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A Compilation of Digitized Satellite Imagery of the Gulf Stream (1982, 1983, and 1985)

by

Jennifer Earles, University of Wisconsin
Lawrence Pratt, Woods Hole Oceanographic Institution
Peter Cornillon, University of Rhode Island
Jean-François Cayula, University of Rhode Island

November 1988

Technical Report

Funding was provided by the Office of Naval Research under contract Number N00014-87-K-0007 and by the National Science Foundation under grant Numbers OCE 87-00601 and OCE 85-10828.

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A Compilation of Digitized Satellite Imagery of the Gulf Stream (1982, 1983, and 1985)

by

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November 1988

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Approved for Distribution:

Robert C Beardsley

Robert C. Beardsley, Chairman
Department of Physical Oceanography

Table of Contents

Abstract ..... pg. 2

Acknowledgements ..... pg. 2

The Images and Digitized Plots (written summary) ..... pgs. 2-3

Table of Included Images ..... pg. 4

Digitized Plots ..... pgs. A1-A89

Photographs of Original Images ..... pgs. B1-B13

Abstract

Ninety plots of digitized temperature boundaries from infared satellite images of the Gulf Stream along with corresponding image snapshots were compiled to determine stream width propagation speed. The satellite images are from the years 1982, 1983, and 1985 and are often of consecutive days. In this report, these images and digitized plots are presented.

Acknowledgements

The image-processing software was developed by R. Evans, O. Brown, J. Brown and A. Li at the University of Miami under Office of Naval Research funding. The continuing support of the Miami Group is gratefully acknowledged.

The Images and Digitized Plots

The ninety images used for this study were chosen from over twelve hundred images because they are cloud free in some region of the Gulf Stream and have a corresponding clear image within five days. Colors on the images range from violet for very cold ($\simeq$2 degrees Celcius) to red for very warm ($\simeq$30 degrees Celcius). The yellows of the Gulf Stream are in the mid 20s. Black areas are clouds. (Note that the converse is not true: all clouds were not detected by the cloud detection algorithm hence cloudy areas do appear in some of the imagery as anomalously cold regions as opposed to black regions; for example, the large violet area trending north - south in the center of the 12 May 1982 image.) The area covered by the 1985 color images is 32.624 to 44.376 degrees North and 64.123 to 75.877 degrees West. The area covered by the 1982 and 1983 images is 33.890 to 44.110 degrees North and 62.923 to 76.077 degrees West. Also superimposed on the color images are the edges located with the edge detection algorithm briefly described in the paragraph.

To locate the edges defining the Gulf Stream that were required for this study, an edge detection algorithm was passed over each image (Cayula, 1988). Although edge detection was the main focus, the first step was to remove the most obvious clouds from the image. To achieve this, a rough segmentation of the image between cloudy and non-cloudy areas was performed by thresholding the entire image with respect to the temperature and the gradient magnitude. The direction of the gradient vector in, and the shape of, each area classified as possibly cloudy were then examined to determine the validity of the classification. Next, the image was segmented into overlapping windows and the histogram associated with each window

was studied to detect any statistically significant edge. If an edge was detected, the temperature threshold determined through histogram analysis was used to segment the window under study into two populations. The temperature variability (a mix of variance and correlation) of each population was then examined to detect any remaining clouds. After all detected clouds were removed, the histogram analysis was performed again, this time to detect possible temperature fronts. When a statistically significant edge was detected, the cohesion of the two populations resulting from the histogram analysis was estimated to determine whether or not the histogram-based segmentation was spatially valid. The fronts detected at the window-level were subsequently completed and further validated at the local level by using a contour following algorithm. This algorithm performs better (lower standard deviation with respect to the inverted echo sounder determination of the edges) than other automated methods with the set of data used. Line drawings of the resulting edges were only produced for the region from 32 to 40 degrees North and 68 to 76 degrees West, the area of particular interest to this study. The program used to plot the sets of data points varied the types of lines representing the temperature boundaries. The reader is asked to ignore these differences.

Reference

Cayula, J. - F., 1988. Edge Detection Algorithm for SST Images. Master of Science Dissertation, University of Rhode Island, Kingston, R. I., 91 pp.

Images

1982	1983	1985
April 2, 19:47:25	April 22, 08:27:45	March 26, 18:41:24
April 4, 19:23:57	April 26, 19:02:34	March 28, 18:21:18
April 12, 19:47:25	April 27, 18:50:52	March 29, 18:10:17
April 15, 07:27:36	April 28, 18:39:10	March 30, 19:42:19
April 19, 18:05:55	April 29, 18:27:39	April 3, 18:56:17
April 30, 07:51:48	May 5, 18:53:48	April 4, 07:19:32
May 1, 07:40:20	May 6, 07:17:50	April 4, 18:45:17
May 1, 19:03:44	May 6, 18:42:15	April 5, 07:09:23
May 6, 08:22:29	May 7, 18:30:36	April 7, 06:48:07
May 6, 18:06:15	May 8, 08:34:42	April 7, 18:14:33
May 11, 07:20:52	May 10, 19:34:20	April 13, 07:24:48
May 12, 18:33:59	May 11, 07:57:22	April 17, 18:07:57
May 16, 19:29:01	May 13, 07:33:14	April 18, 06:31:51
May 18, 07:38:43	June 12, 08:09:43	April 18, 19:38:39
June 2, 19:28:09	June 13, 19:22:40	April 19, 08:03:13
June 3, 07:49:15	June 23, 19:00:45	April 20, 07:51:49
July 3, 18:19:12	June 24, 07:24:39	April 21, 19:07:17
July 8, 07:35:27	June 24, 18:48:57	April 23, 18:44:31
July 8, 18:59:46	June 26, 08:41:56	April 26, 18:12:45
	June 28, 08:15:46	April 27, 06:37:02
	June 30, 19:16:46	April 28, 08:08:21
	July 10, 18:54:51	April 28, 17:51:24
	July 13, 20:00:37	April 30, 17:31:12
	July 14, 19:48:25	May 1, 07:34:17
	July 17, 19:10:30	May 5, 06:52:25
	July 23, 08:12:47	May 6, 08:23:44
	July 27, 18:48:59	May 6, 18:06:56
		May 19, 19:10:57
		May 20, 17:20:12
		May 26, 08:12:11
		May 26, 17:55:02
		May 27, 08:00:52
		May 27, 17:44:56
		May 28, 07:49:27
		May 28, 19:15:40
		June 2, 06:55:58
		June 2, 18:21:09
		June 4, 06:34:20
		June 9, 18:47:08
		June 10, 07:11:07
		June 15, 07:59:39
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Note: Times are Greenwich Mean Time.

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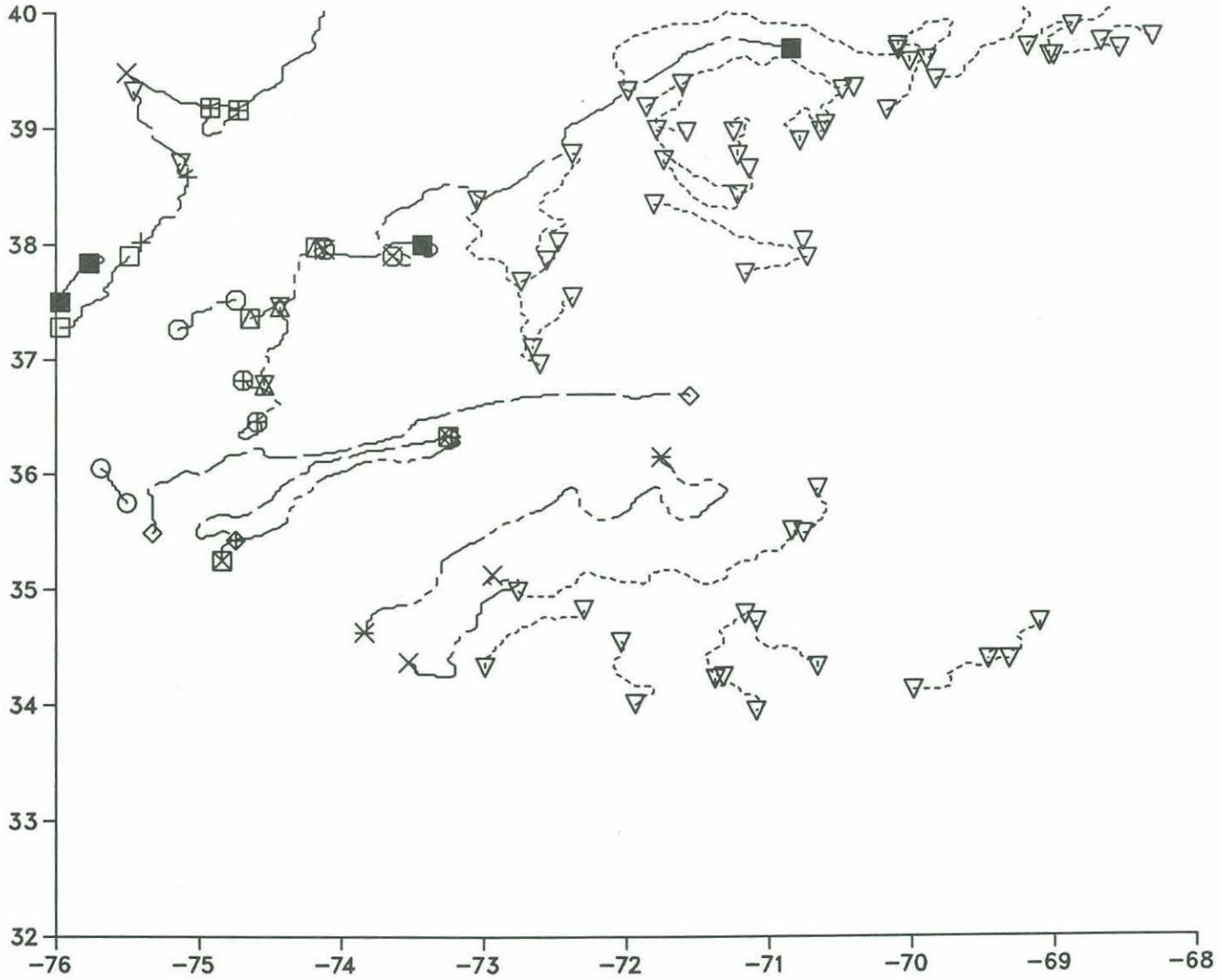

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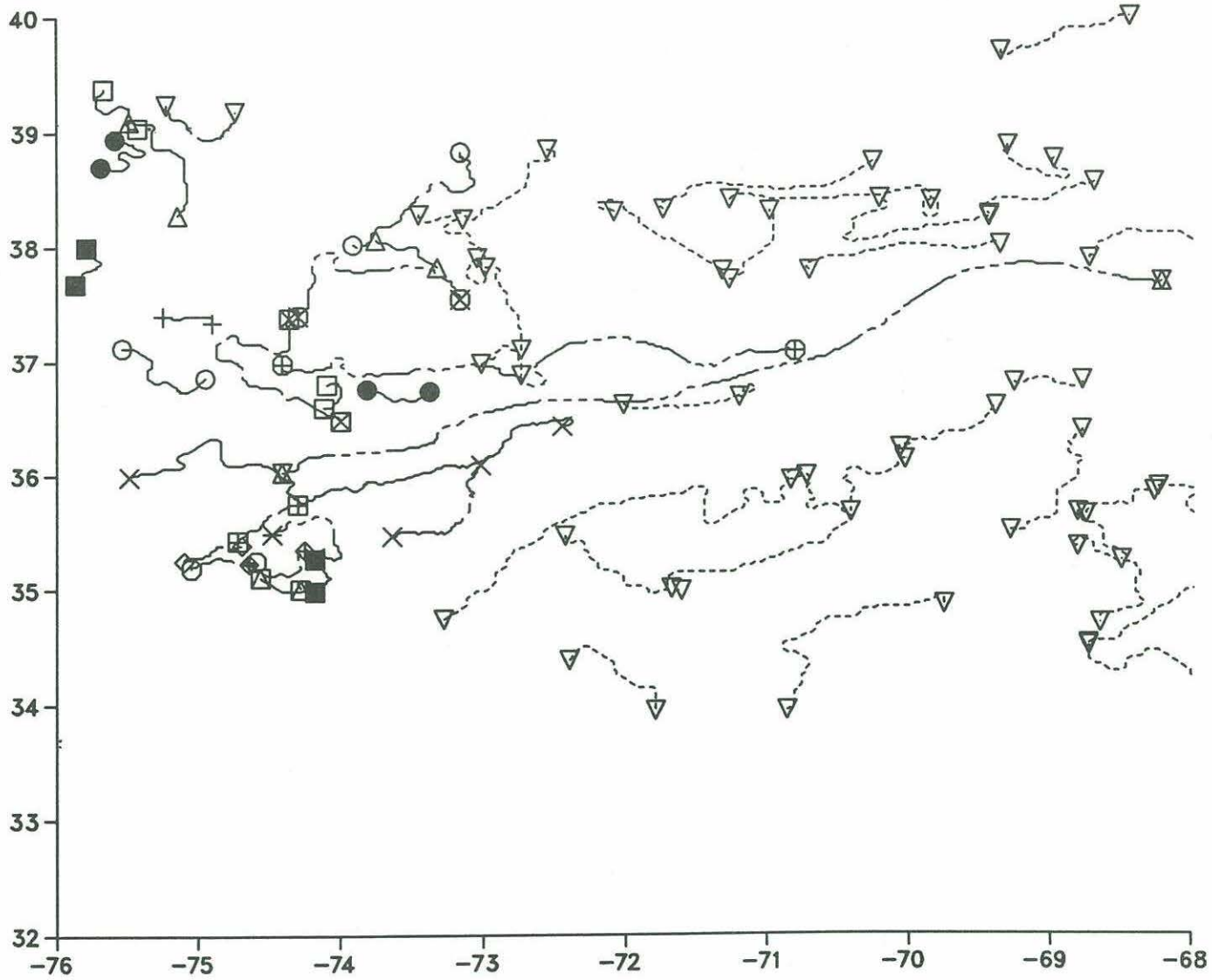

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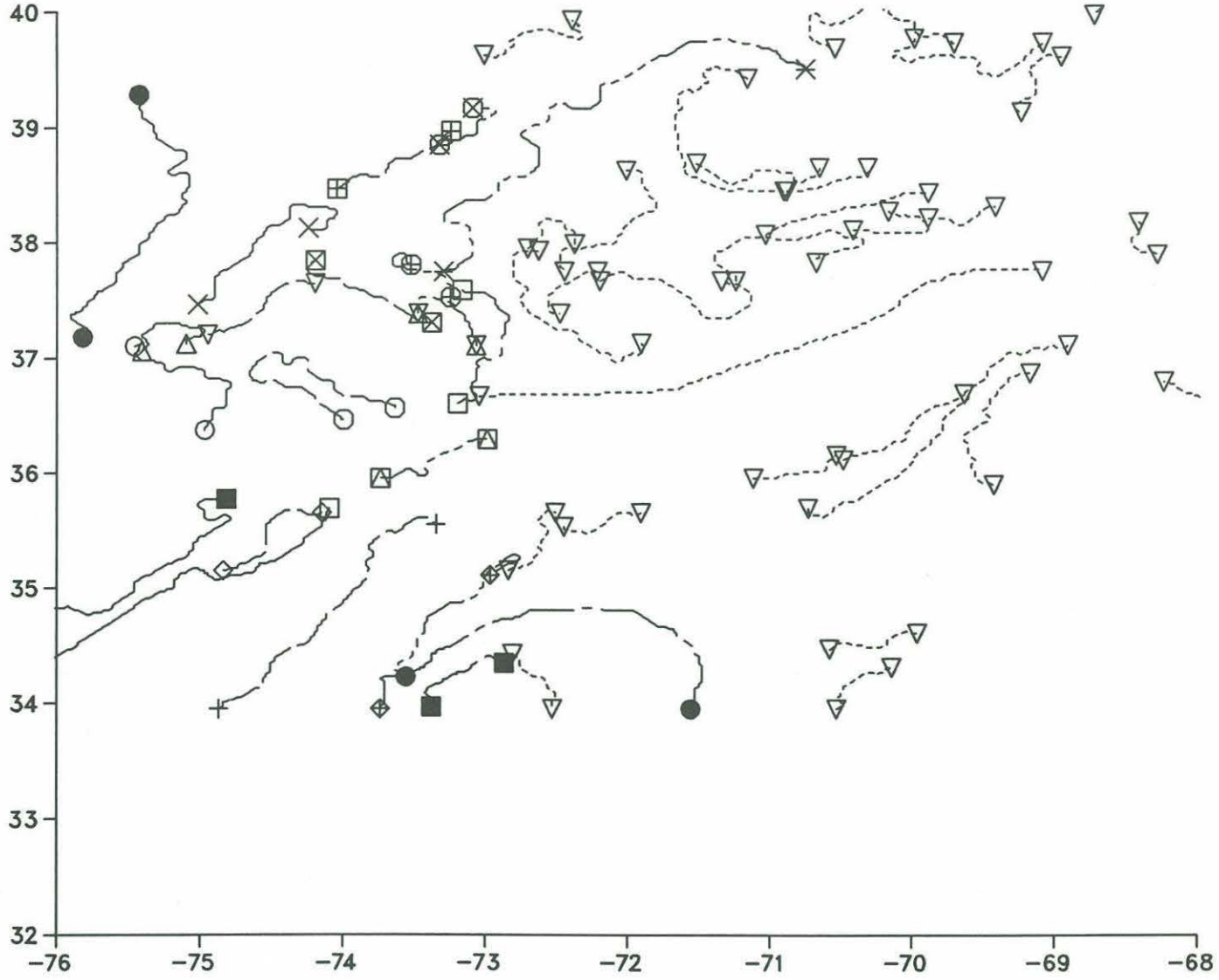

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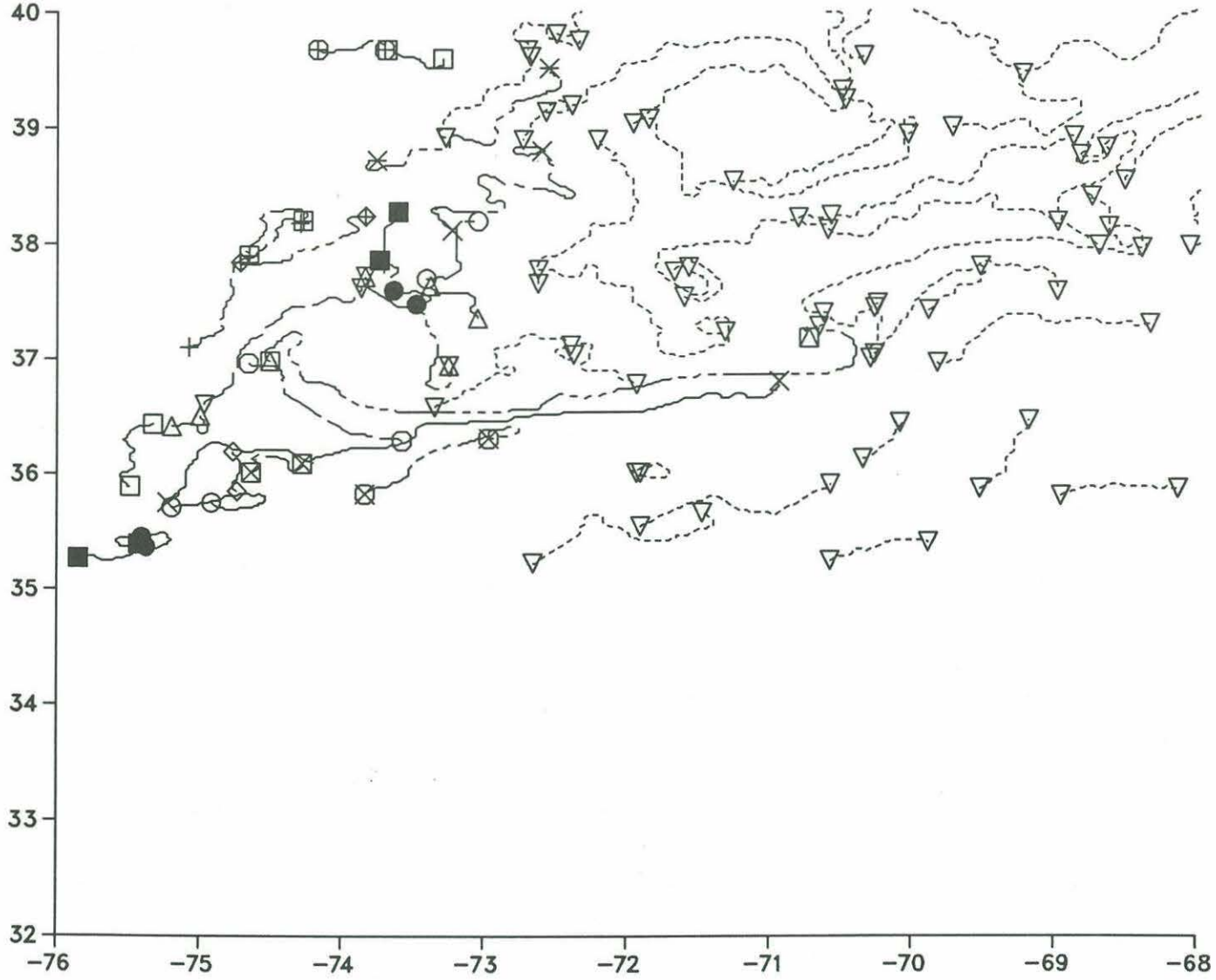

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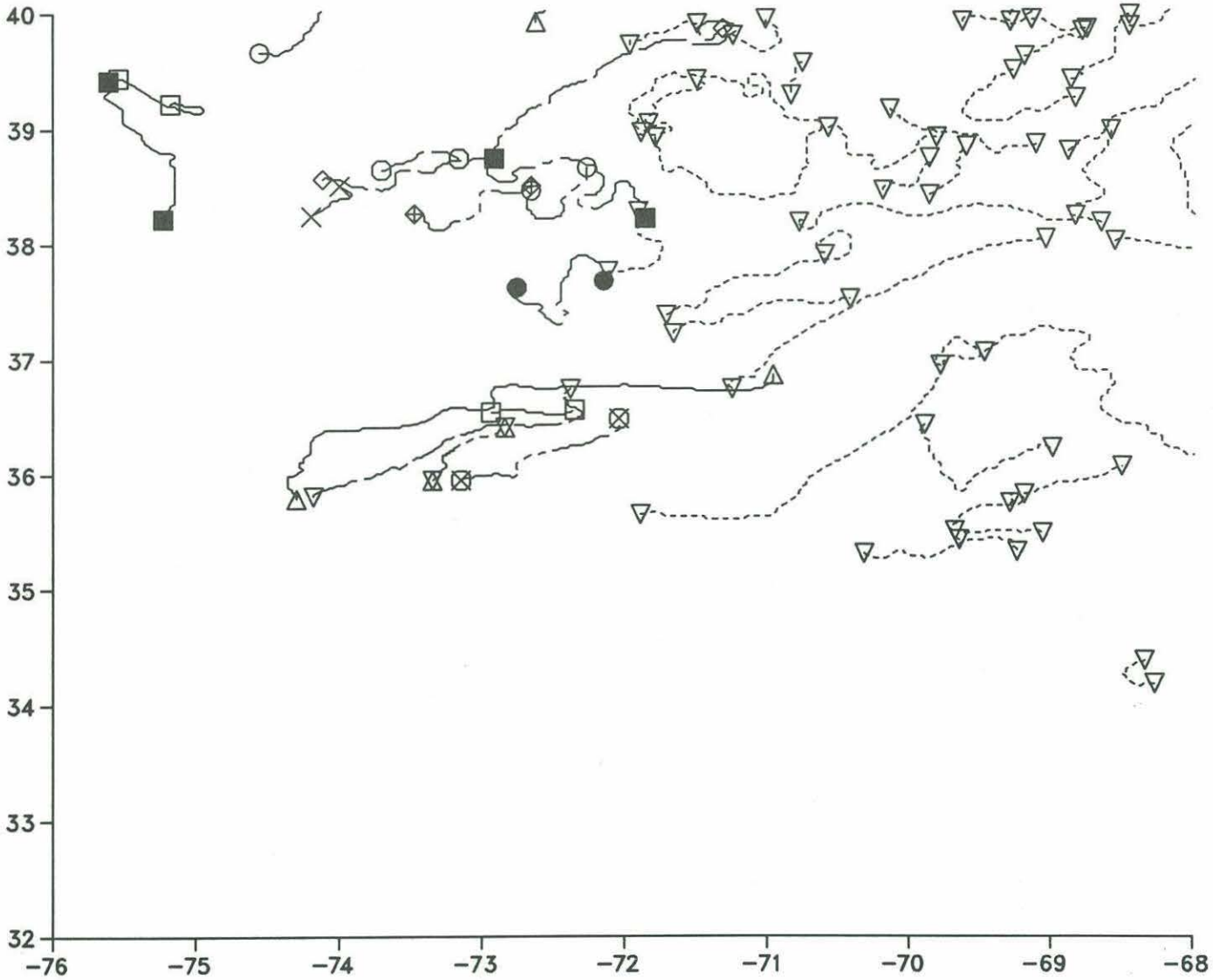

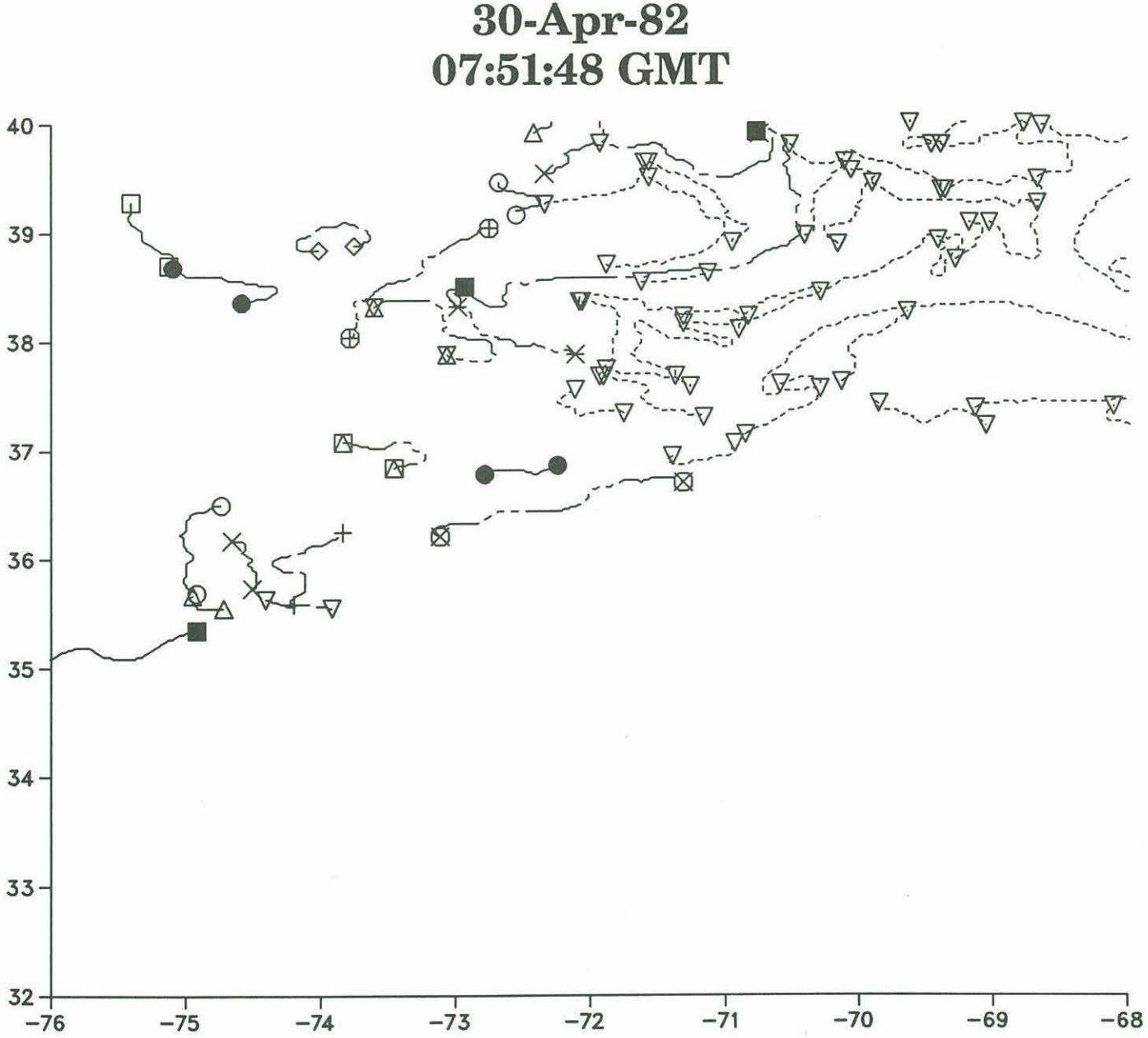
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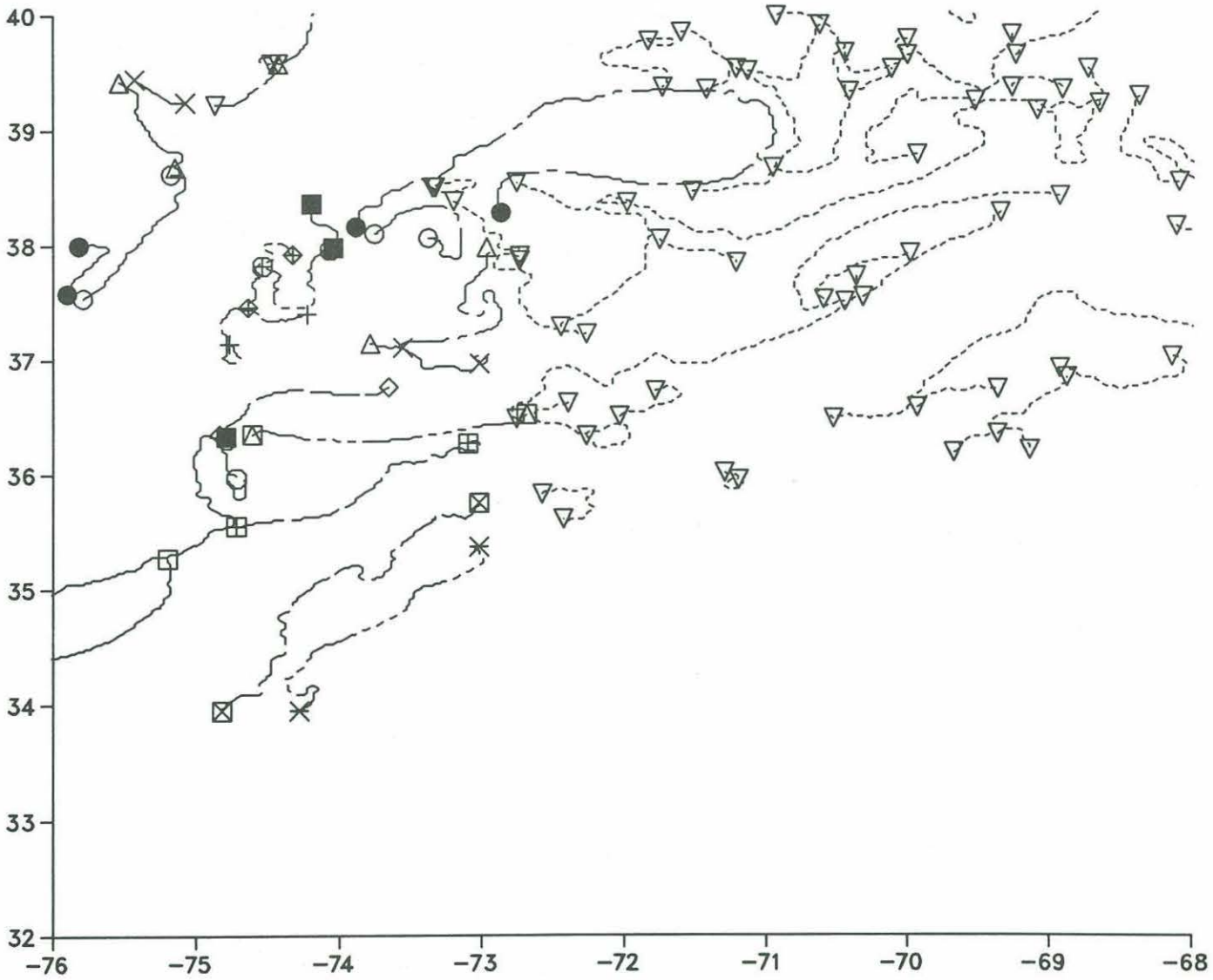

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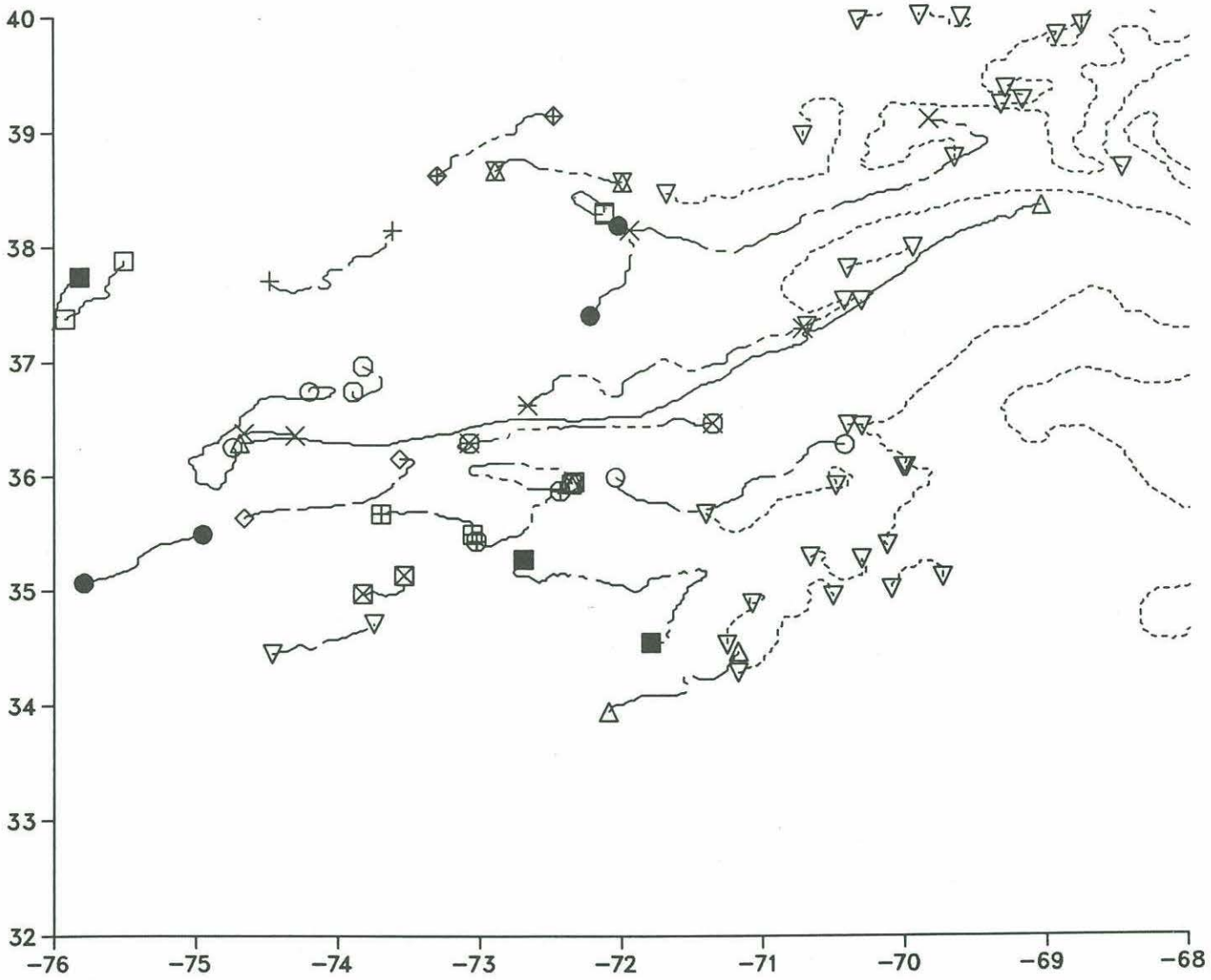

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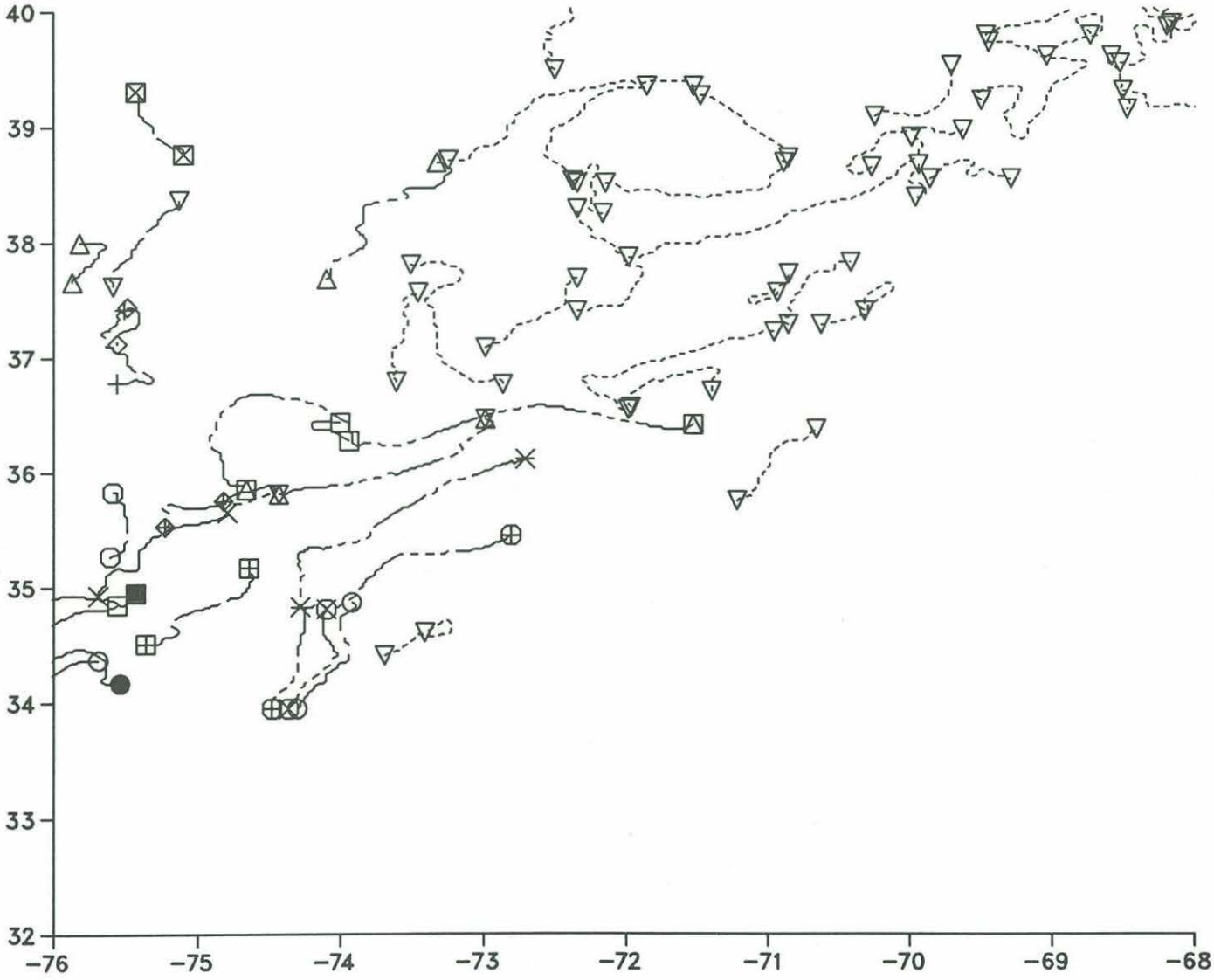

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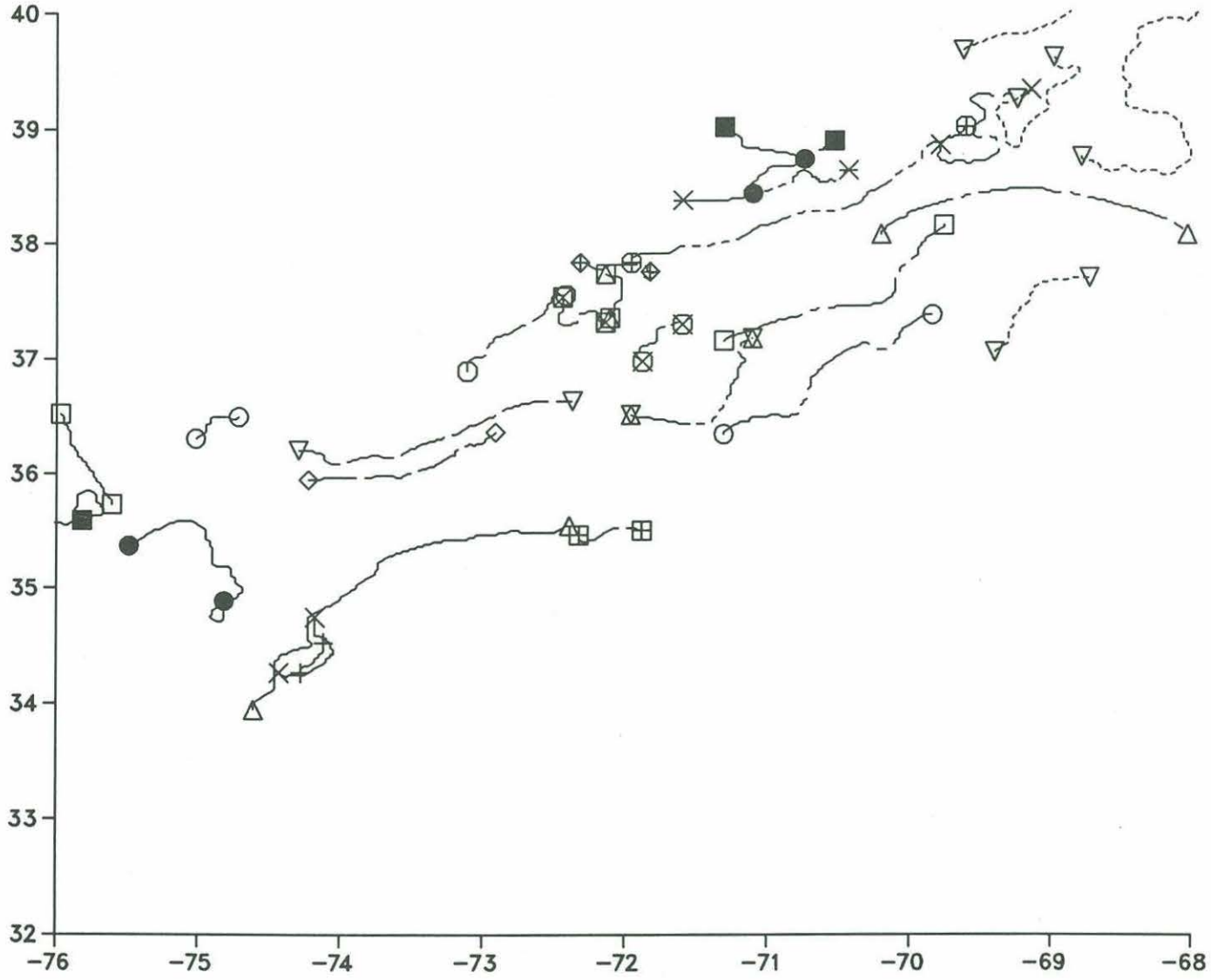

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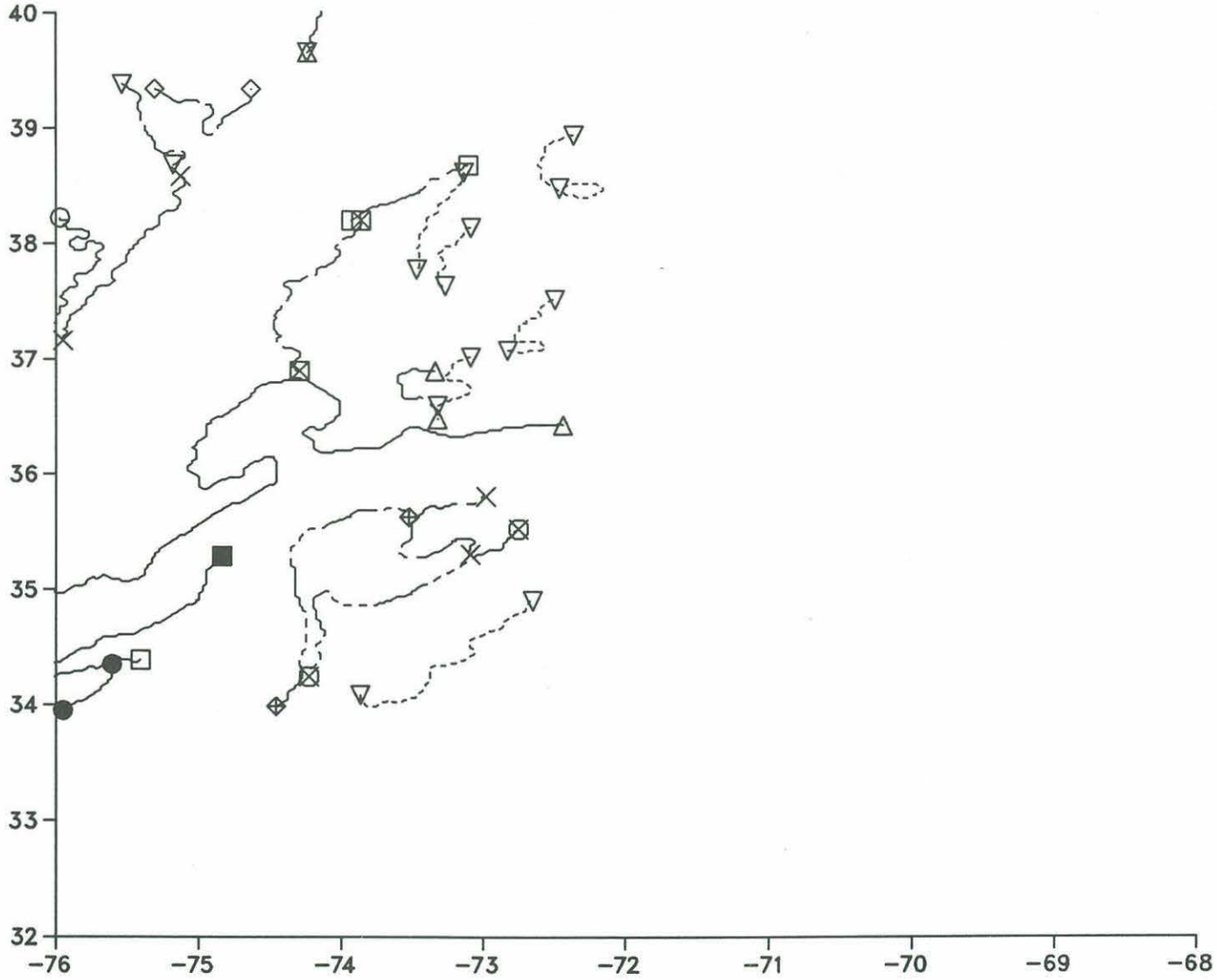

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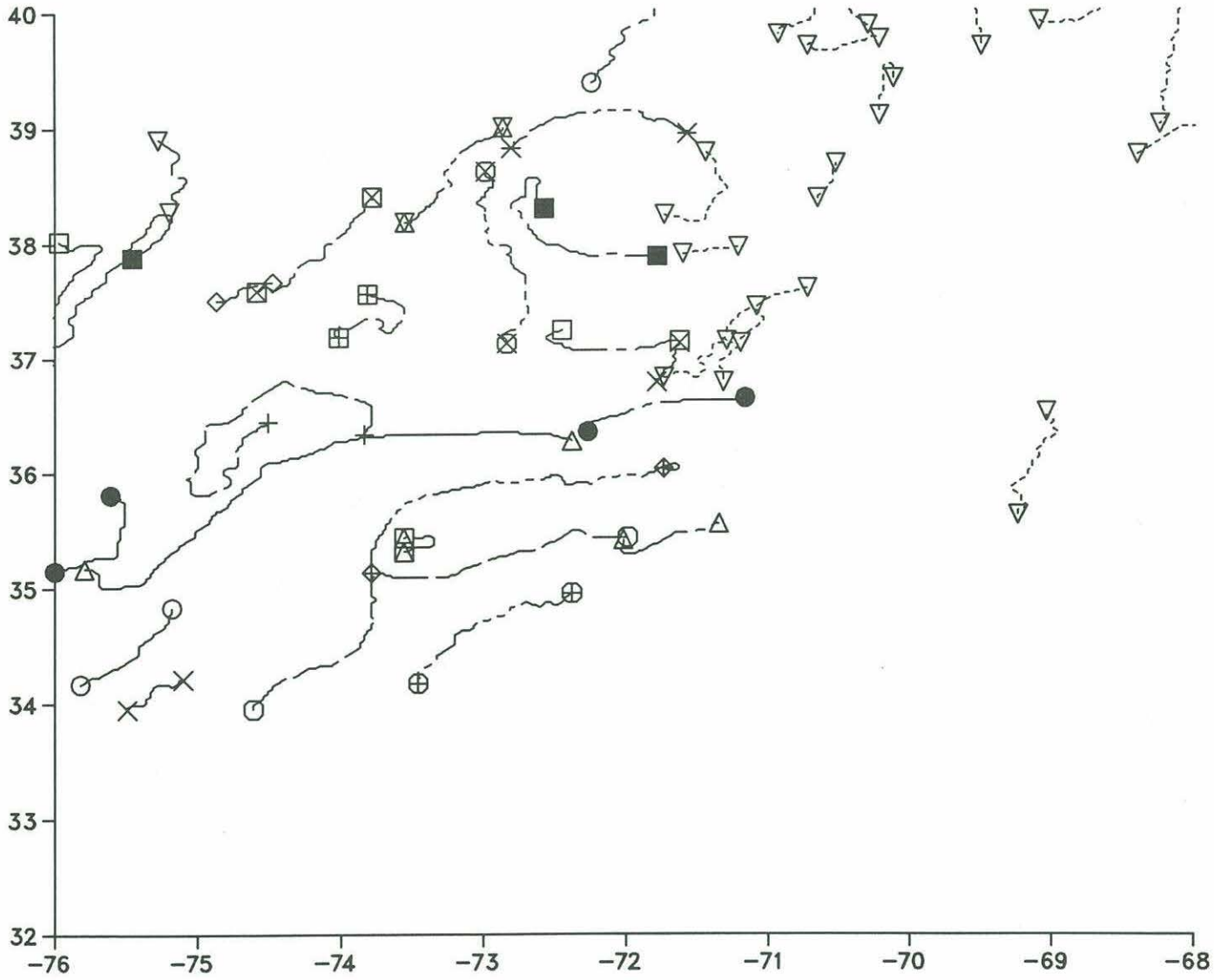

