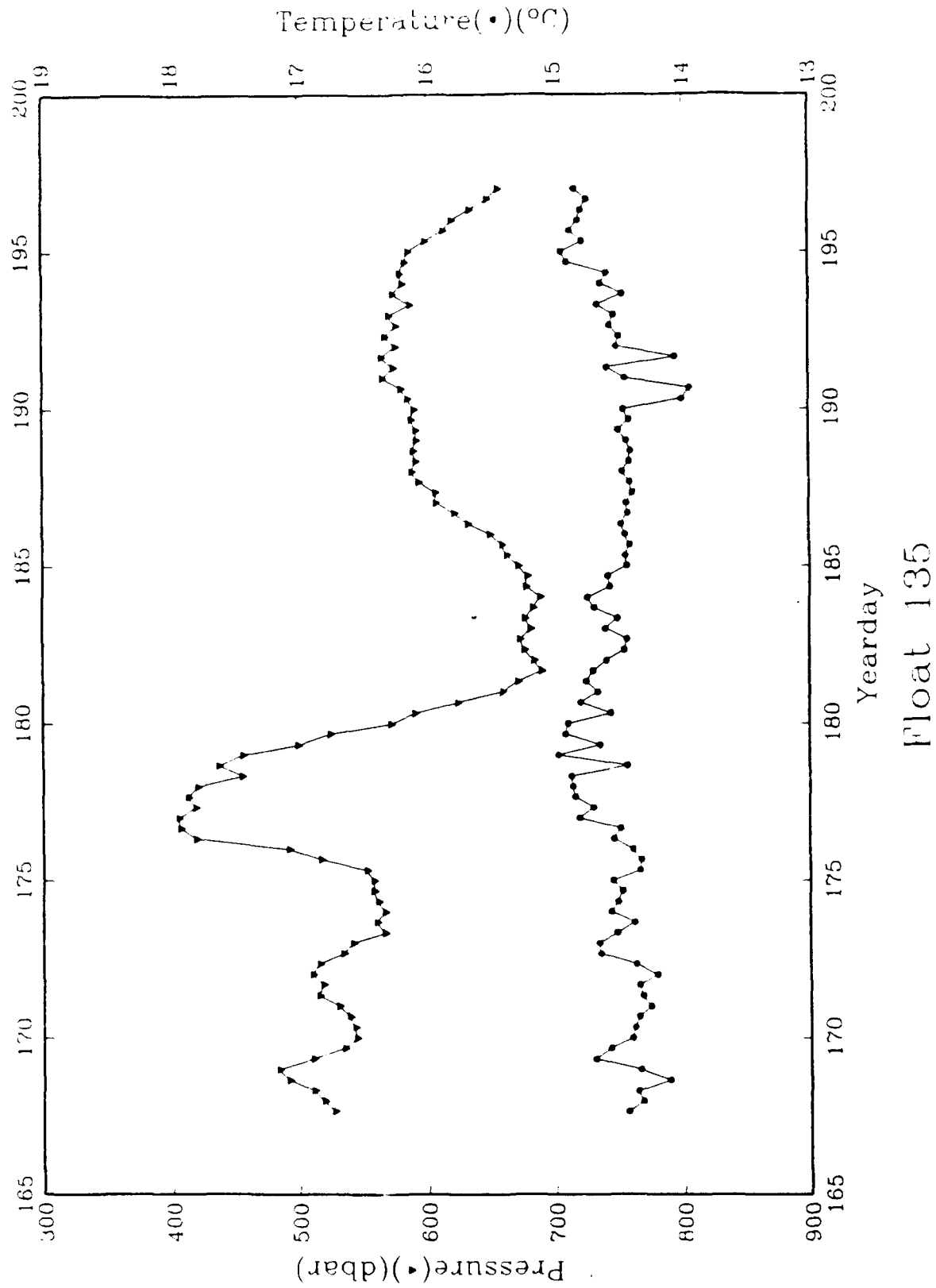
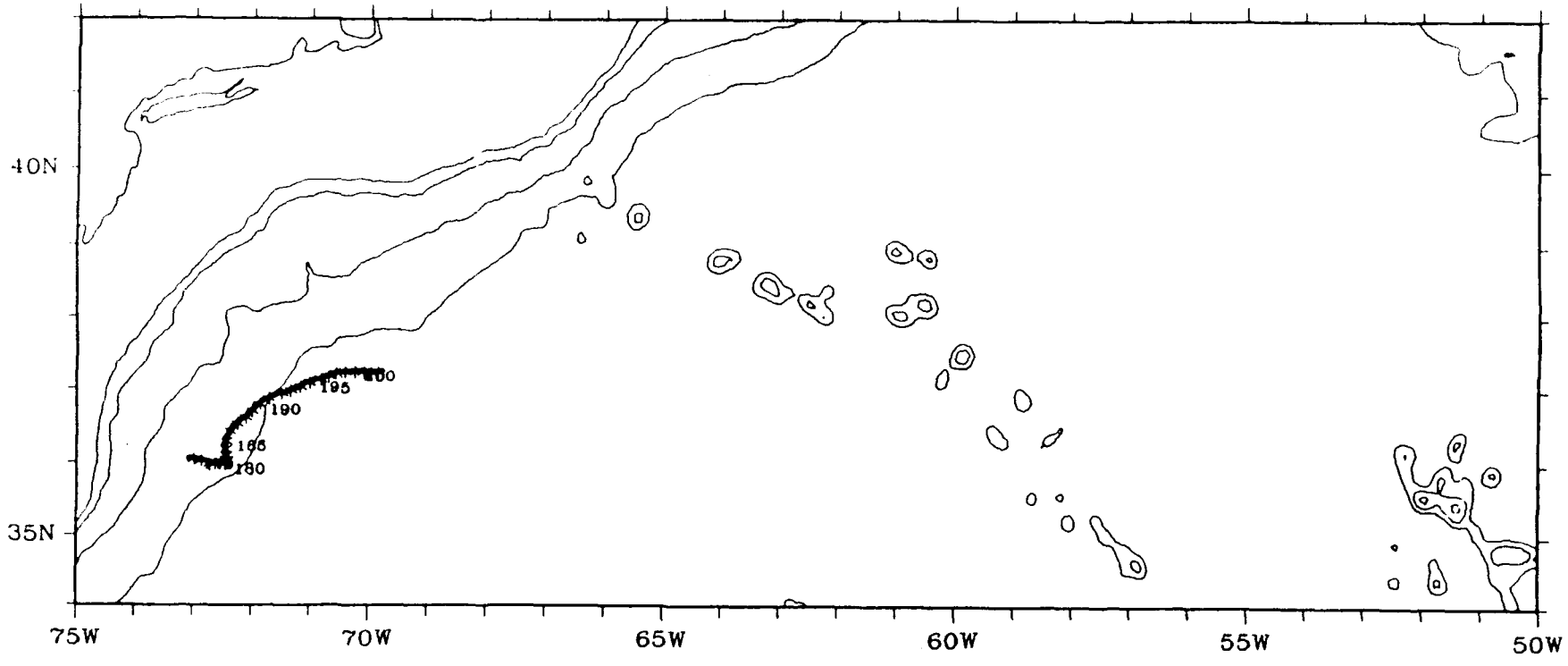

Temperature(•)(°C)
19
18
17
16
15
14
13
200
195
190
185
180
175
170
165
Yearday
Float 135
Pressure(•)(dbar)
300
400
500
600
700
800
900



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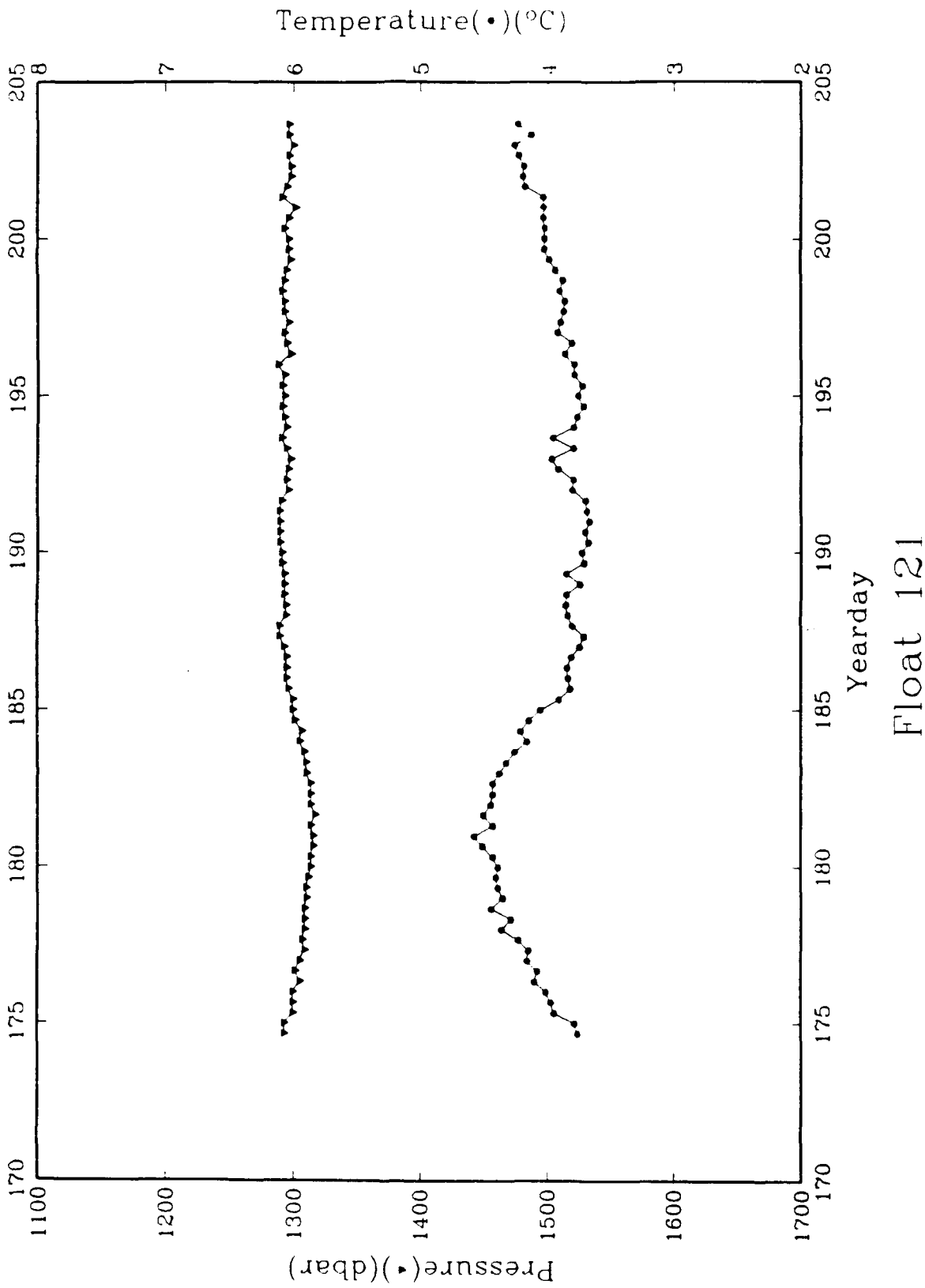
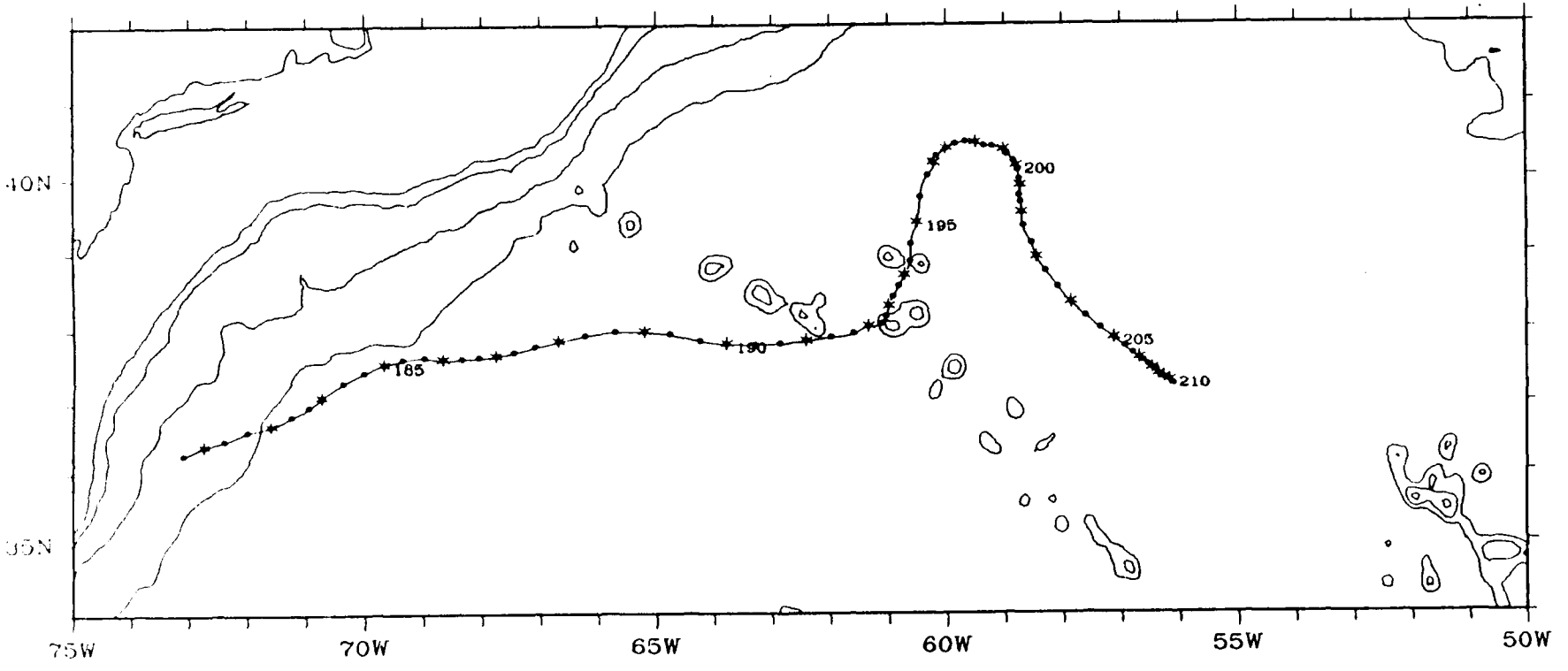

Temperature(•)(°C)
8
7
6
5
4
3
2
205
200
195
190
185
180
175
170
1100
1200
1300
1400
1500
1600
1700
Pressure(◂)(dbar)
Yearday
Float 121



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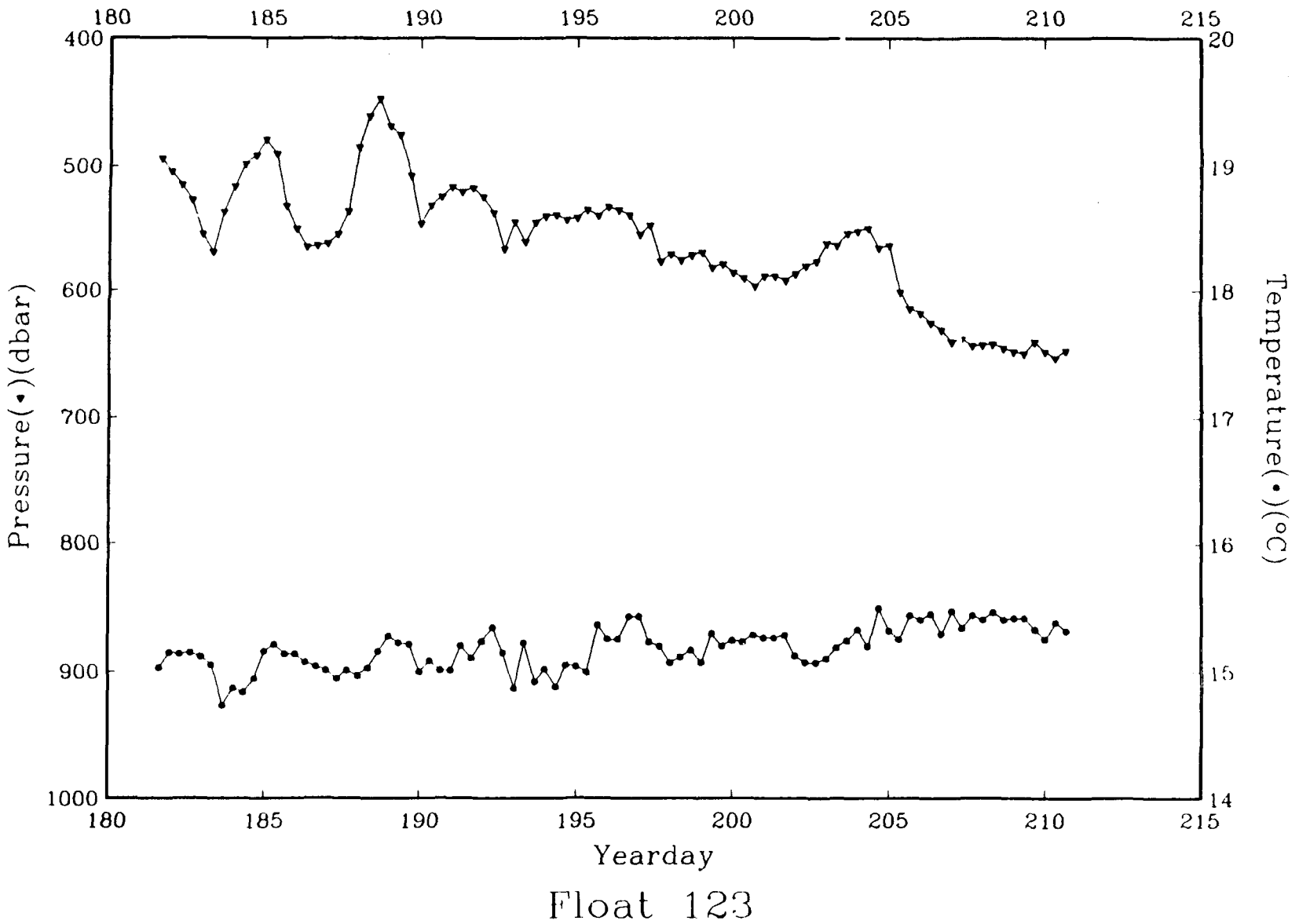
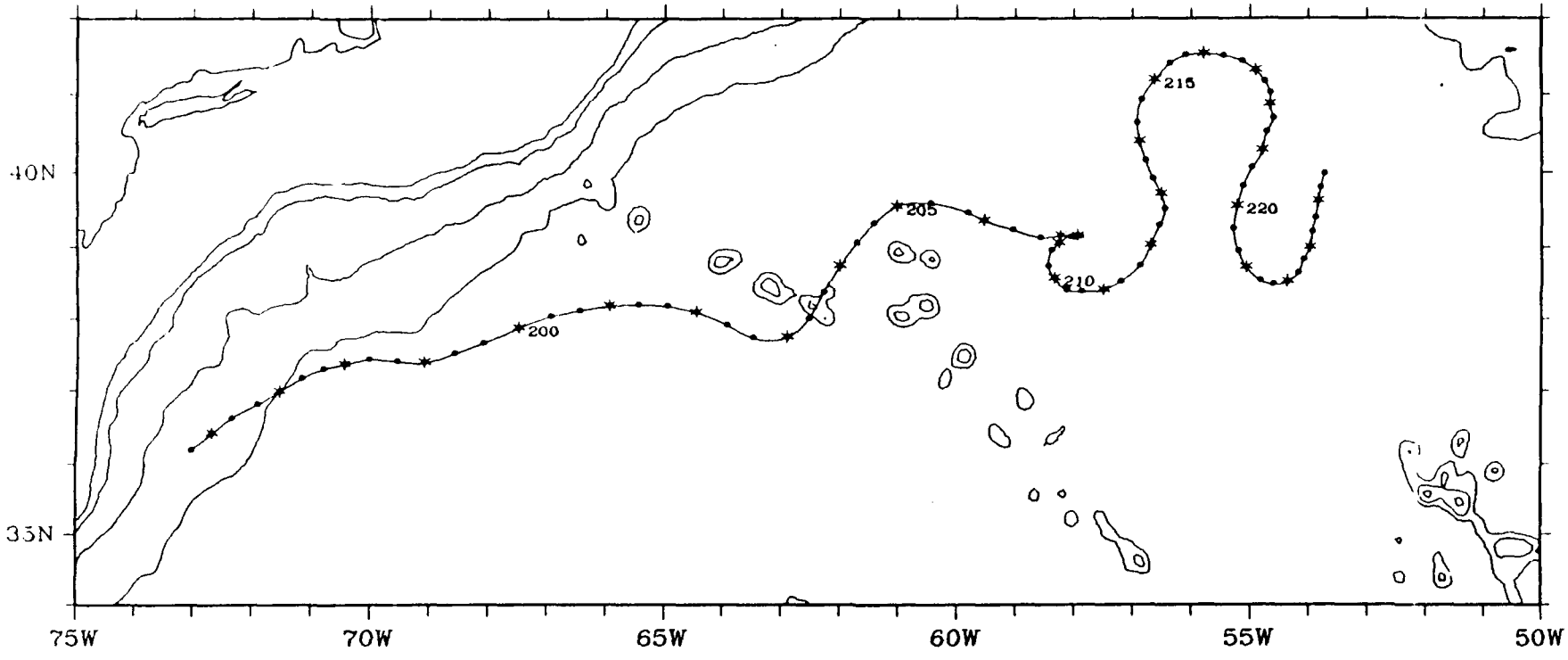

180
185
190
195
200
205
210
215
400
500
600
700
800
900
1000
20
19
18
17
16
15
14
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

Float 123



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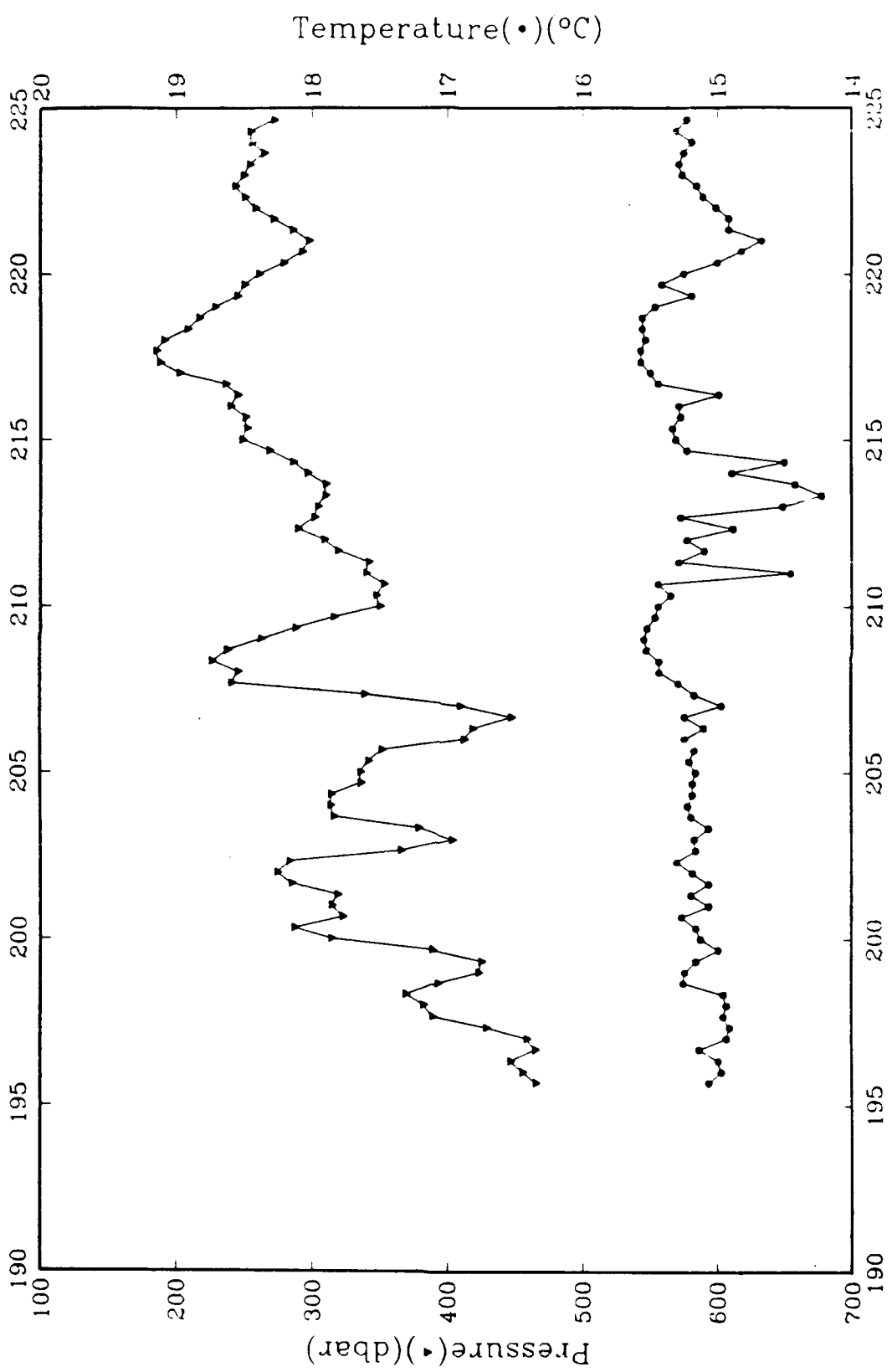
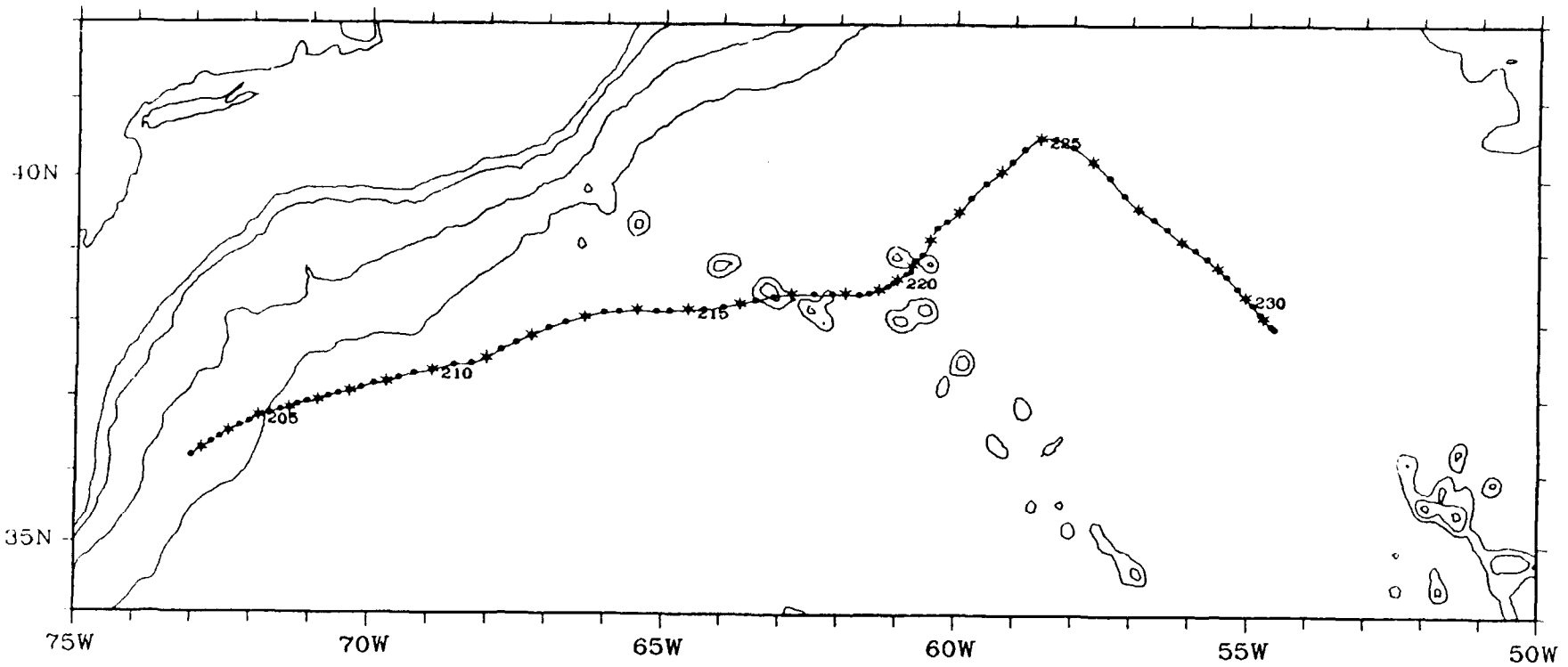
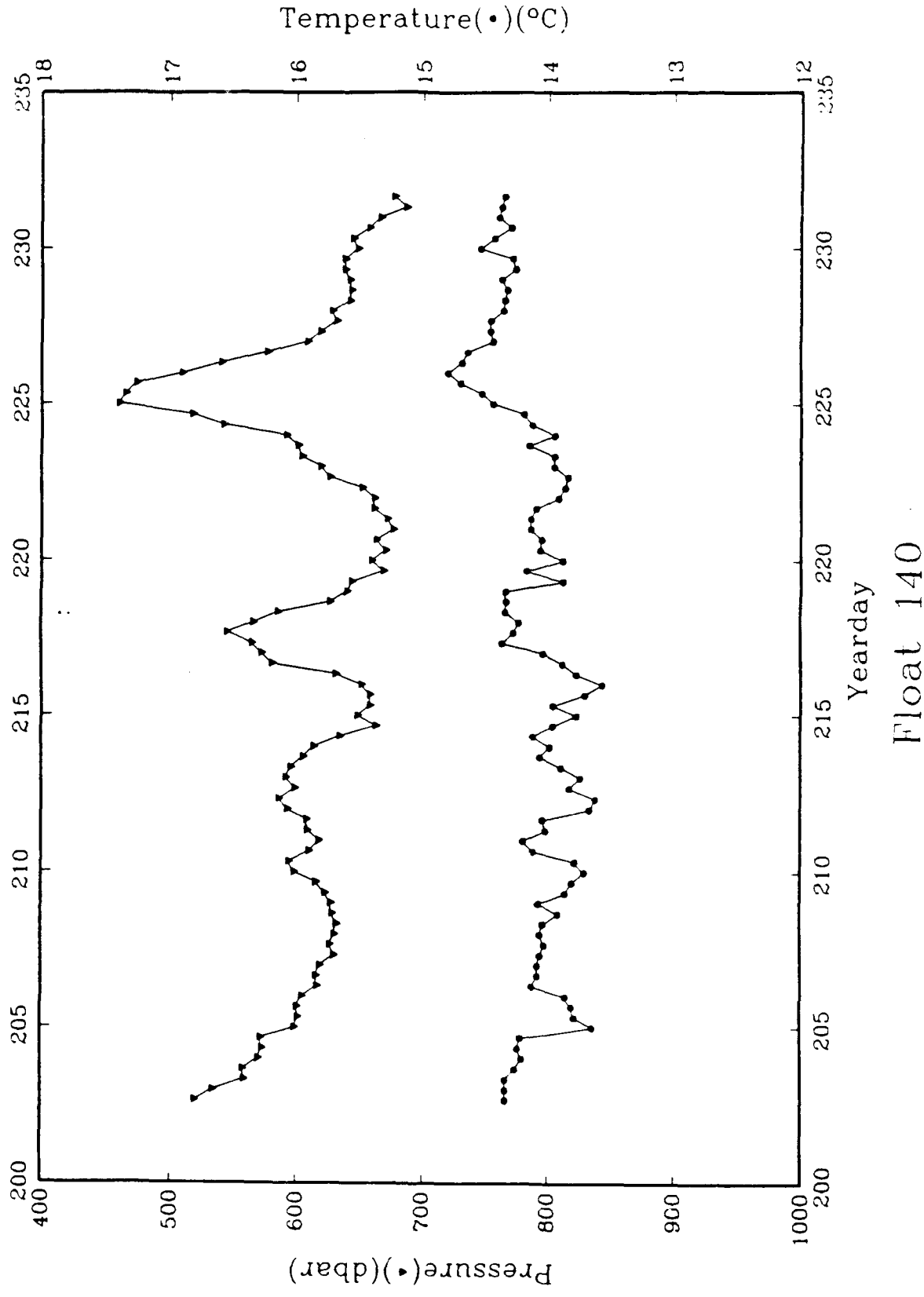
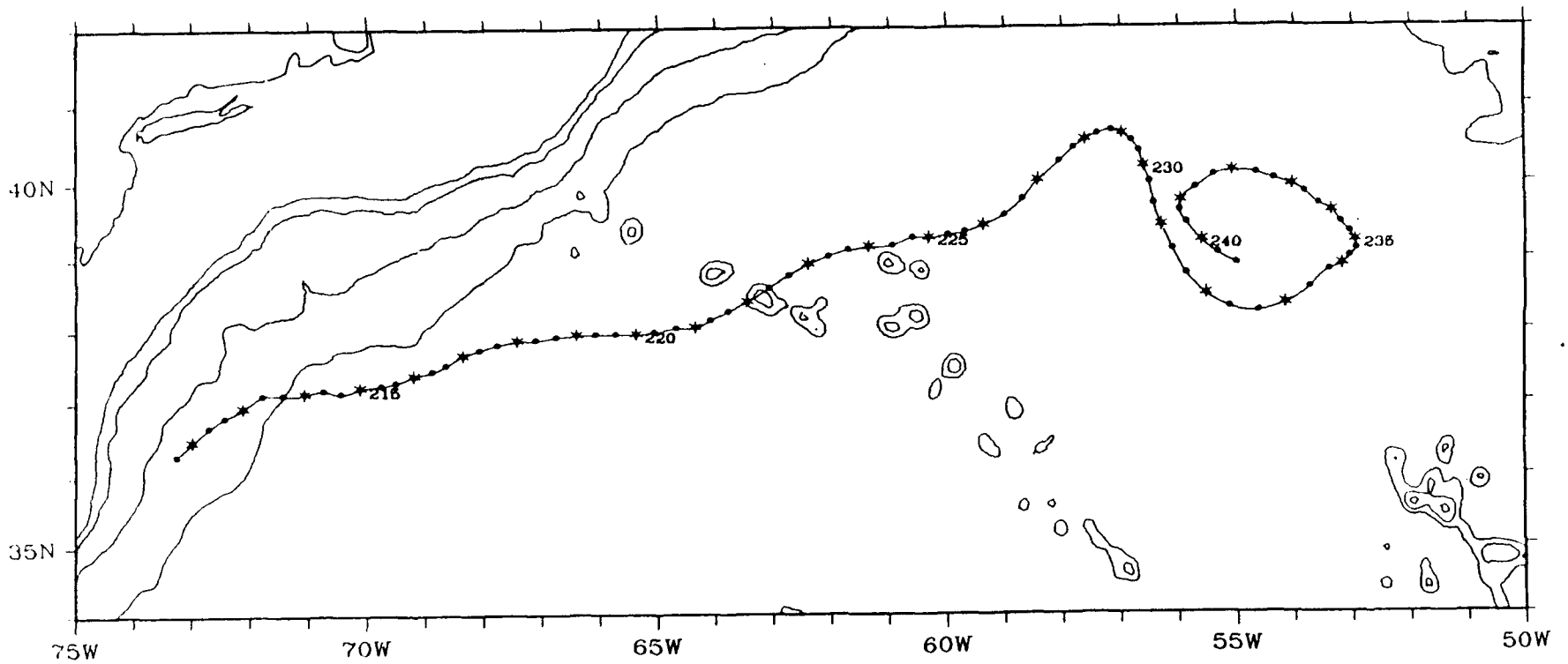

Temperature(•)(°C)
20
19
18
17
16
15
14
225
220
215
210
205
200
195
190
Yearday
Pressure(◂)(dbar)
100
200
300
400
500
600
700

Float 125

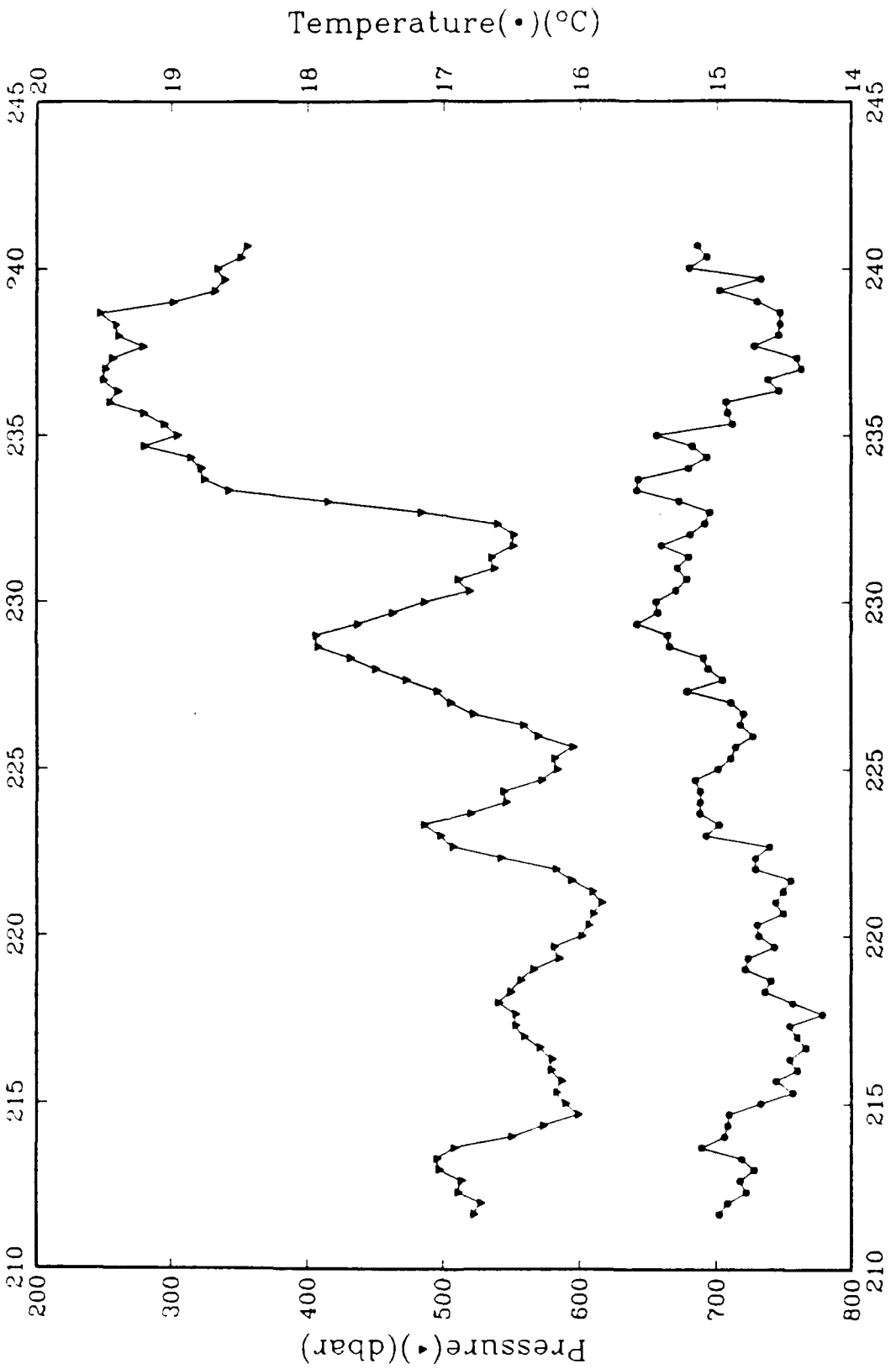


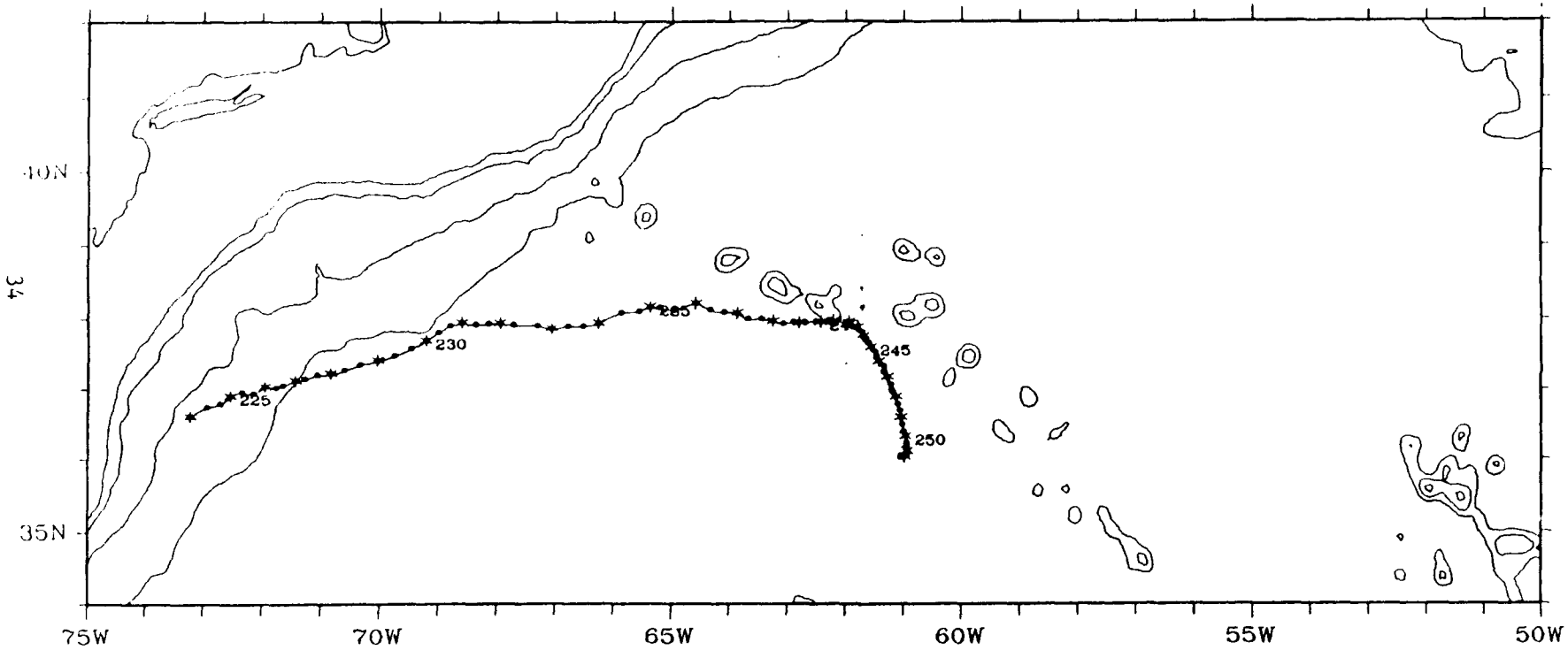
Float 140


Temperature(•)(°C)
18
17
16
15
14
13
12
235
230
225
220
215
210
205
200
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000
Float 140

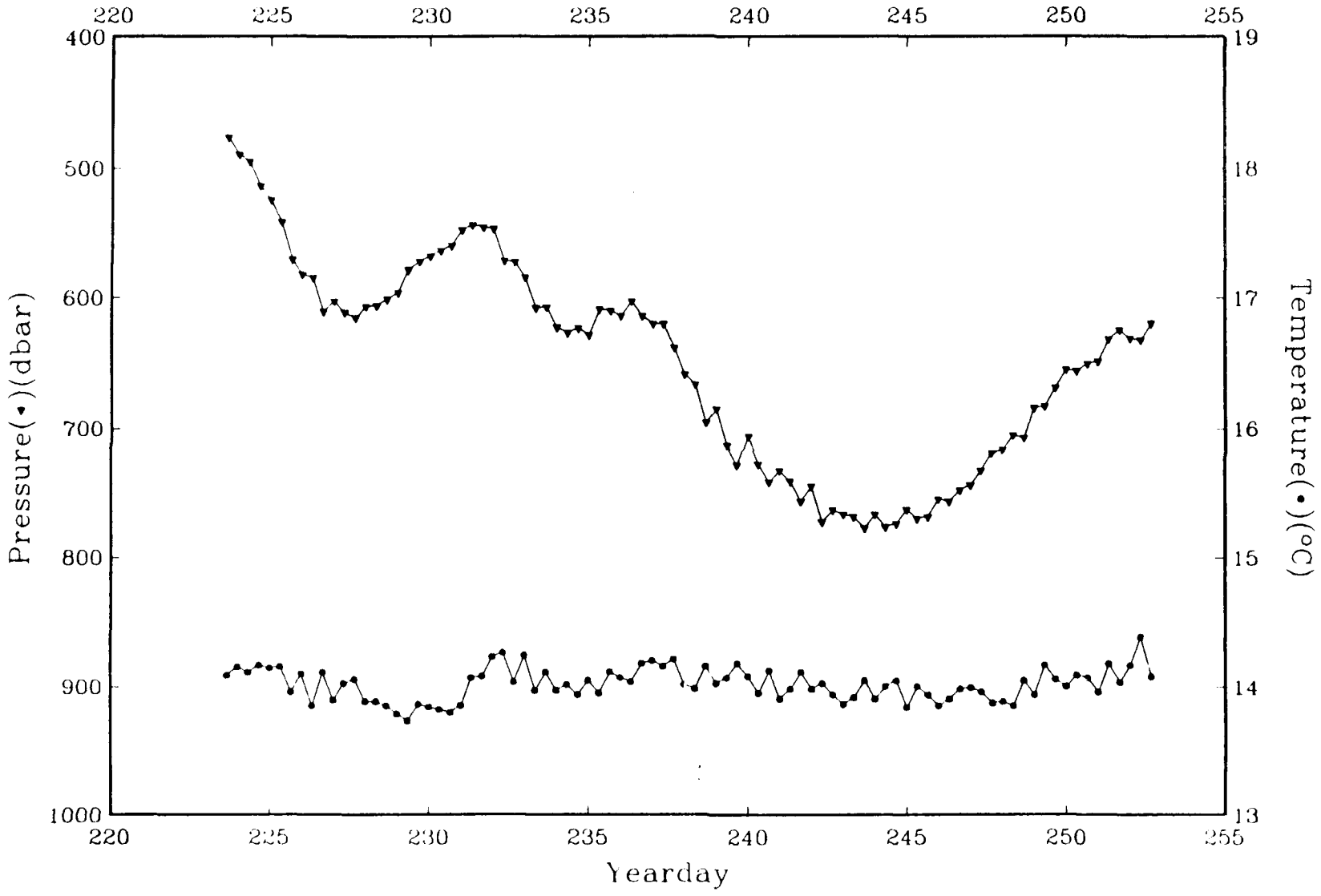


Float 127

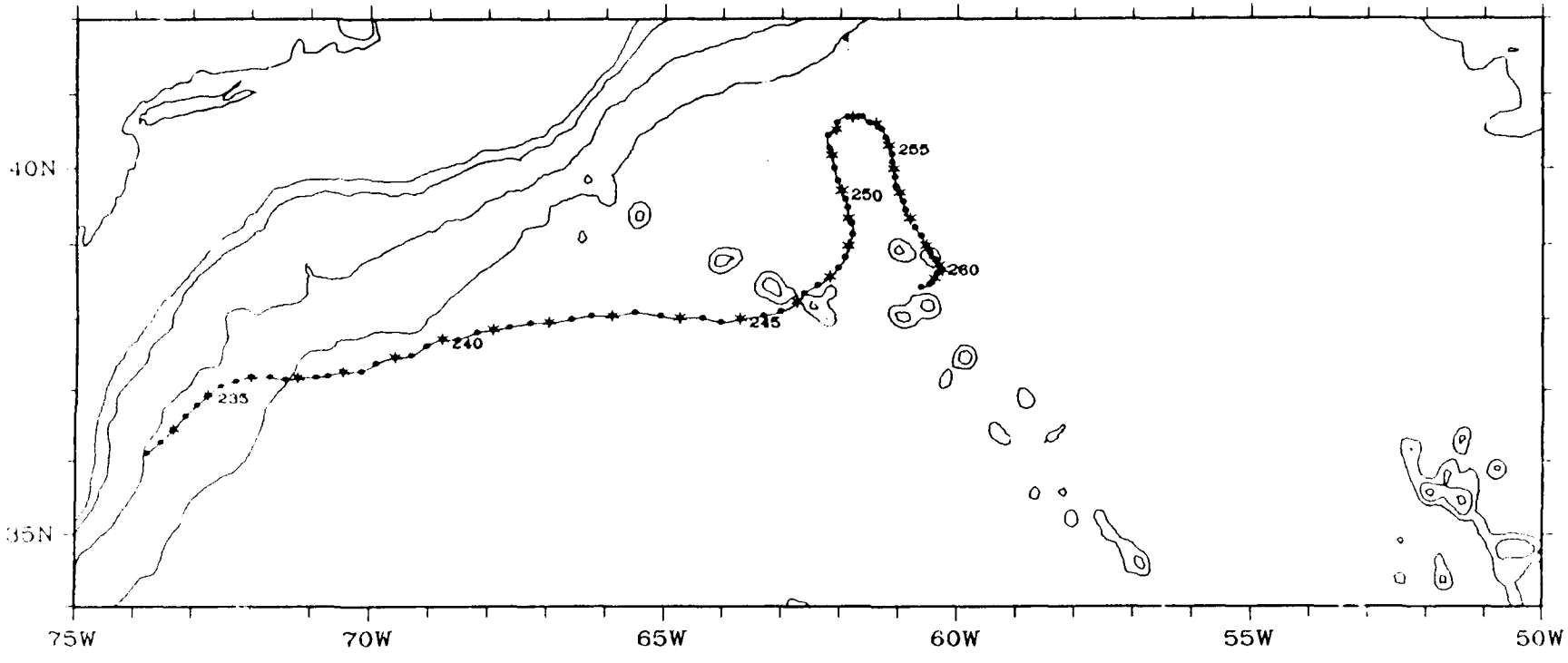

Temperature(•)(°C)
20
19
18
17
16
15
14
245
240
235
230
225
220
215
210
Yearday
Pressure(•)(dbar)
200
300
400
500
600
700
800
Float 127



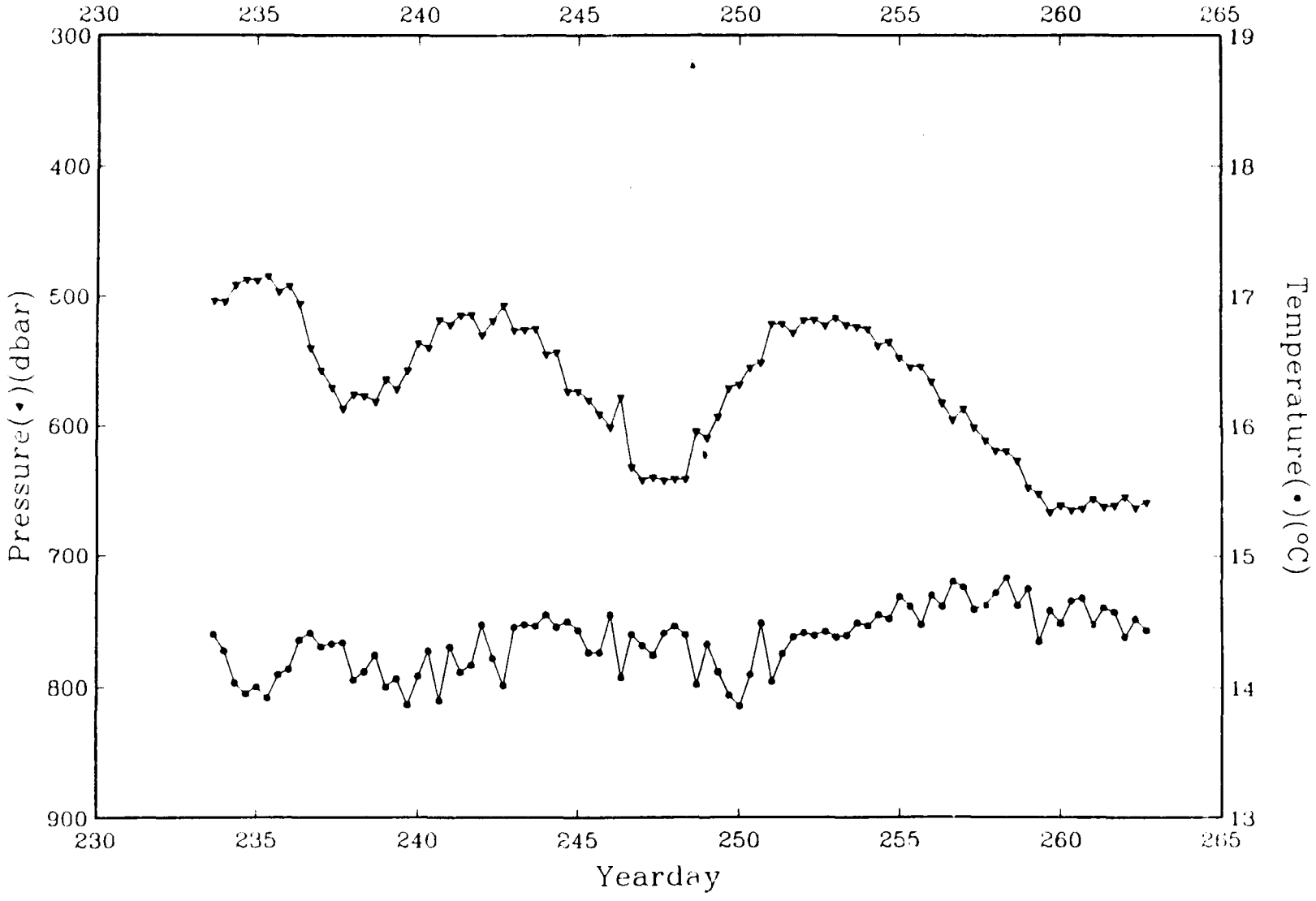
Float 124


220
225
230
235
240
245
250
255
400
500
600
700
800
900
1000
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

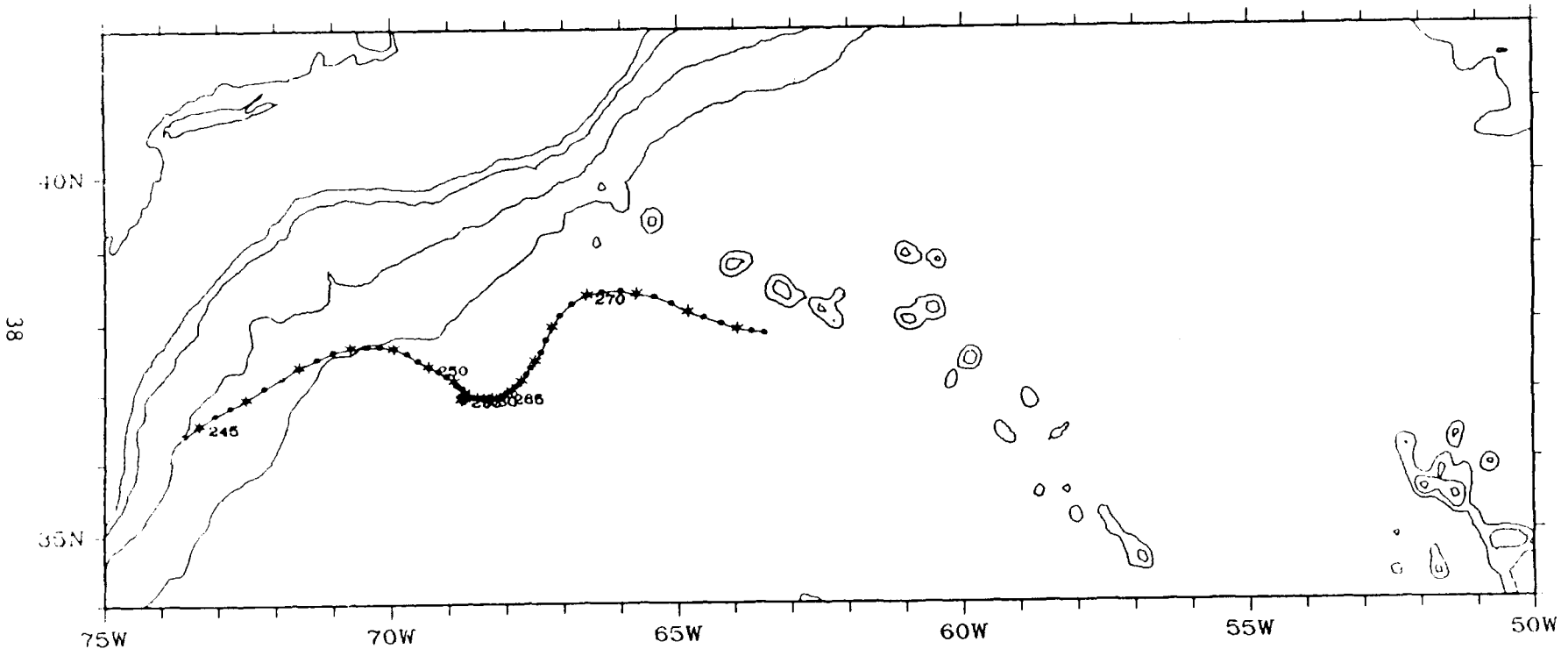
Float 124



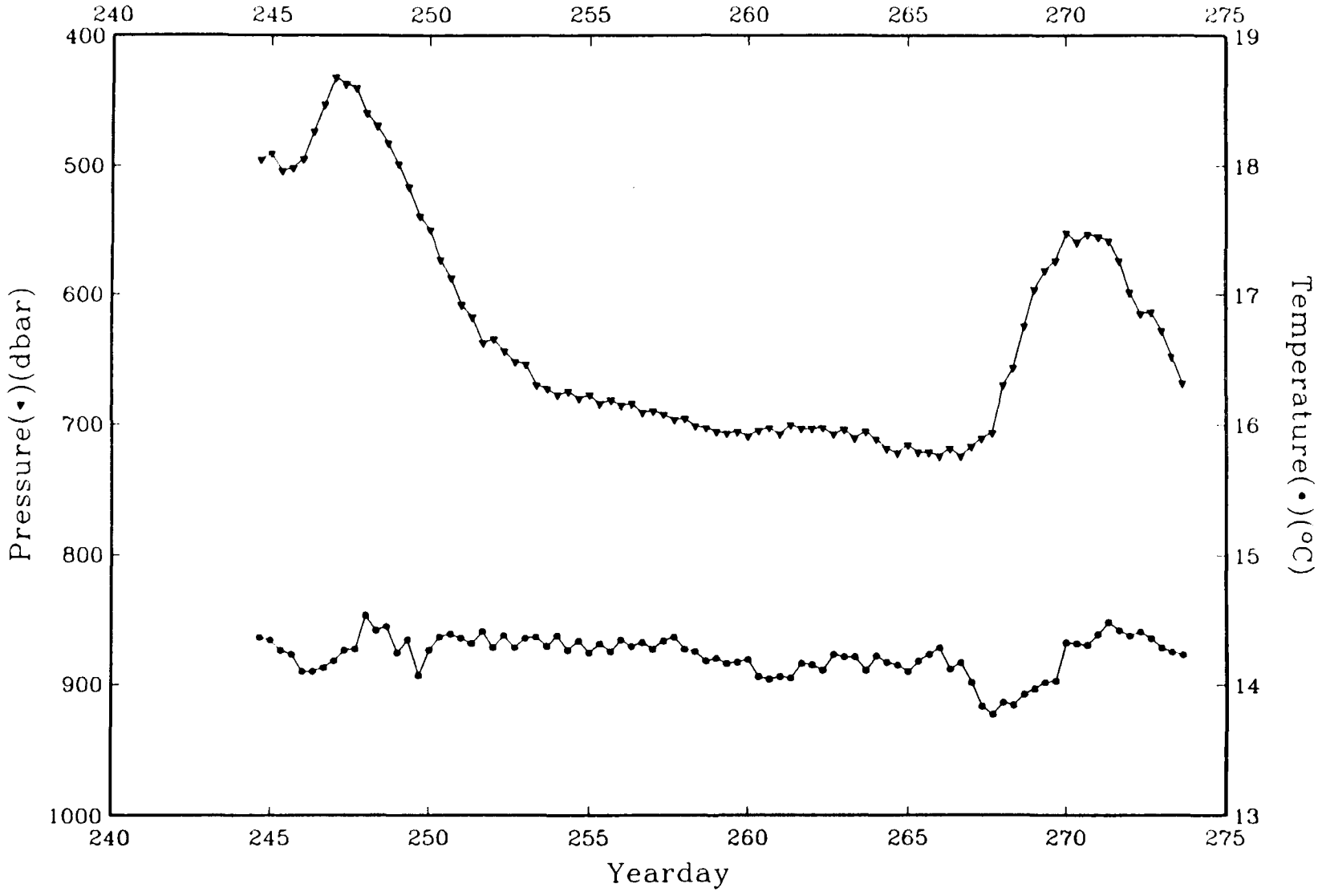
Float 142


230
235
240
245
250
255
260
265
300
400
500
600
700
800
900
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