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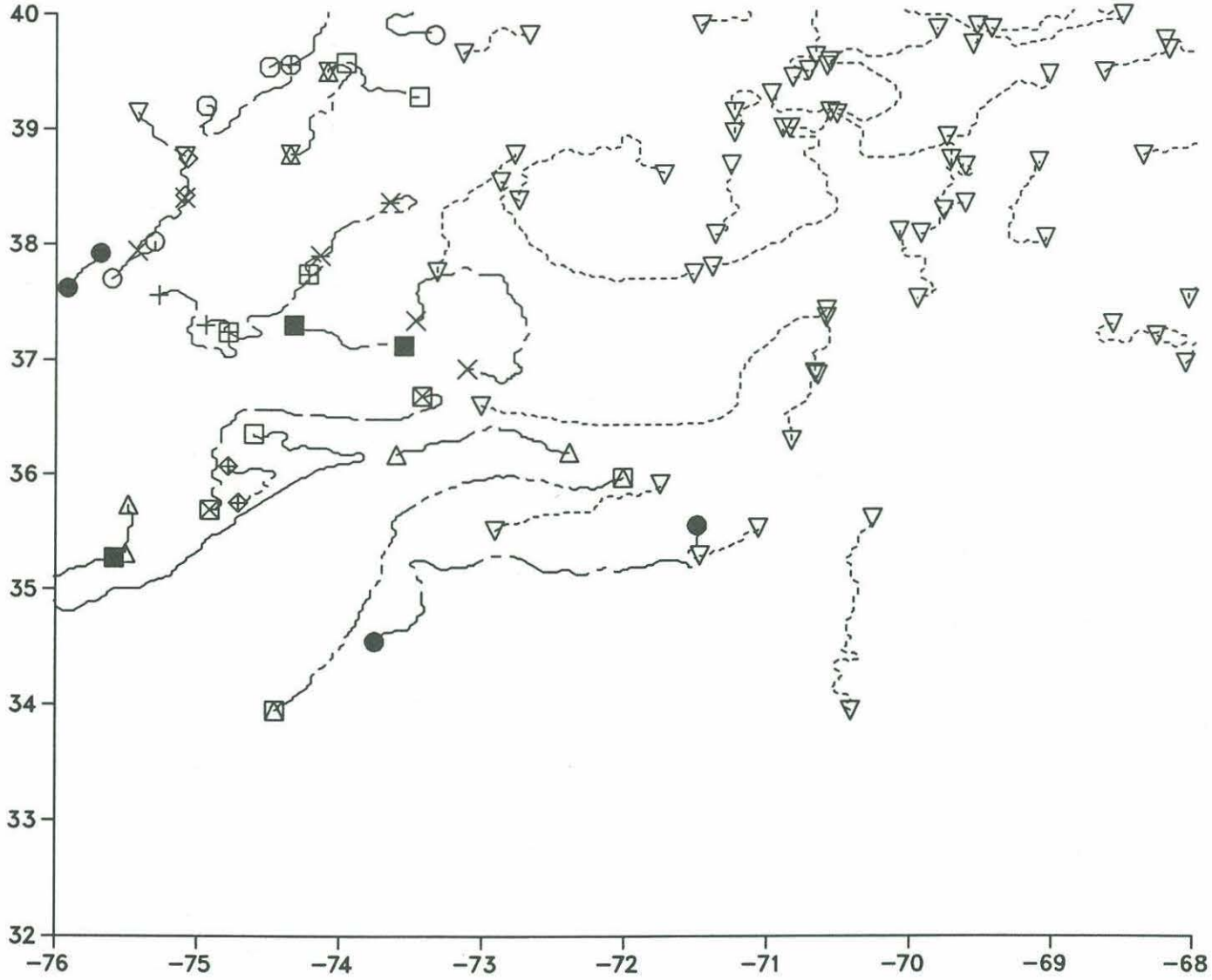

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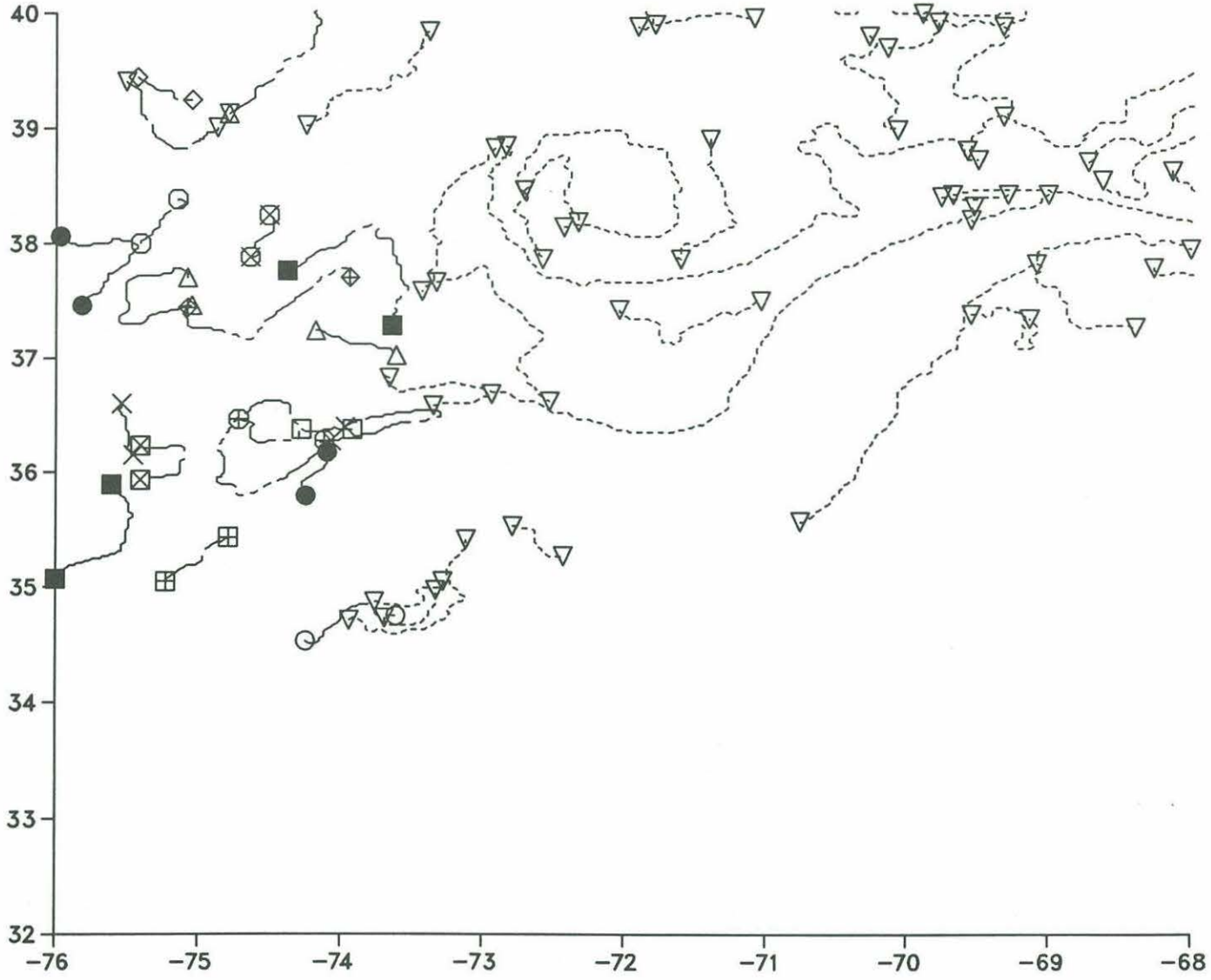

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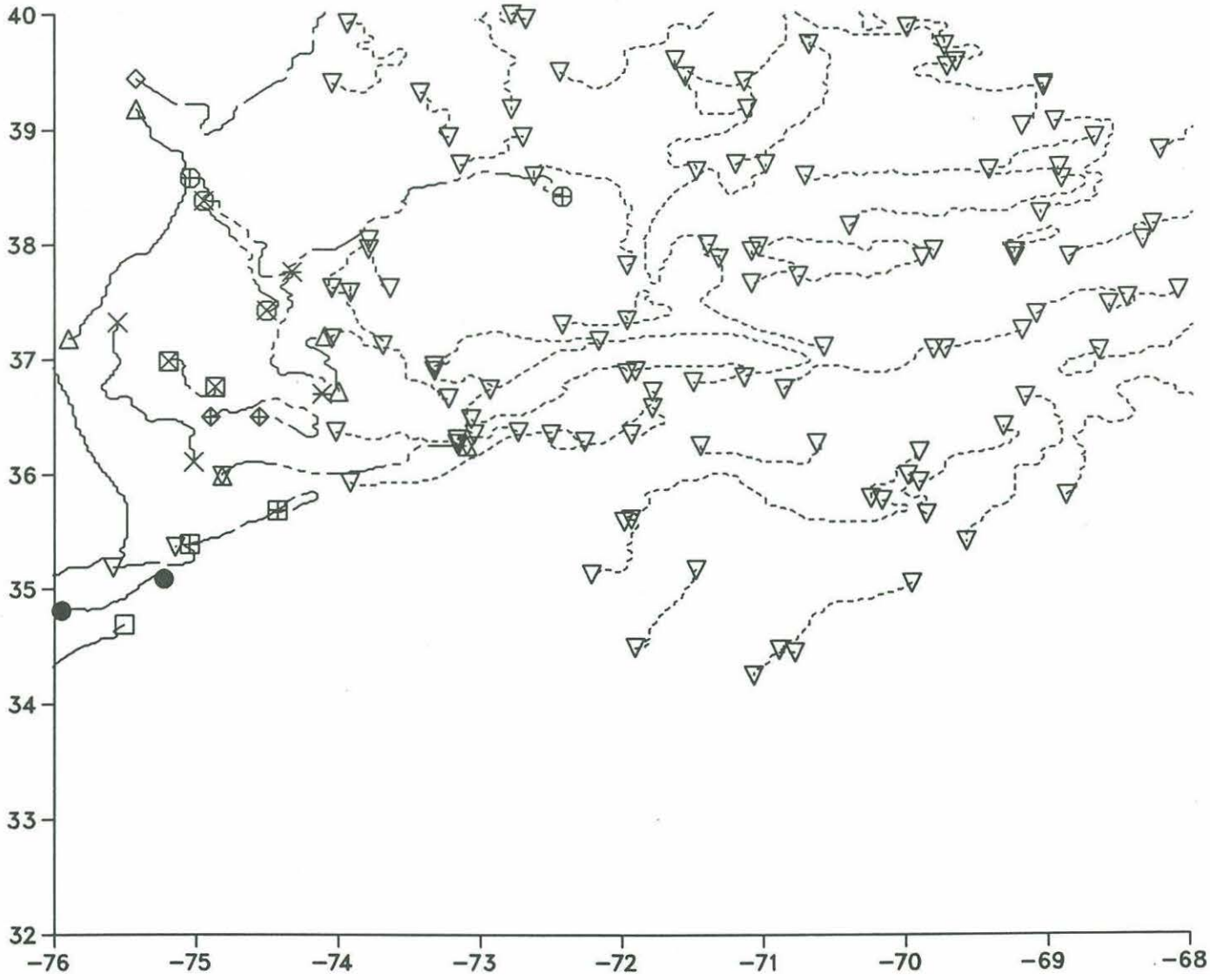

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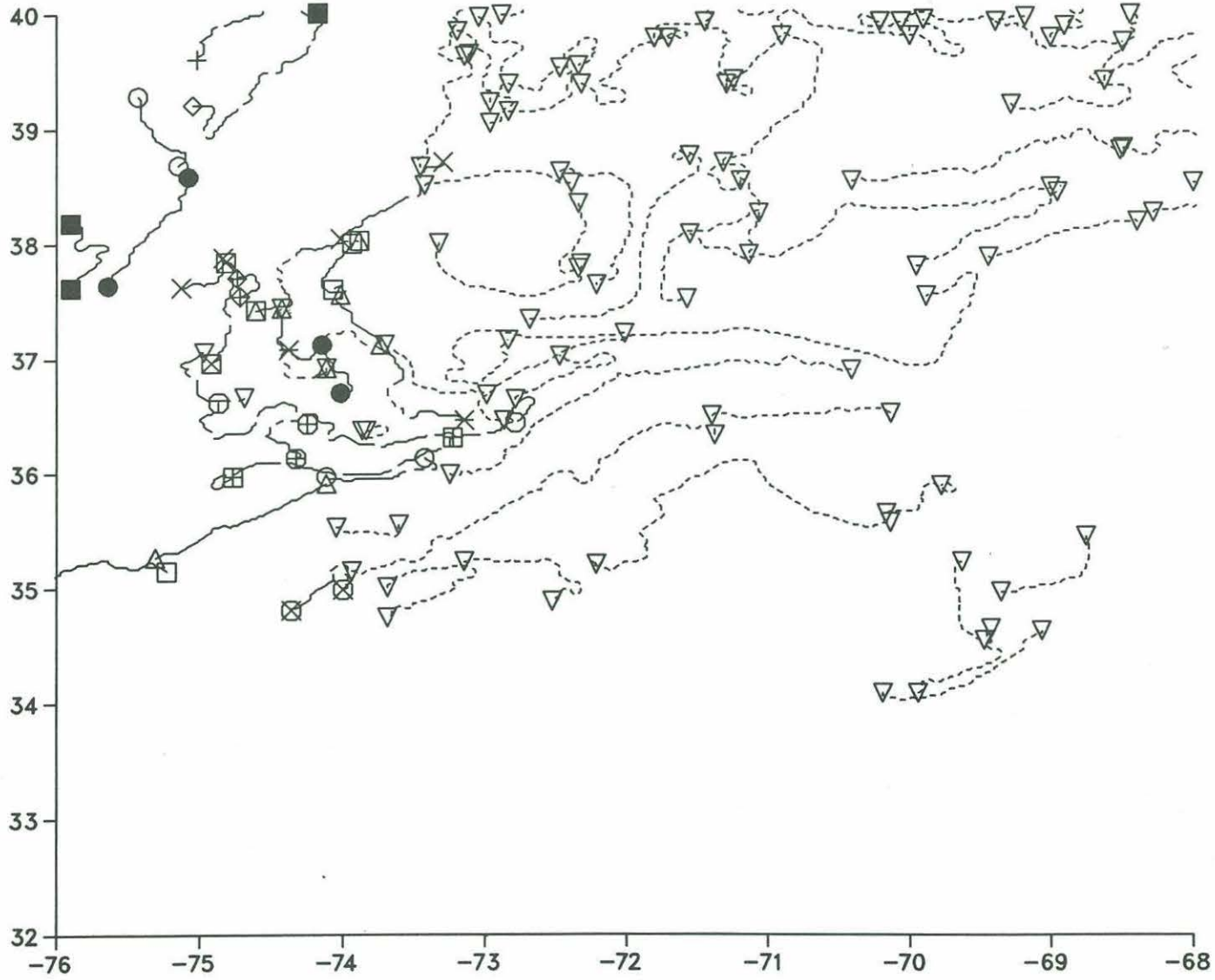

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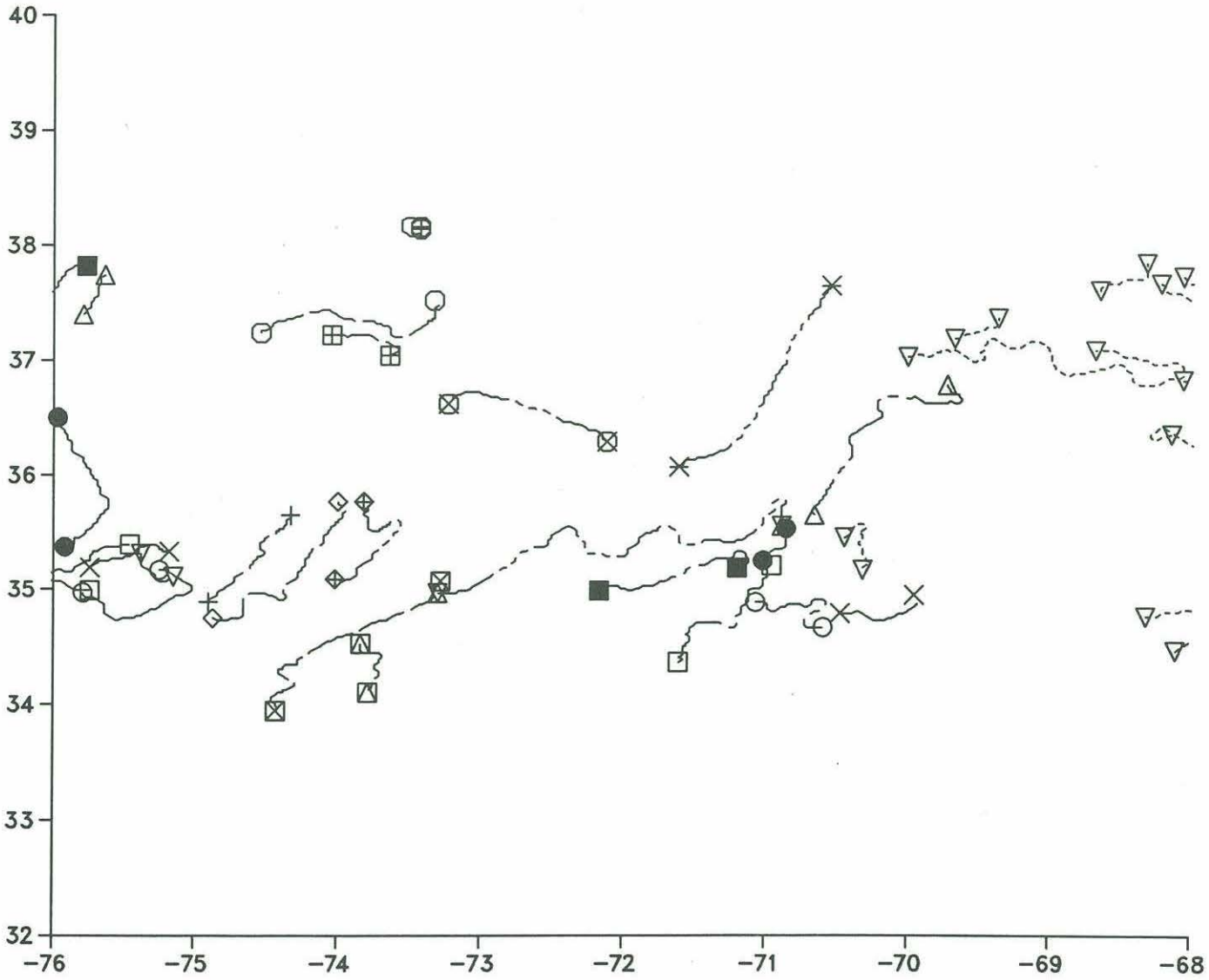

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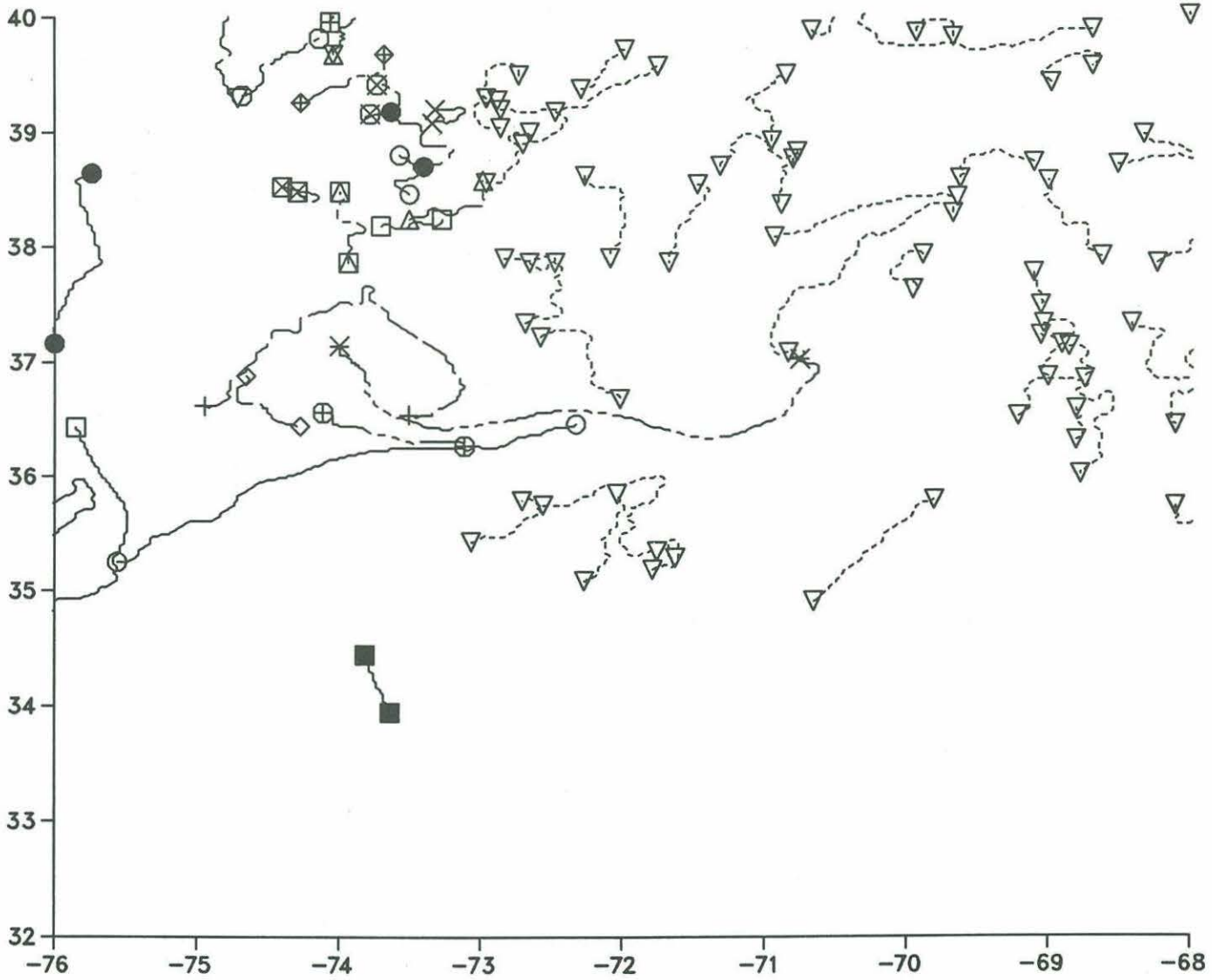

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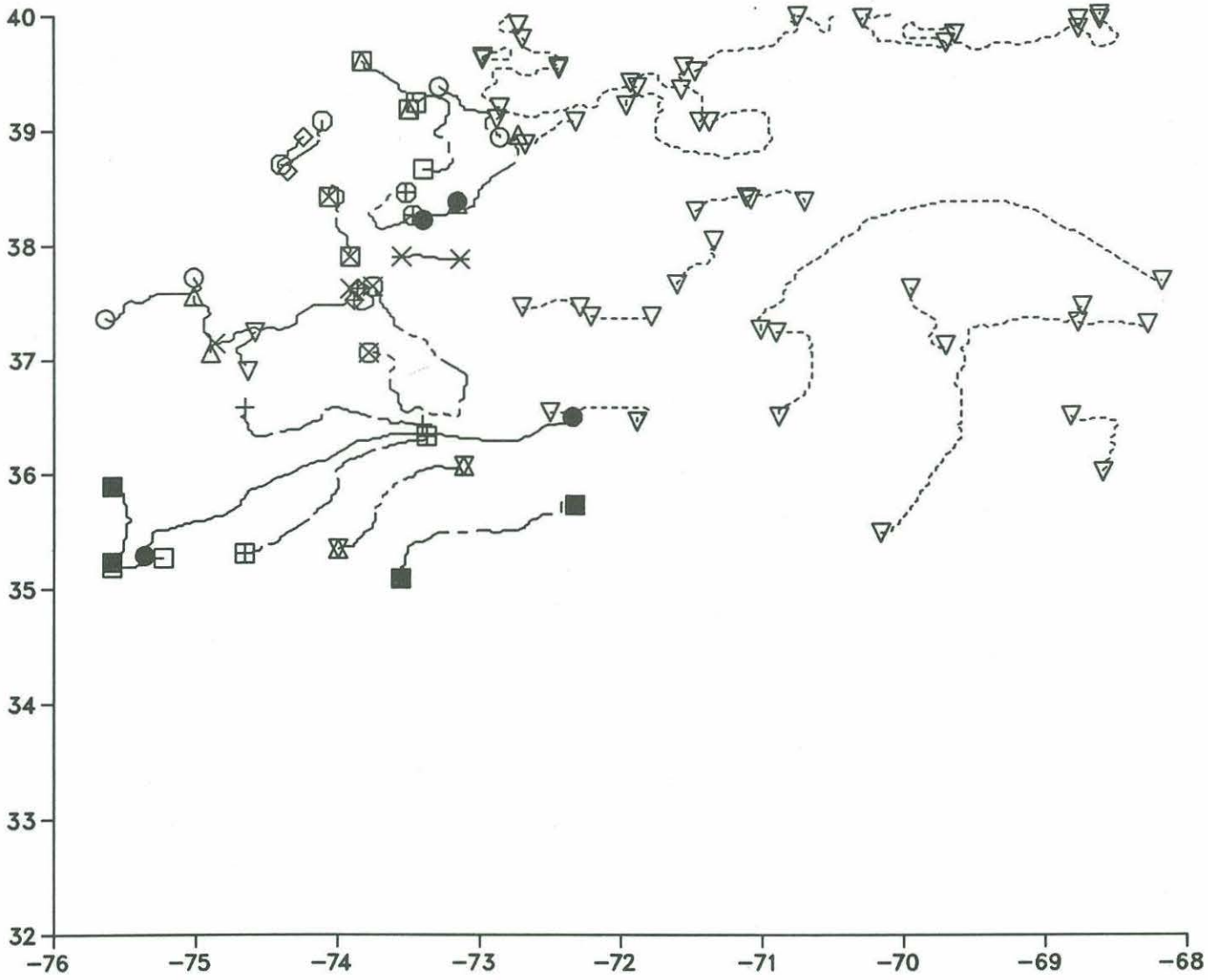

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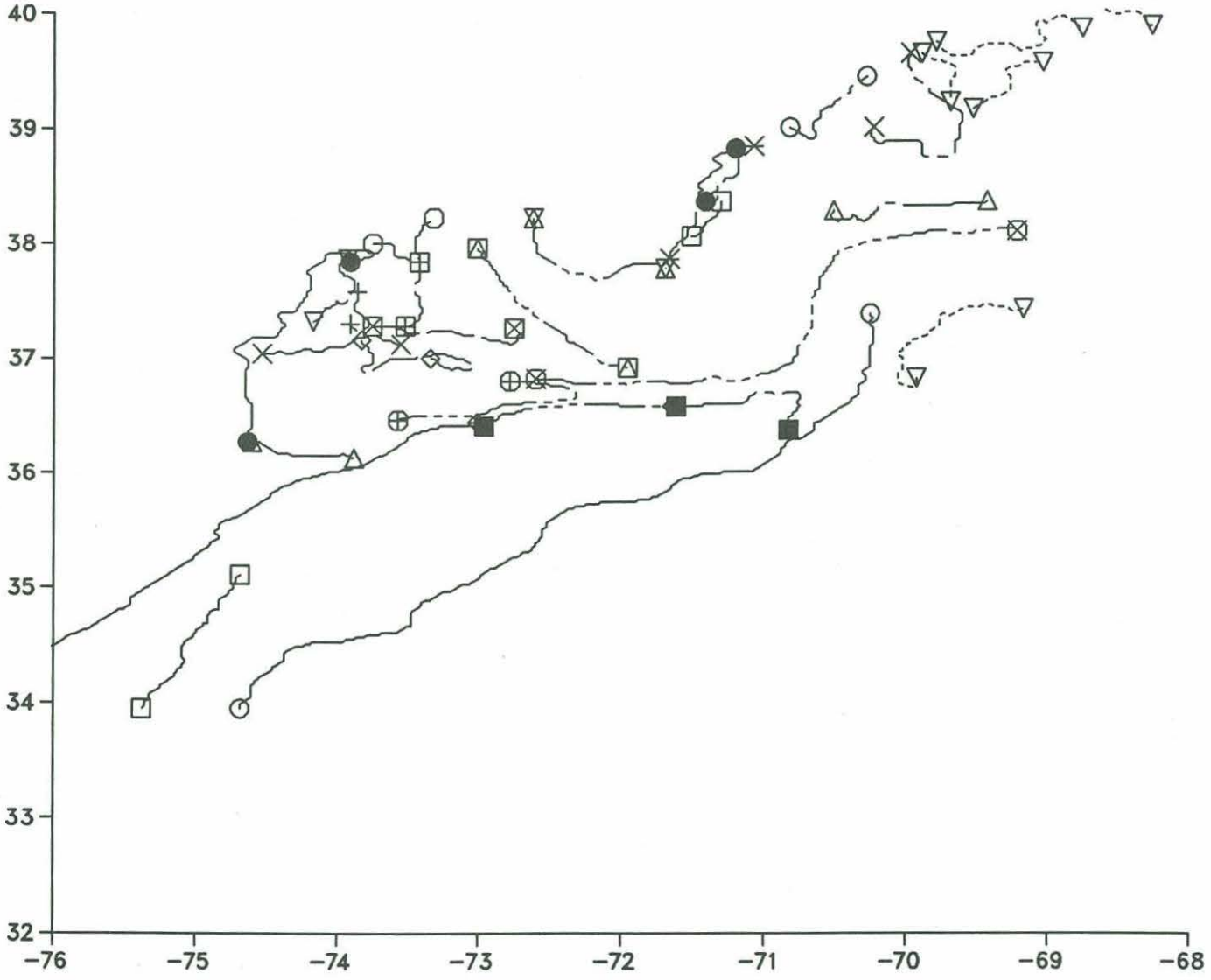

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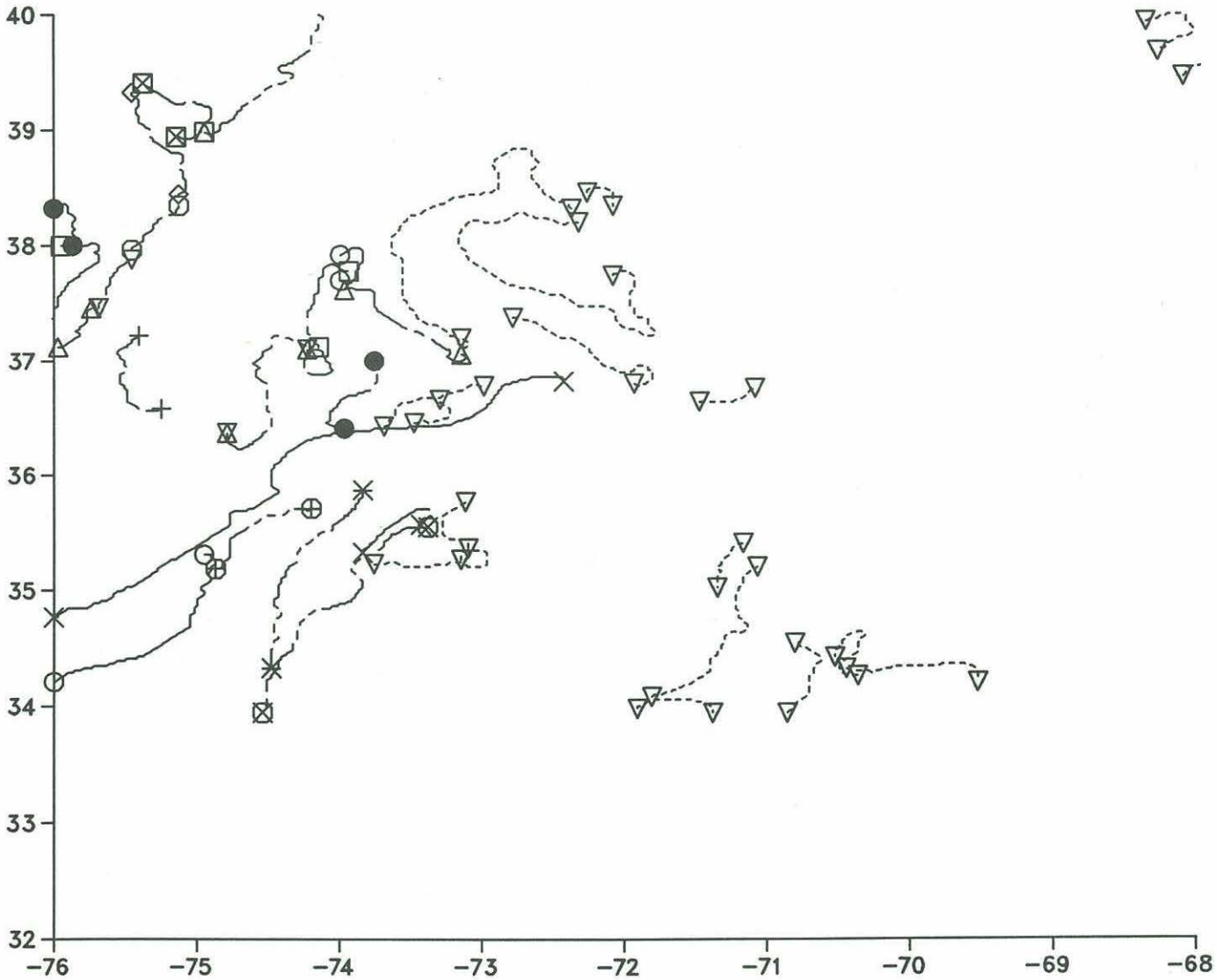

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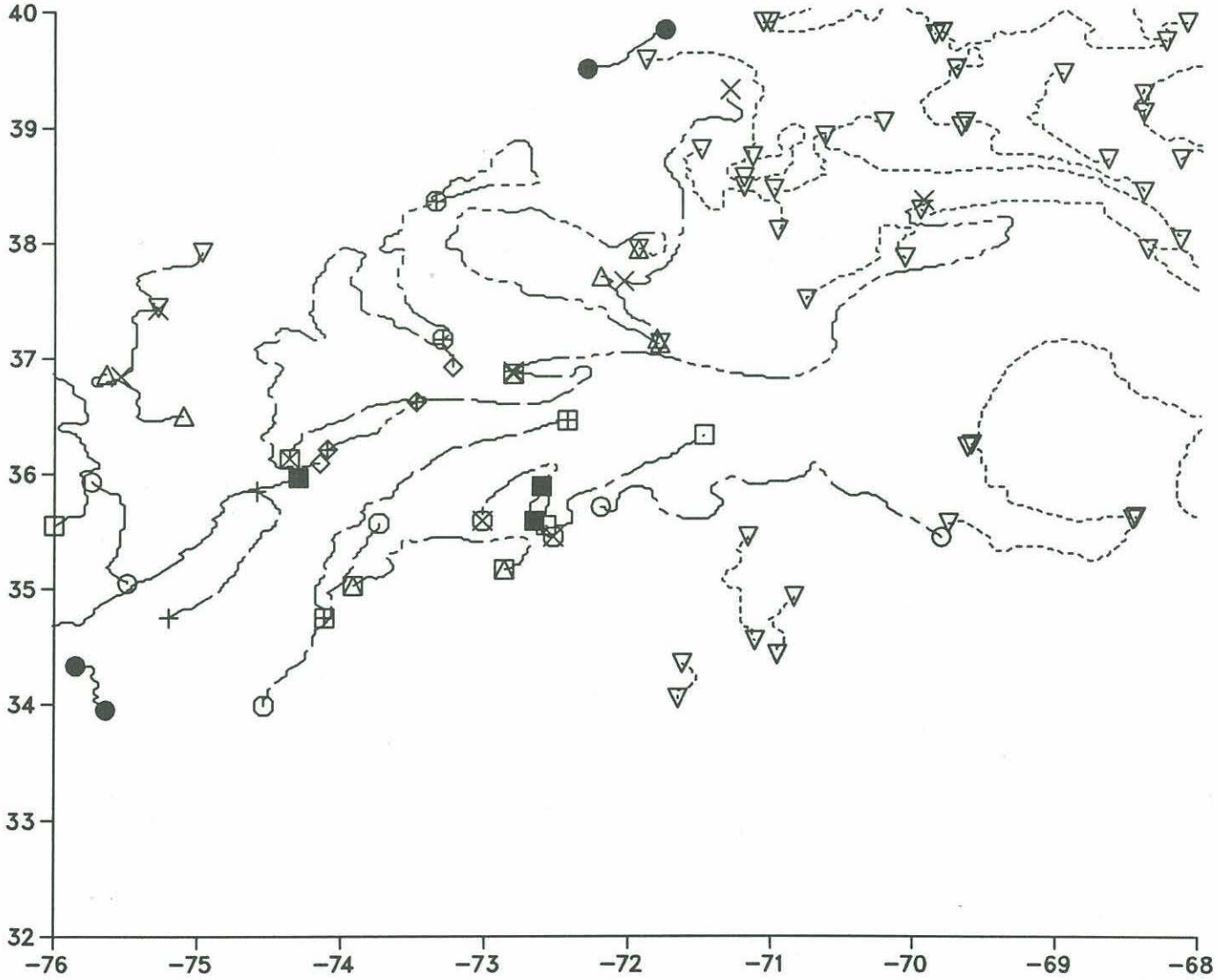

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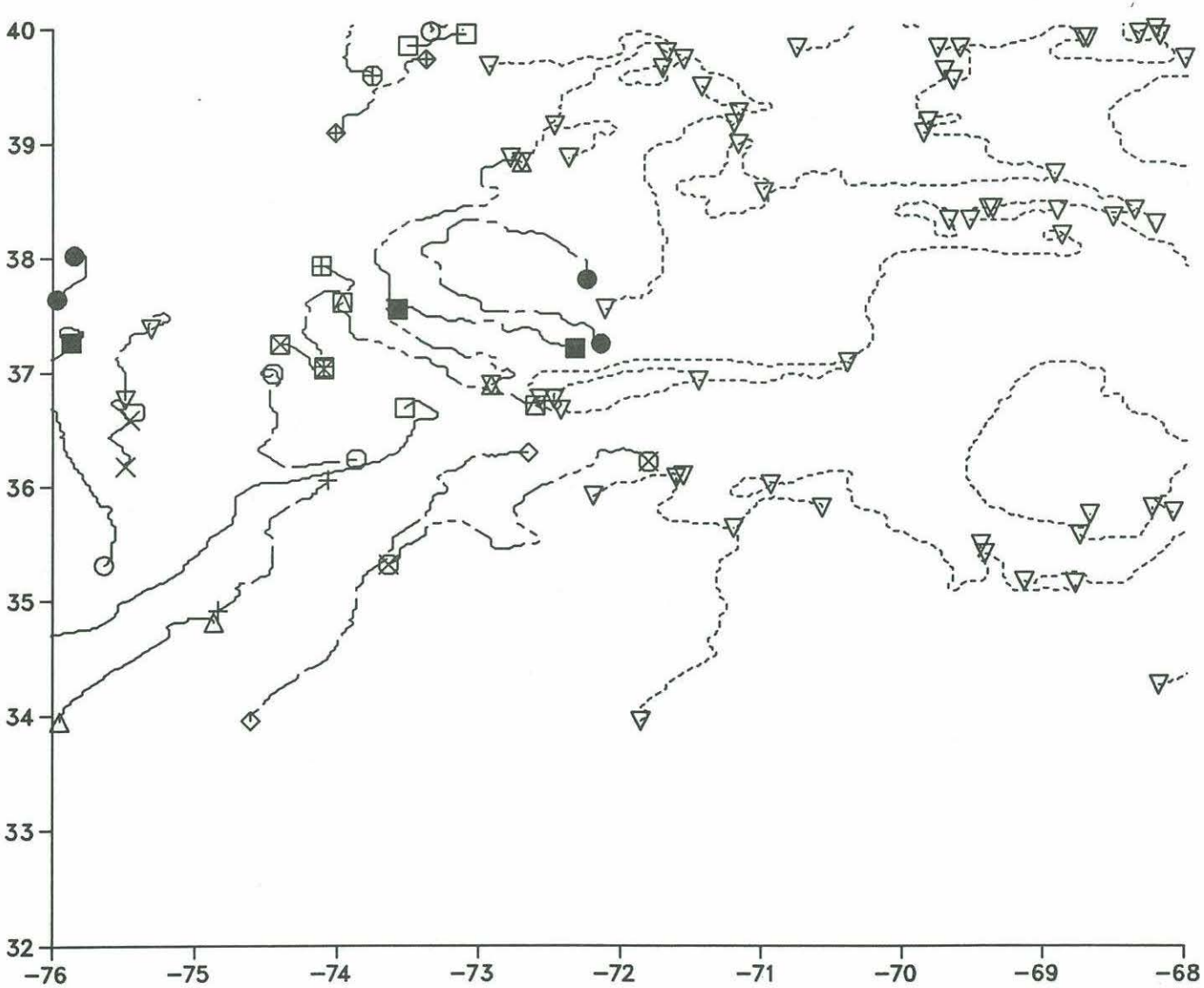

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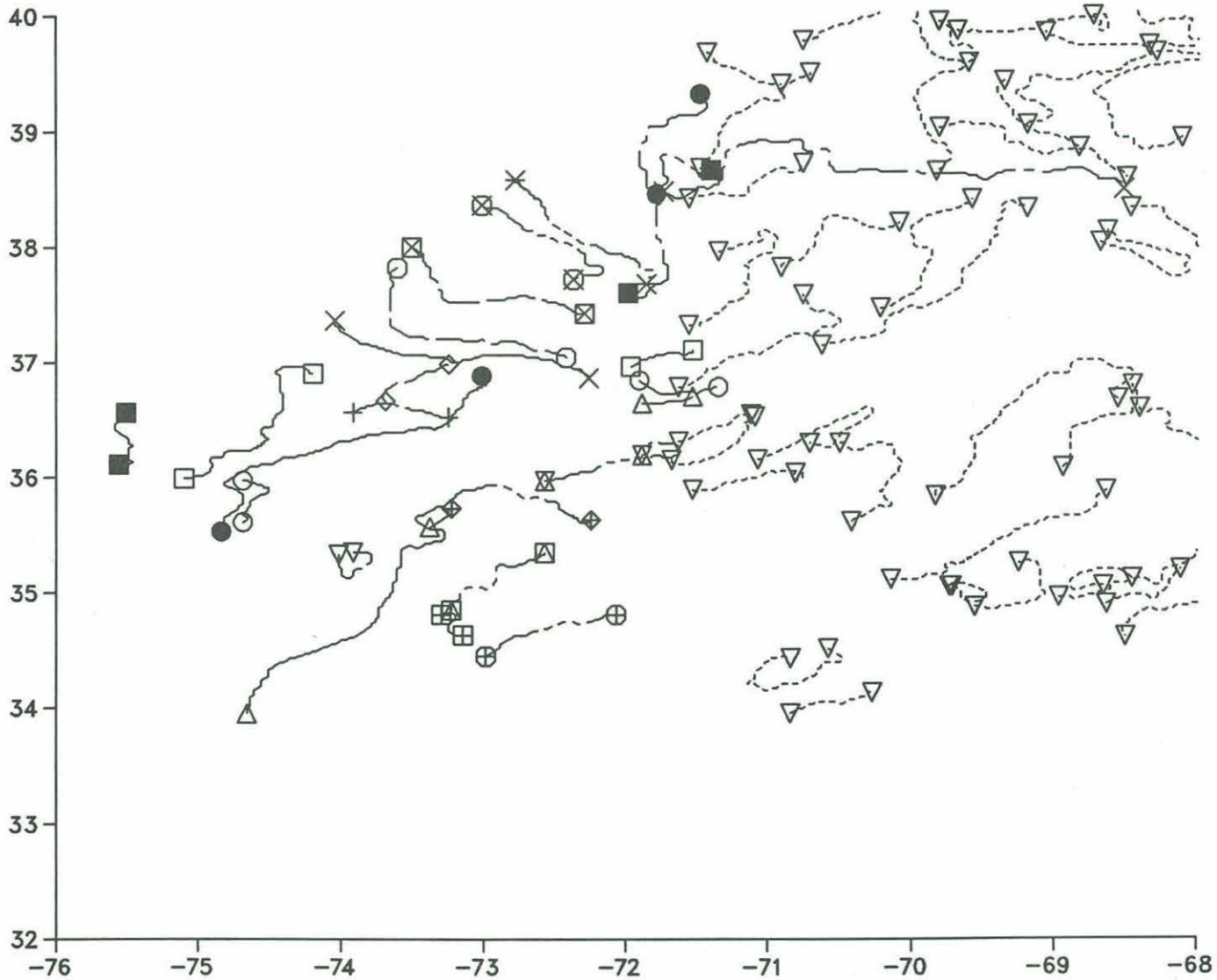

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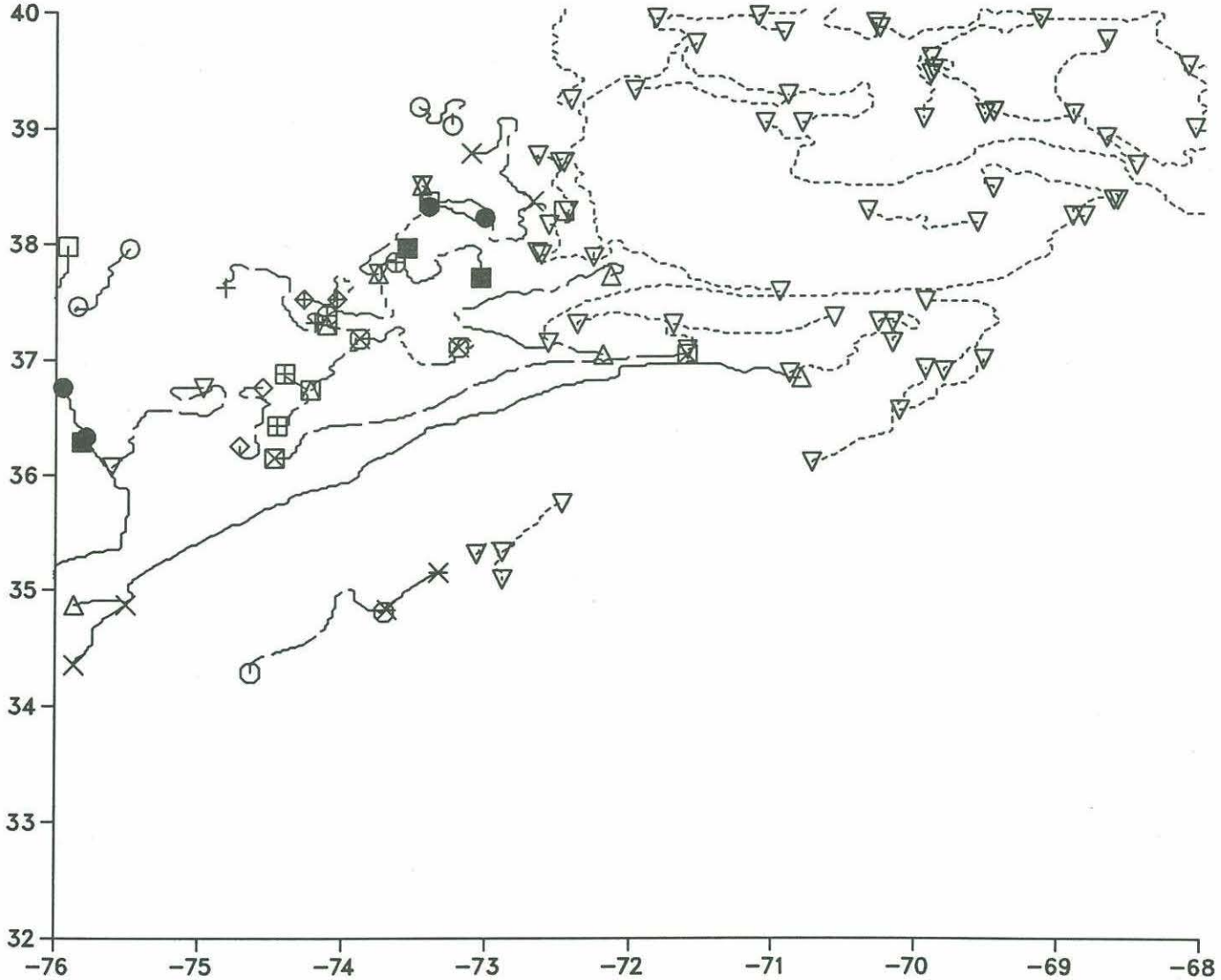

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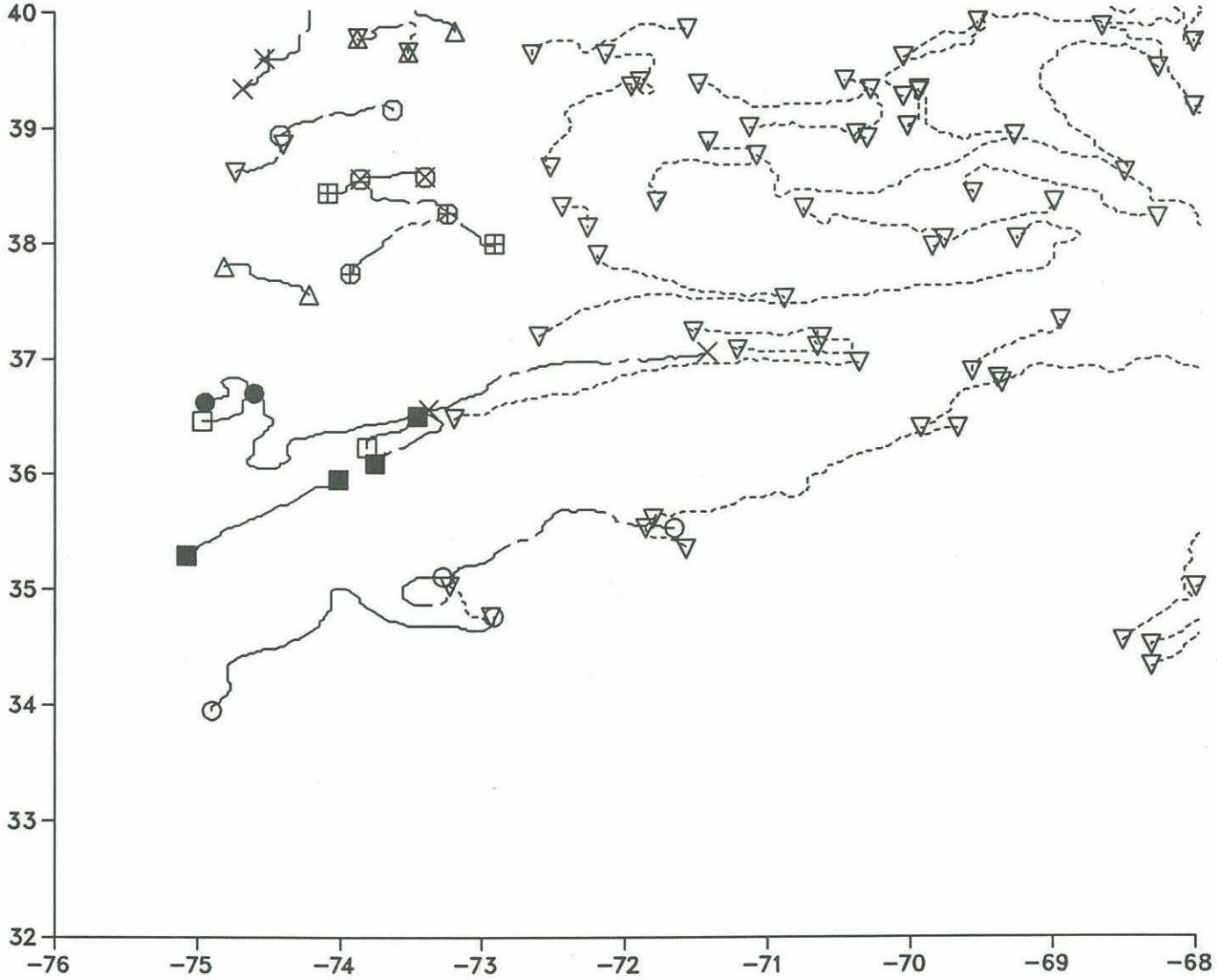