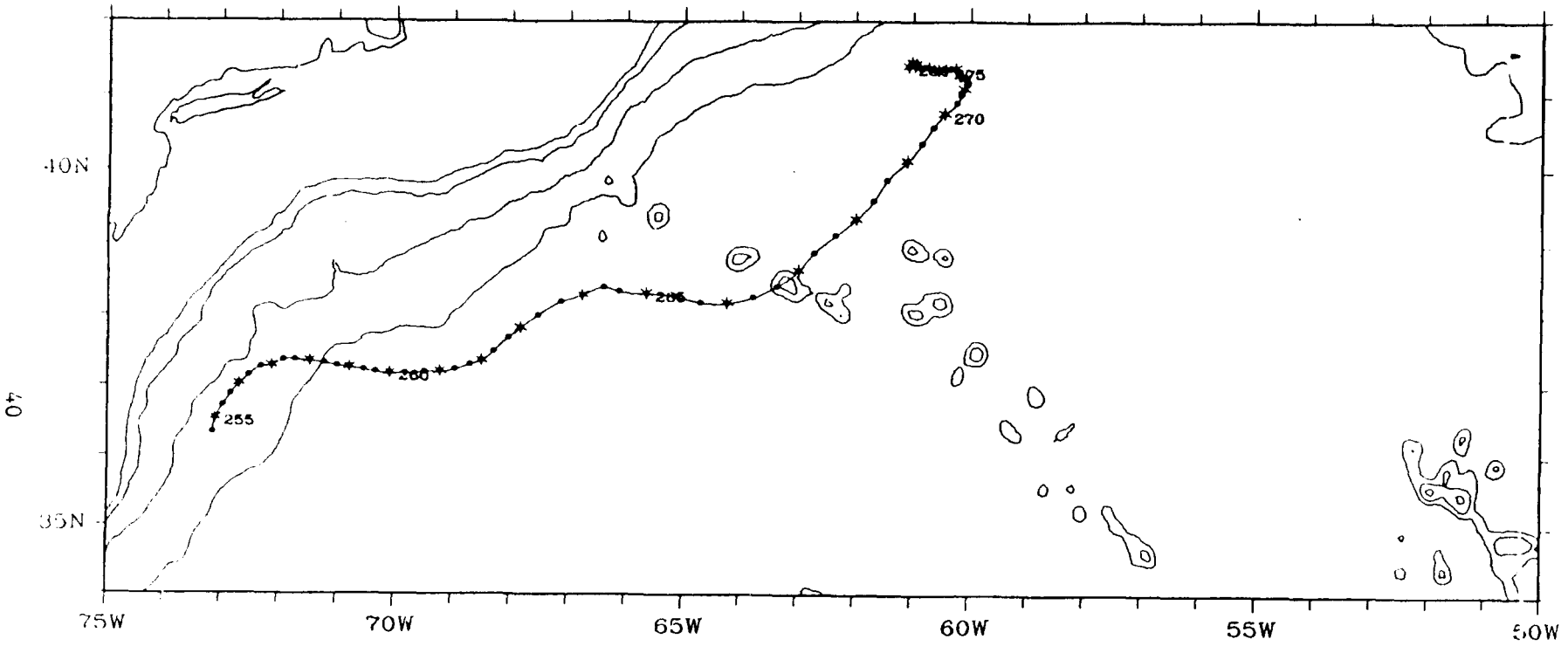
Float 142



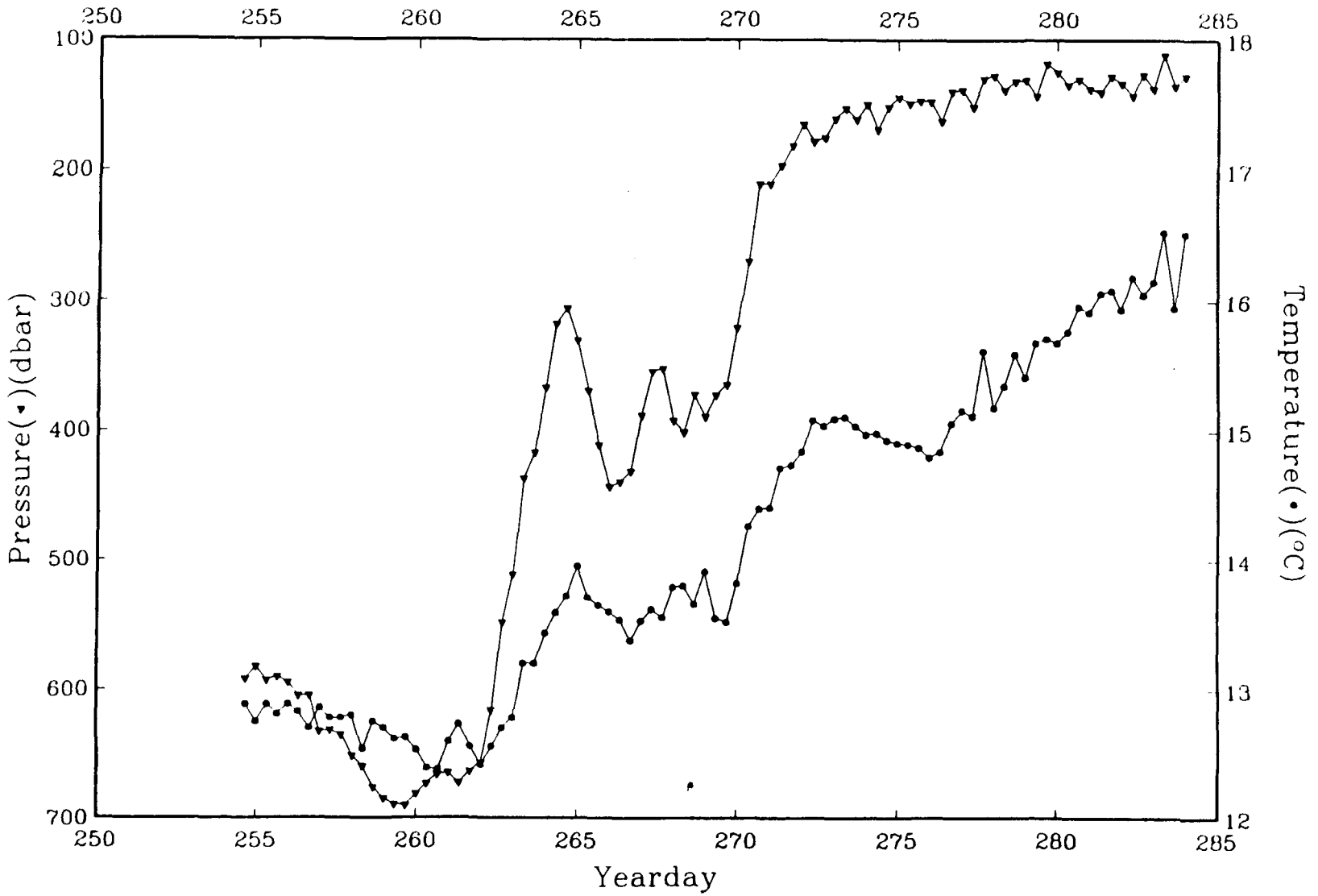
Float 129


240
245
250
255
260
265
270
275
400
500
600
700
800
900
1000
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

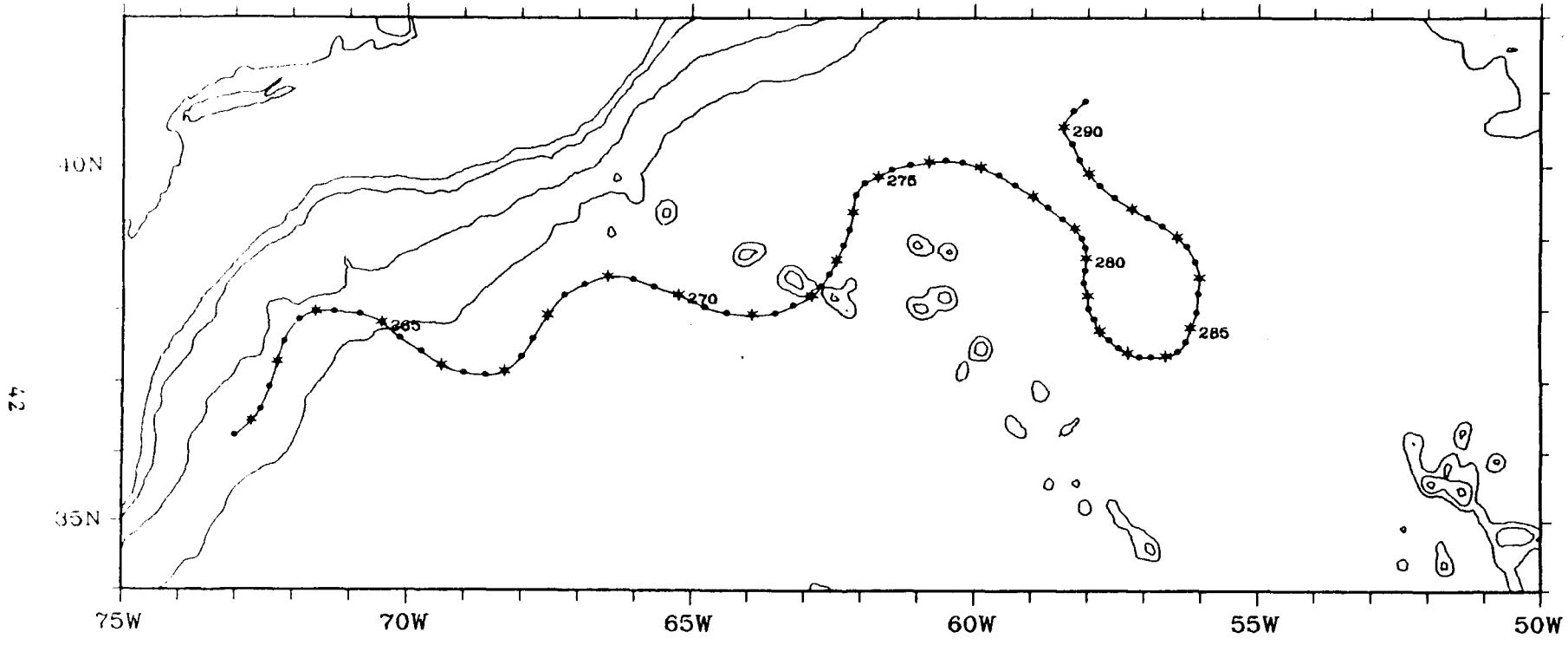
Float 129



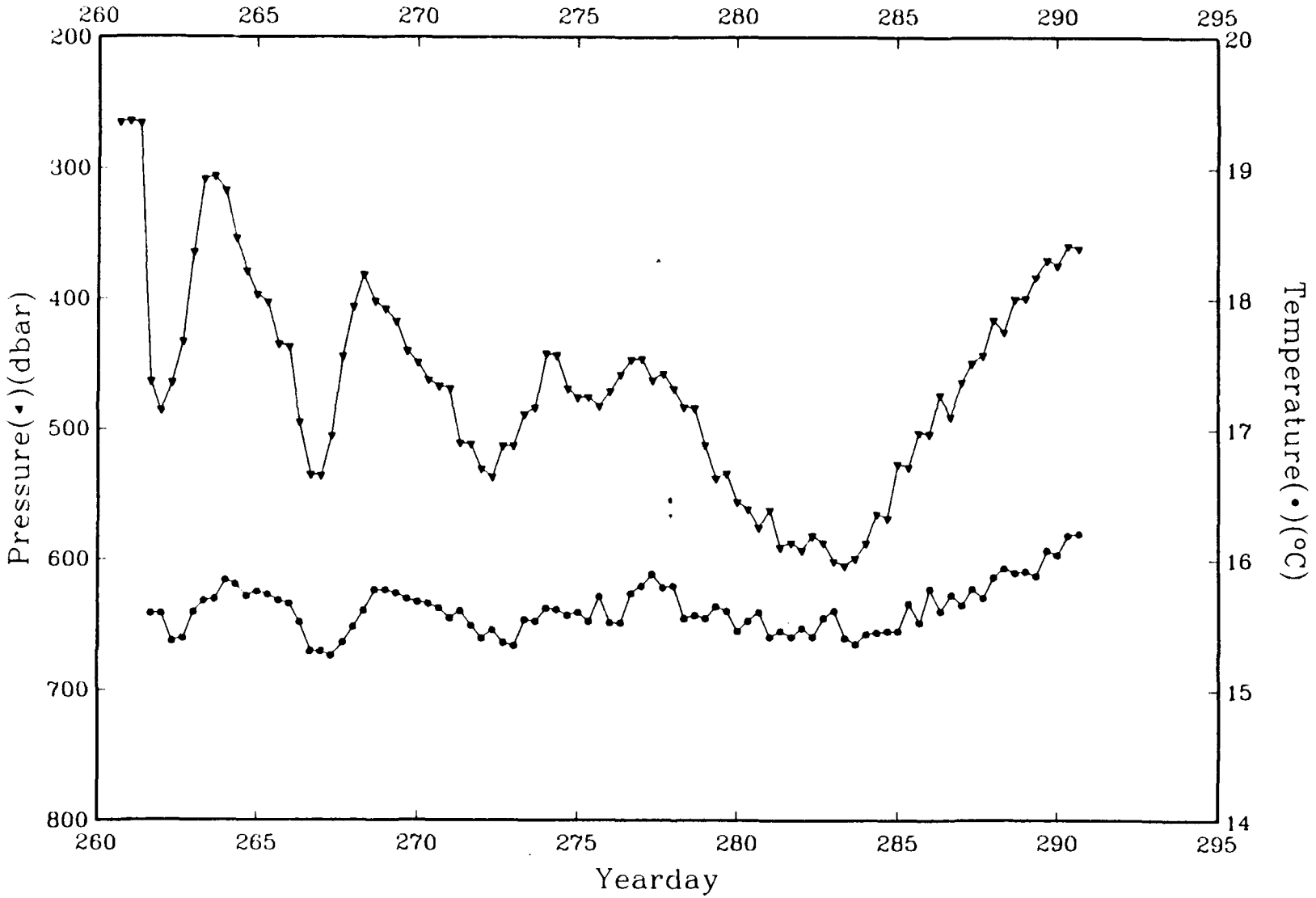
Float 131


250
255
260
265
270
275
280
285
100
200
300
400
500
600
700
18
17
16
15
14
13
12
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

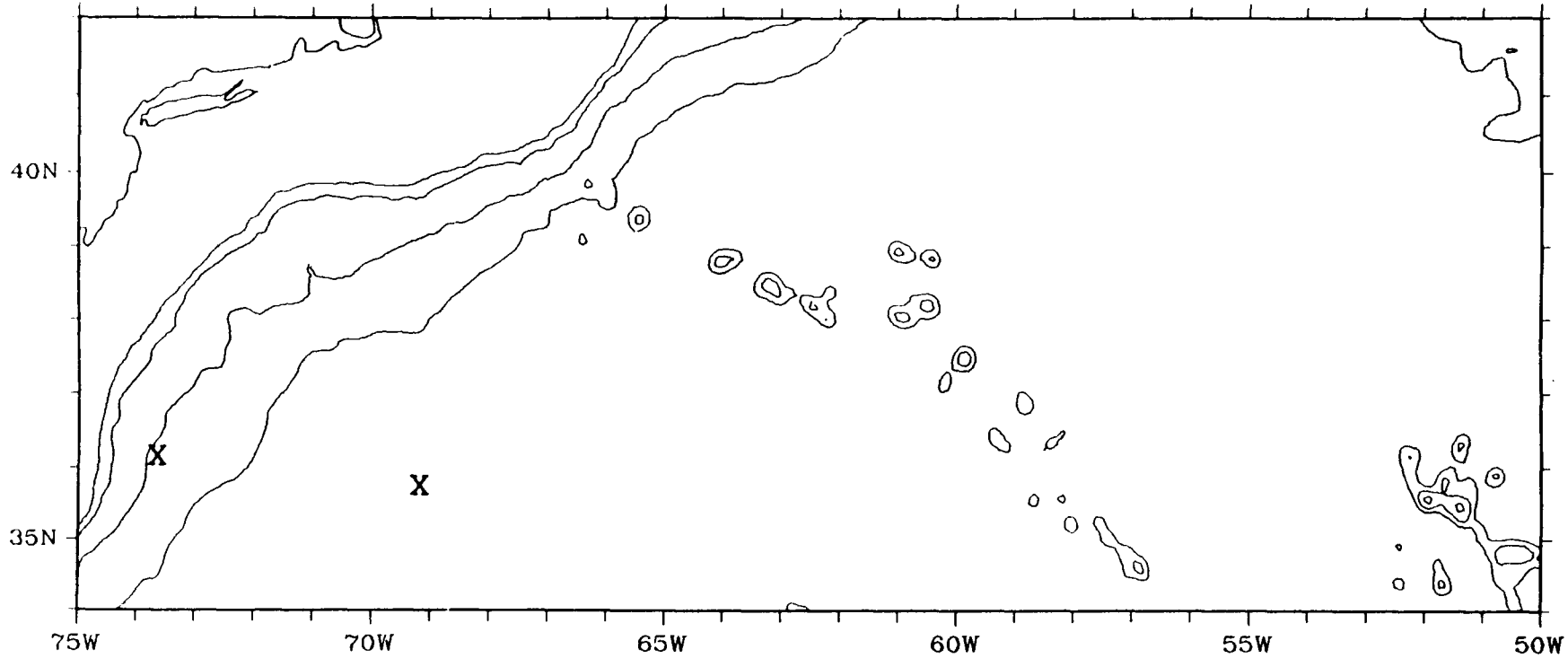
Float 131



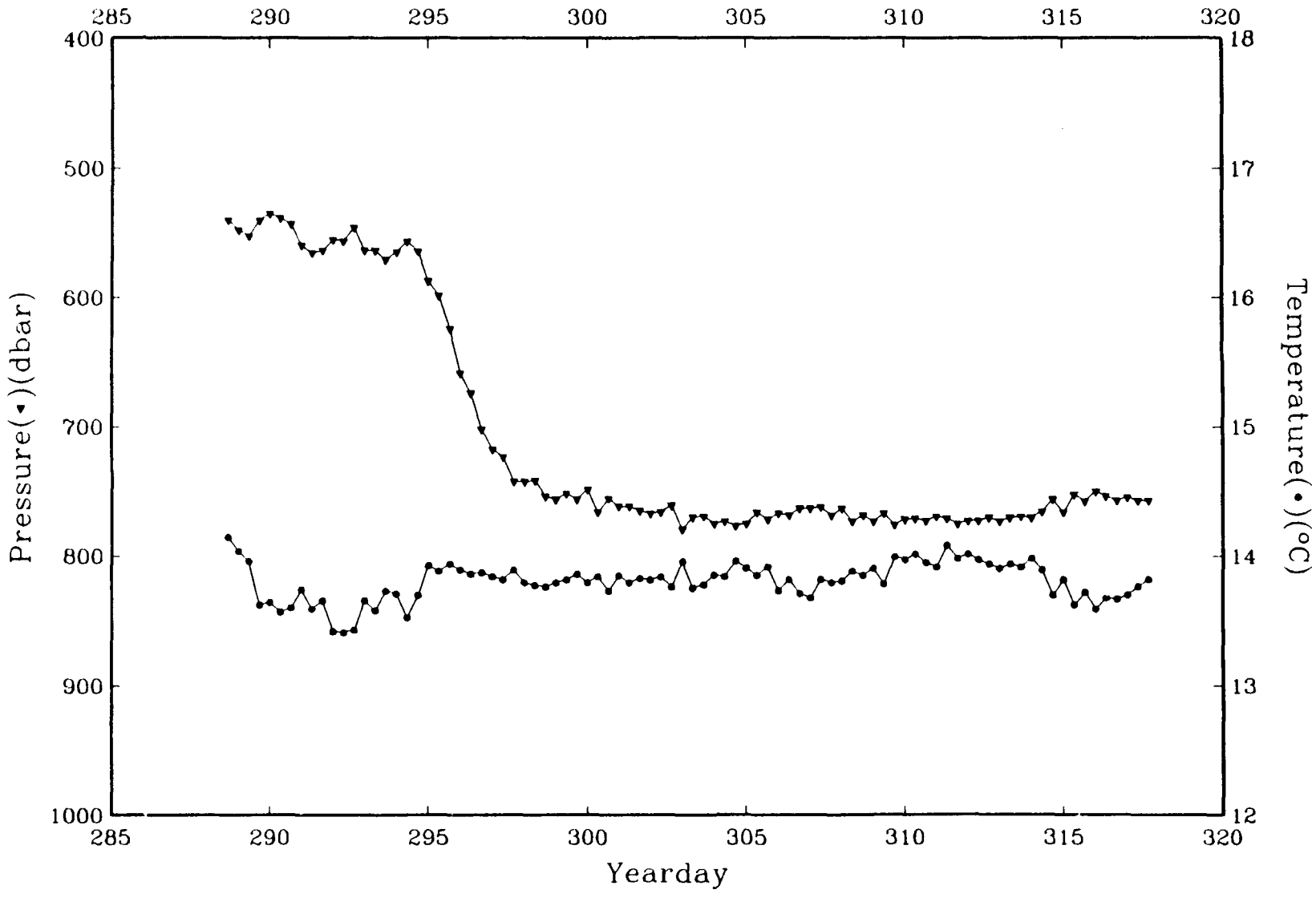
Float 134


260
265
270
275
280
285
290
295
200
300
400
500
600
700
800
20
19
18
17
16
15
14
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

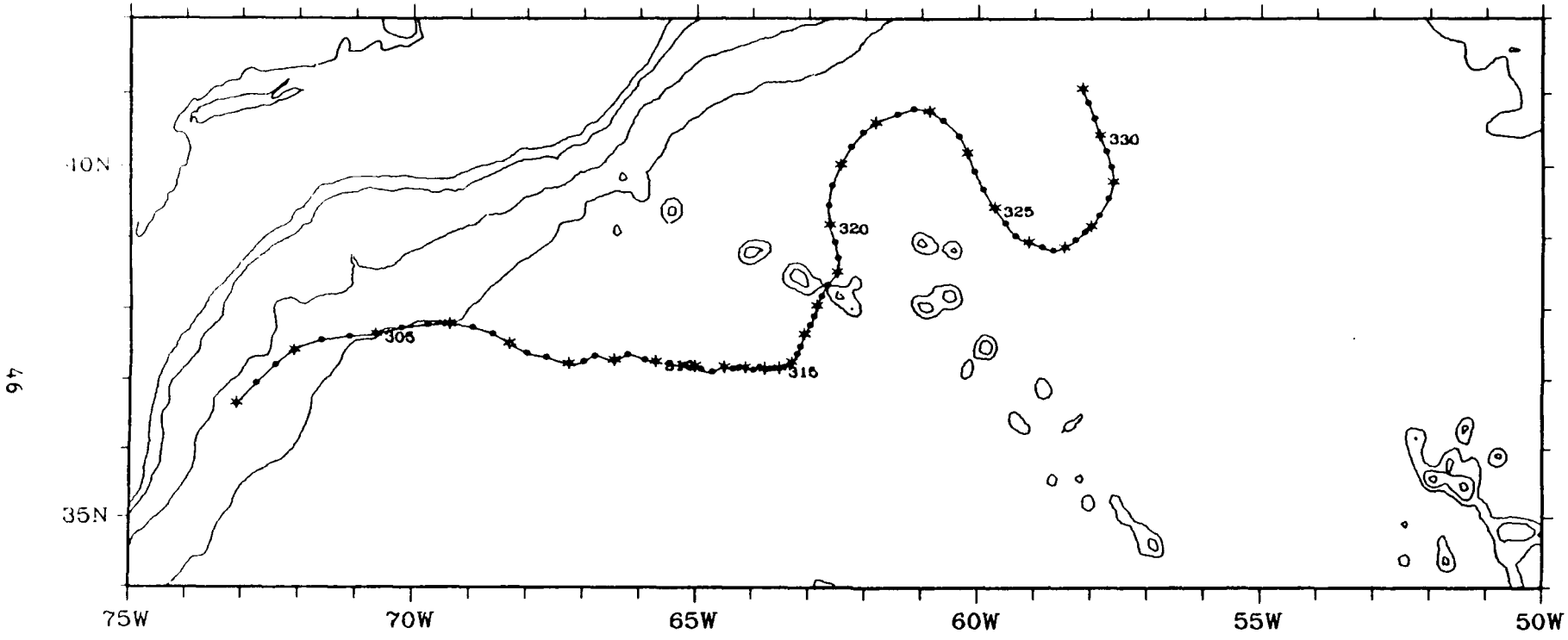
Float 134



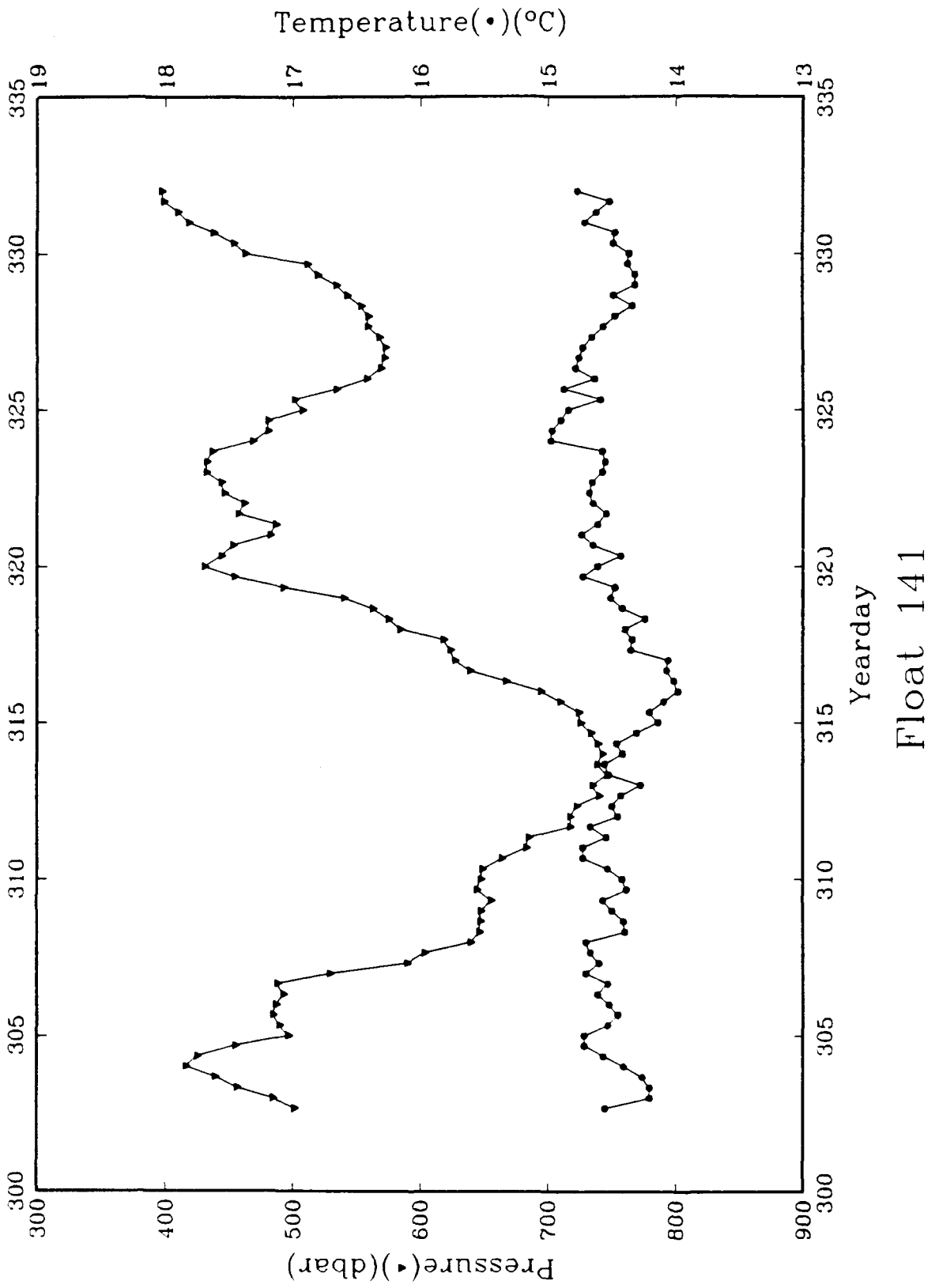
Float 137

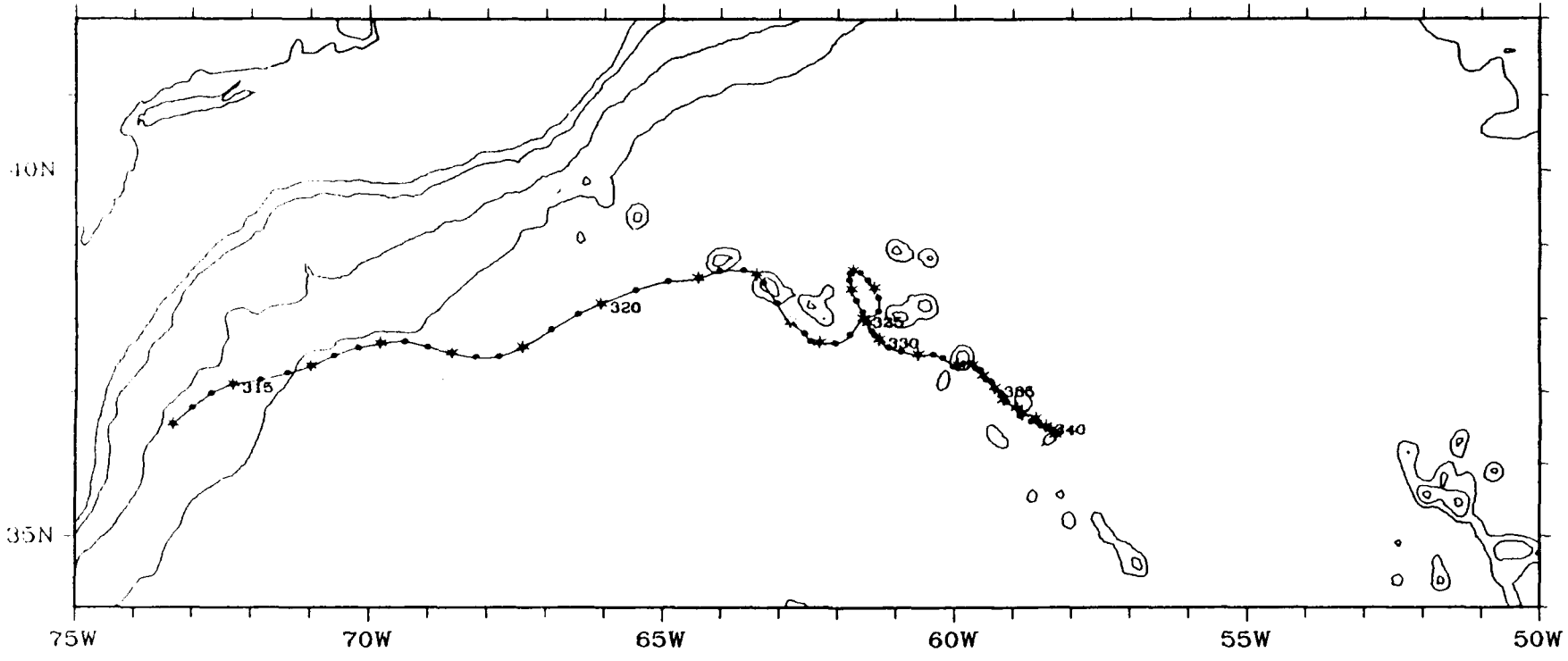

285
290
295
300
305
310
315
320
400
500
600
700
800
900
1000
18
17
16
15
14
13
12
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

Float 137

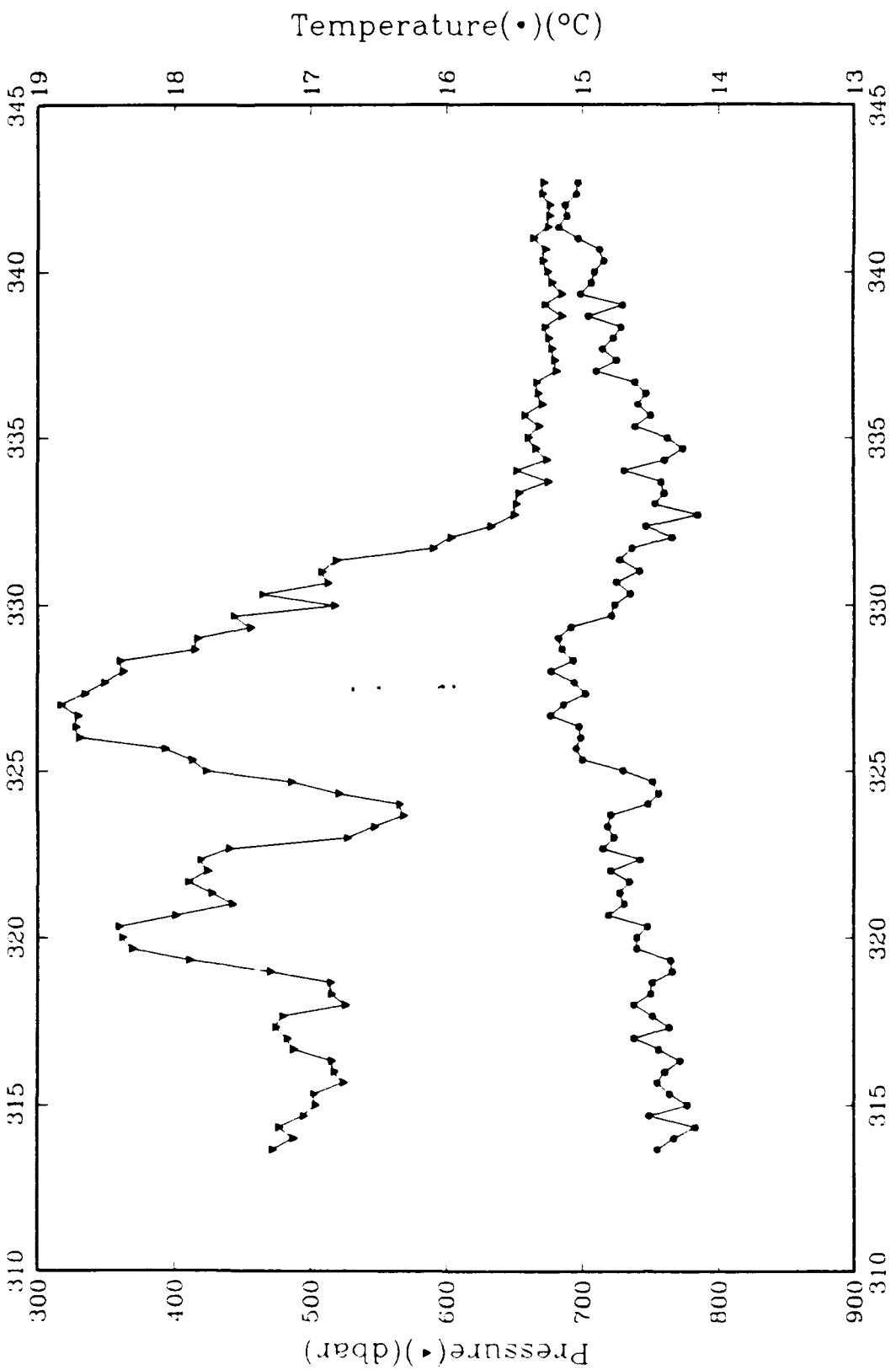


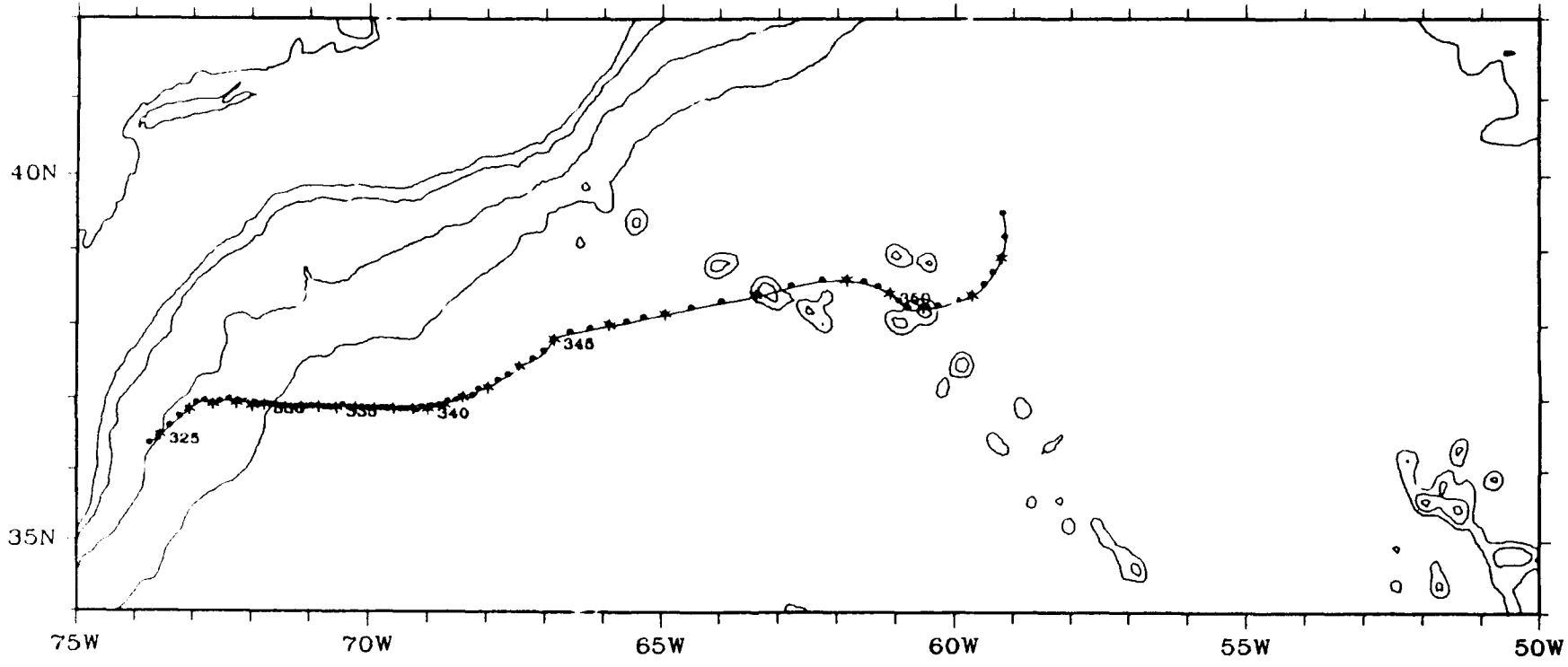
Float 141


Temperature(•)(°C)
19
18
17
16
15
14
13
335
330
325
320
315
310
305
300
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 141

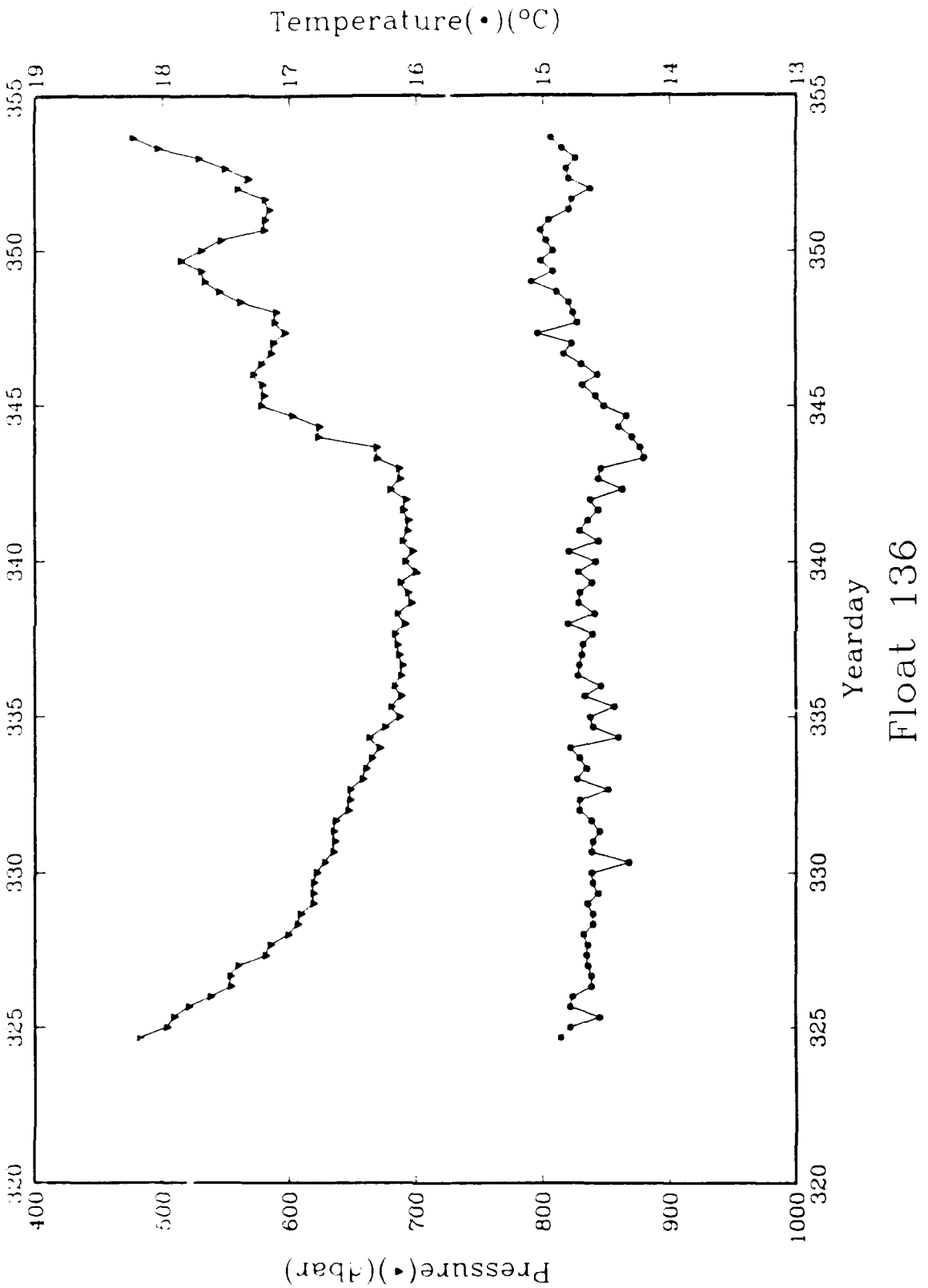


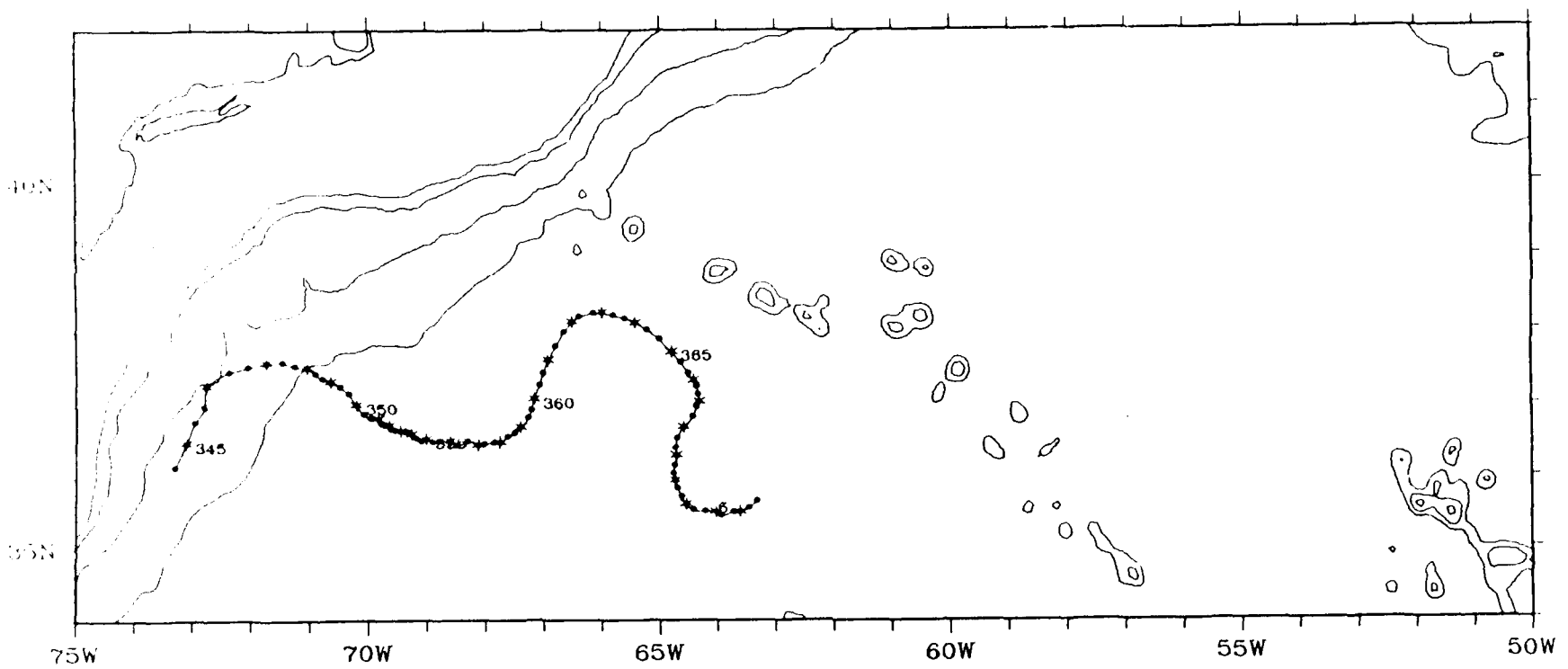
Float 130


Temperature(•)(°C)
19
18
17
16
15
14
13
345
340
335
330
325
320
315
310
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 130

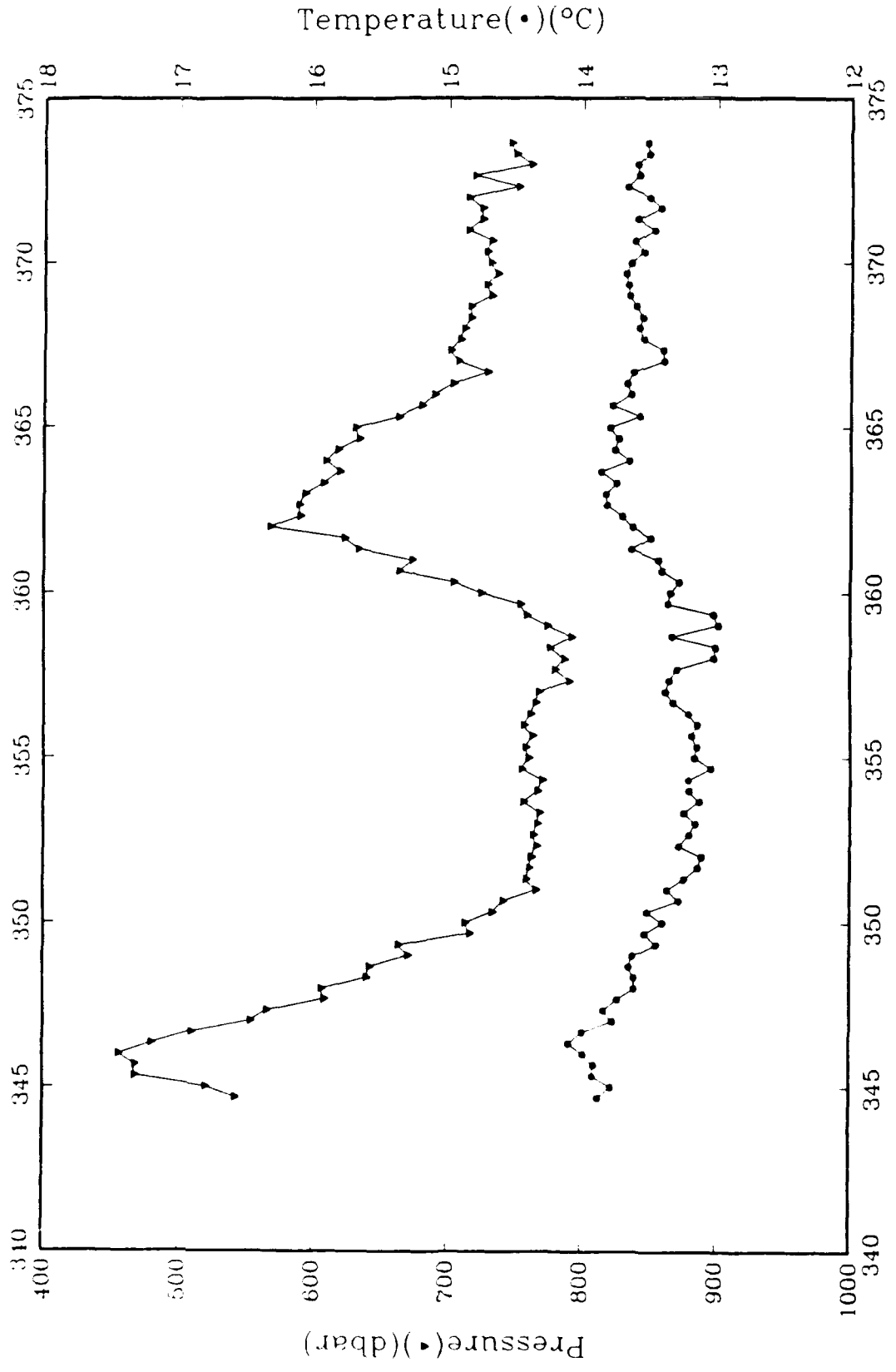


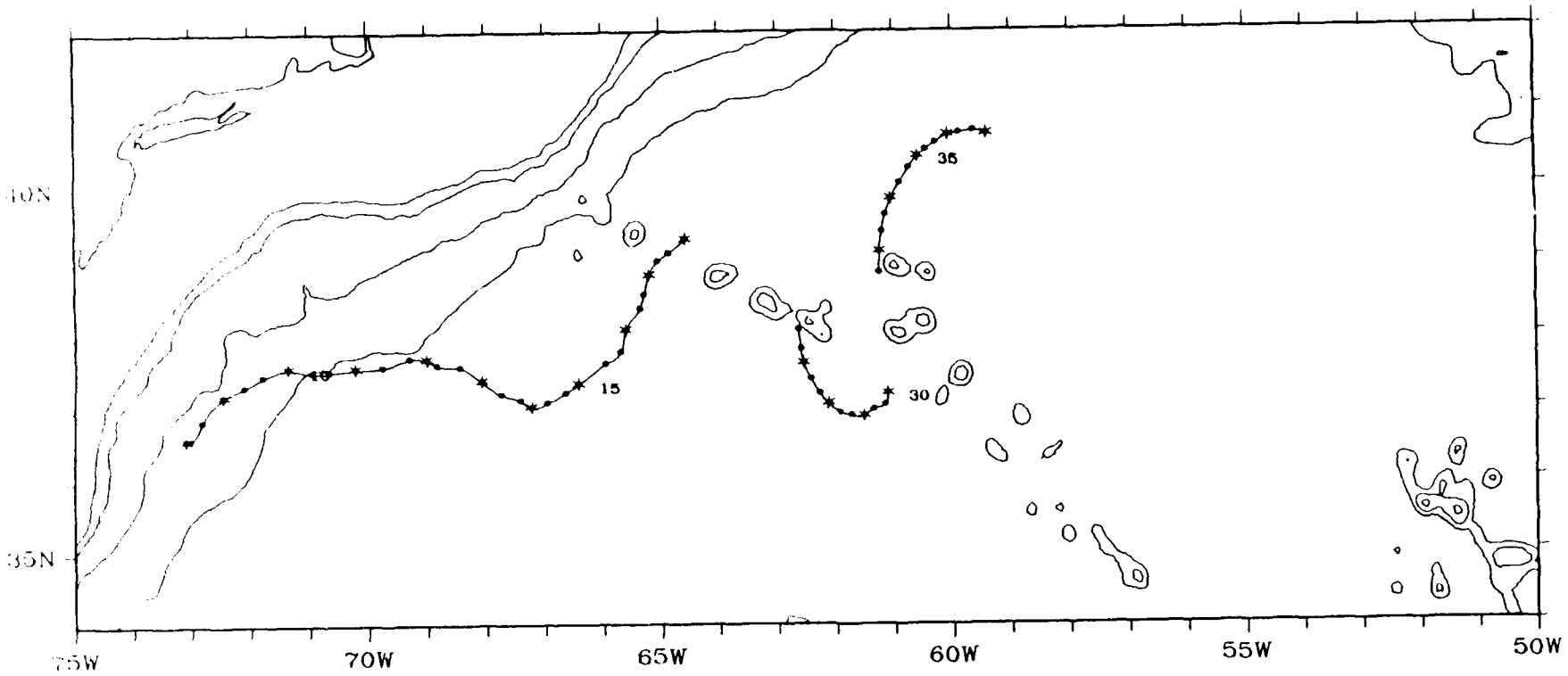
Float 136


Temperature(•)(°C)
19
18
17
16
15
14
13
355
350
345
340
335
330
325
320
Yearday
Float 136
Pressure(•)(dbar)
400
500
600
700
800
900
1000

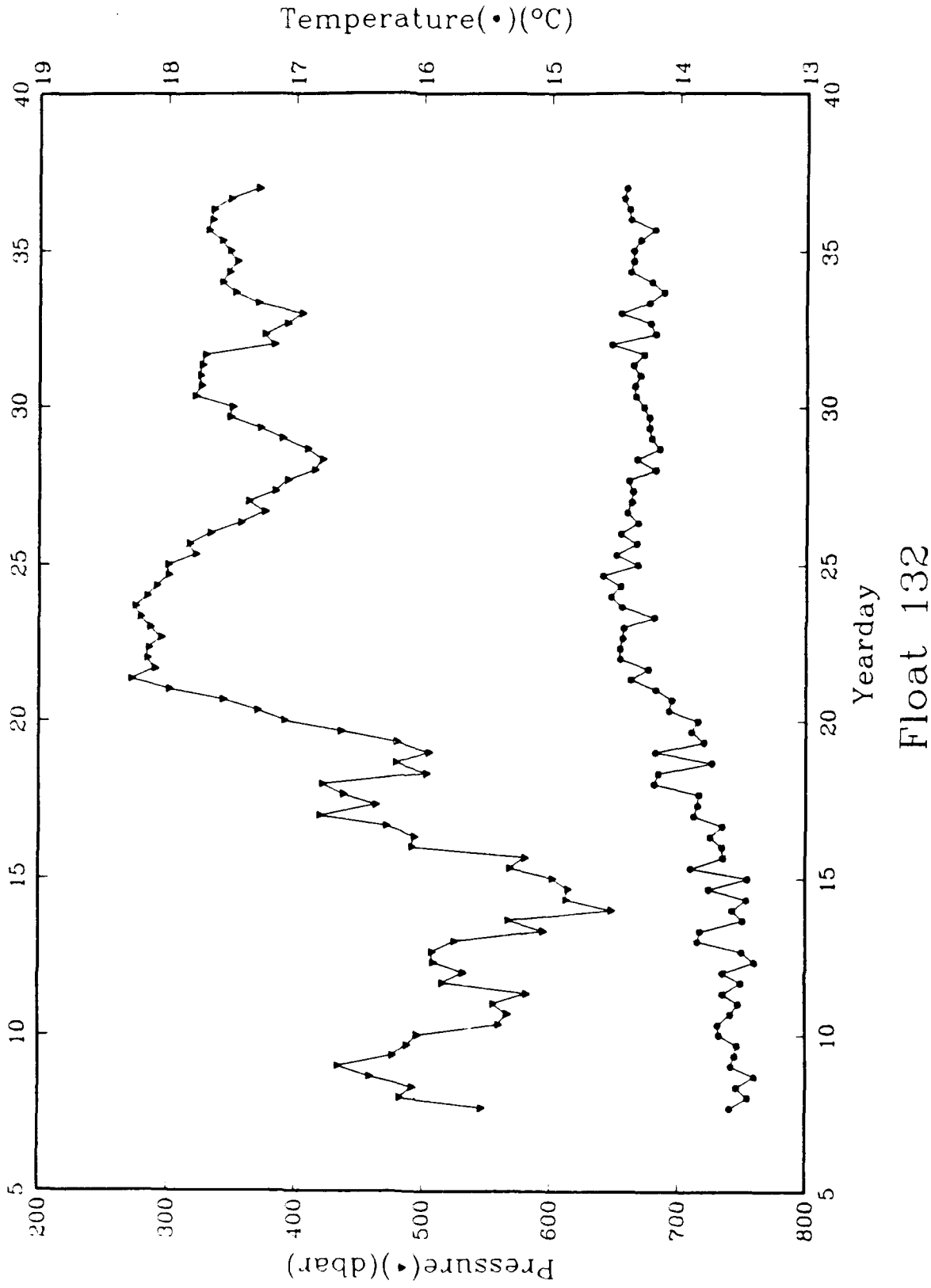


Float 128

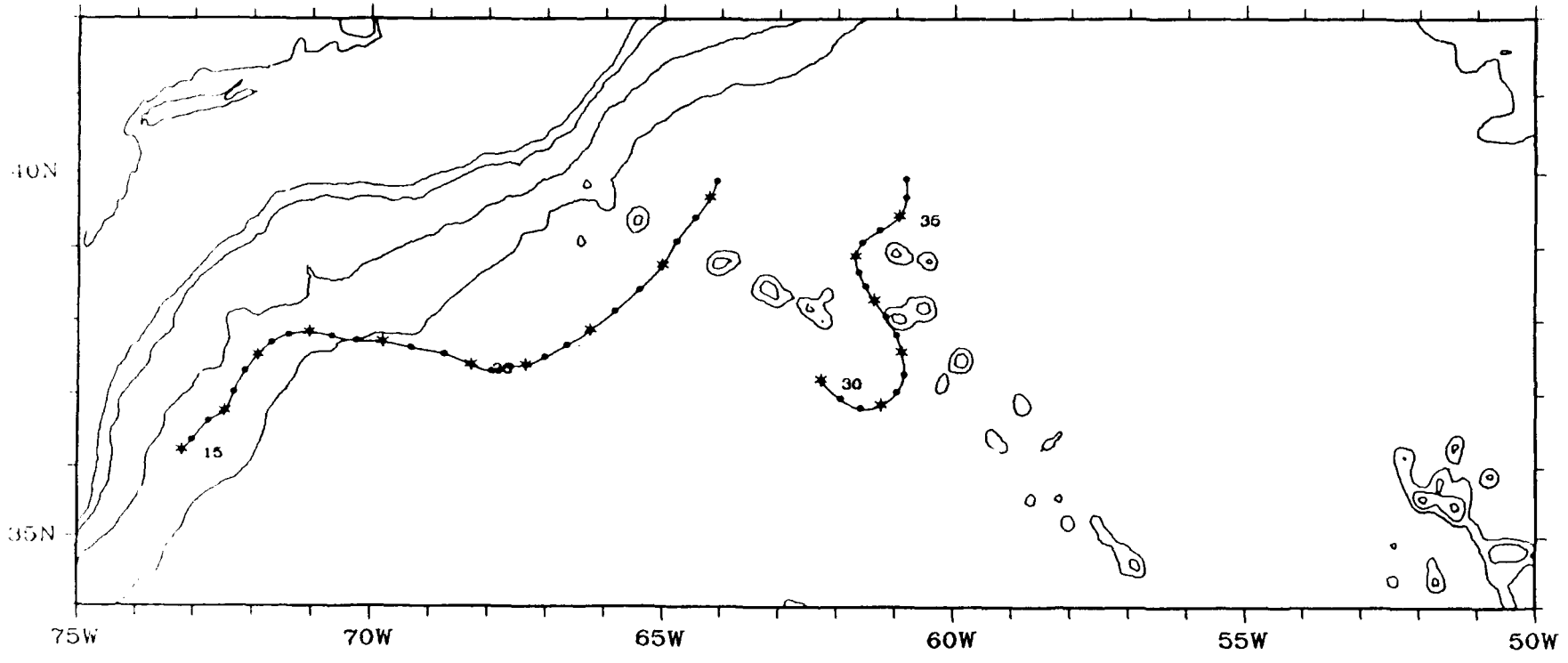

Temperature(•)(°C)
18
17
16
15
14
13
12
375
370
365
360
355
350
345
340
Yearday
Pressure(•)(dbar)
310
400
500
600
700
800
900
1000
Float 128



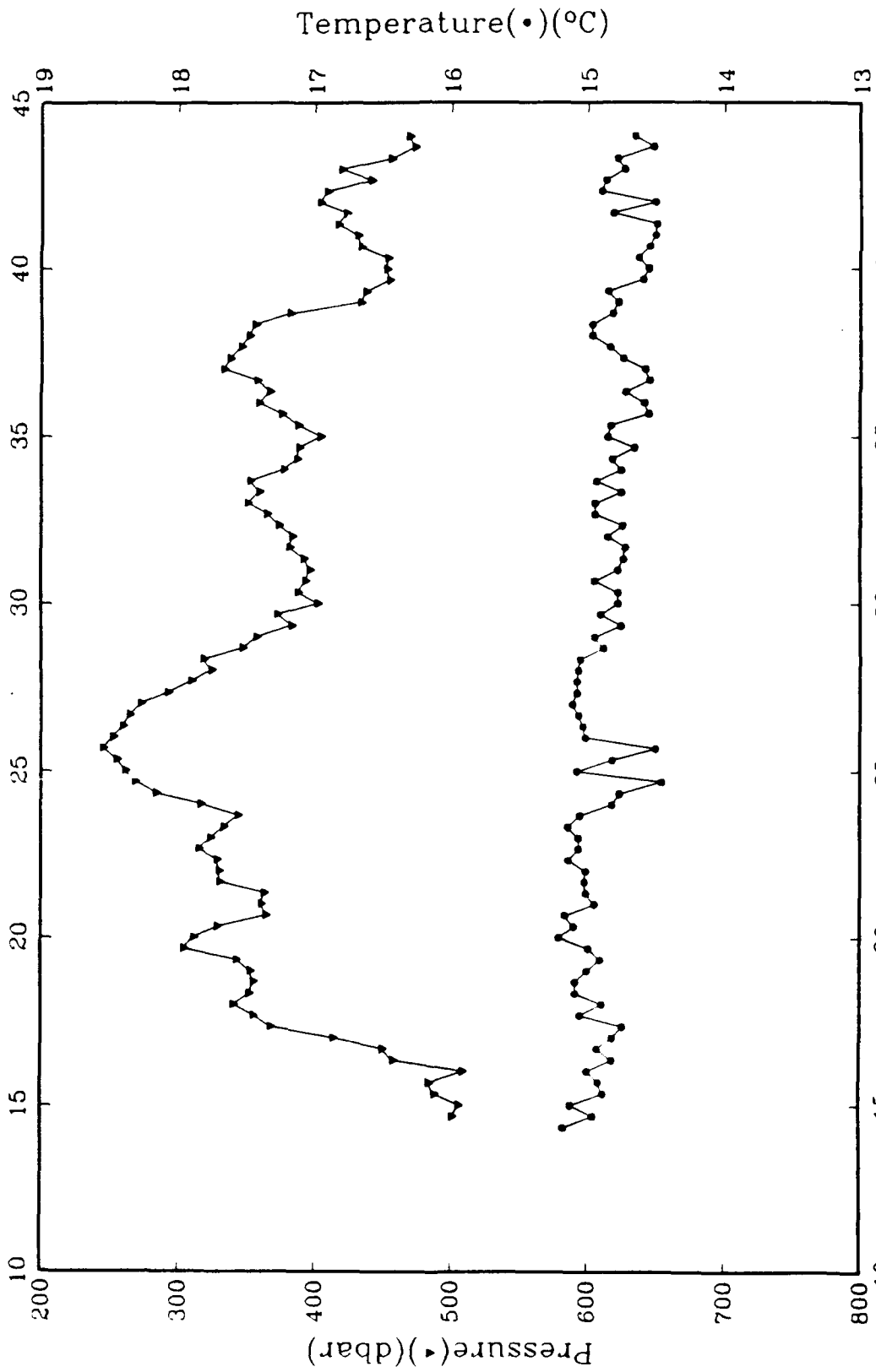
Float 132


Temperature(•)(°C)
19
18
17
16
15
14
13
40
35
30
25
20
15
10
5
Yearday
Pressure(•)(dbar)
200
300
400
500
600
700
800

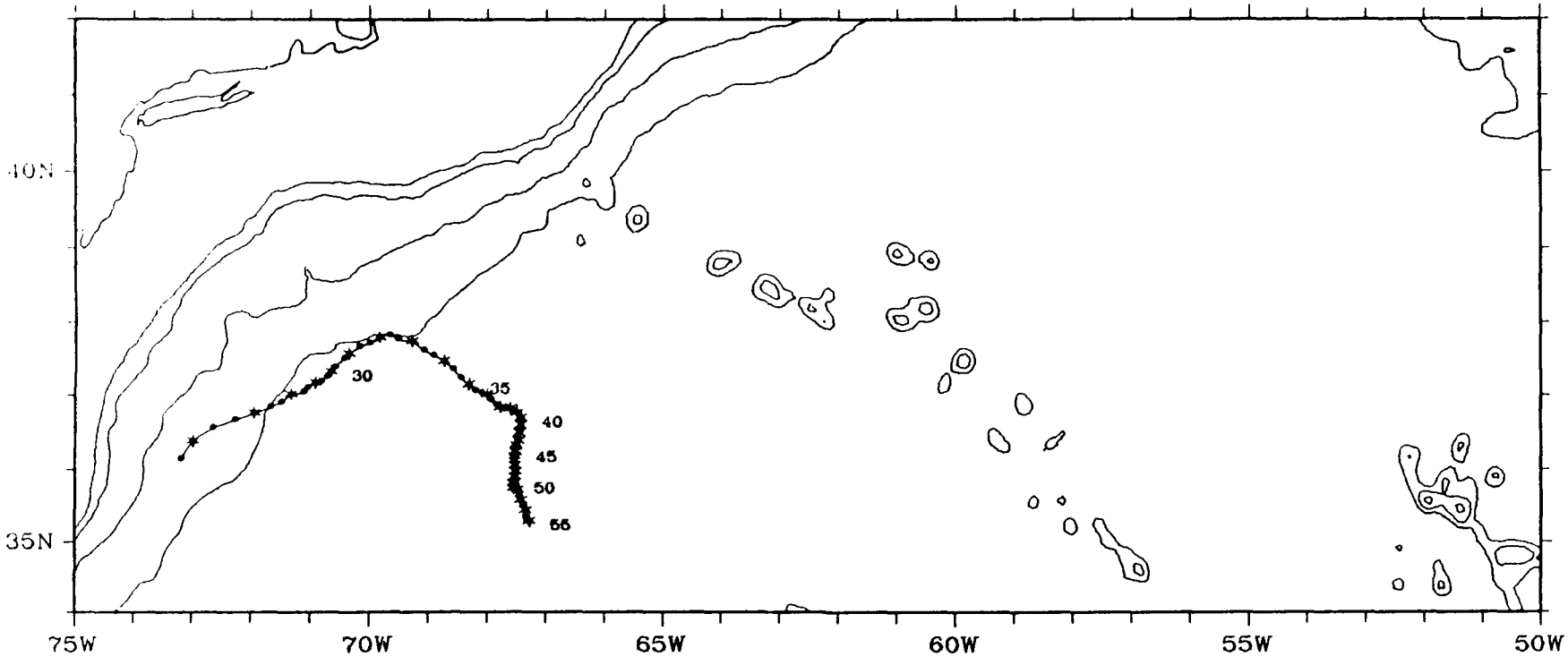
Float 132



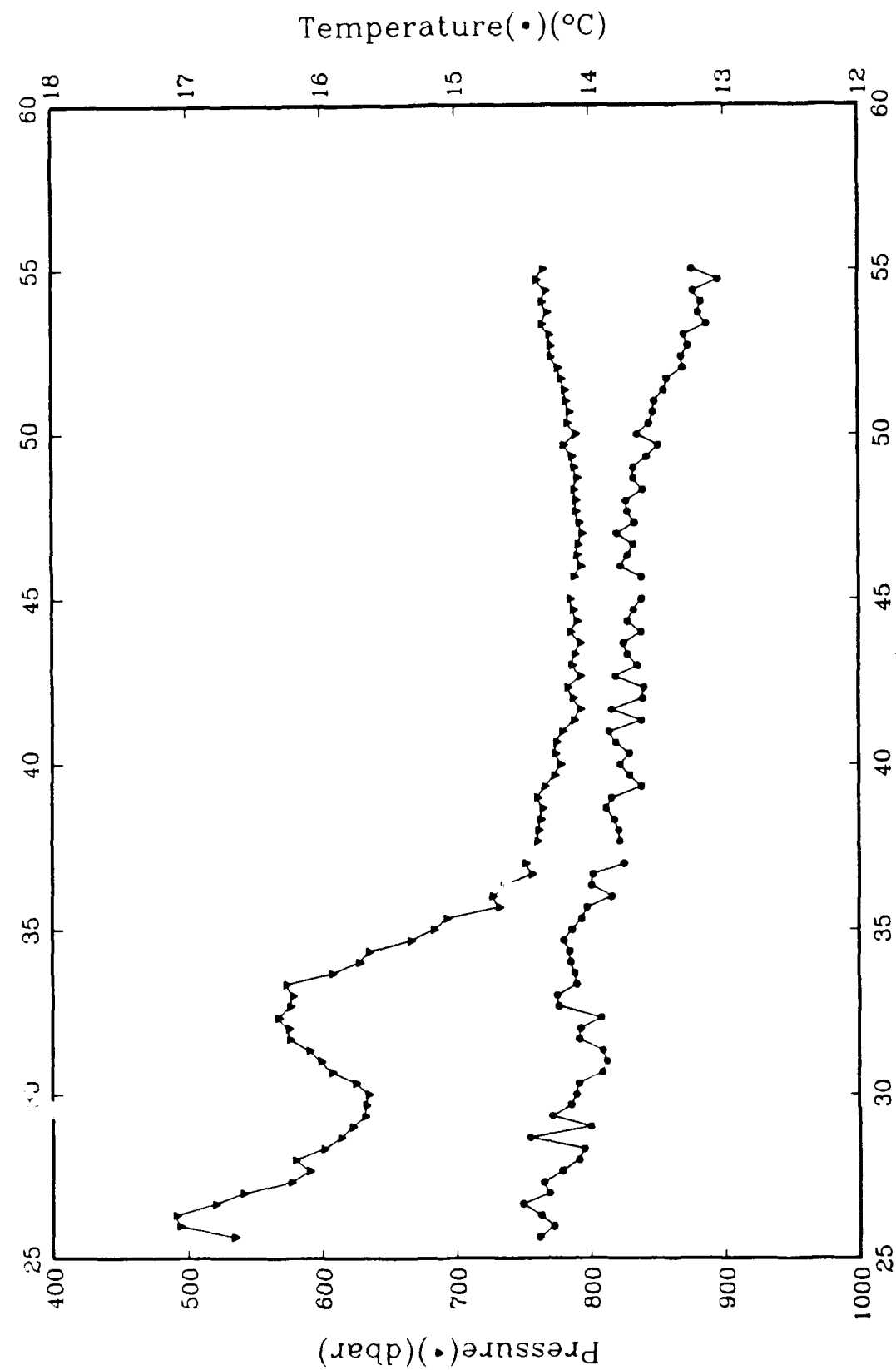
Float 175


Temperature(•)(°C)
19
18
17
16
15
14
13
45
40
35
30
25
20
15
10
Yearday
Pressure(◂)(dbar)
200
300
400
500
600
700
800

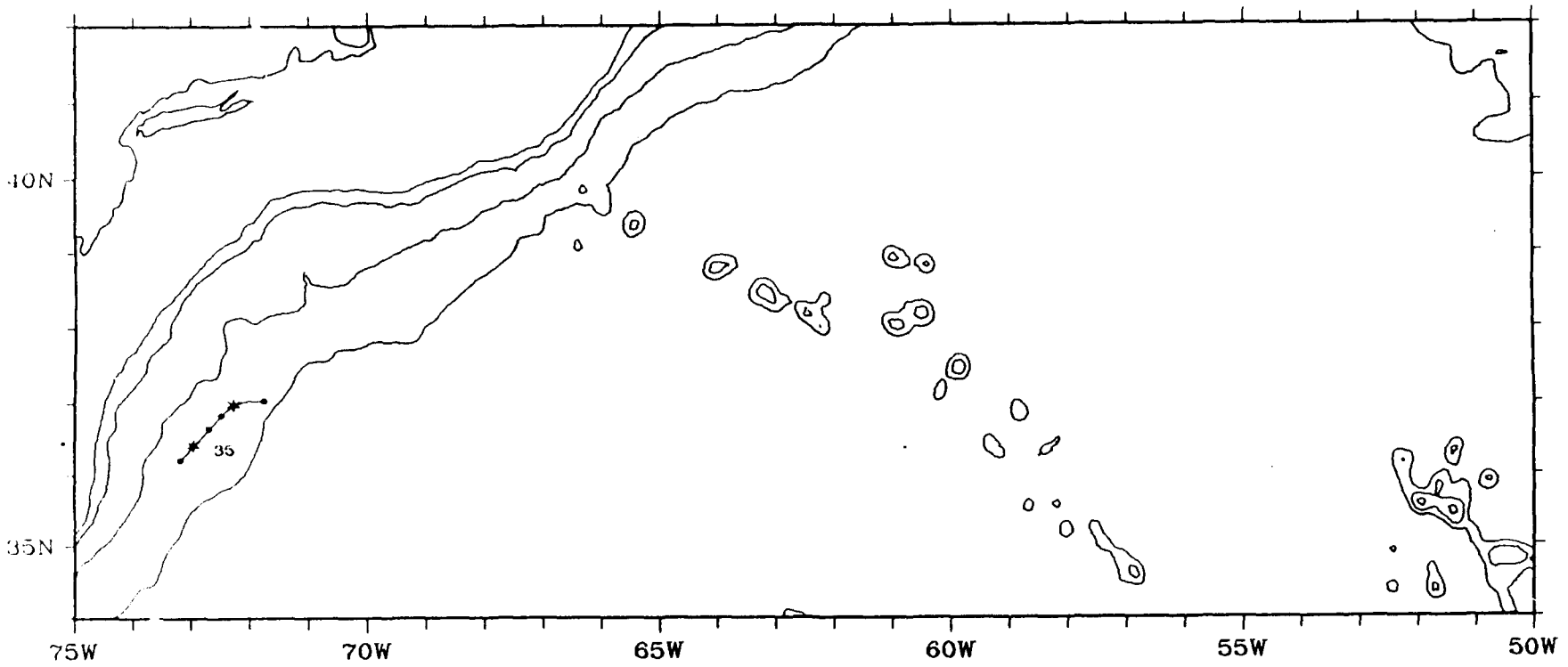
Float 175



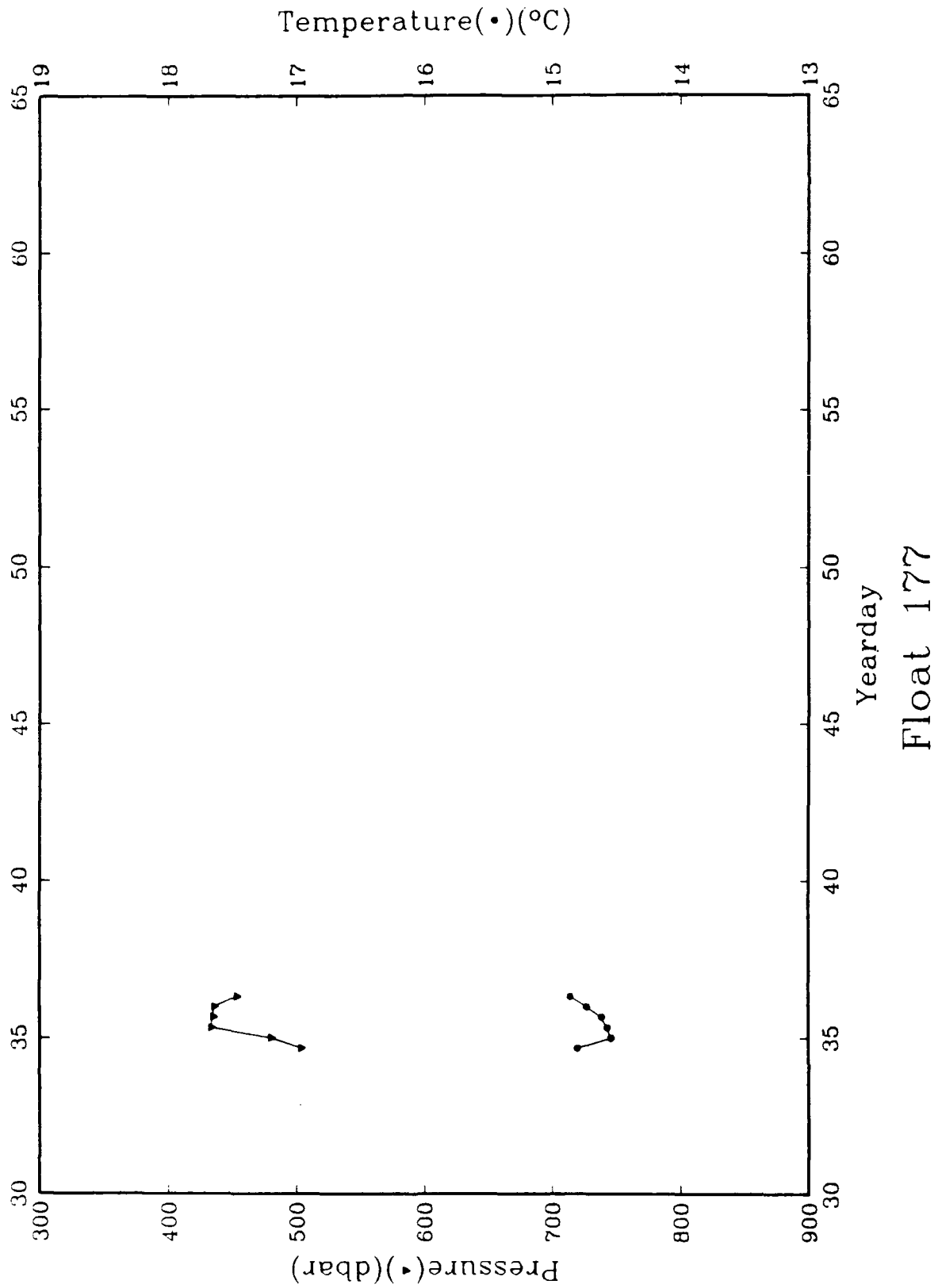
Float 176

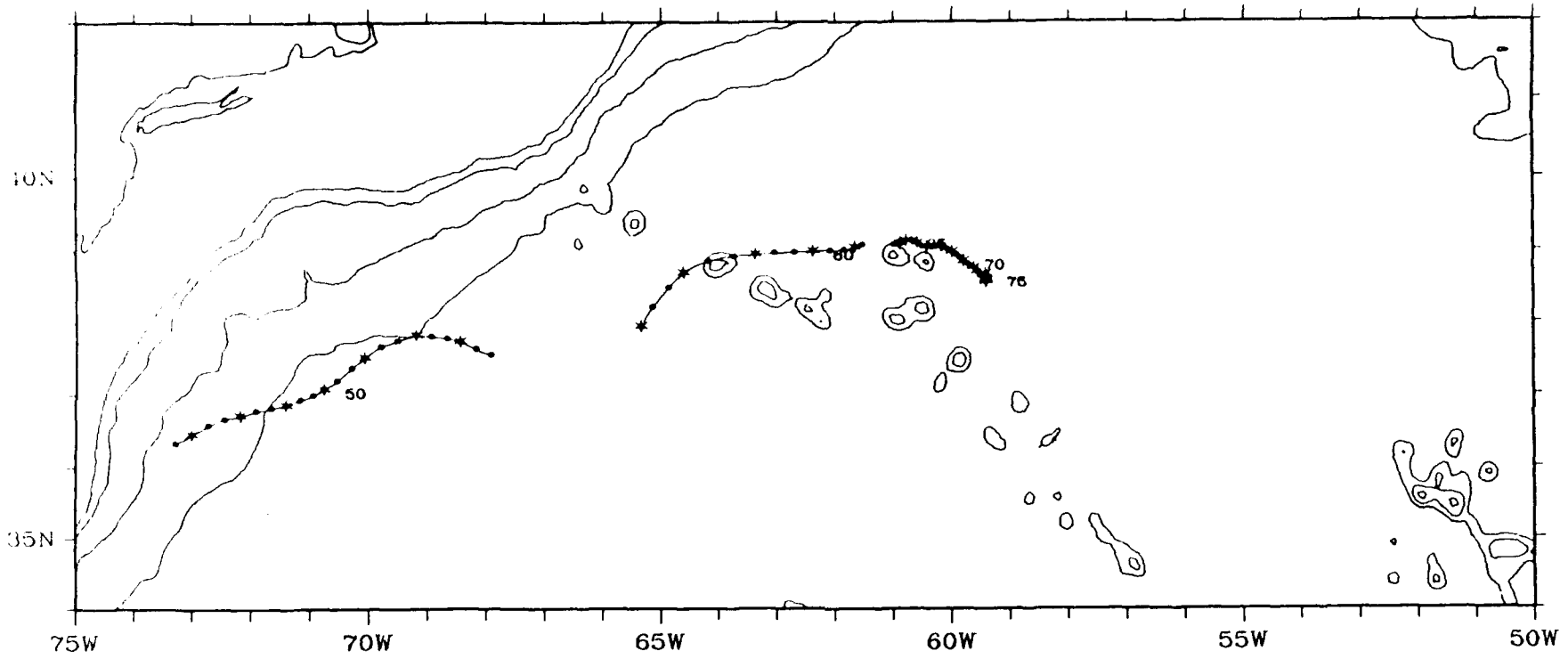

Temperature(•)(°C)
18
17
16
15
14
13
12
60
55
50
45
40
35
30
25
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000

Float 176

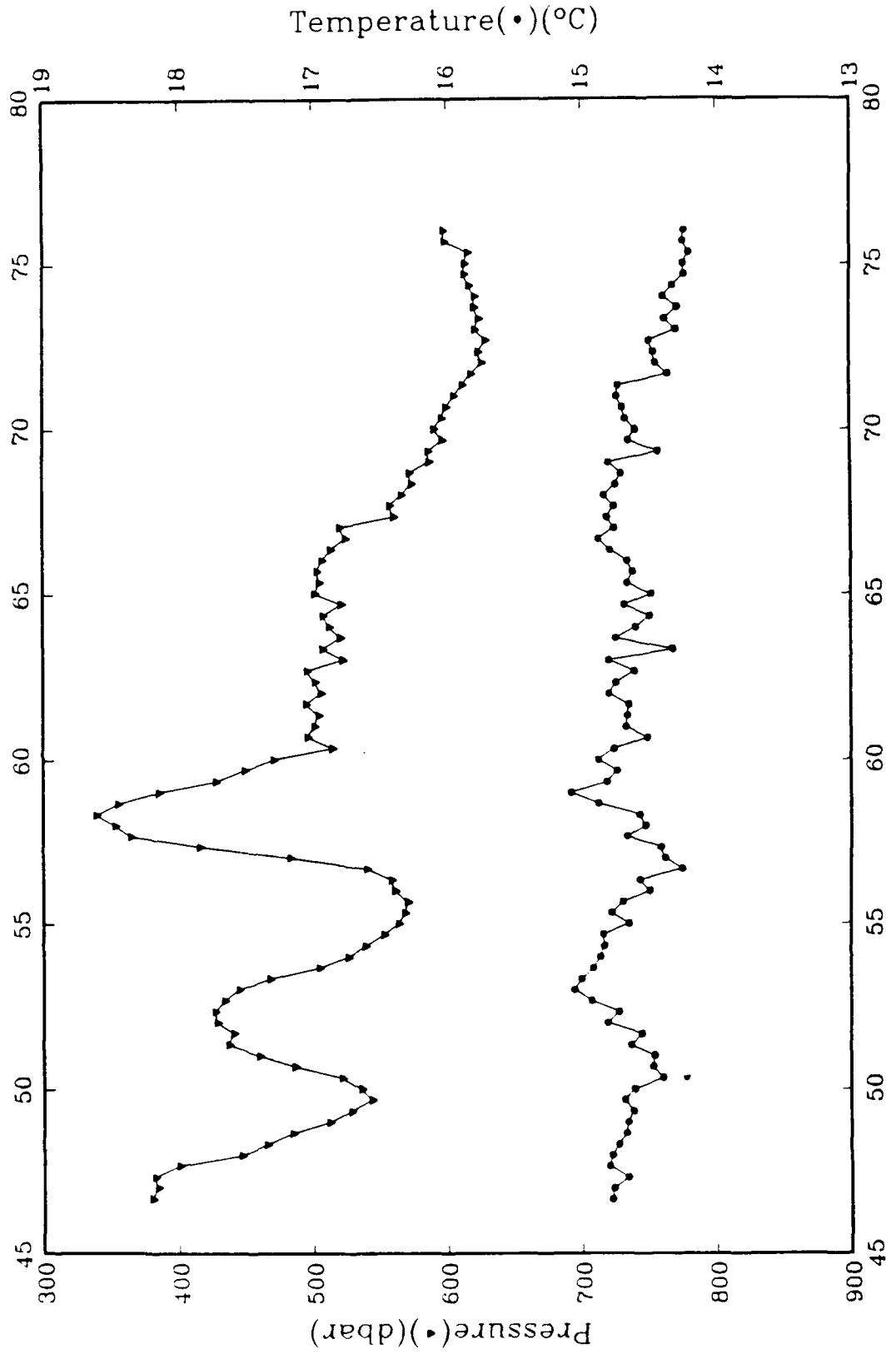


Float 177

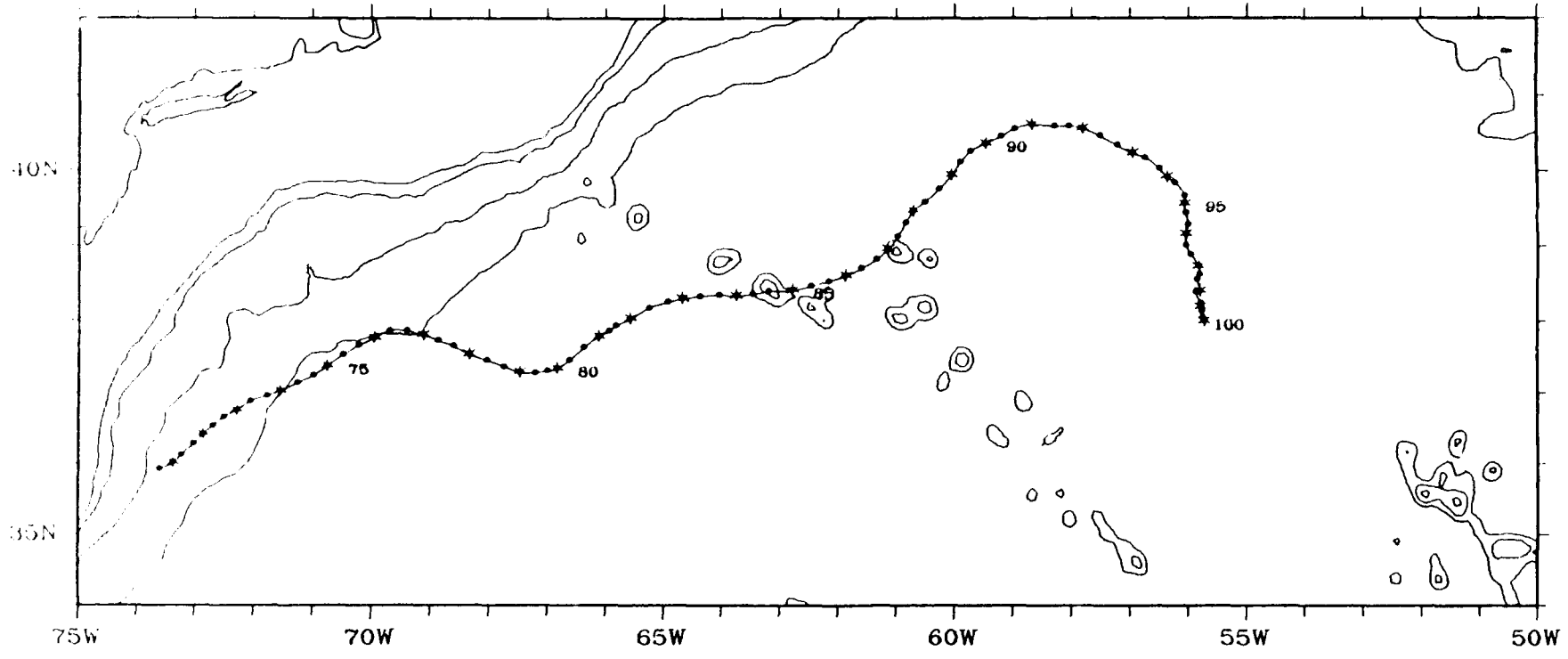

Temperature(•)(°C)
19
18
17
16
15
14
13
65
60
55
50
45
40
35
30
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 177



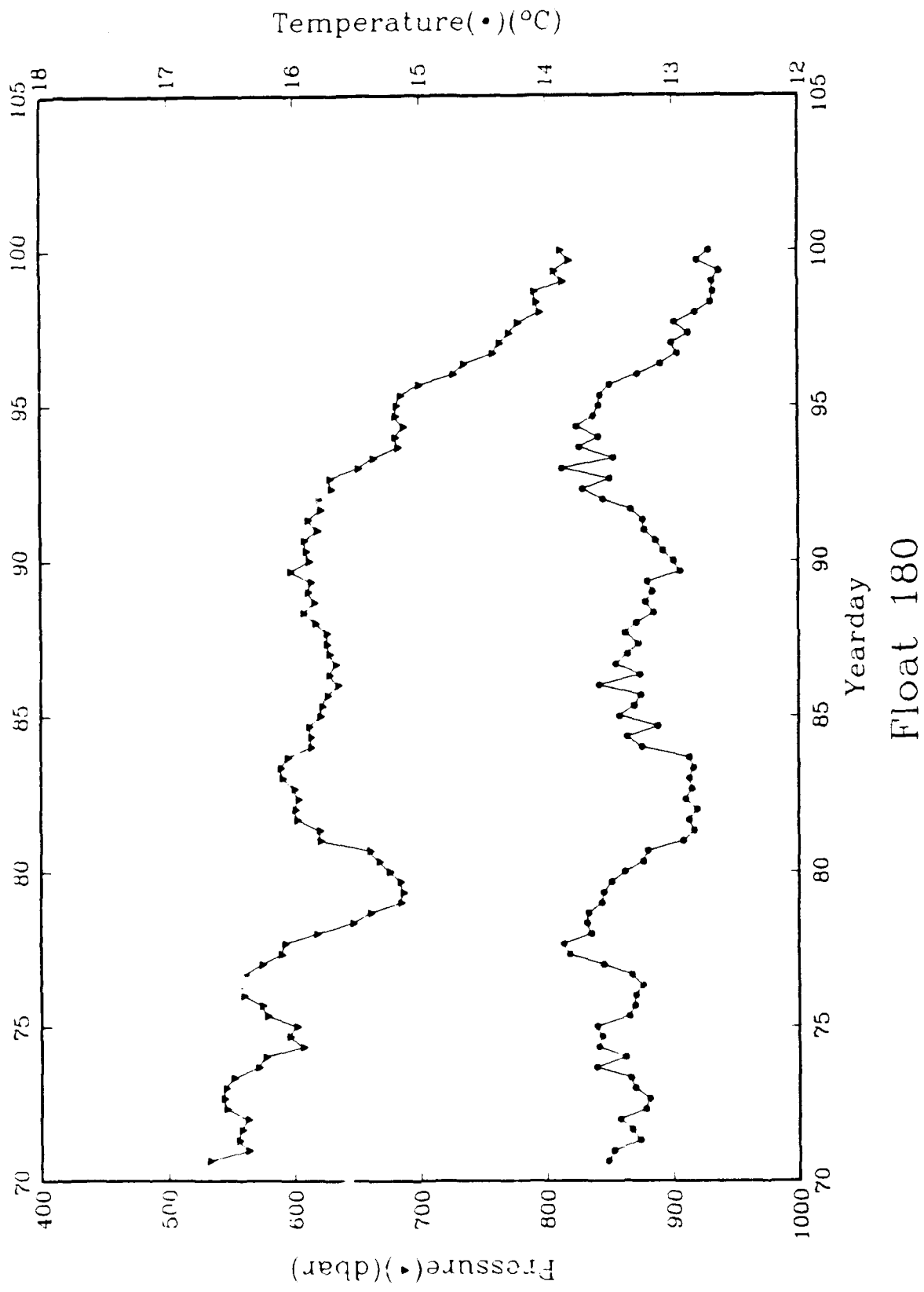
Float 179

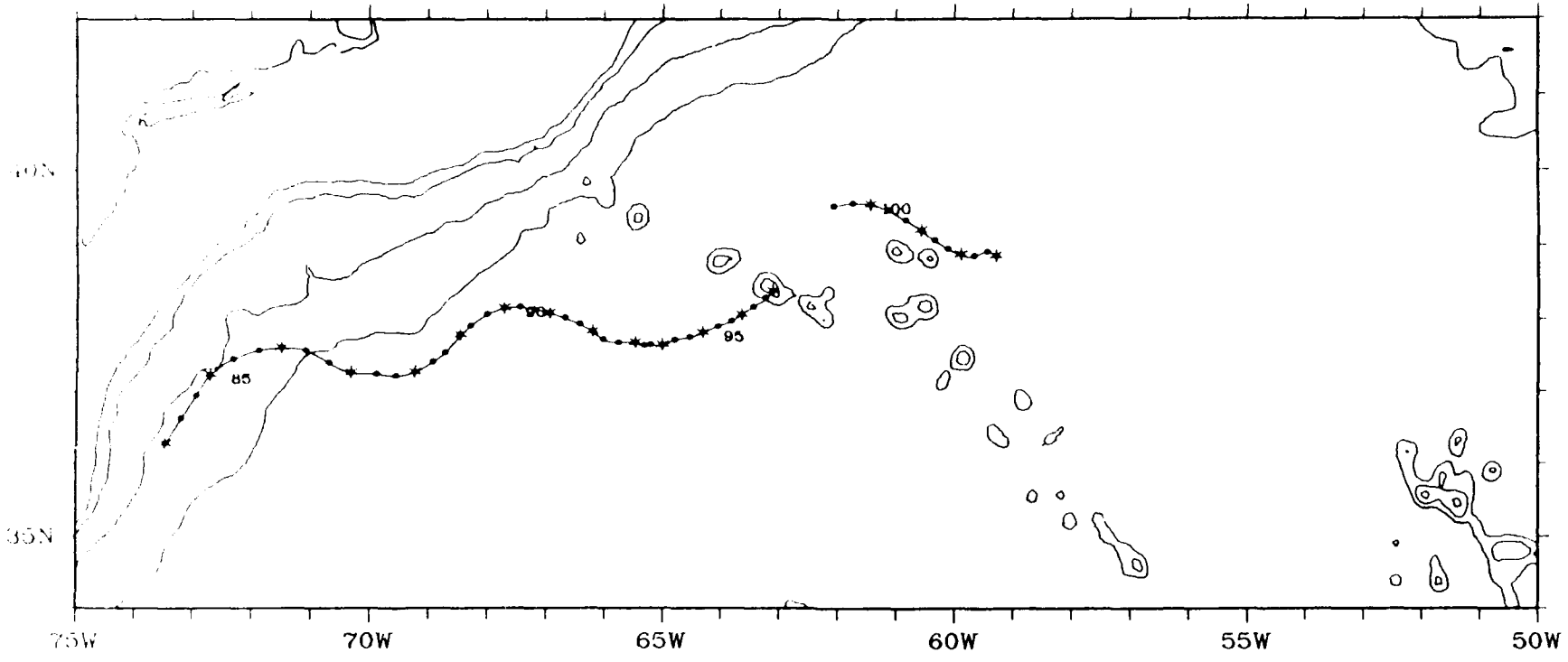

Temperature(•)(°C)
19
18
17
16
15
14
13
80
75
70
65
60
55
50
45
Yearday
Pressure(•)(dbar)
300
400
500
600
700
800
900

Float 179

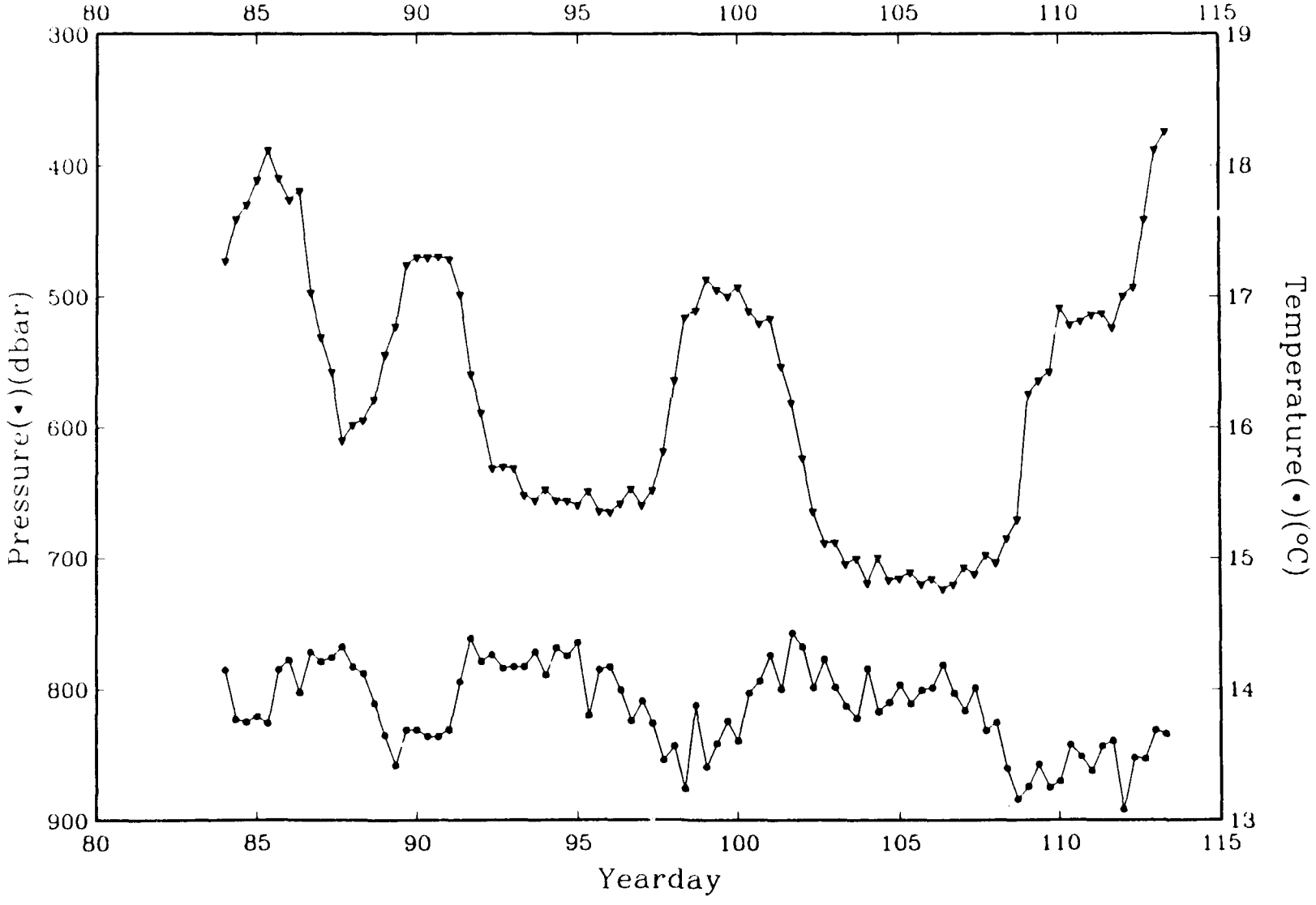


Float 180

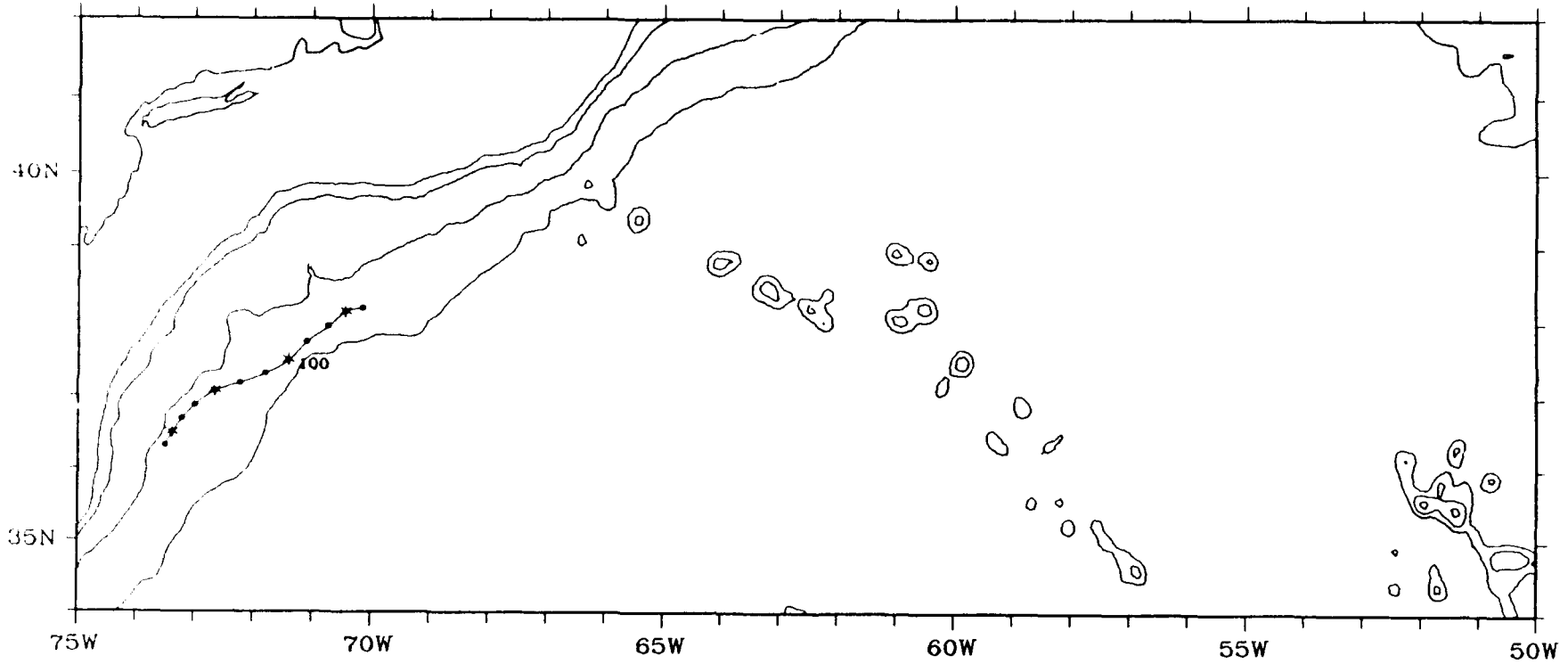

Temperature(•)(°C)
18
17
16
15
14
13
12
105
100
95
90
85
80
75
70
Yearday
Pressure(◂)(dbar)
400
500
600
700
800
900
1000
Float 180



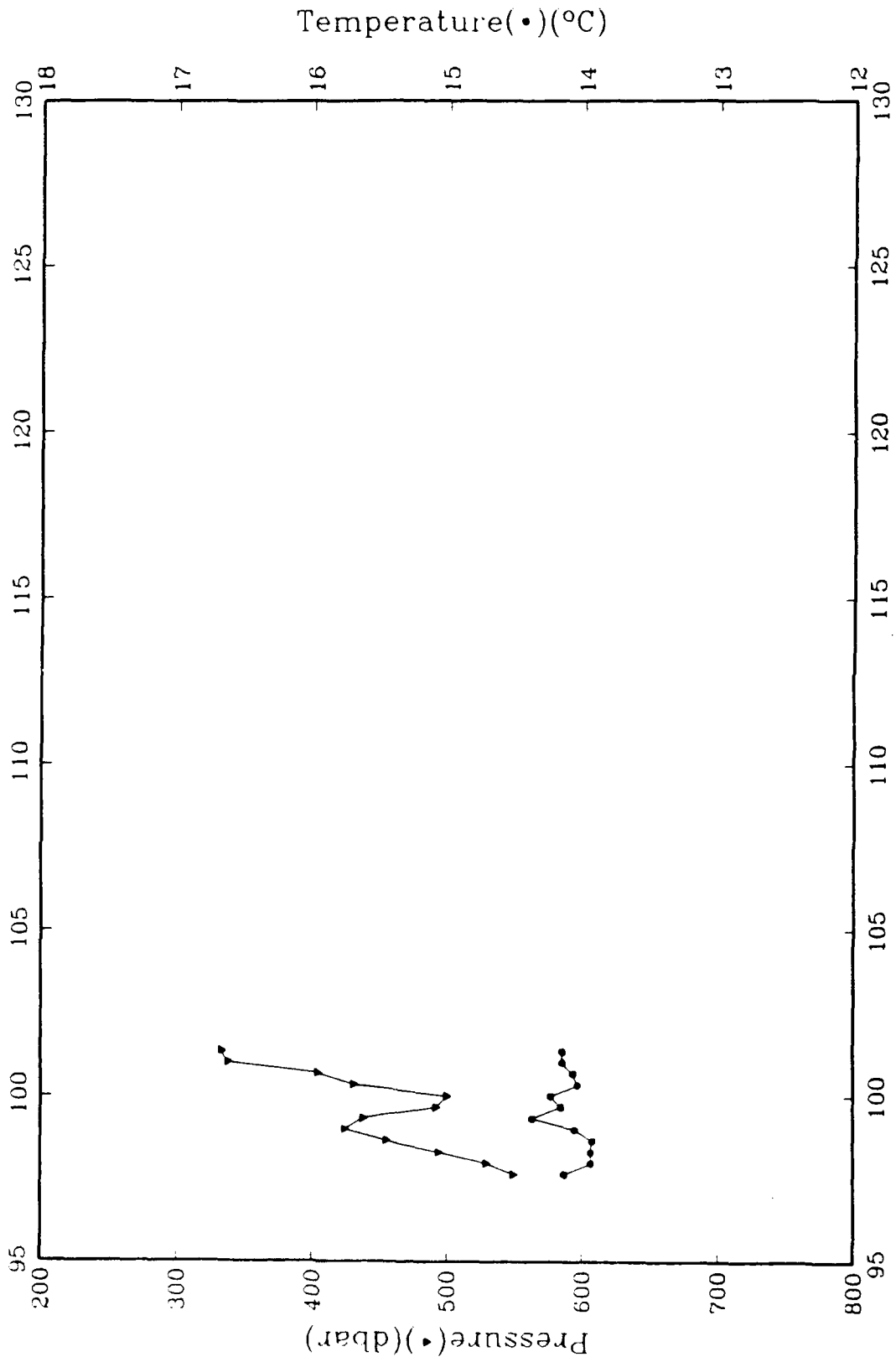
Float 178


80
85
90
95
100
105
110
115
300
400
500
600
700
800
900
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

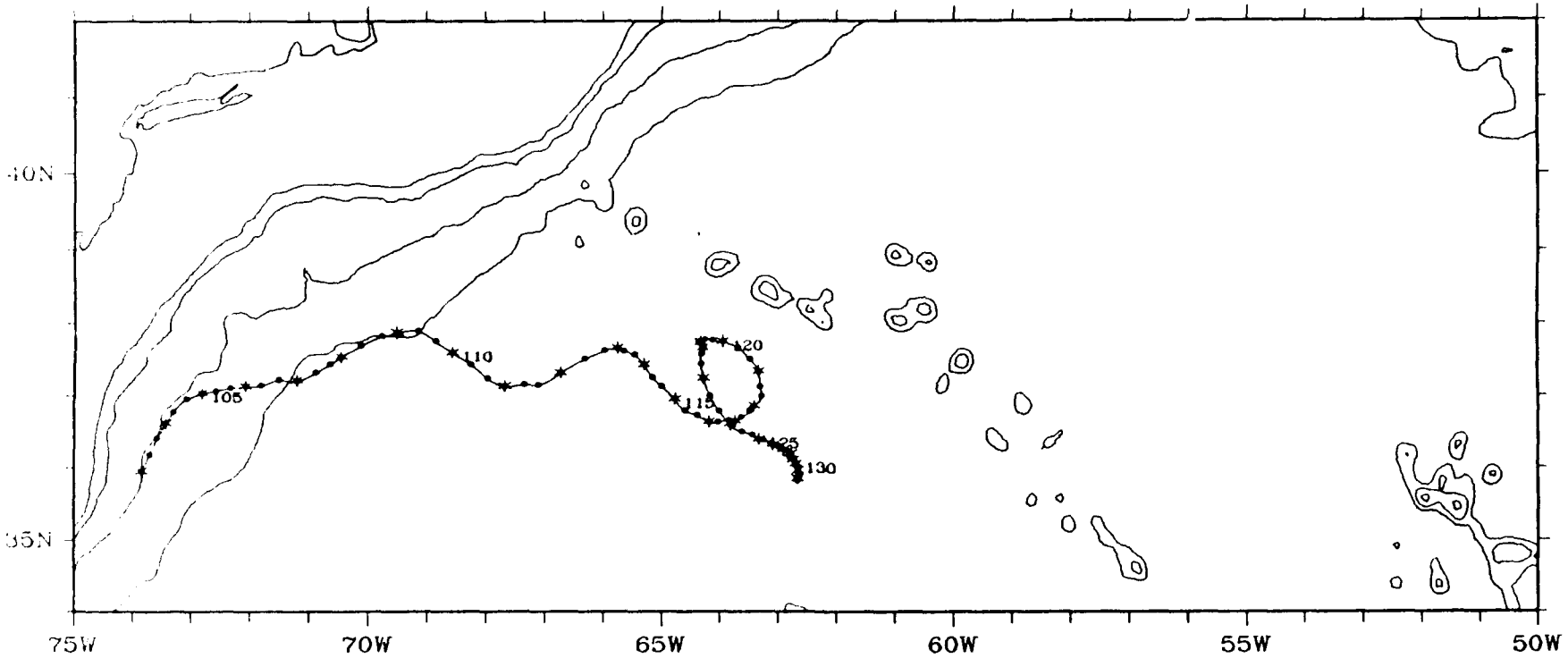
Float 178



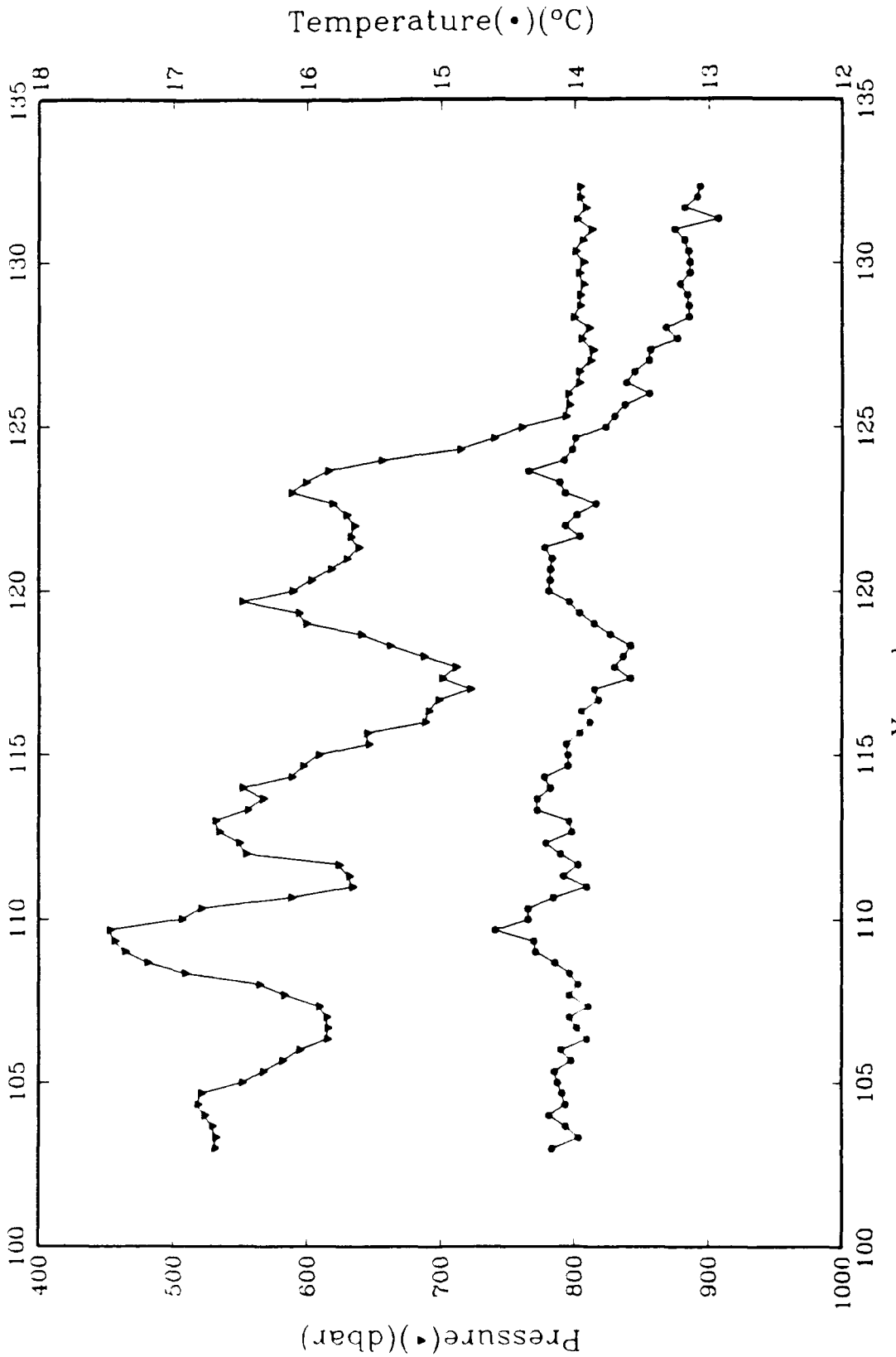
Float 181


Temperature(•)(°C)
18
17
16
15
14
13
12
130
125
120
115
110
105
100
95
Yearday
Pressure(•)(dbar)
200
300
400
500
600
700
800