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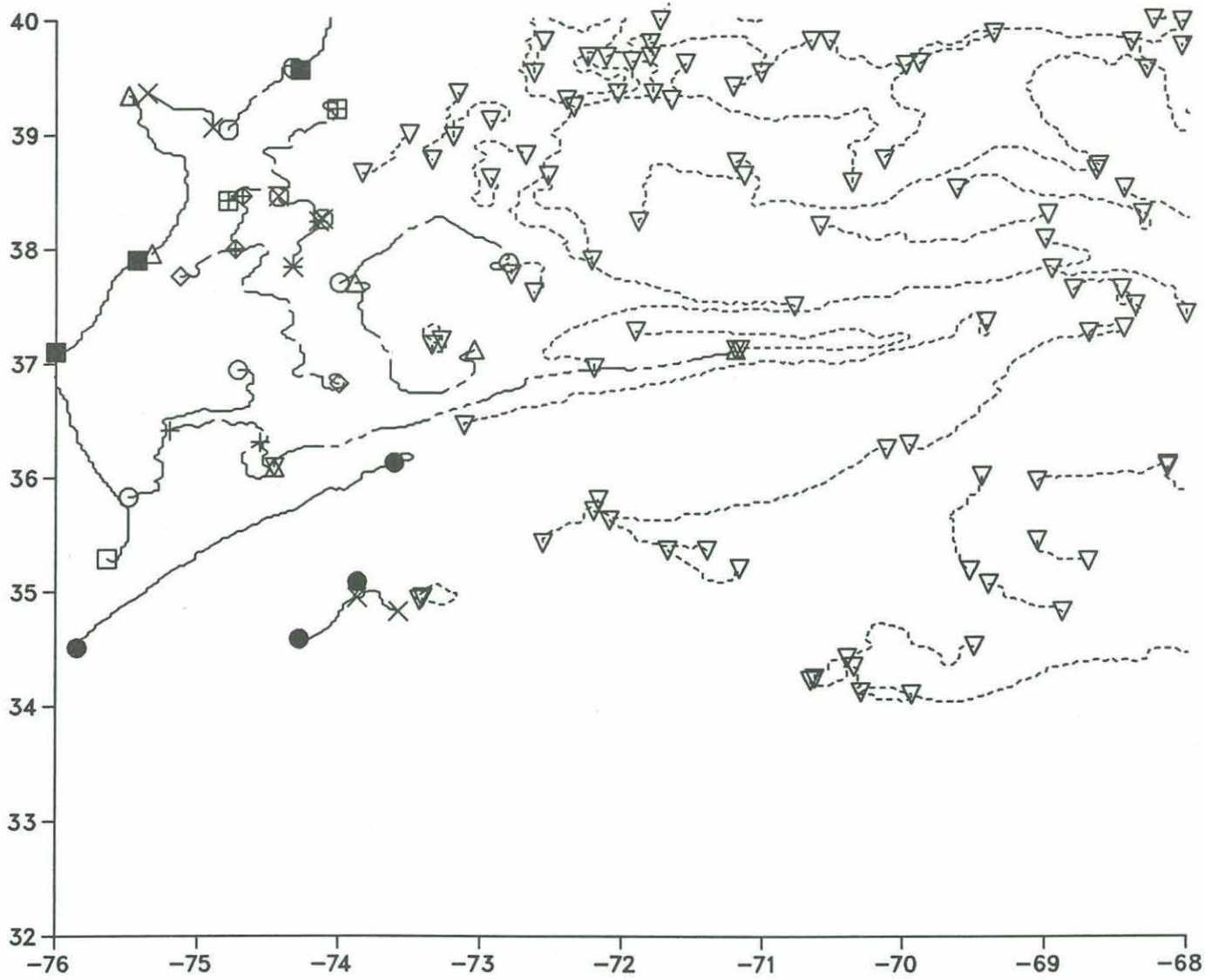

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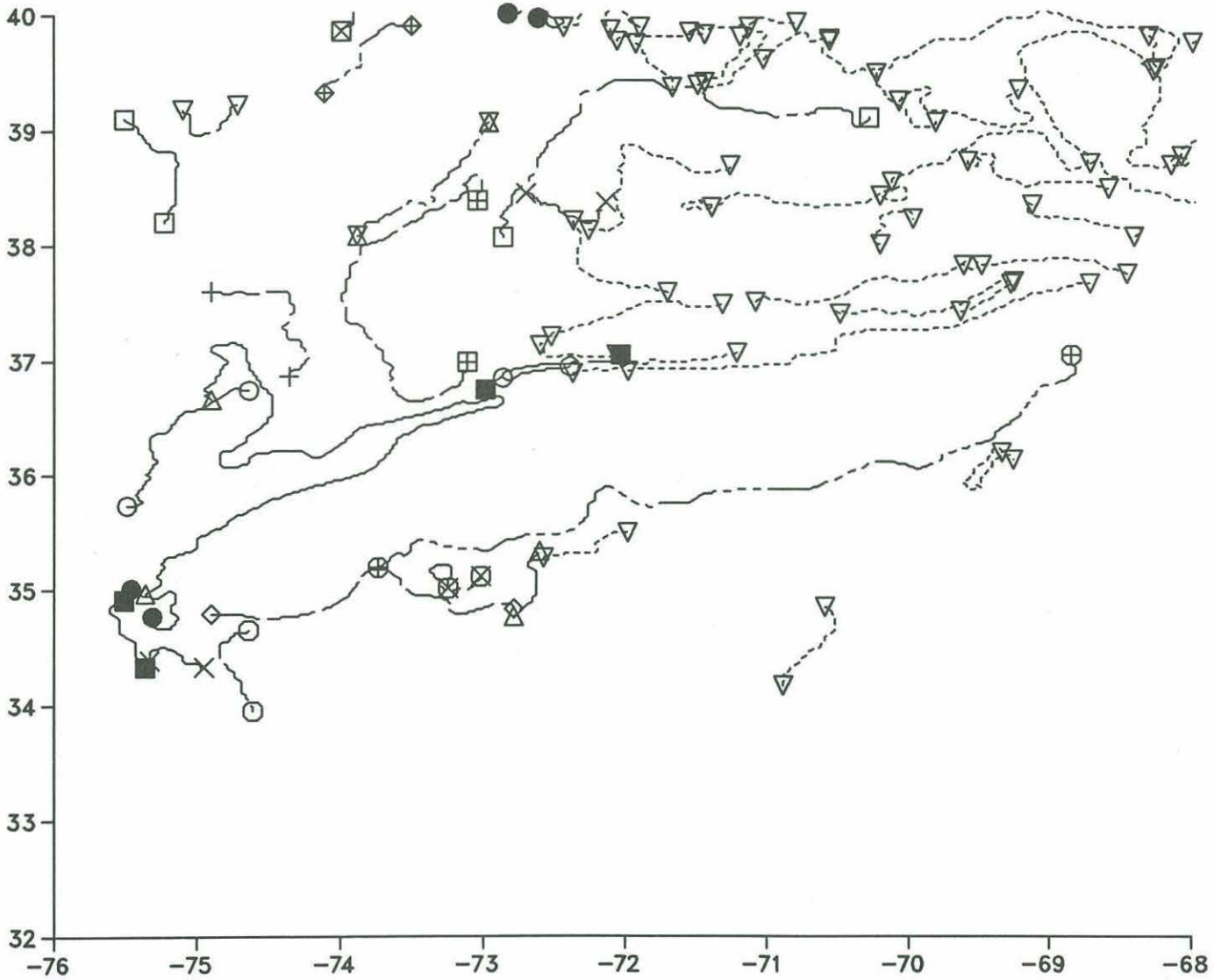

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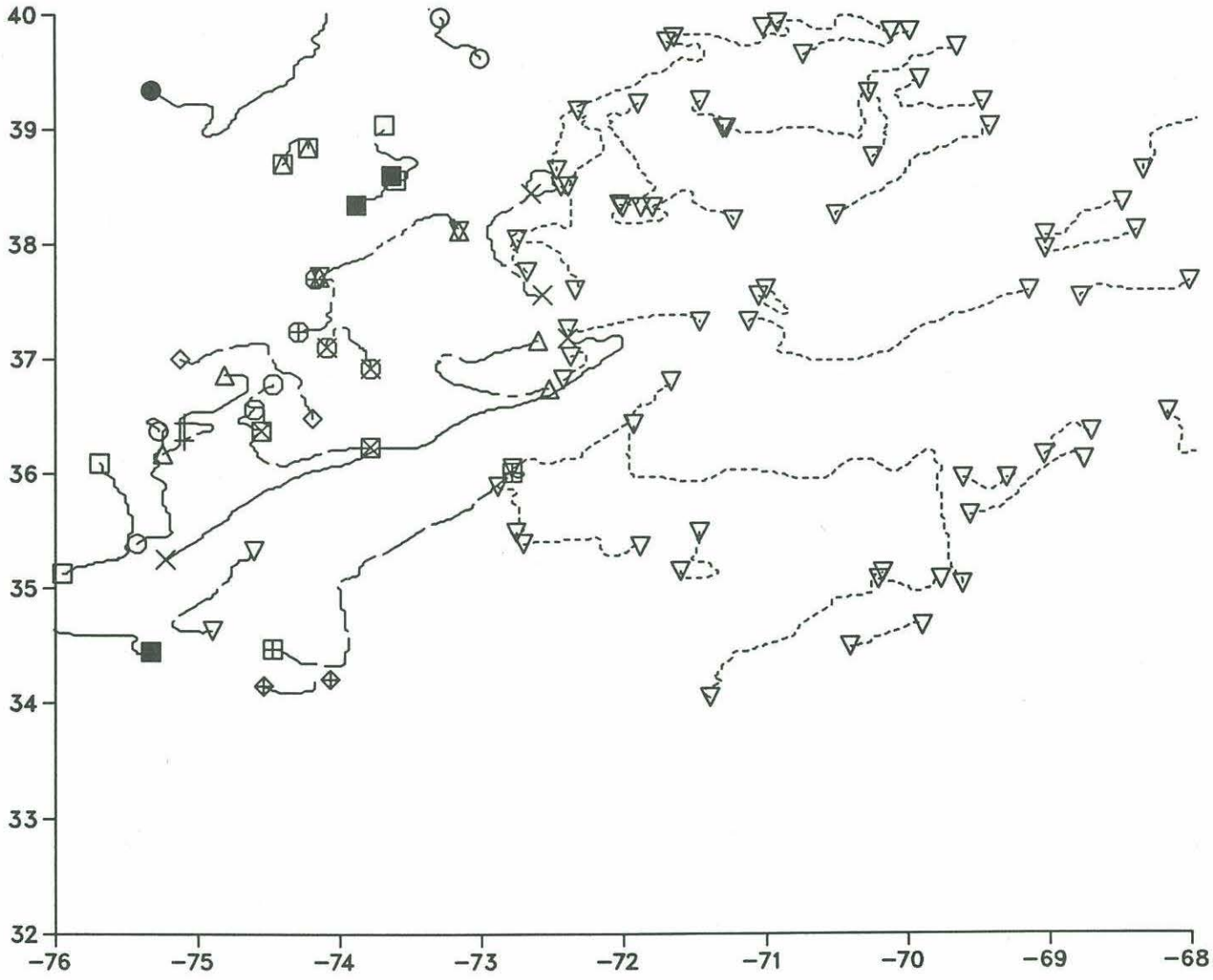

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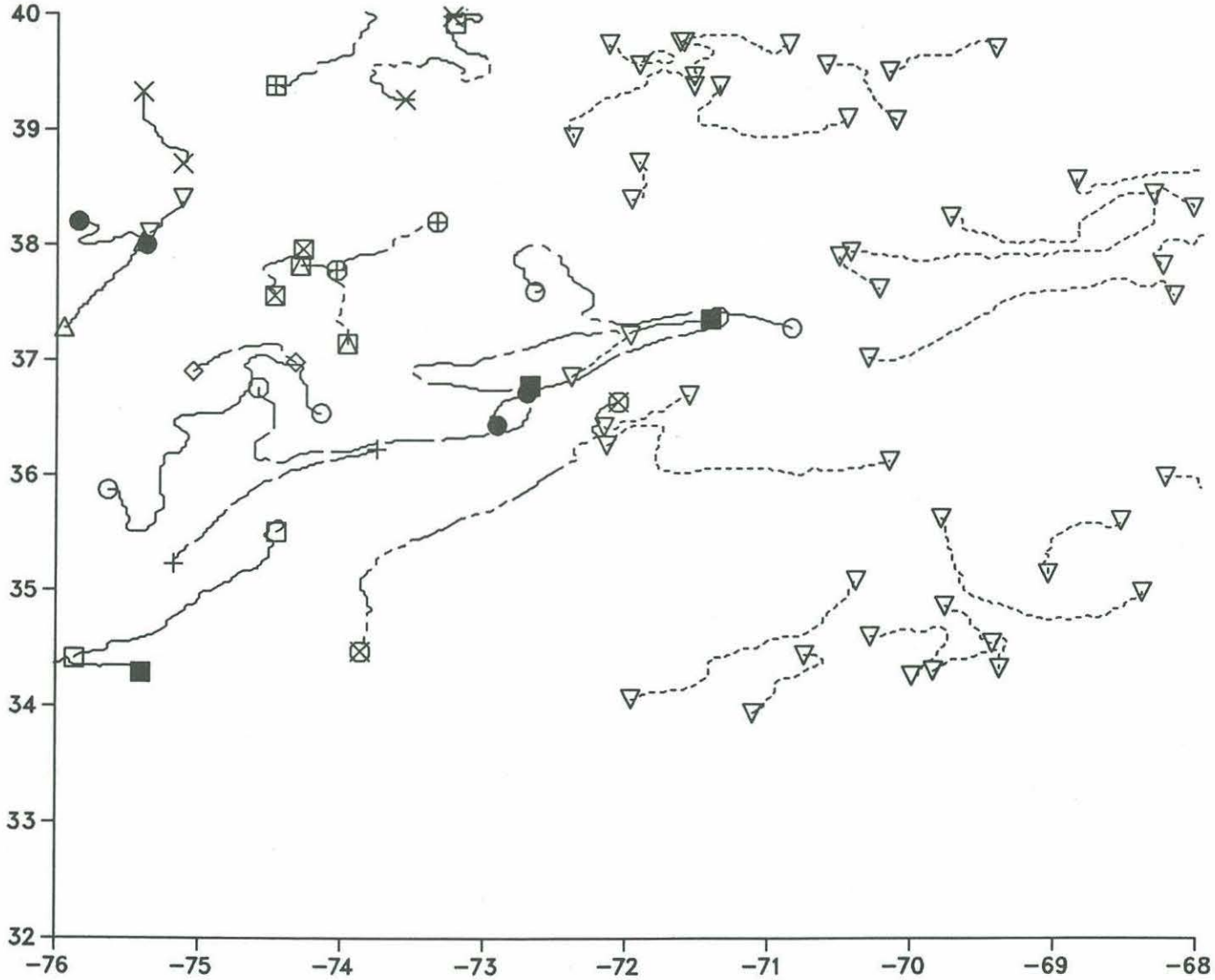

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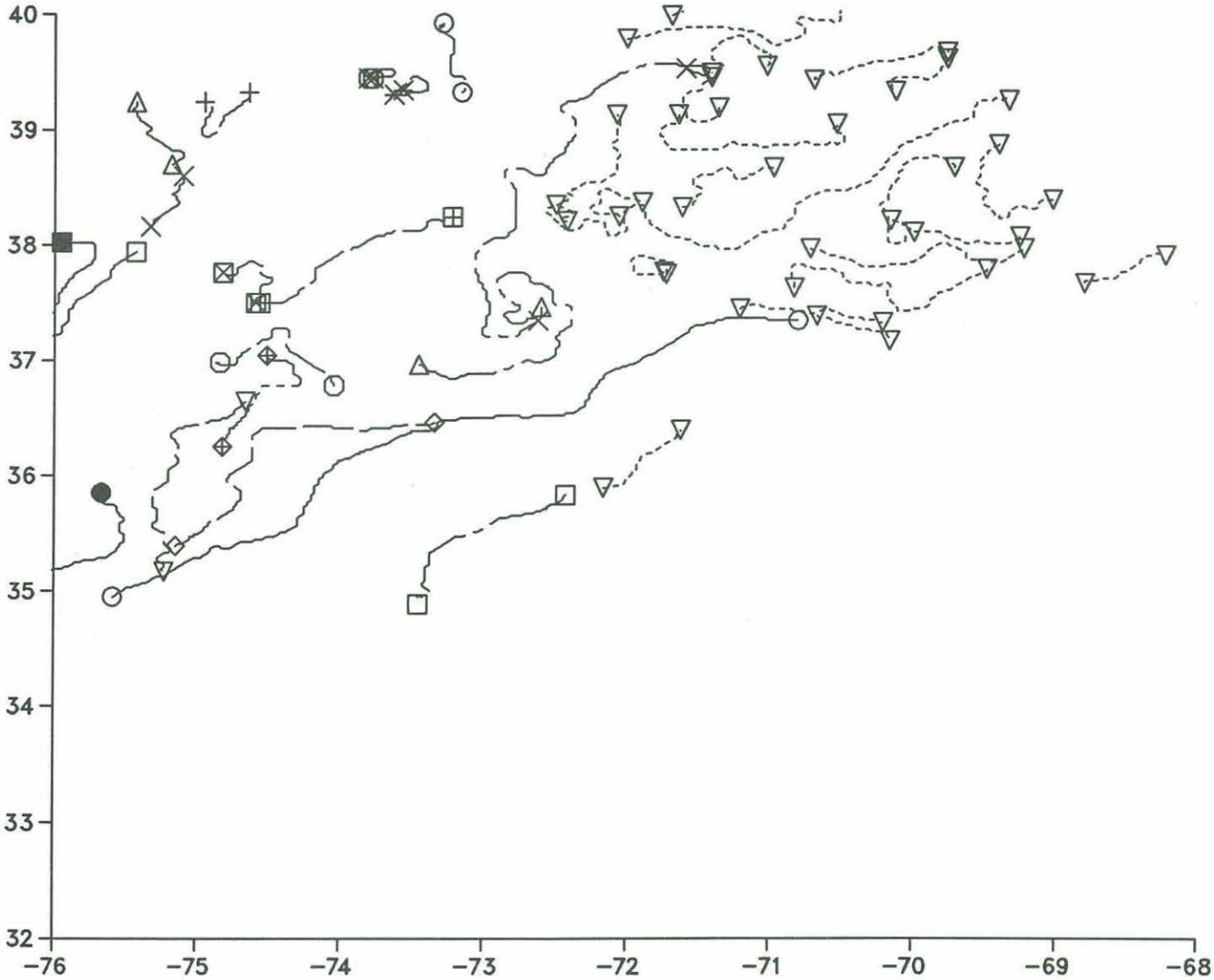

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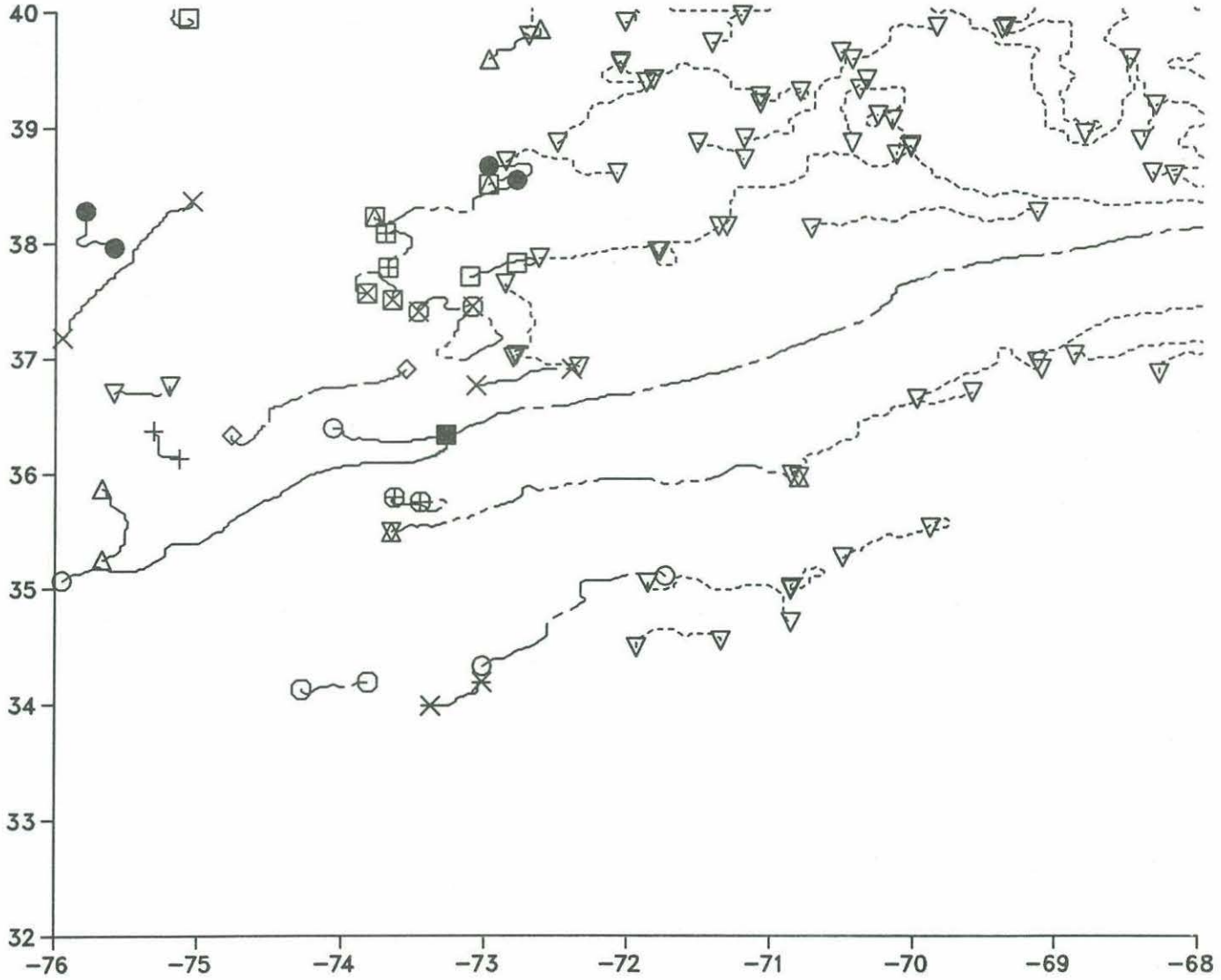

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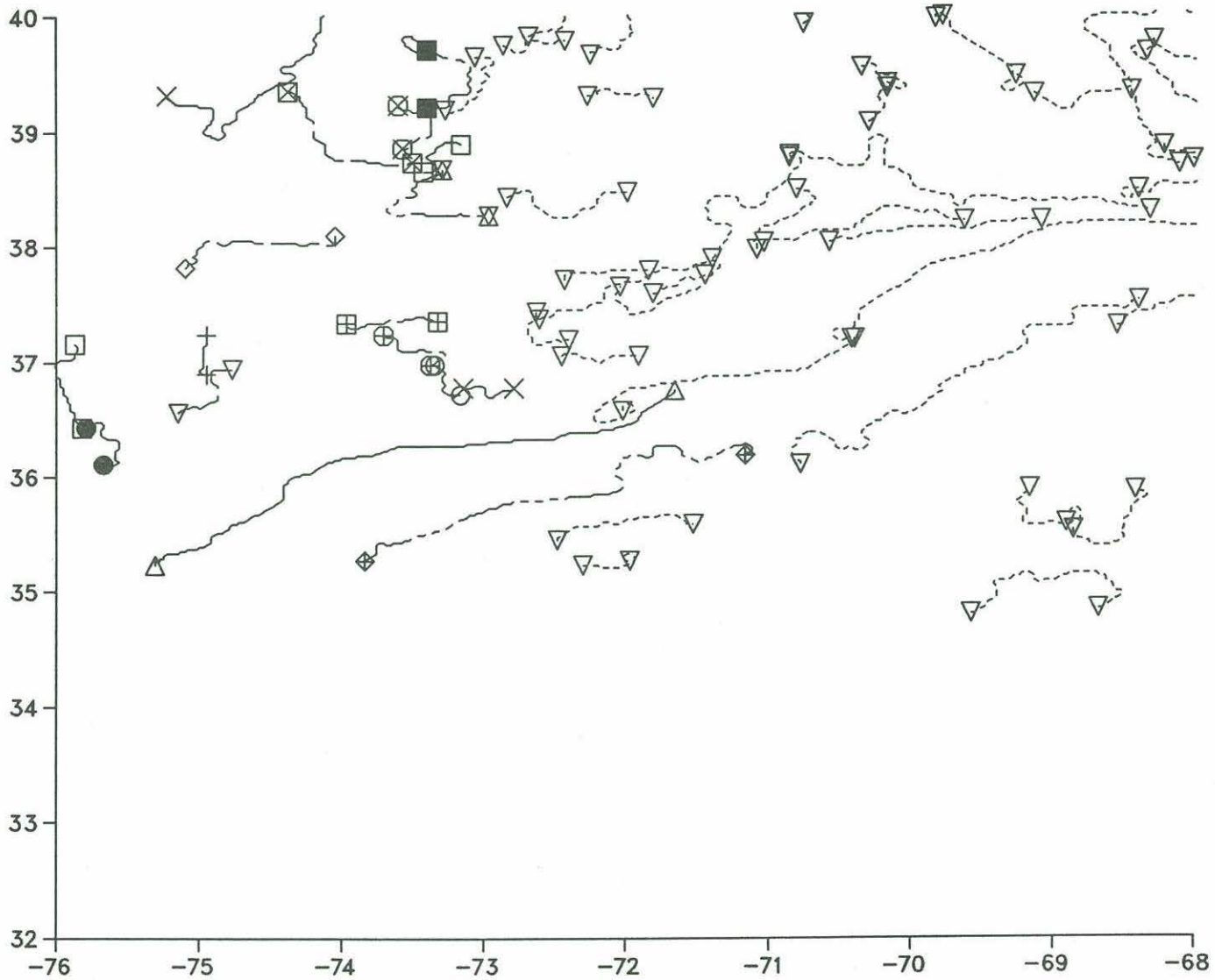

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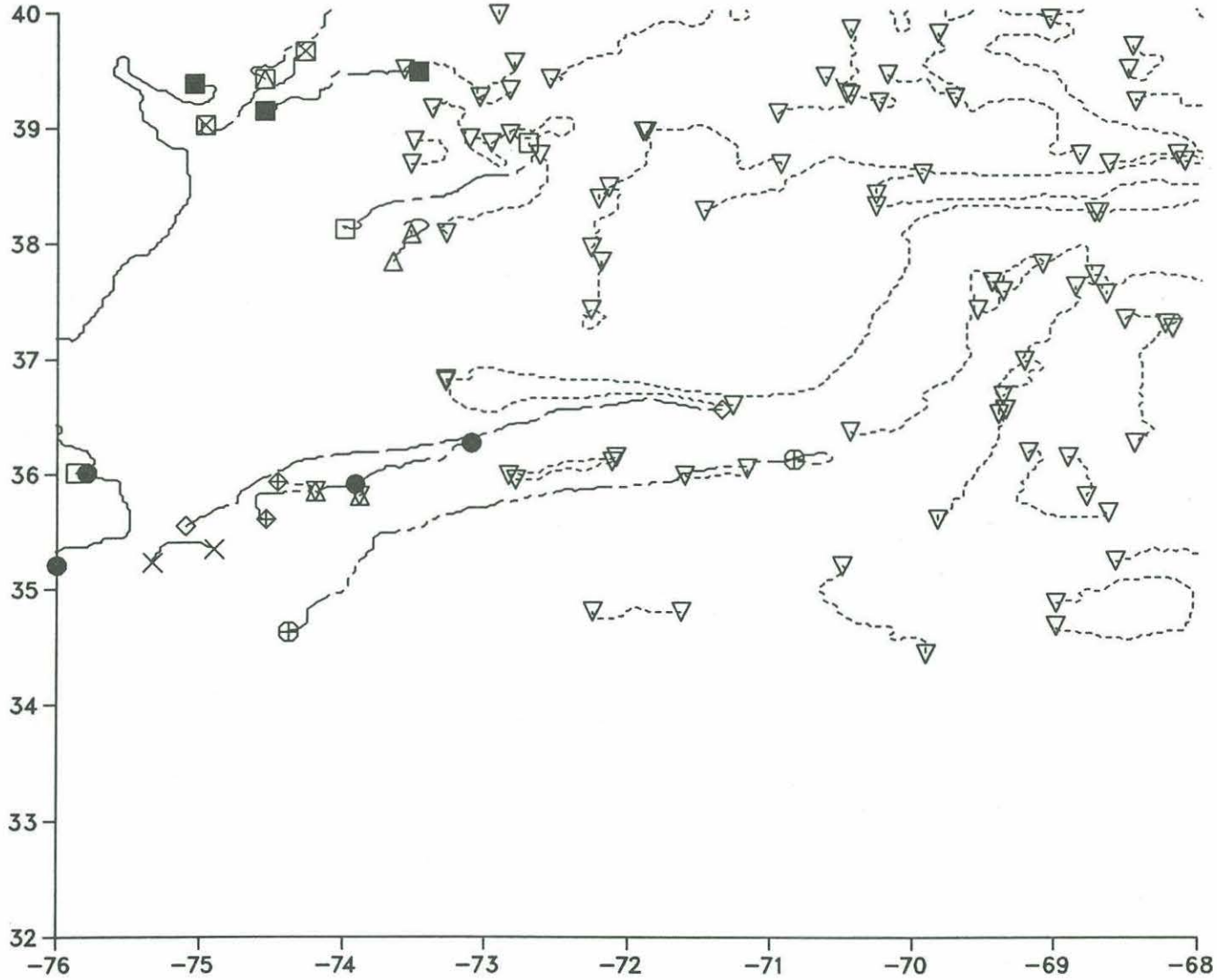

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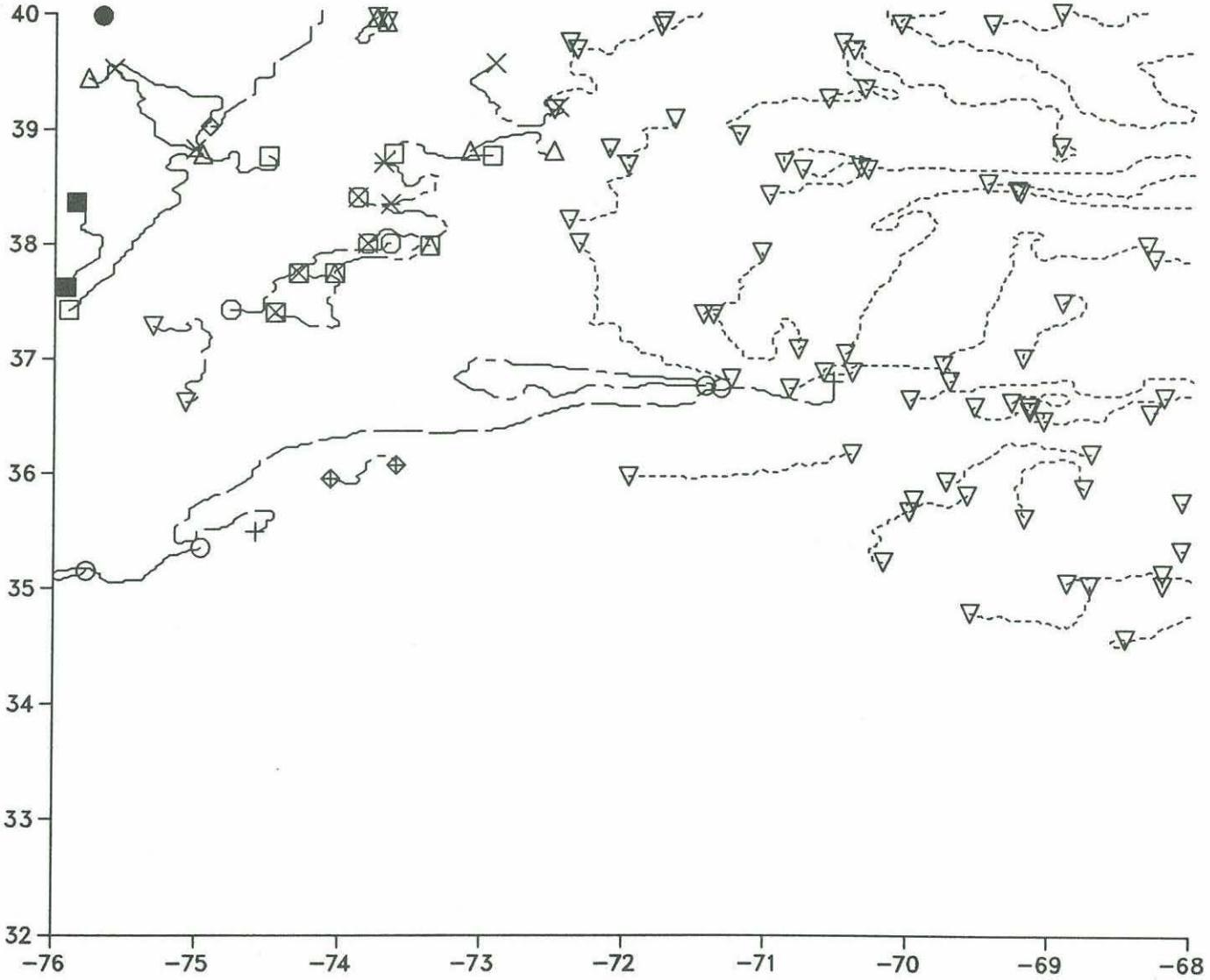

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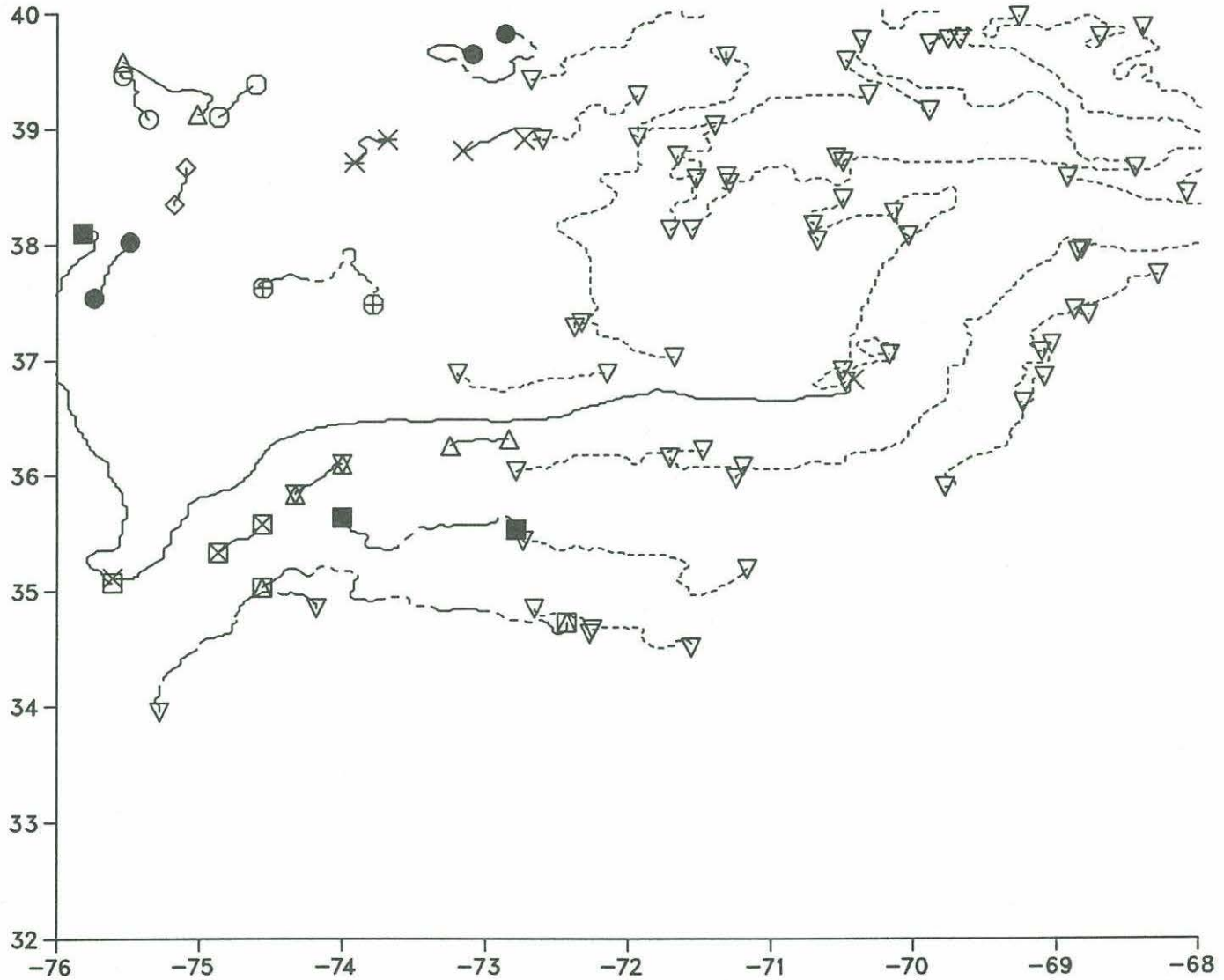

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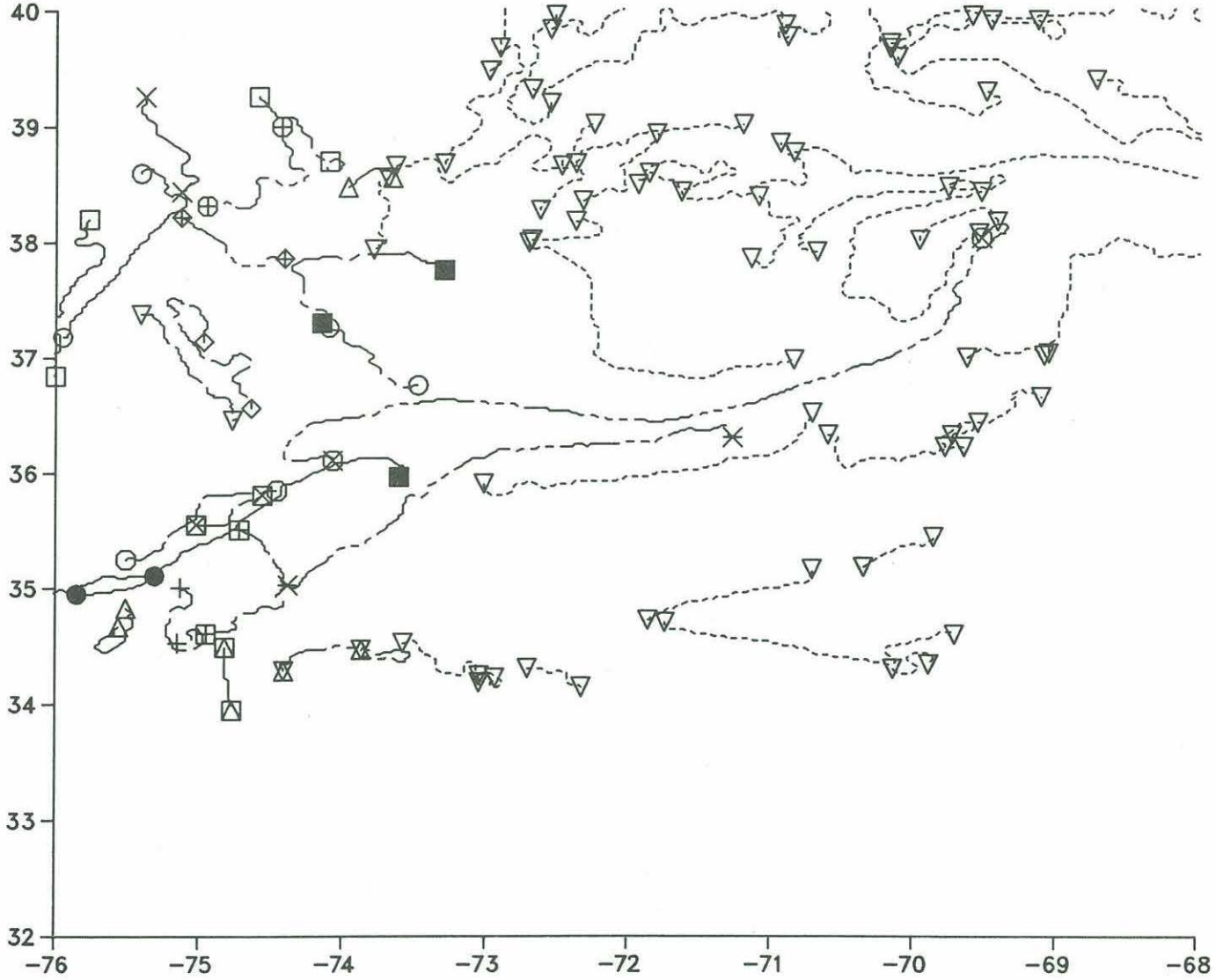

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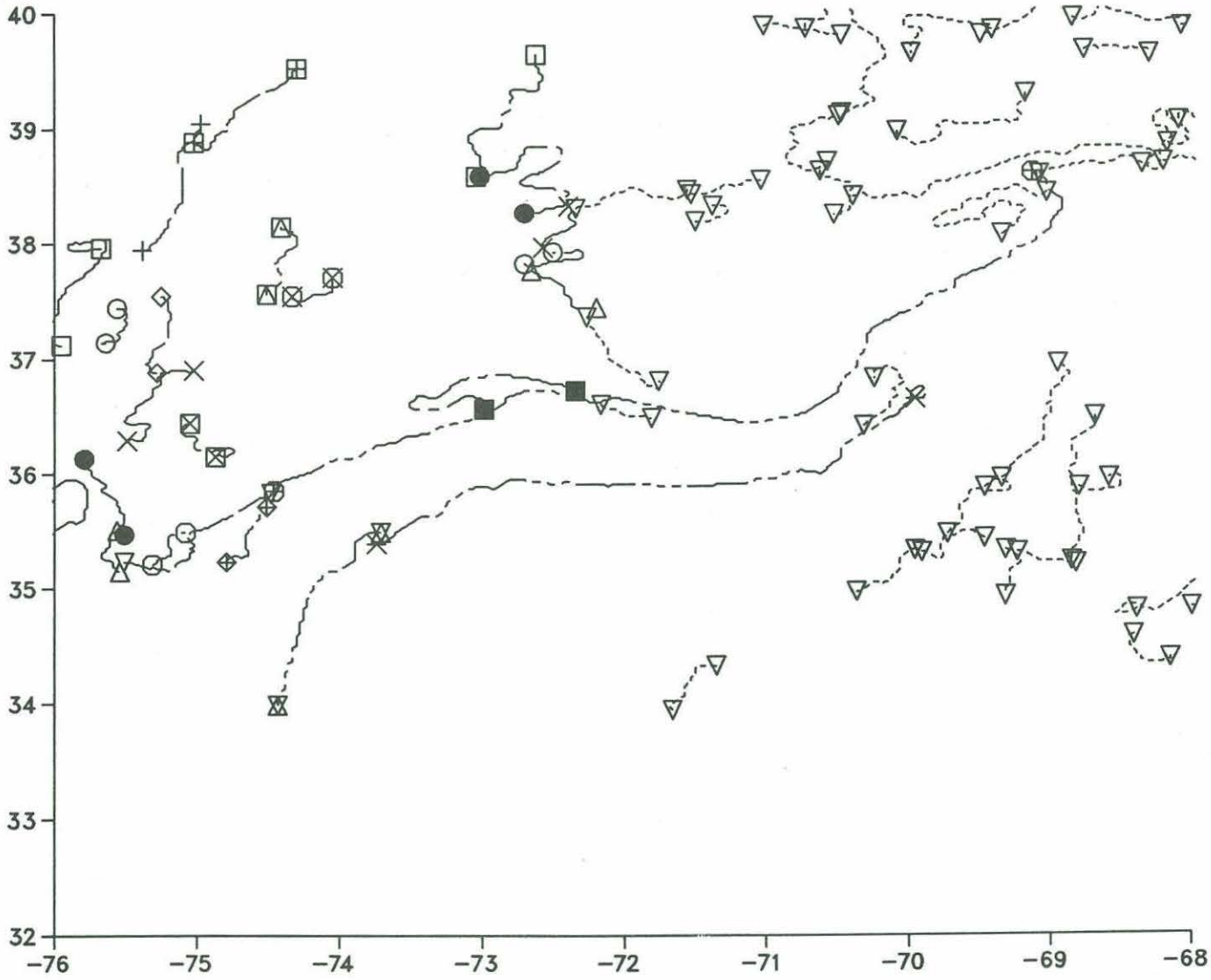
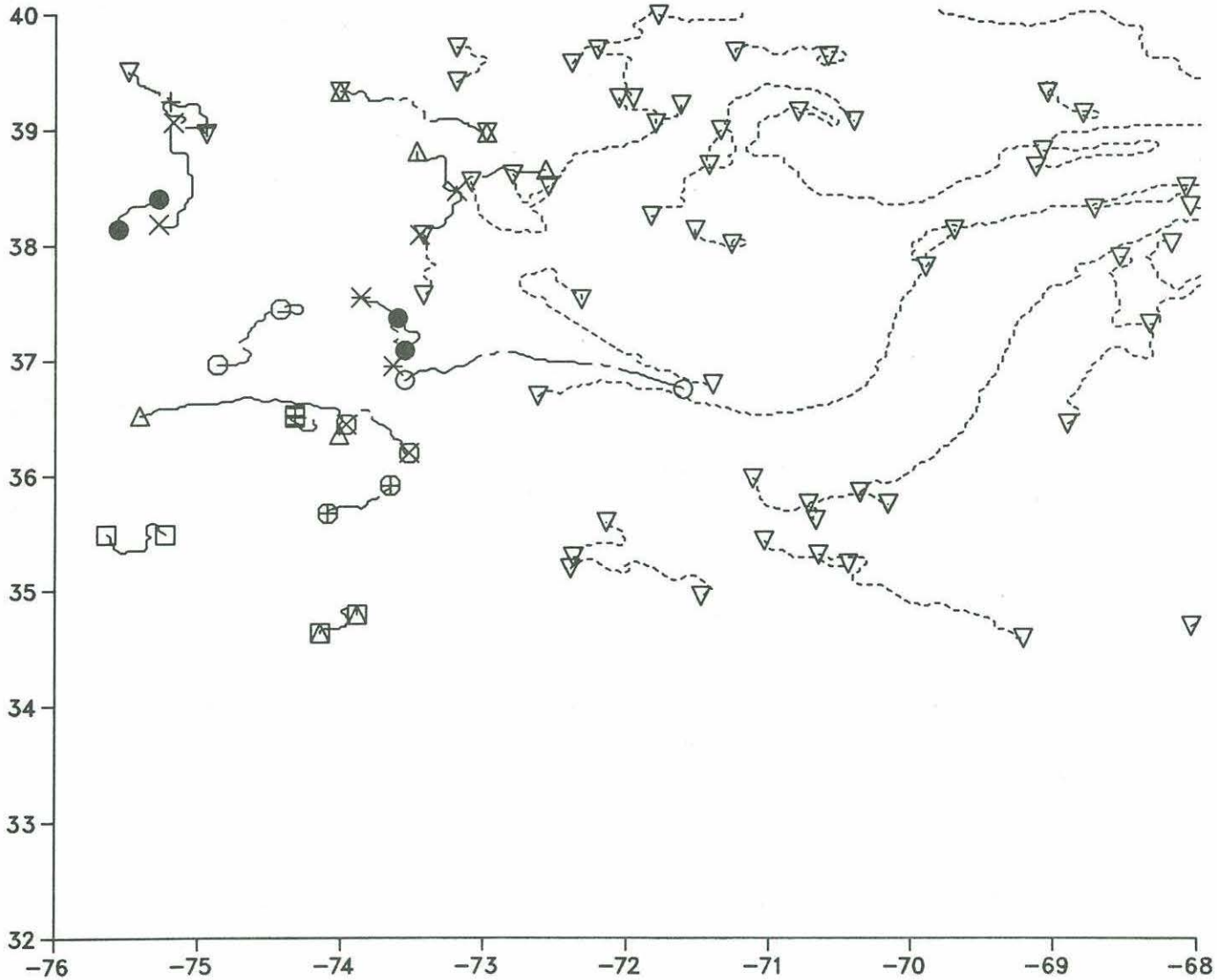
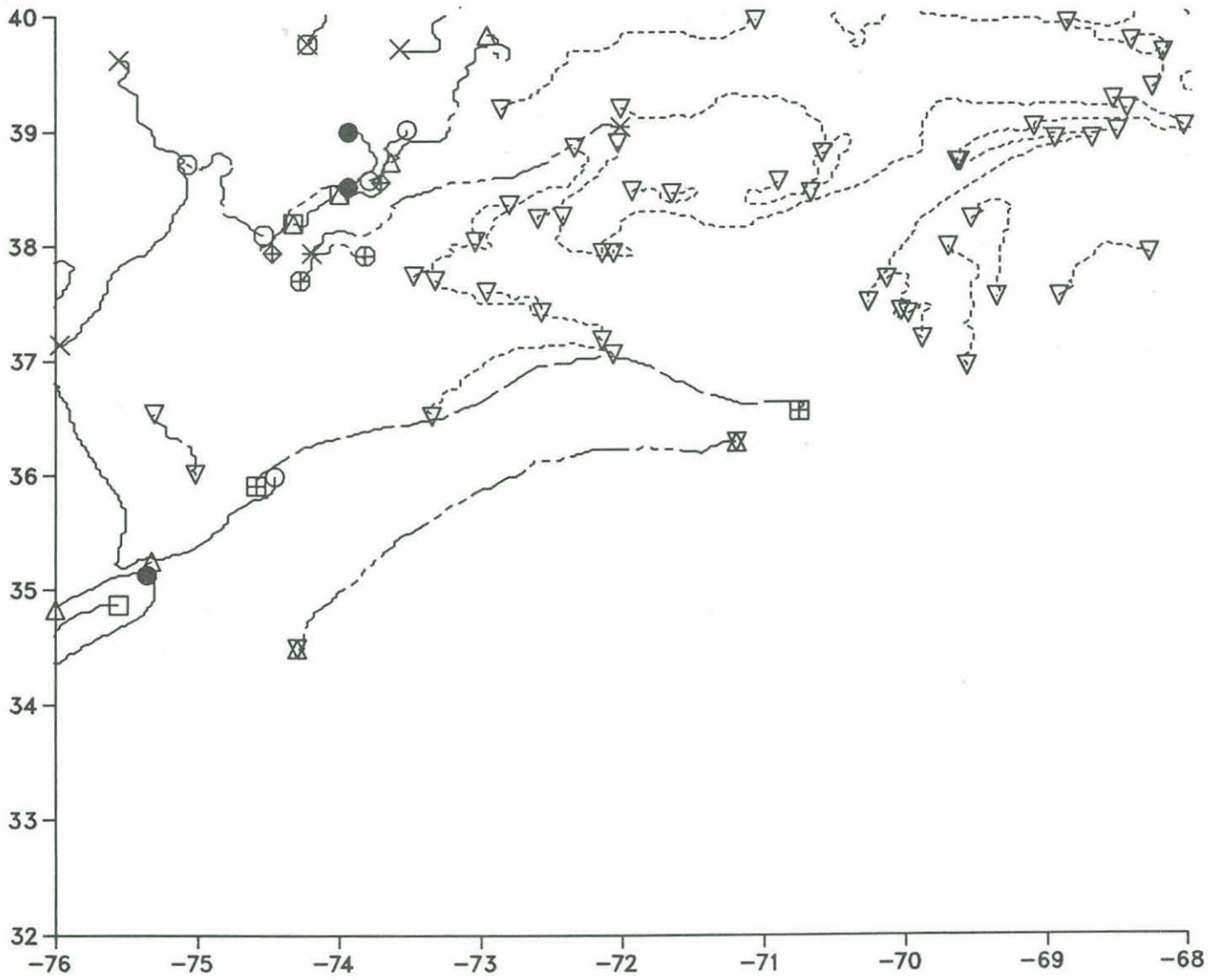