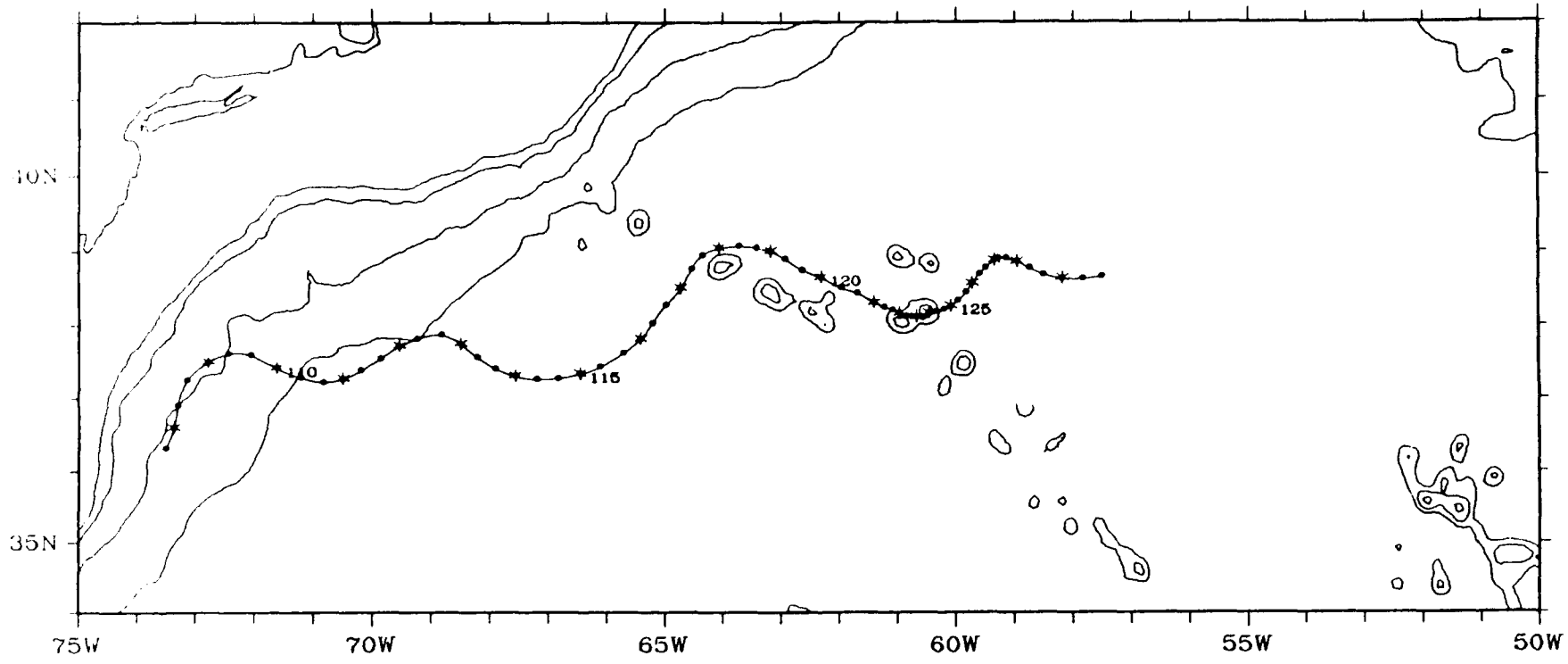
Float 181



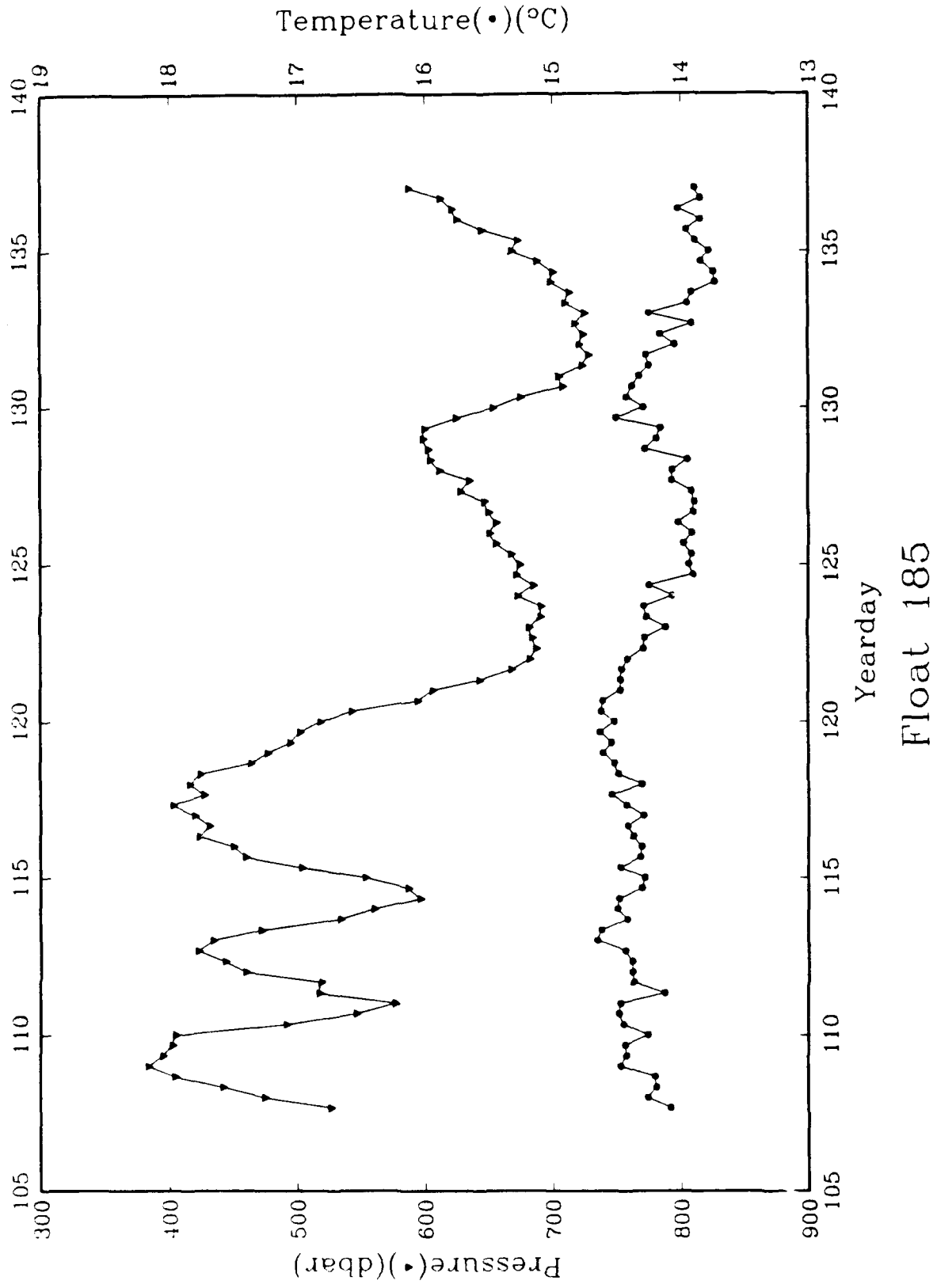
Float 182

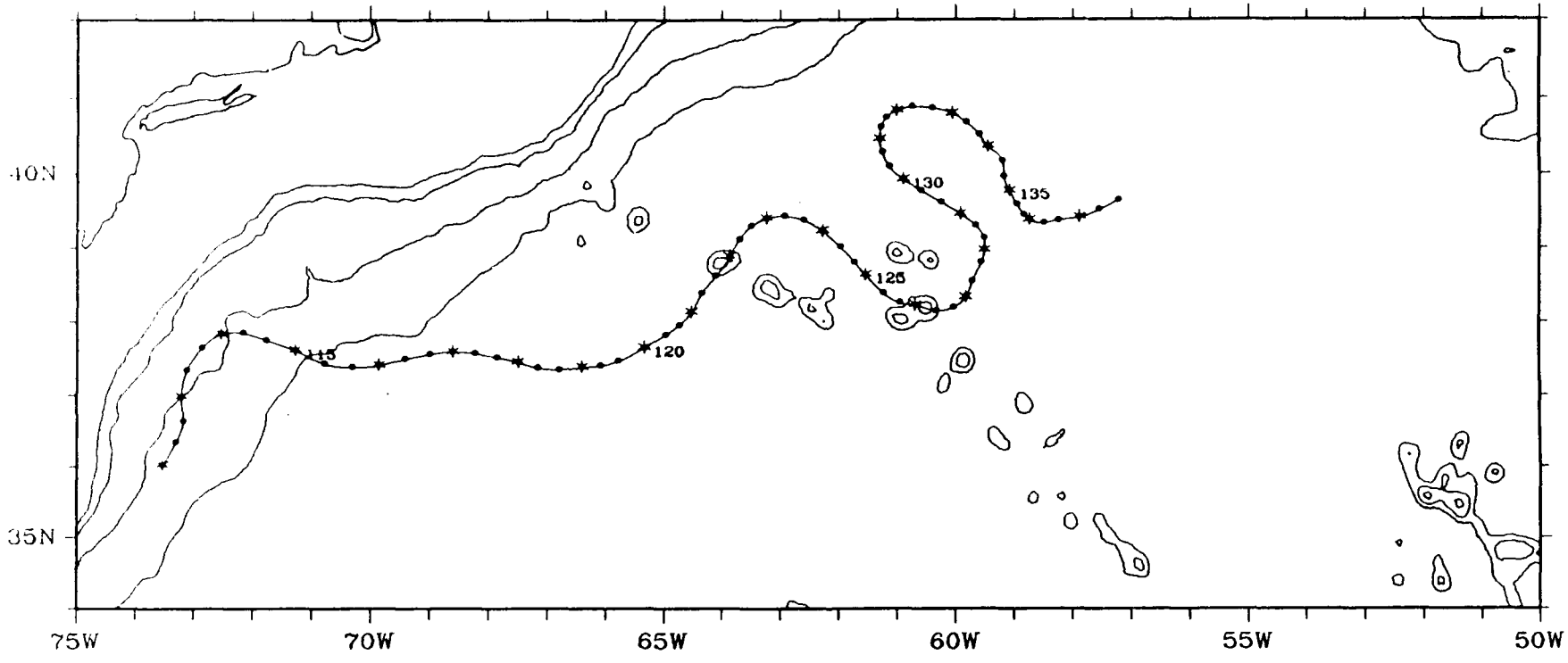

Temperature(•)(°C)
18
17
16
15
14
13
12
135
130
125
120
115
110
105
100
Yearday
Pressure(◂)(dbar)
400
500
600
700
800
900
1000

Float 182

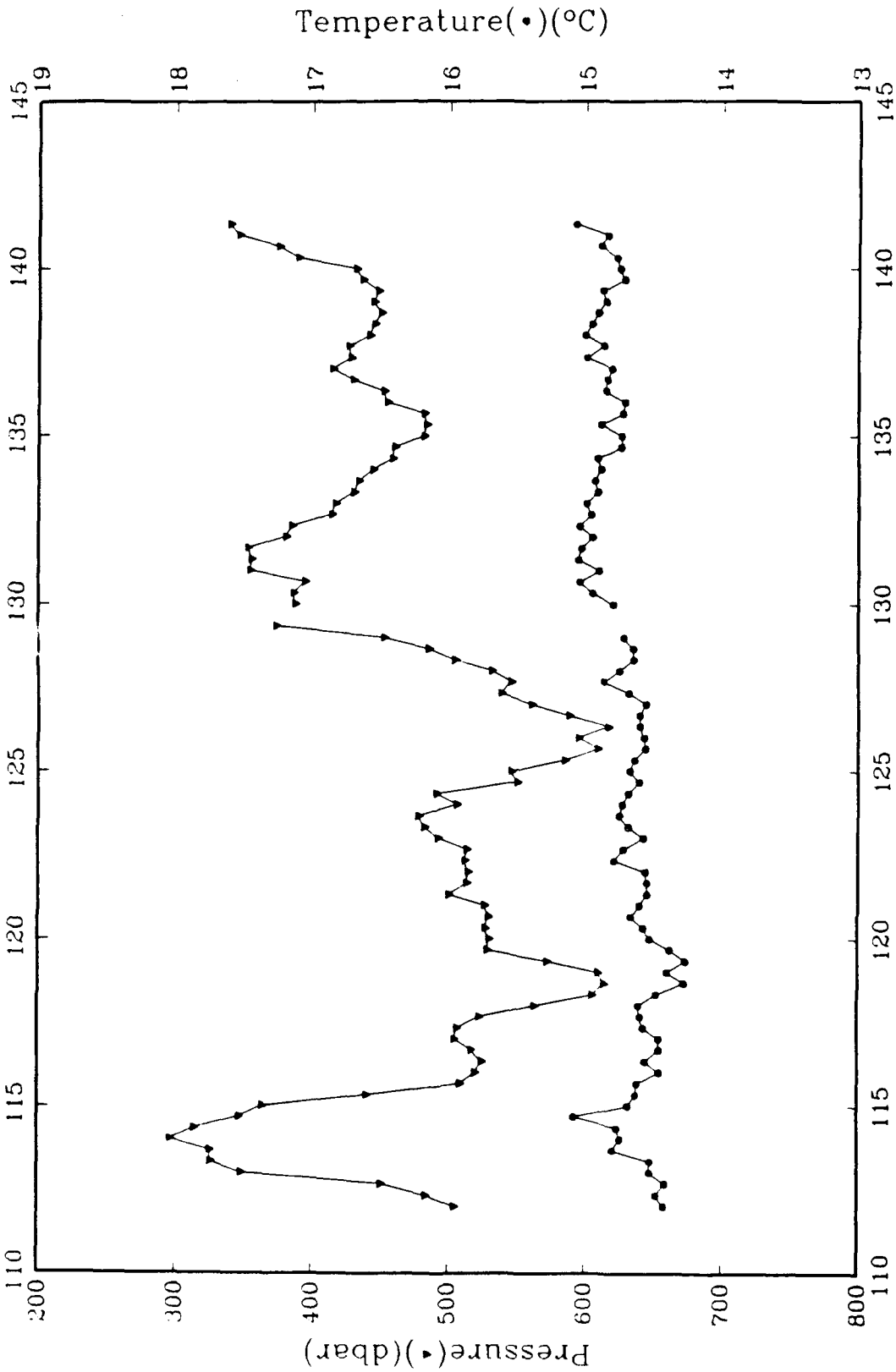


Float 185

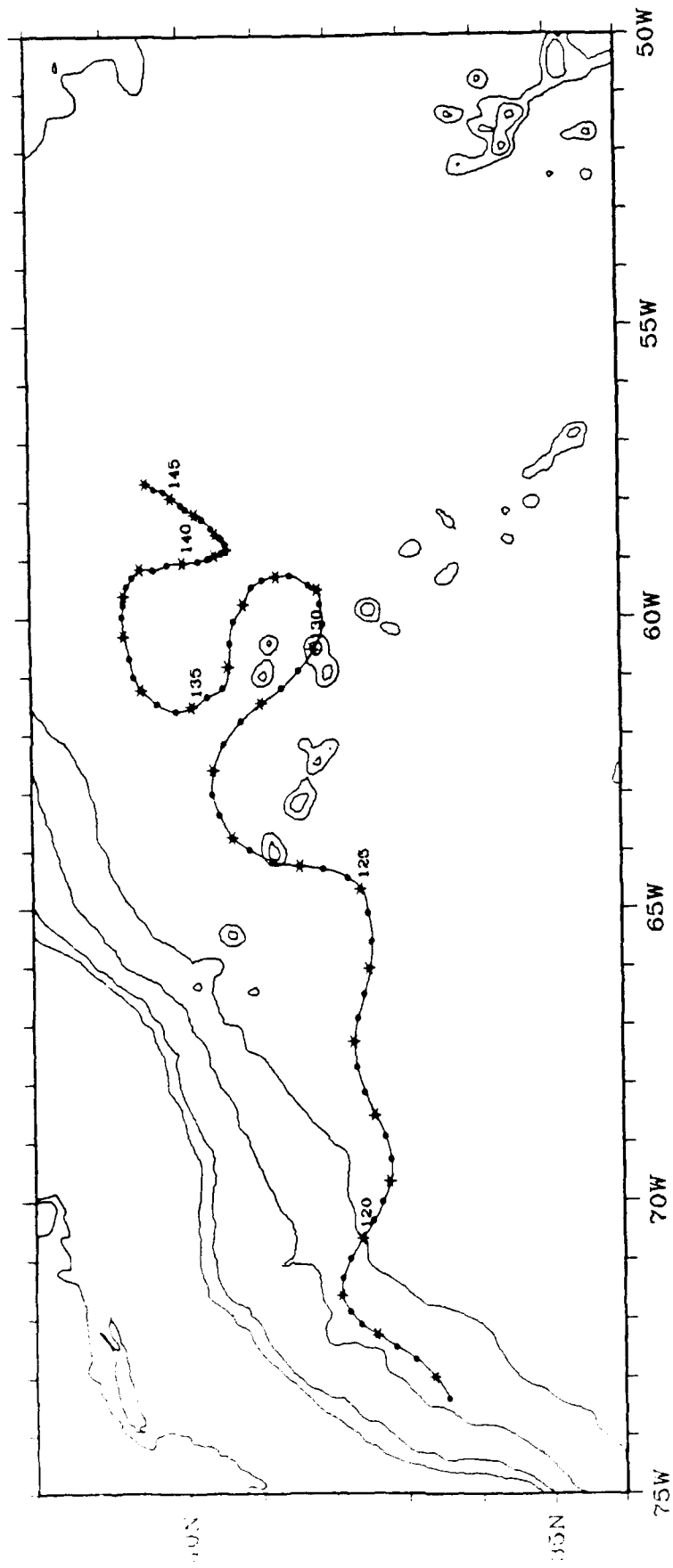

Temperature(•)(°C)
19
18
17
16
15
14
13
140
135
130
125
120
115
110
105
300
400
500
600
700
800
900
Pressure(•)(dbar)
Yearday
Float 185



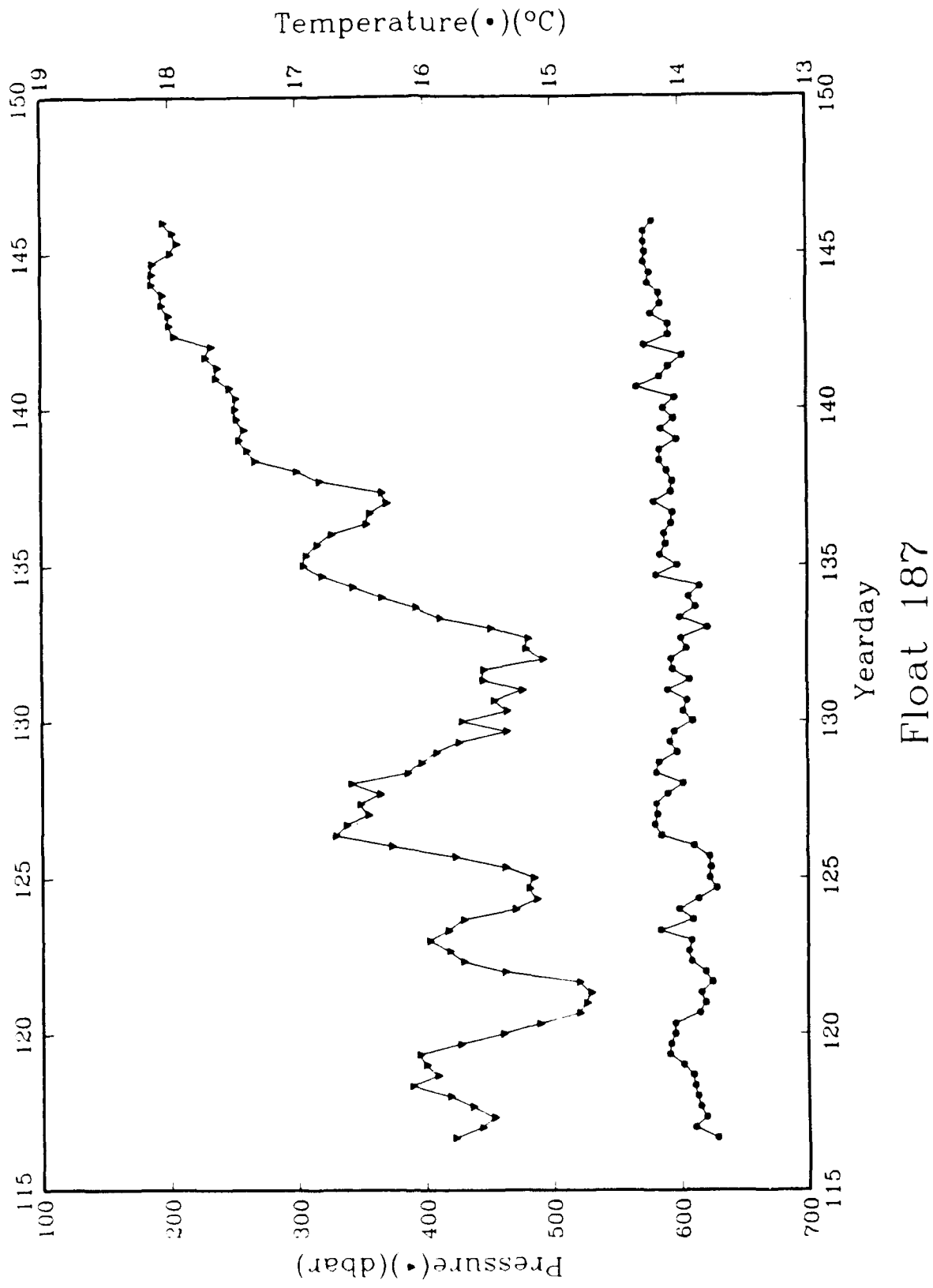
Float 184


Temperature(•)(°C)
19
18
17
16
15
14
13
145
140
135
130
125
120
115
110
Yearday
Pressure(◂)(dbar)
200
300
400
500
600
700
800

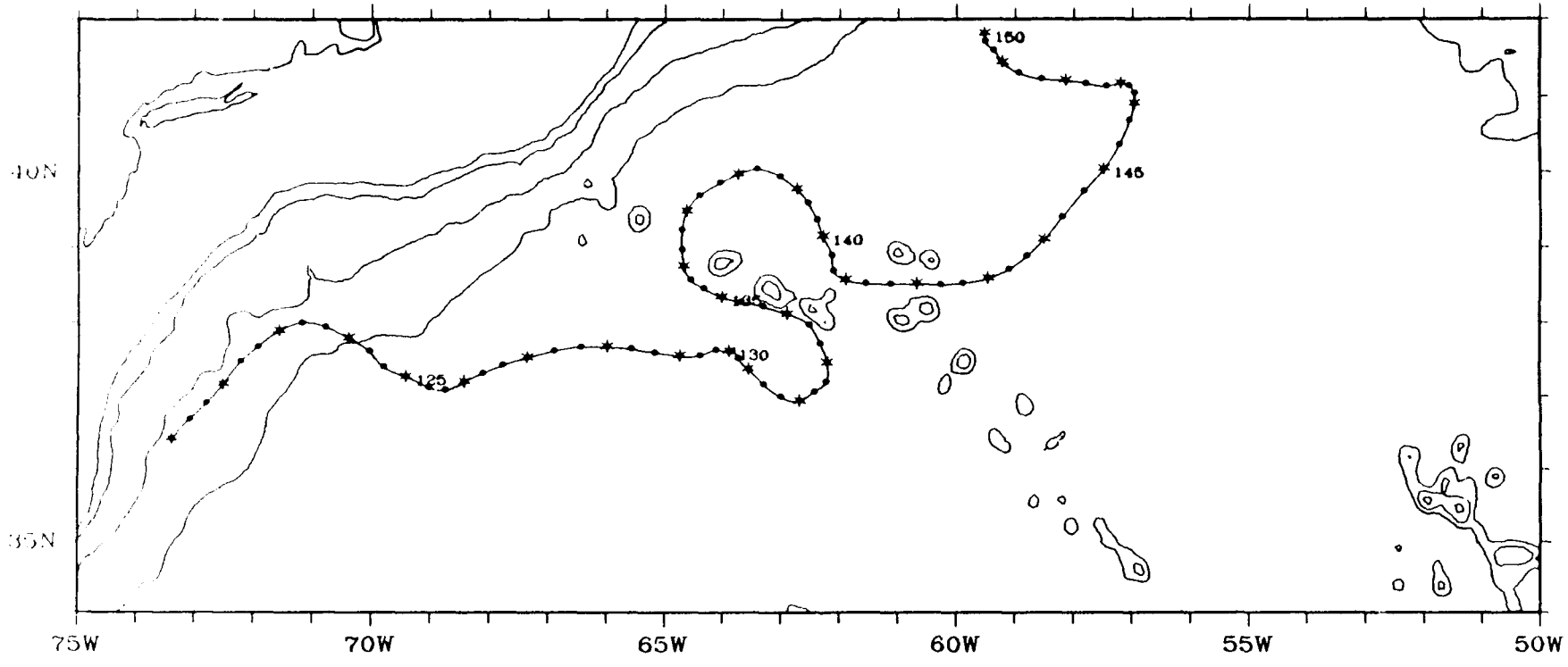
Float 184



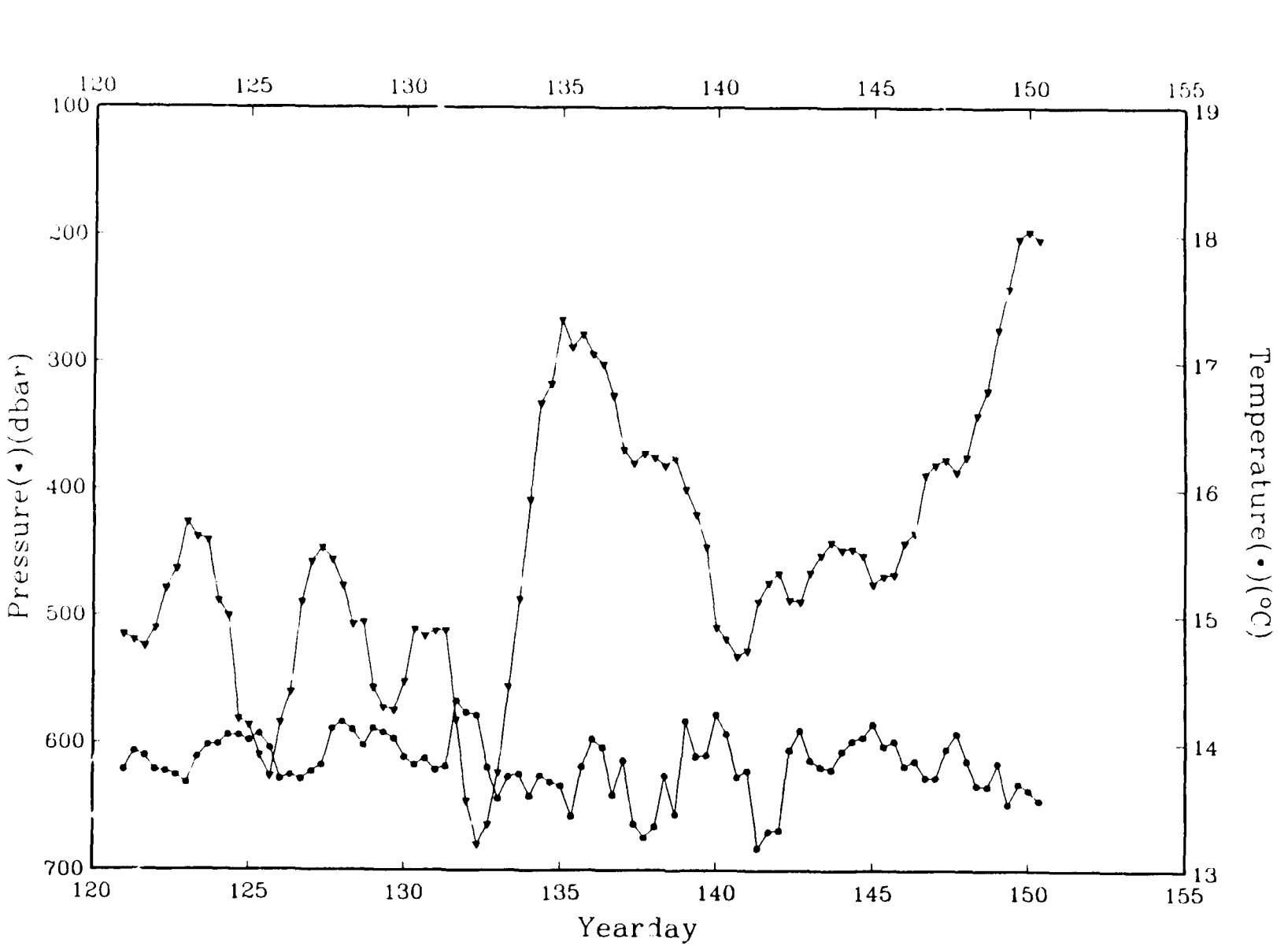
Float 187


Temperature(•)(°C)
19
18
17
16
15
14
13
150
145
140
135
130
125
120
115
Yearday
Pressure(•)(dbar)
100
200
300
400
500
600
700

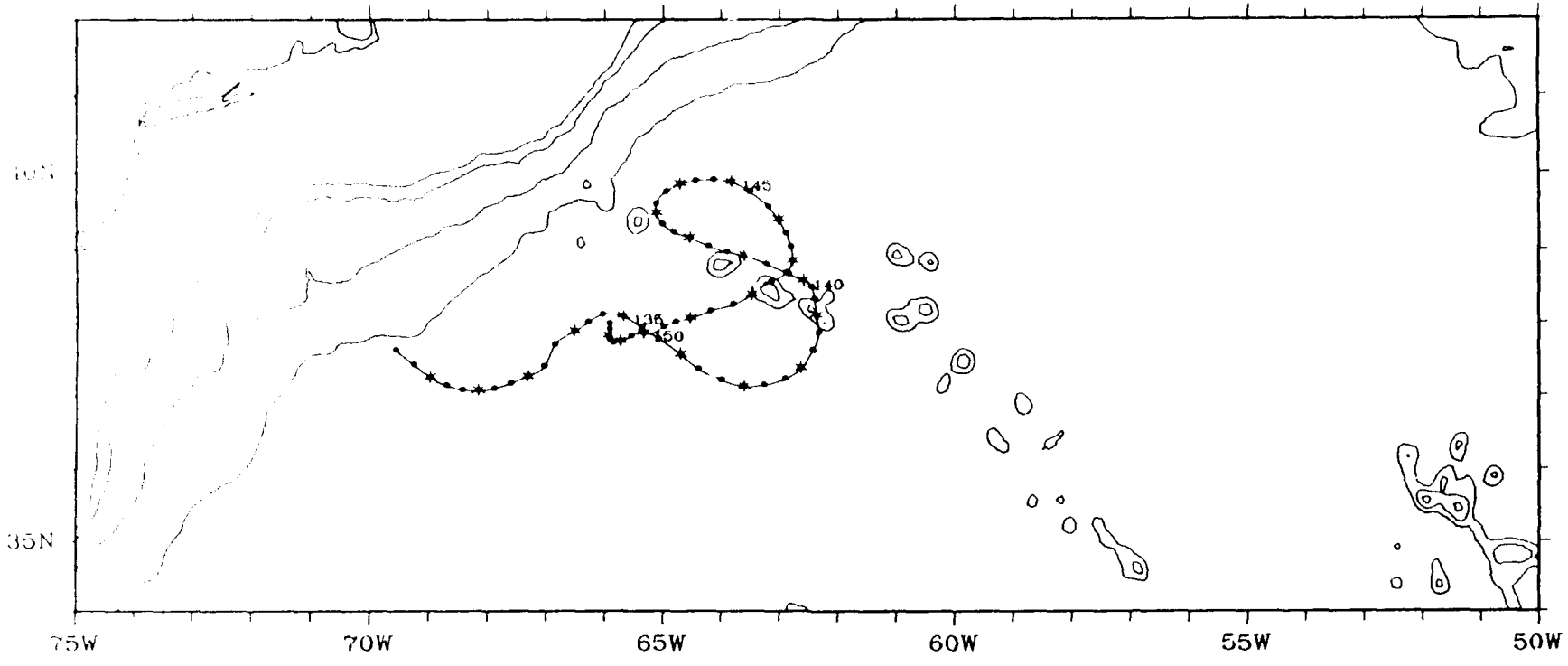
Float 187



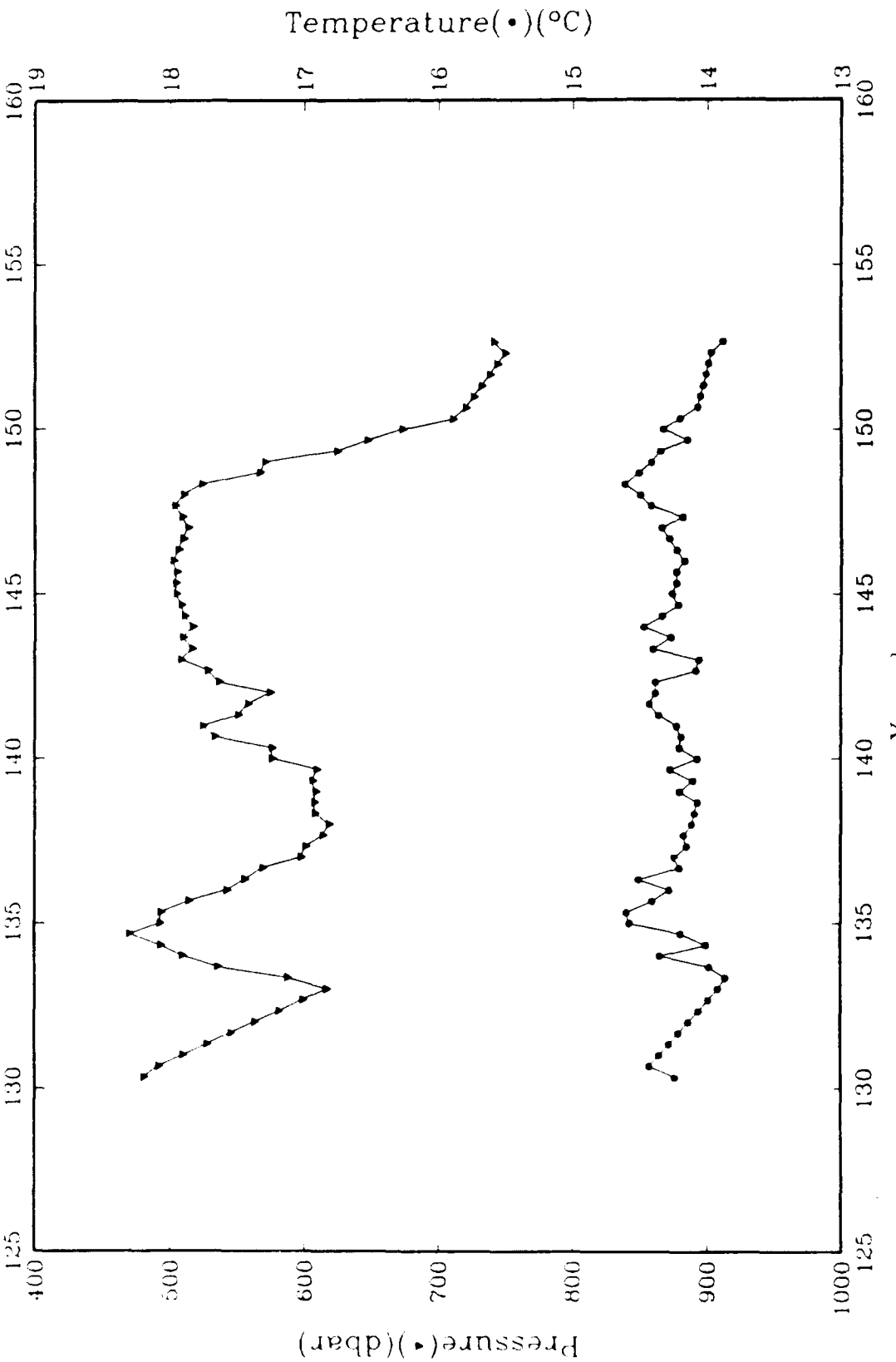
Float 186


120
125
130
135
140
145
150
155
100
200
300
400
500
600
700
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

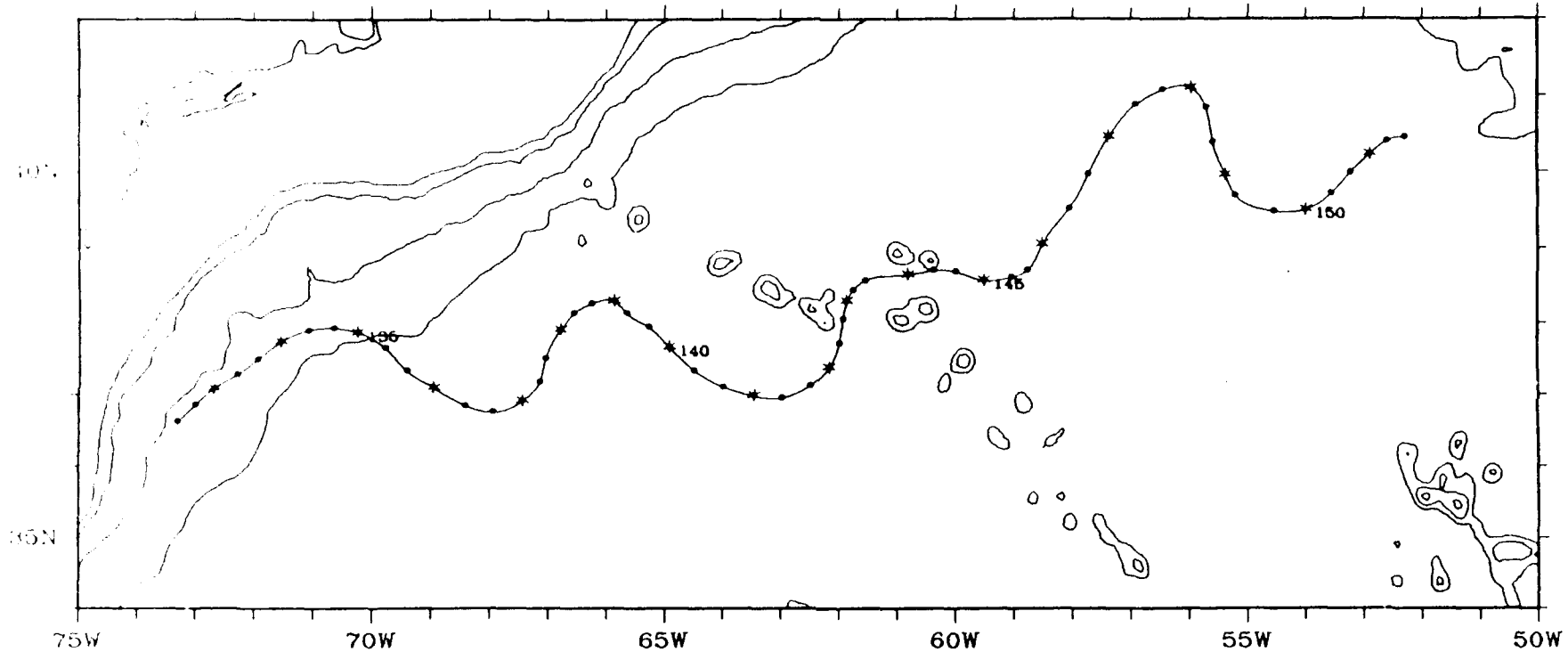
Float 186



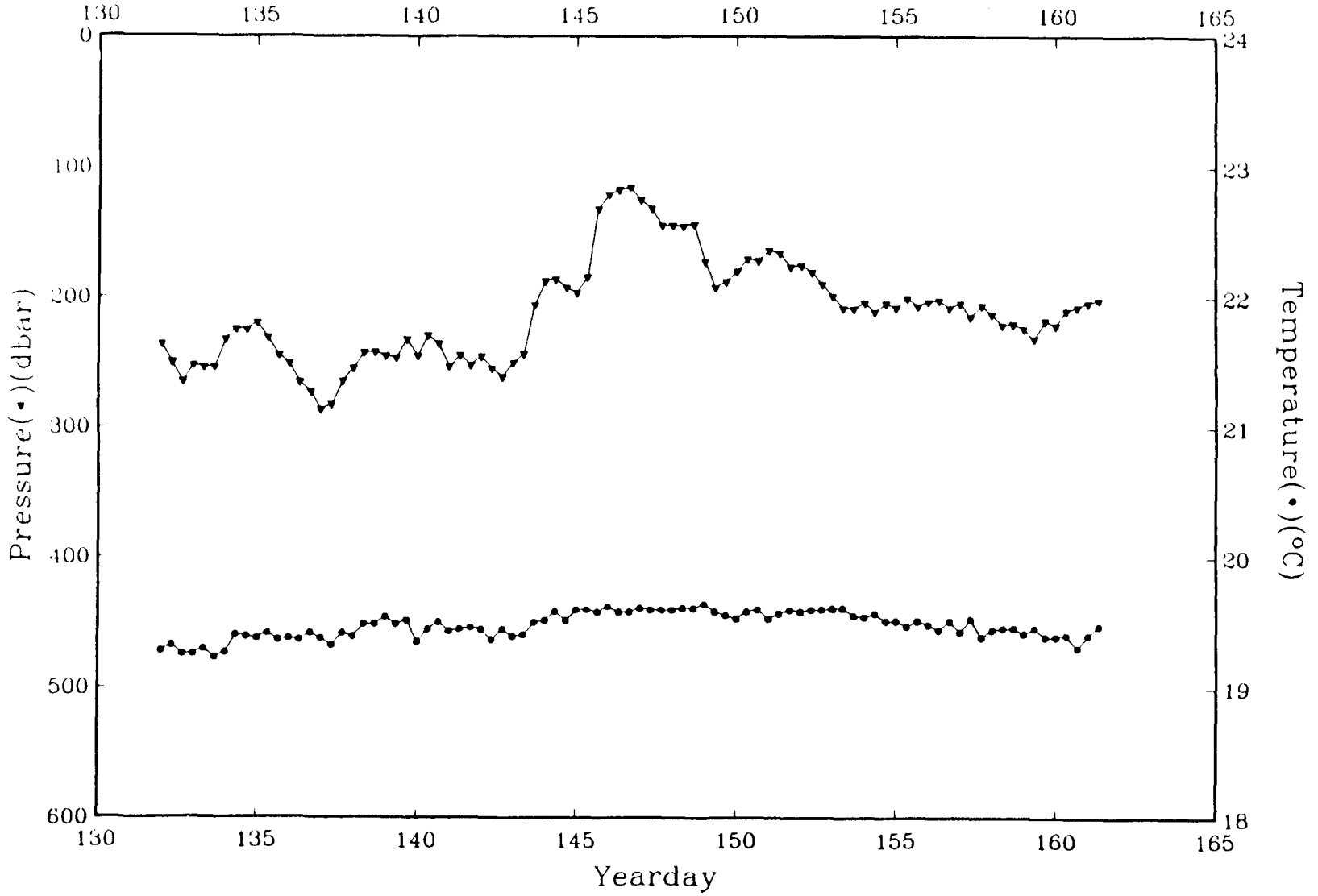
Float 198


Temperature(•)(°C)
19
18
17
16
15
14
13
160
155
150
145
140
135
130
125
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000

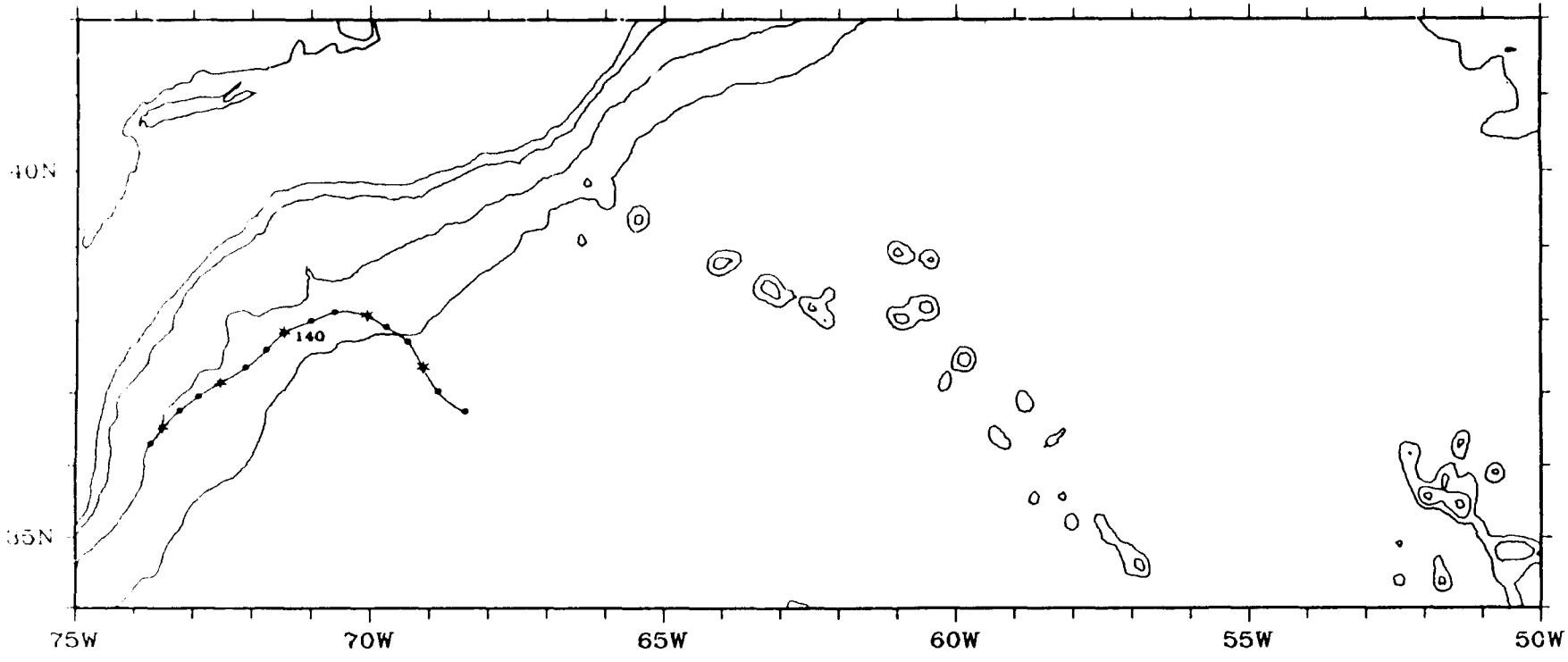
Float 198



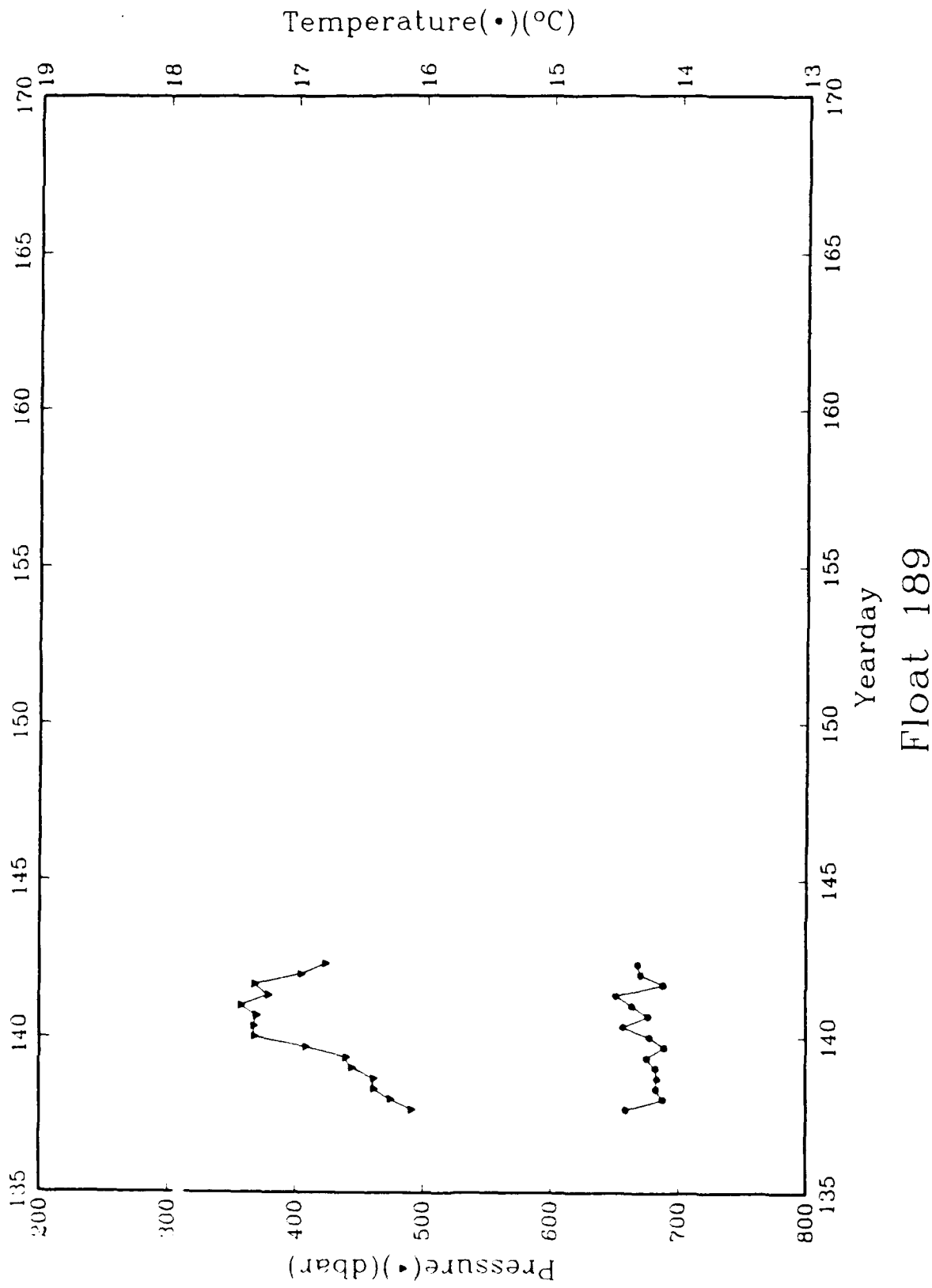
Float 191

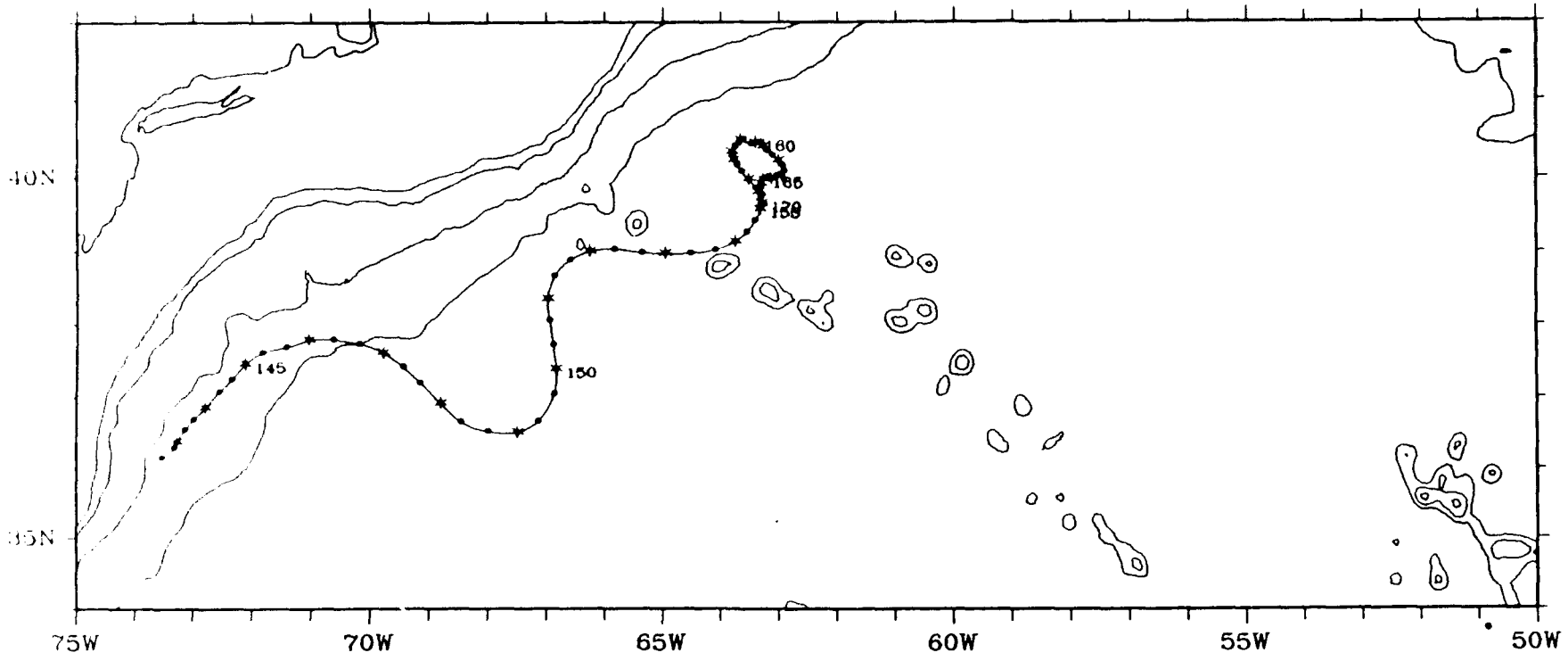

130
135
140
145
150
155
160
165
0
100
200
300
400
500
600
24
23
22
21
20
19
18
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

Float 191

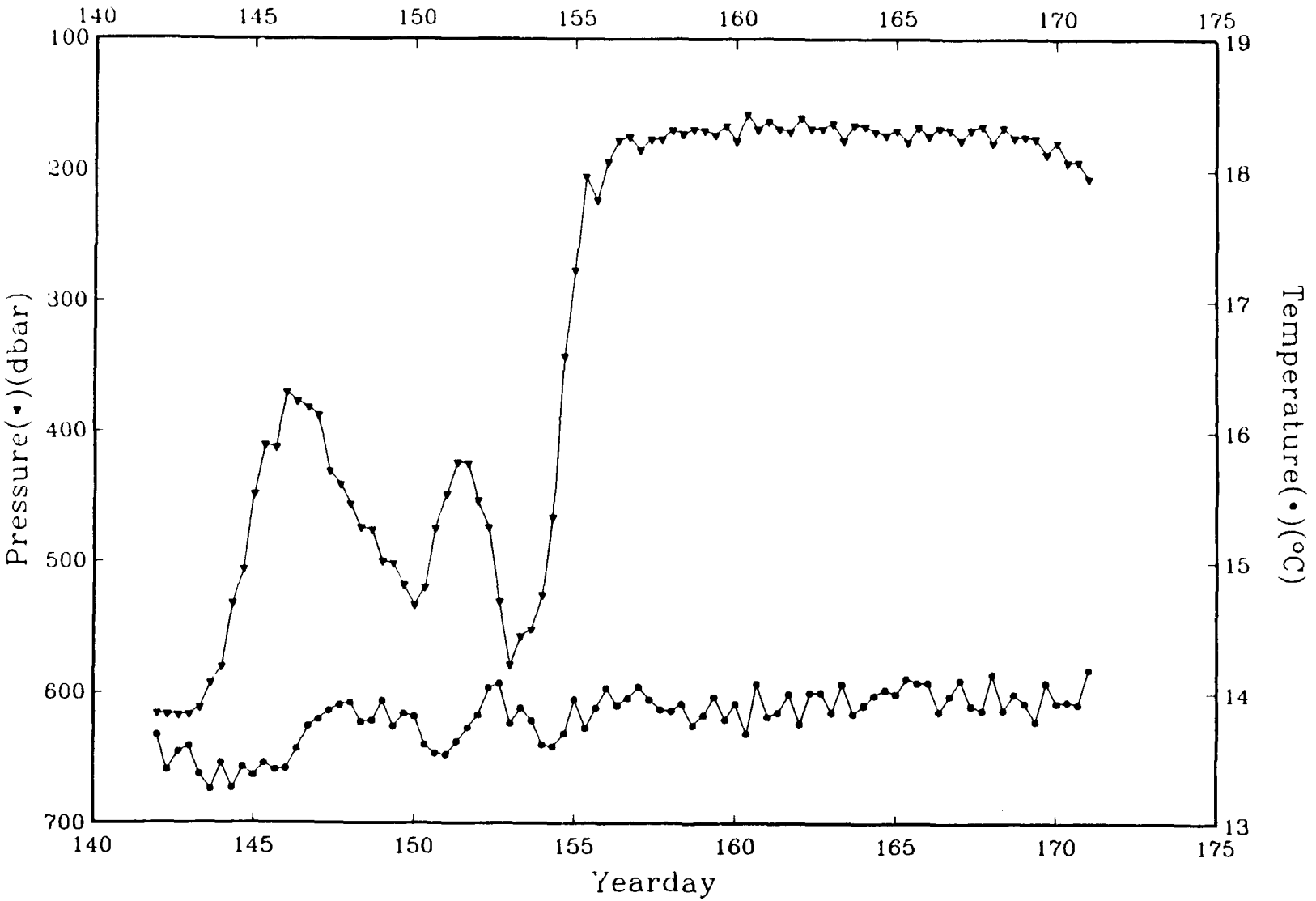


Float 189

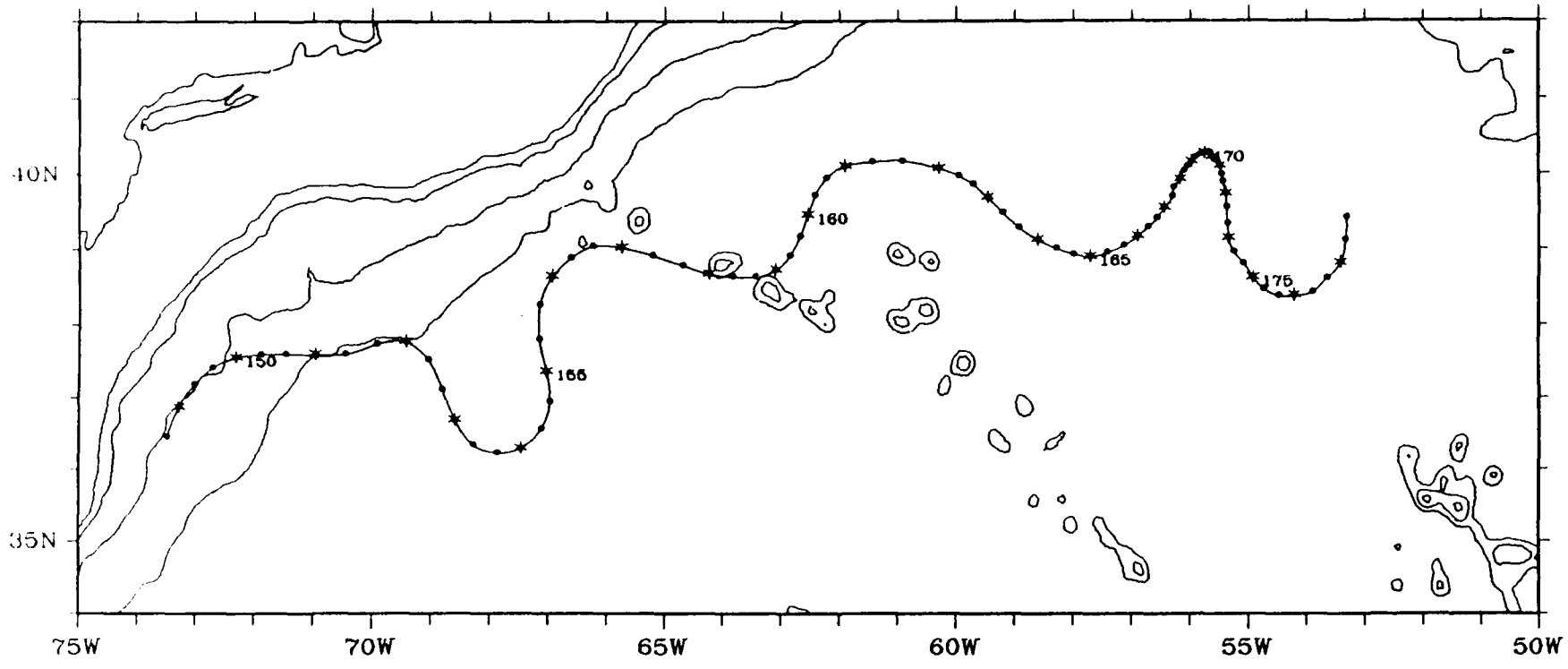

Temperature(•)(°C)
19
18
17
16
15
14
13
Pressure(◂)(dbar)
200
300
400
500
600
700
800
135
140
145
150
155
160
165
170
Yearday
Float 189



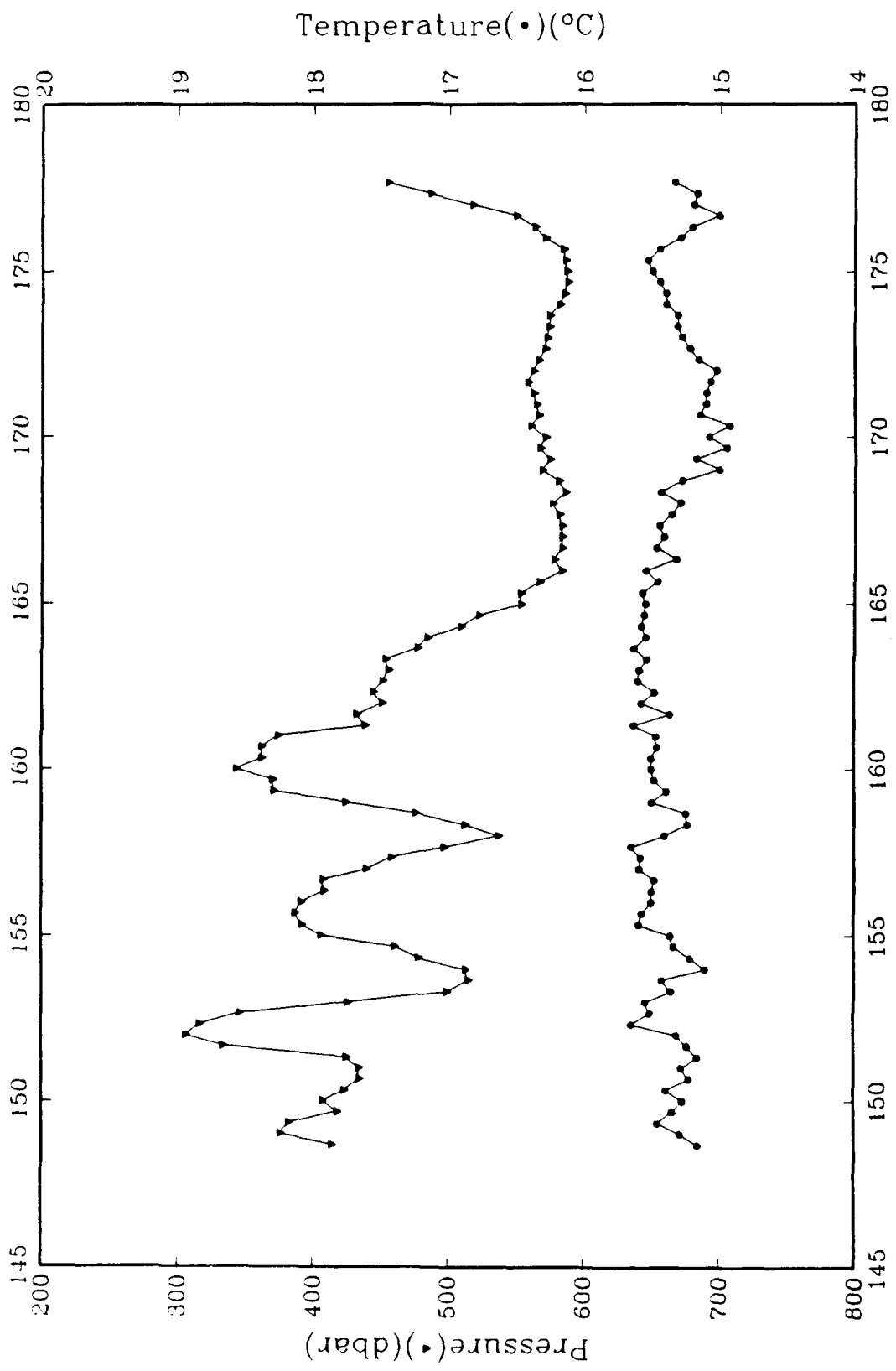
Float 190


140
145
150
155
160
165
170
175
100
200
300
400
500
600
700
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