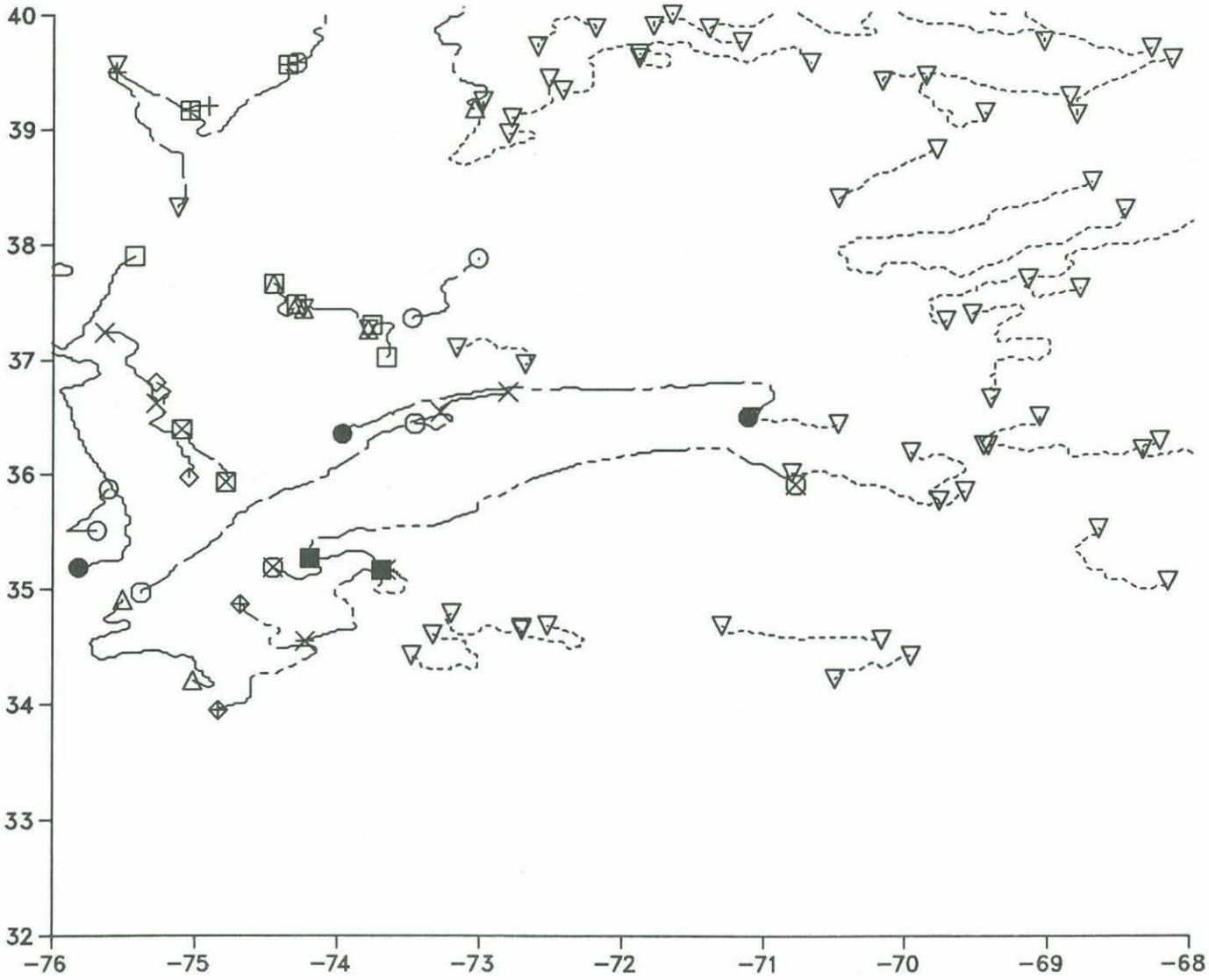
30-Jun-83
19:16:46 GMT



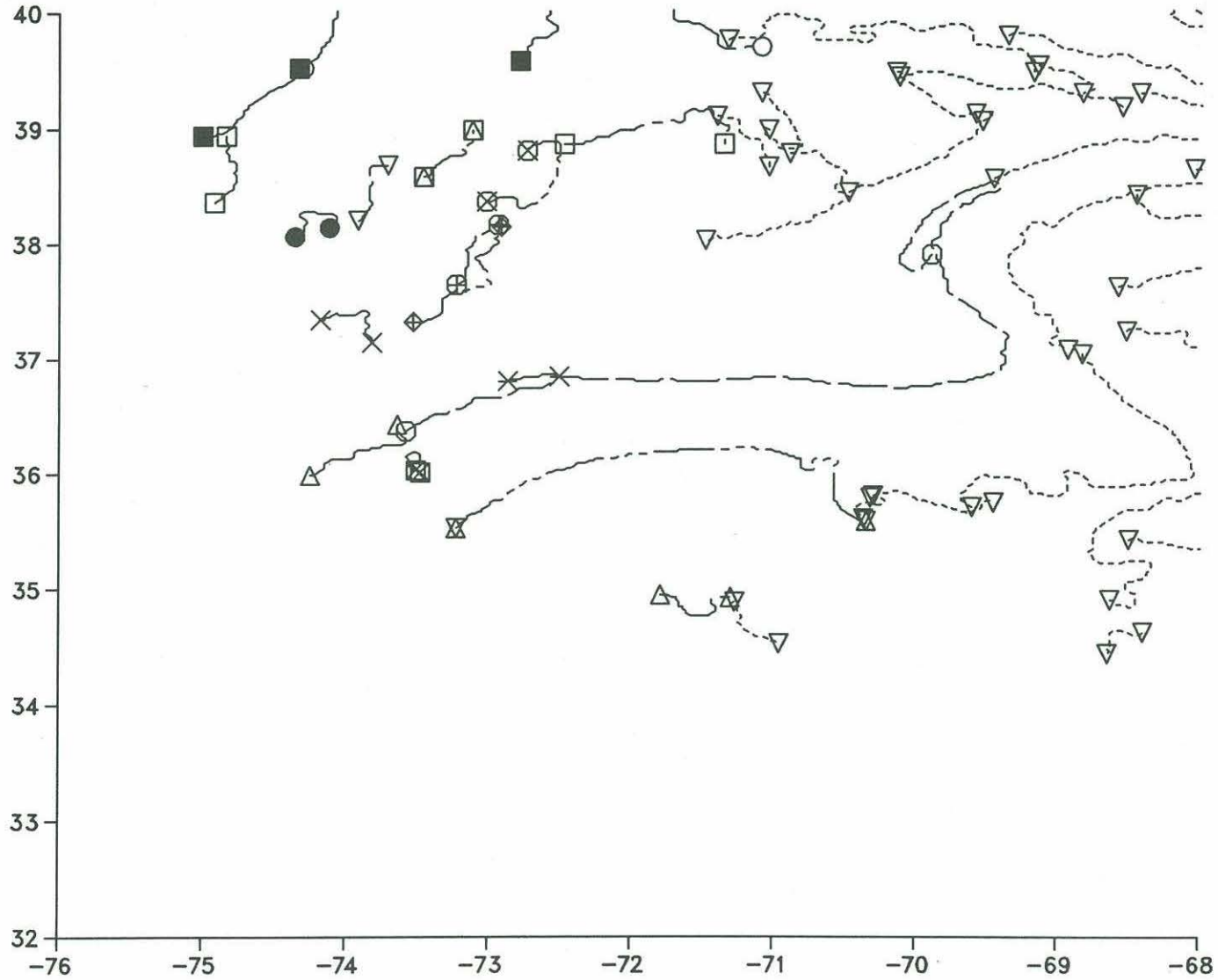
10-Jul-83
18:54:51 GMT



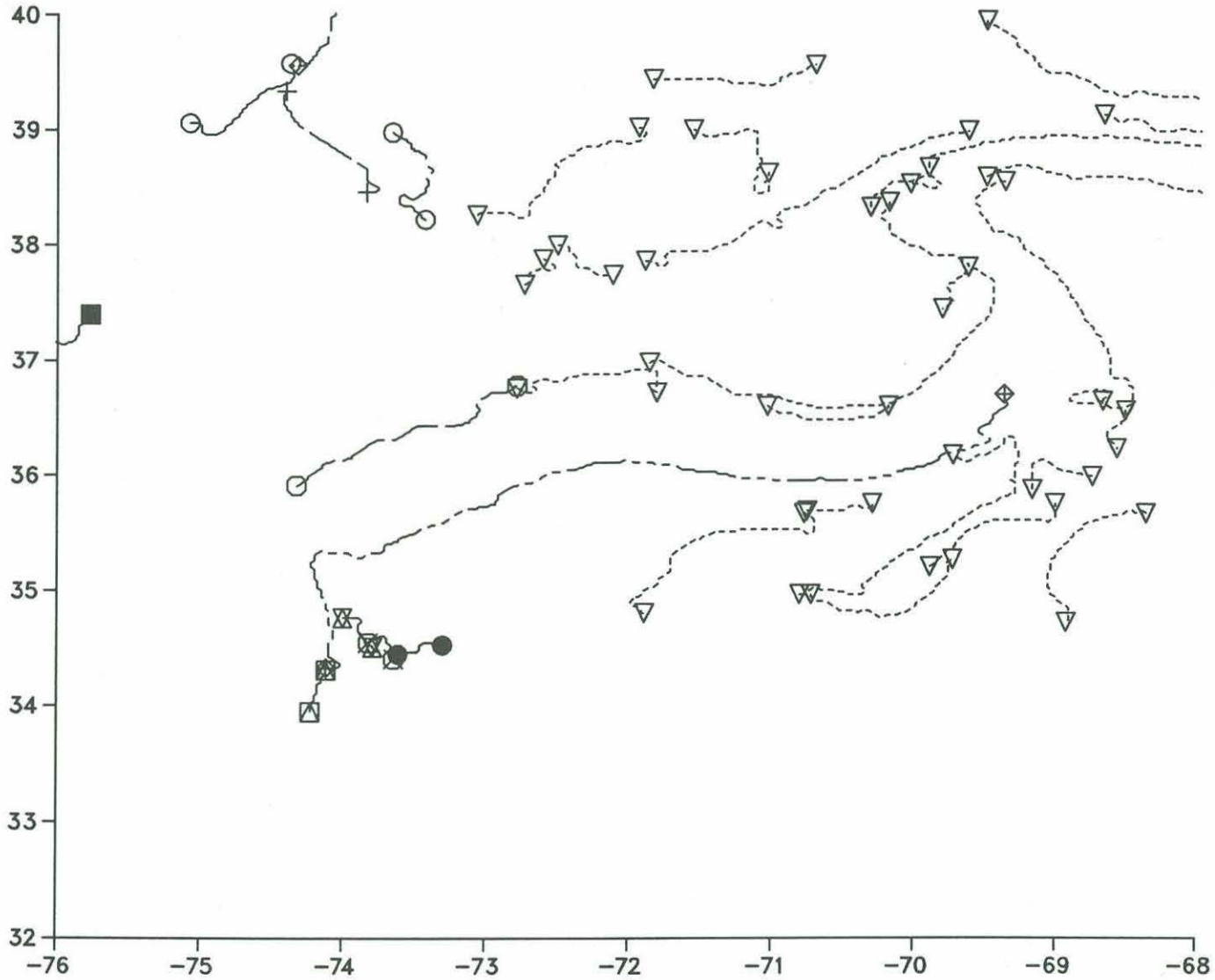
13-Jul-83
20:00:37 GMT



14-Jul-83
19:48:25 GMT



17-Jul-83
19:10:30 GMT



23-Jul-83
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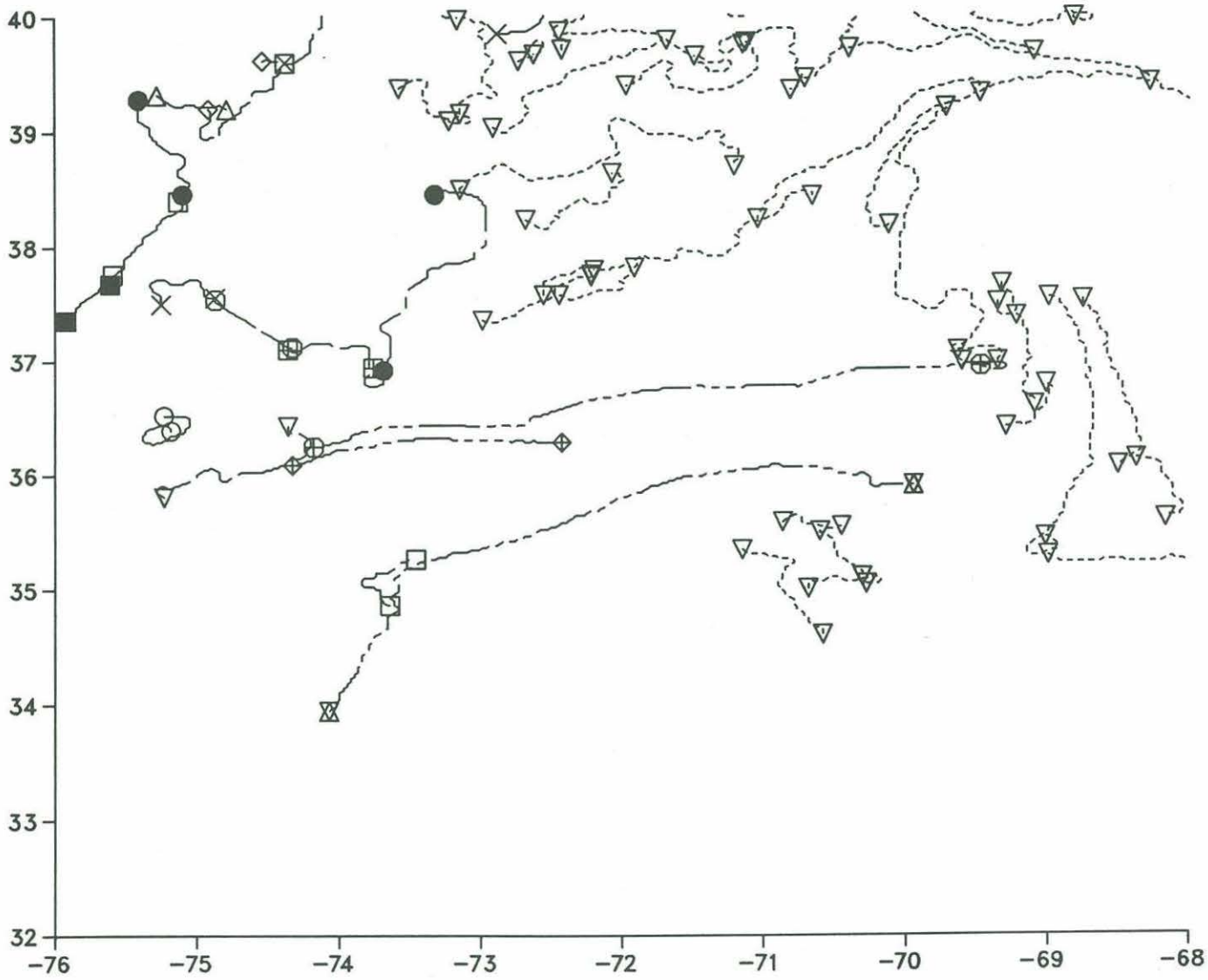
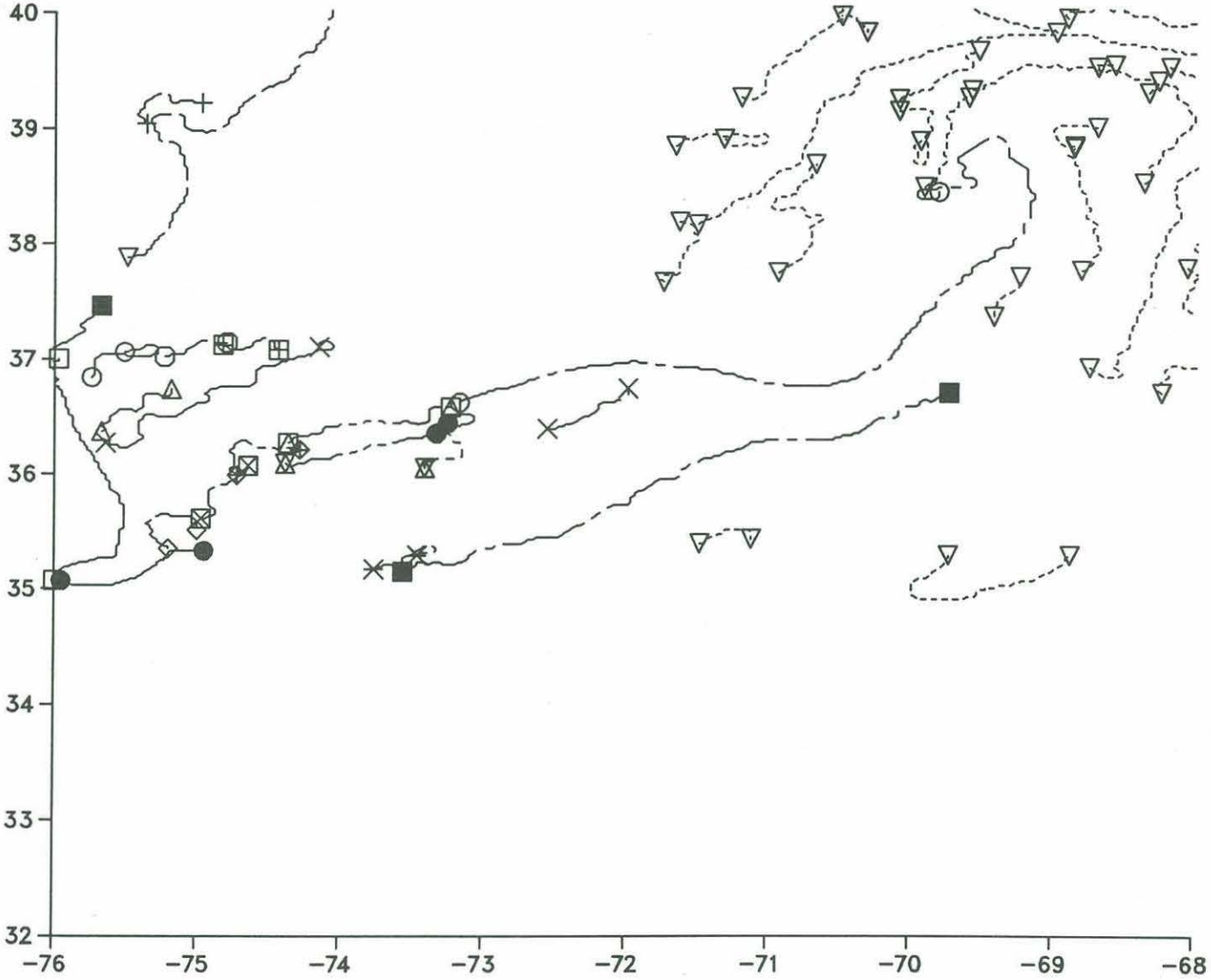
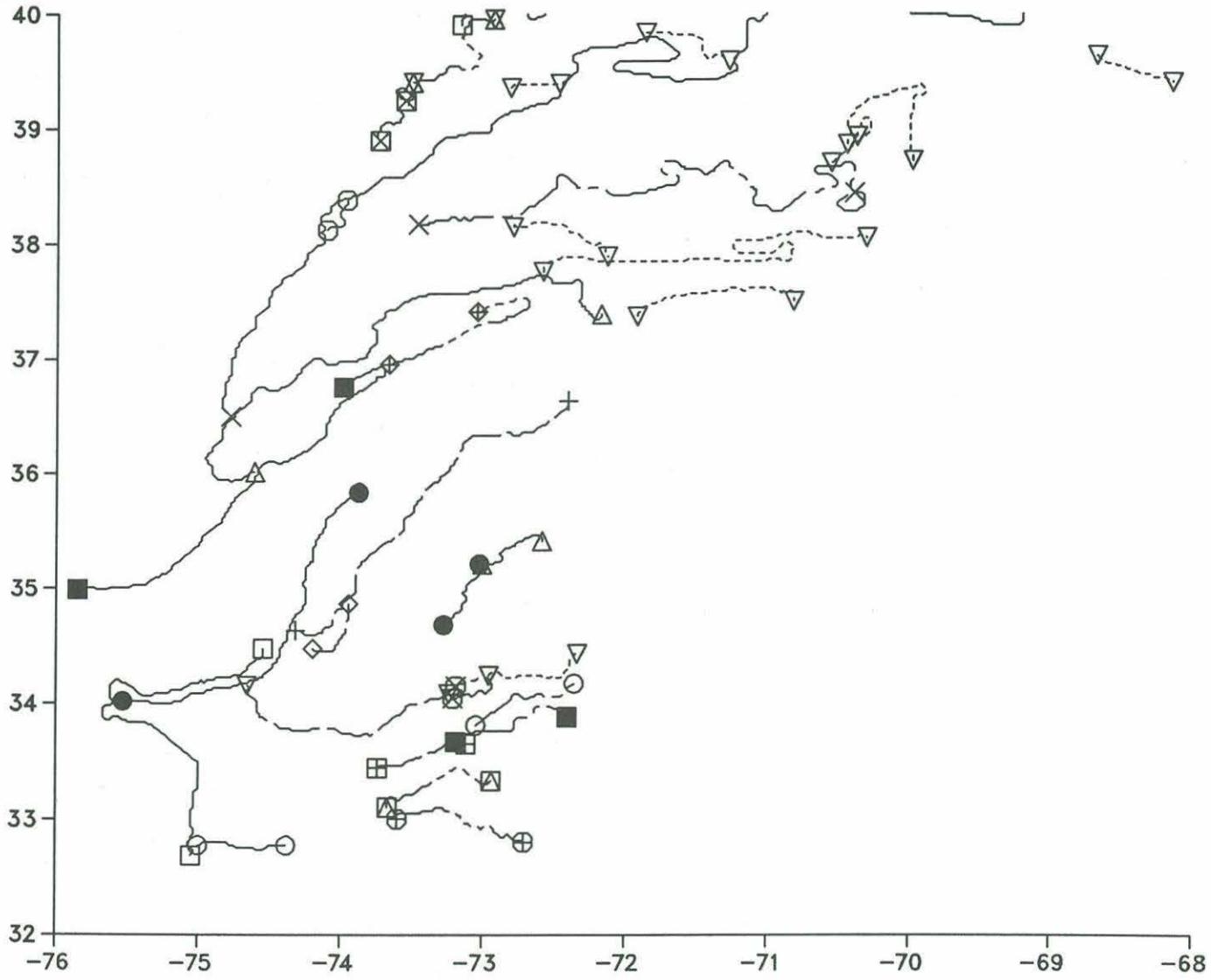


27-Jul-83
18:48:59 GMT



26-Mar-85
18:41:24 GMT



28-Mar-85
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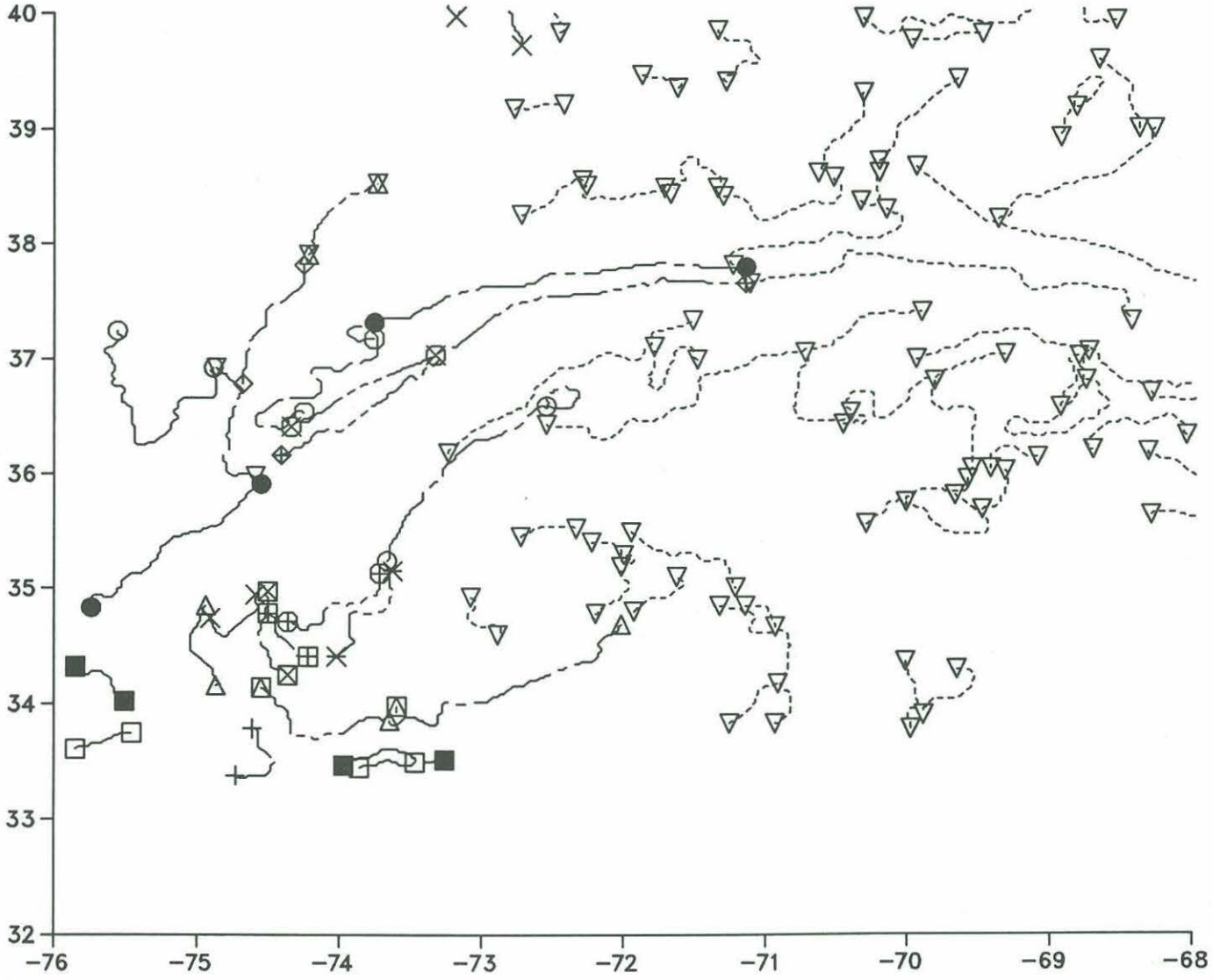

29-Mar-85
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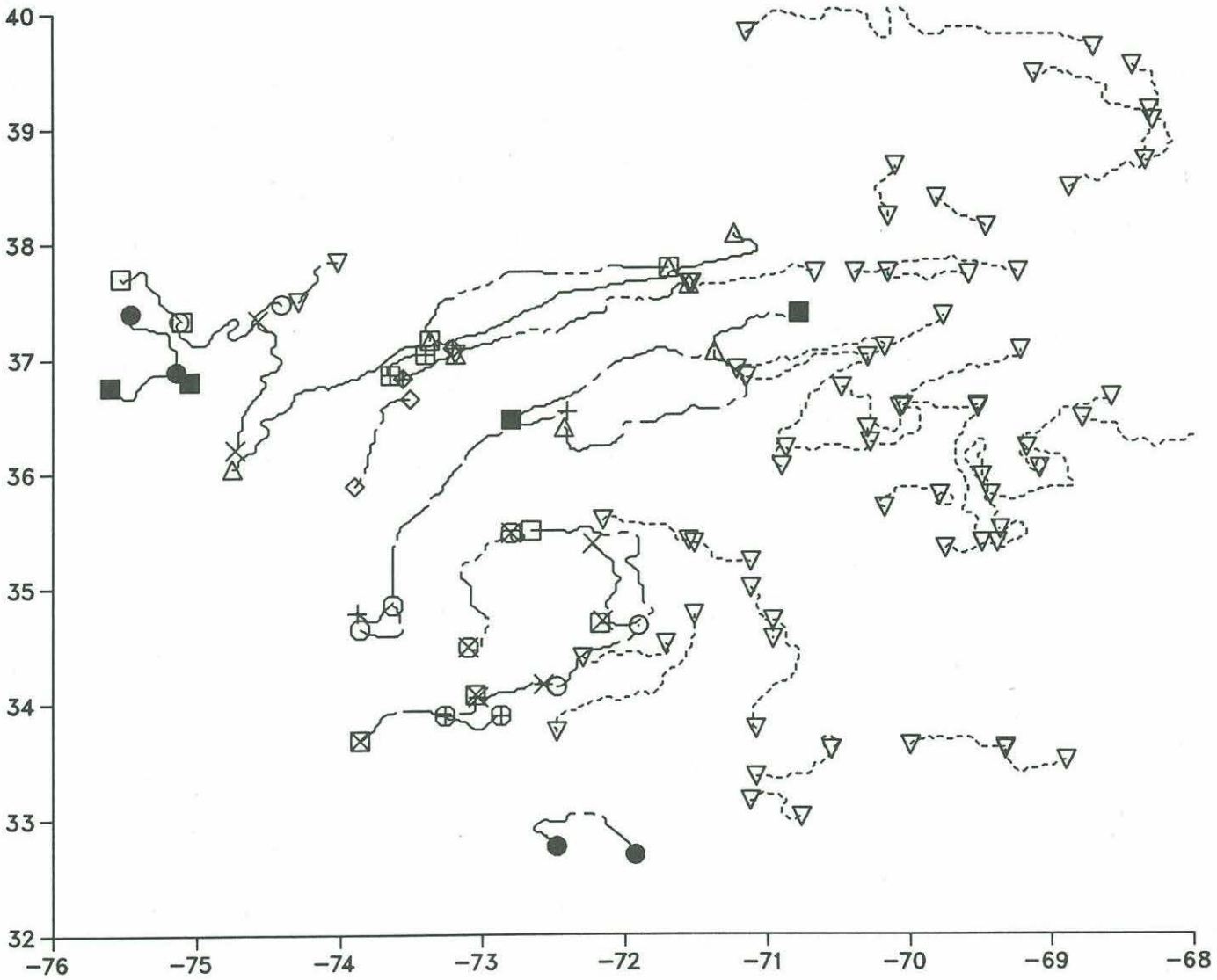

30-Mar-85
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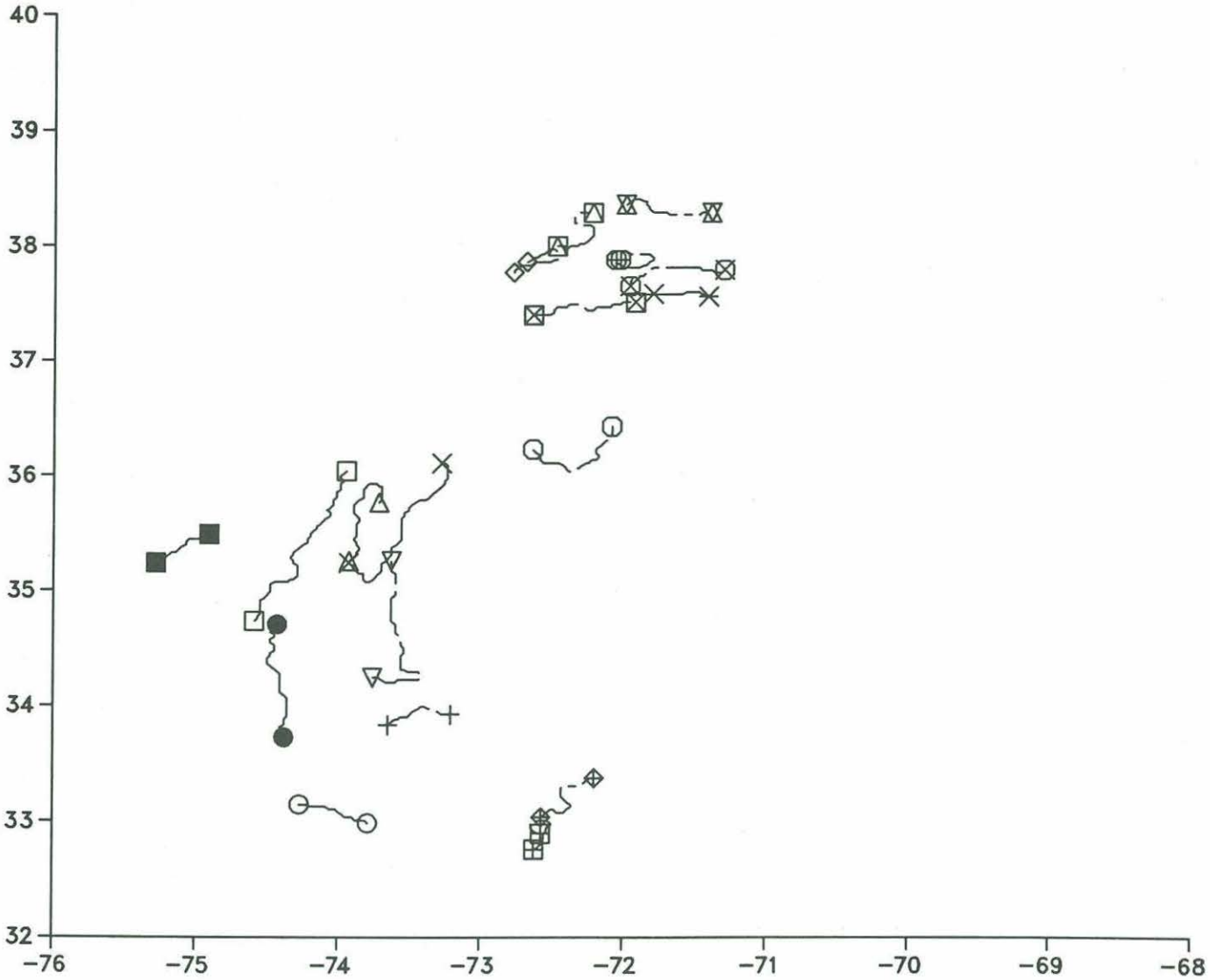
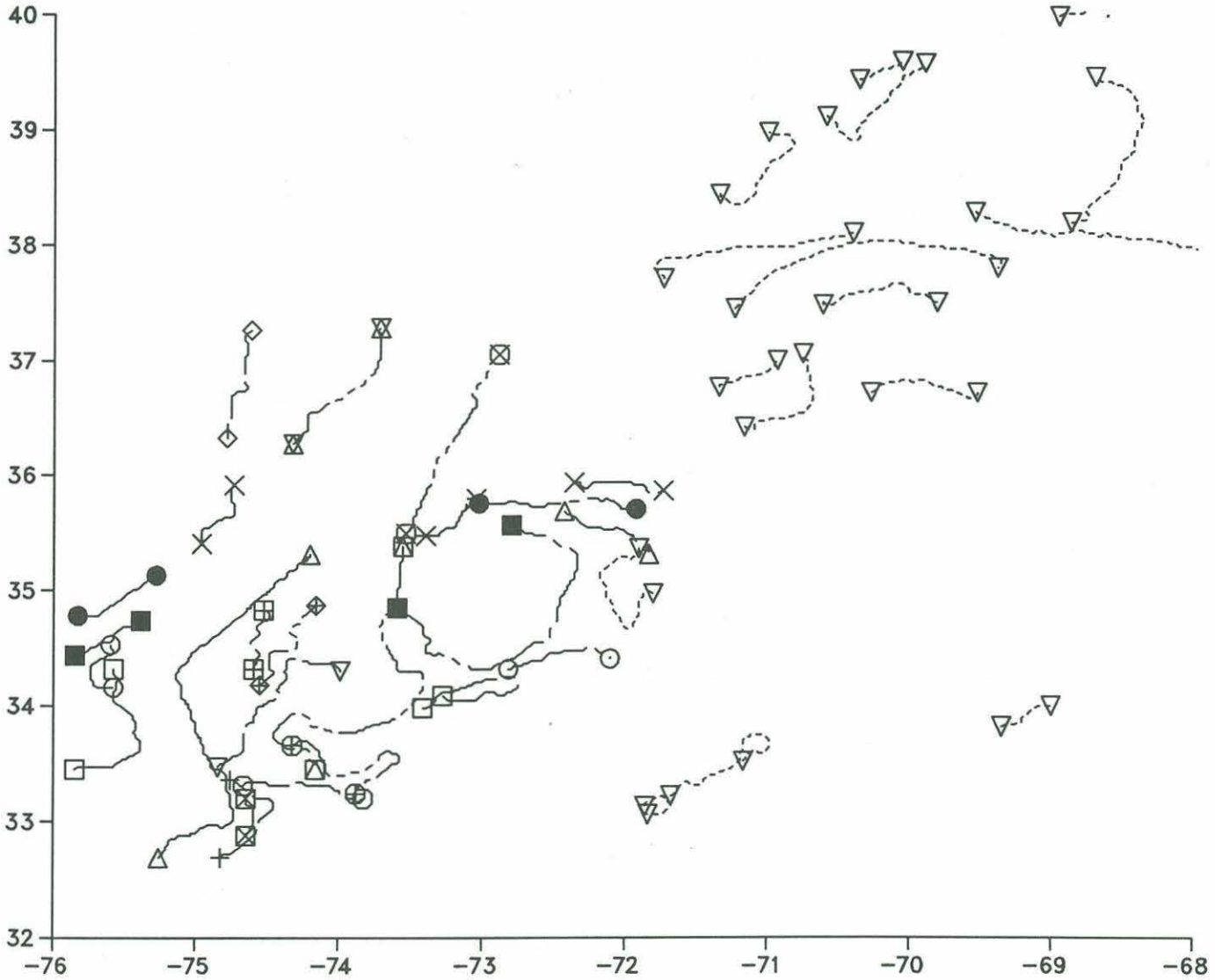
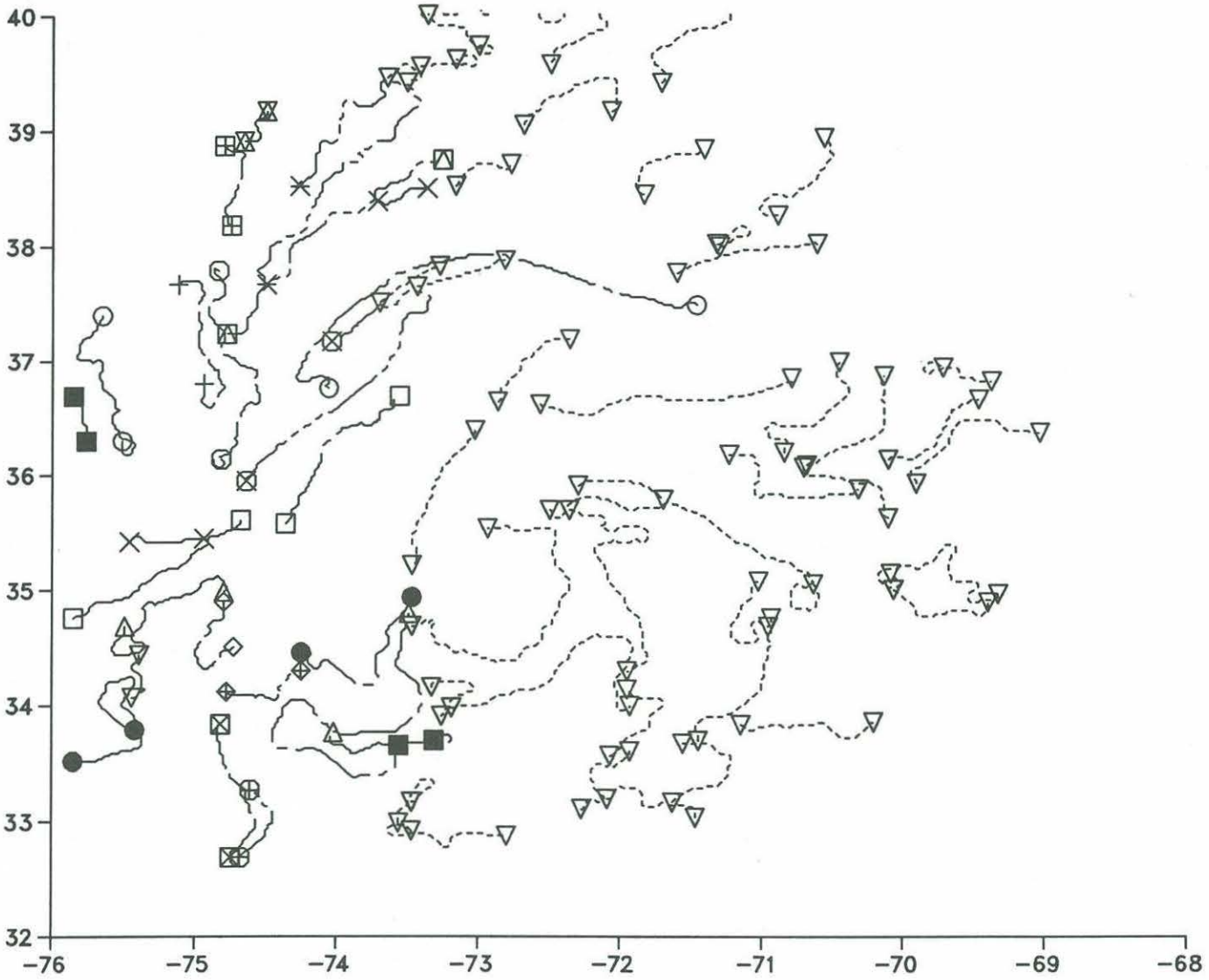


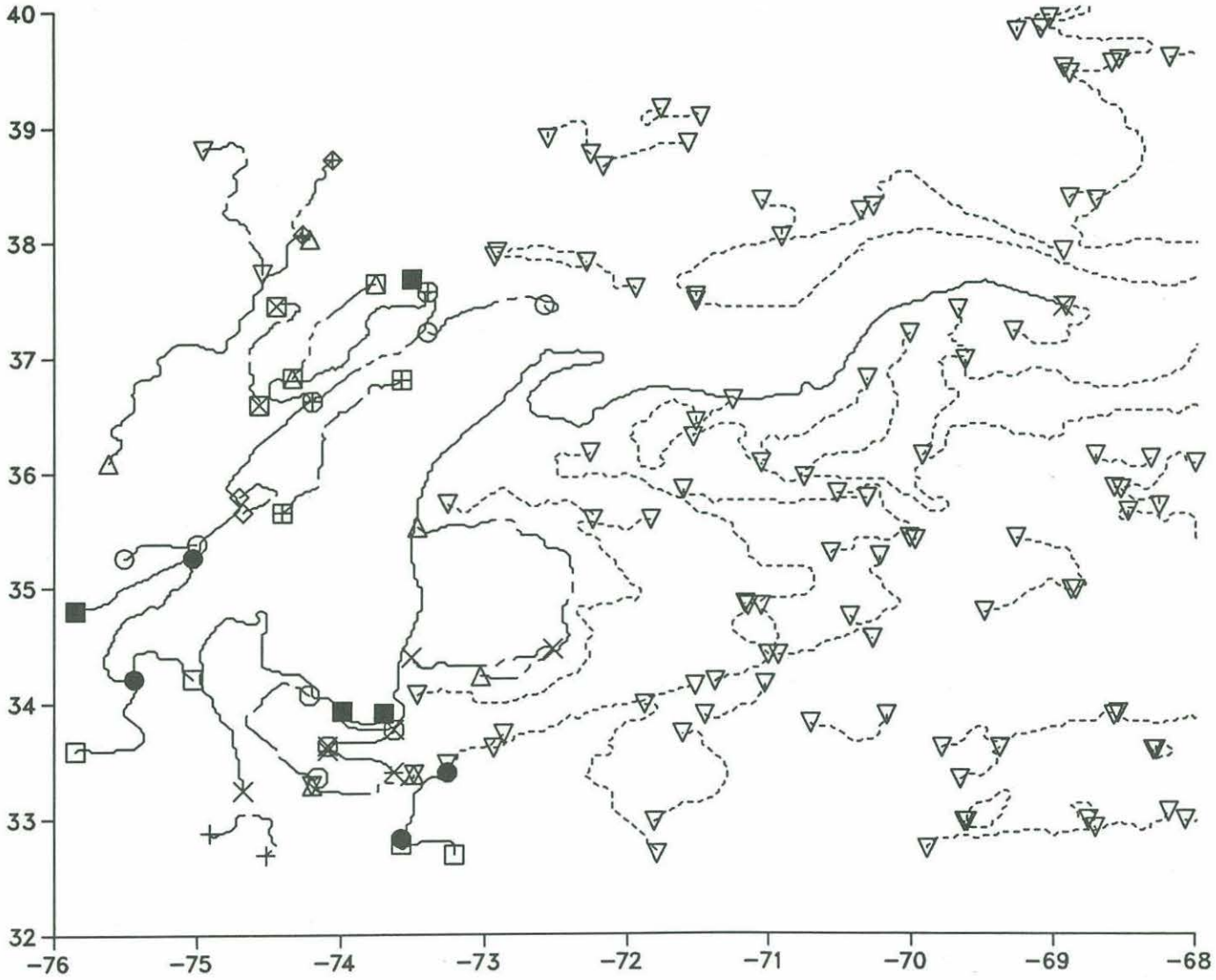
03-Apr-85
18:56:17 GMT



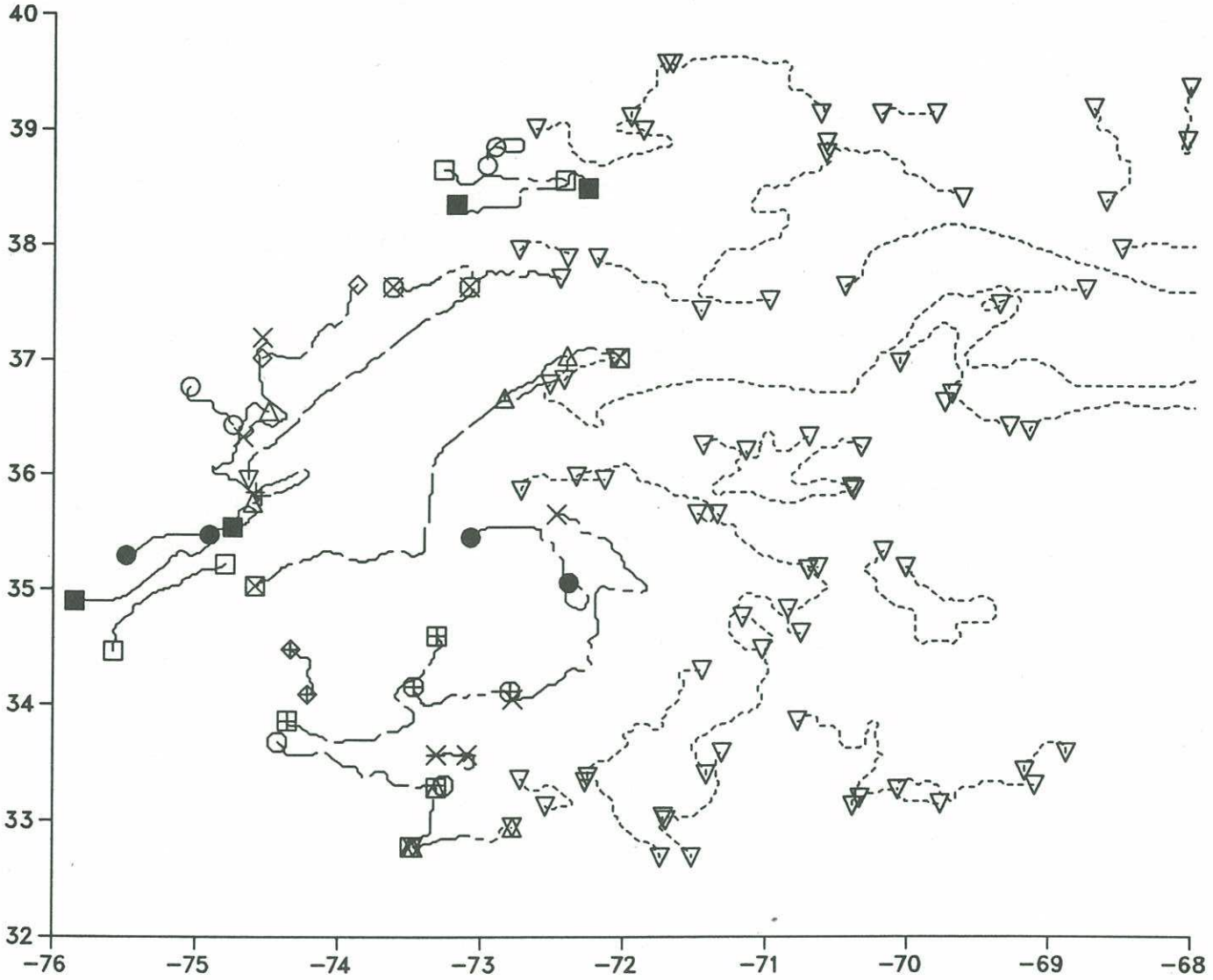
04-Apr-85
07:19:32 GMT



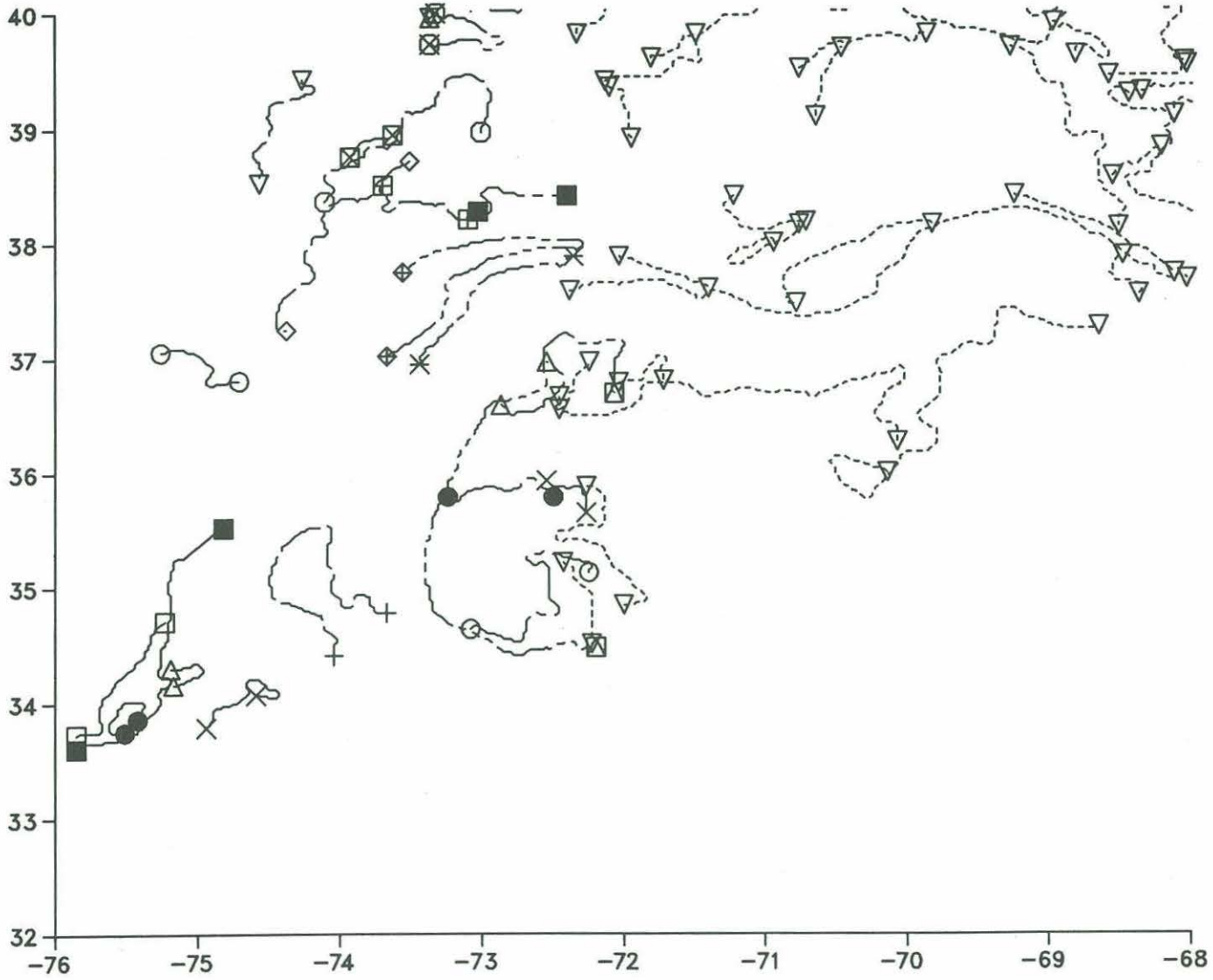
04-Apr-85
18:45:17 GMT



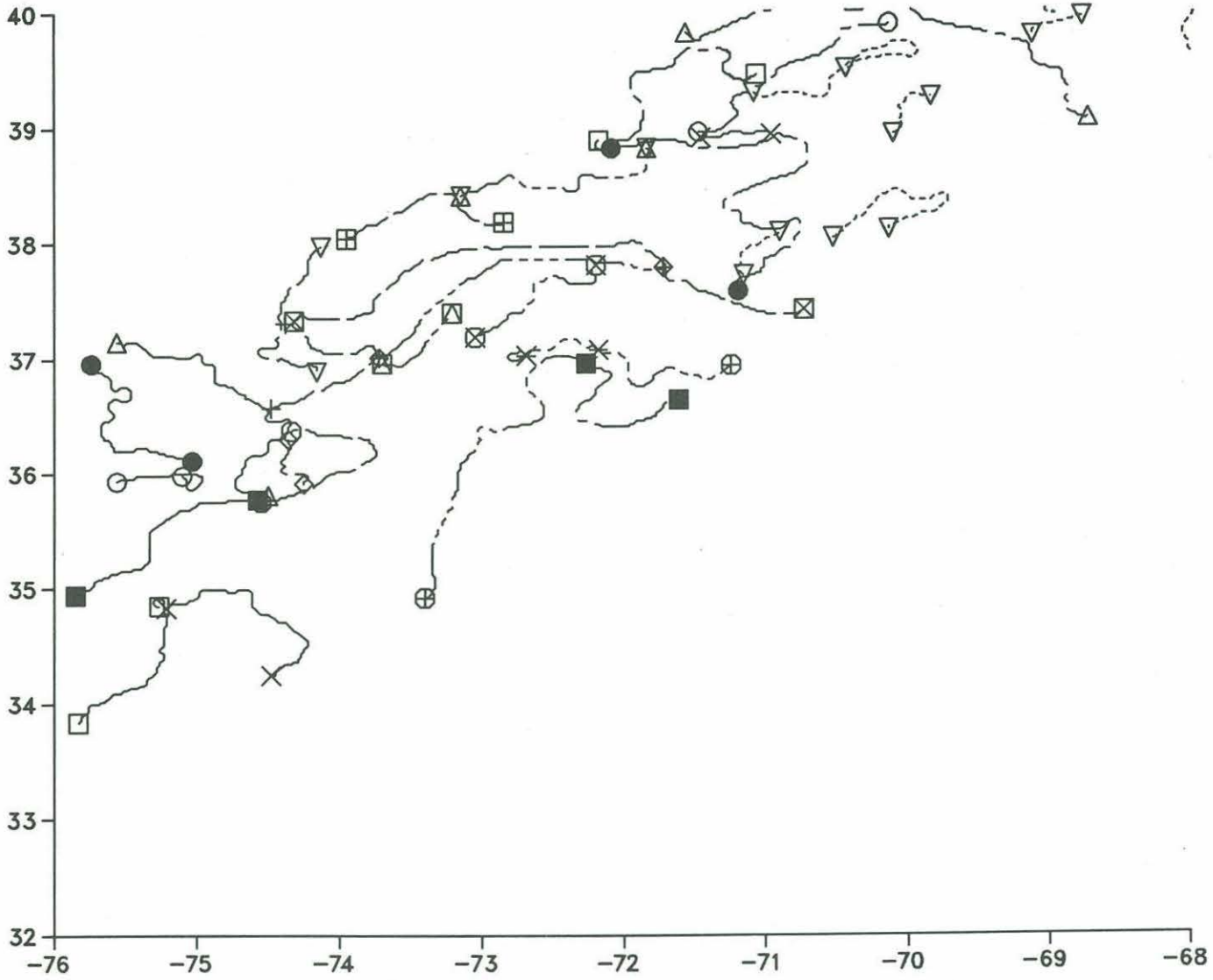
05-Apr-85
07:09:23 GMT



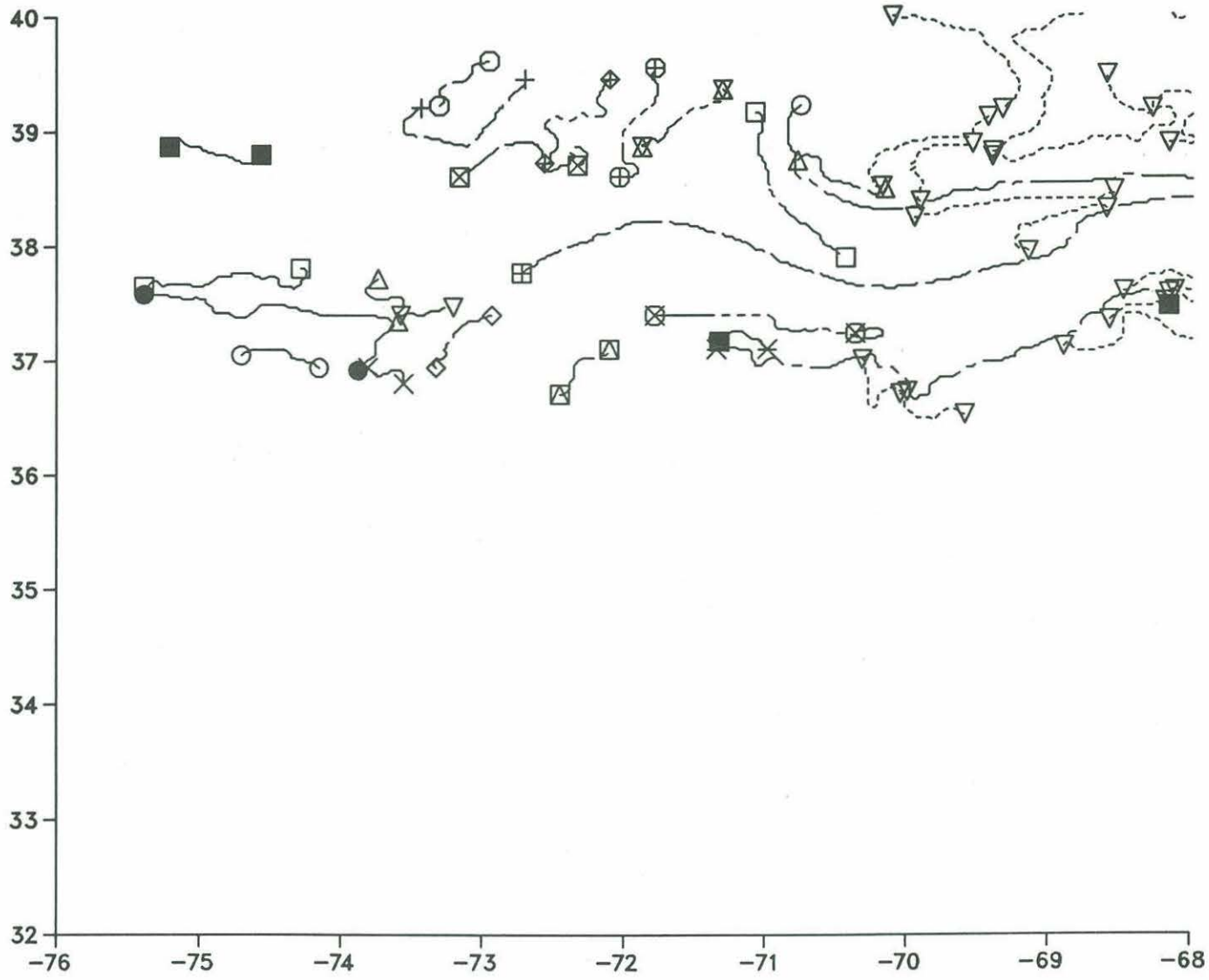
07-Apr-85
06:48:07 GMT



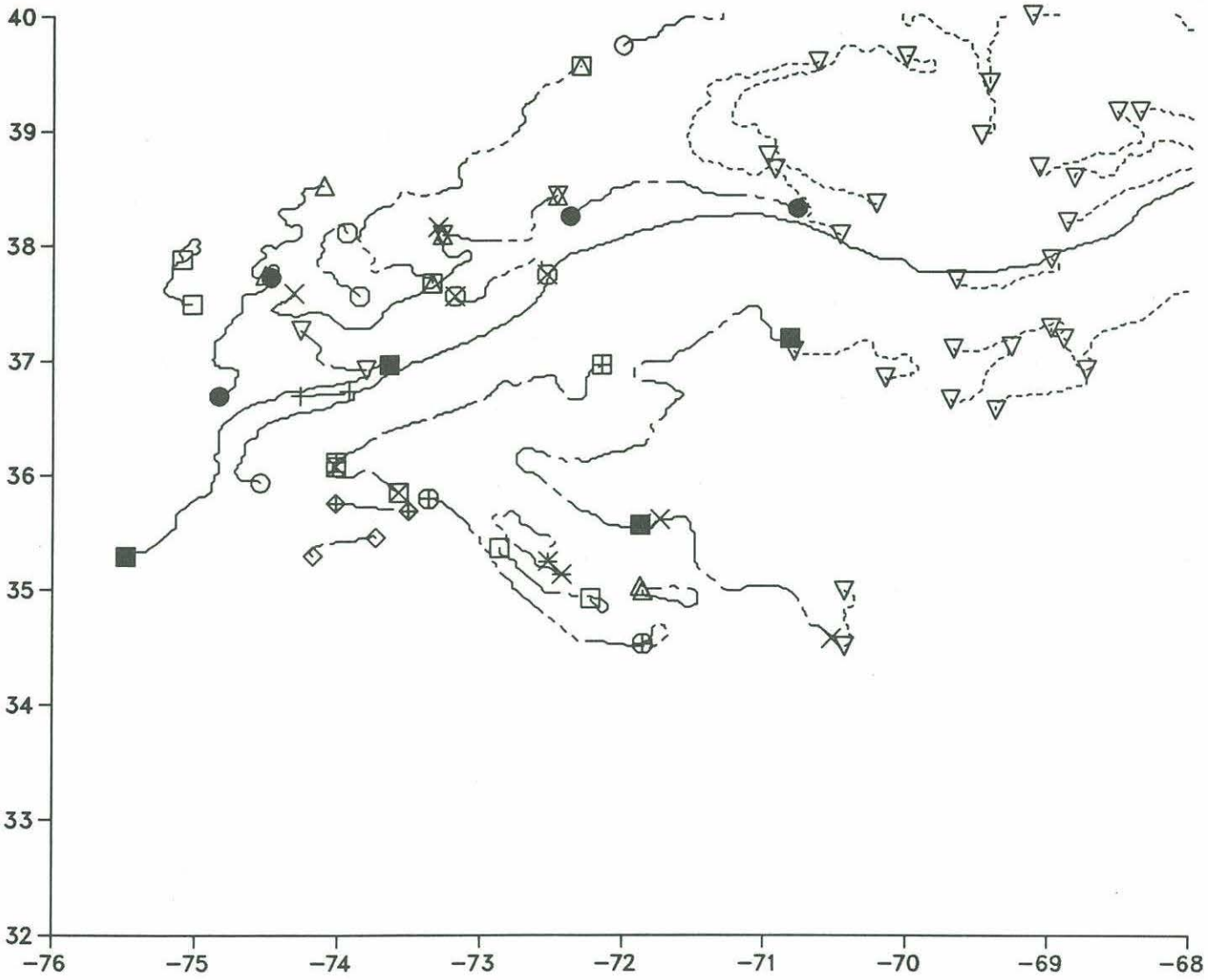
07-Apr-85
18:14:33 GMT



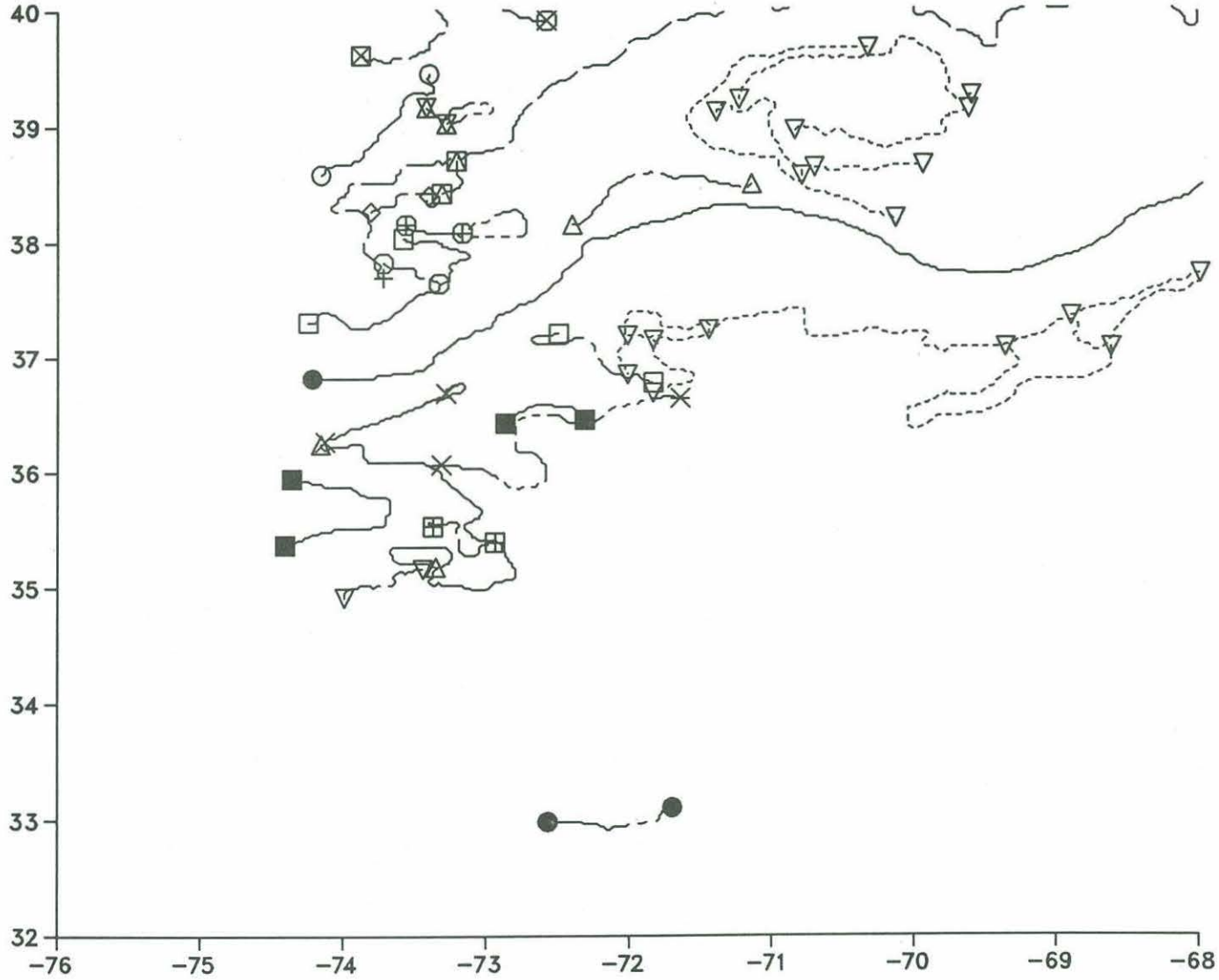
13-Apr-85
07:24:48 GMT



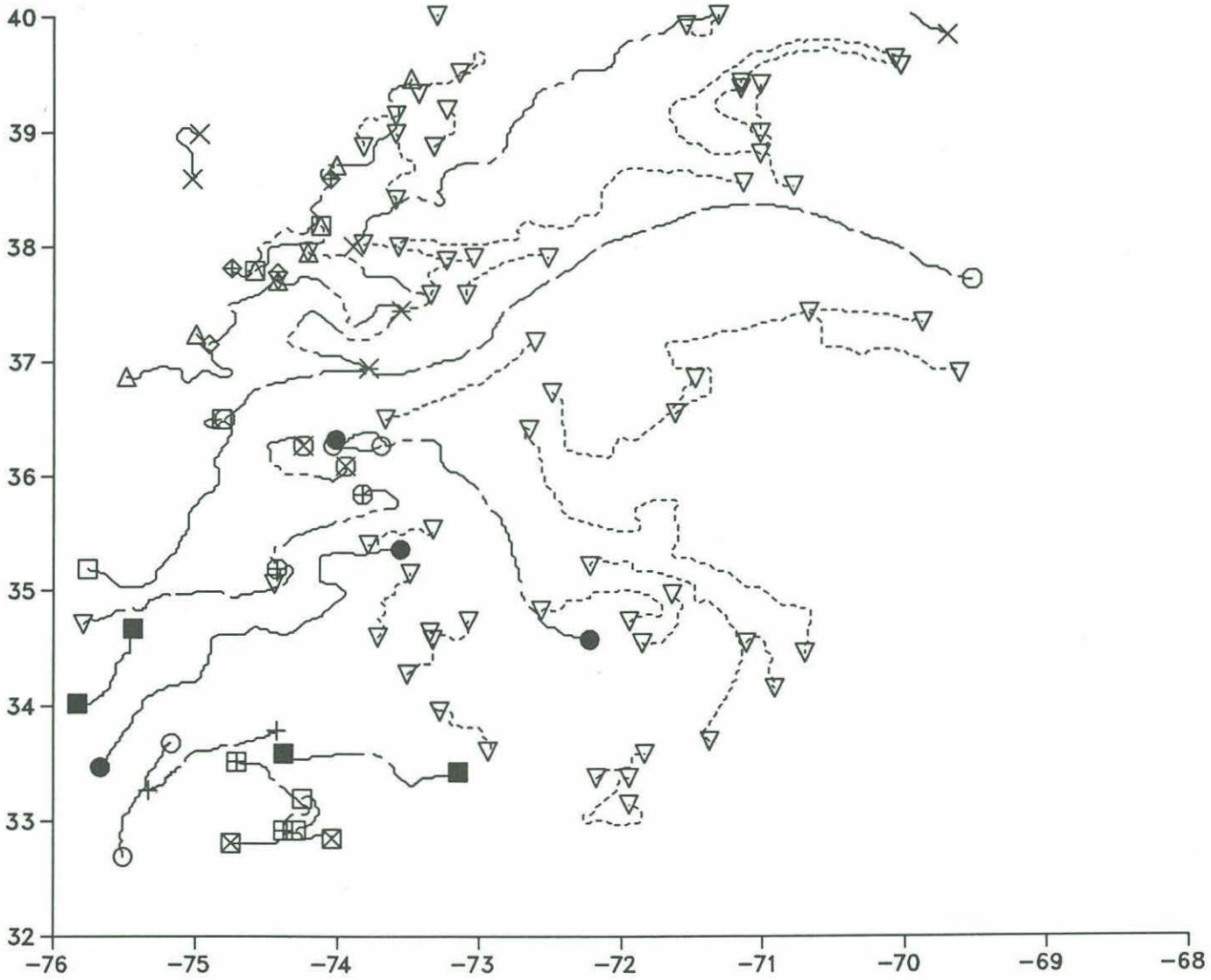
*17-Apr-85
18:07:57 GMT



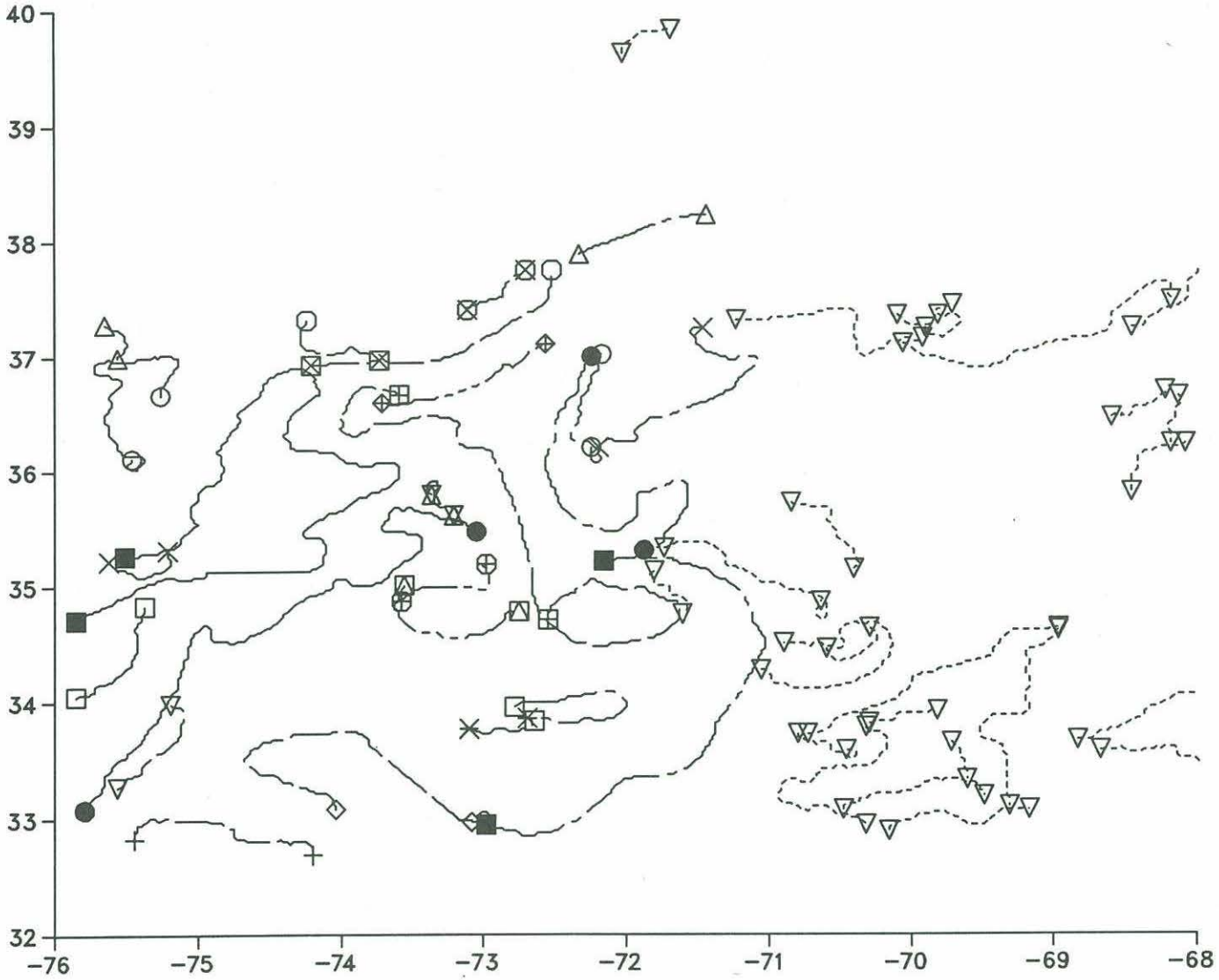
18-Apr-85
06:31:51 GMT



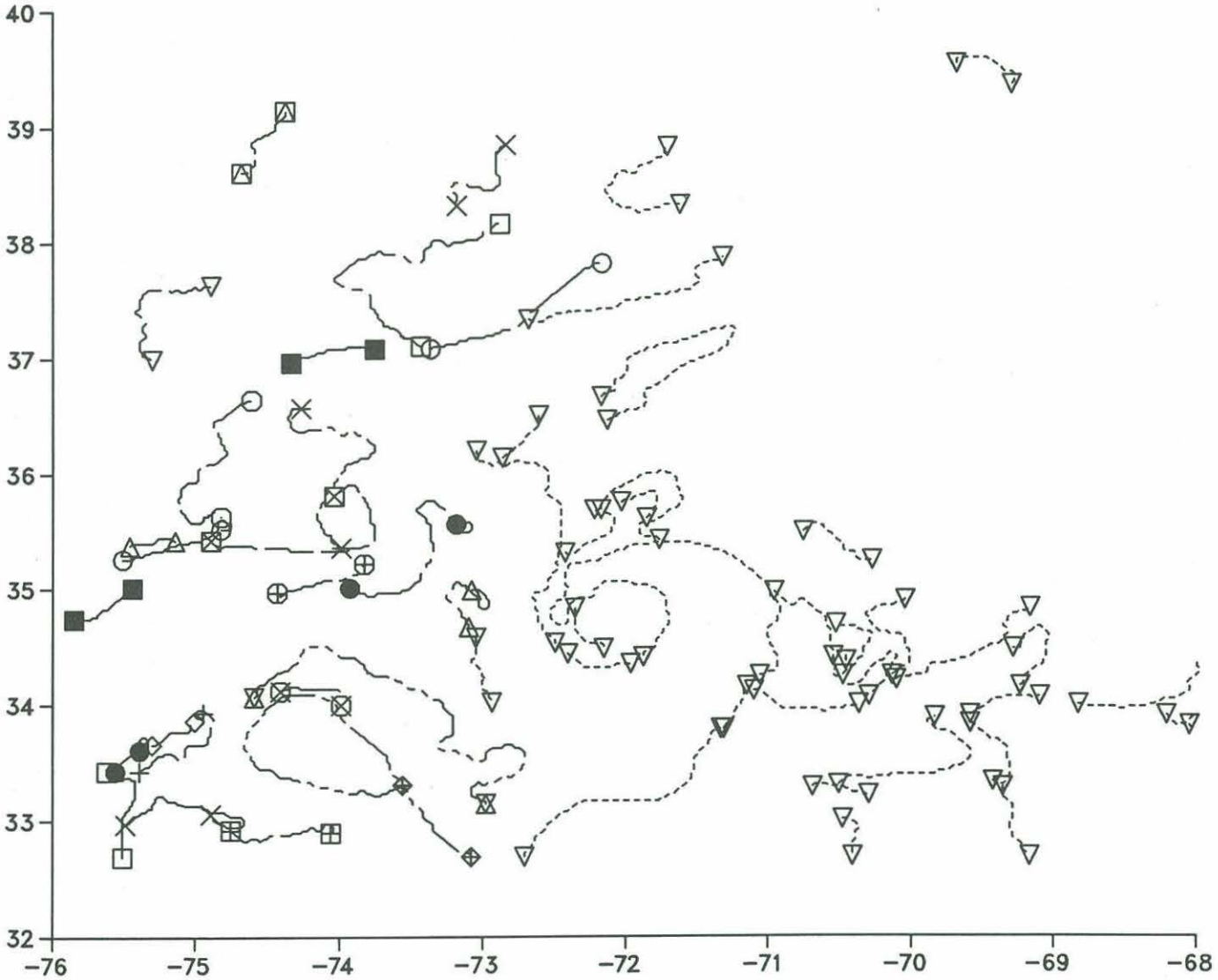
18-Apr-85
19:38:39 GMT



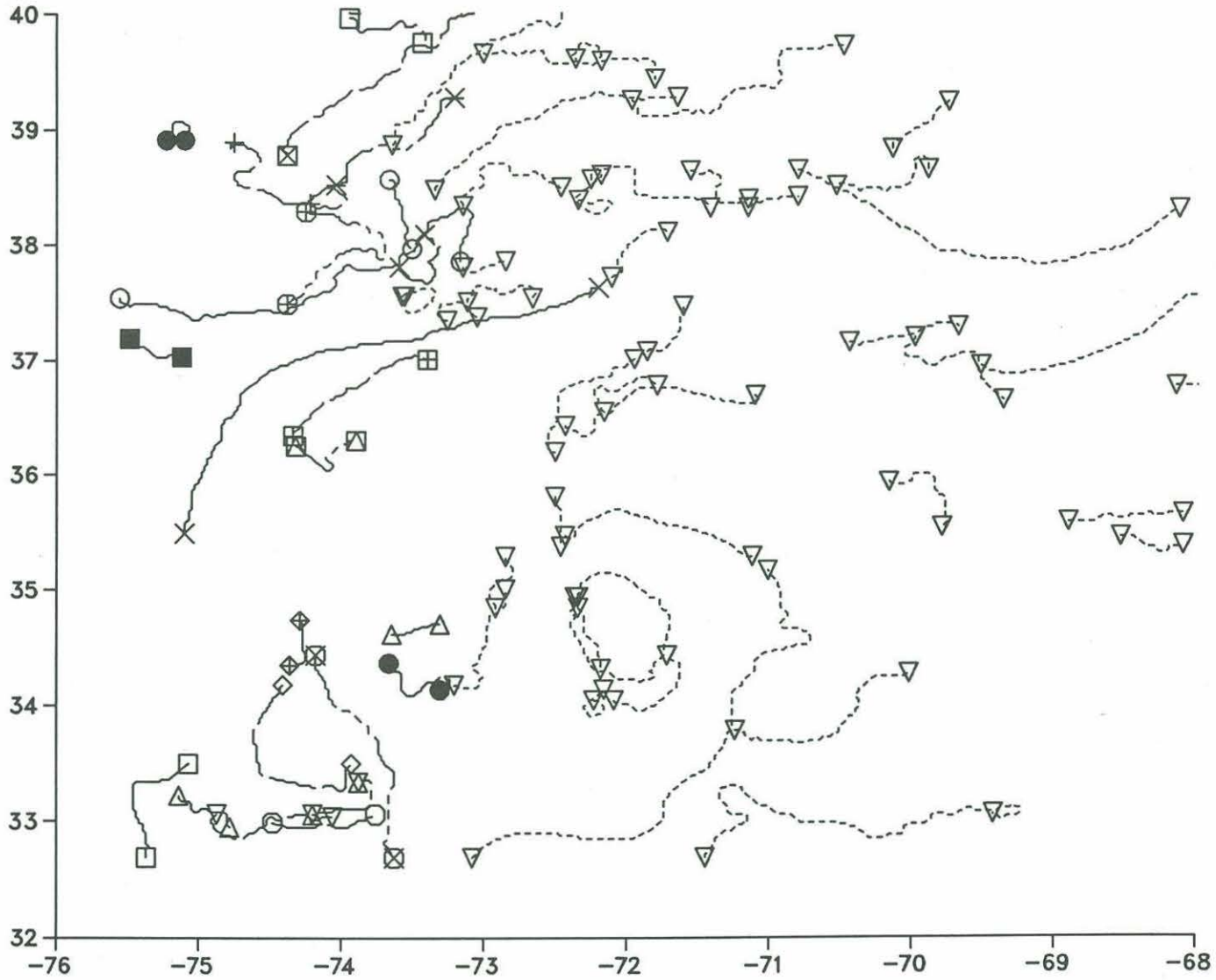
19-Apr-85
08:03:13 GMT



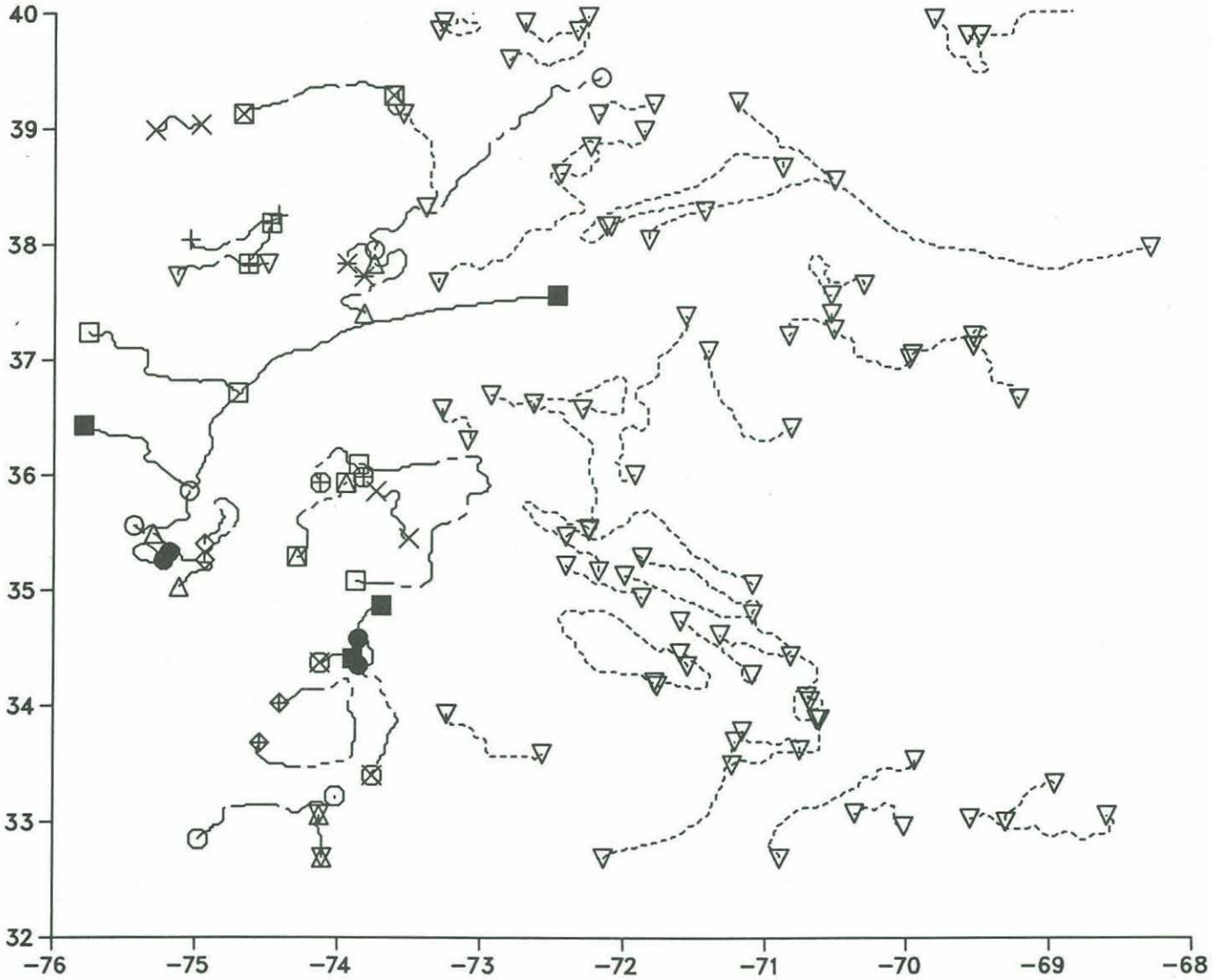
20-Apr-85
07:51:49 GMT



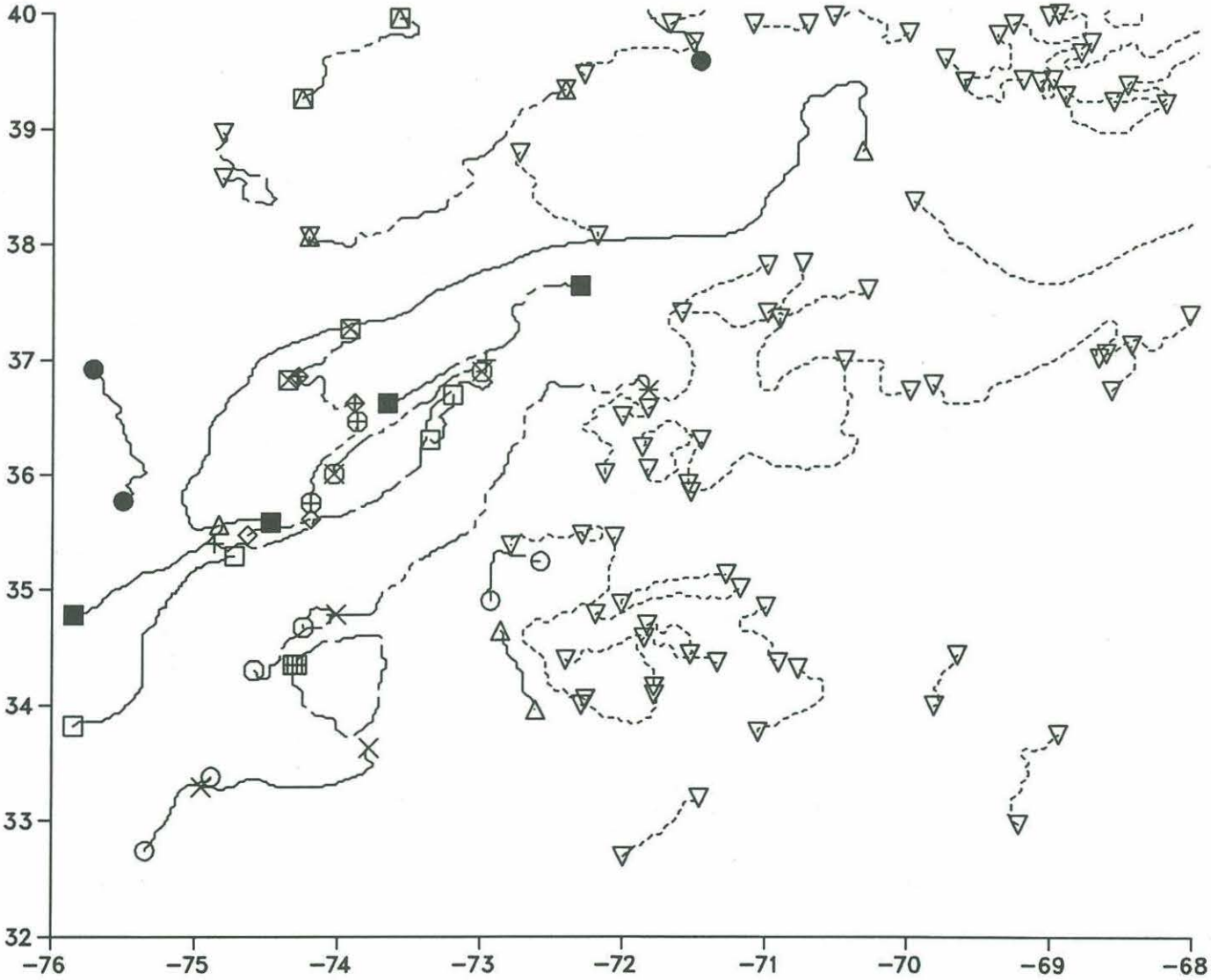
21-Apr-85
19:07:17 GMT



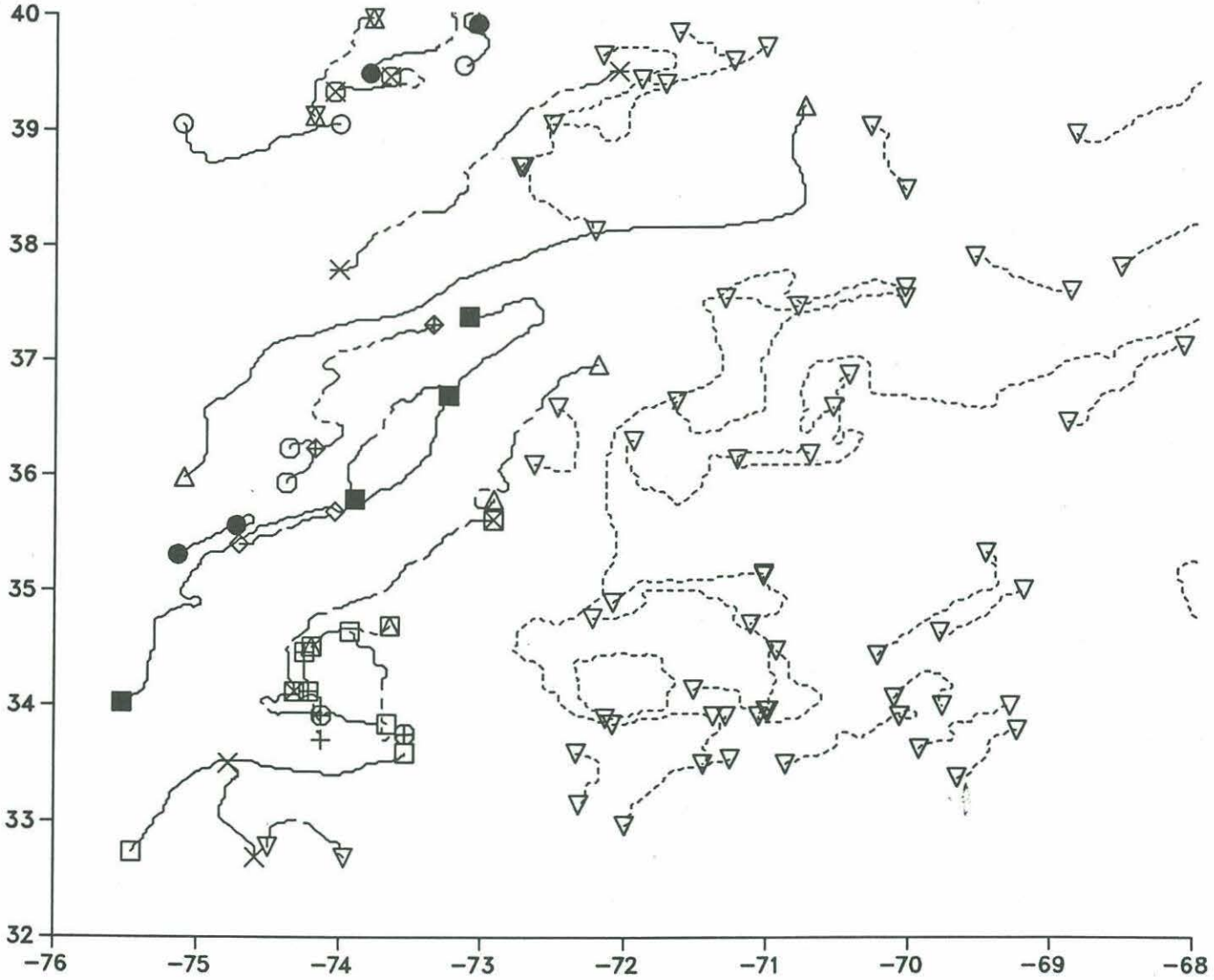
23-Apr-85
18:44:31 GMT



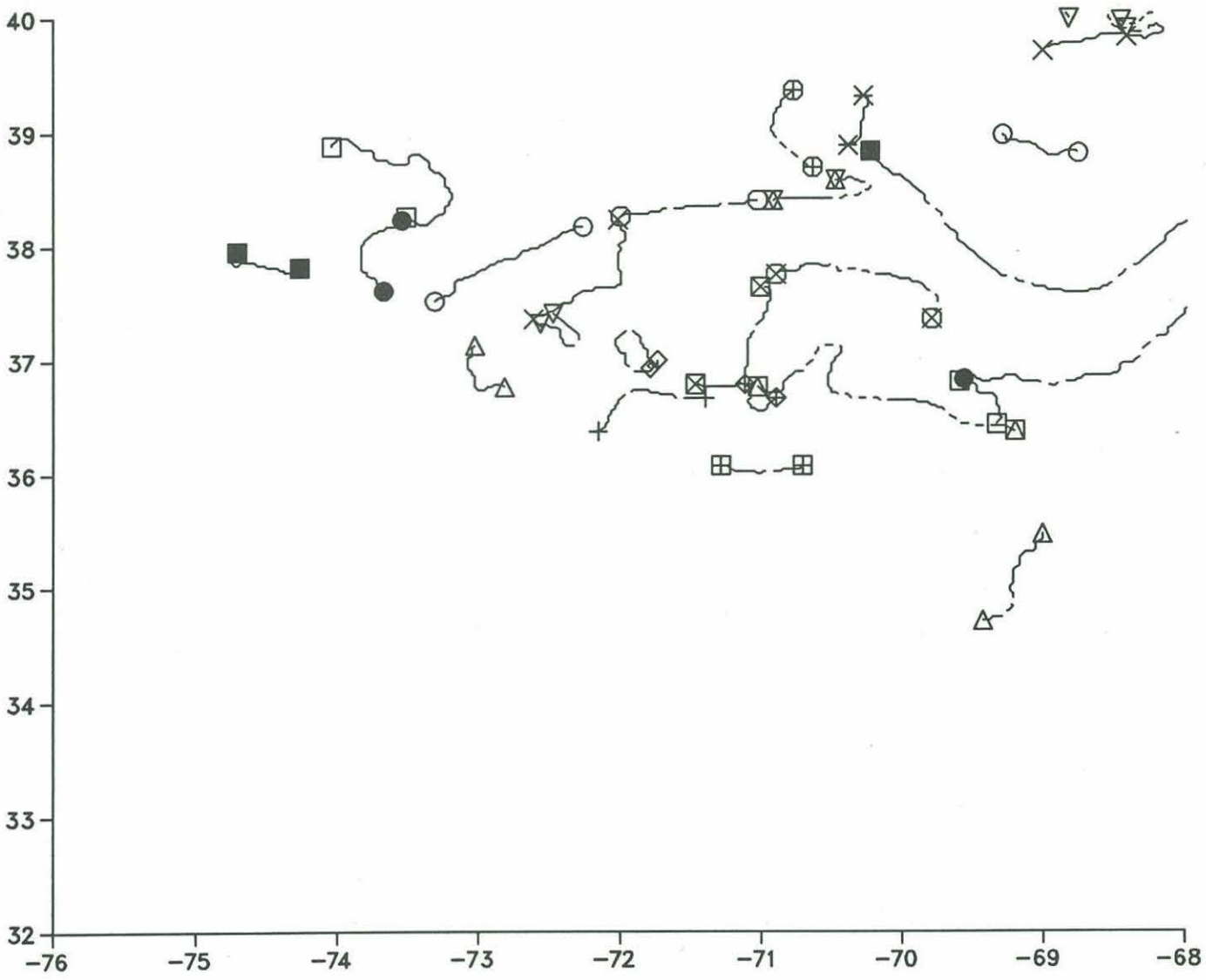
26-Apr-85
18:12:45 GMT



27-Apr-85
06:37:02 GMT



*28-Apr-85
08:08:21 GMT



28-Apr-85
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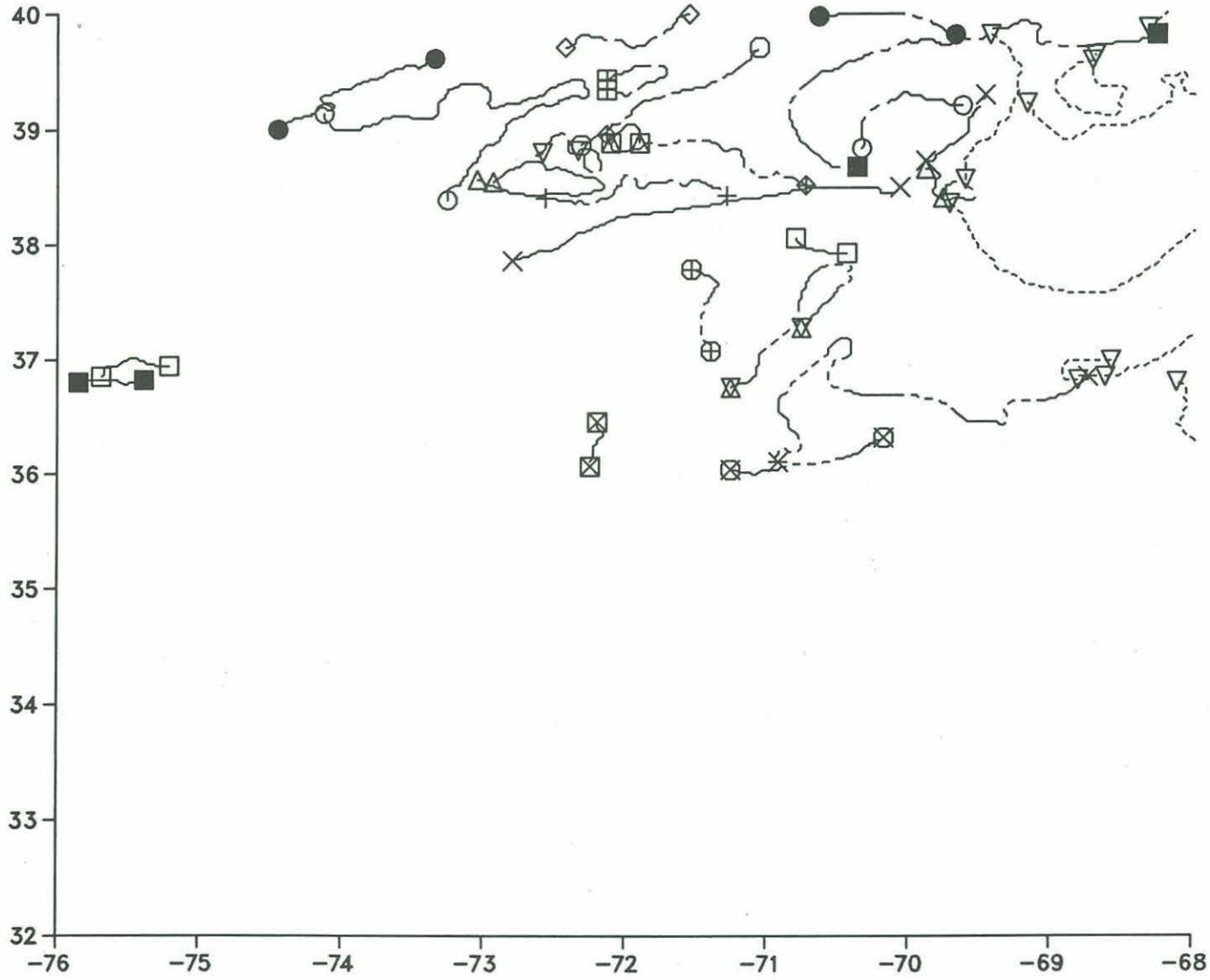