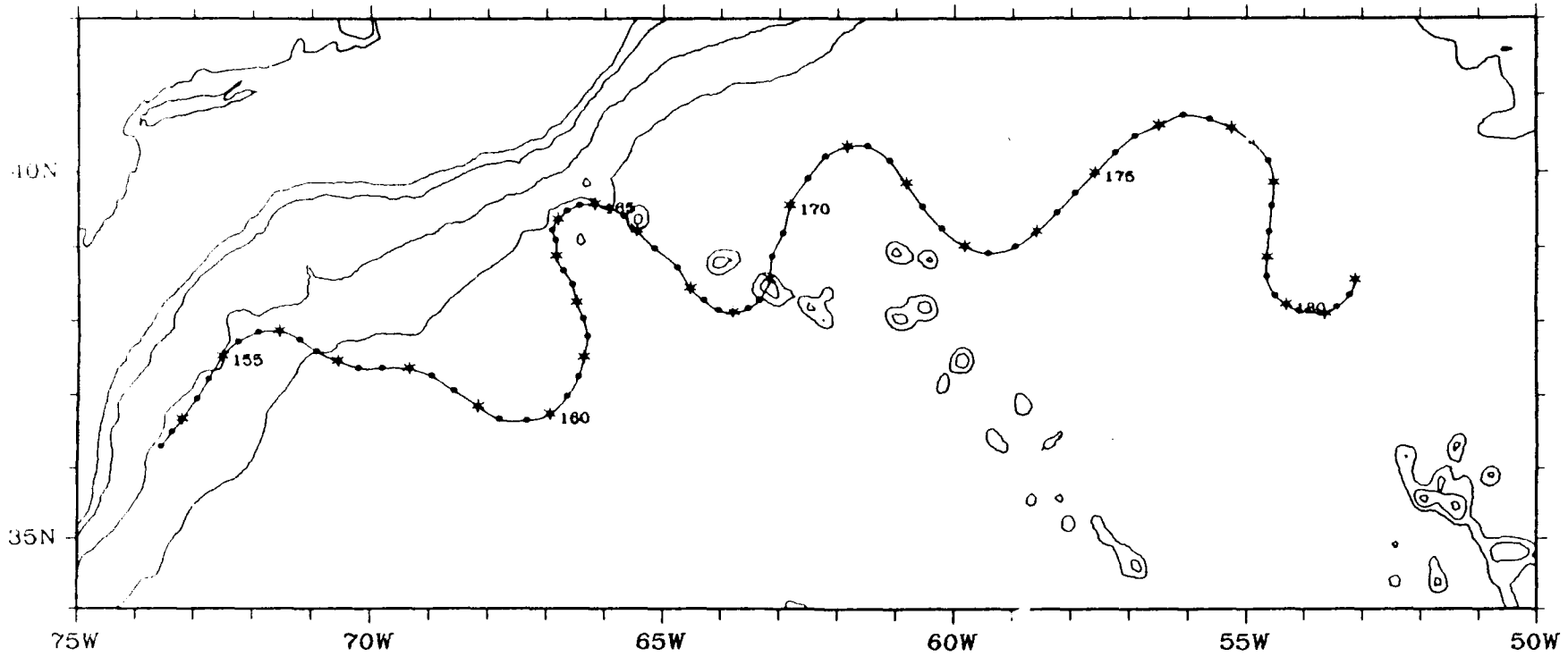
Float 190



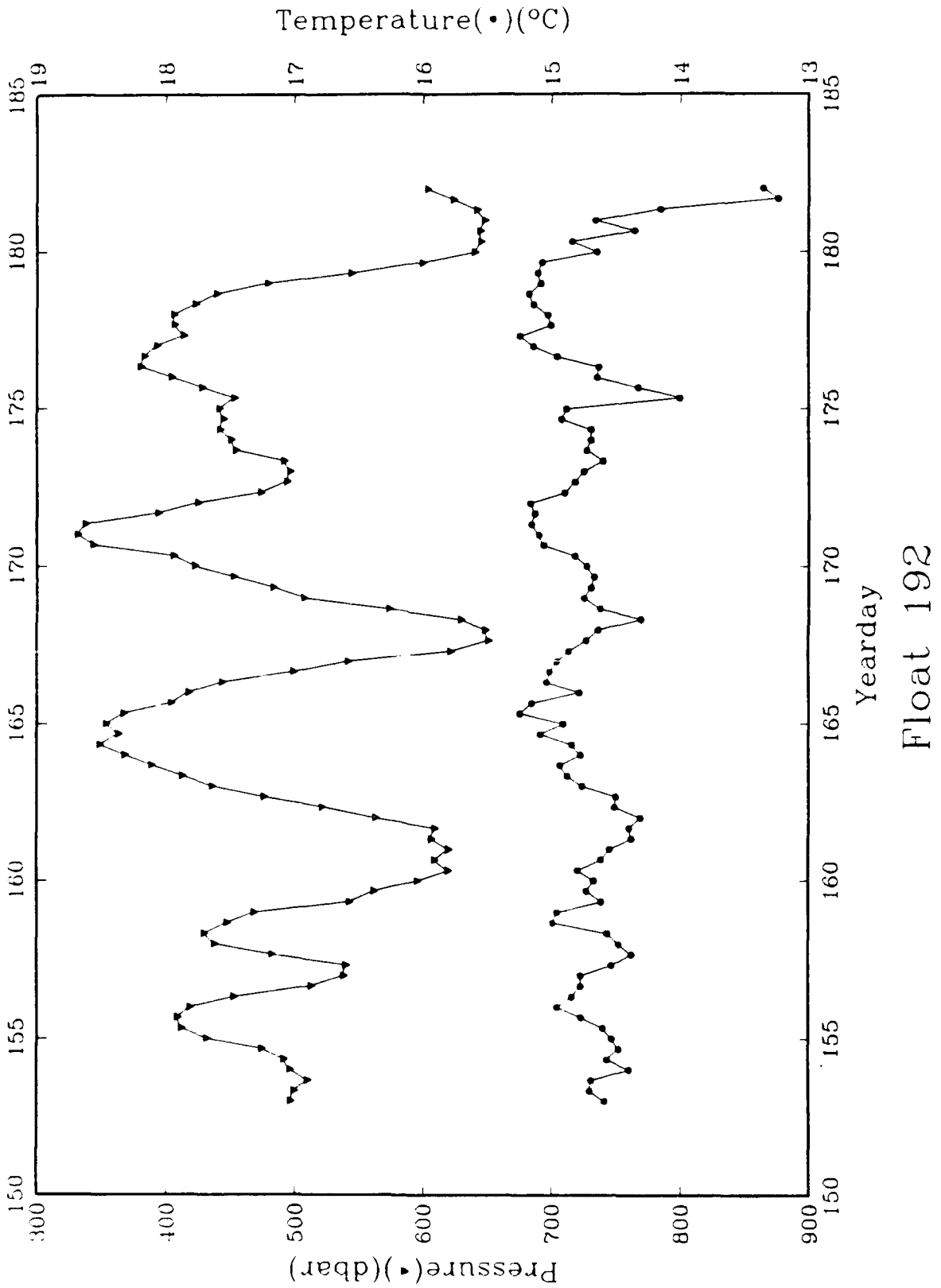
Float 193

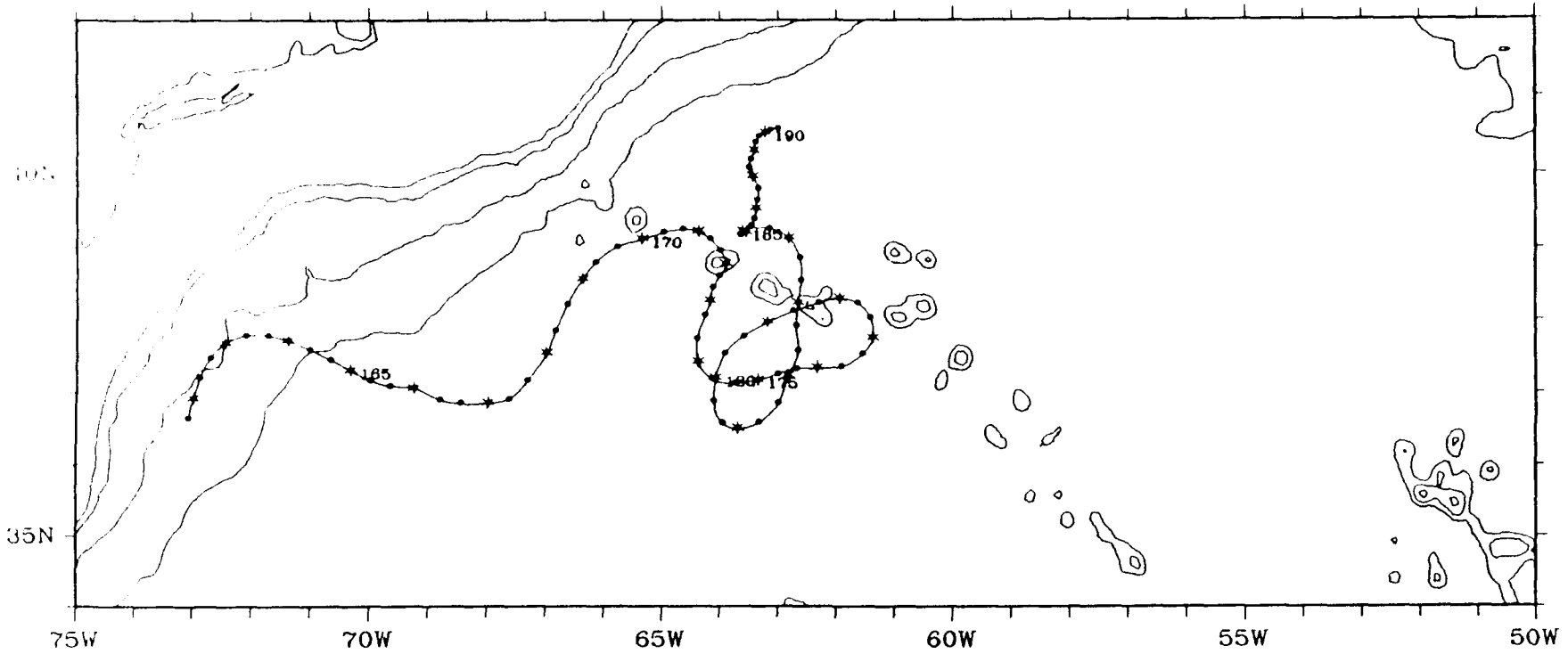

Temperature(•)(°C)
20
19
18
17
16
15
14
180
175
170
165
160
155
150
145
Yearday
Pressure(◂)(dbar)
200
300
400
500
600
700
800

Float 193

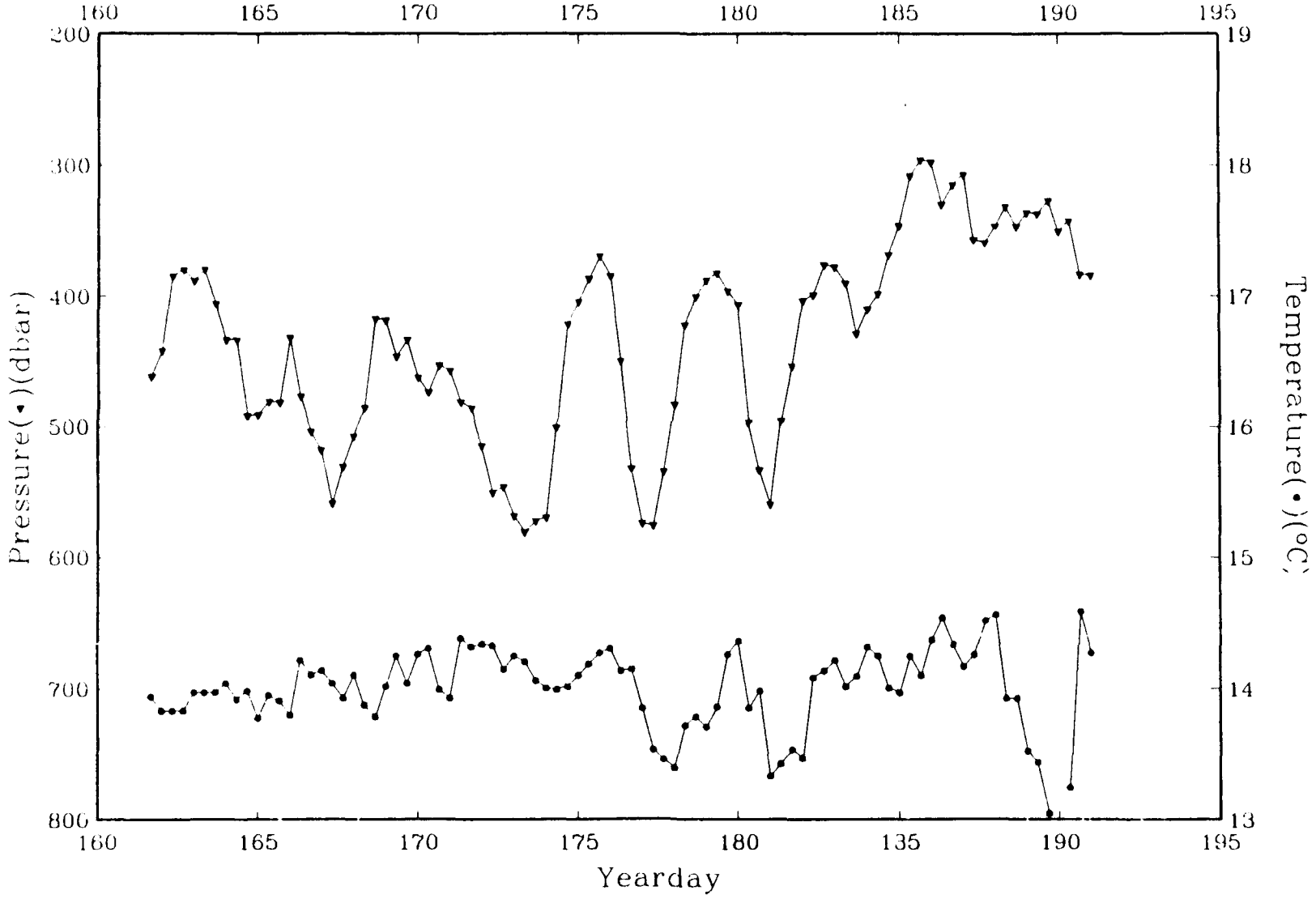


Float 192

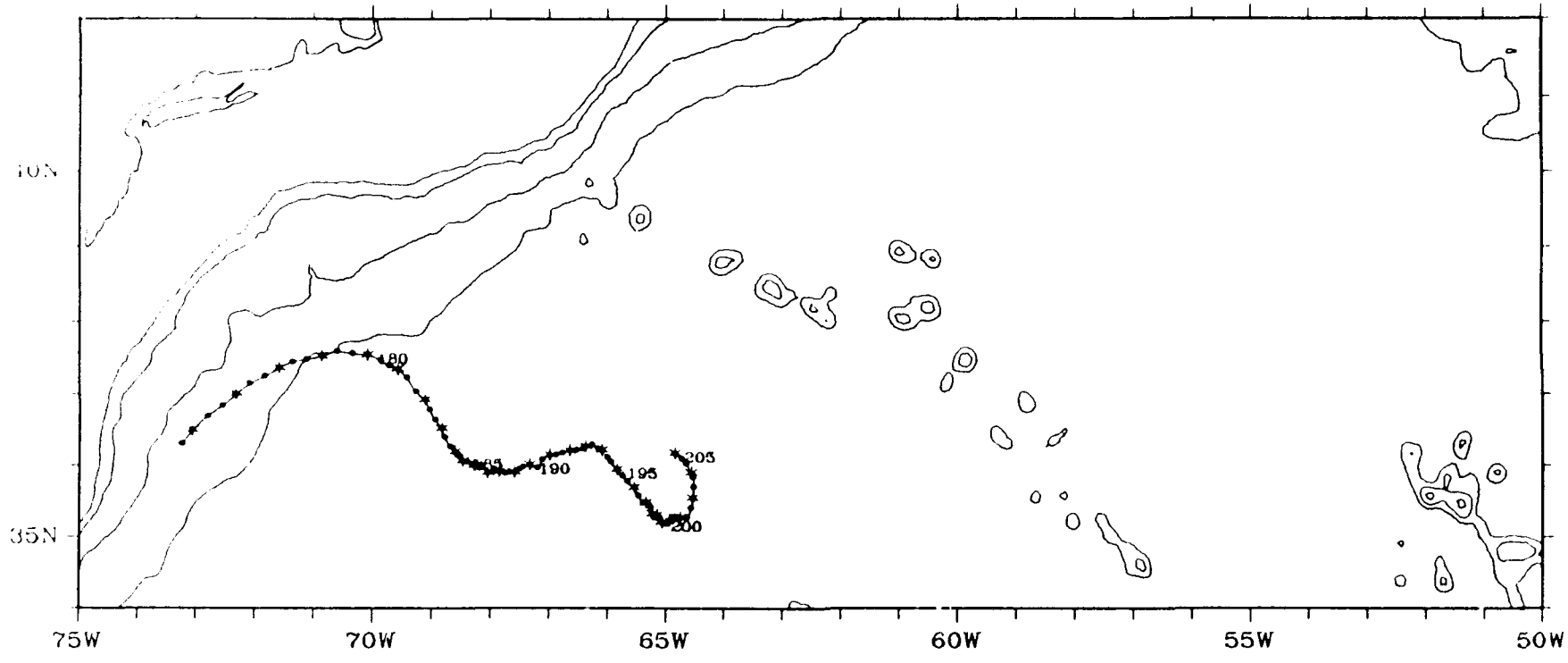

Temperature(•)(°C)
19
18
17
16
15
14
13
185
180
175
170
165
160
155
150
Yearday
Pressure(•)(dbar)
300
400
500
600
700
800
900
Float 192



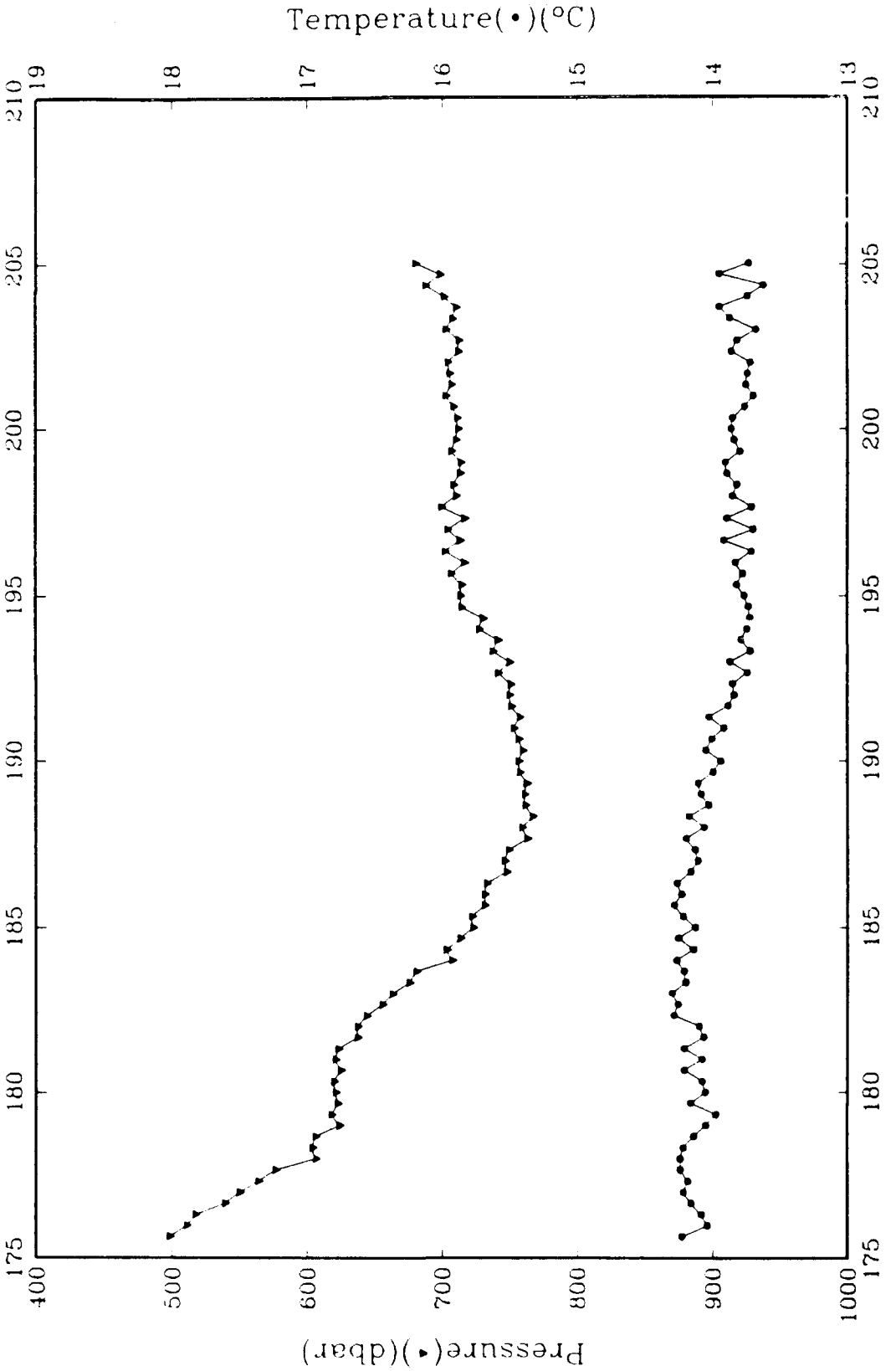
Float 183


160
165
170
175
180
185
190
195
200
300
400
500
600
700
800
Pressure(•)(dbar)
19
18
17
16
15
14
13
Temperature(•)(°C)
Yearday

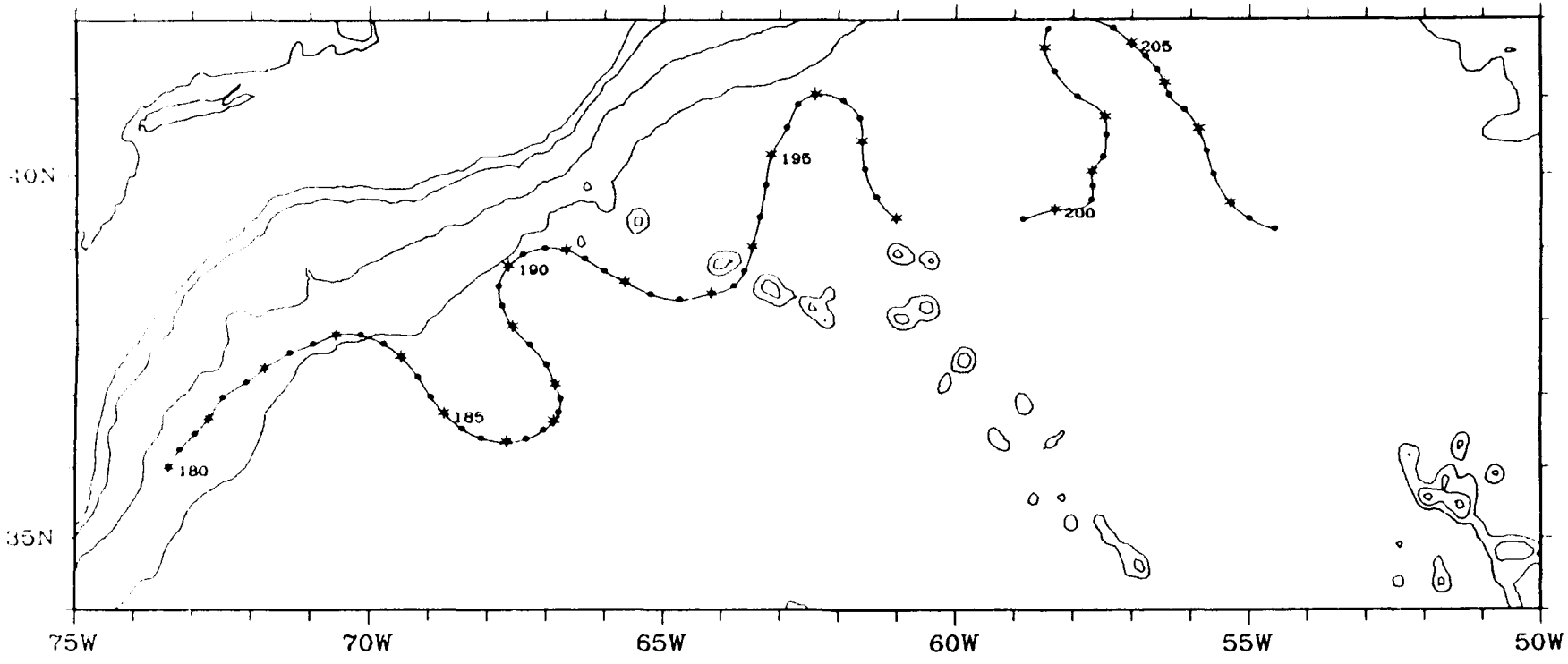
Float 183



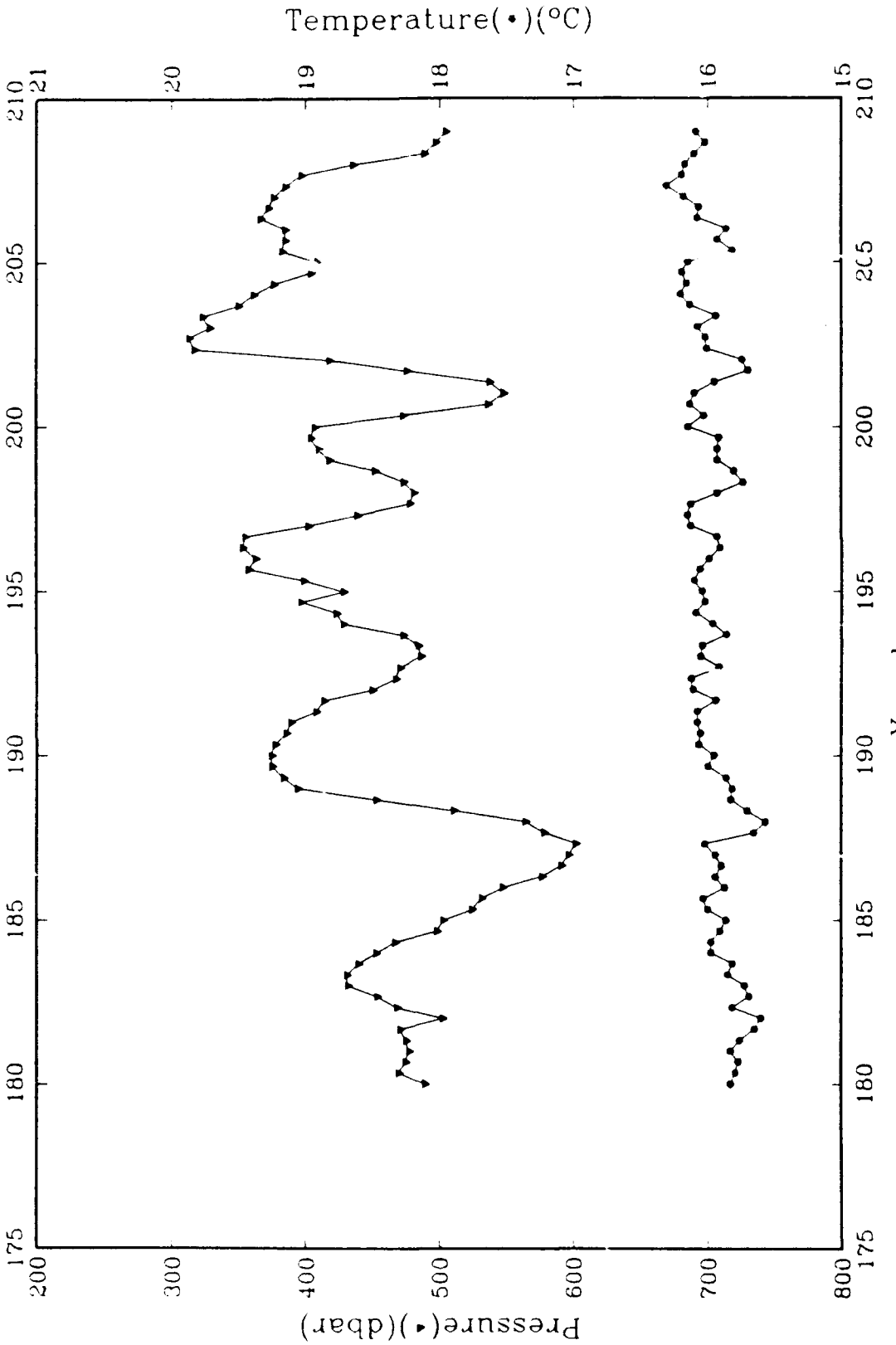
Float 197

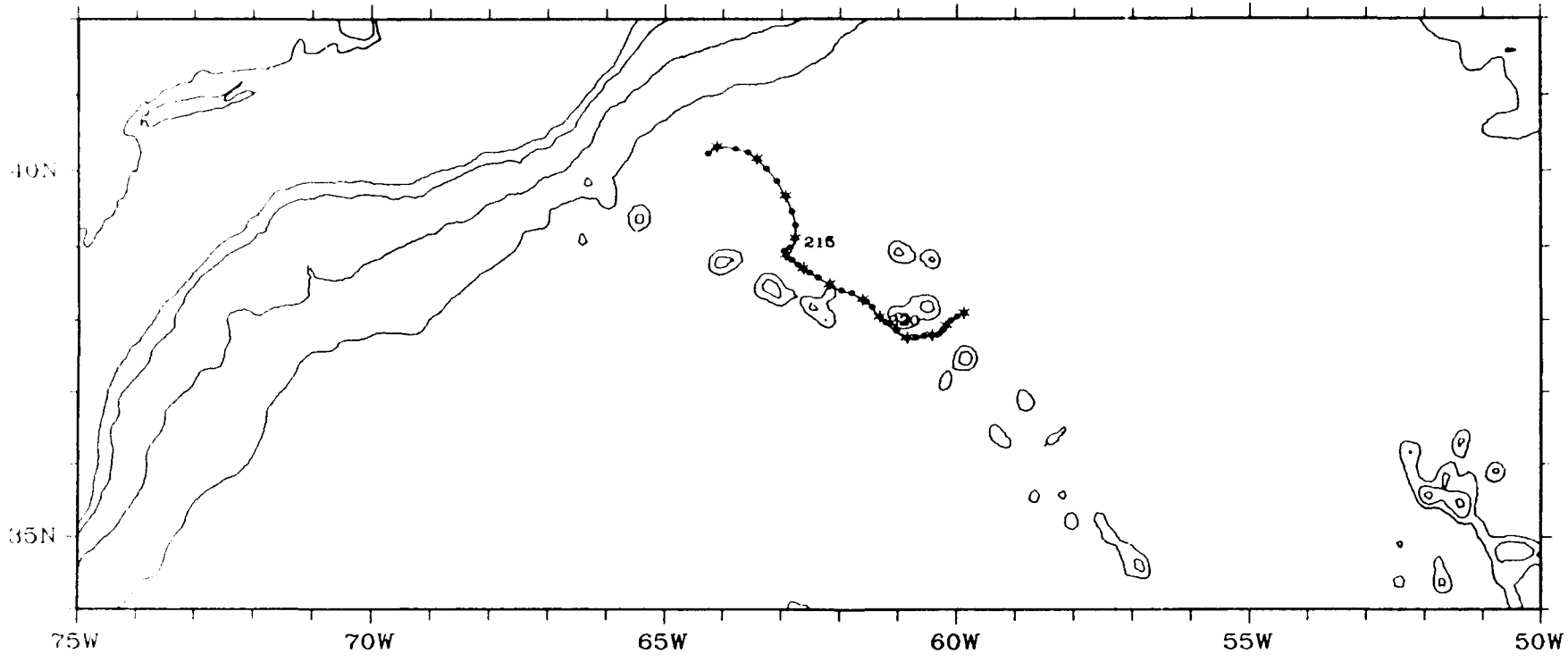

Temperature(•)(°C)
19
18
17
16
15
14
13
210
205
200
195
190
185
180
175
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000

Float 197

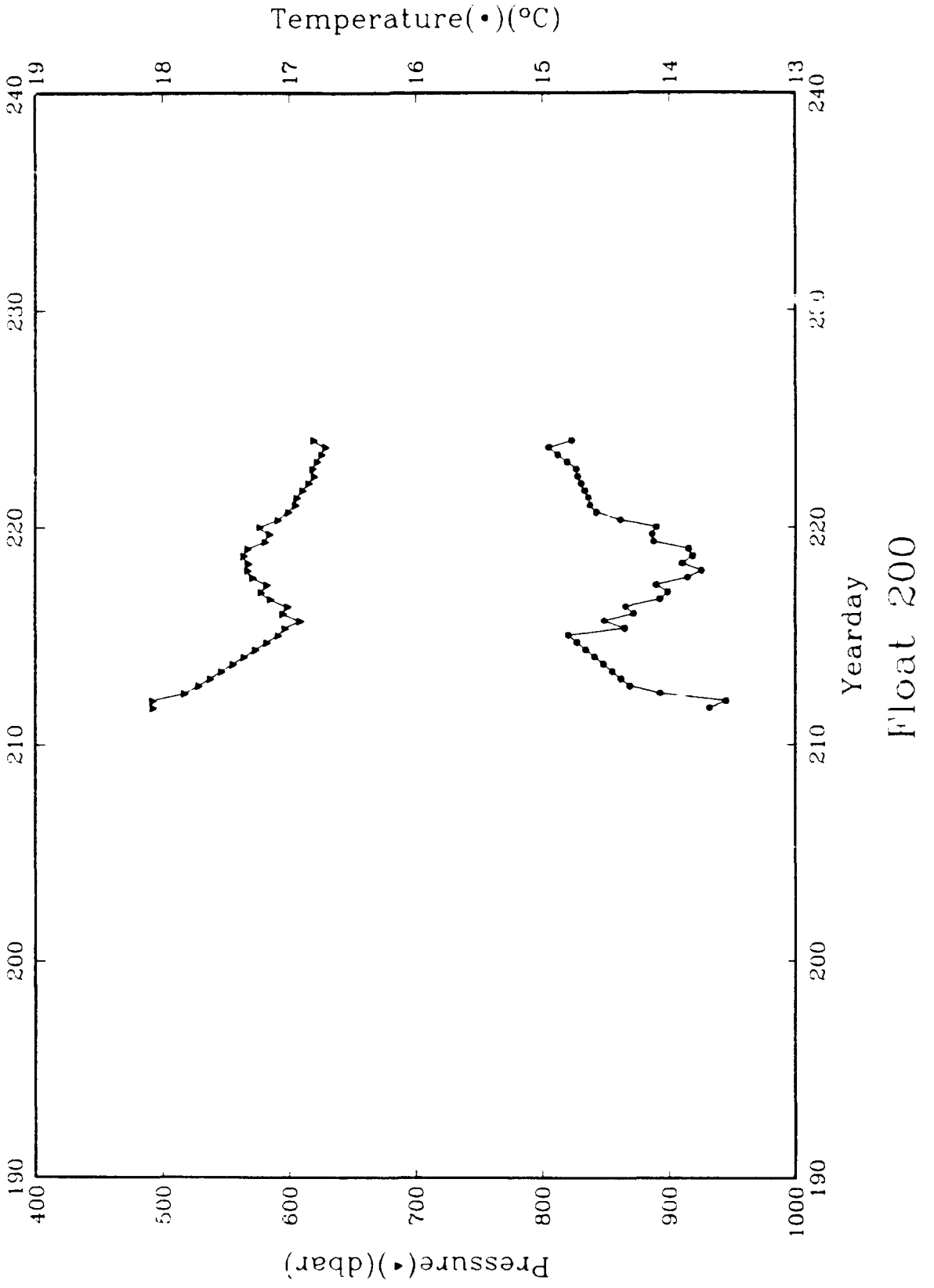


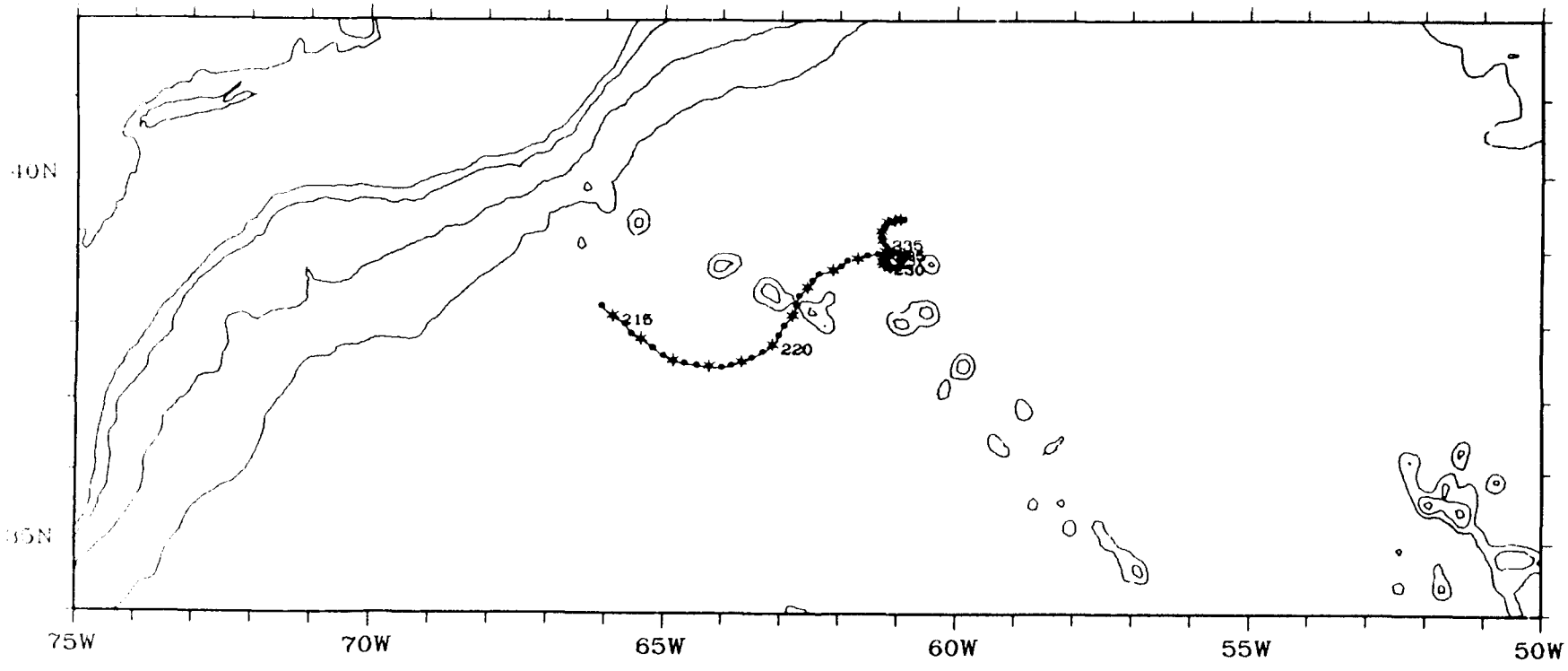
Float 196


Temperature(•)(°C)
21
20
19
18
17
16
15
210
205
200
195
190
185
180
175
Yearday
Pressure(◂)(dbar)
200
300
400
500
600
700
800
Float 196

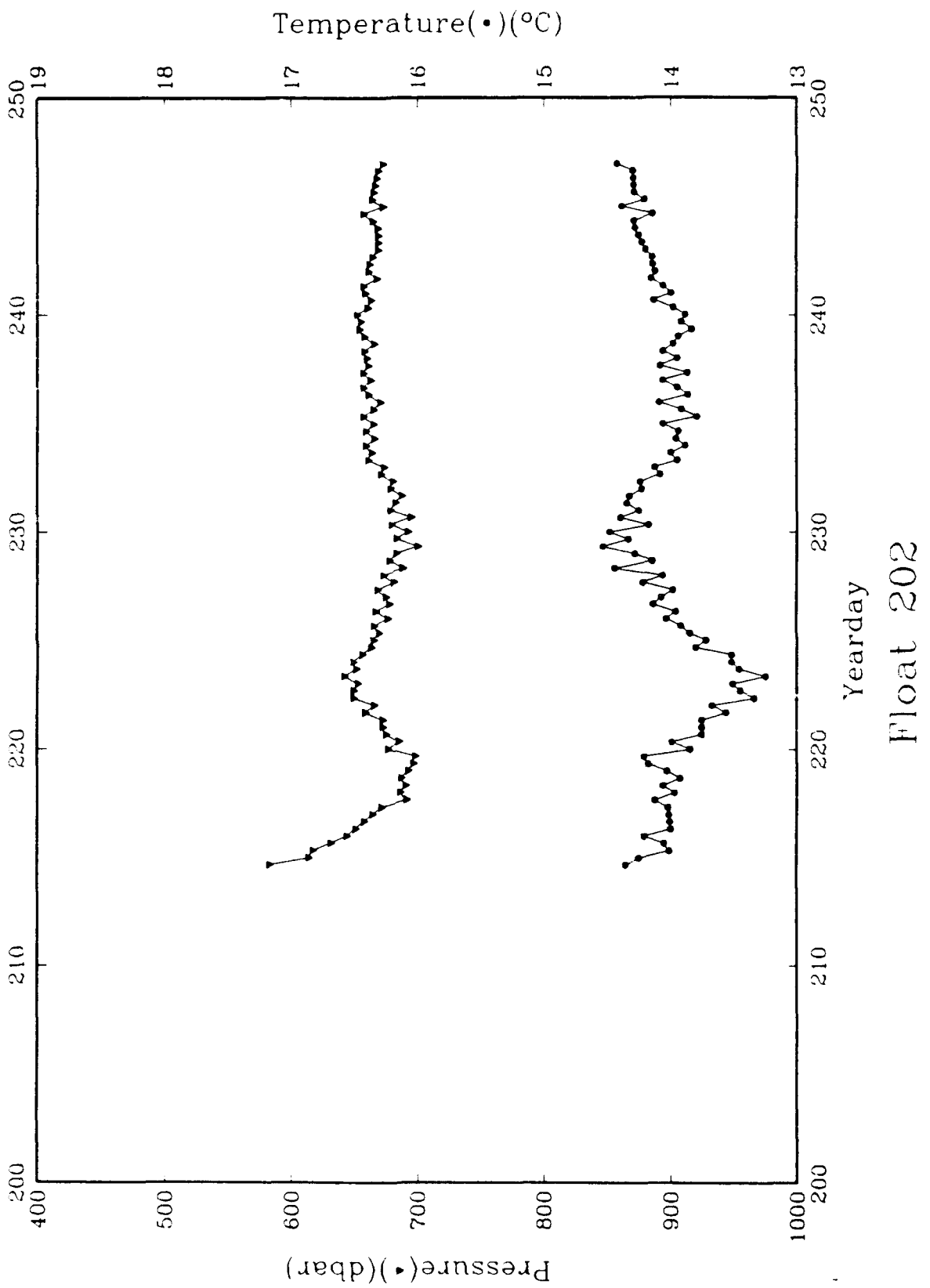


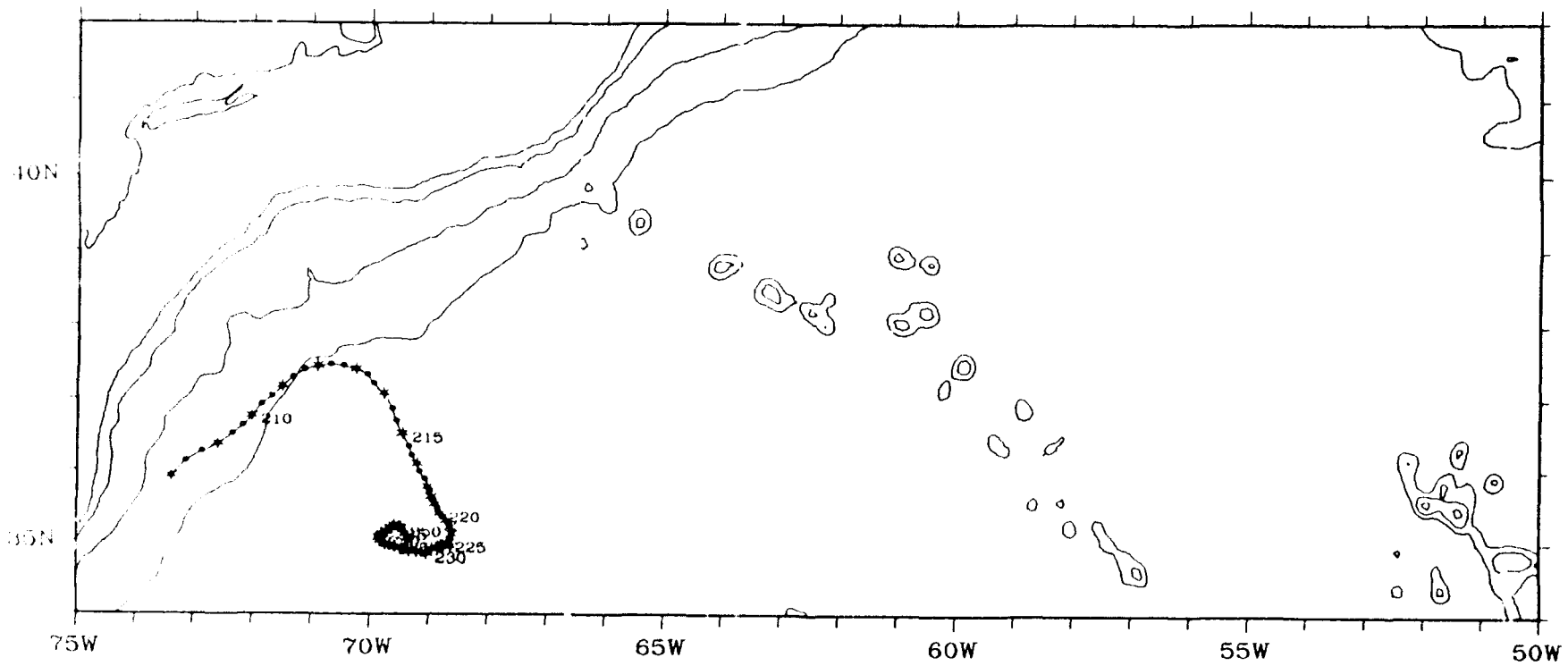
Float 200


Temperature(•)(°C)
19
18
17
16
15
14
13
240
230
220
210
200
190
Yearday
Float 200
Pressure(◂)(dbar)
400
500
600
700
800
900
1000

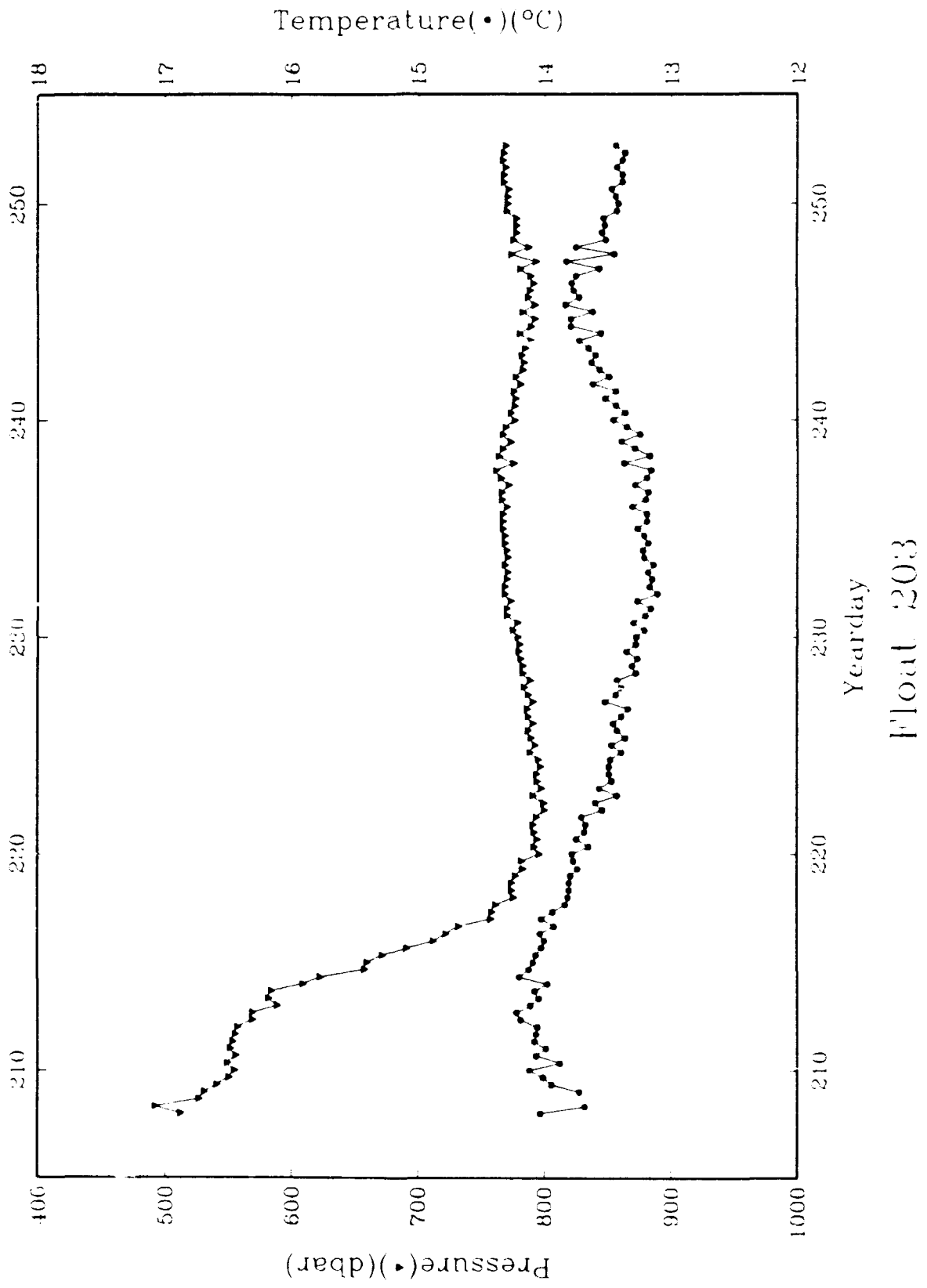


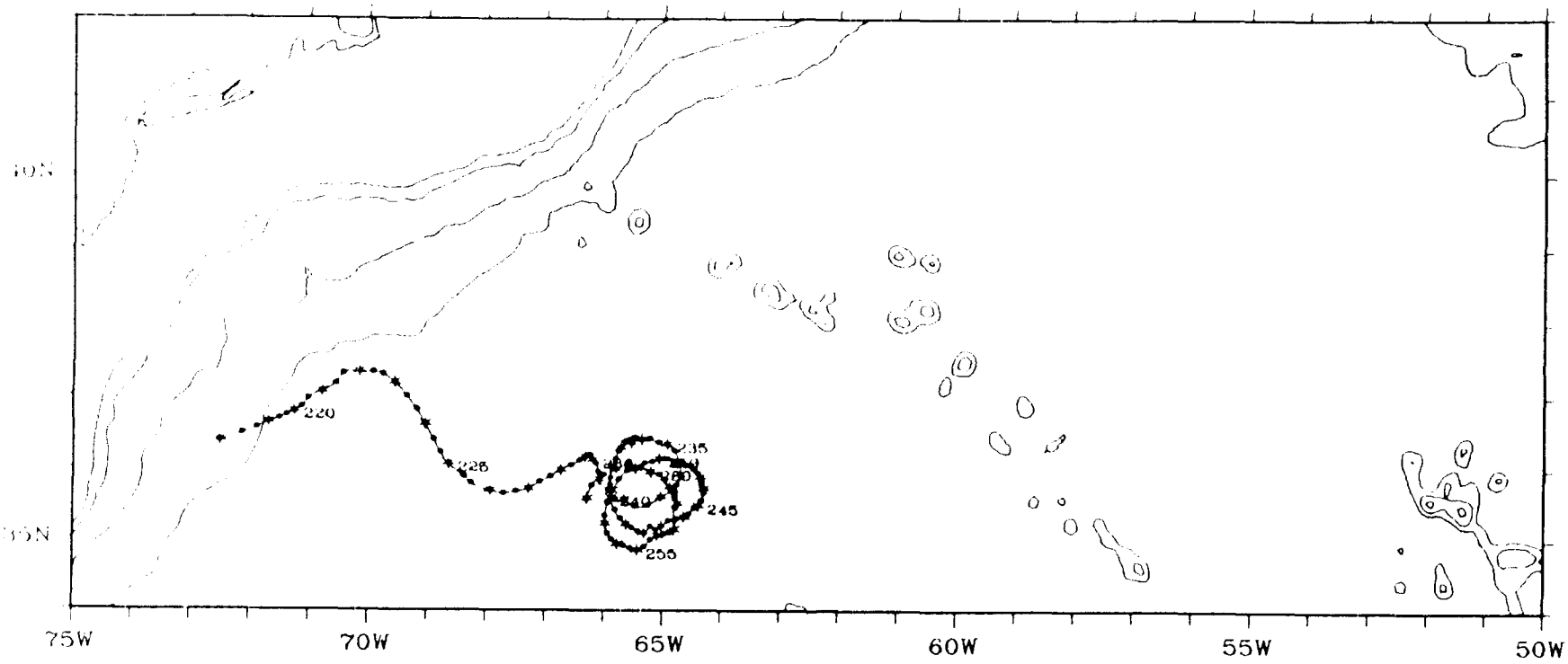
Float 202


Temperature(•)(°C)
19
18
17
16
15
14
13
250
240
230
220
210
200
Yearday
Float 202
Pressure(•)(dbar)
400
500
600
700
800
900
1000

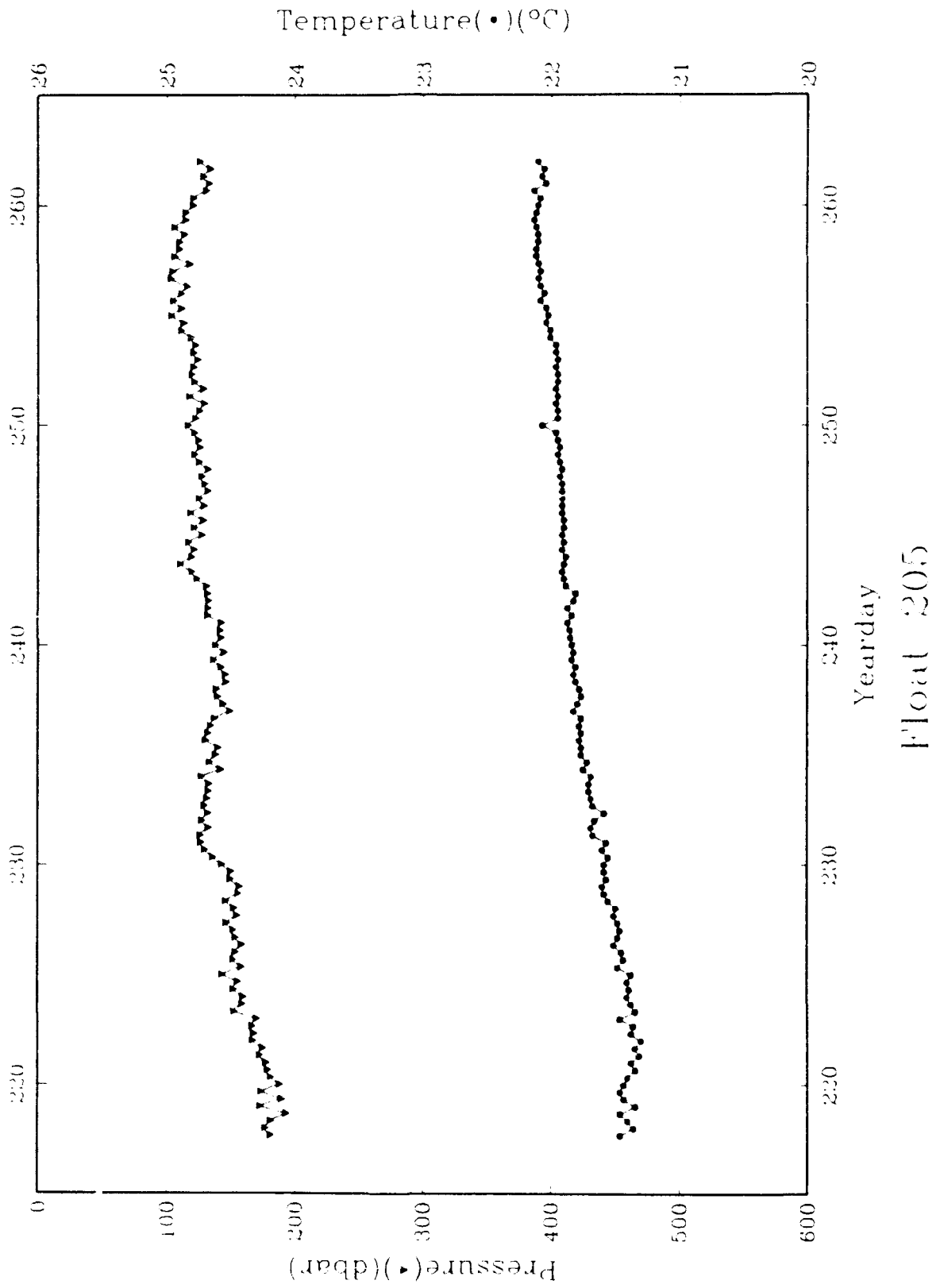


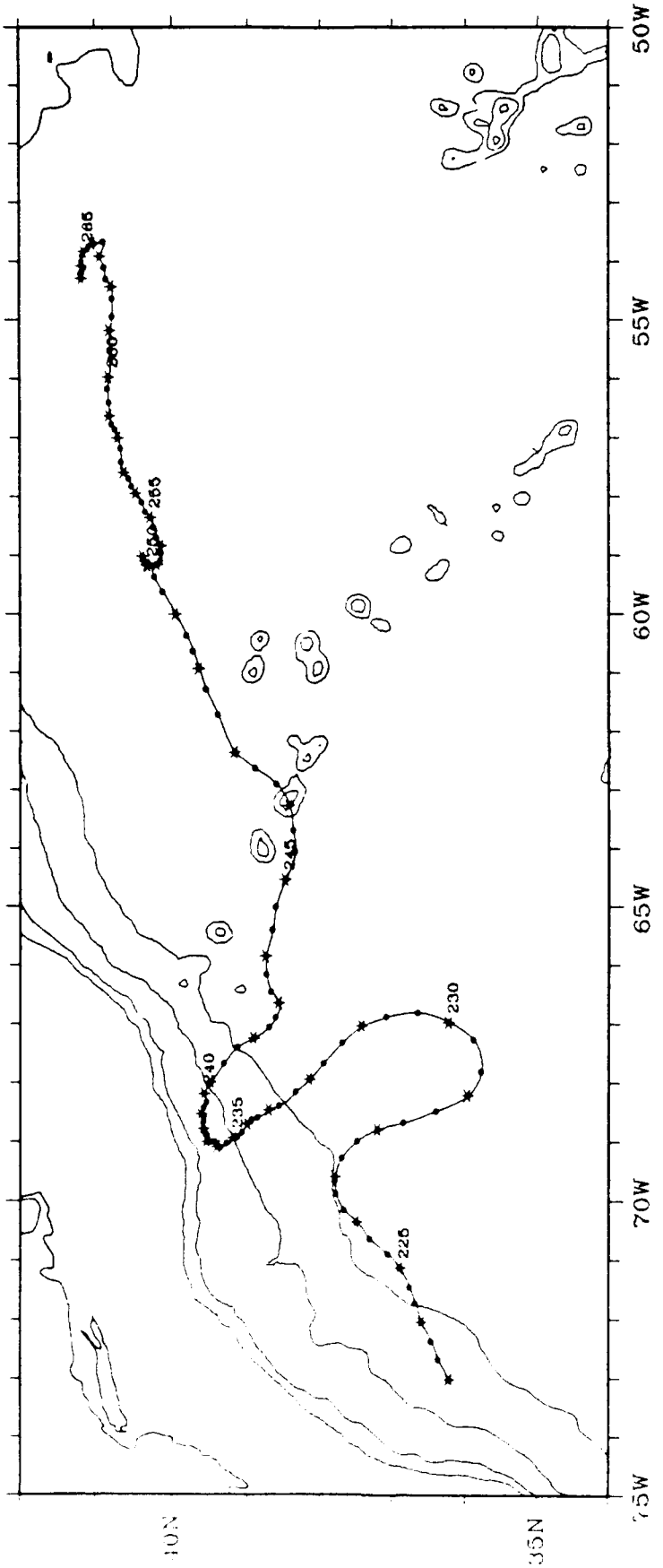
Float 203


Temperature(•)(°C)
18
17
16
15
14
13
12
210
220
230
240
250
Yearday
Pressure(•)(dbar)
400
500
600
700
800
900
1000
Float 2013