*30-Apr-85
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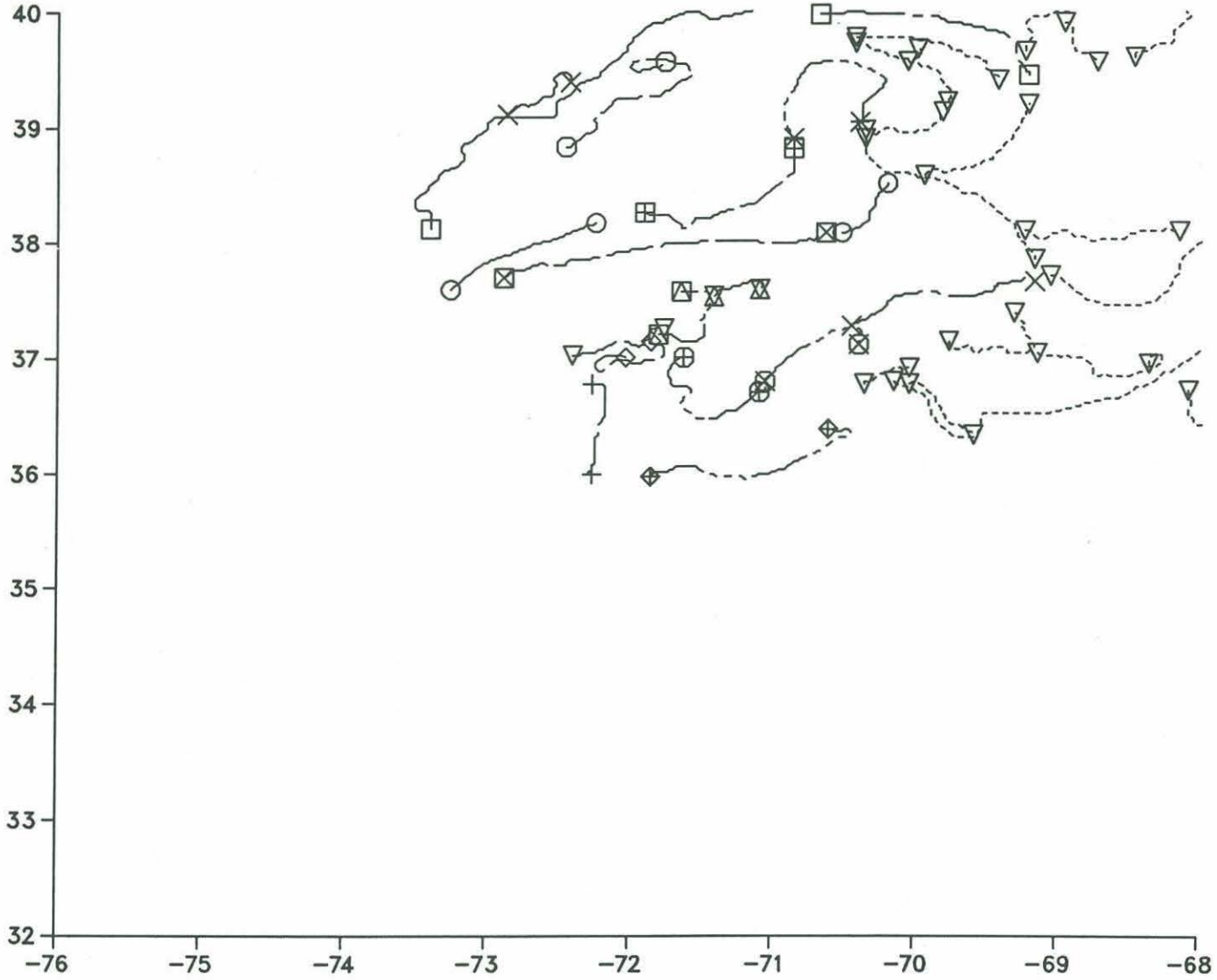
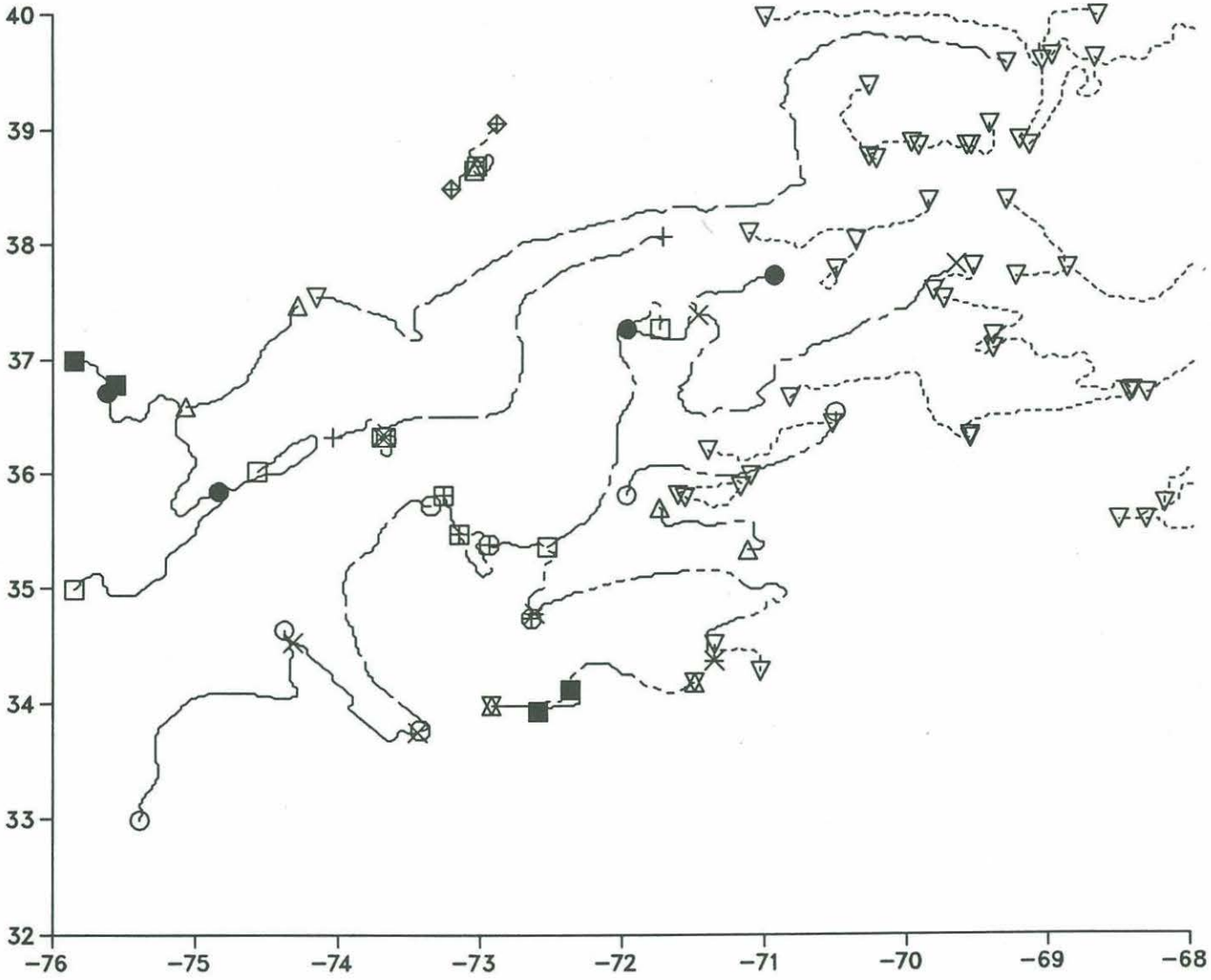
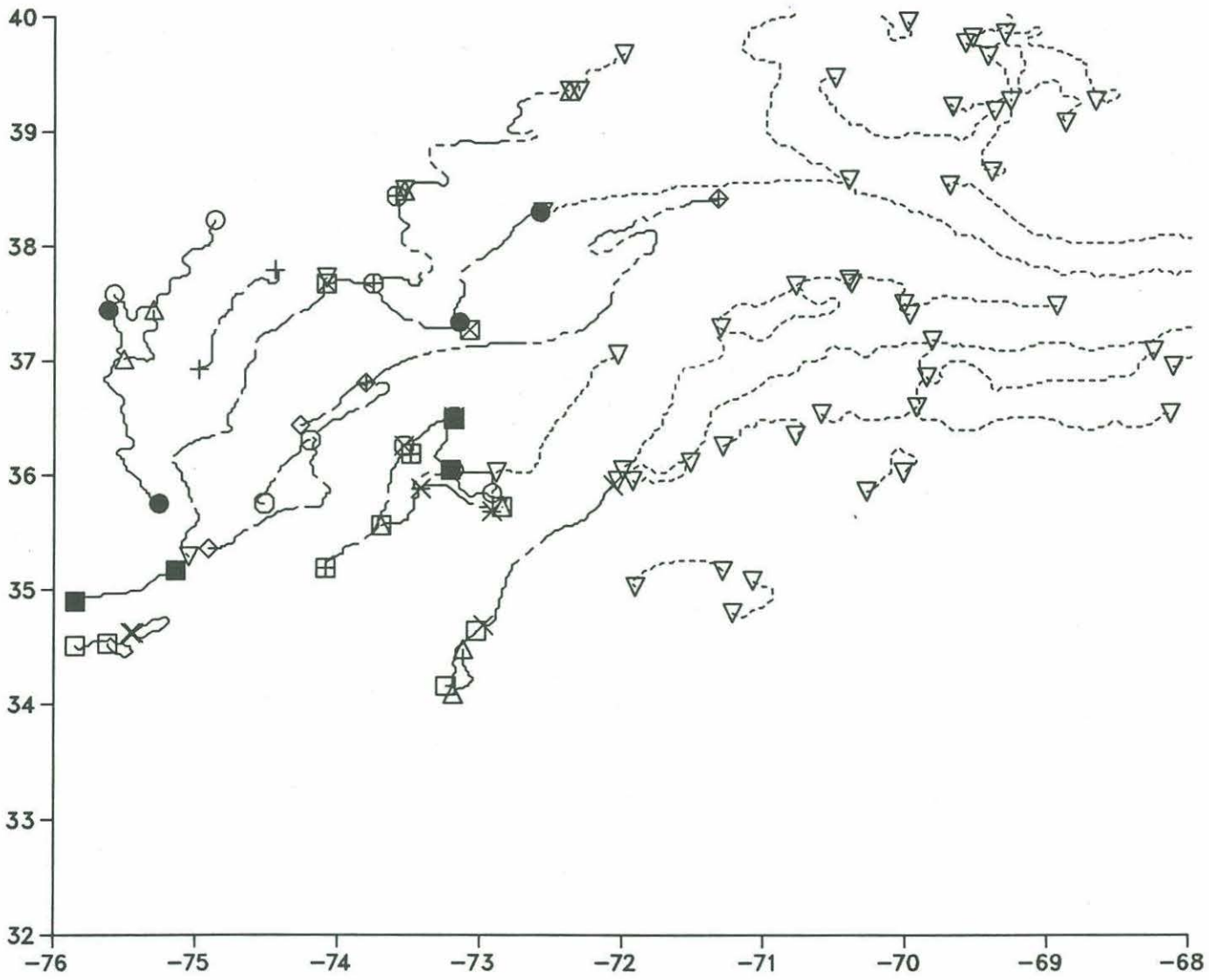


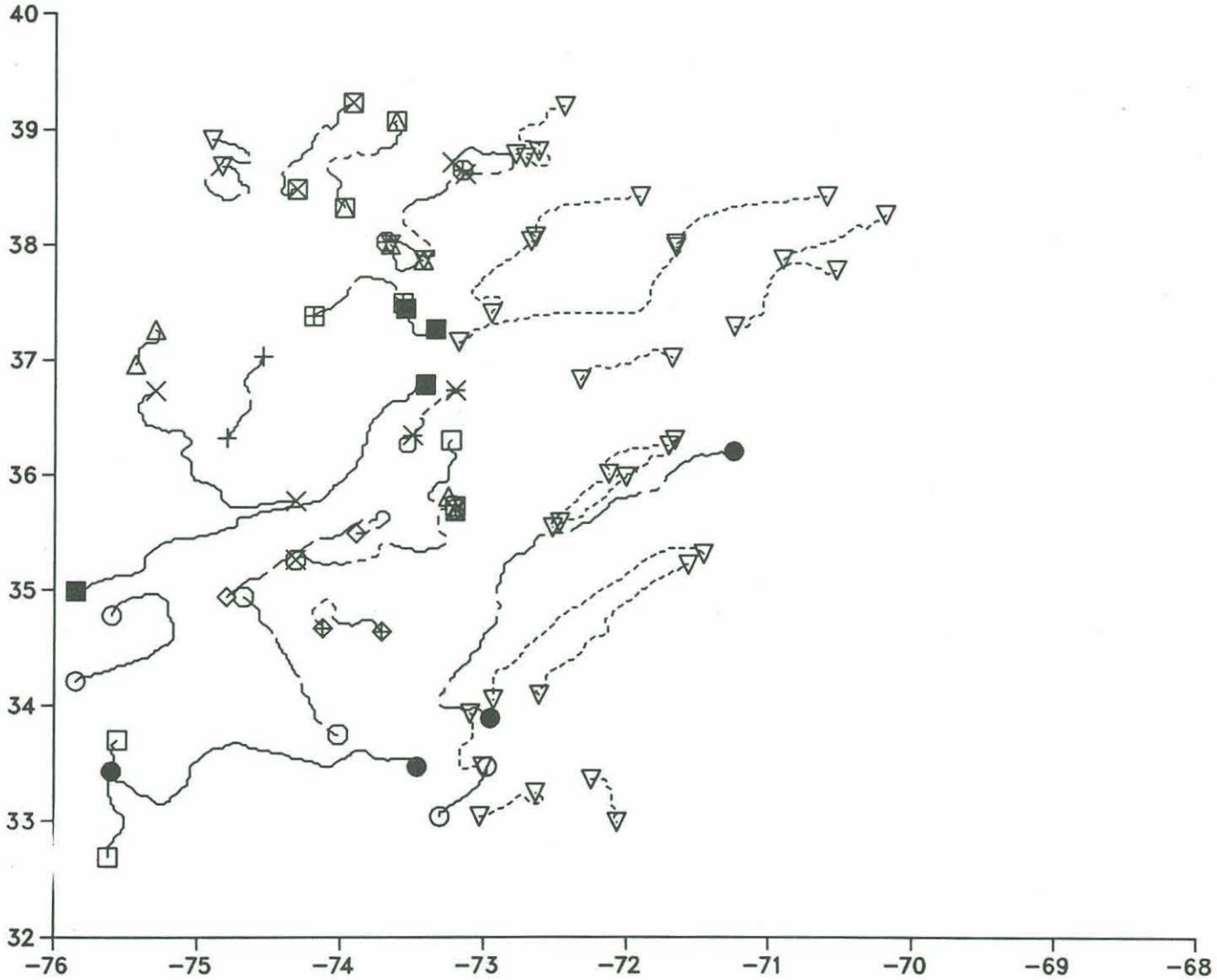
01-May-85
07:34:17 GMT



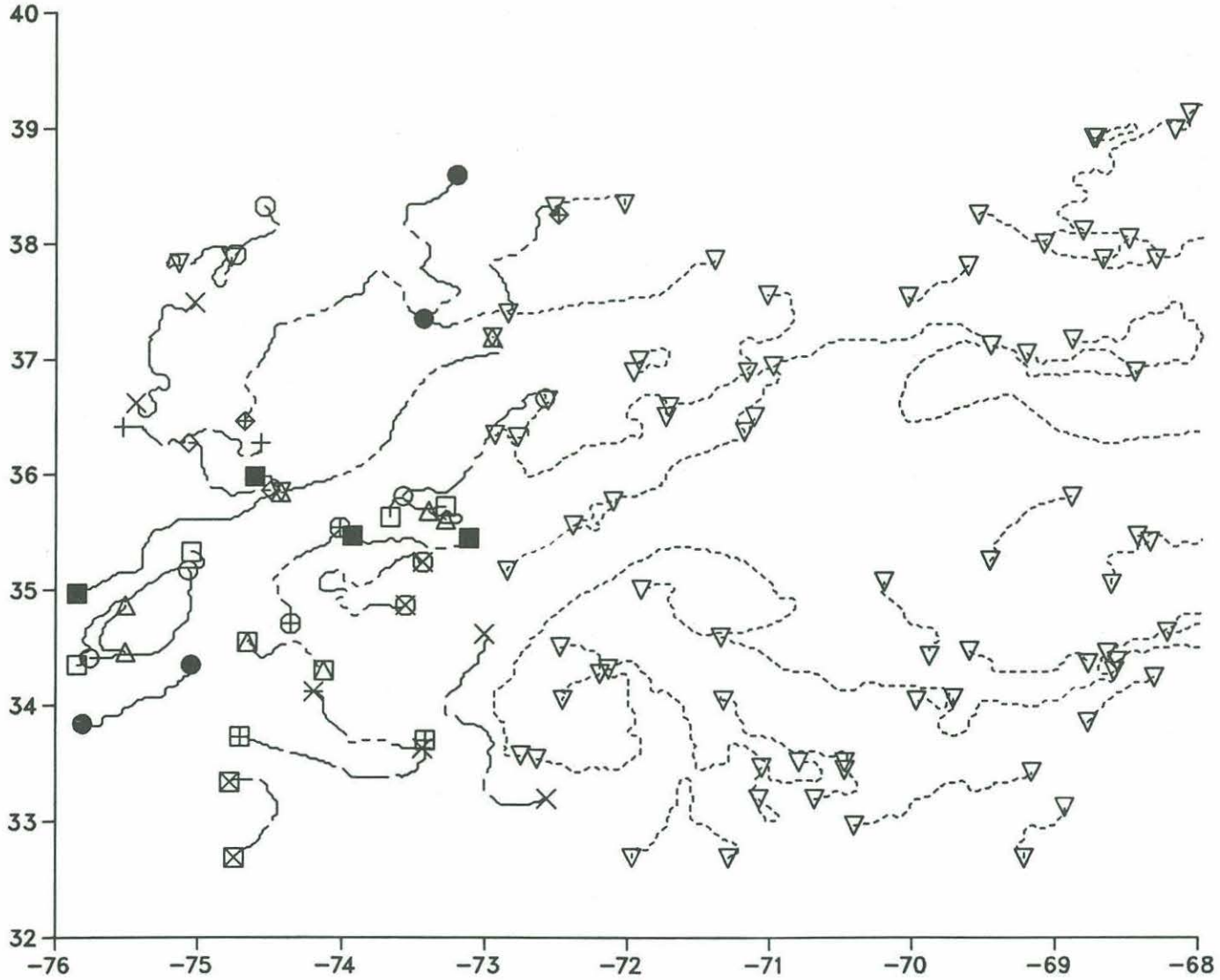
05-May-85
06:52:25 GMT



06-May-85
08:23:44 GMT



06-May-85
18:06:56 GMT



06-May-85
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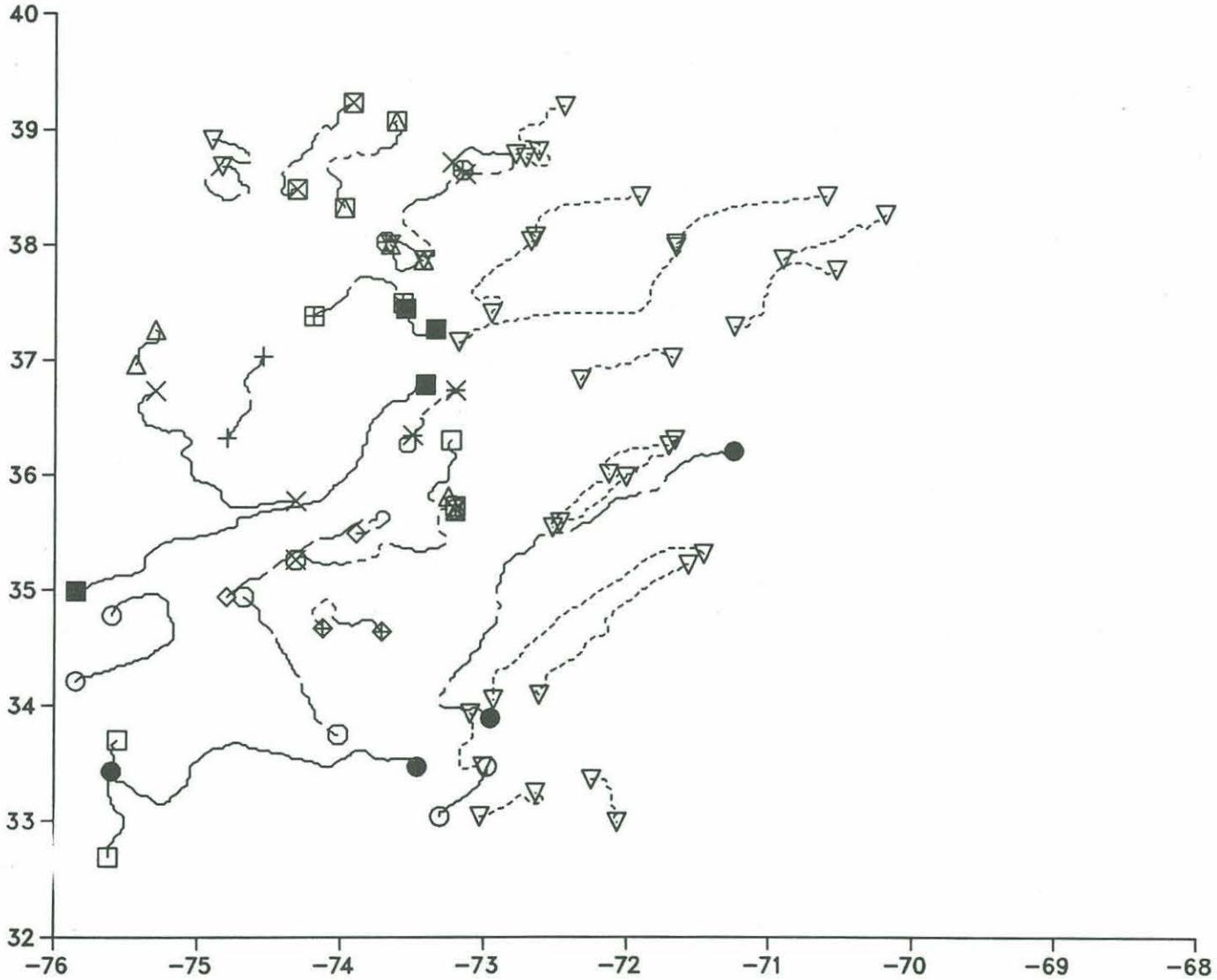

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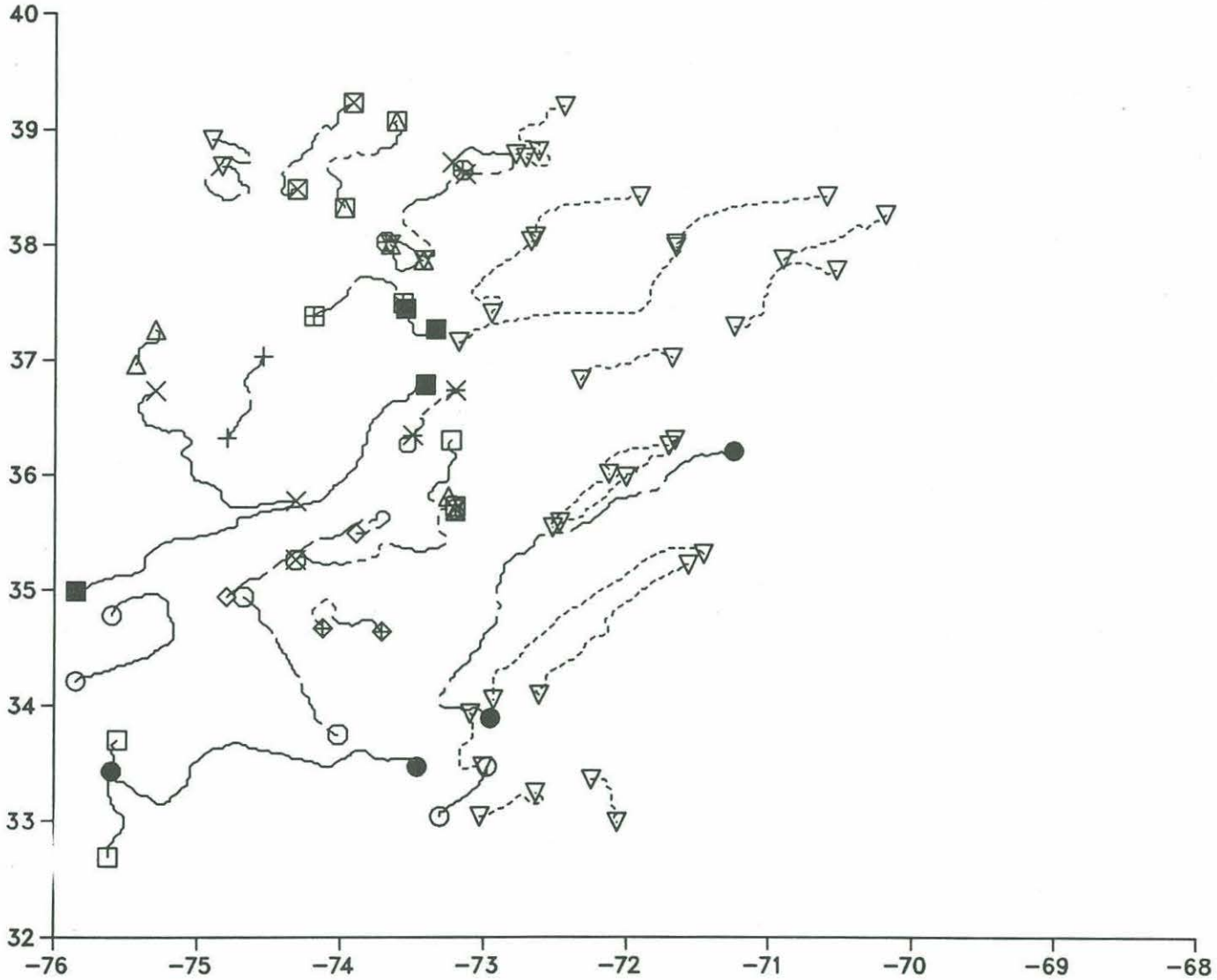
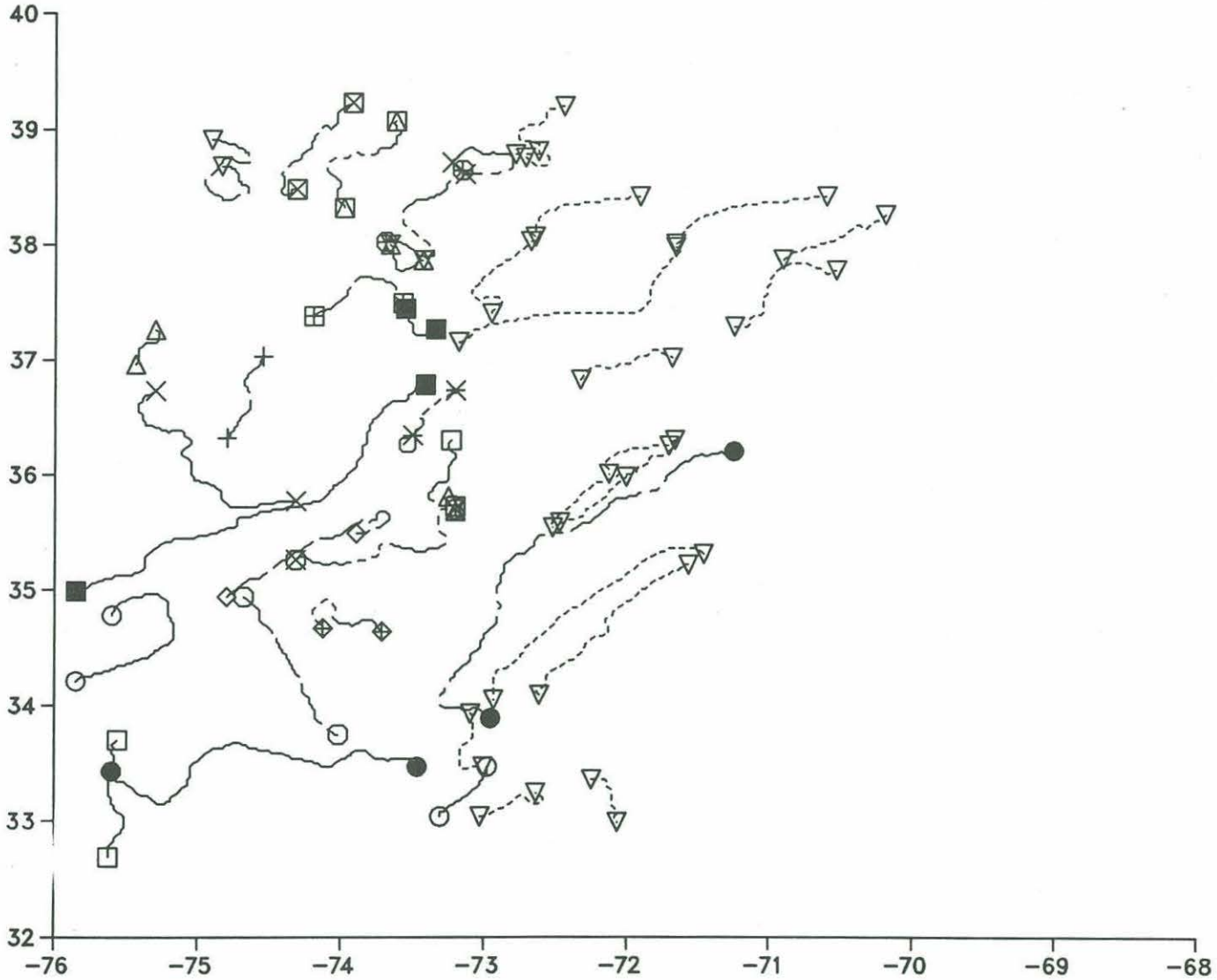
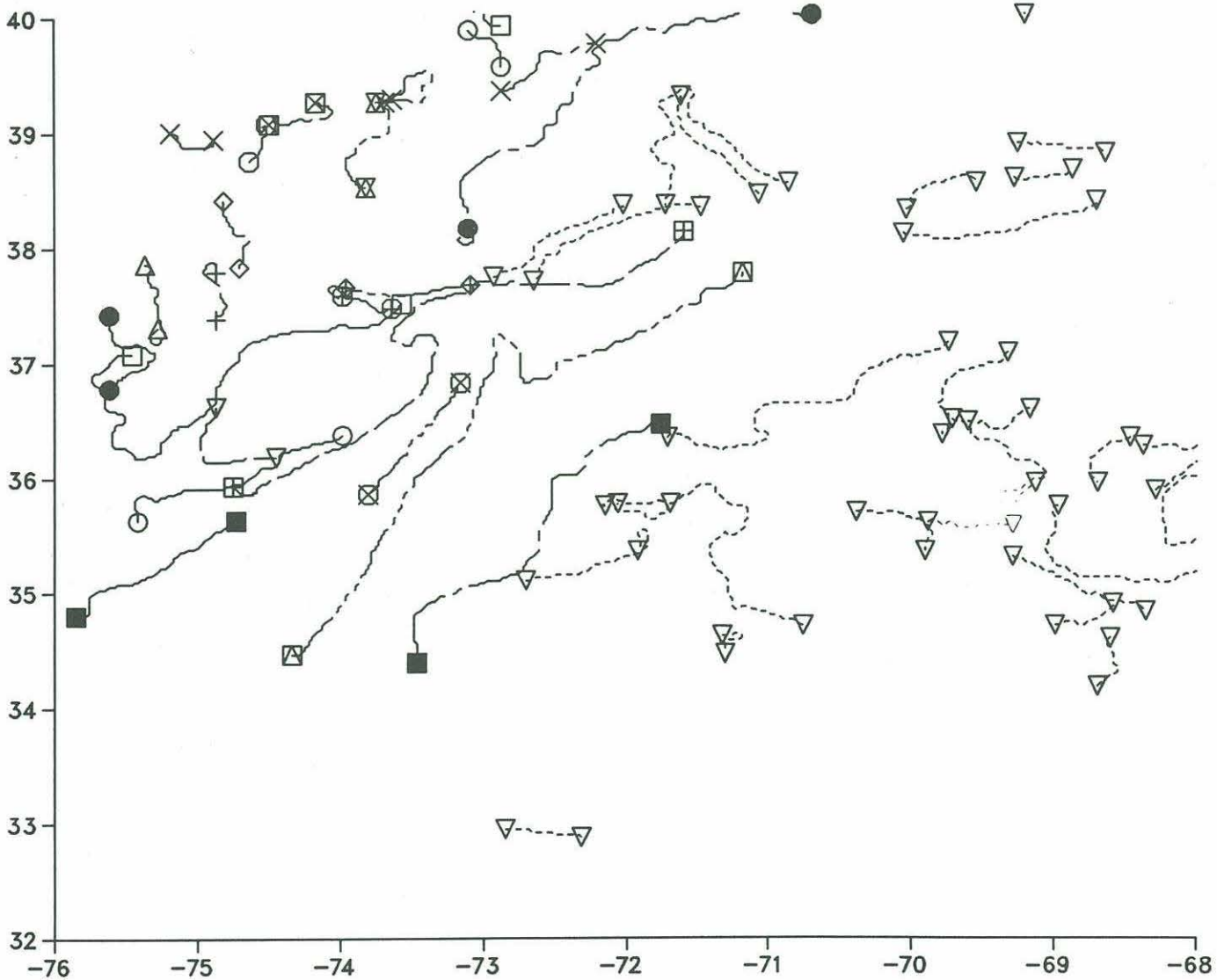


06-May-85
08:23:44 GMT



19-May-85
19:10:57 GMT



19-May-85
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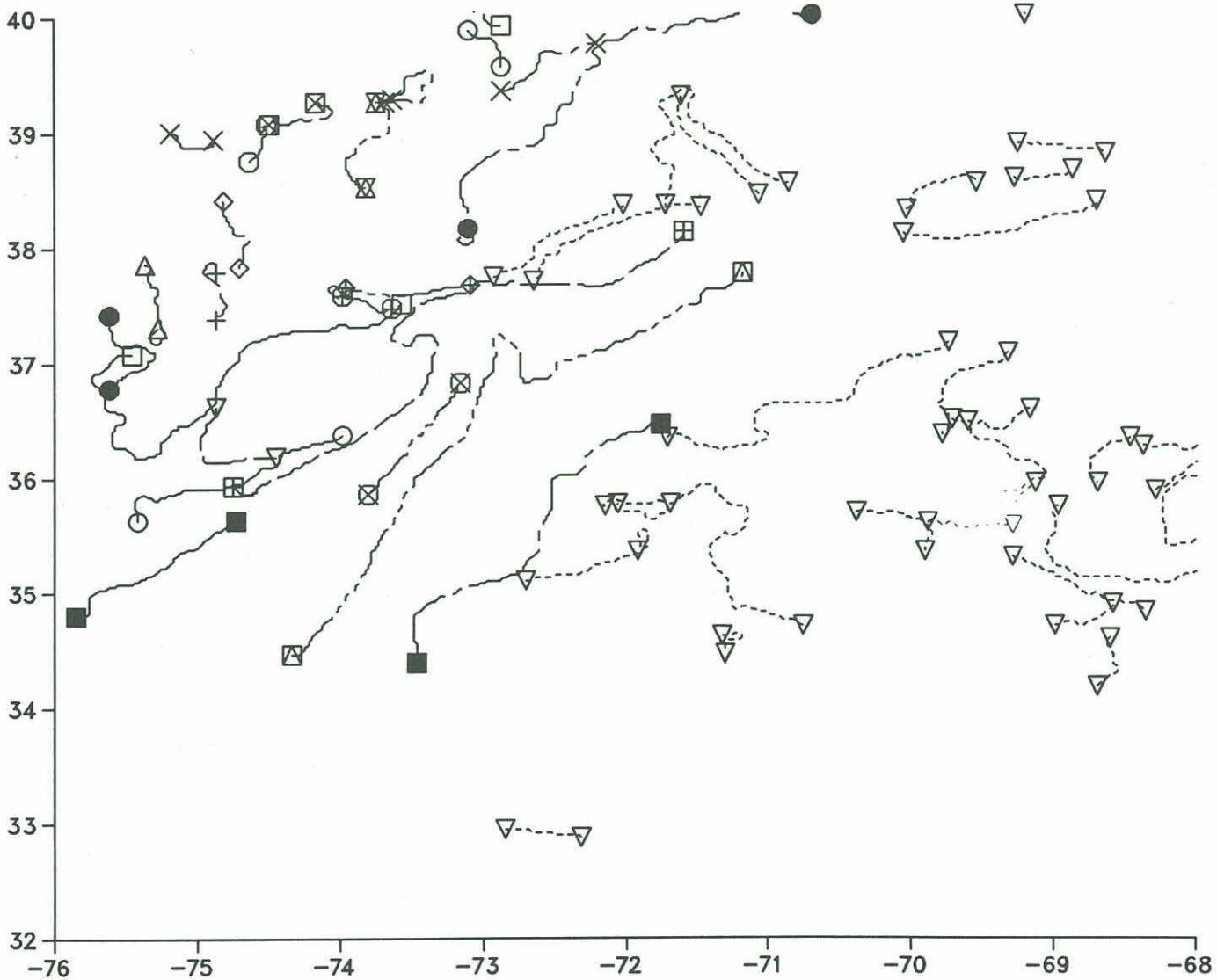
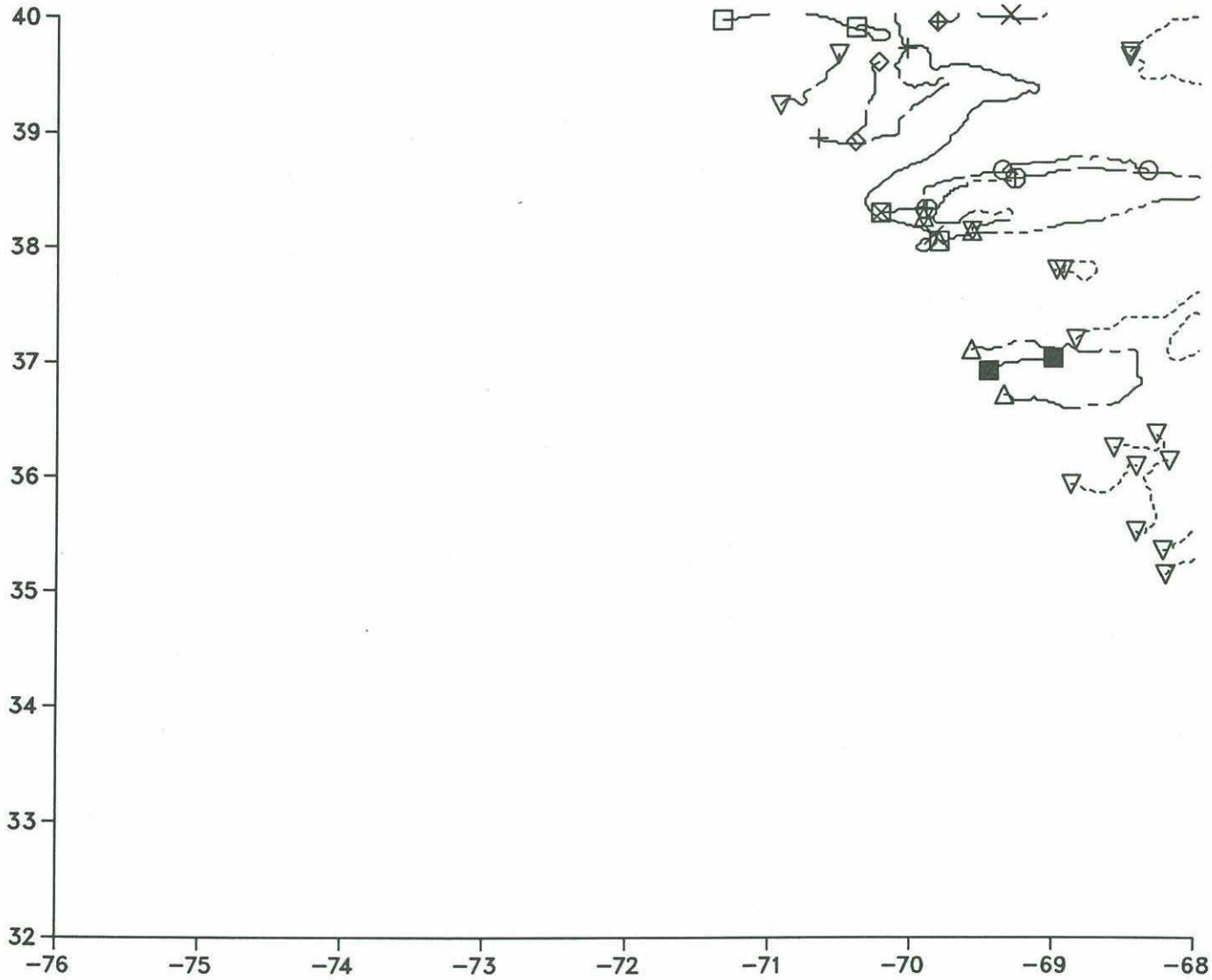
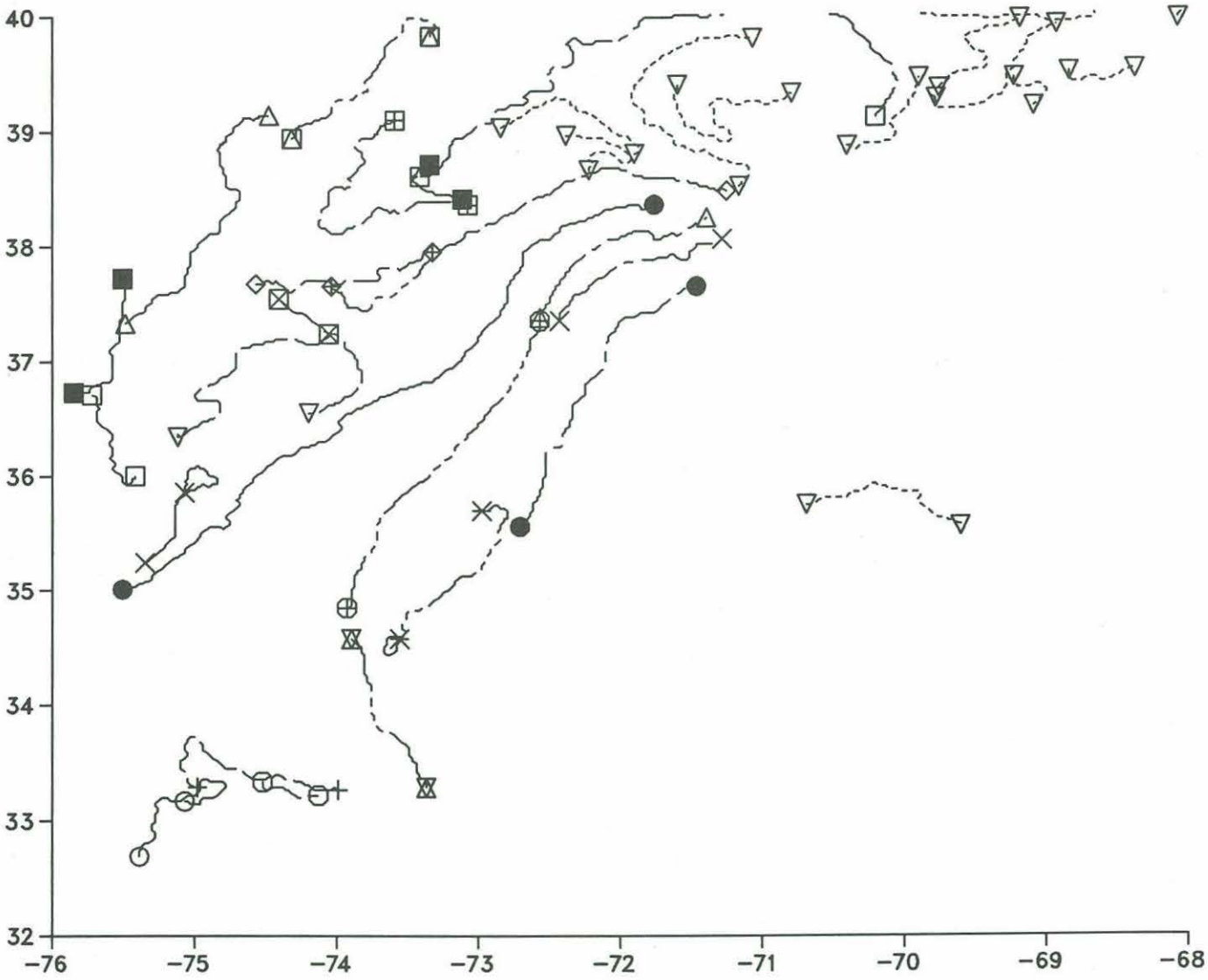


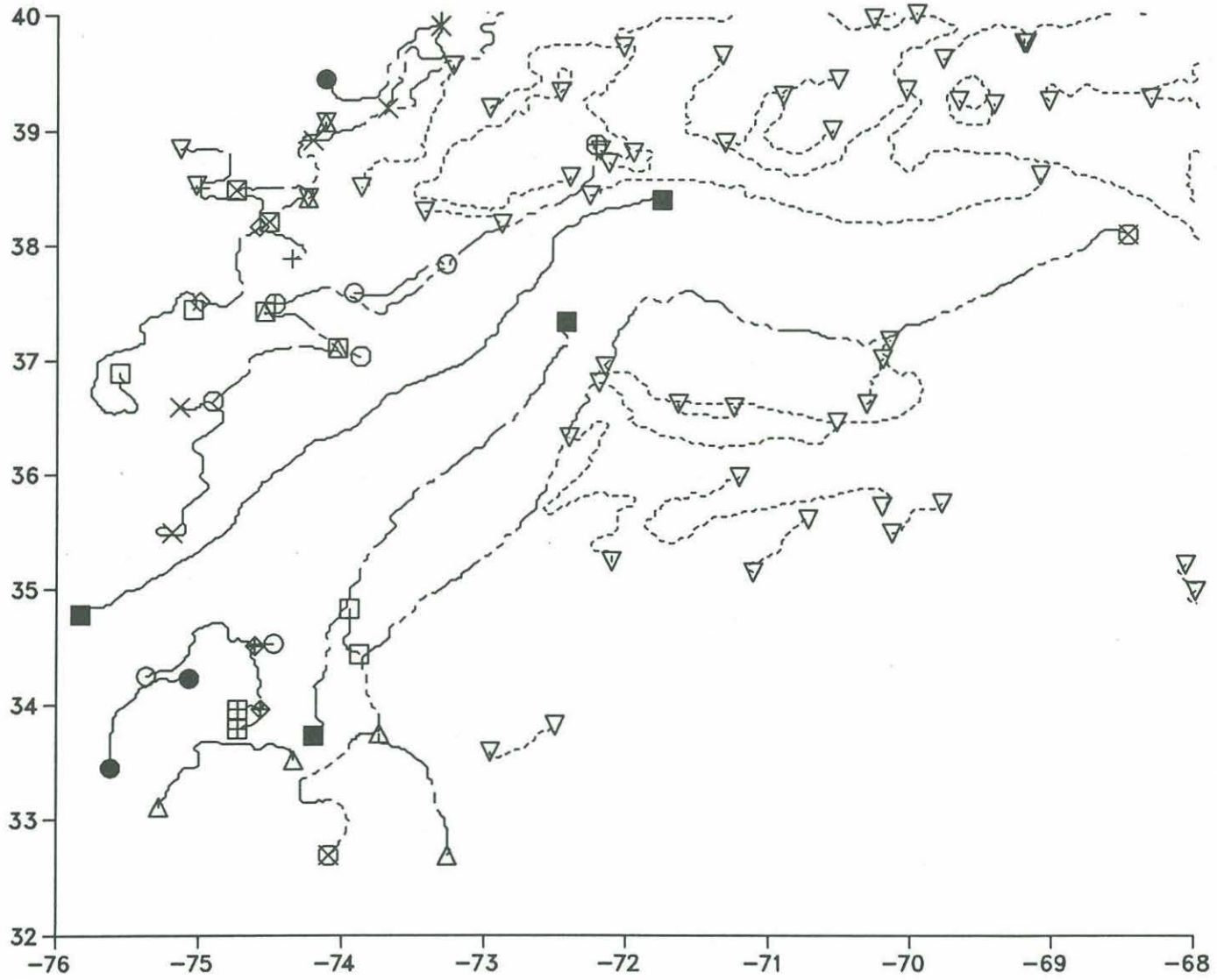
*20-May-85
17:20:12 GMT



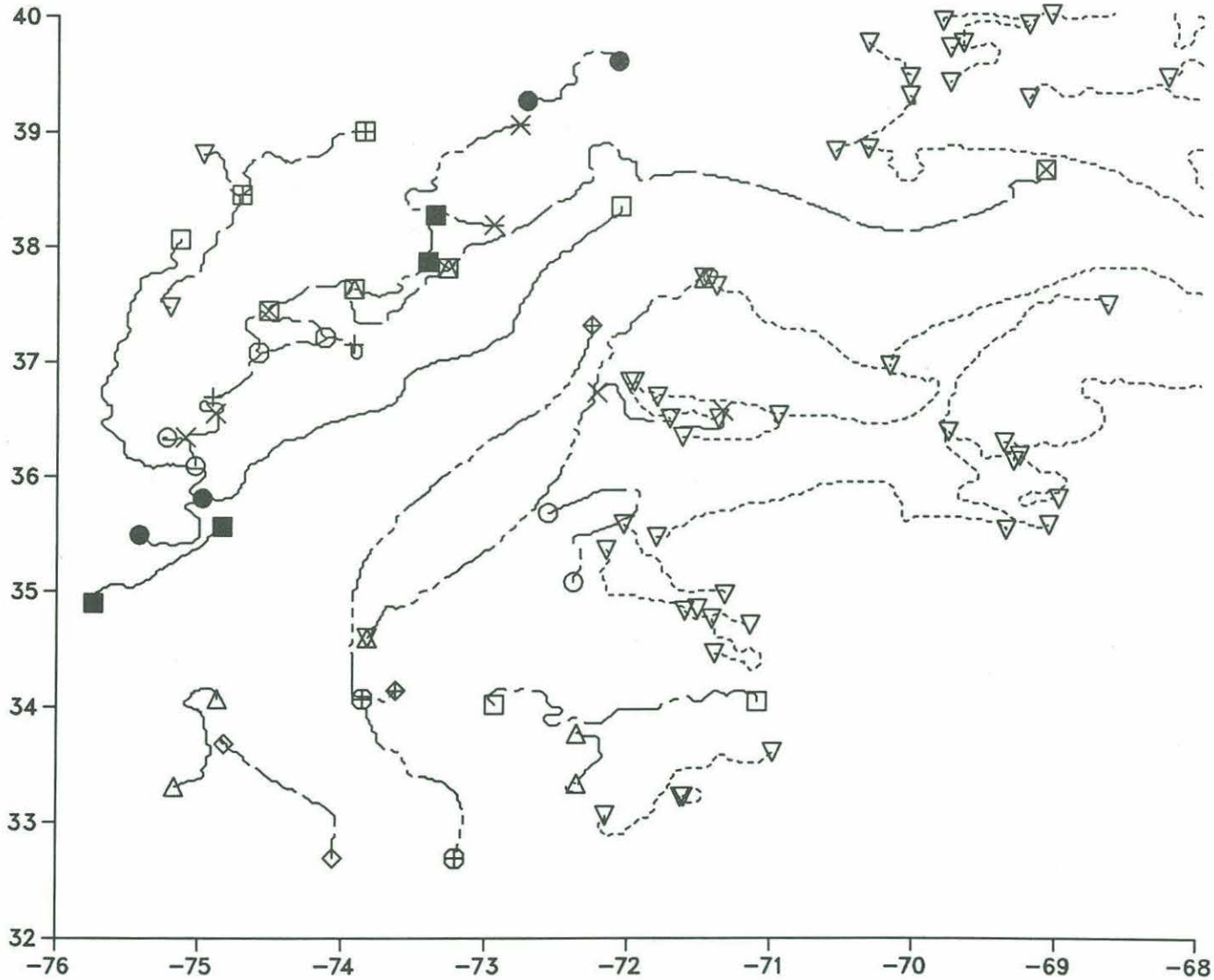
26-May-85
08:12:11 GMT



26-May-85
17:55:02 GMT



27-May-85
08:00:52 GMT



27-May-85
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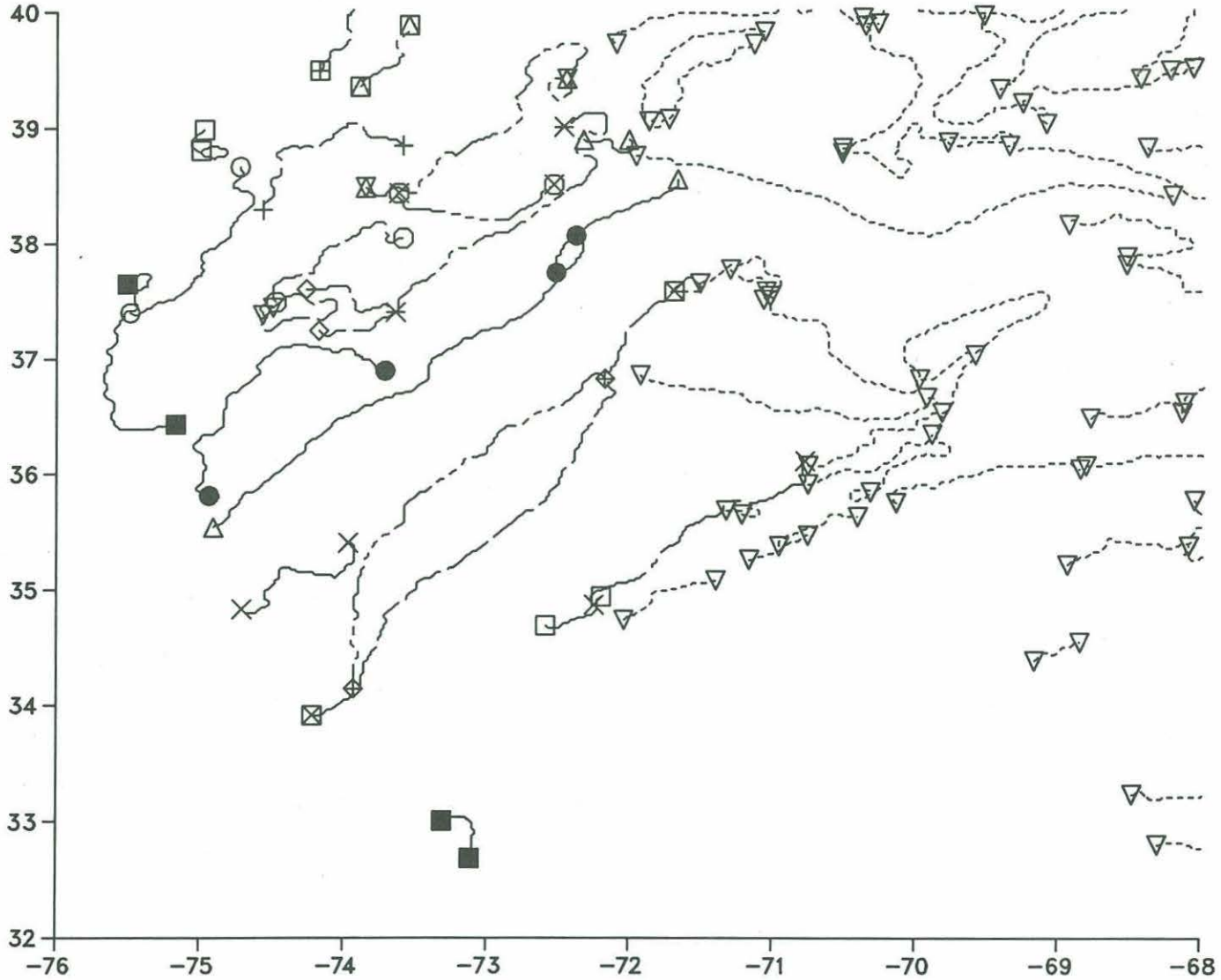
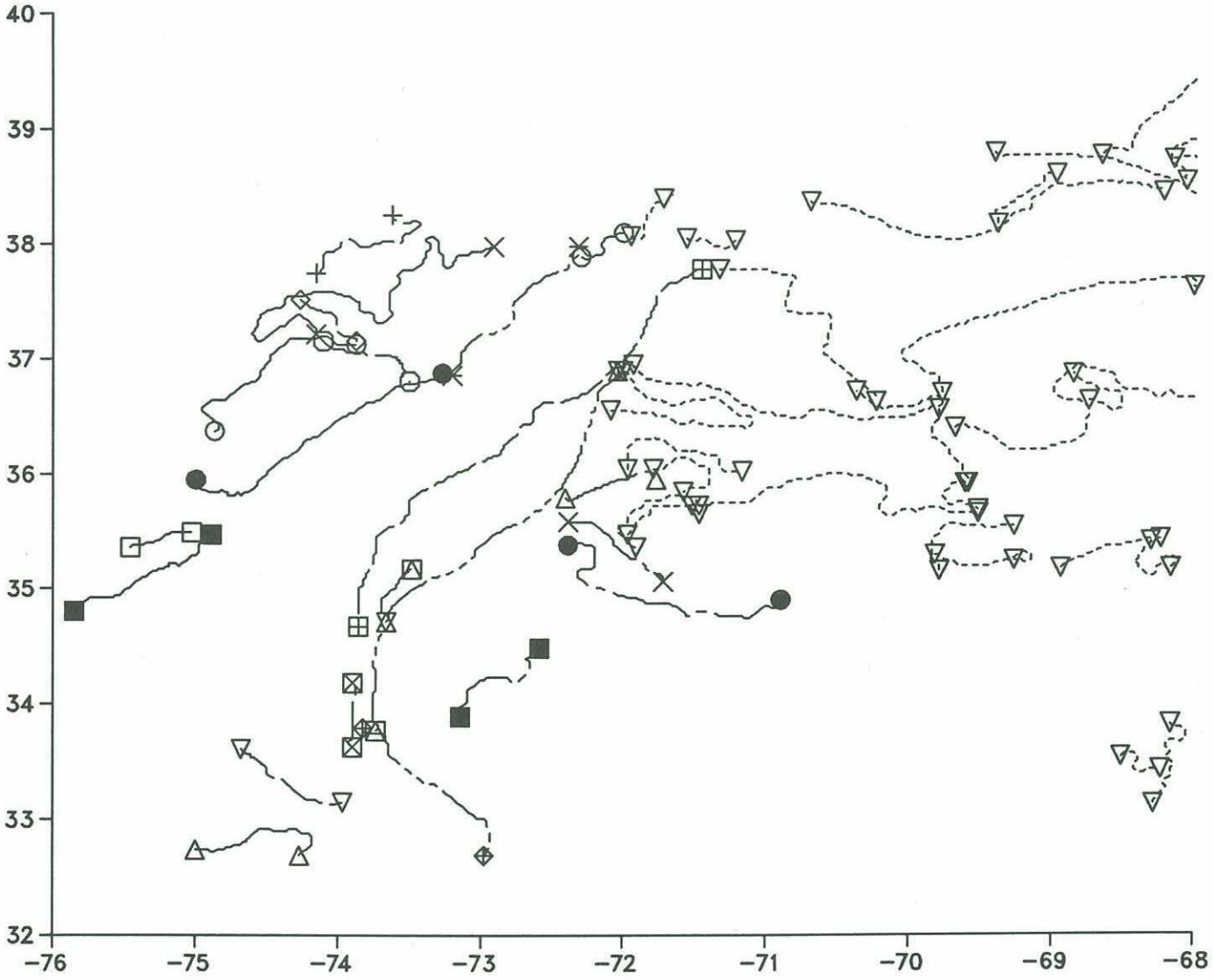
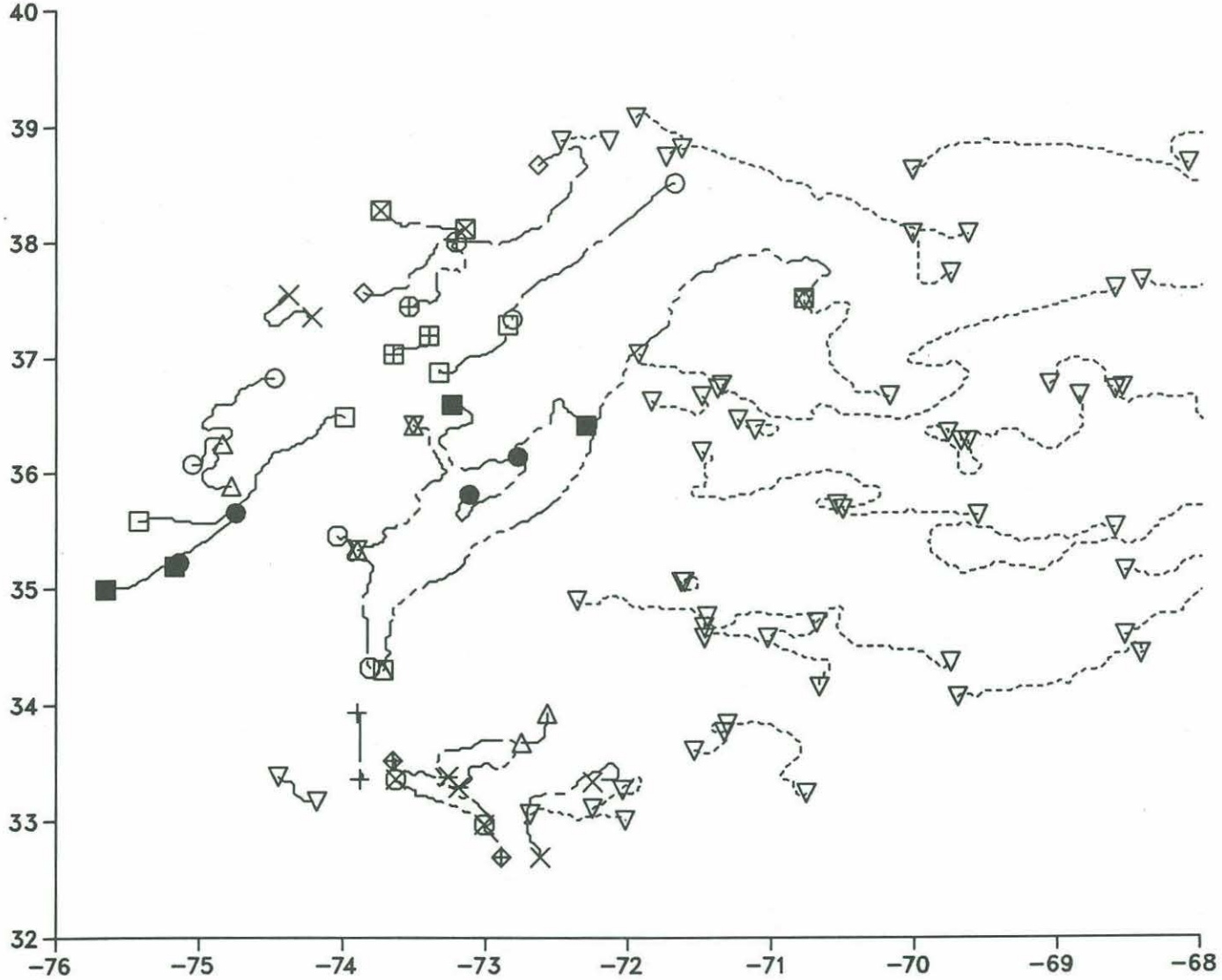


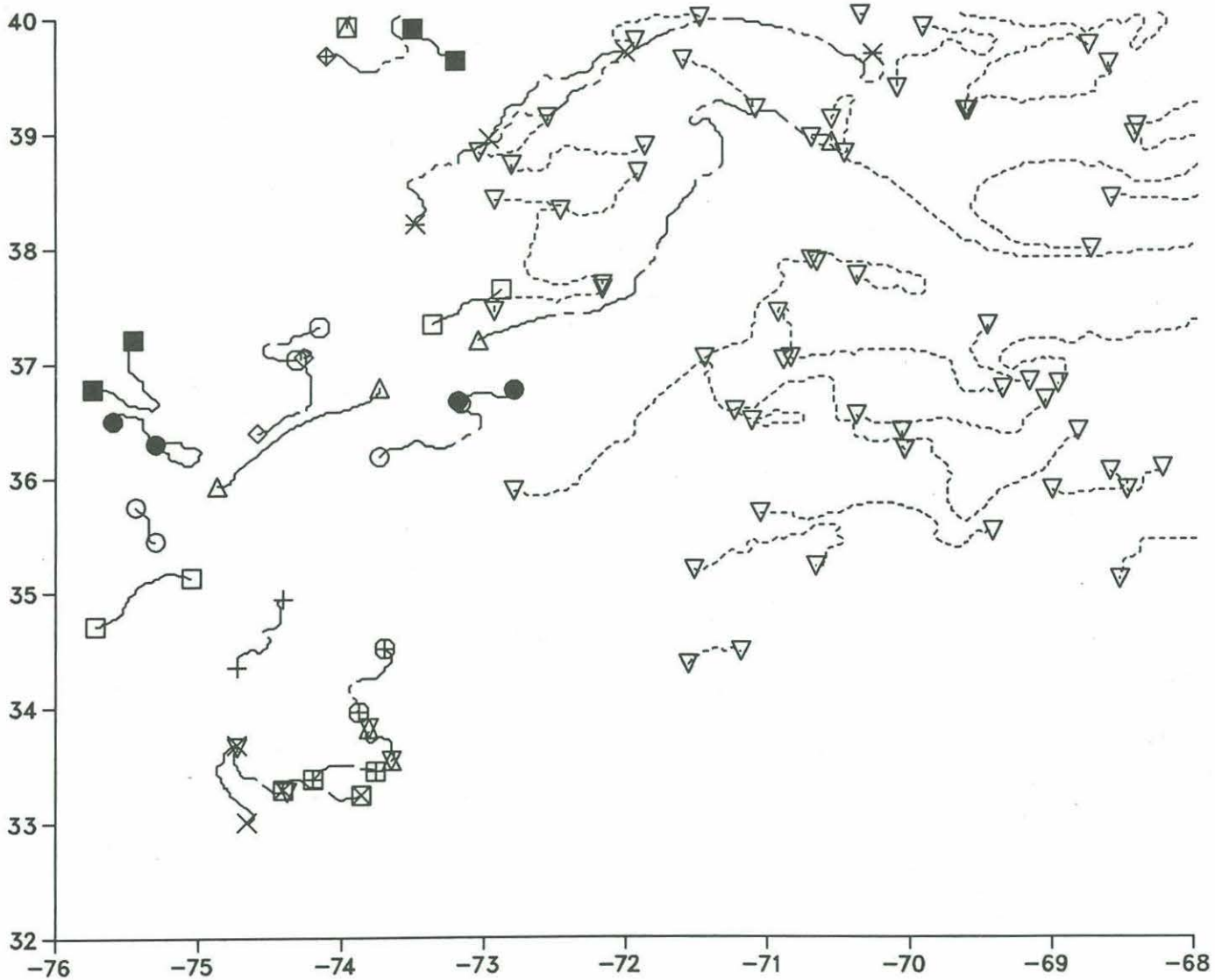
28-May-85
07:49:27 GMT



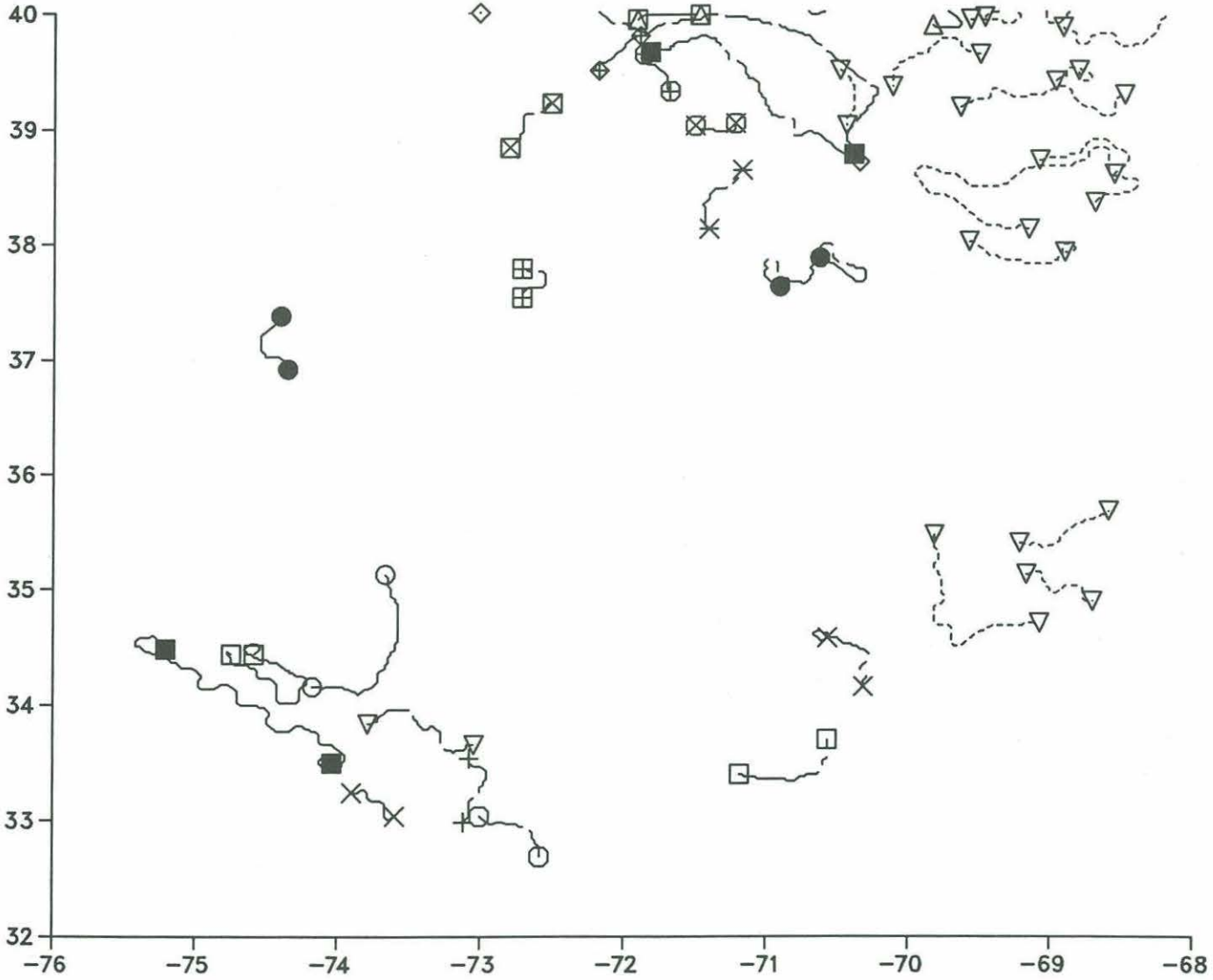
28-May-85
19:15:40 GMT



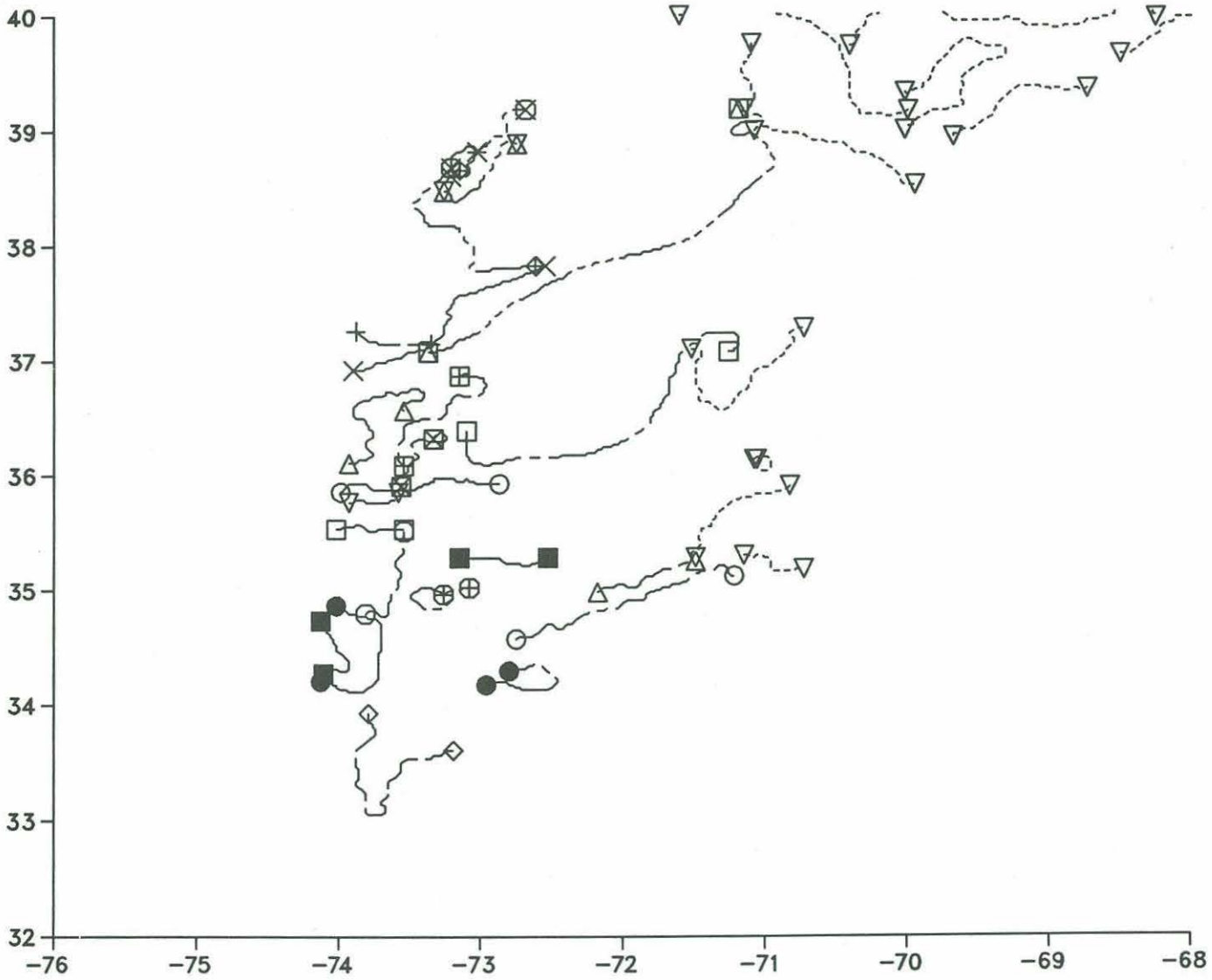
02-Jun-85
06:55:58 GMT



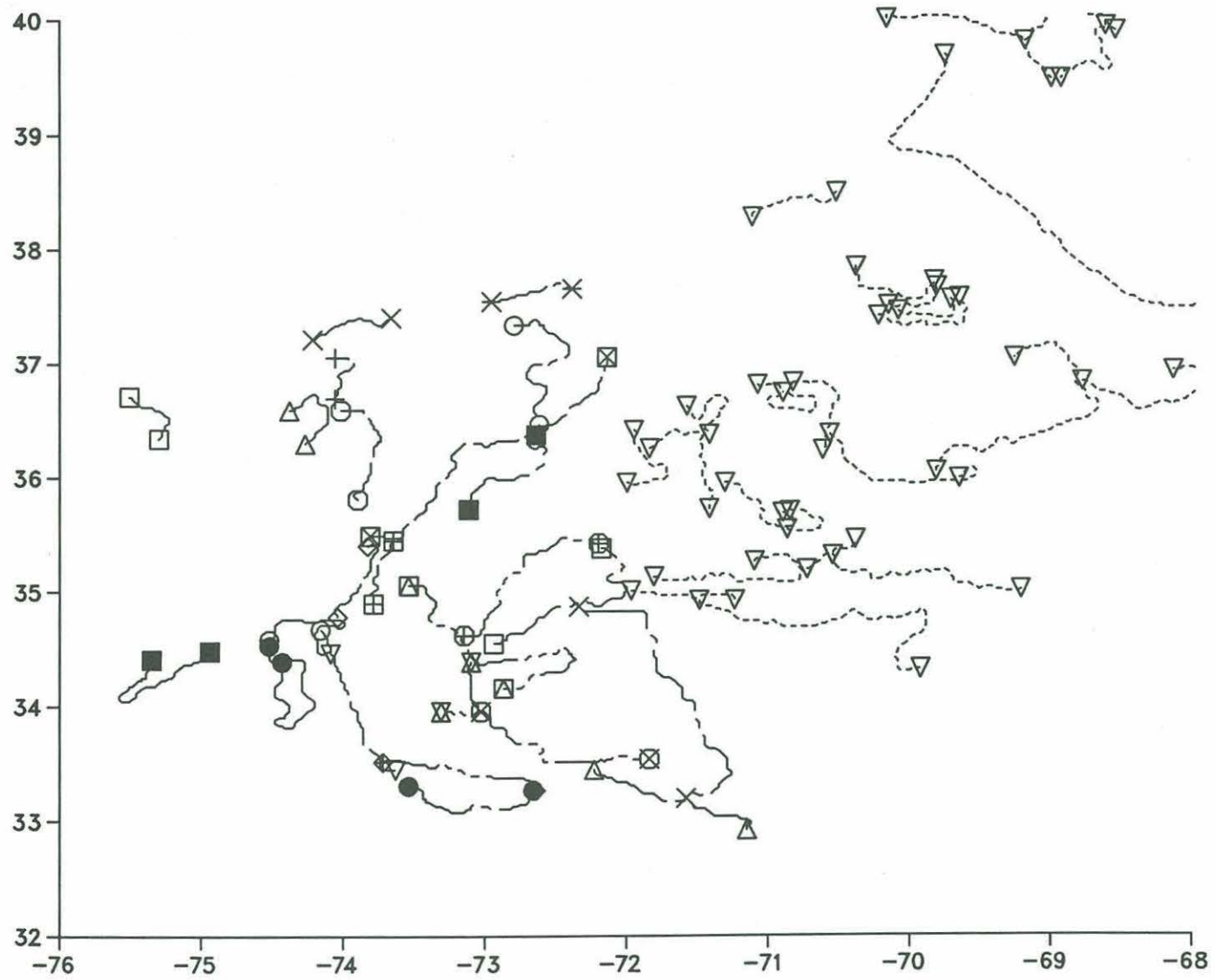
02-Jun-85
18:21:09 GMT



04-Jun-85
06:34:20 GMT



09-Jun-85
18:47:08 GMT



10-Jun-85
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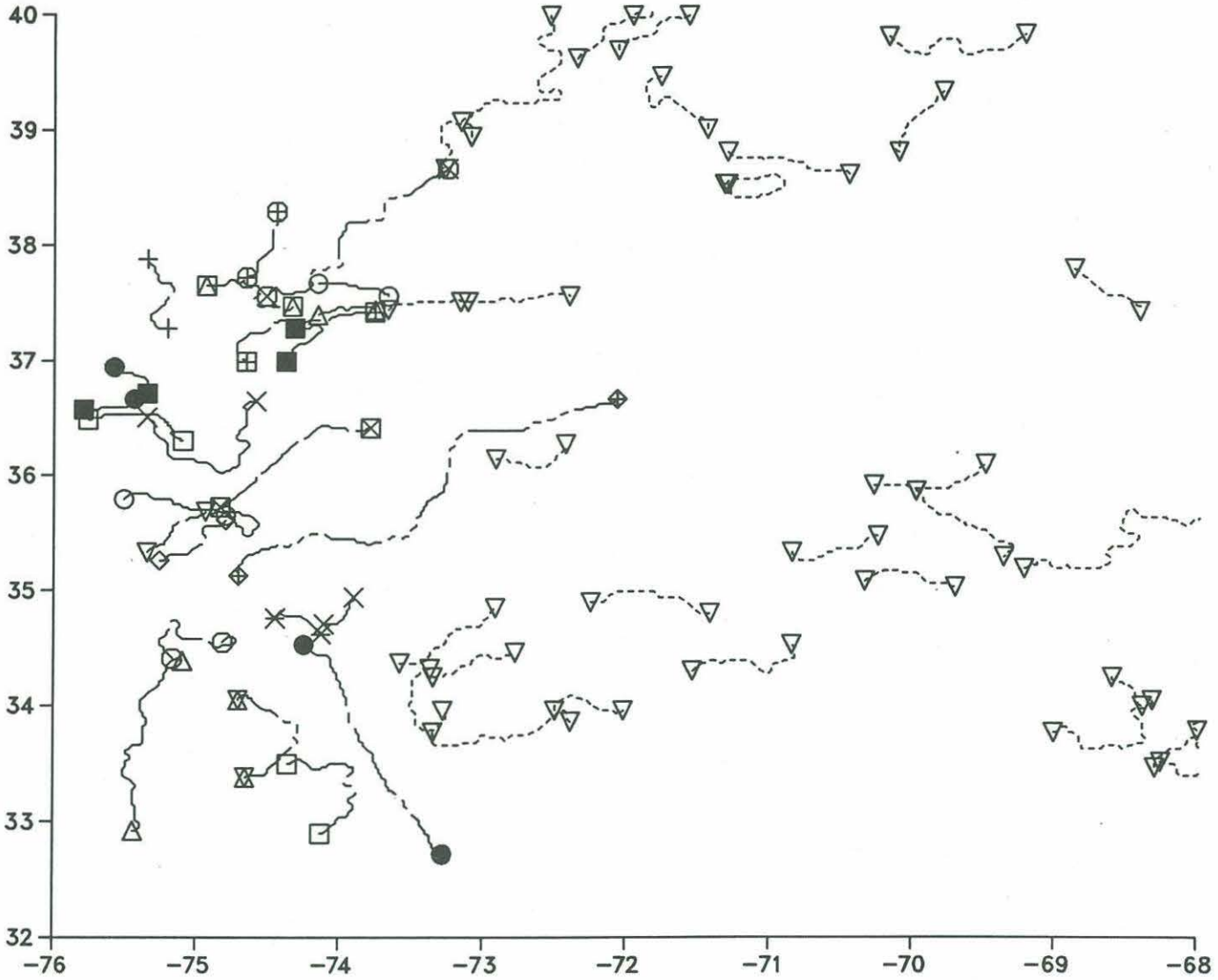
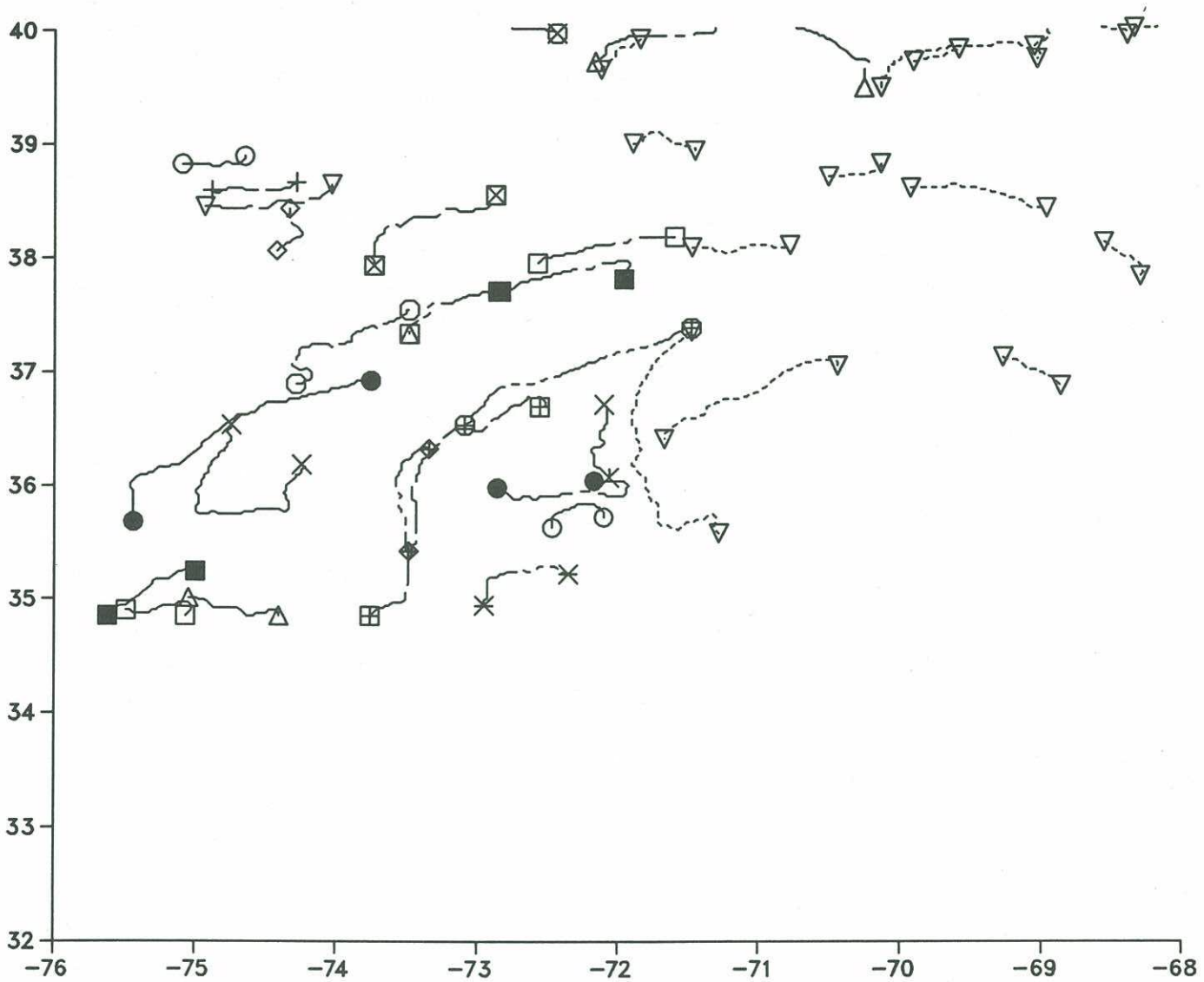


15-Jun-85
07:59:39 GMT



17-Jun-85
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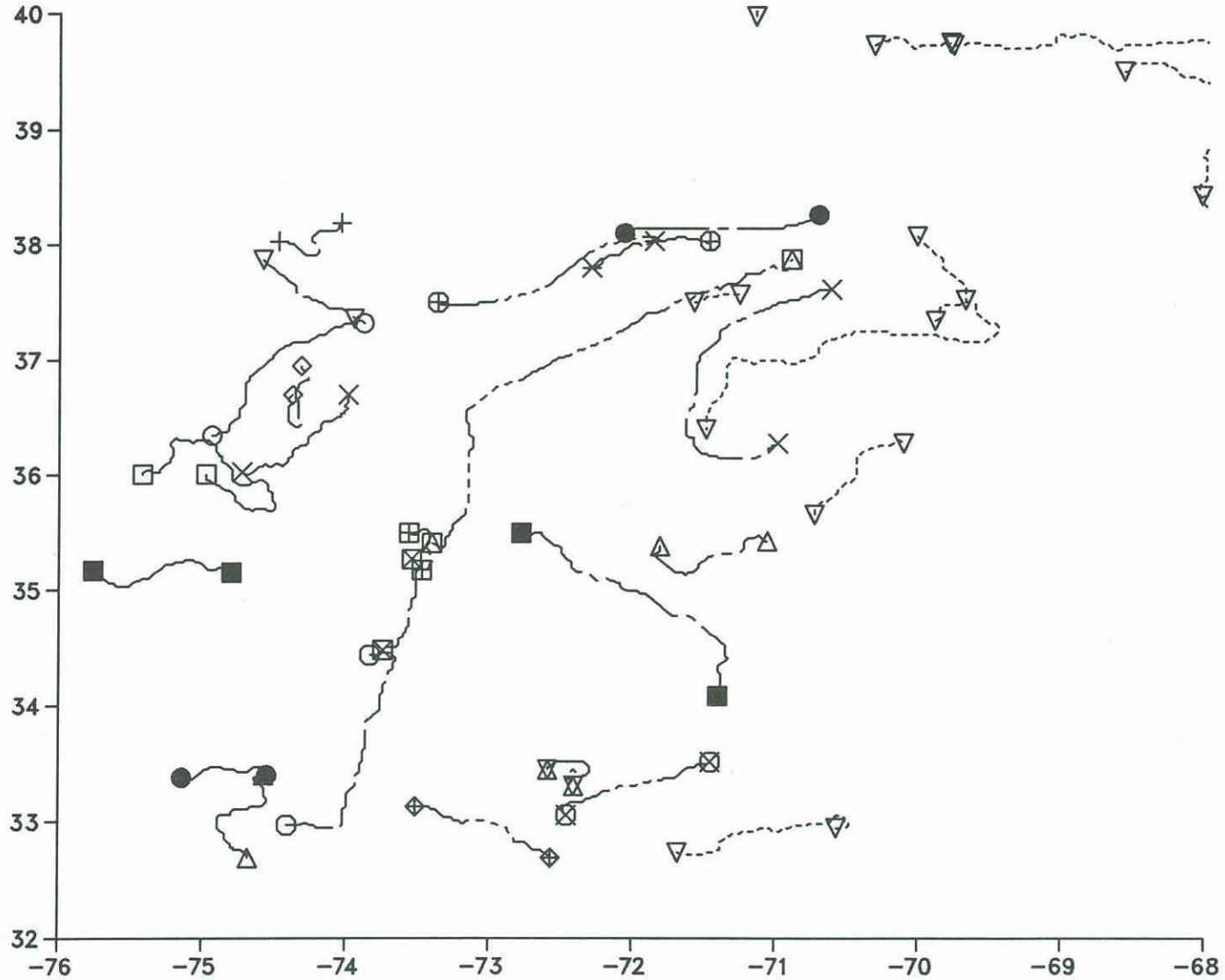

21-Jun-85
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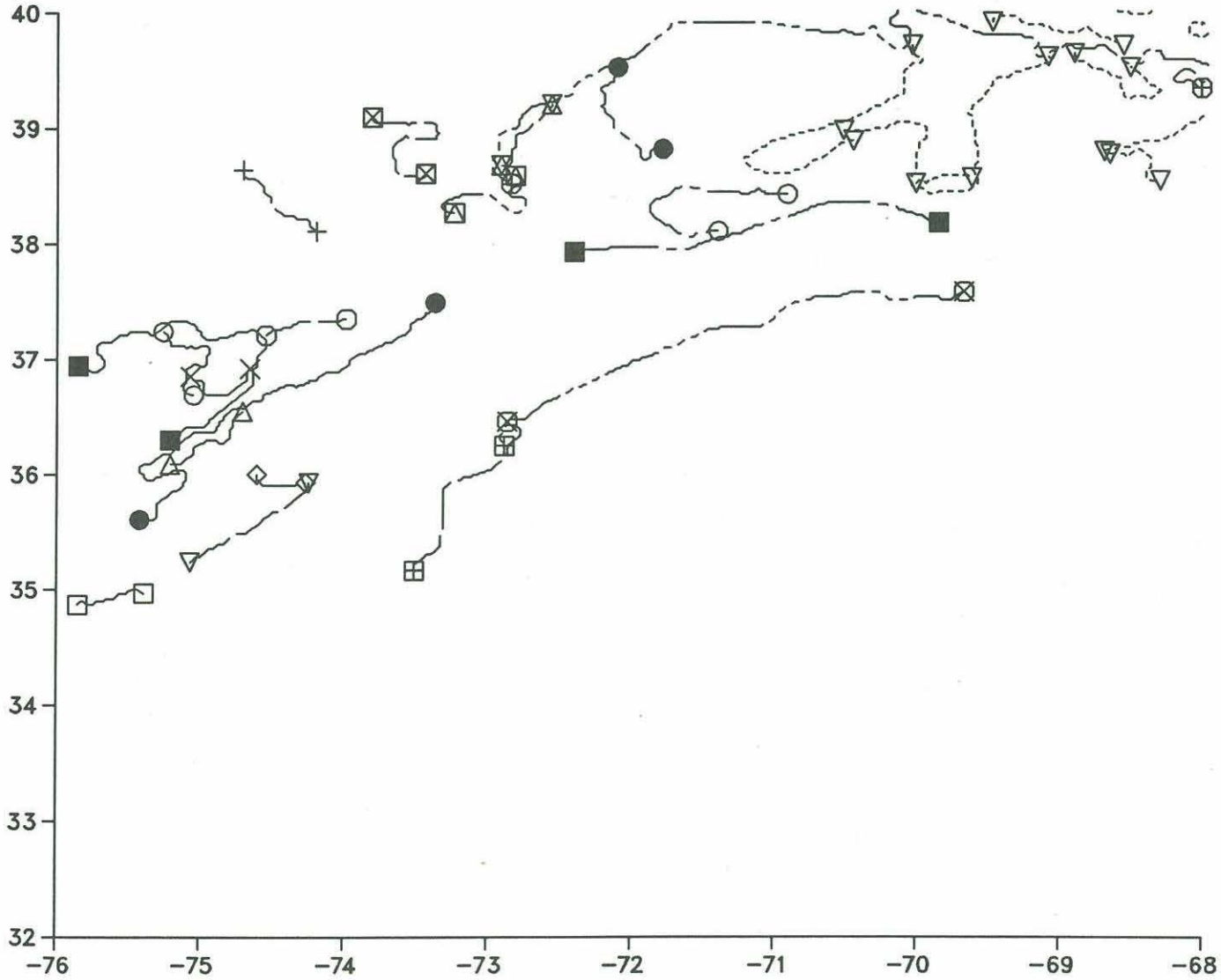

22-Jun-85
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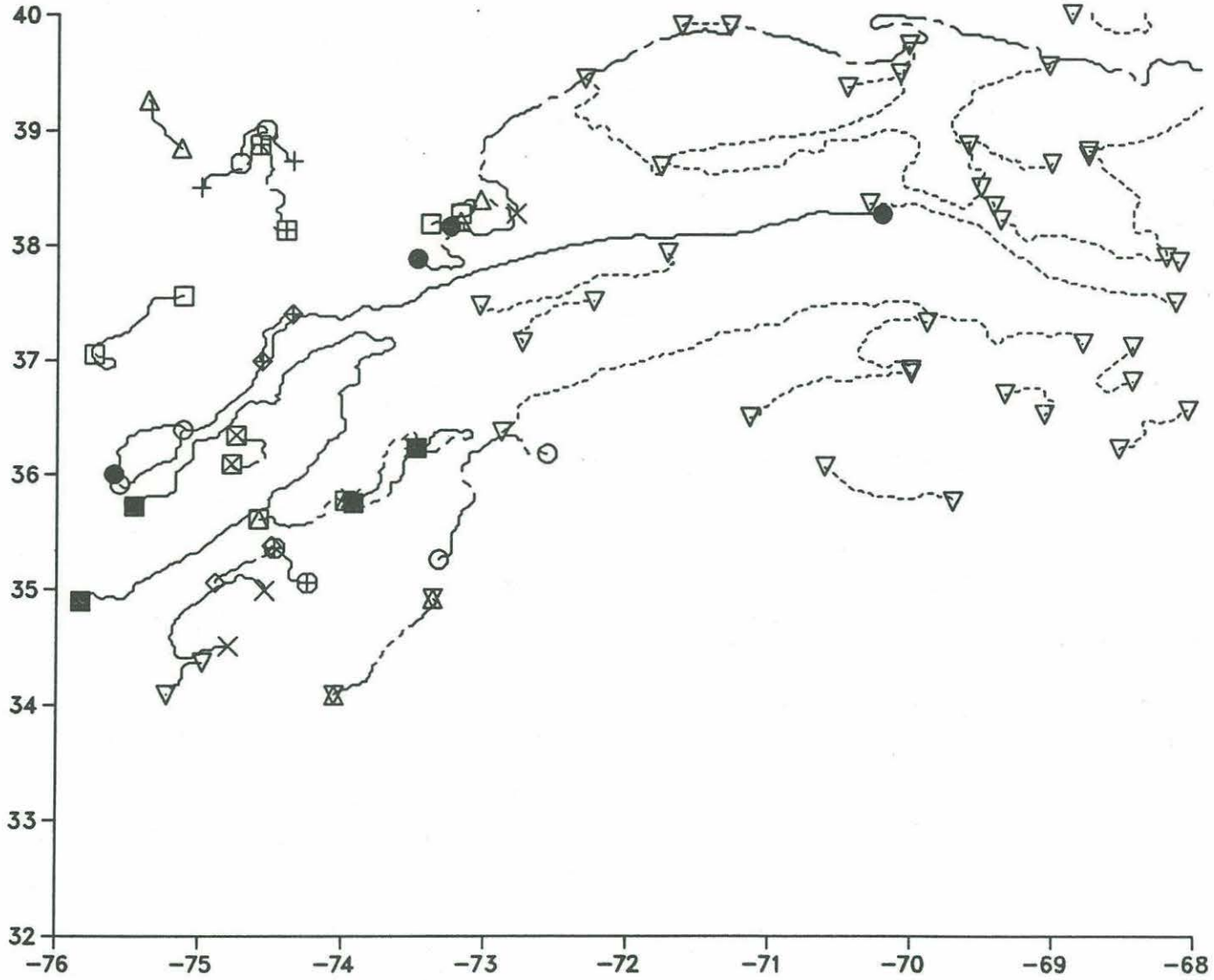
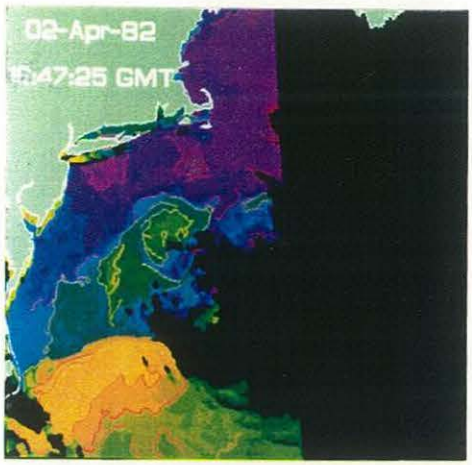
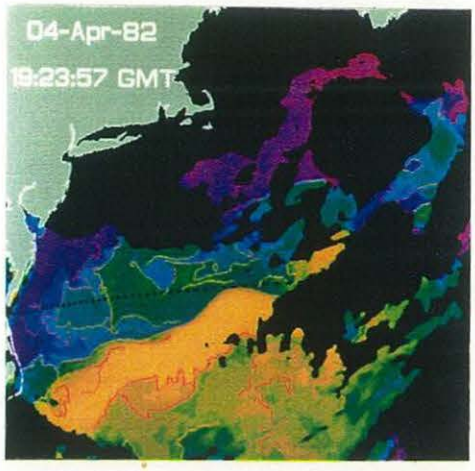



02-Apr-82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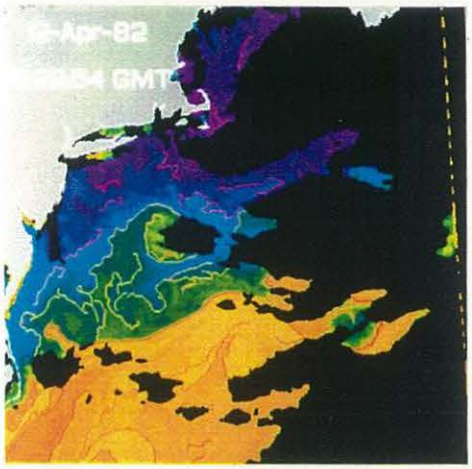

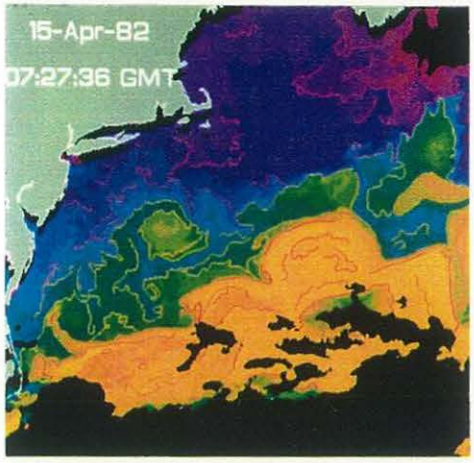
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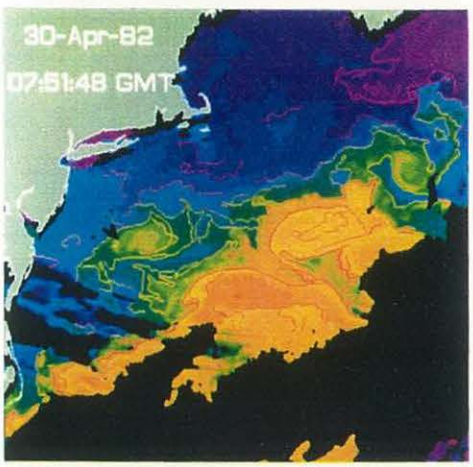
18-Apr-82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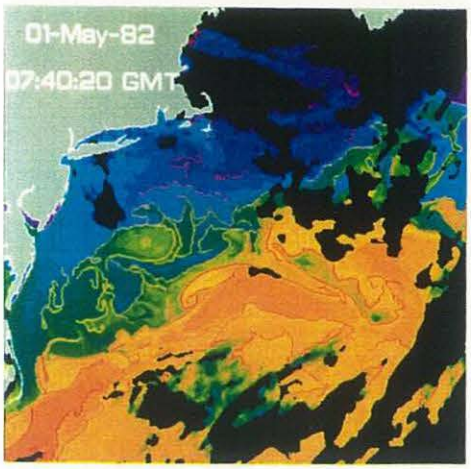
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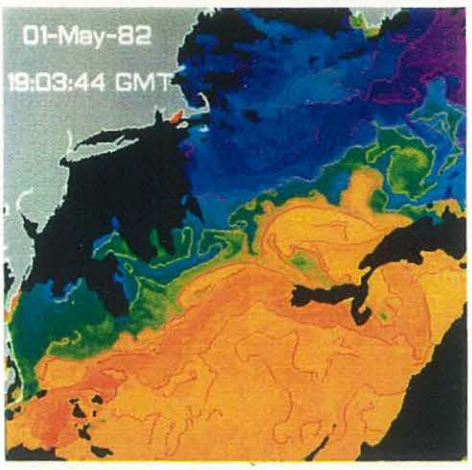
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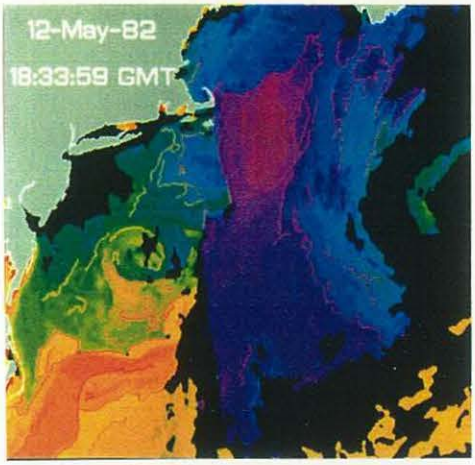
06-May-82