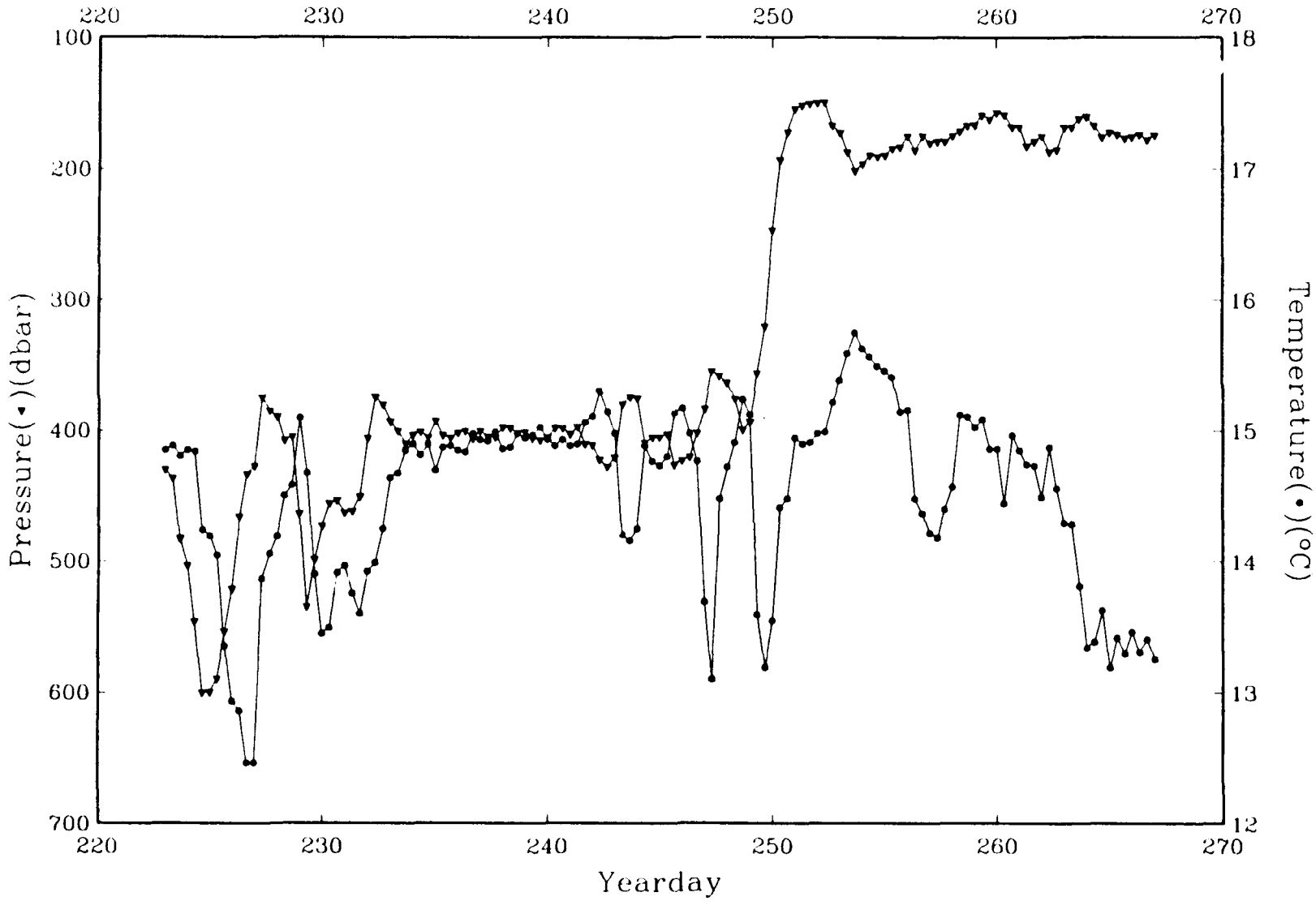


Float 205

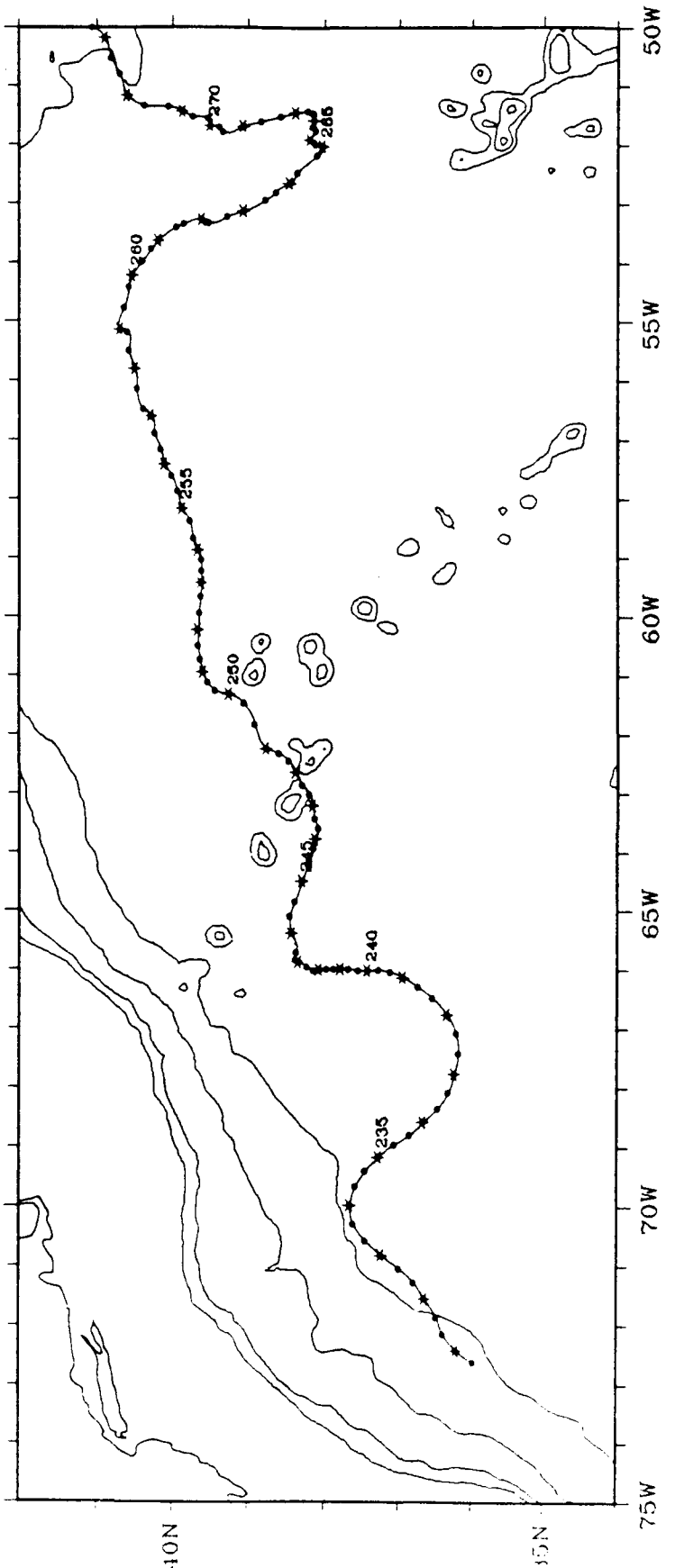

Temperature(•)(°C)
26
25
24
23
22
21
20
220
230
240
250
260
Yearday
Pressure(•)(dbar)
0
100
200
300
400
500
600
Float 205



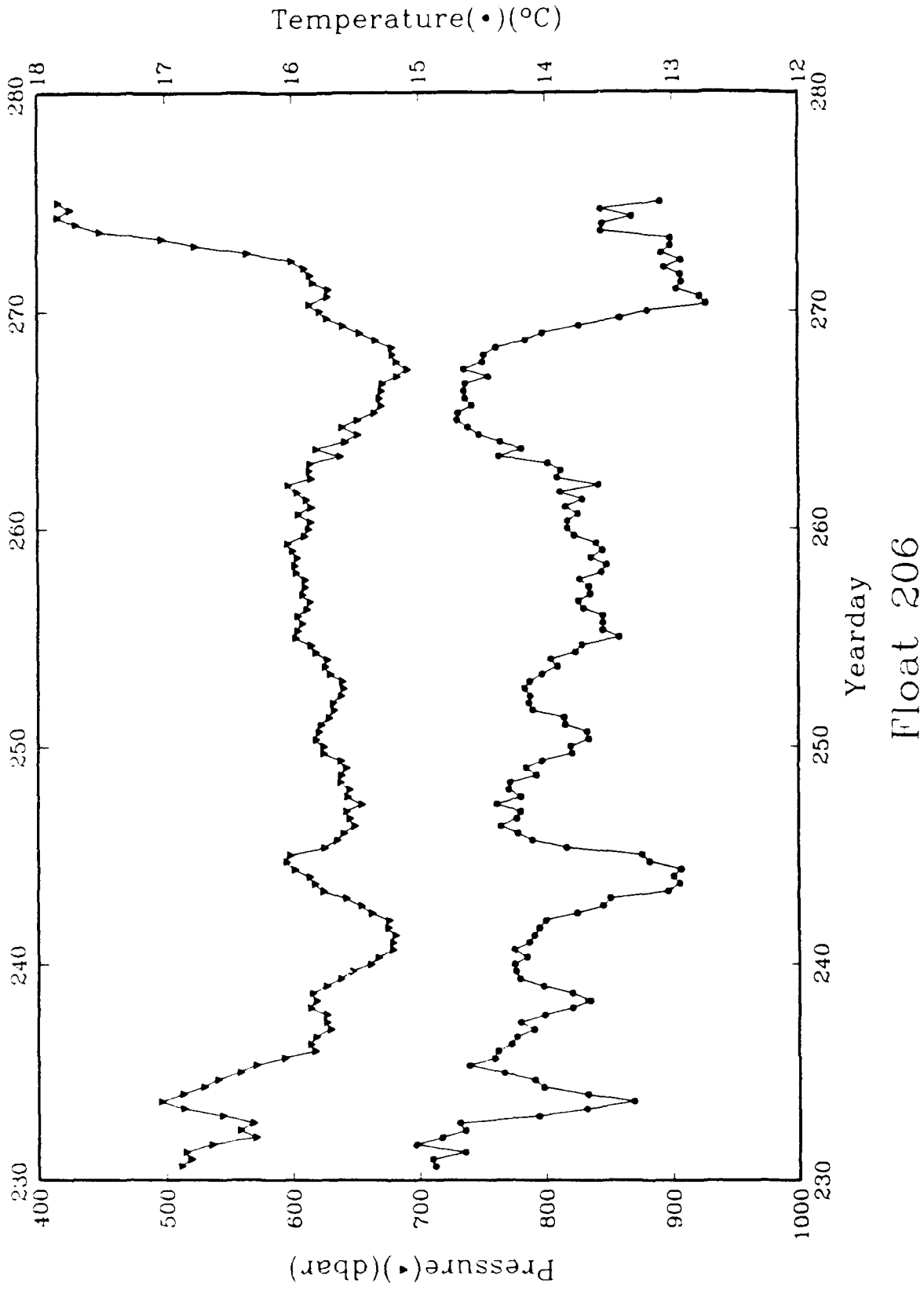
Float 204

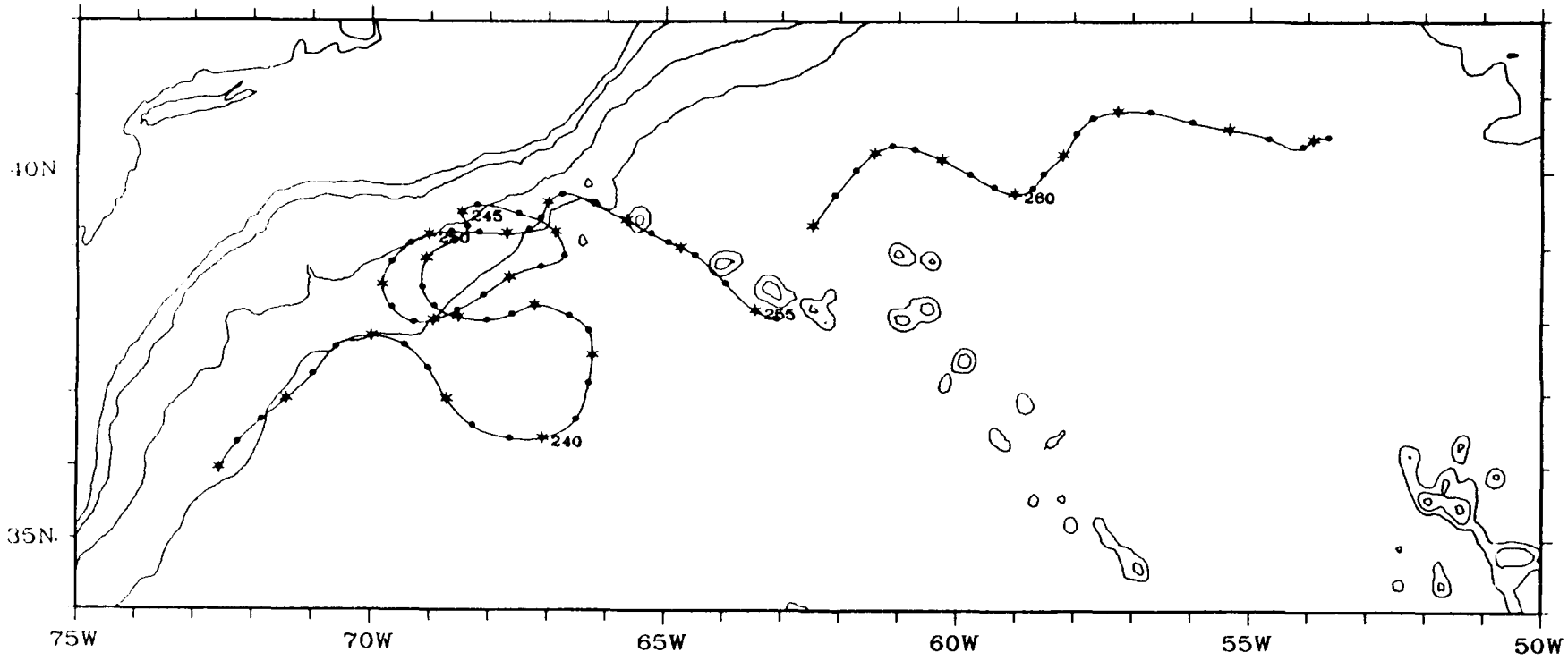

220
230
240
250
260
270
100
200
300
400
500
600
700
18
17
16
15
14
13
12
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

Float 204

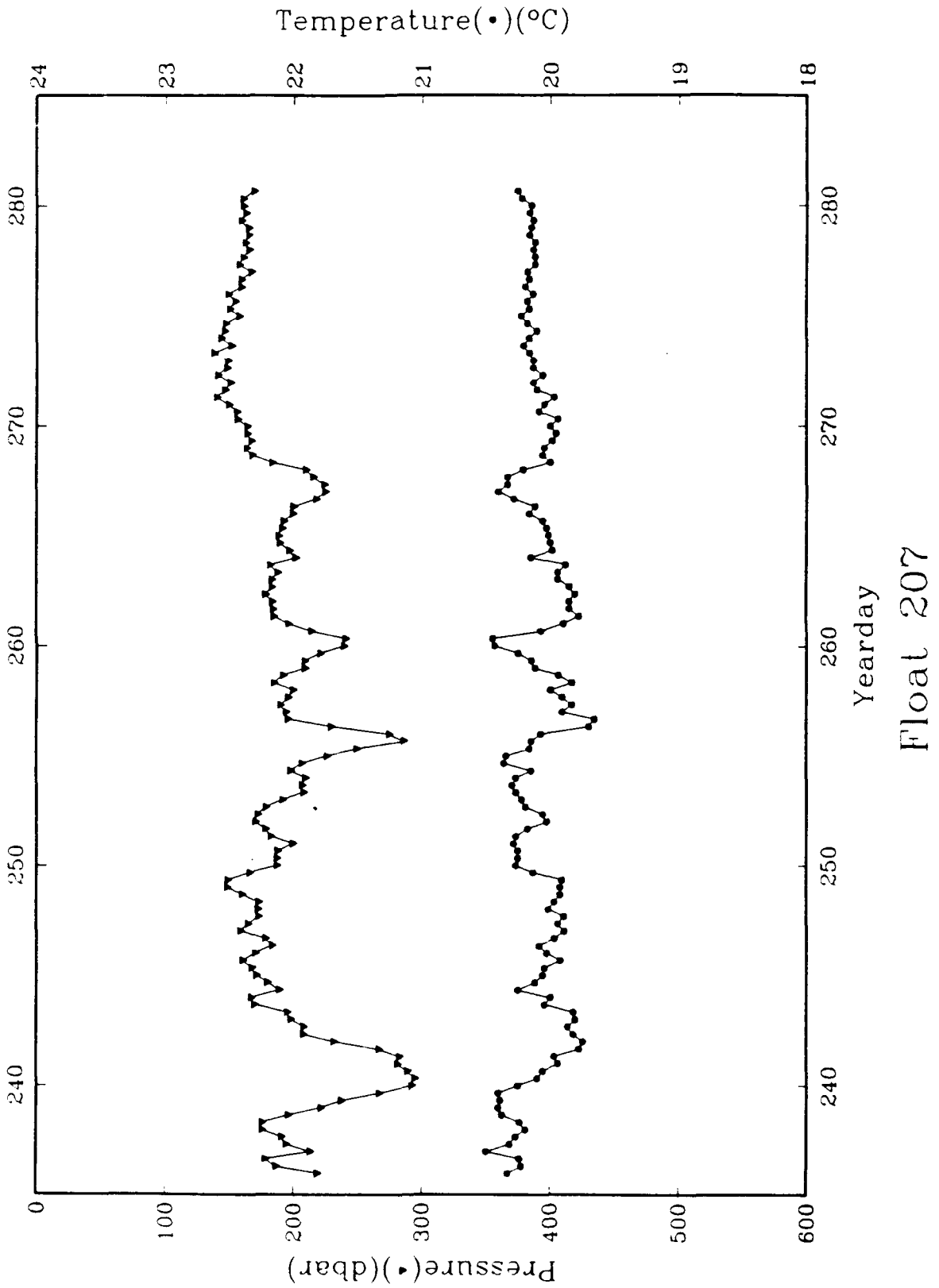


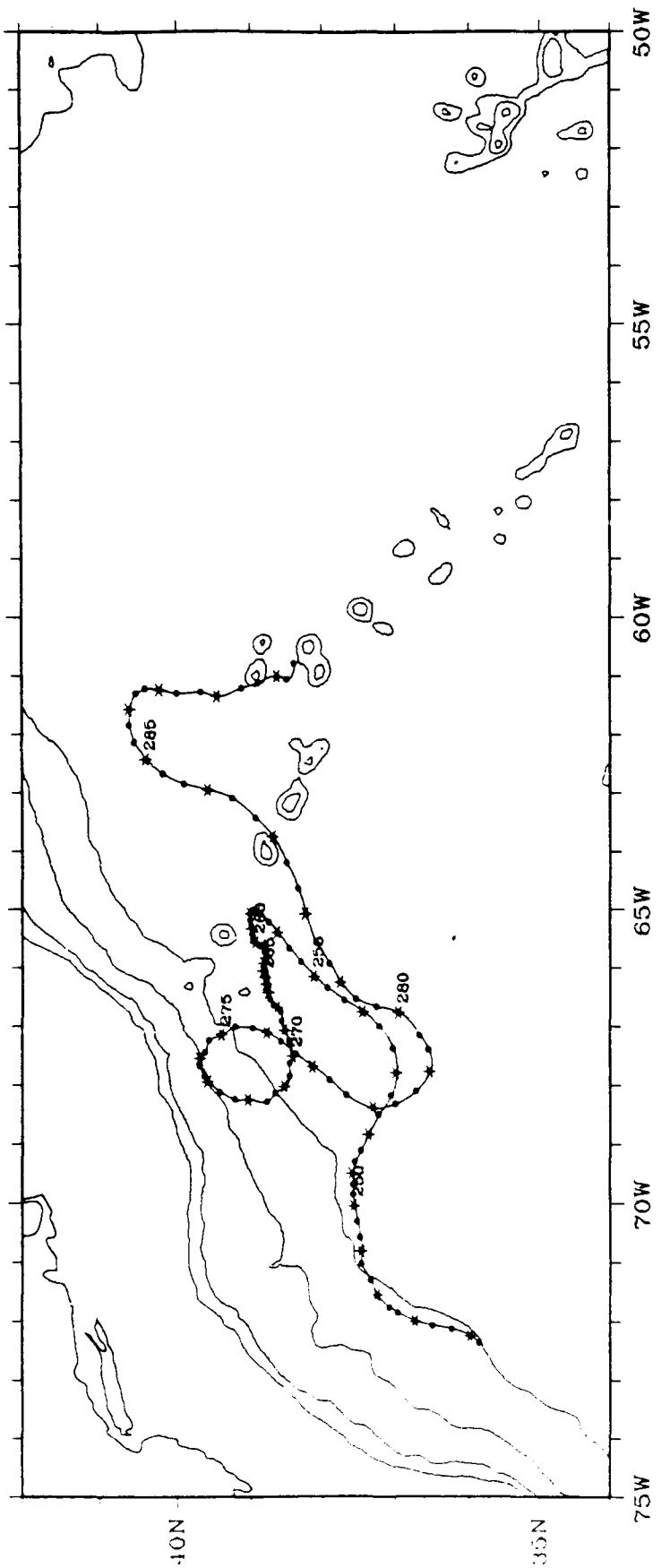
Float 206


Temperature(•)(°C)
18
17
16
15
14
13
12
280
270
260
250
240
230
Yearday
Float 206
Pressure(◂)(dbar)
400
500
600
700
800
900
1000

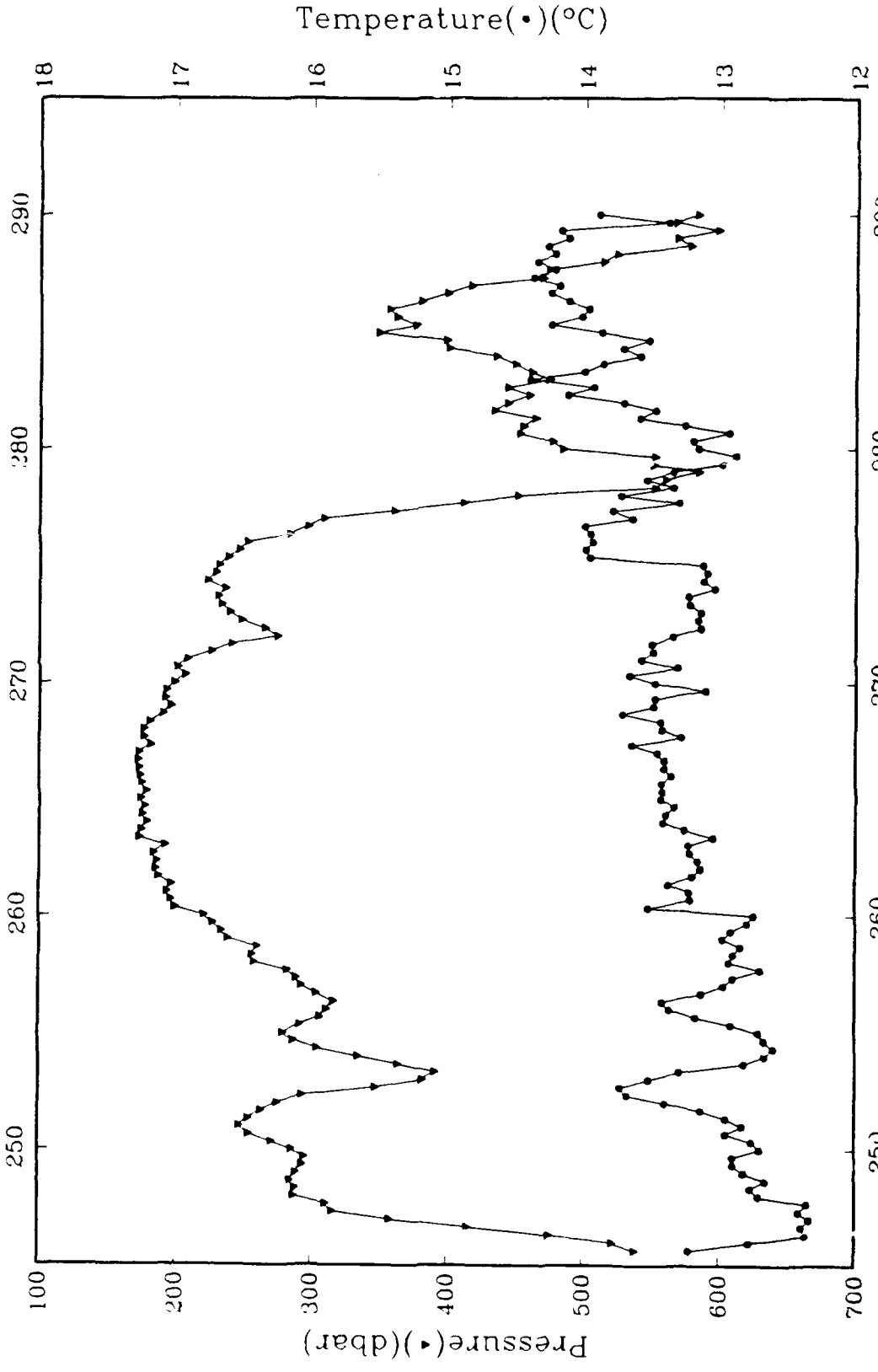


Float 207

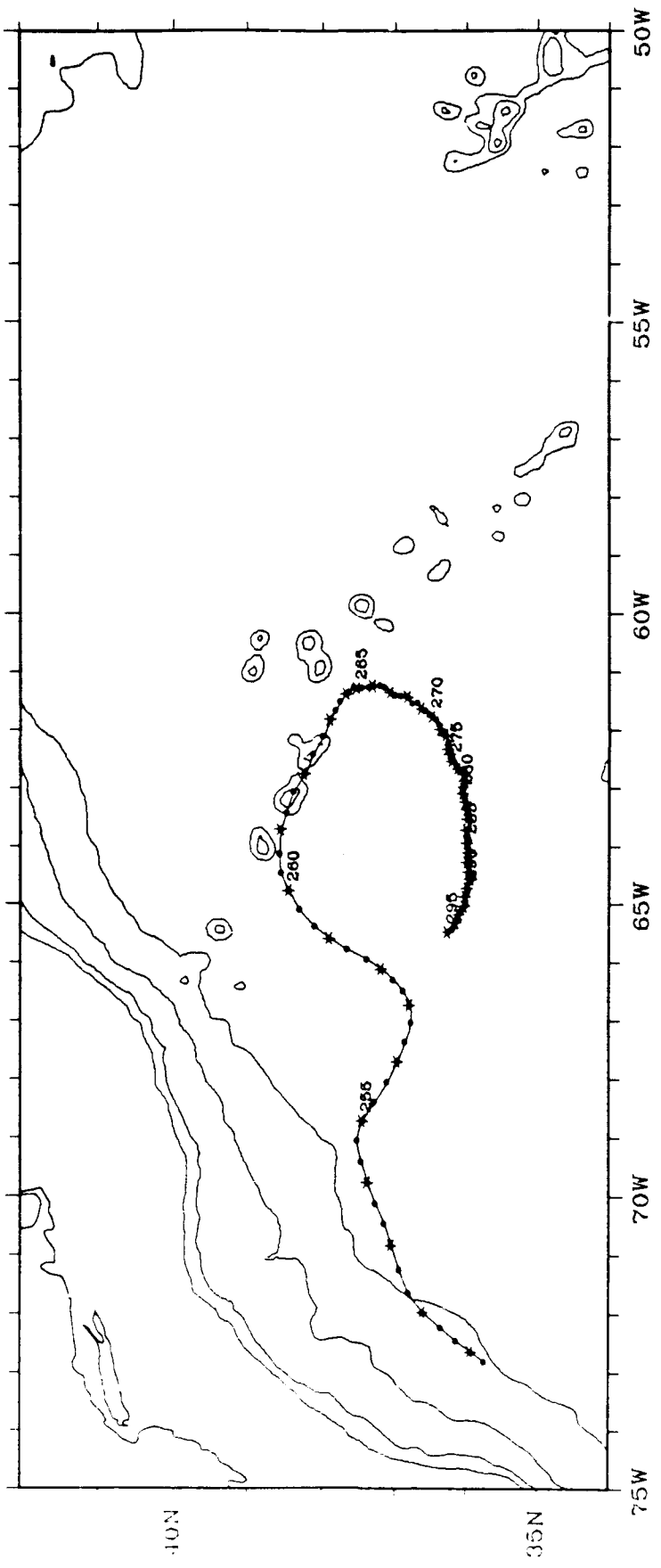

Temperature(•)(°C)
24
23
22
21
20
19
18
280
270
260
250
240
Yearday
0
100
200
300
400
500
600
Pressure(•)(dbar)
Float 207



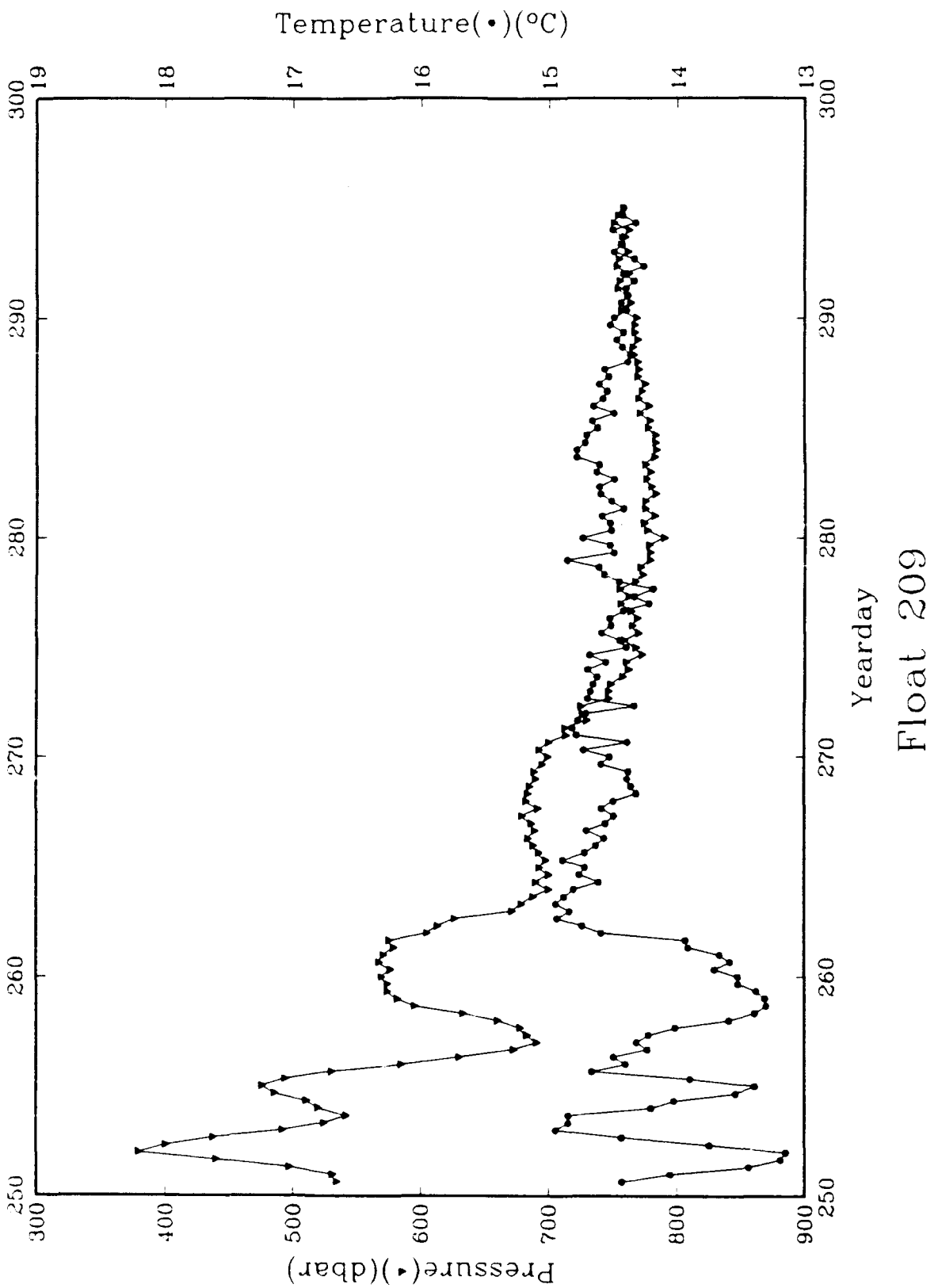
Float 208

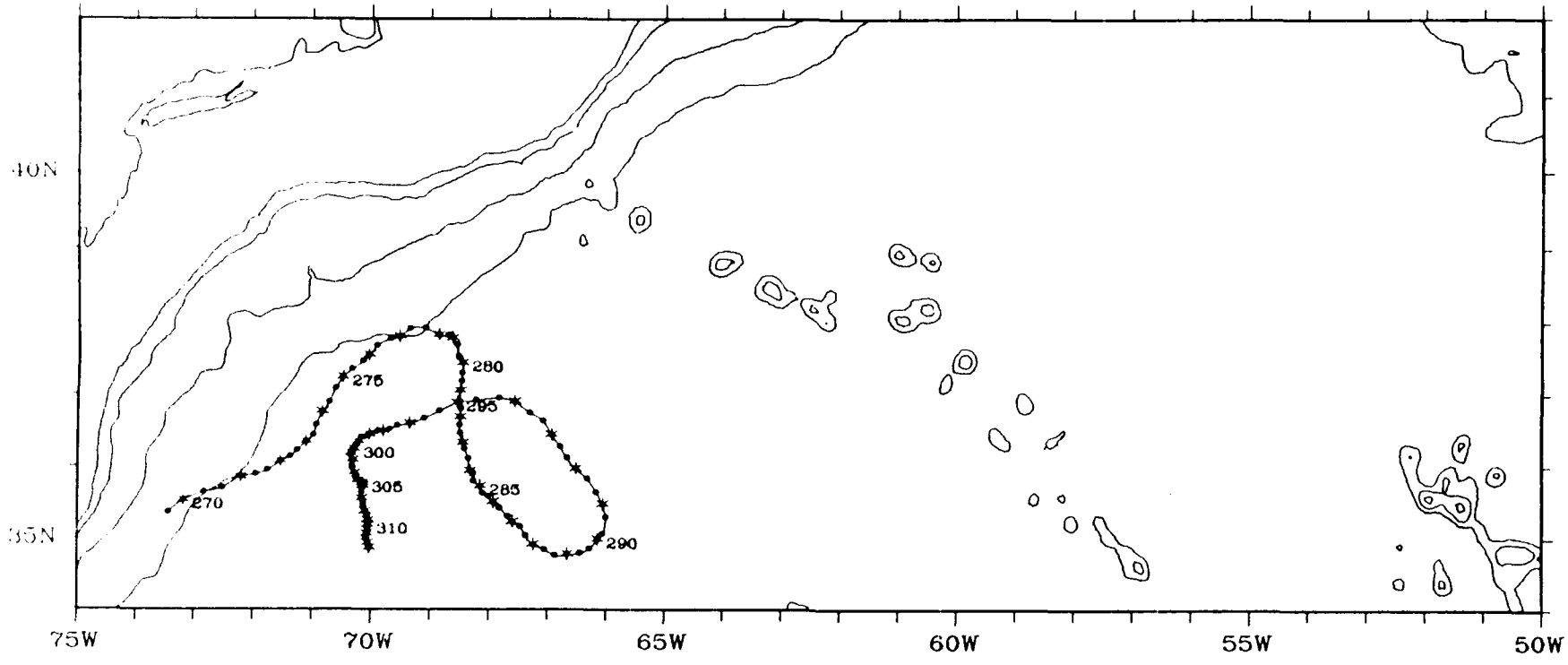

Temperature(•)(°C)
18
17
16
15
14
13
12
290
280
270
260
250
Yearday
Pressure(◂)(dbar)
100
200
300
400
500
600
700

Float 208

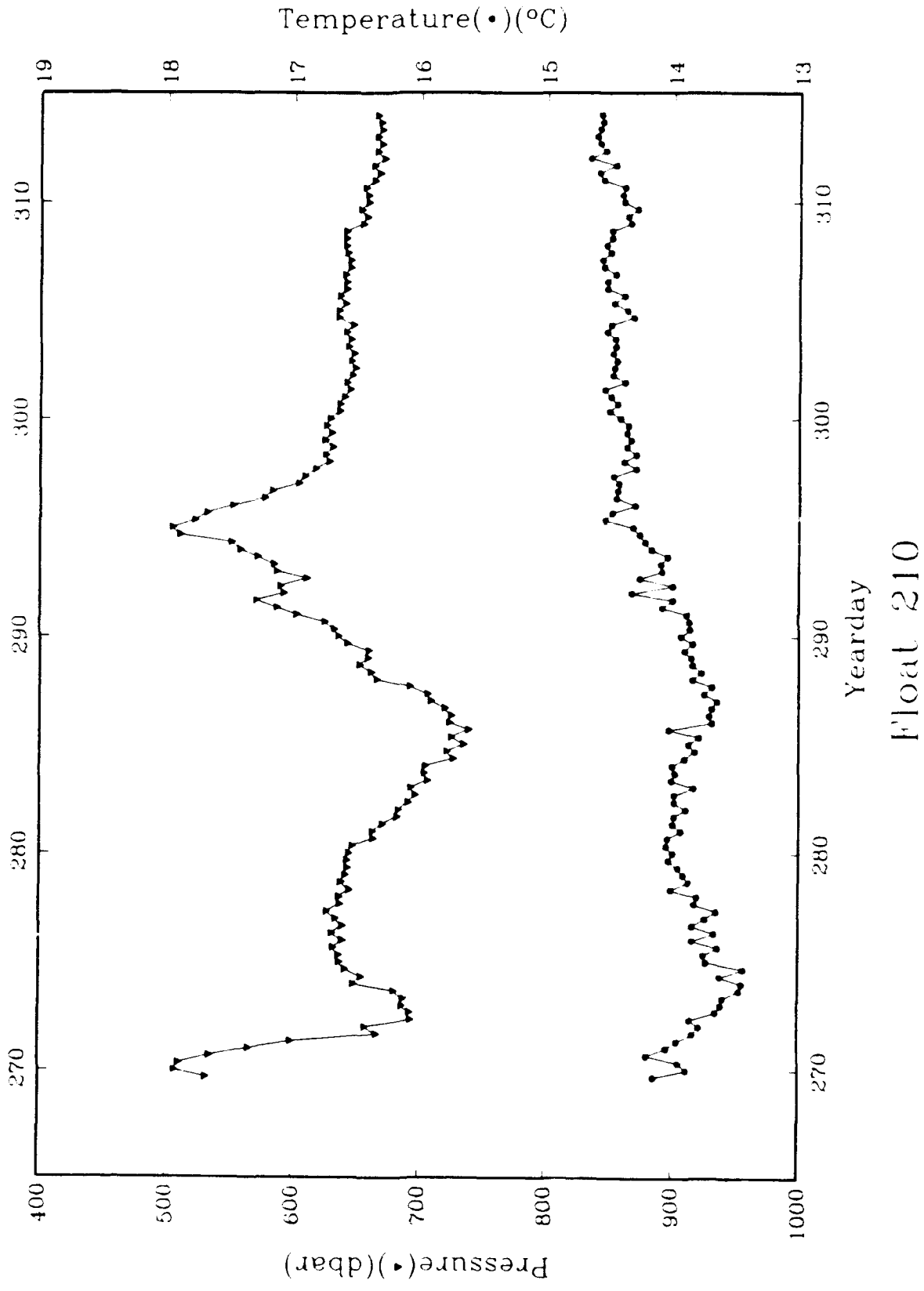


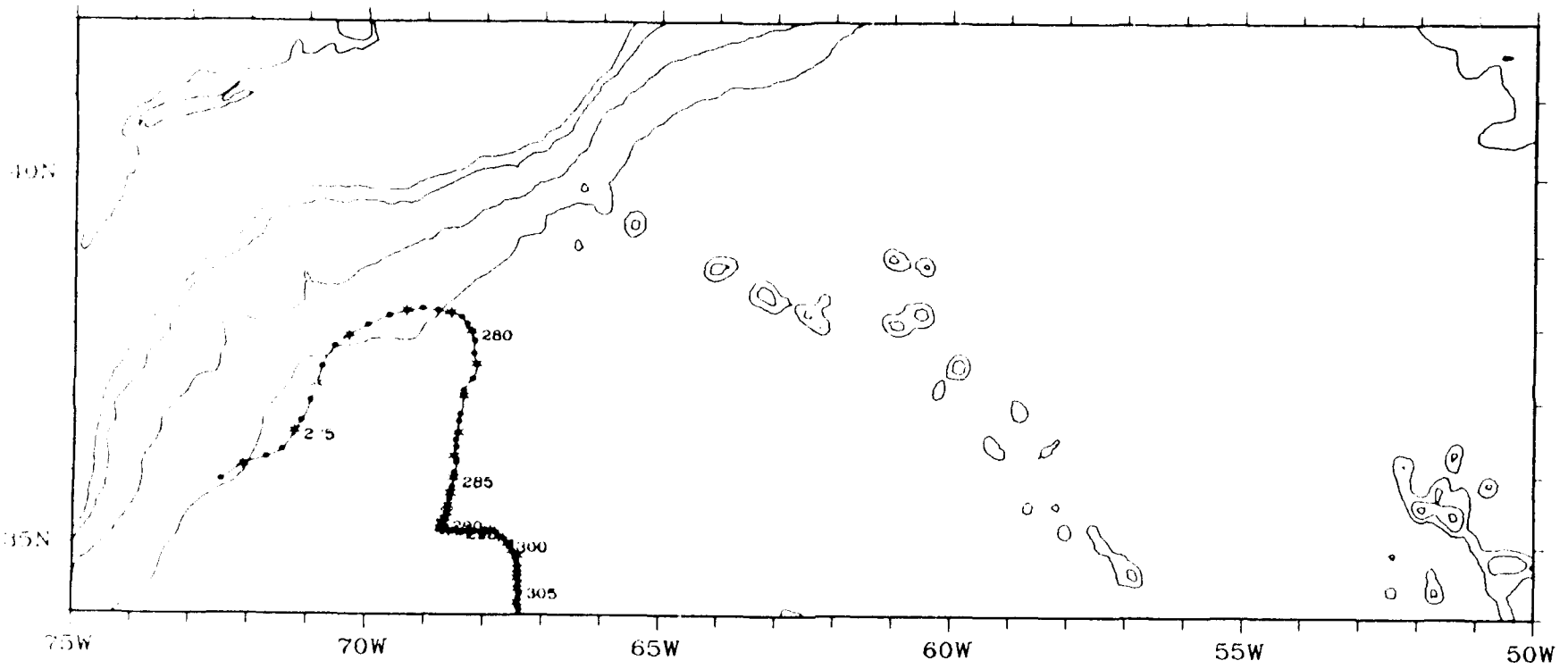
Float 209


Temperature(•)(°C)
19
18
17
16
15
14
13
300
290
280
270
260
250
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 209

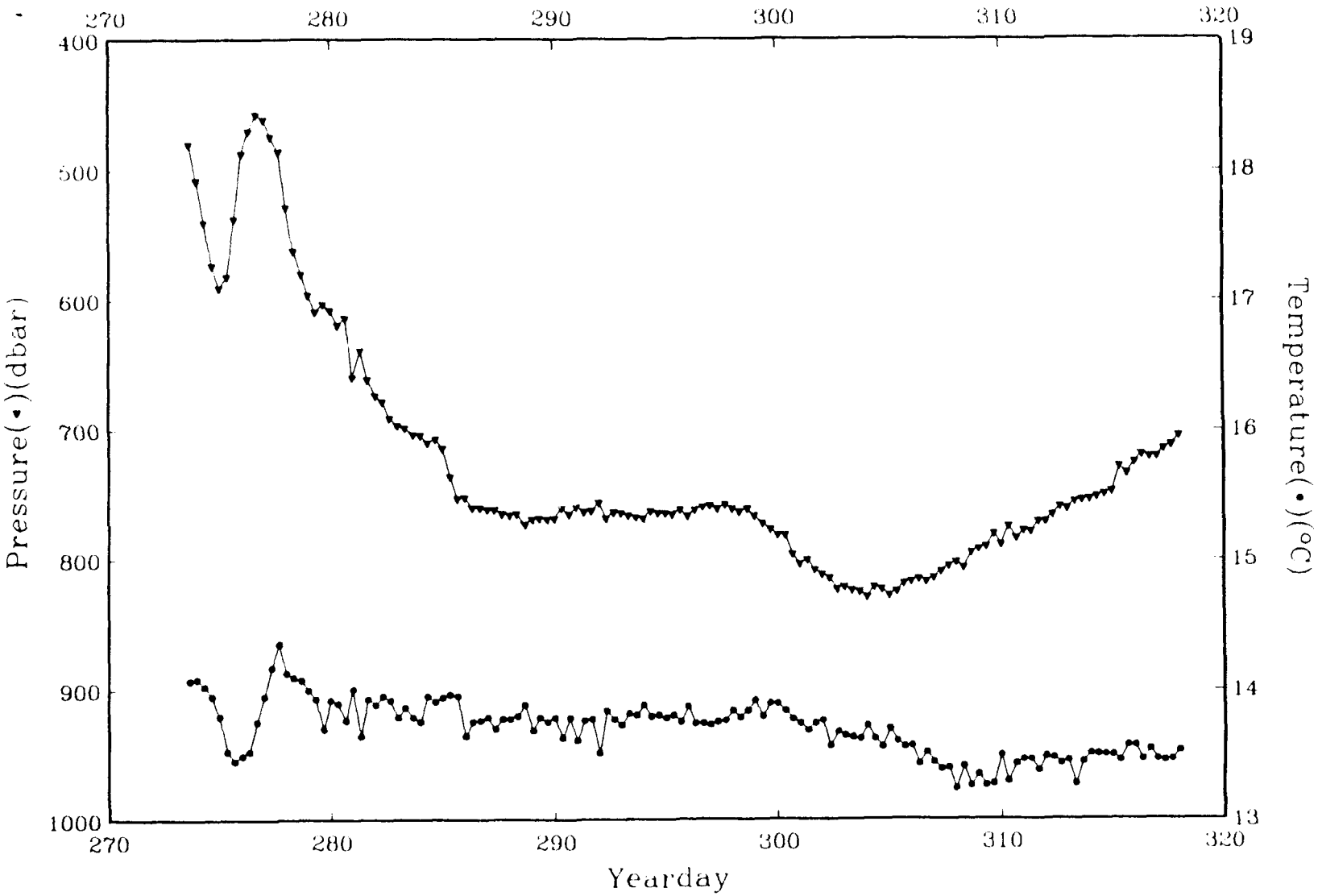


Float 210

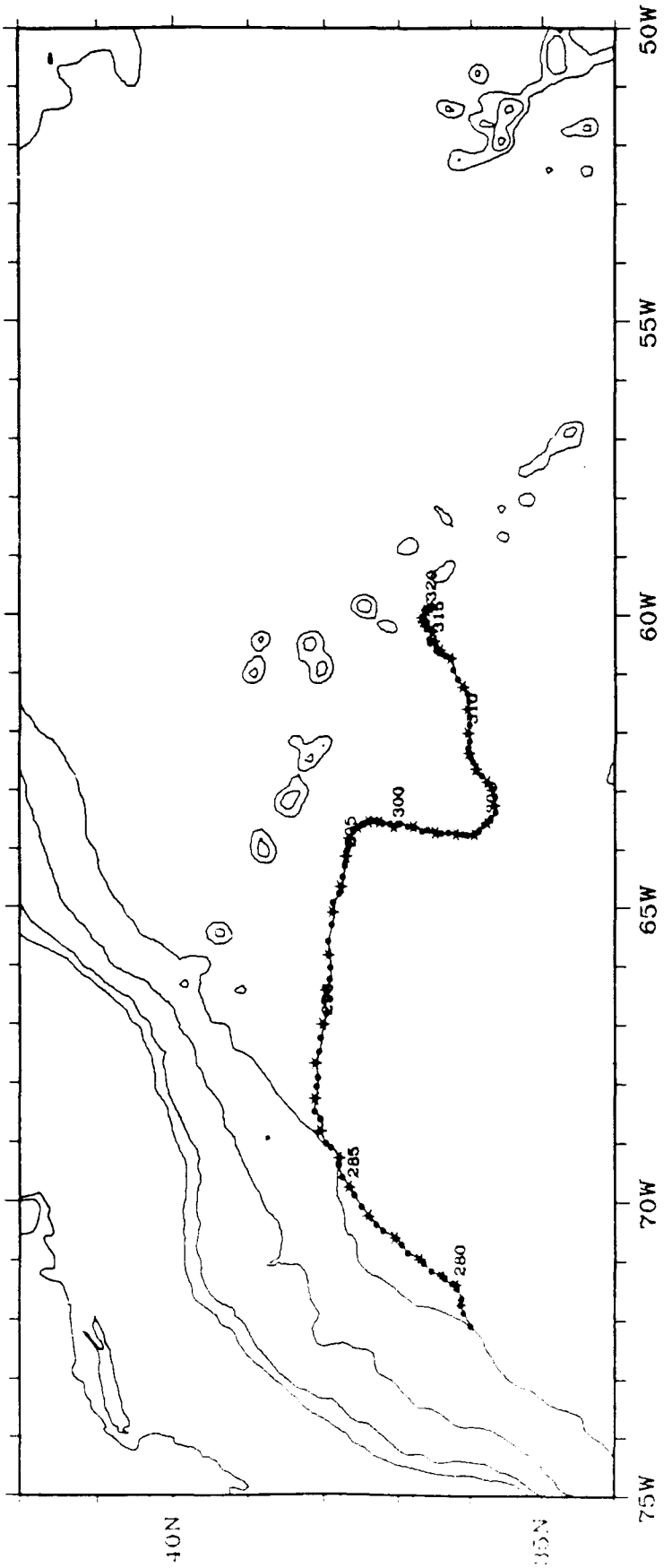

Temperature(•)(°C)
19
18
17
16
15
14
13
310
300
290
280
270
Yearday
Float 210
400
500
600
700
800
900
1000
Pressure(•)(dbar)



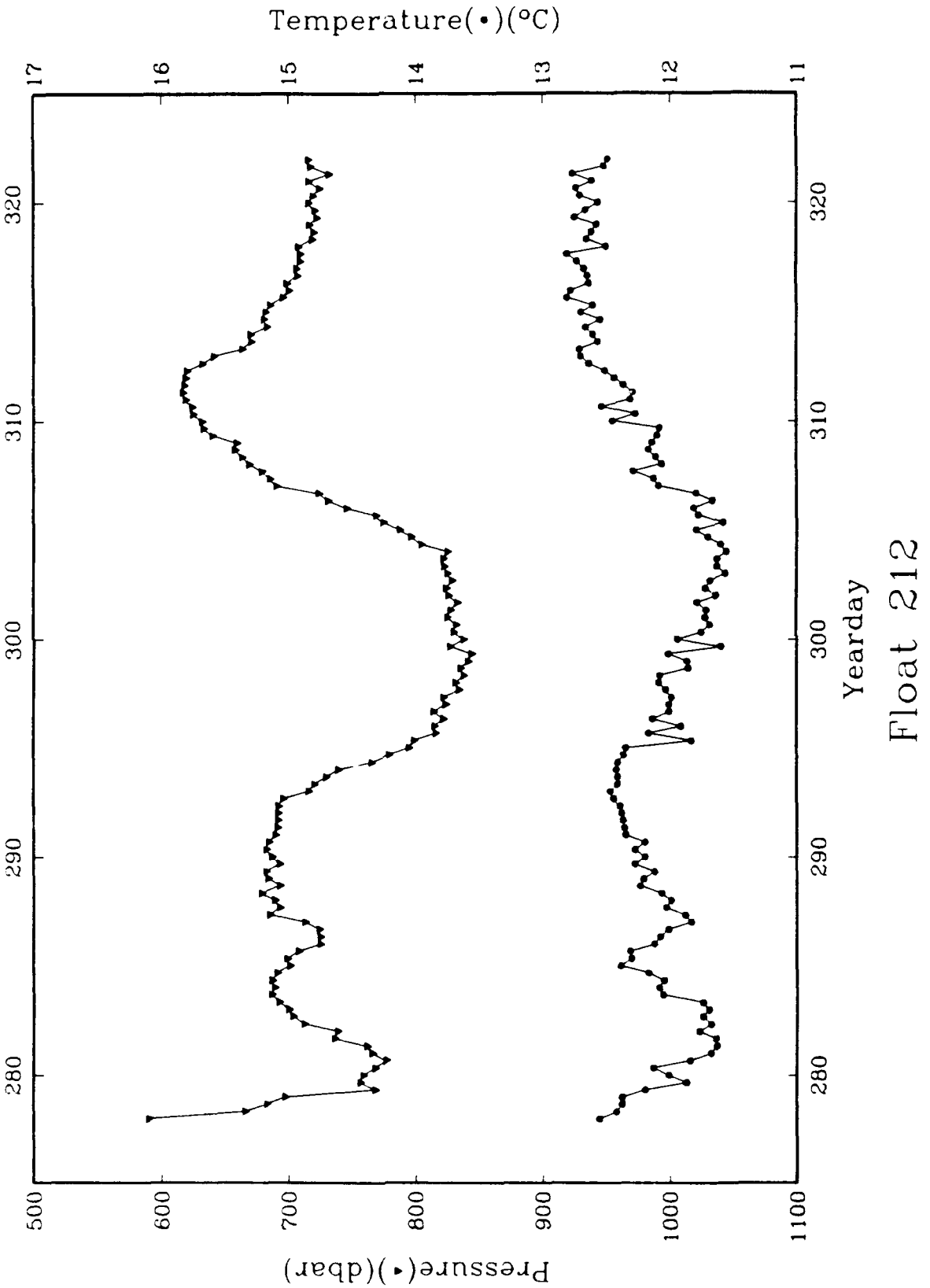
Float 211

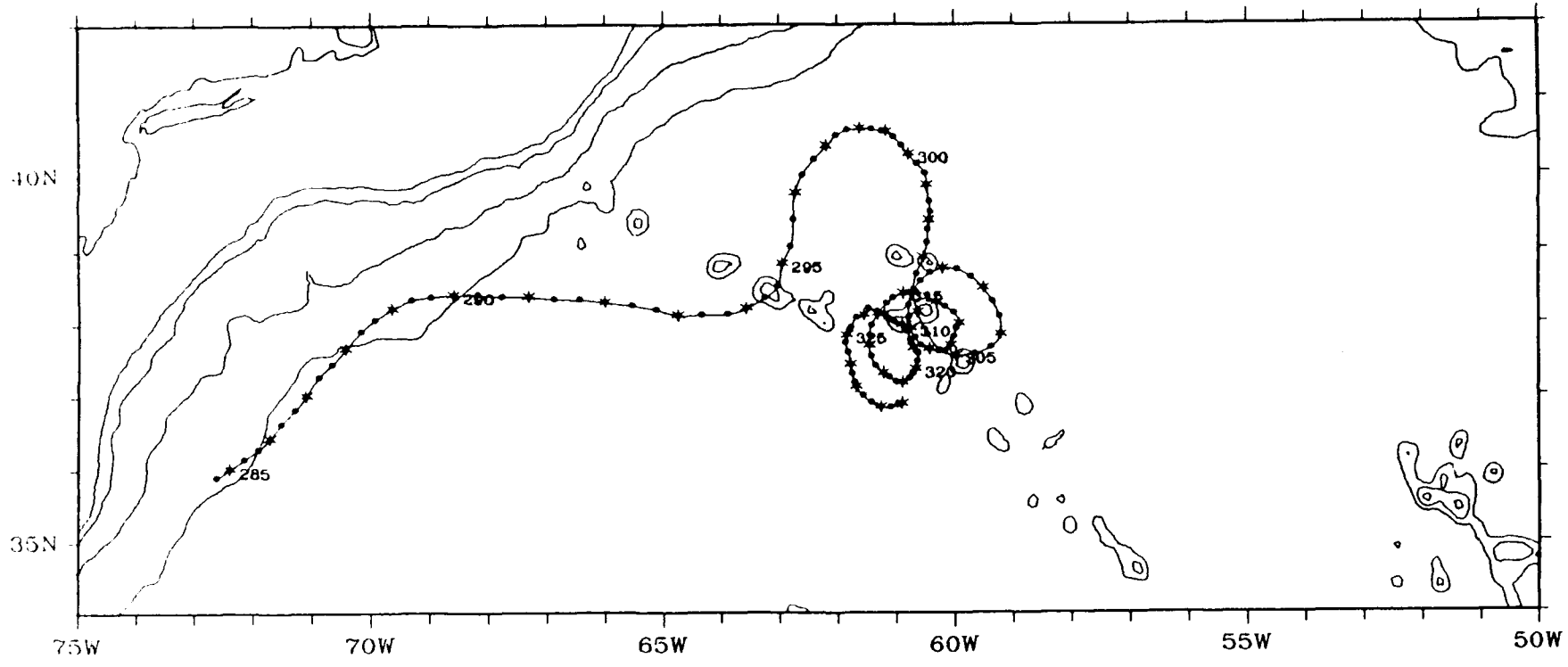

270
280
290
300
310
320
400
500
600
700
800
900
1000
Pressure(•)(dbar)
19
18
17
16
15
14
13
Temperature(•)(°C)
Yearday