06-May-82
18:06:15 GMT

11-May-82


12-May-82
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16-May-82
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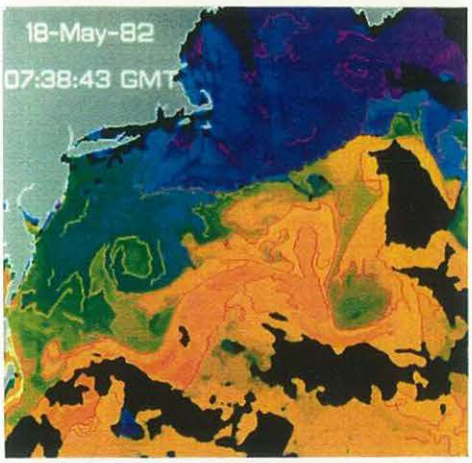
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02-Jun-82
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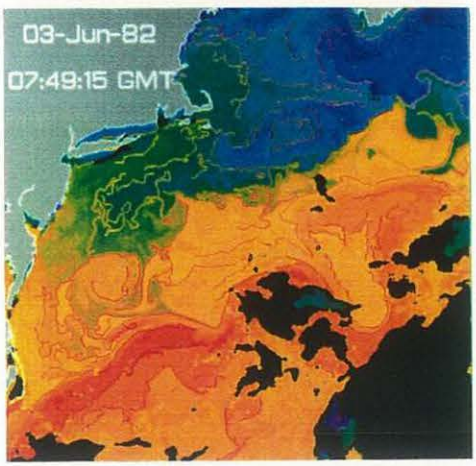
03-Jun-82
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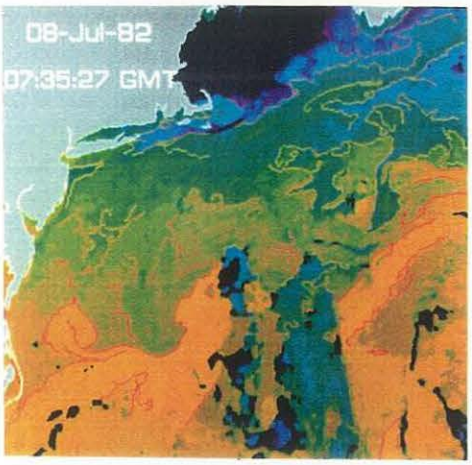
08-Jul-82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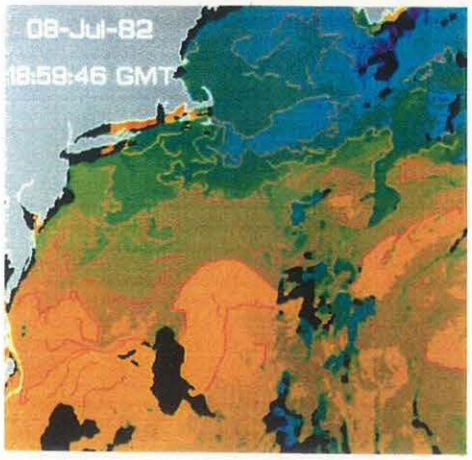
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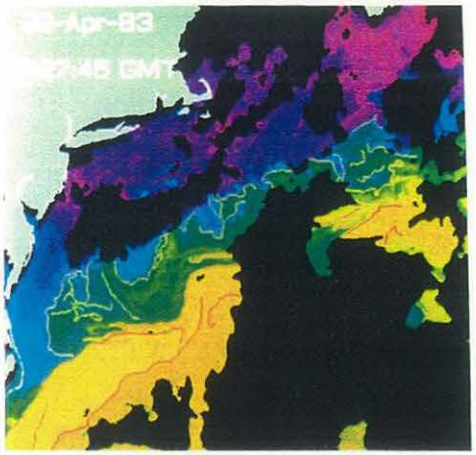
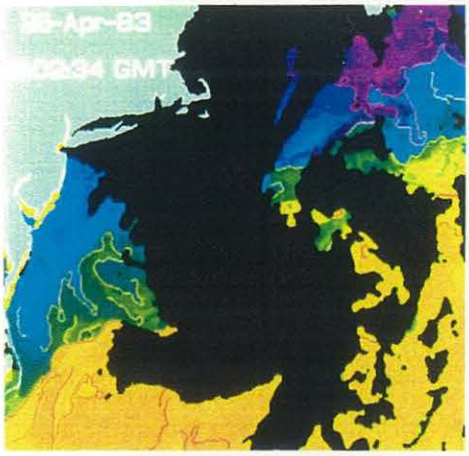
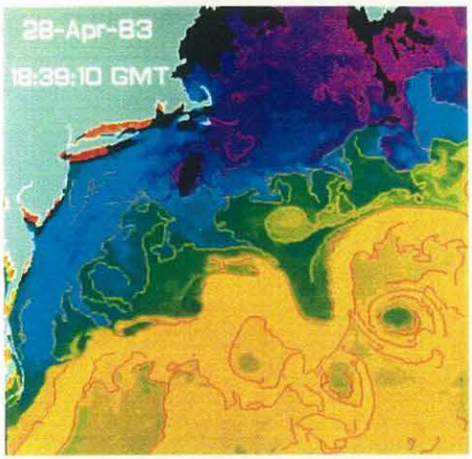




27-Apr-83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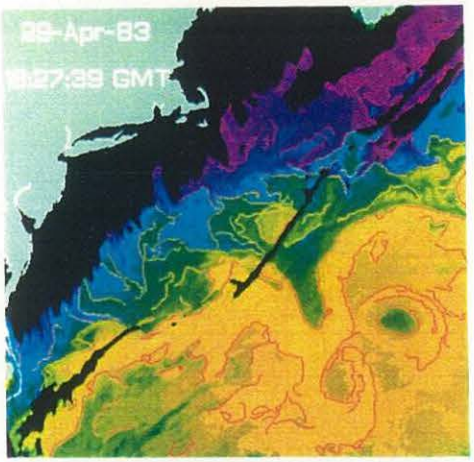

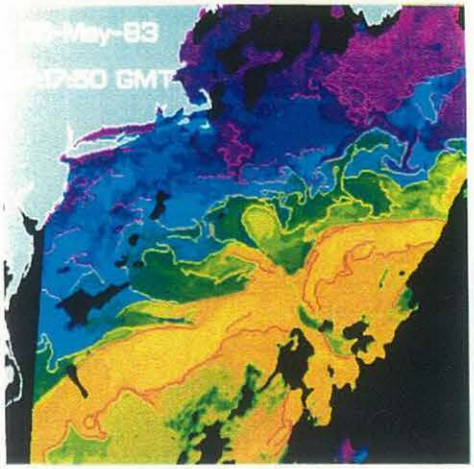

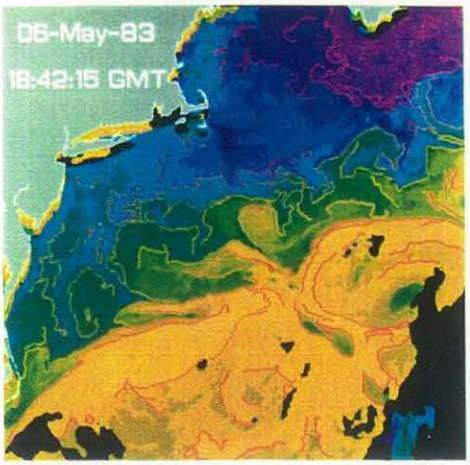
06-May-83
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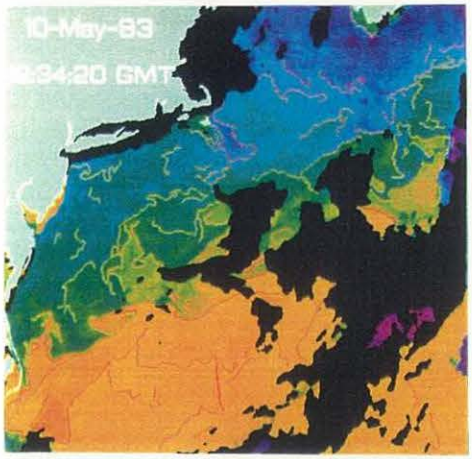
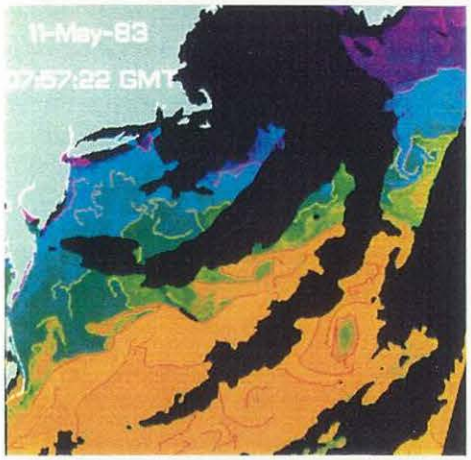
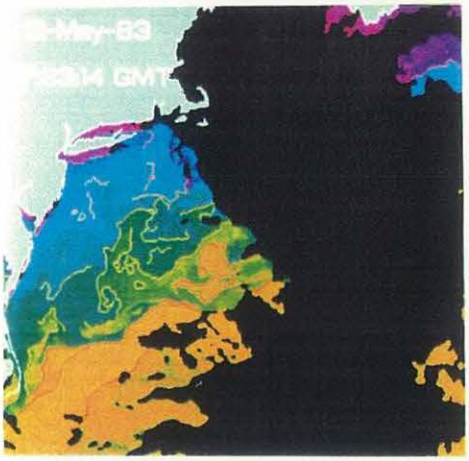
07-May-83

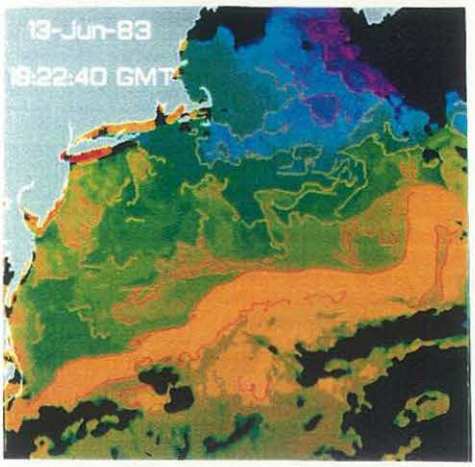
08-May-83


10-May-83

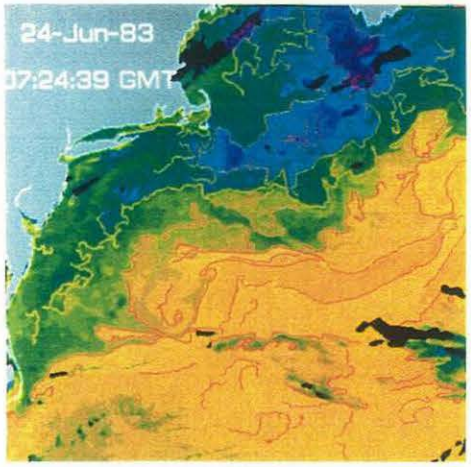

11-May-83



12-Jun-83


13-Jun-83

23-Jun-83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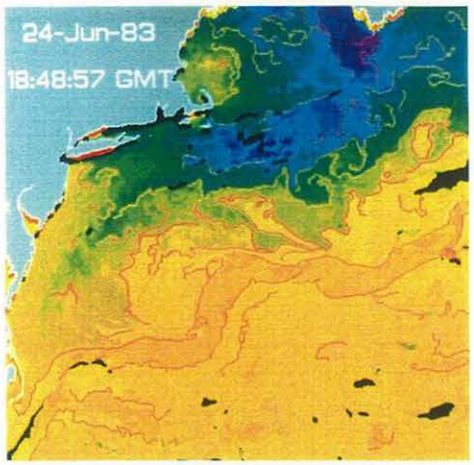
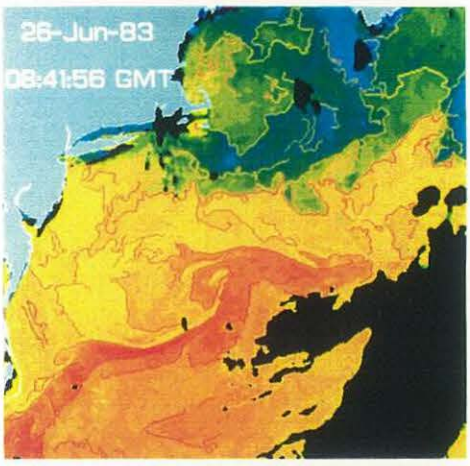

24-Jun-83
18:48:57 GMT


26-Jun-83
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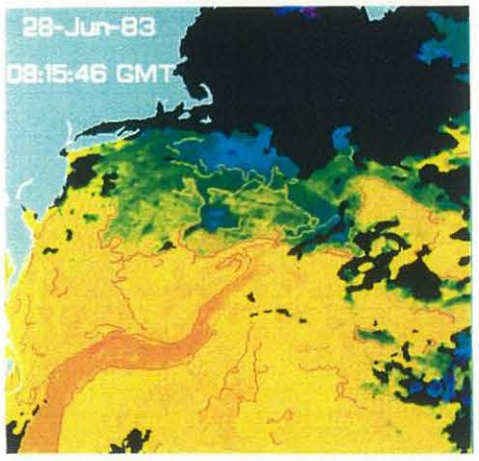
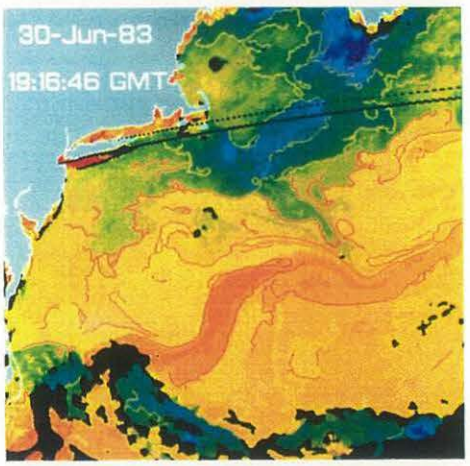
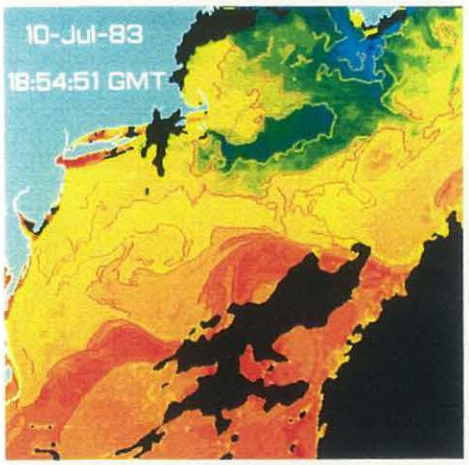
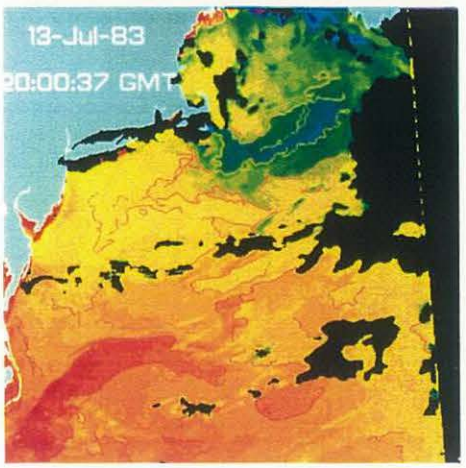
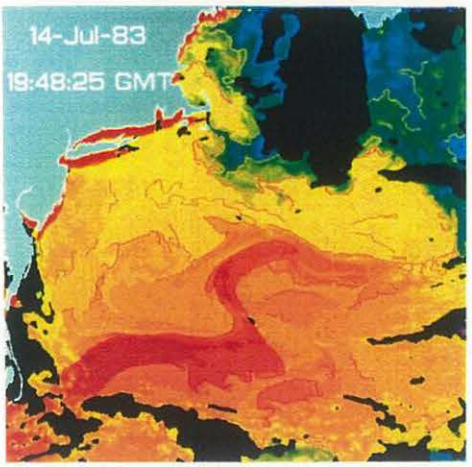

28-Jun-83
08:15:46 GMT


30-Jun-83
19:16:46 GMT


10-Jul-83
18:54:51 GMT


13-Jul-83
20:00:37 GMT


14-Jul-83
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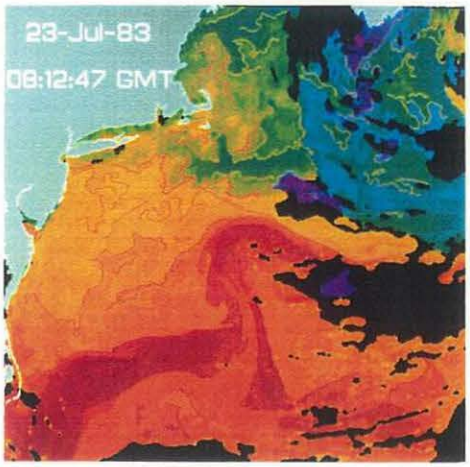
17-Jul-83
19:10:30 GMT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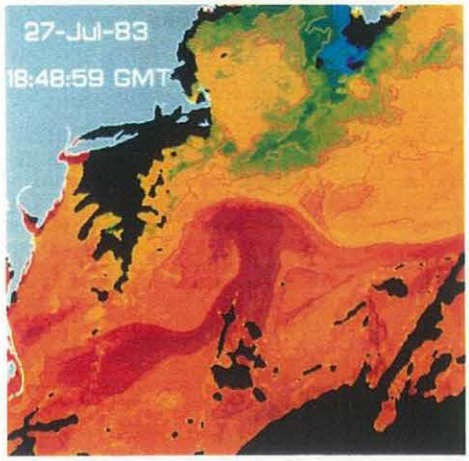
08:12:47 GMT


27-Jul-83
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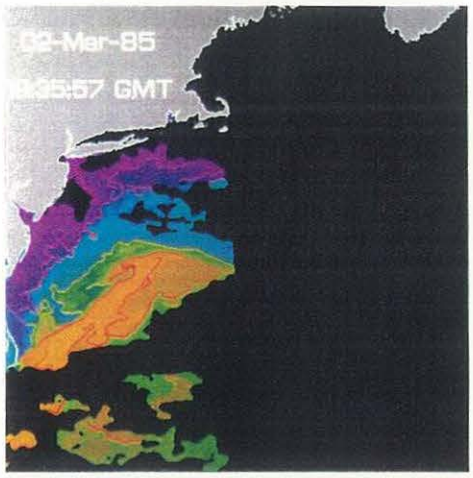
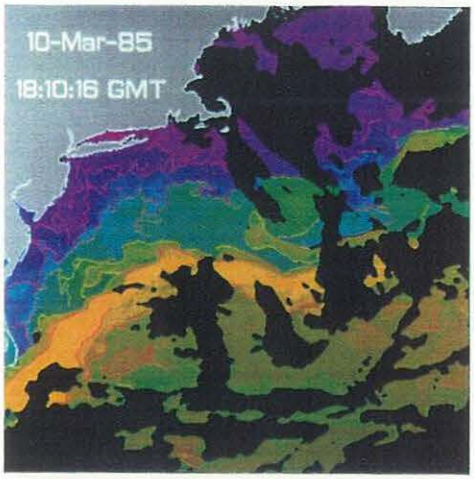

02-Mar-85
18:35:57 GMT


10-Mar-85
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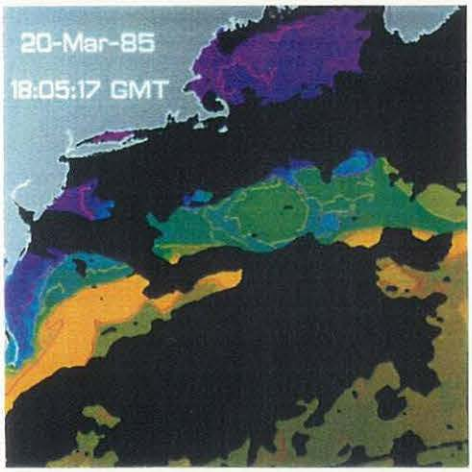
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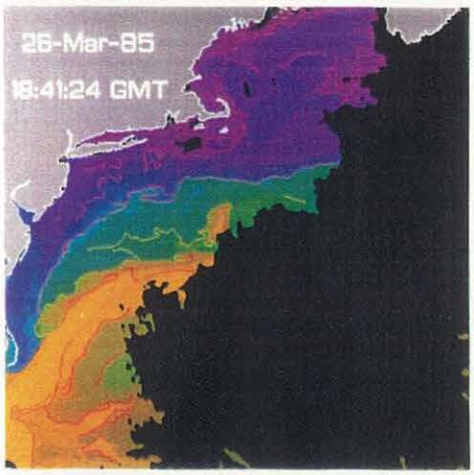
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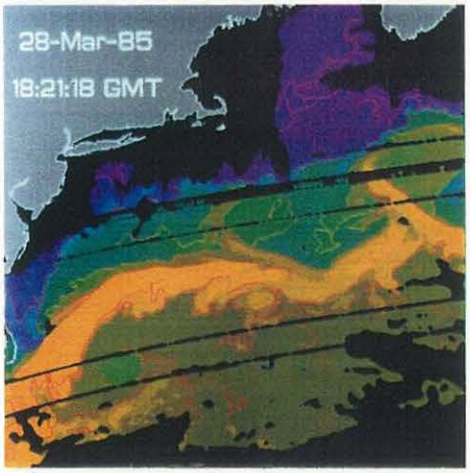
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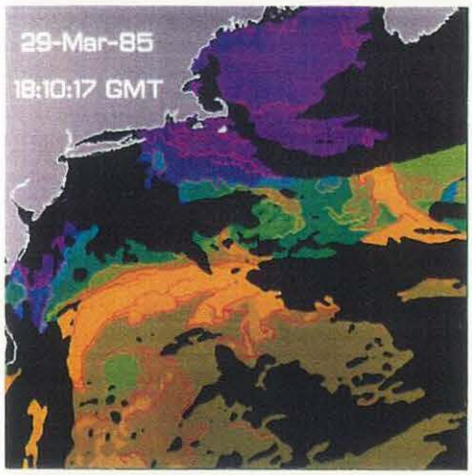
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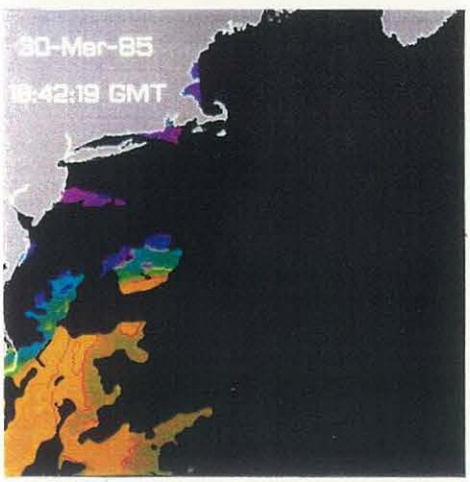
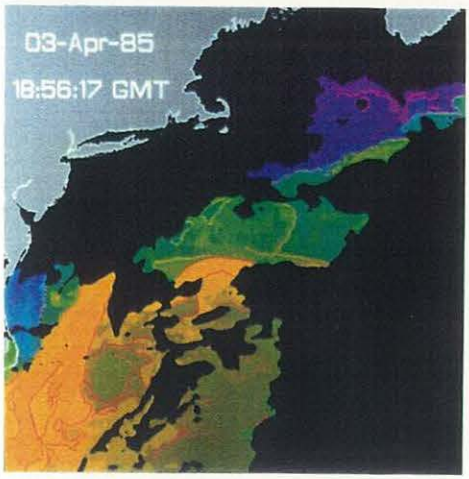
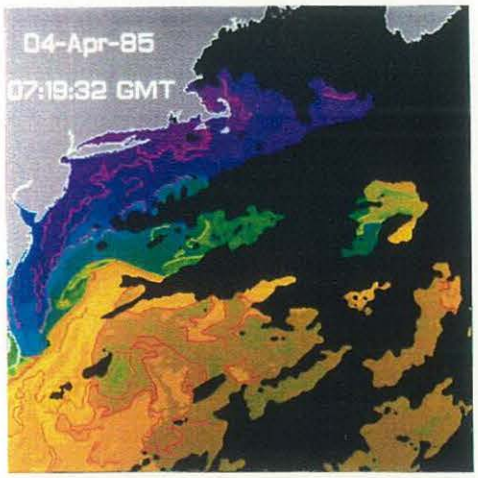
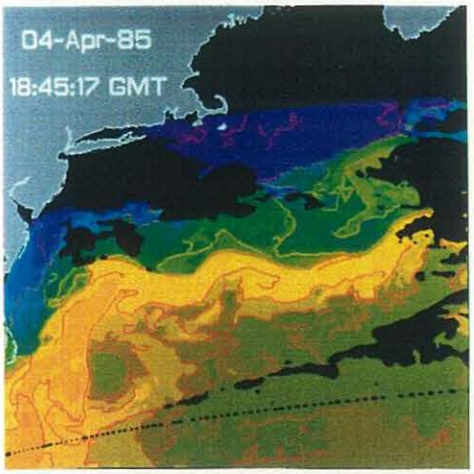
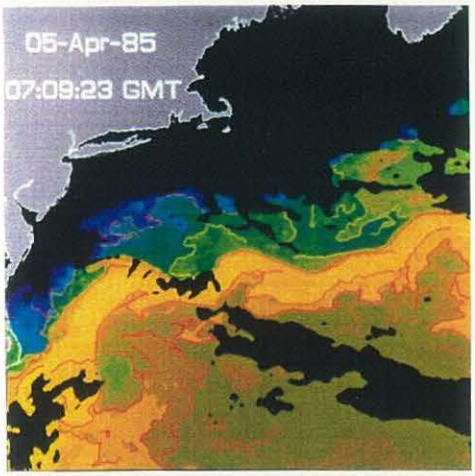
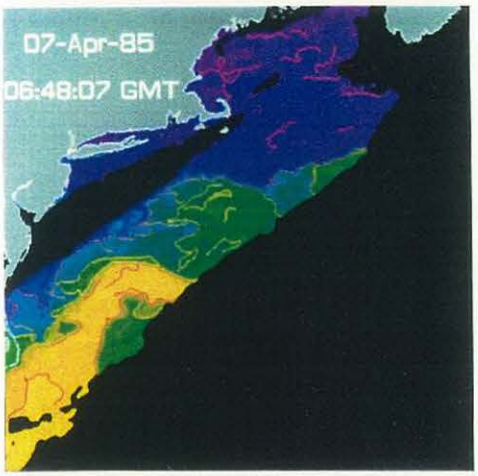

30-Mar-85
18:42:19 GMT

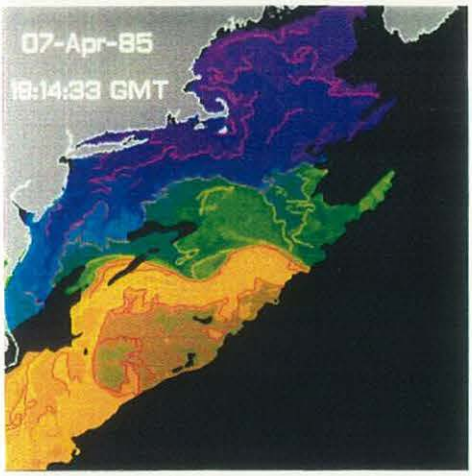

03-Apr-85
18:56:17 GMT


04-Apr-85
07:19:32 GMT


04-Apr-85
18:45:17 GMT


05-Apr-85
07:09:23 GMT


07-Apr-85
06:48:07 GMT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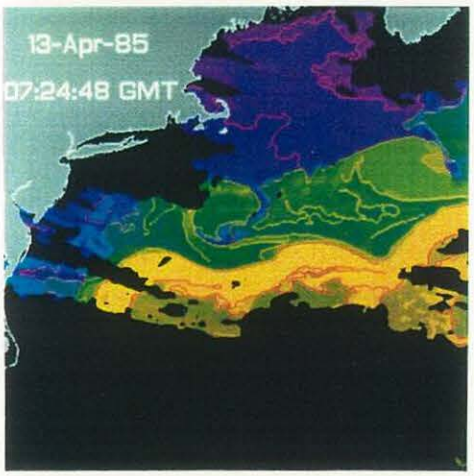
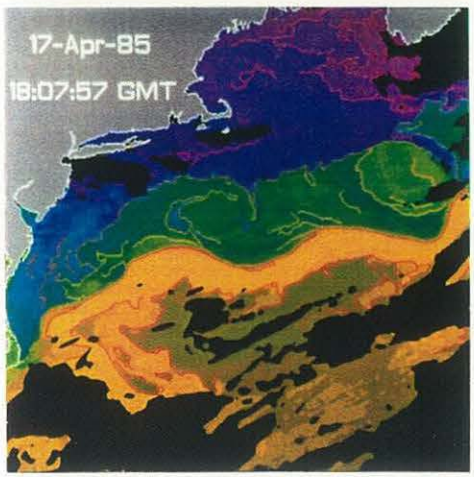
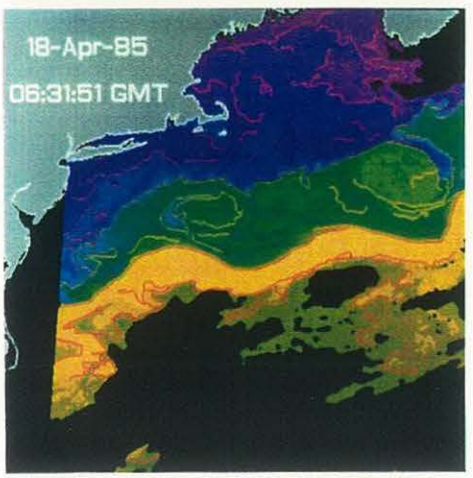

13-Apr-85
07:24:48 GMT


17-Apr-85
18:07:57 GMT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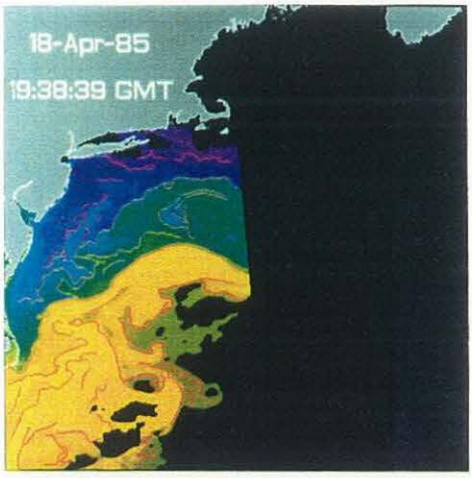
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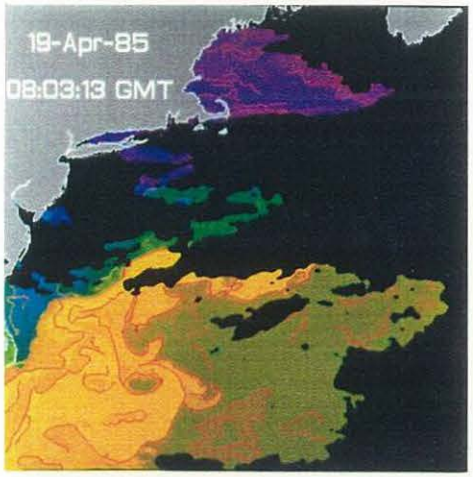
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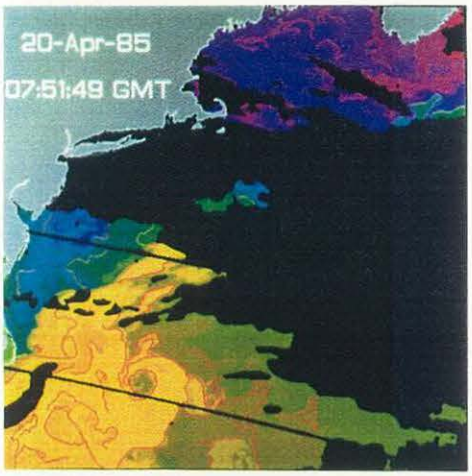
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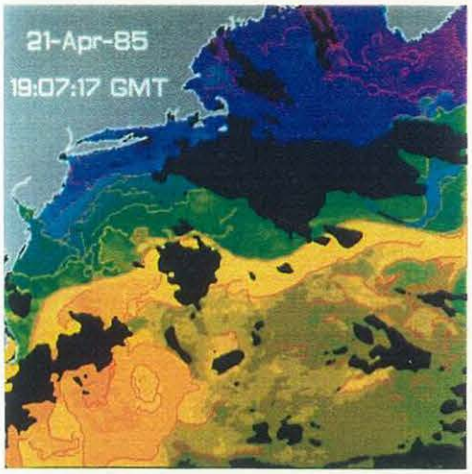
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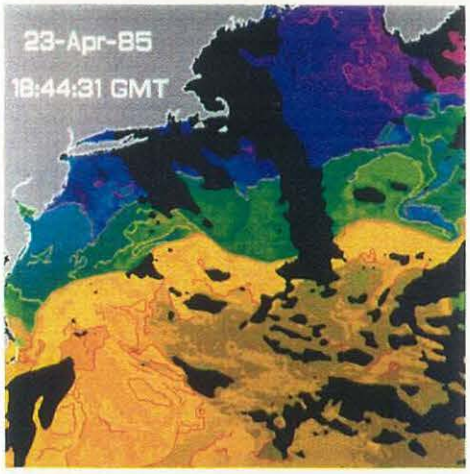
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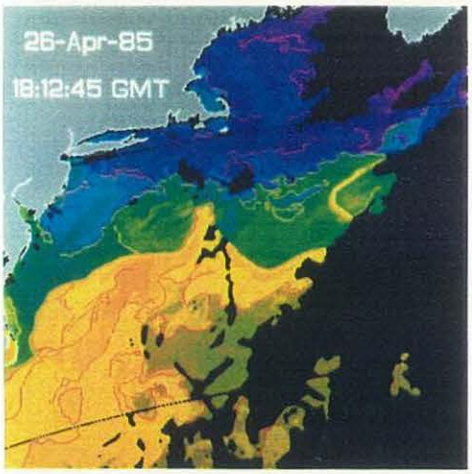
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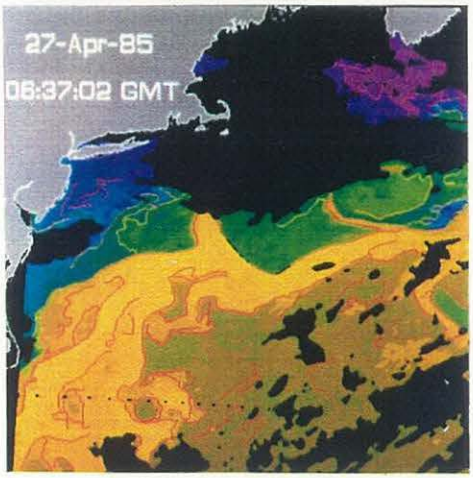
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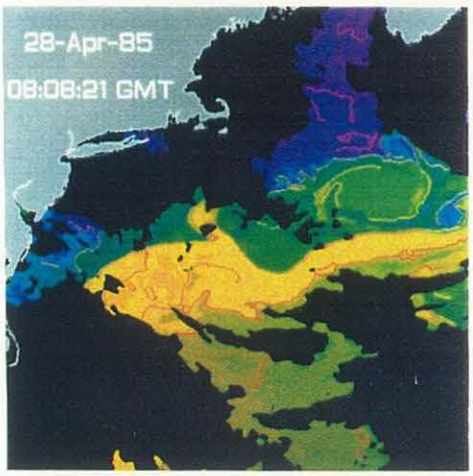
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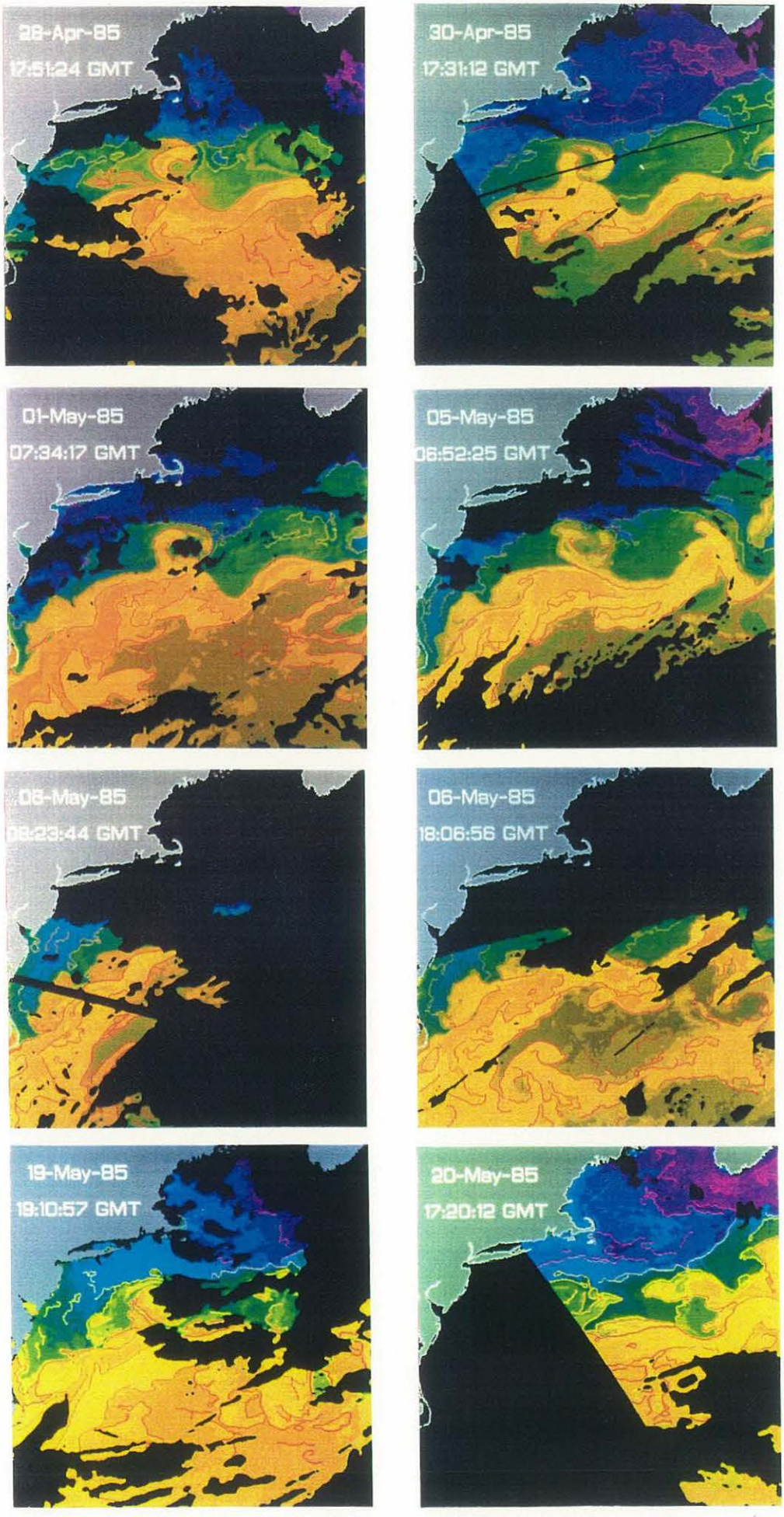
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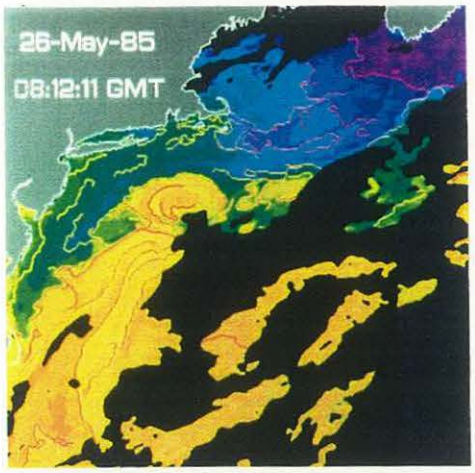
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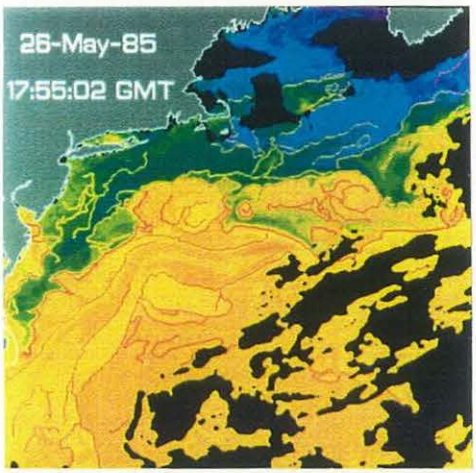
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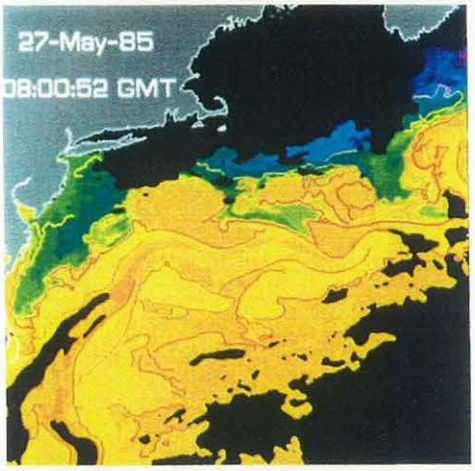
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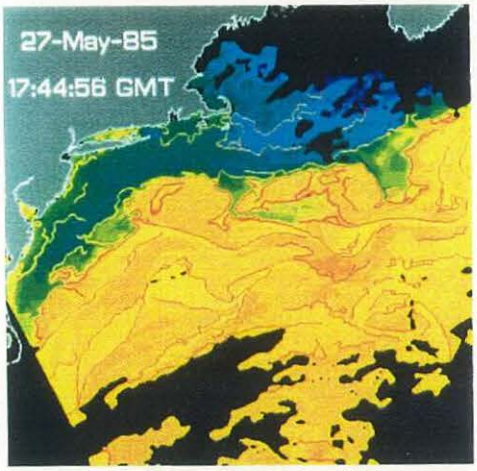
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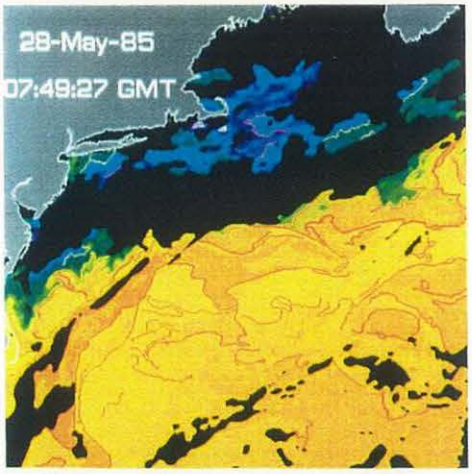
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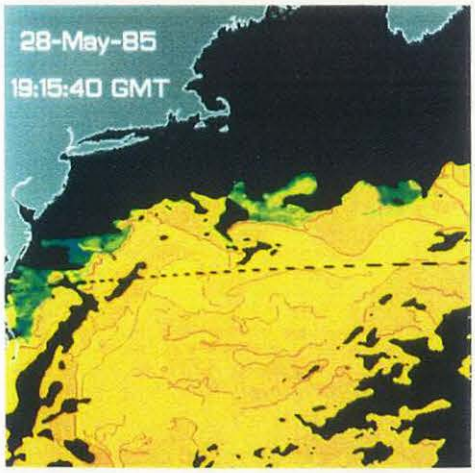
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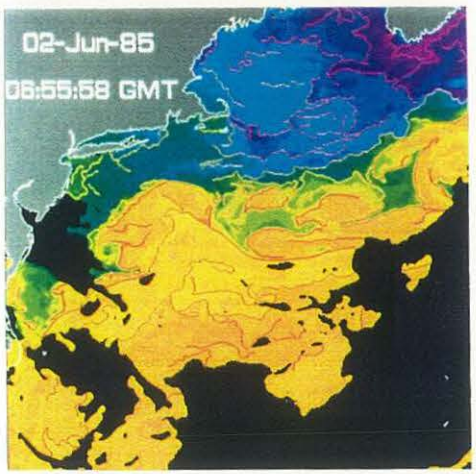
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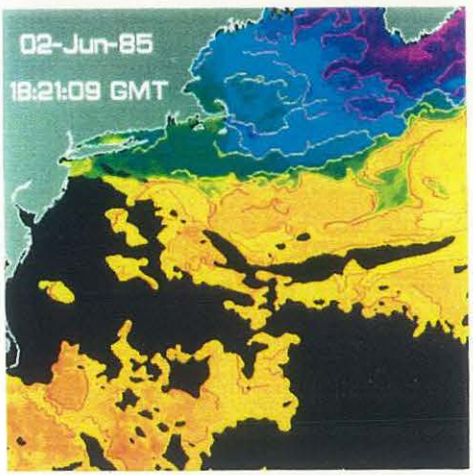
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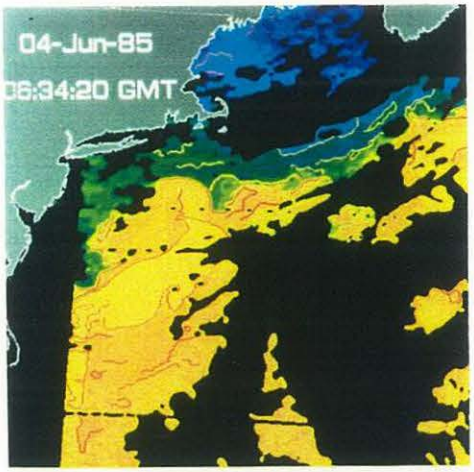
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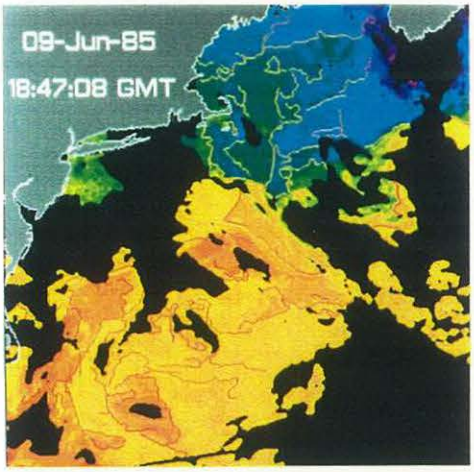
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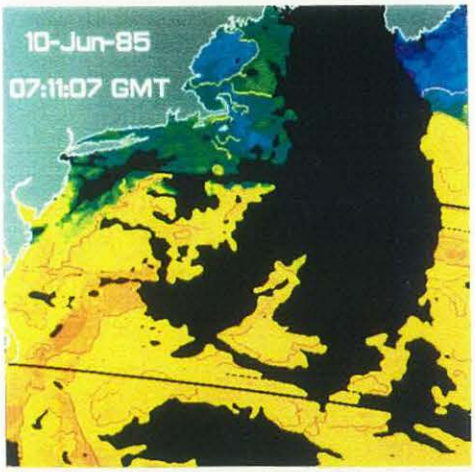
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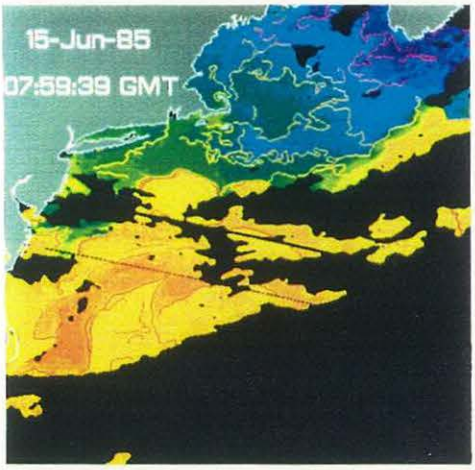
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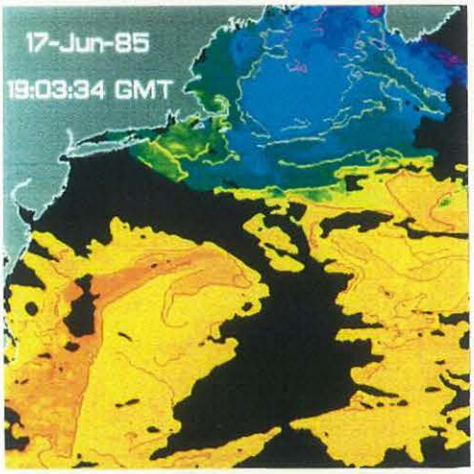
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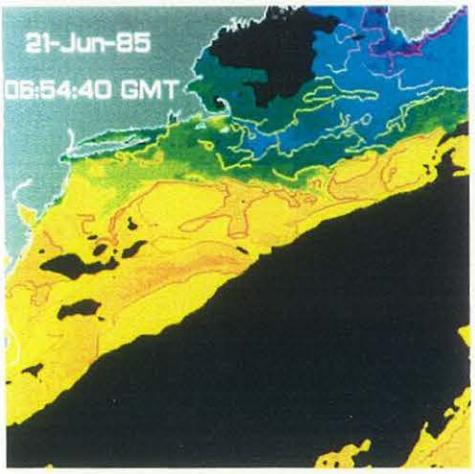
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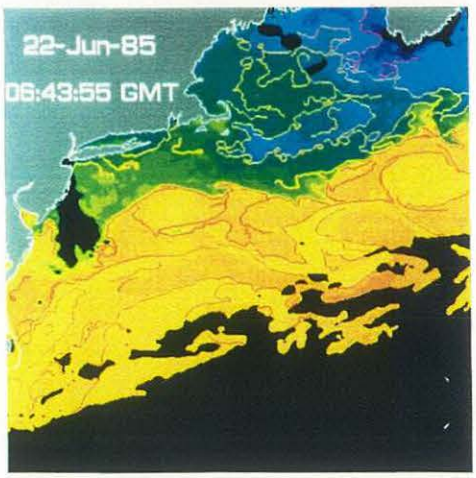
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Ninety plots of digitized temperature boundaries from infrared satellite images of the Gulf Stream along with corresponding image snapshots were compiled to determine stream width propagation speed. The satellite images are from the years 1982, 1983, and 1985 and are often of consecutive days. In this report, these images and digitized plots are presented.

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3. Satellite Imagery

b. Identifiers/Open-Ended Terms

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