Float 211

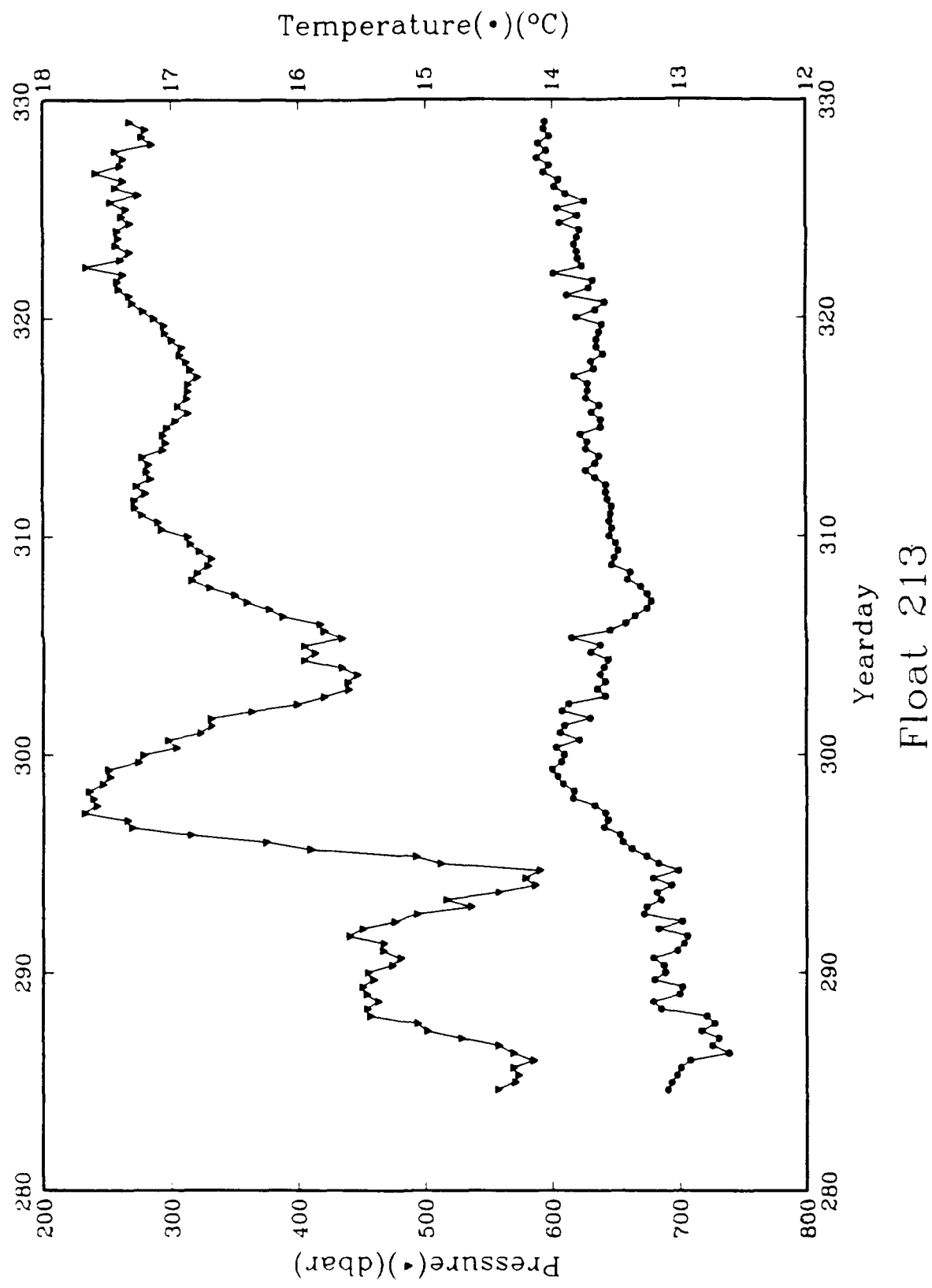


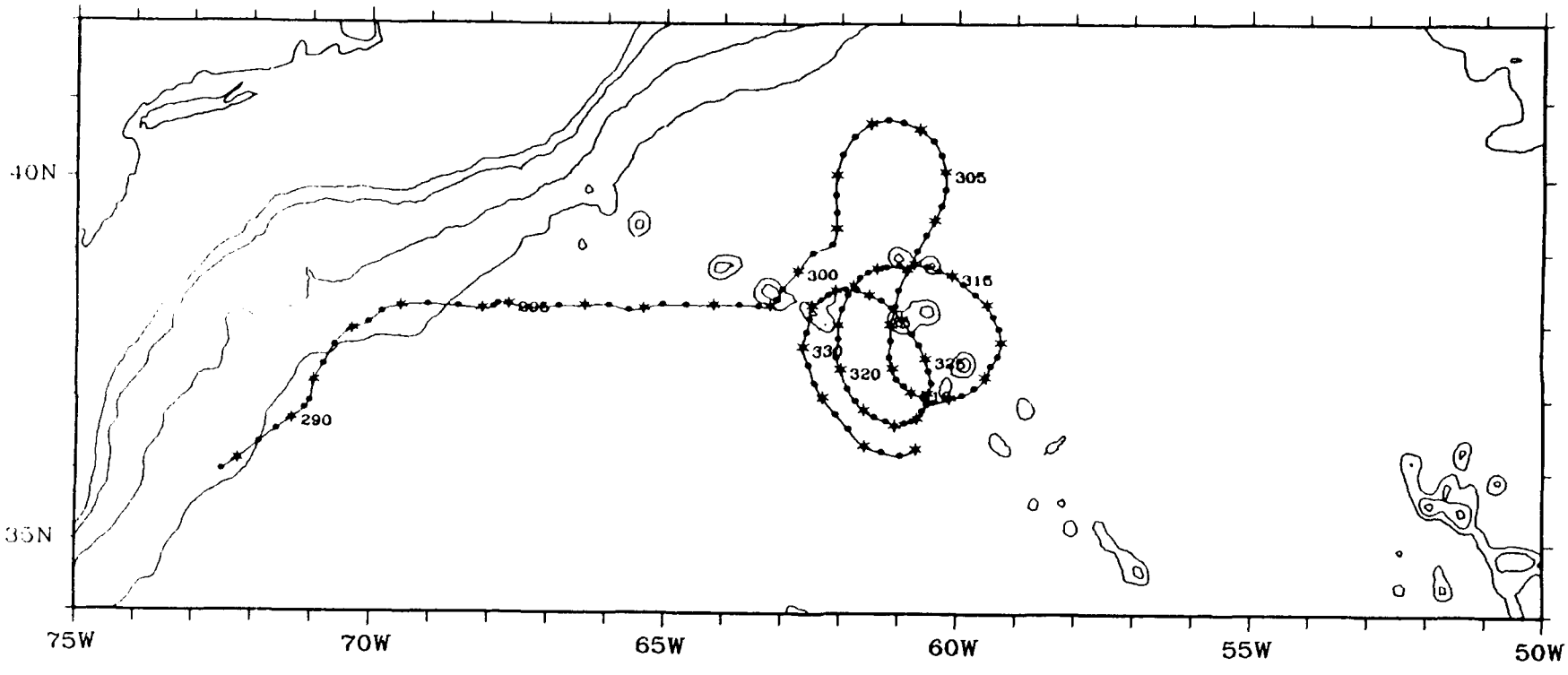
Float 212


Temperature(•)(°C)
17
16
15
14
13
12
11
320
310
300
290
280
Yearday
Float 212
500
600
700
800
900
1000
1100
Pressure(◂)(dbar)

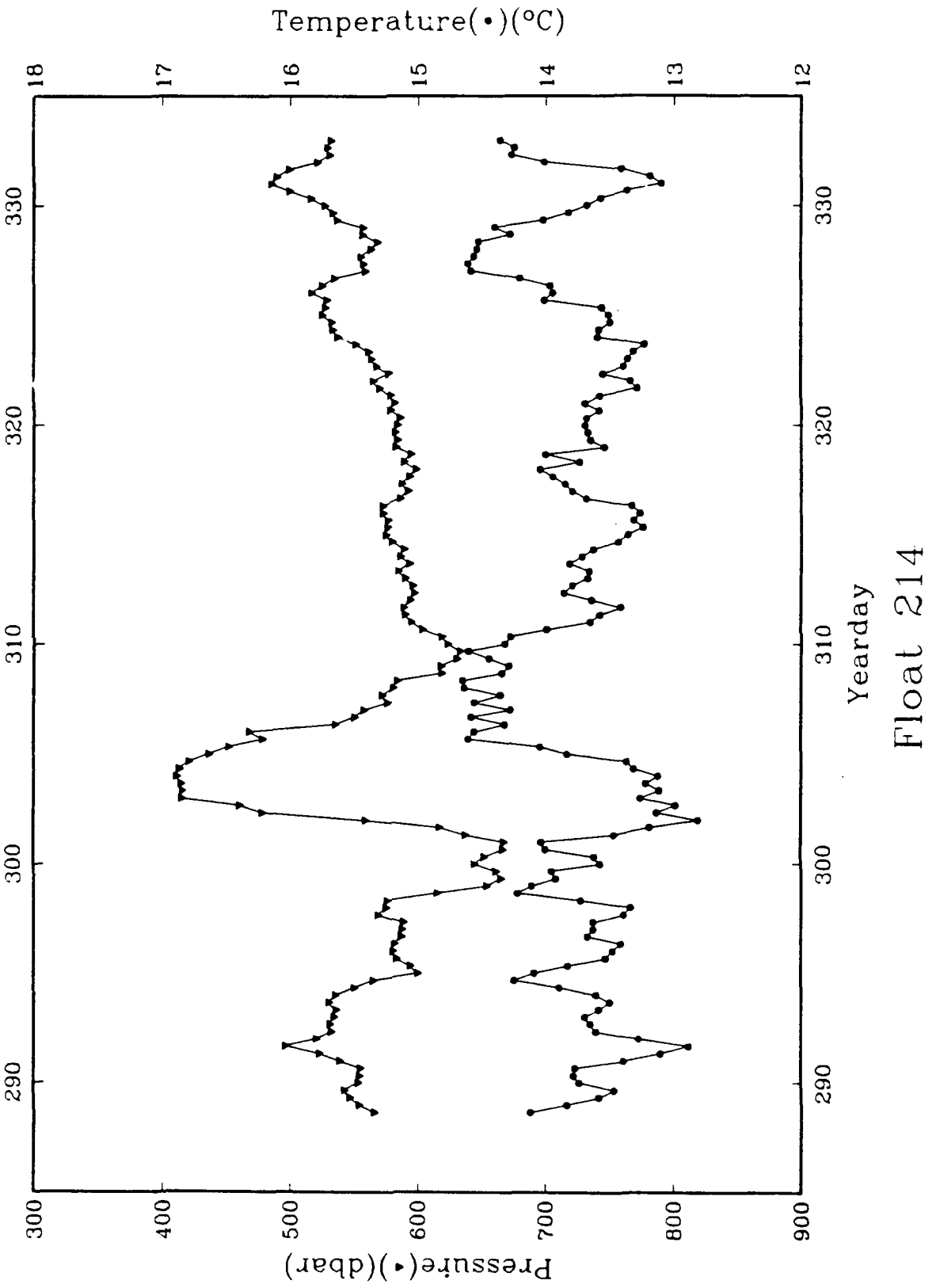

40N
35N
75W
70W
65W
60W
55W
50W
285
290
295
300
305
310
315
320
325

Float 213

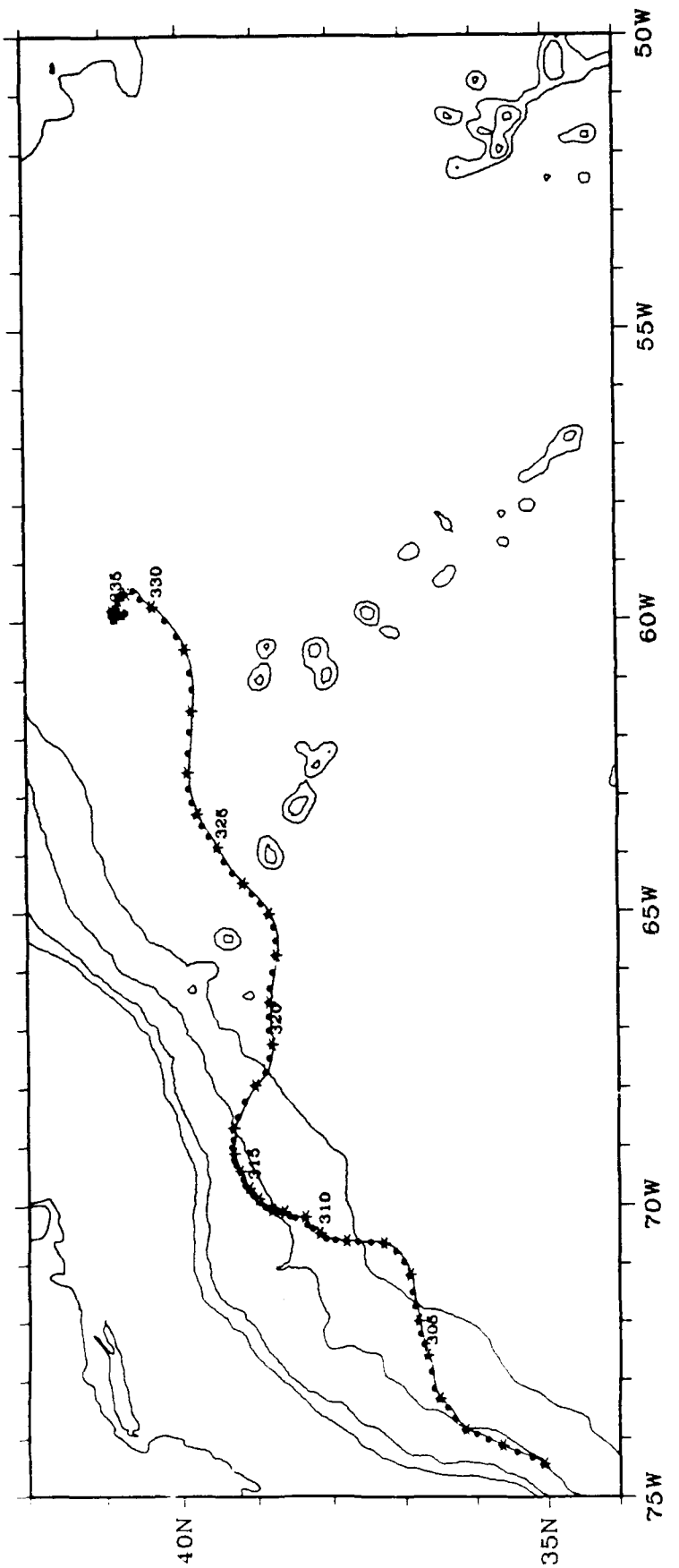

Temperature(•)(°C)
18
17
16
15
14
13
12
330
320
310
300
290
280
Yearday
Float 213
Pressure(◂)(dbar)
200
300
400
500
600
700
800



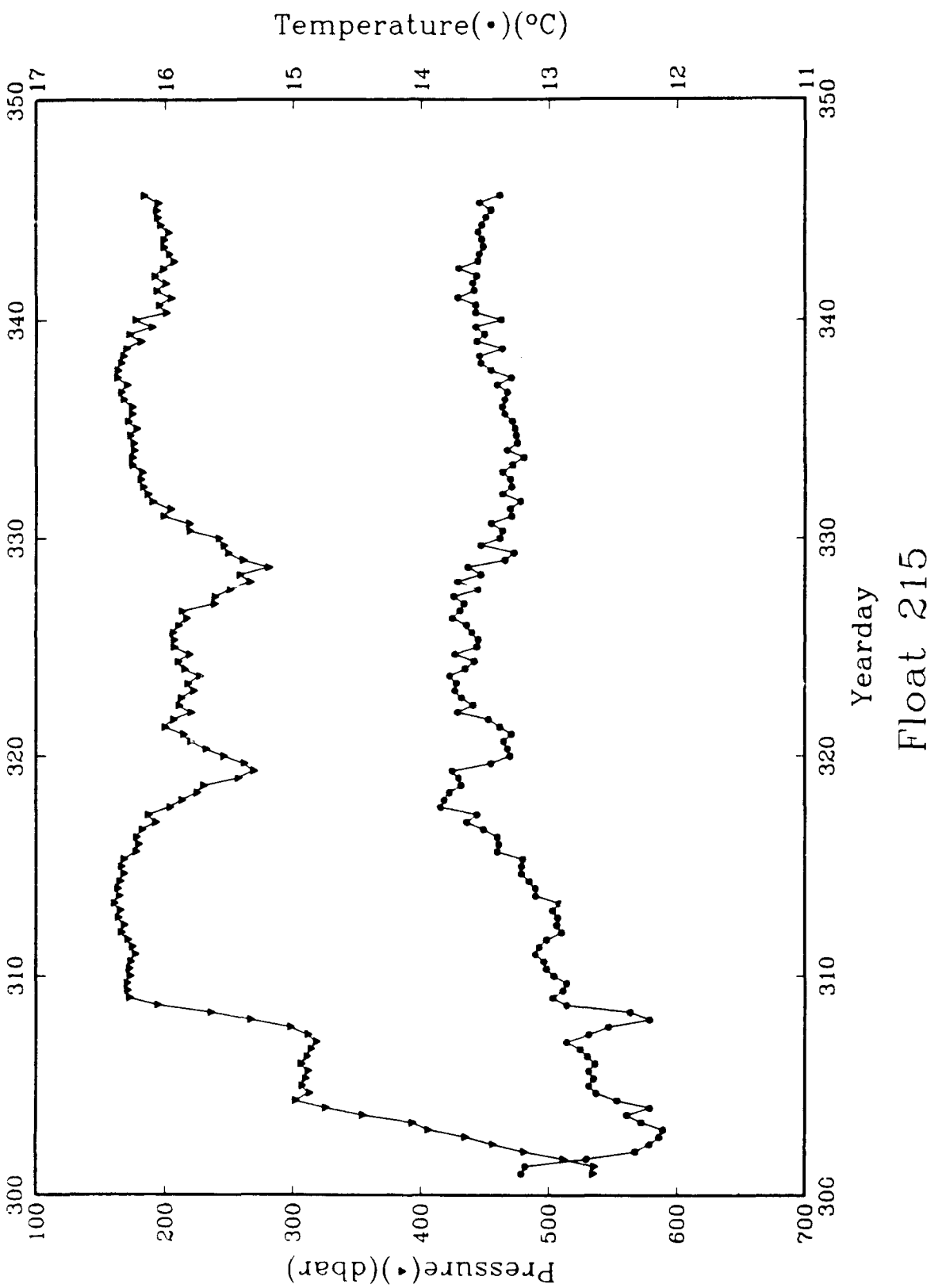
Float 214

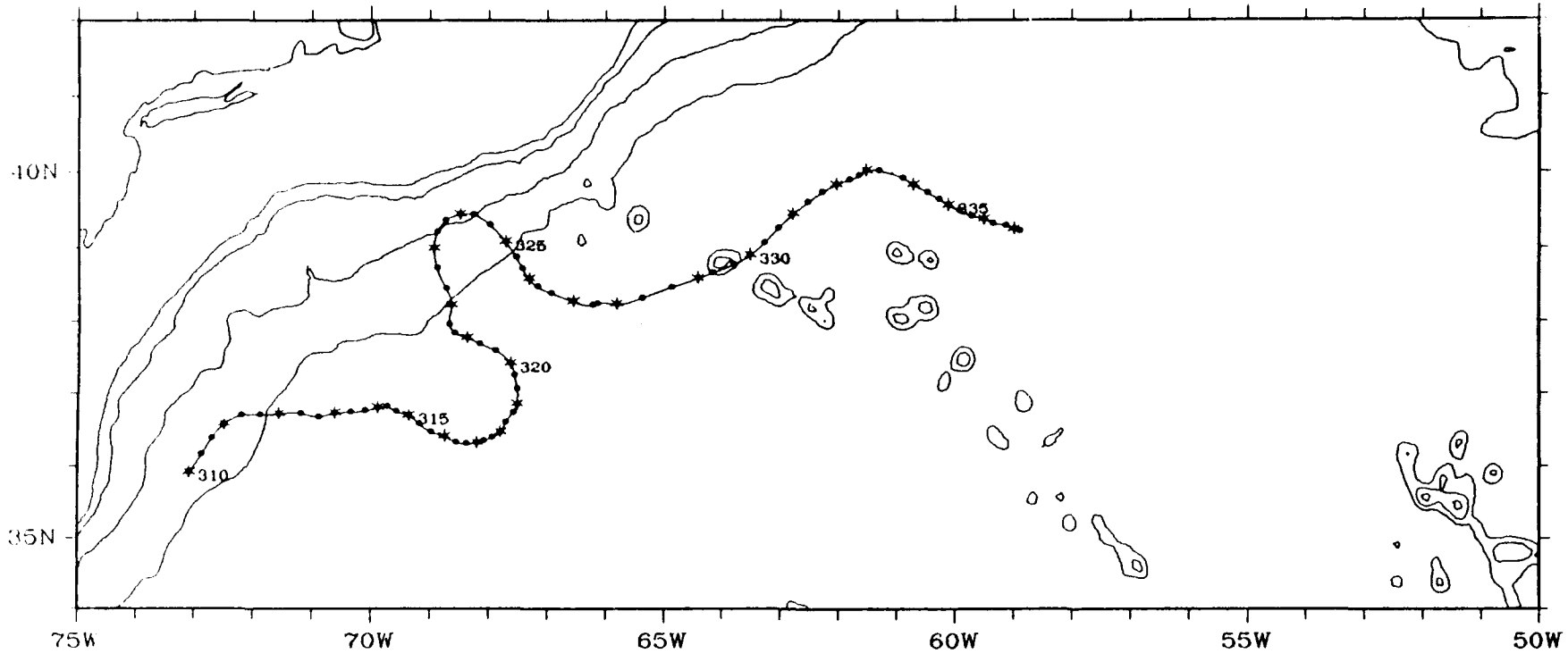

Temperature(•)(°C)
18
17
16
15
14
13
12
330
320
310
300
290
Yearday
300
400
500
600
700
800
900
Pressure(•)(dbar)

Float 214

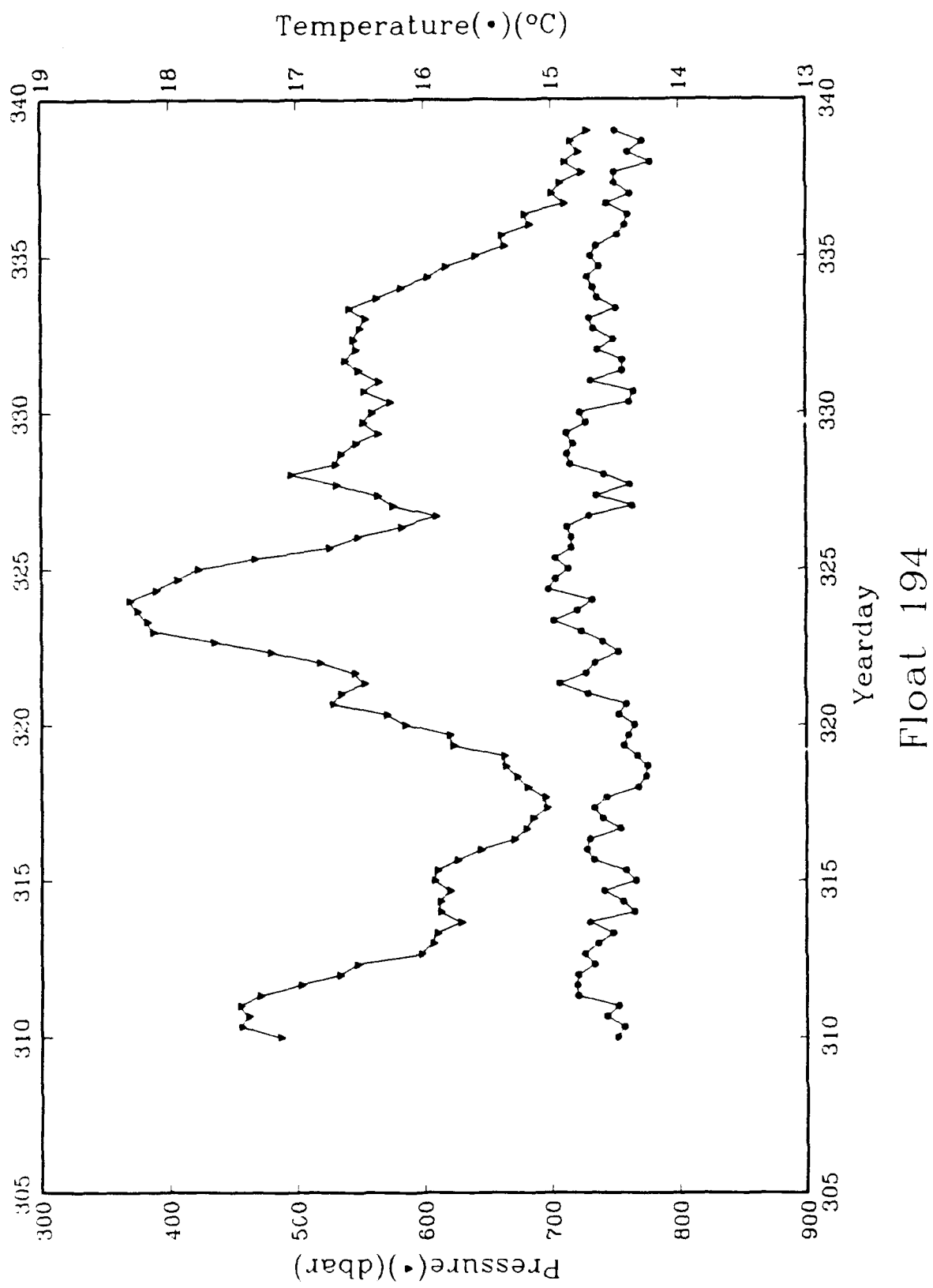


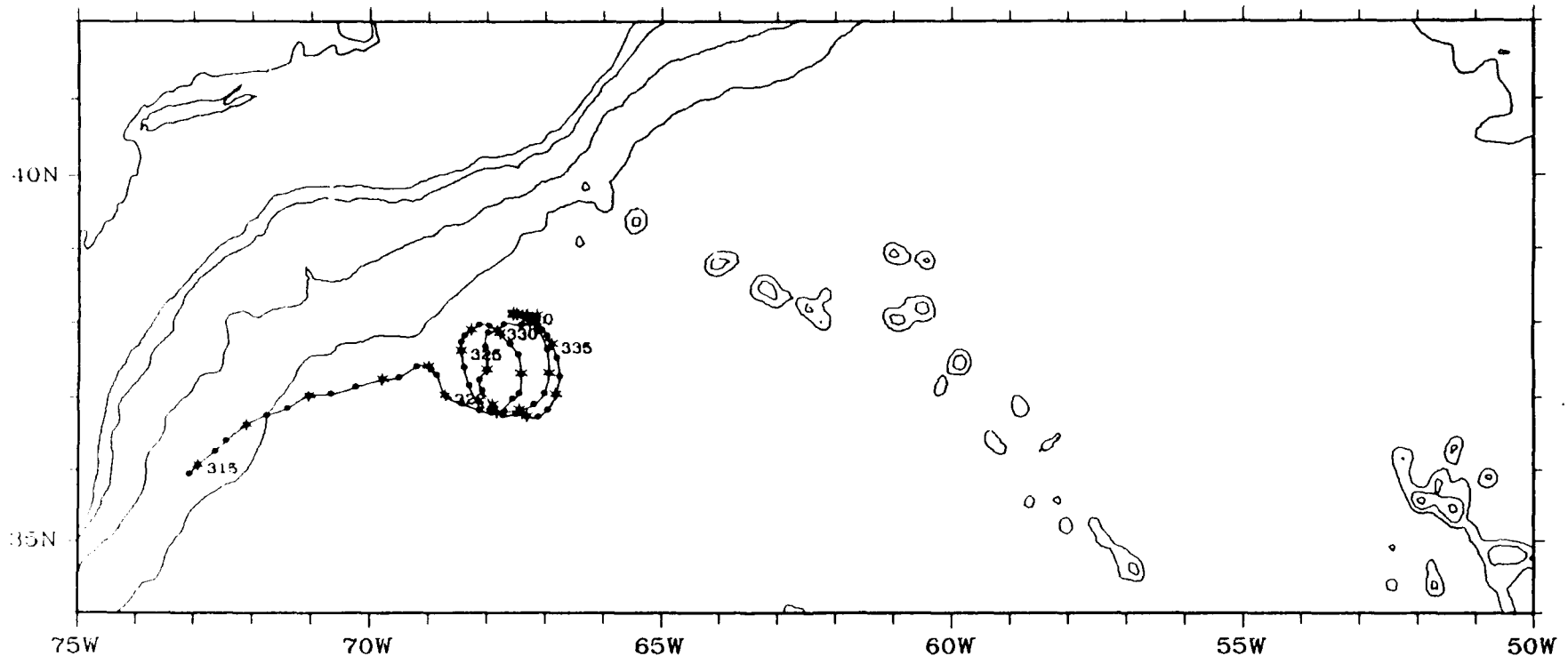
Float 215


Temperature(•)(°C)
17
16
15
14
13
12
11
350
340
330
320
310
300
Yearday
Pressure(◂)(dbar)
100
200
300
400
500
600
700
Float 215

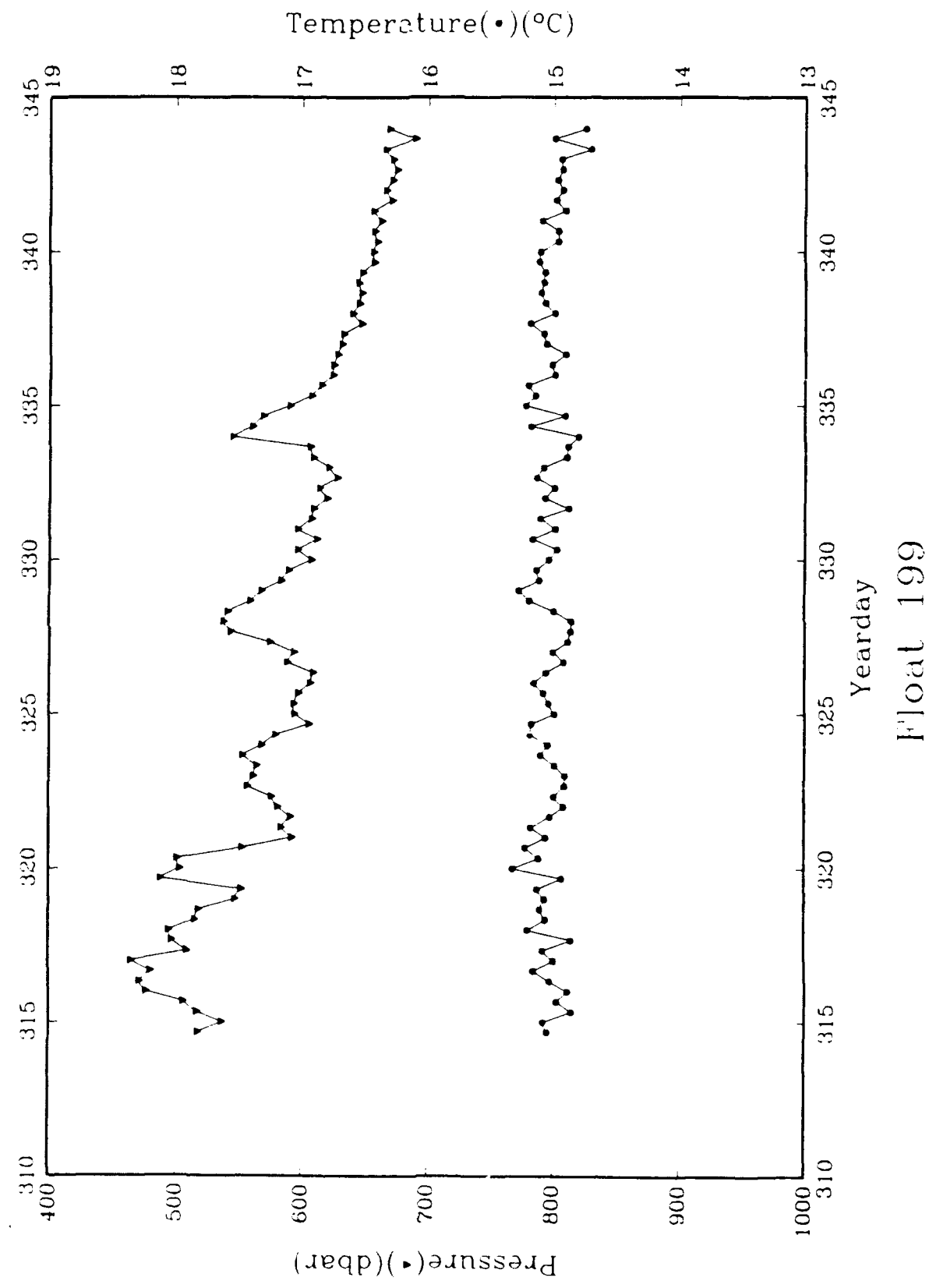


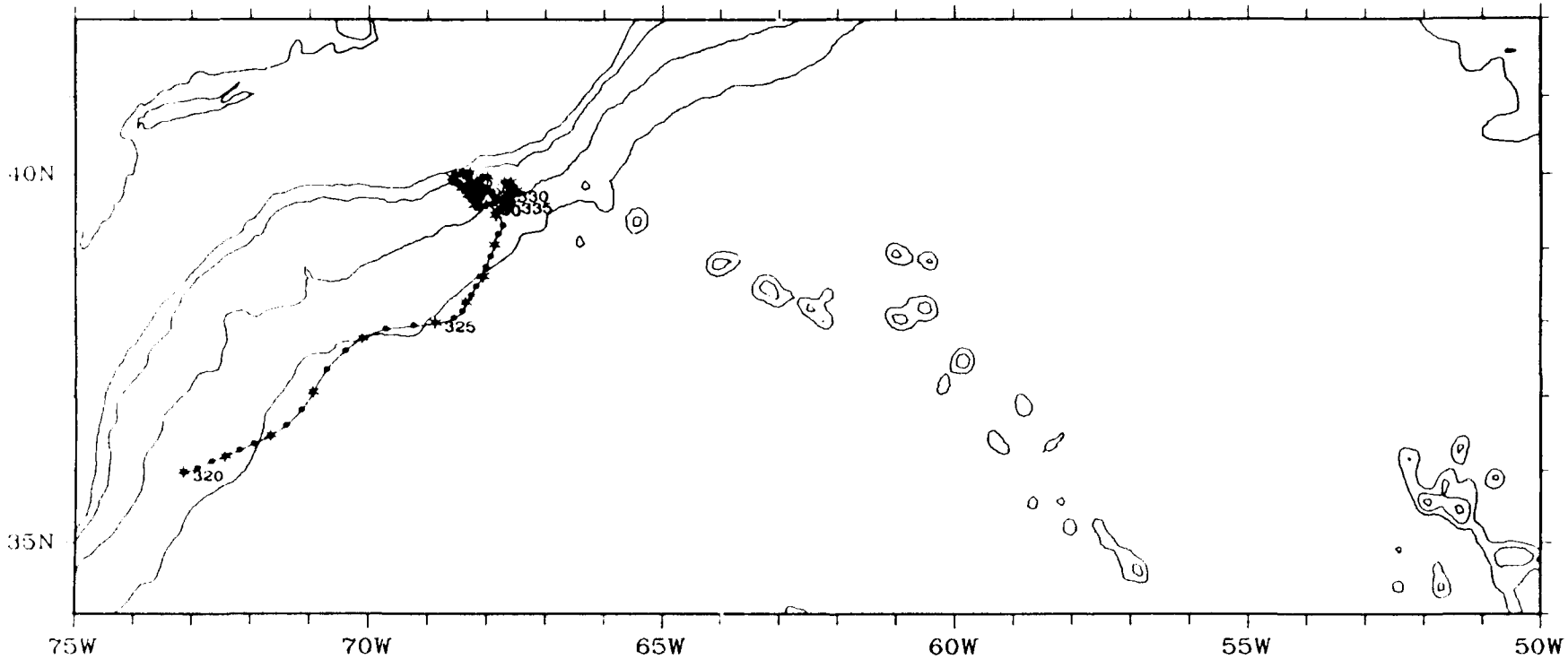
Float 194


Temperature(•)(°C)
19
18
17
16
15
14
13
340
335
330
325
320
315
310
305
Yearday
Pressure(•)(dbar)
300
400
500
600
700
800
900
Float 194

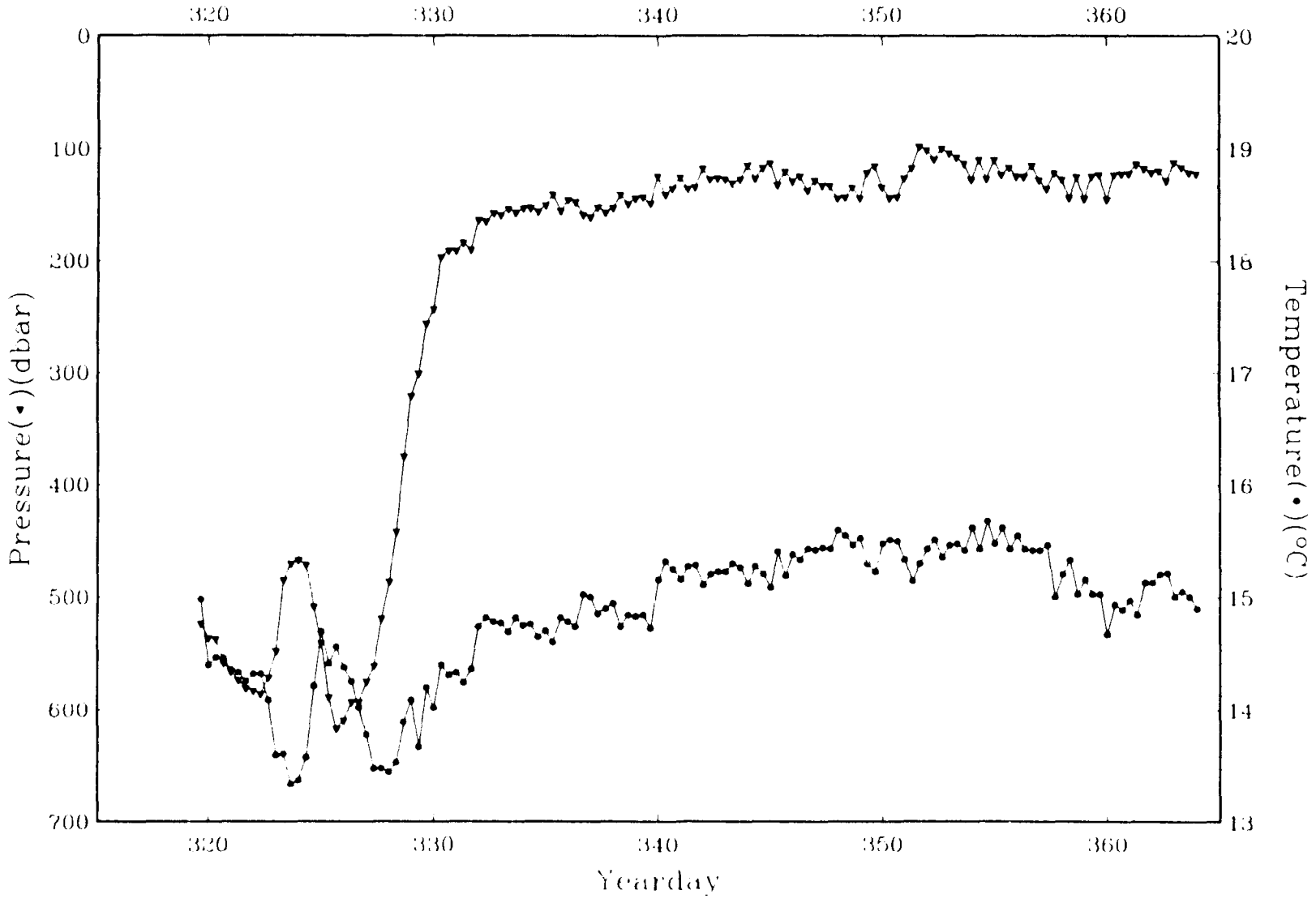


Float 199

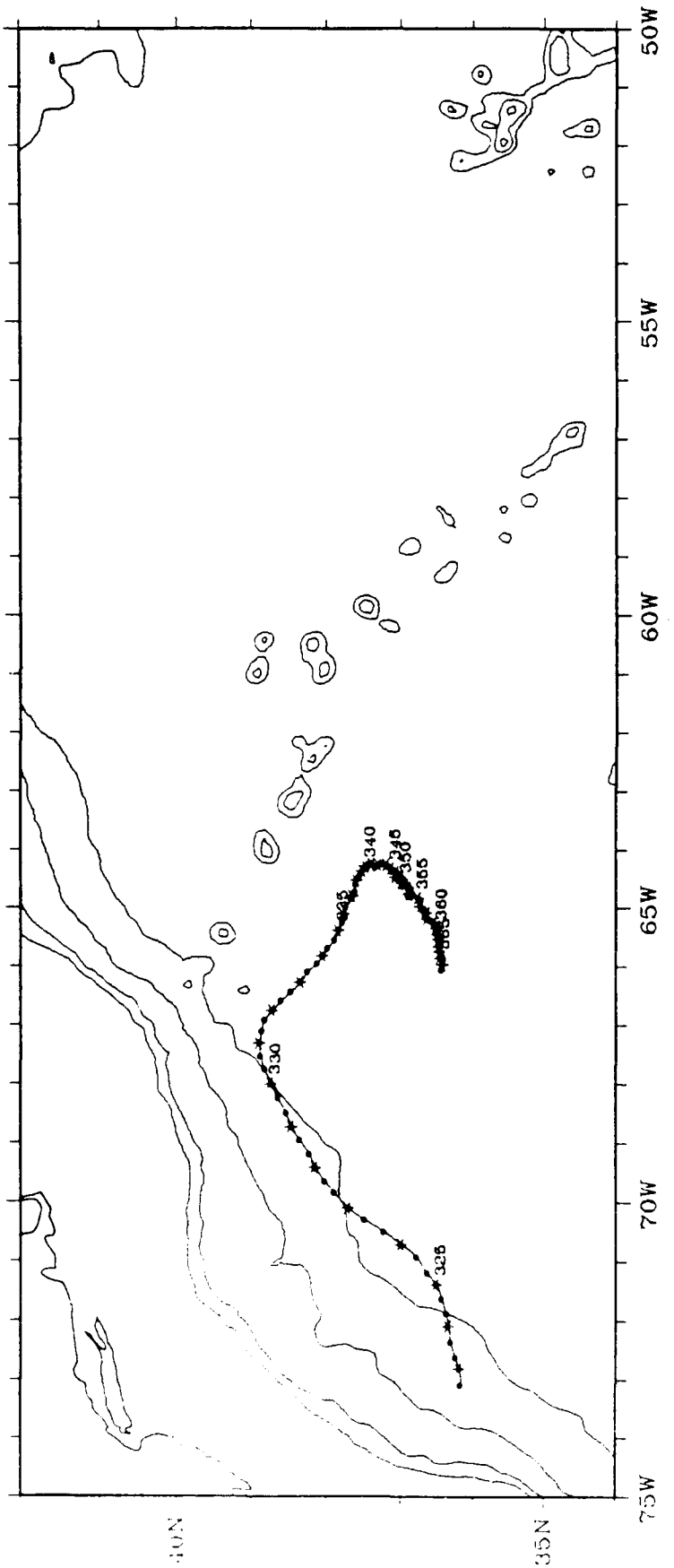

Temperature(•)(°C)
19
18
17
16
15
14
13
345
340
335
330
325
320
315
310
Yearday
Float 199
Pressure(◂)(dbar)
400
500
600
700
800
900
1000



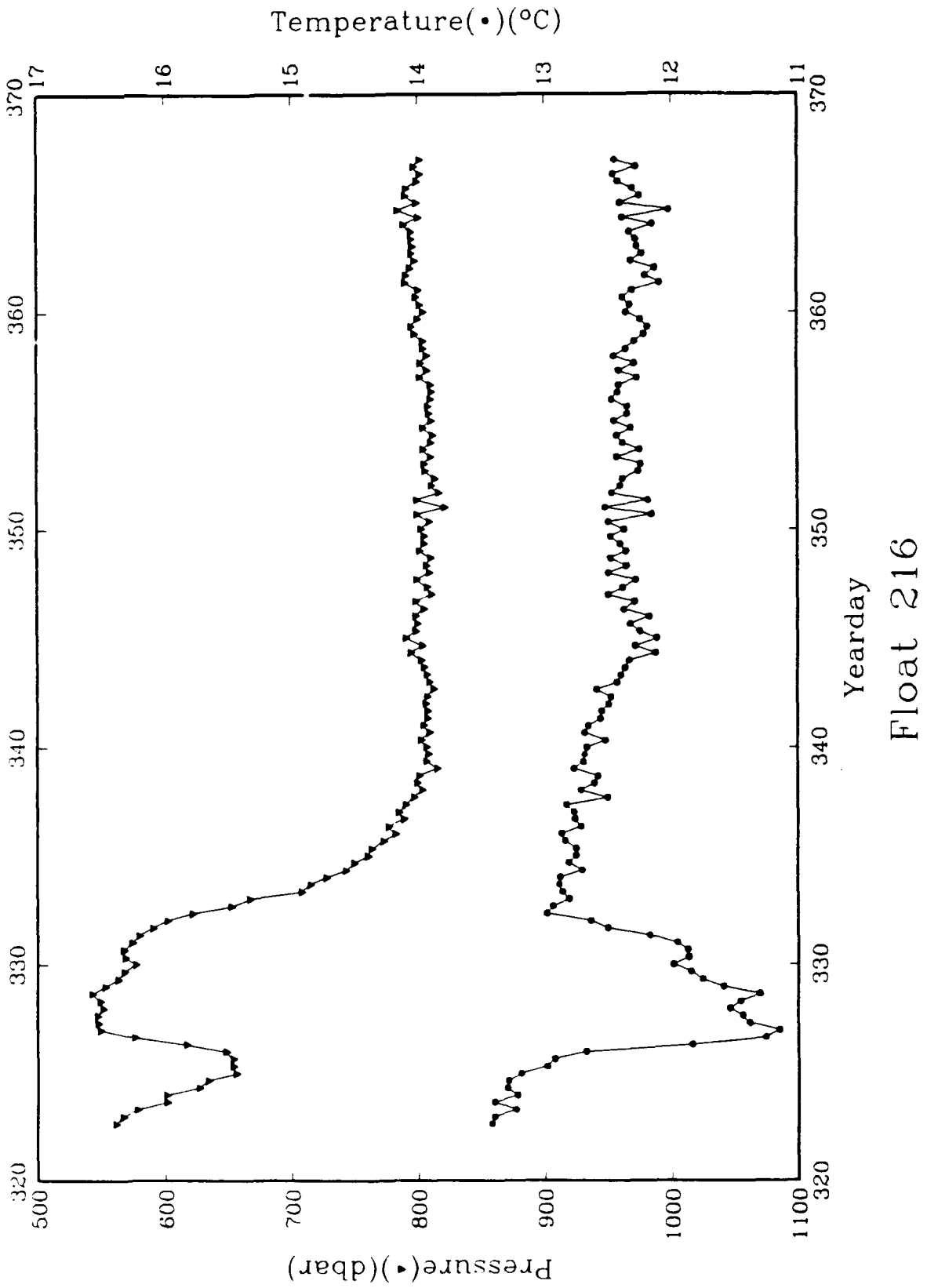
Float 201

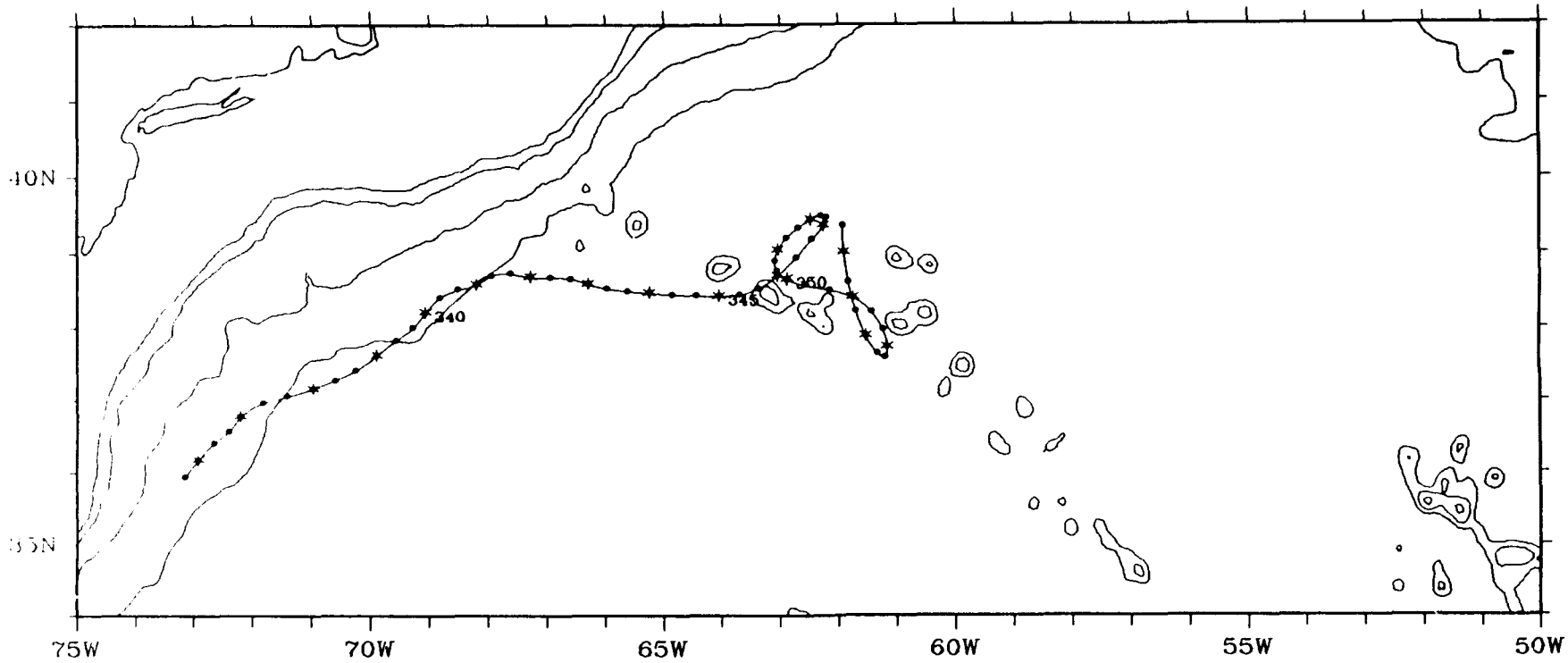

320
330
340
350
360
0
100
200
300
400
500
600
700
20
19
18
17
16
15
14
13
Pressure(•)(dbar)
Temperature(•)(°C)
Yearday

Float 201

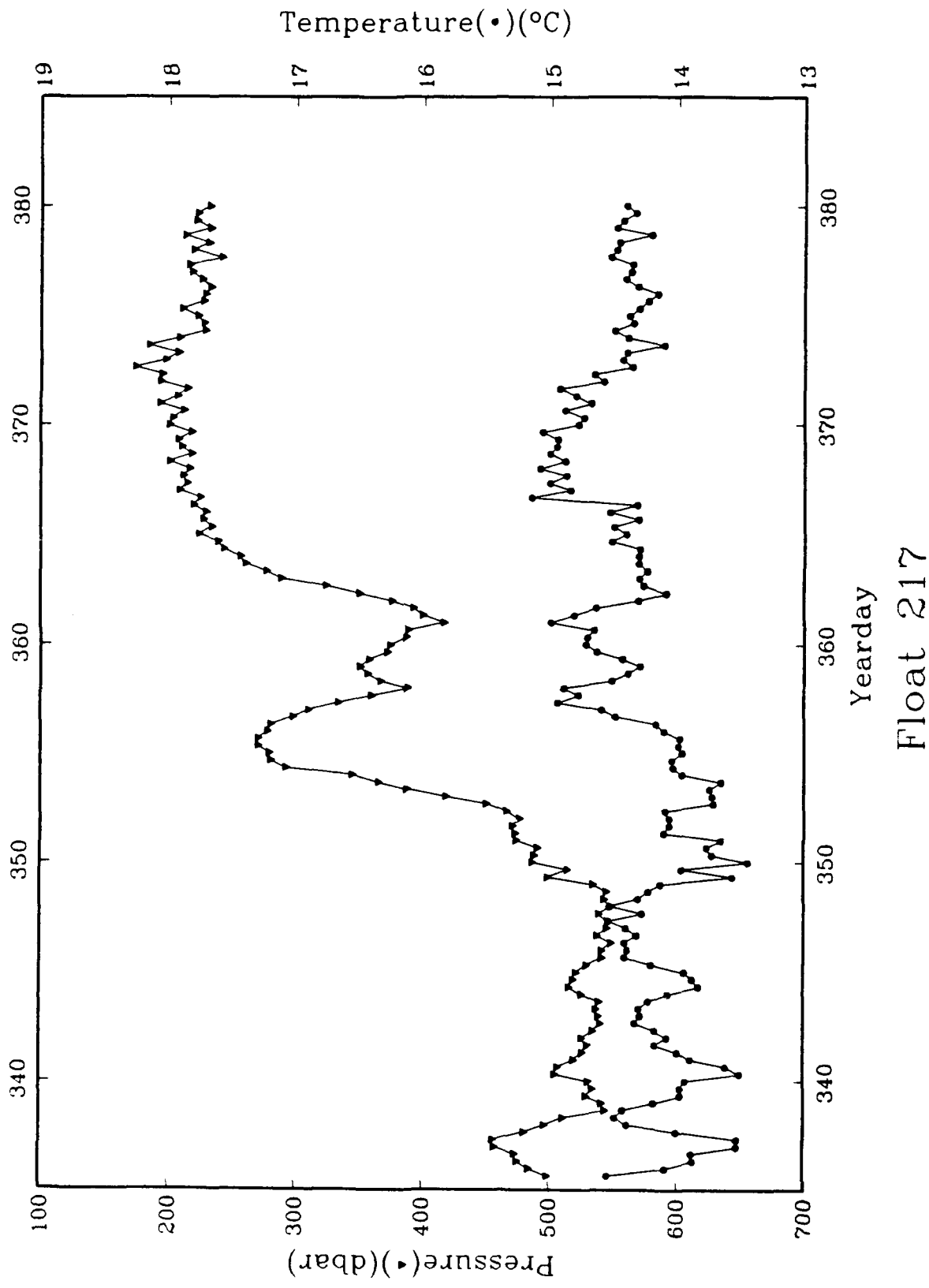


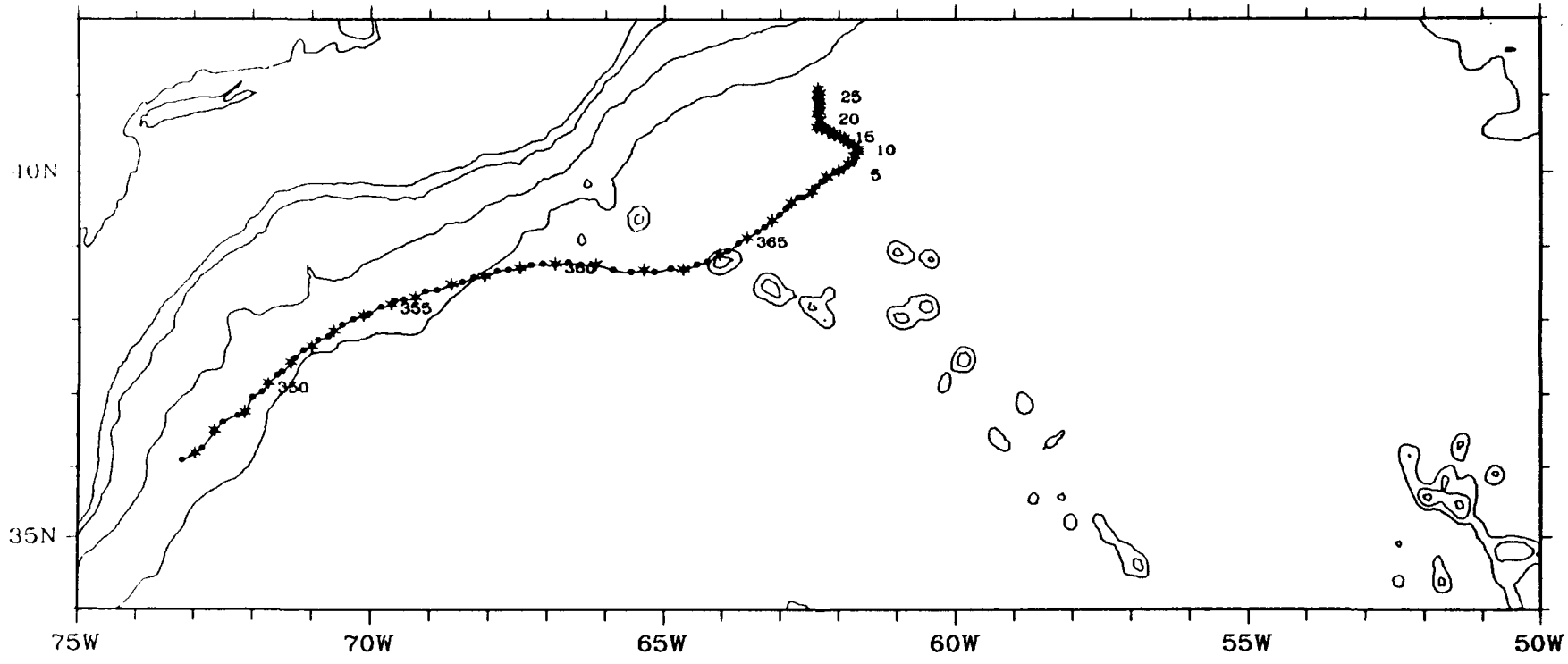
Float 216


Temperature(•)(°C)
17
16
15
14
13
12
11
370
360
350
340
330
320
500
600
700
800
900
1000
1100
Pressure(◂)(dbar)
Yearday
Float 216

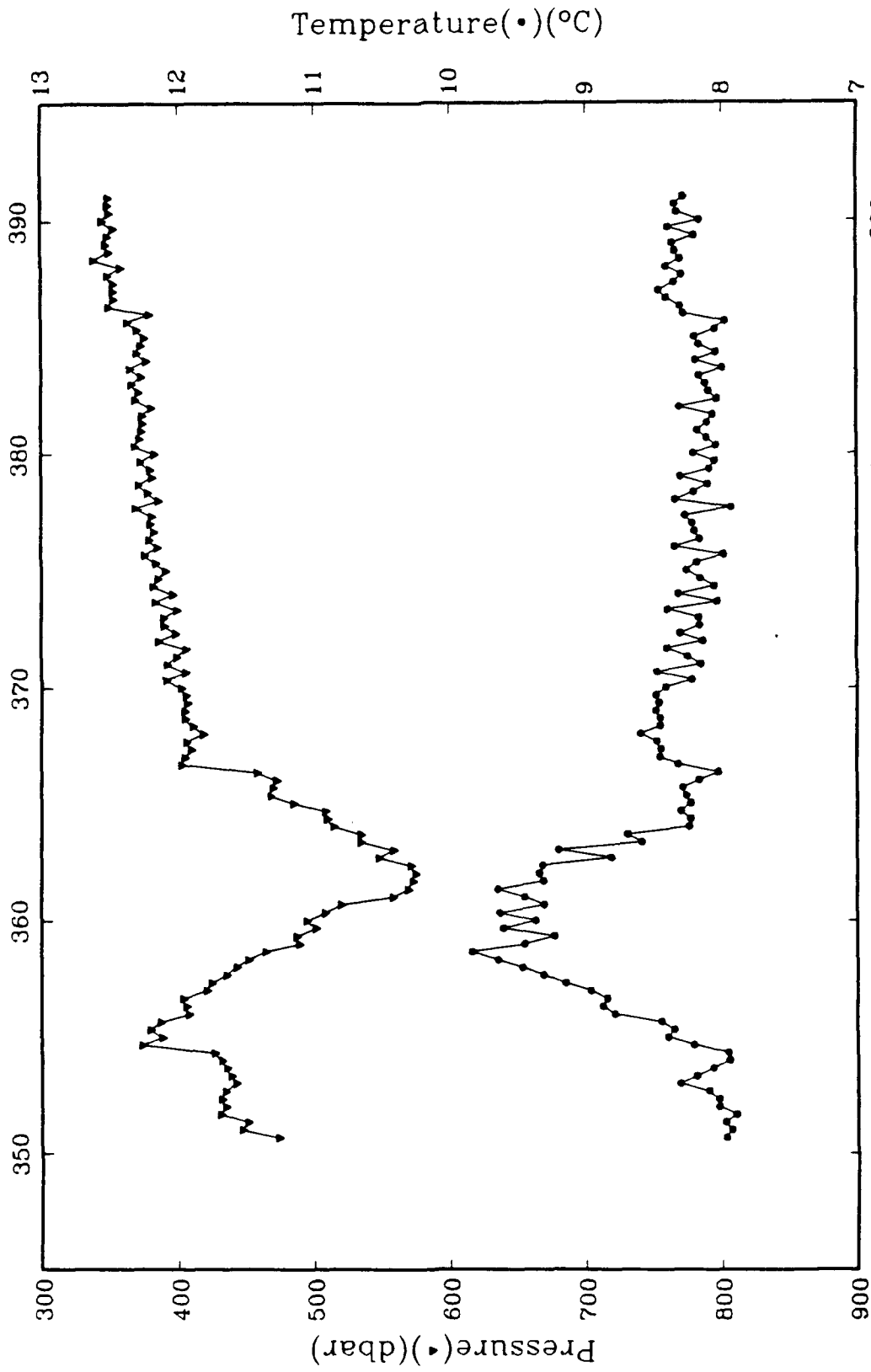


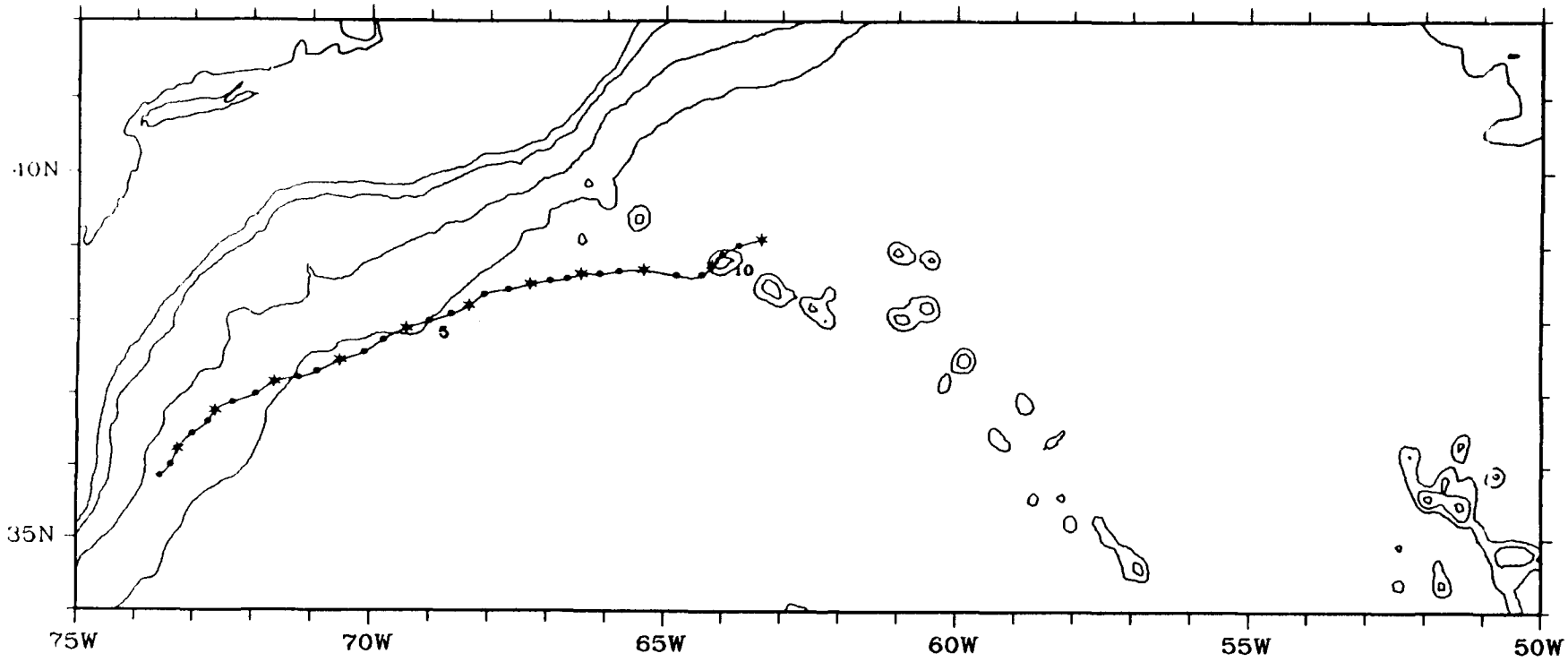
Float 217


Temperature(•)(°C)
19
18
17
16
15
14
13
380
370
360
350
340
Yearday
100
200
300
400
500
600
700
Pressure(◂)(dbar)
Float 217

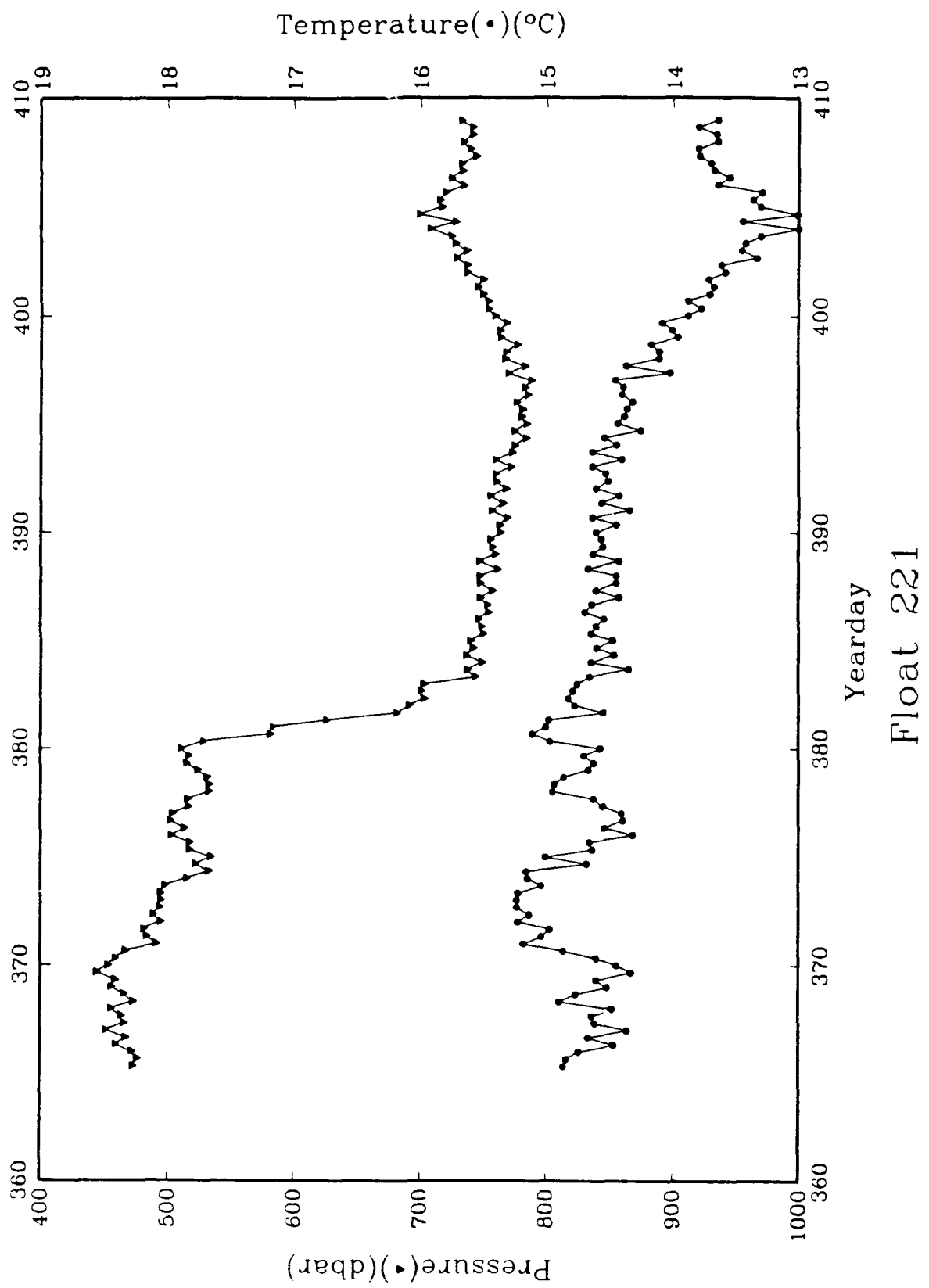


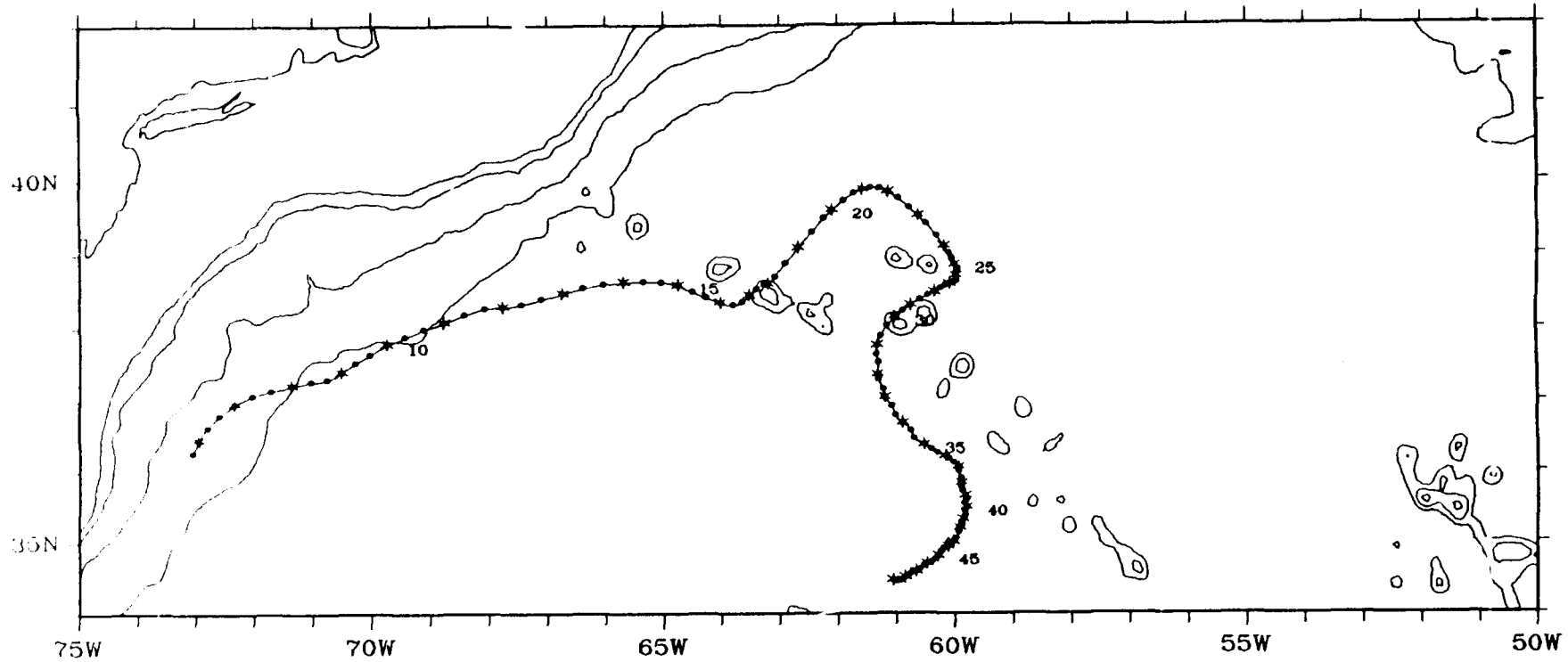
Float 220


Temperature(•)(°C)
13
12
11
10
9
8
7
390
380
370
360
350
Yearday
300
400
500
600
700
800
900
Pressure(◂)(dbar)
Float 220

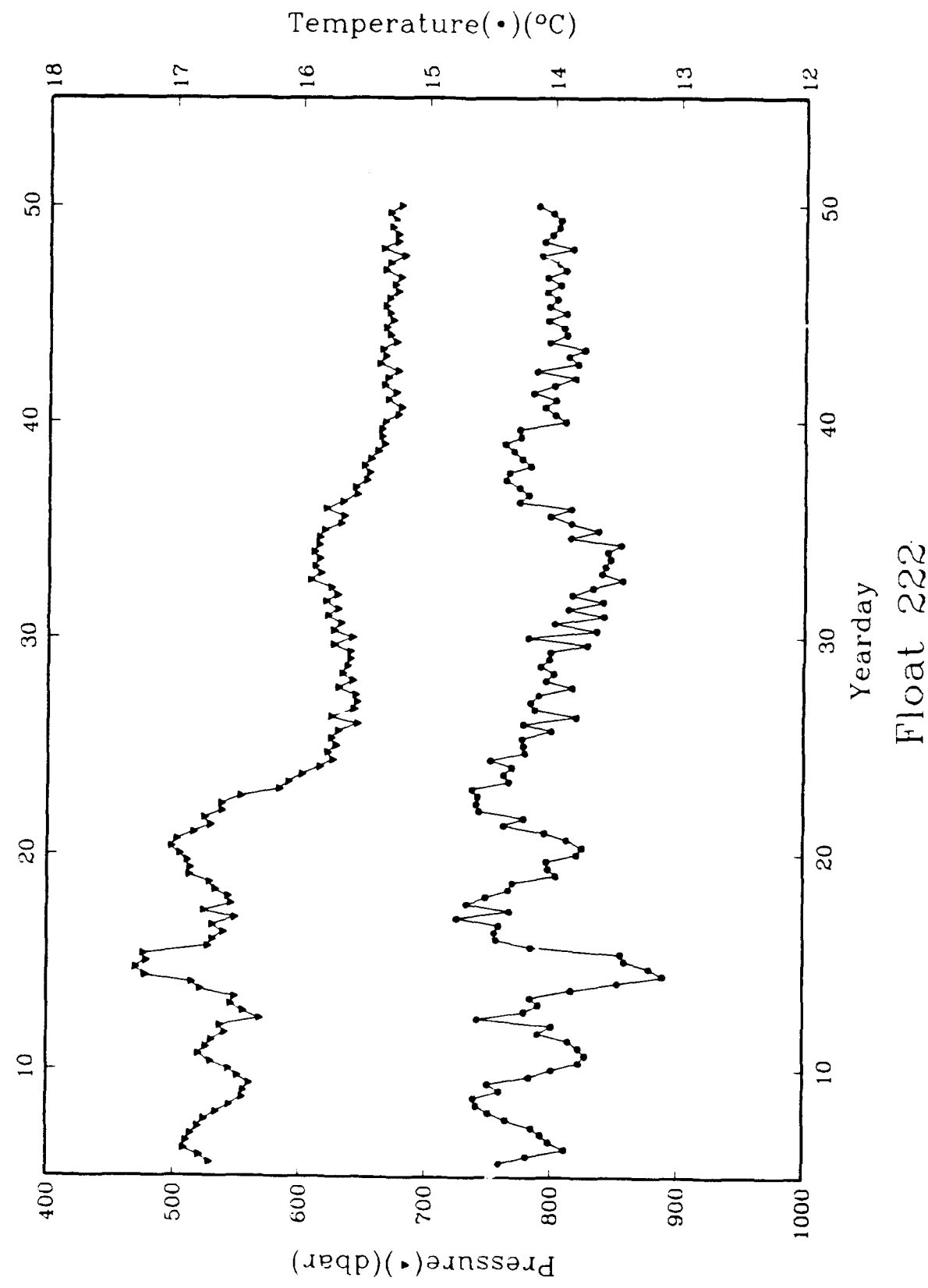


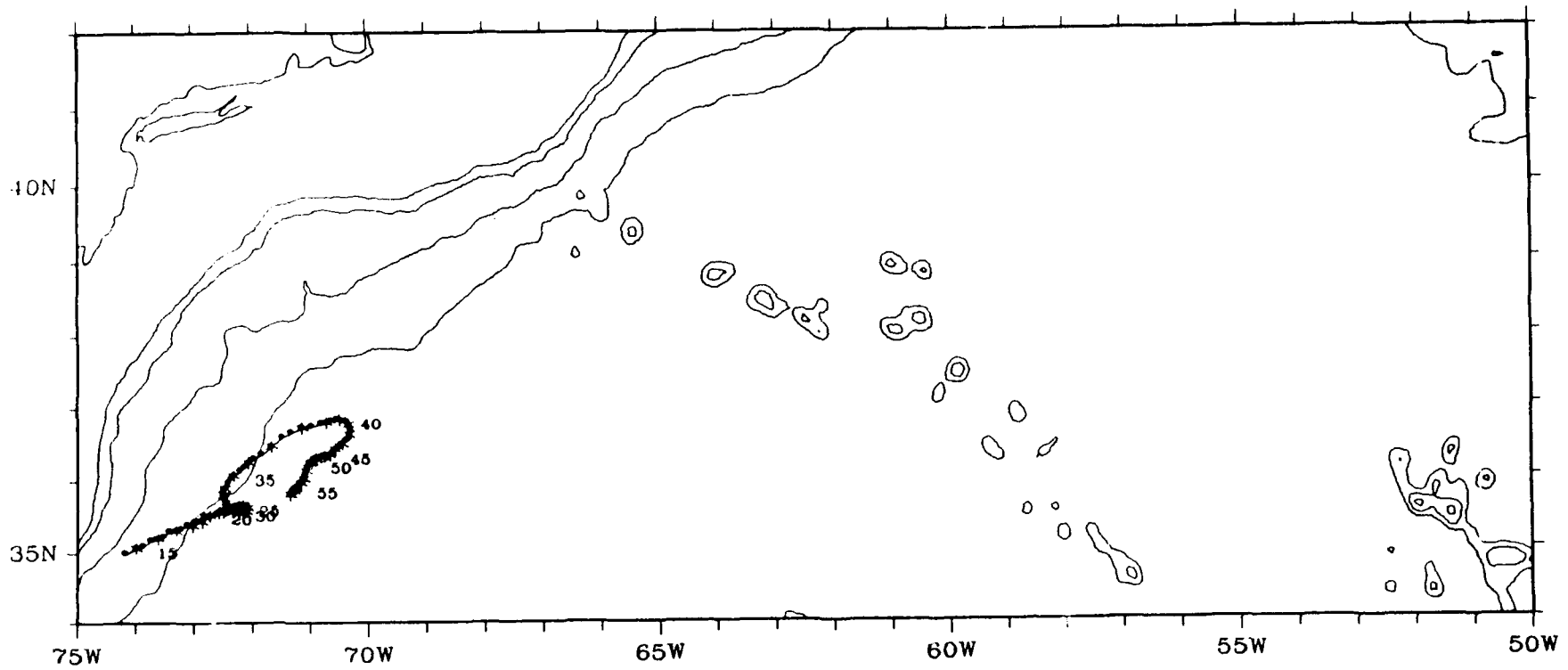
Float 221


Temperature(•)(°C)
19
18
17
16
15
14
13
410
400
390
380
370
360
Yearday
Float 221
Pressure(◂)(dbar)
400
500
600
700
800
900
1000

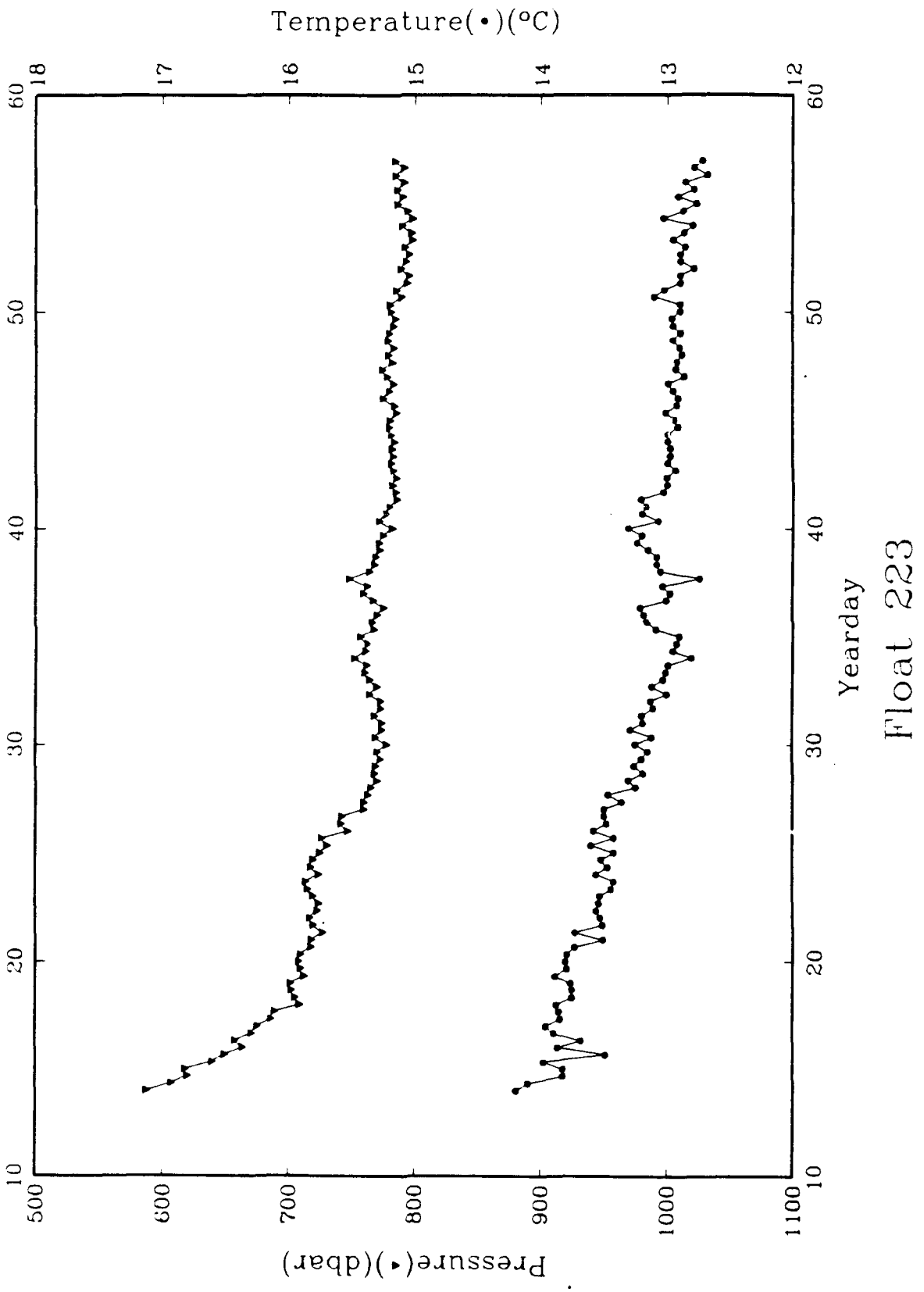


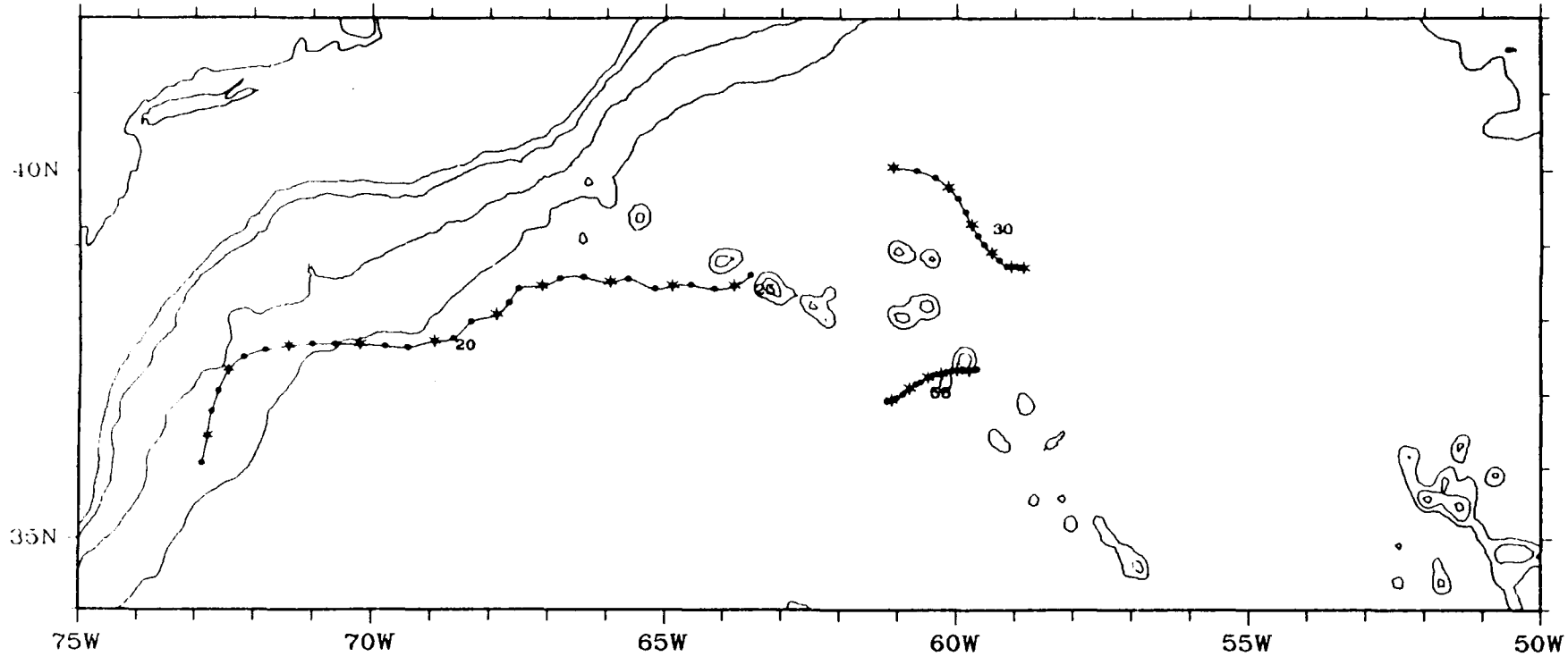
Float 222


Temperature(•)(°C)
18
17
16
15
14
13
12
50
40
30
20
10
Yearday
Float 222
Pressure(◂)(dbar)
400
500
600
700
800
900
1000

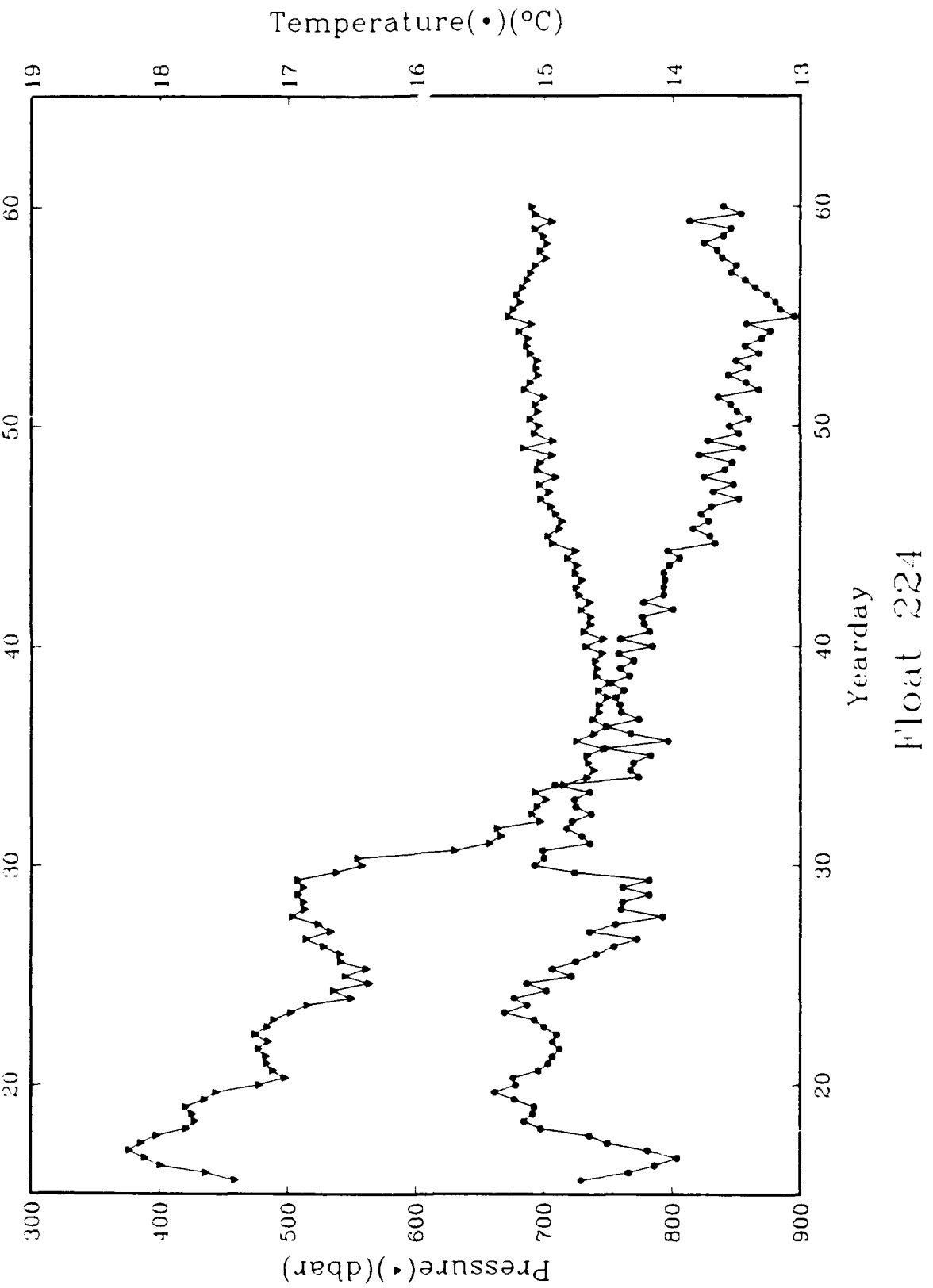


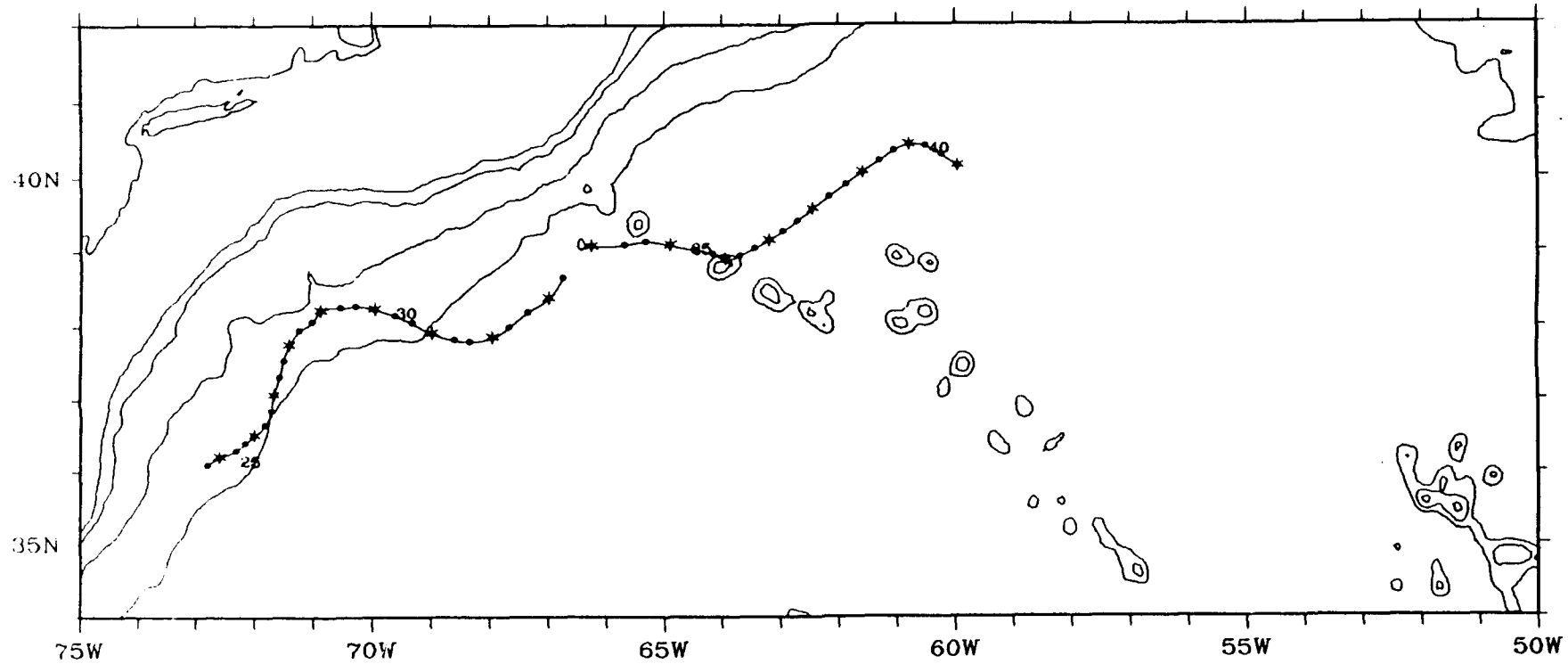
Float 223


Temperature(•)(°C)
18
17
16
15
14
13
12
60
50
40
30
20
10
Yearday
Float 223
Pressure(◂)(dbar)
500
600
700
800
900
1000
1100

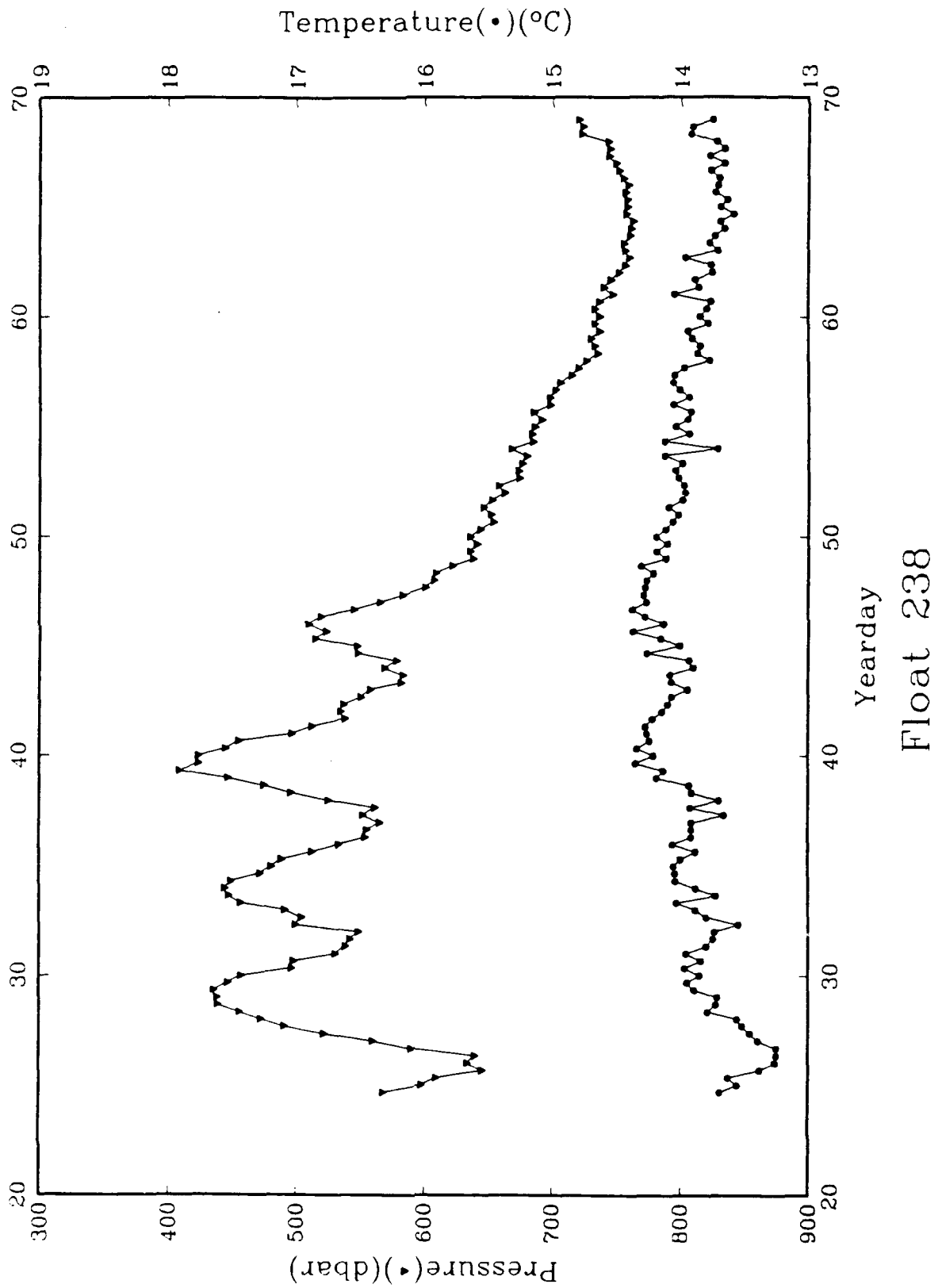


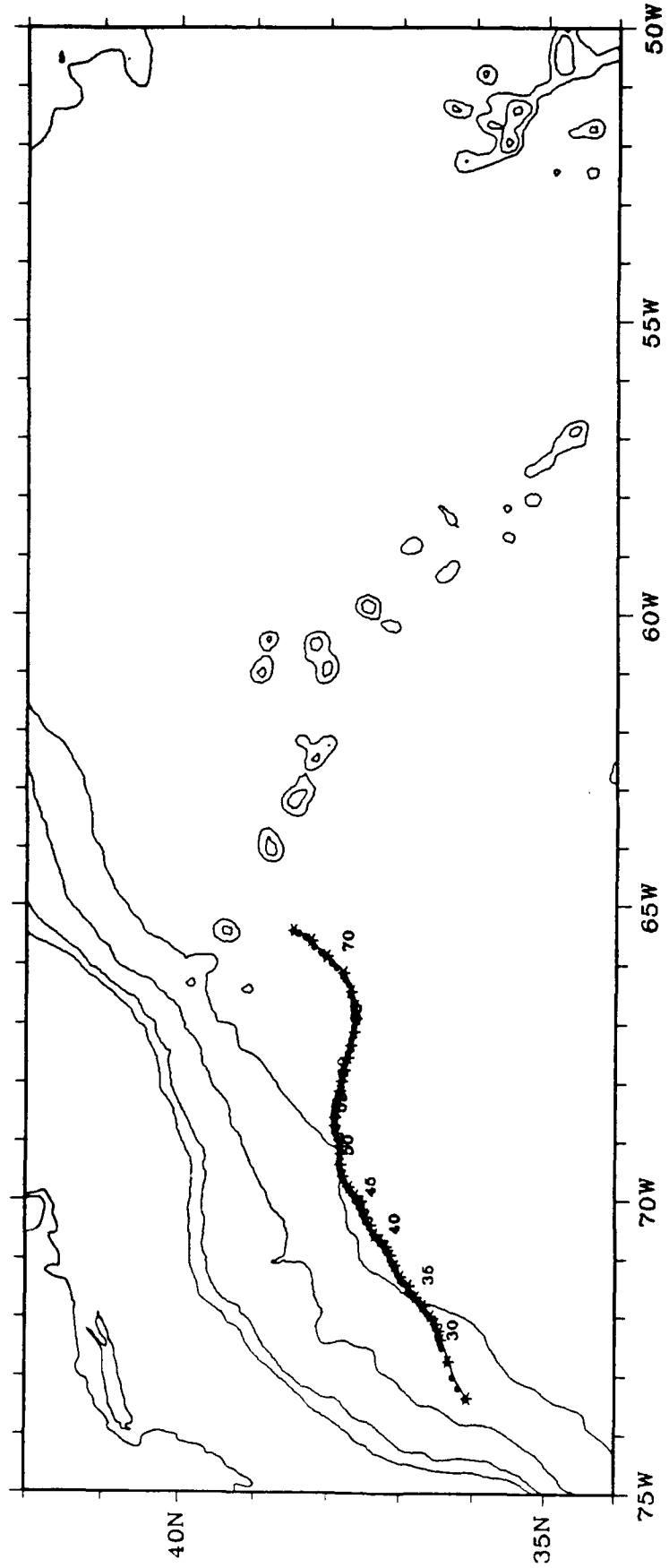
Float 224


Temperature(•)(°C)
19
18
17
16
15
14
13
60
50
40
30
20
Yearday
Float 224
300
400
500
600
700
800
900
Pressure(•)(dbar)

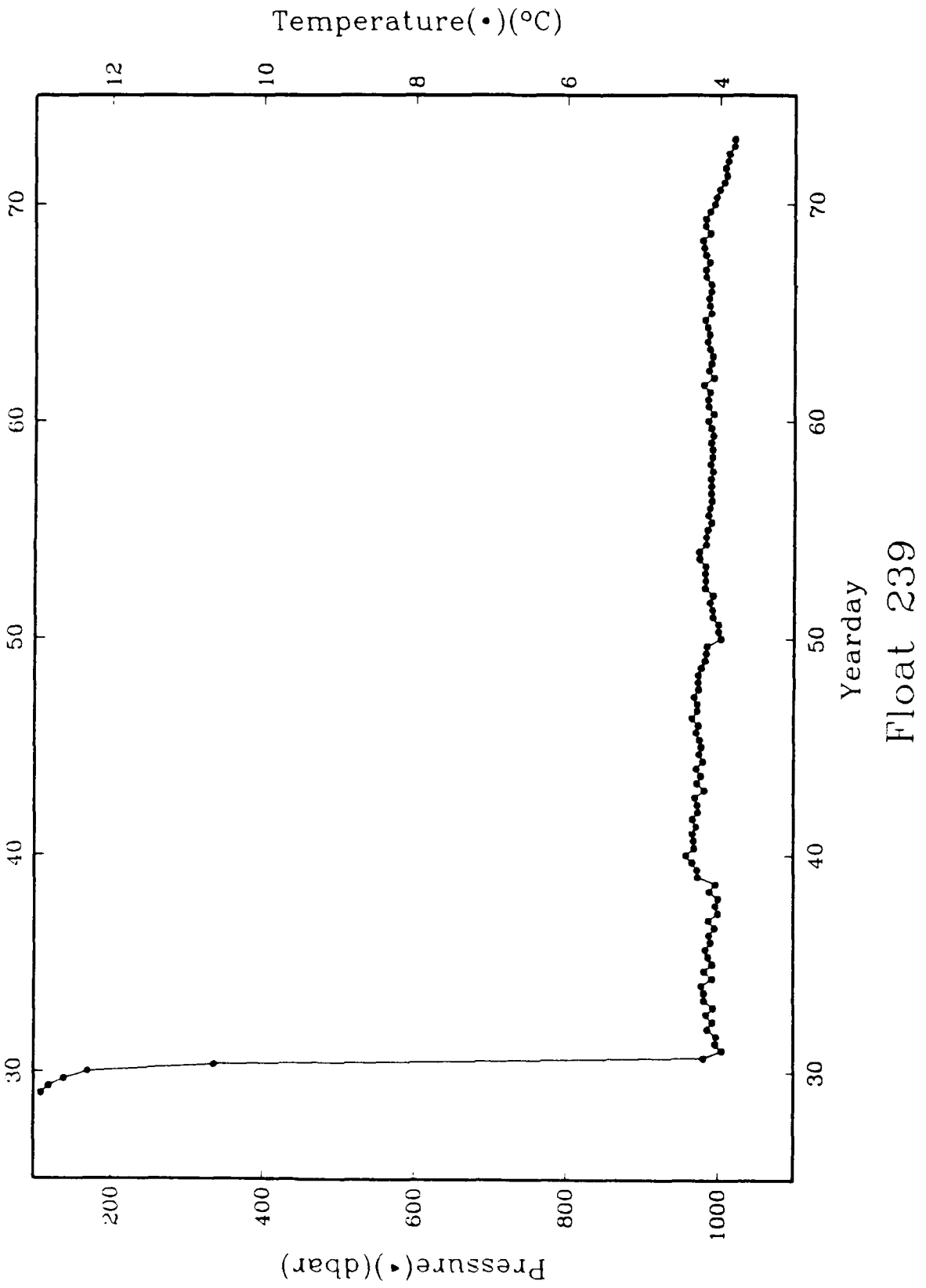


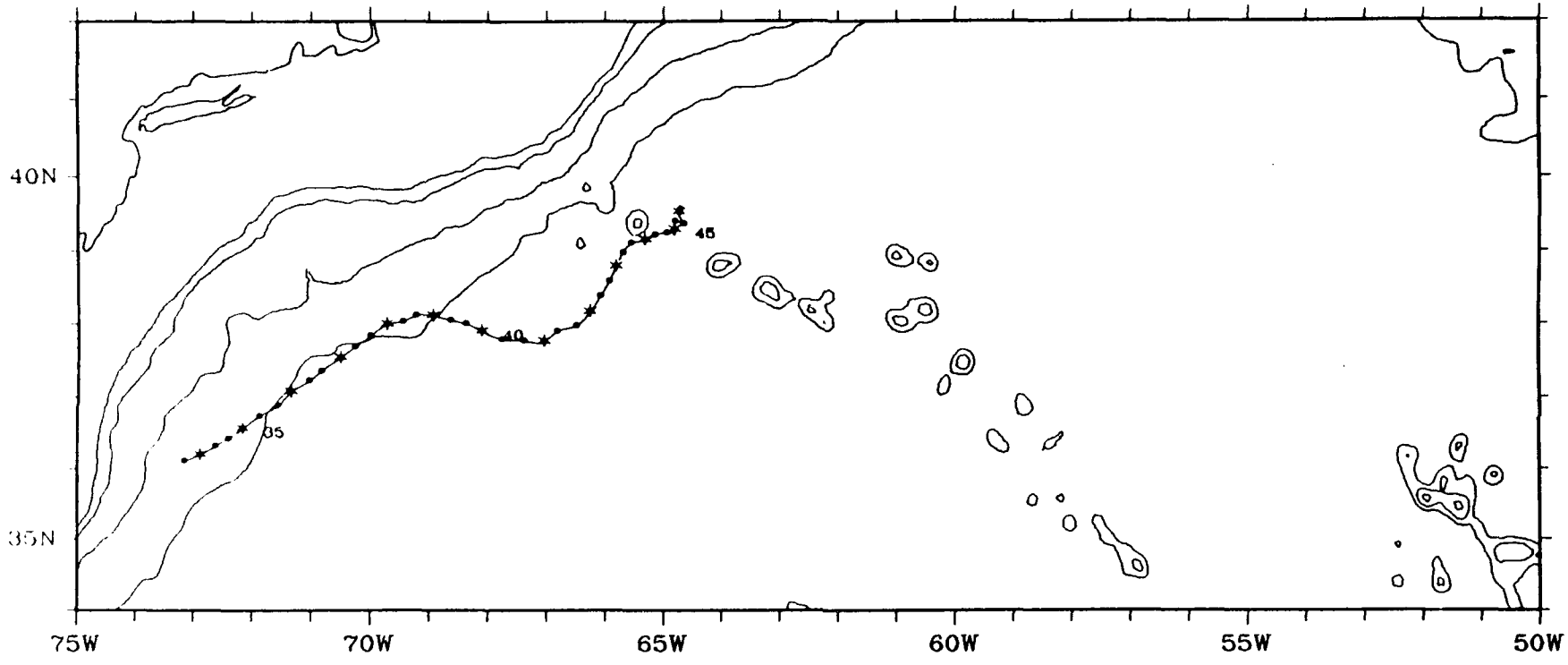
Float 238


Temperature(•)(°C)
19
18
17
16
15
14
13
70
60
50
40
30
20
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 238

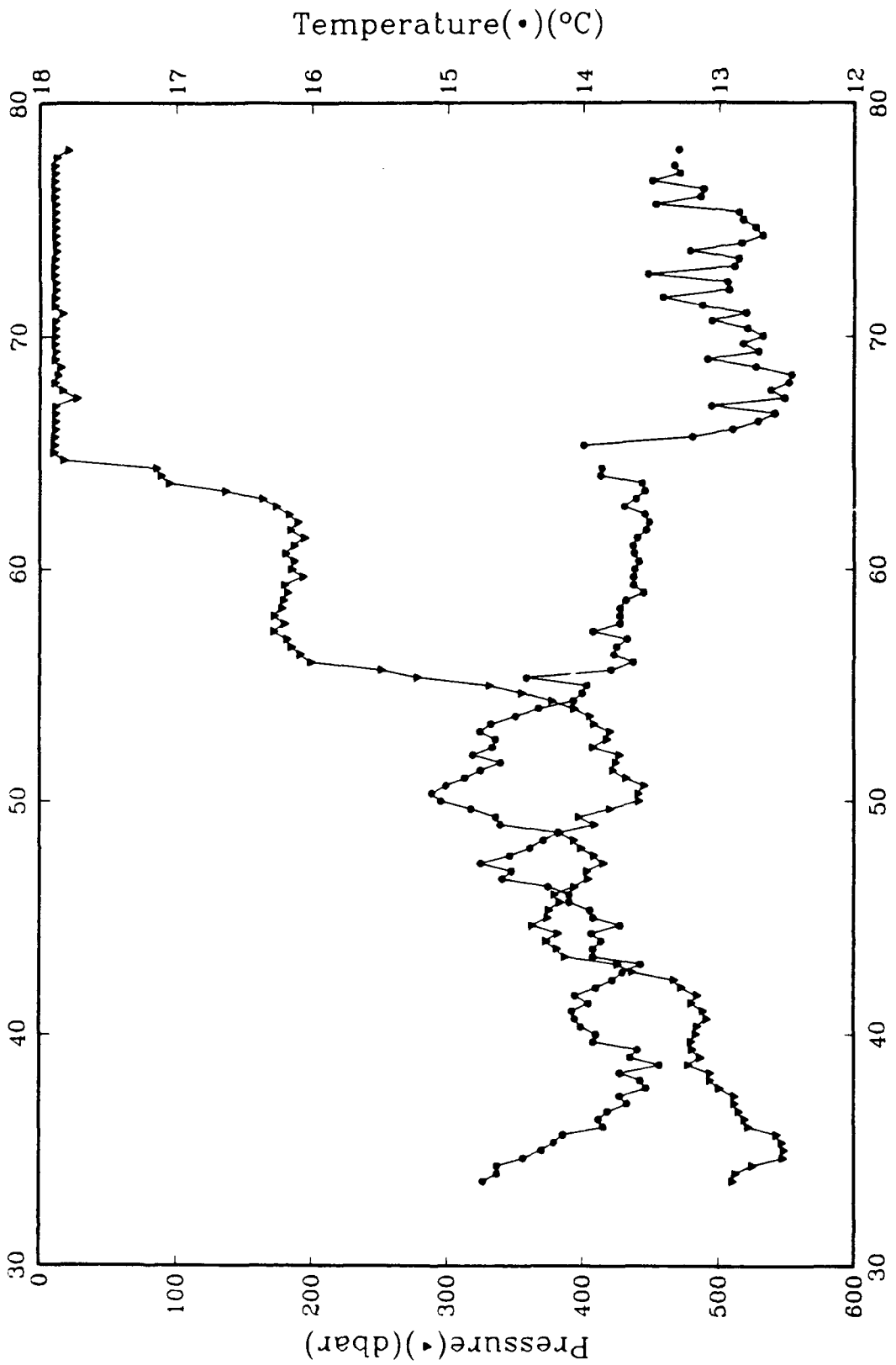


Float 239

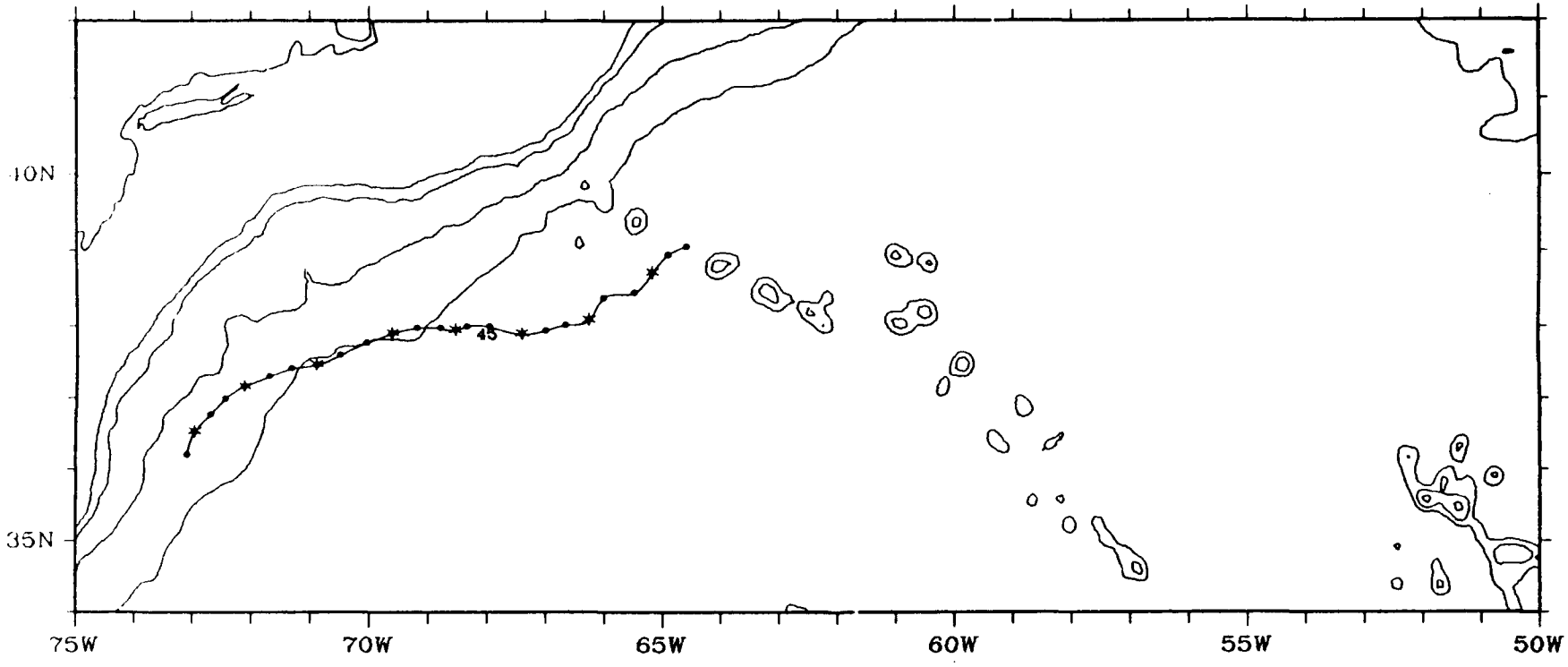

Temperature(•)(°C)
12
10
8
6
4
70
60
50
40
30
Yearday
Float 239
200
400
600
800
1000
Pressure(◂)(dbar)



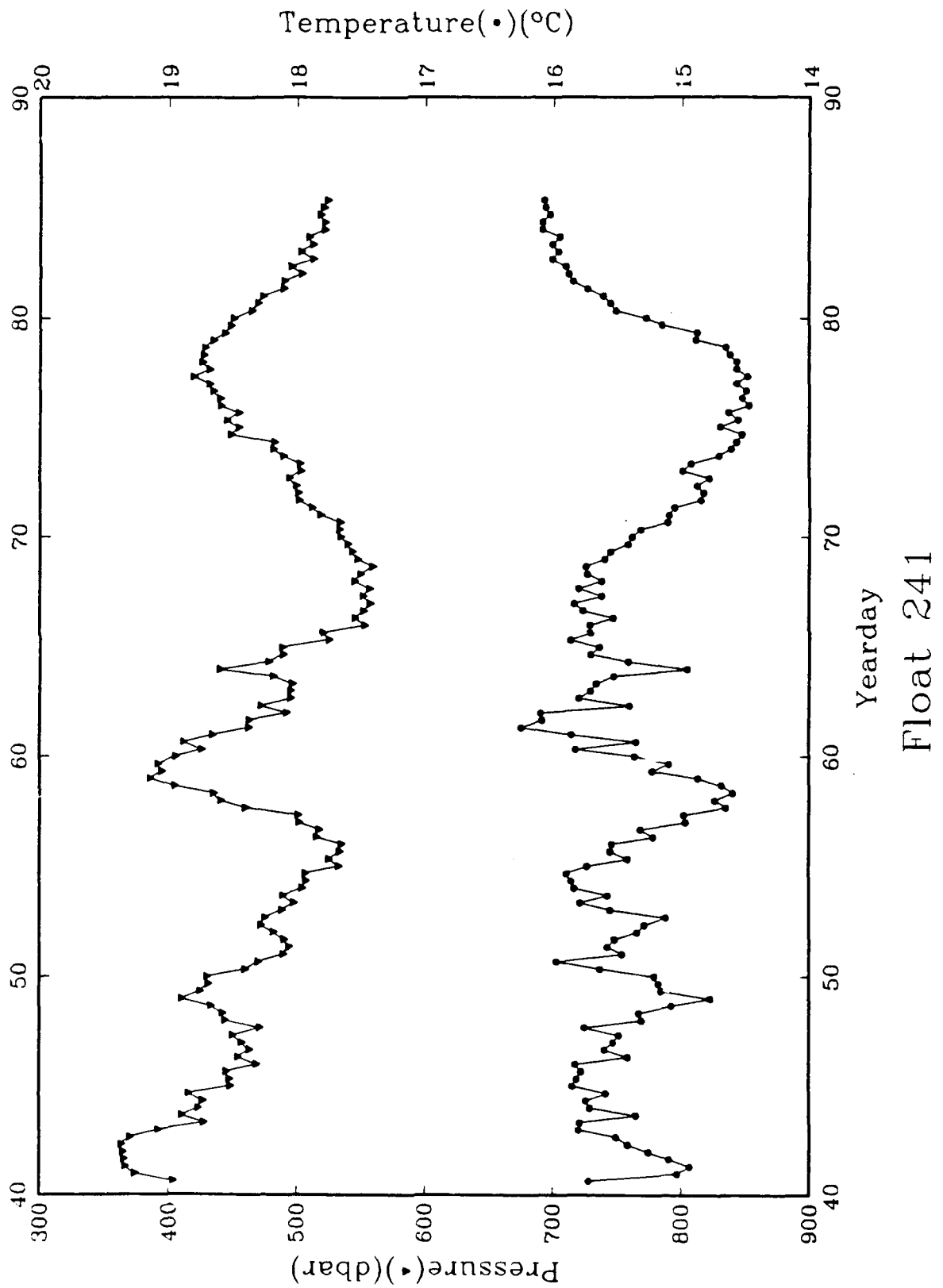
Float 240


Temperature(•)(°C)
18
17
16
15
14
13
12
80
70
60
50
40
30
Yearday
Pressure(◂)(dbar)
0
100
200
300
400
500
600

Float 240



Float 241


Temperature(•)(°C)
20
19
18
17
16
15
14
90
80
70
60
50
40
Yearday
Pressure(◂)(dbar)
300
400
500
600
700
800
900
Float 241

SECURITY CLASSIFICATION OF THIS PAGE

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1a. REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
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RAFOS Floats in the SYNOP Experiment 1988-1990

12. PERSONAL AUTHOR(S)
Sandra Anderson-Fontana and H. Thomas Rossby

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17. COSATI CODES			18. SUBJECT TERMS (*Continue on reverse if necessary and identify by block number*)
FIELD	GROUP	SUB-GROUP	
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19. ABSTRACT (*Continue on reverse if necessary and identify by block number*)

Seventy-five RAFOS floats were launched in the center of the Gulf Stream off Cape Hatteras between April 1988 and February 1990 and Bermuda. Each float was tracked acoustically for 30 to 45 days using sound sources moored to the south of the Gulf Stream at the depth of the permanent sound channel. The main objective has been to study the spatial and temporal characteristics of the meandering ulf Stream east of Cape Hatteras. This document presents all RAFOS float data collected and processed under this program. A plot of the float trajectory for each float is shown, along with a plot of the temperature and pressure time series. of the 75 floats launched, all but three returned useful data.

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