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May 19, 1986

Mr. Richard McGrath
Battelle Laboratories
397 Washington Street
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Dear Dick,

Enclosed is a brief report describing the results from the Buzzards Bay profiling study from December and January 1984-1985. The averaged data as plotted should be quite adequate for comparisons with model outputs. Should you wish the raw data or further interpretation of the averaged data presented, please let me know and we can easily provide it for you. Note that the nature of profiling operations make data processing considerations very important and this is reflected in the final format the data is presented in.

Sincerely,

Bill

Dr. William D. Grant
Associate Scientist
Ocean Engineering Department

WDG/gam
enclosures

cc: Y. Onishi
J. Yeasted

PROFILING MEASUREMENTS

Introduction

Profiles of velocity and temperature were measured at two locations in Buzzards Bay in December and January 1984-1985. These measurements were made in support of modeling studies by Battelle and at their request. The stations are located on Figure 1 and designated as Stations 1 and 2.

Station 1 is in the proximity of Cleveland Ledge in 11.3 meters of water. This station was occupied on December 10th, 1984. During this time a drifter study was being carried out at the mouth of the Bay by R. Beardsley and R. Signell of WHOI and the Buzzards Bay flux array was in place. In addition, the Cleveland Ledge Station is the location of both long term tripod deployments by Brad Butman of the USGS and of the 1983 storm measurements by Grant et al. The duration of the profiles at Station 1 is only 9 hours since an approaching storm caused sea conditions to increase to the point where it was not possible to continue to collect accurate profile data.

Station 2 is adjacent to Buoy 11 in New Bedford Outer Harbor and is 8.2 meters deep. This station was occupied on January 10th and 30th, 1985. It is located near the Outer Harbor station where Grant and C.A. Butman have carried out extensive storm flow measurements and biological sedimentological studies. The set of profiles taken on January 10th were deemed to be of unsatisfactory quality because of excessive boat motion due to opposing wind and tide forces, in spite of the weak wind. The profiles were repeated on January 30th. Only the January 30th data set is included here. Again, because of weather conditions, only 10 hours of continuous profile data could be taken.

Equipment

A Neil Brown Acoustic Direct Reading Current Meter System (CMDT-1), with pressure and temperature sensors, was used for all profiles. Data was displayed and recorded using a system consisting of a NEC PC compatible micro-computer display and logger with Coastal Leasing NBLOG-proprietary software. The resolution of the current sensor is 1 cm/sec and of the temperature sensor .05°C.

Profiling Operation

The vertical profiles were divided up into 5 points with the top point approximately 2 meters below the surface, the bottom point approximately 1 meter above the bottom and with the points in between divided into nearly equal segments. The actual depths are recorded from the pressure transducer reading. The profiling system was lowered to an approximate depth and held there for 3-5 minutes to obtain the average velocity for that level. The averaging time was picked to try to ensure a long enough average at each level to remove boat motion and to adequately sample the variability in the velocity field at each level, while still being able to profile the entire water column rapidly enough that quasi-steady conditions could be assumed for each profile.

Weather Condition

To minimize ship motion and keep data quality high, all profiles were taken during light winds. Wind speeds during each profiling operation from locations near each respective Station are listed in Table 1.

Data Processing and Results

The raw data from both the temperature and velocity time series is in an awkward format to work with because of several factors: (1) The depth of each measurement is measured accurately with the pressure sensor, but there is variability between the location of each successive measurement that is about 10 to 15 percent. (2) The time period over which each measurement was made varied between 3-5 minutes depending on ship motion and the time required to move the profiling system from one level to another. (3) Each profile takes 20-30 minutes to complete. Thus, at any depth successive points in each profile are separated in time by the time it took to complete the previous profile measurement points. Due to the mechanics of the operation, it is not possible to keep the points uniform in time.

In order to present the data in a format that lends itself to easier comparison and visual interpretation, time averaging was carried out. Because the time and location of each measurement point varies slightly, the resulting

time averaged points are not uniform in time and represent the average velocity at a given depth \pm 15 percent. The exact variability for each point is known and easily calculated from the raw data; however, for the purpose of model comparisons, the averaged data should be more than adequate. Inspection of the resulting plots shows that minor variability in both time (over the averaging time) and vertical (relative to variability in the profile location) velocity occurs and the non-uniformity in the averaging process introduces little variability in the data.

Figure 2 is a vector plot of the December 21st 1984 Cleveland Ledge (Station 1) velocity data in averaged form. Each vector represents the average of two velocities, each a 3-5 minute average approximately 25-30 minutes apart. Figure 3 shows a plot of the corresponding speed profiles. Again, these profiles represent an average over time and space since they are constructed from profiles which take 20-30 minutes to complete and which have some small (< 10 percent) variability on the actual depth of each successive measurement.

Figures 4 and 5 are similar plots for New Bedford Outer Harbor (Station 2) for January 30th 1985. The same averaging sequence has been applied as in Figures 2 and 3.

Figures 6 and 7 plot average temperature profiles corresponding to the speed plots in Figures 3 and 5 respectively.

Concluding Remarks

The nature of profiling operations requires considerable care in data processing and the interpretation of the results. These considerations are due to the non-uniform sampling in time. There is a trade-off between the length of a sample at any given point required to adequately resolve the velocity and its variability at that point and the time it takes to complete a given profile while still being able to assume quasi-steady conditions (i.e., that the same population is being sampled over the entire profile). The

averaged results presented here and the profiling sampling scheme carefully considered this trade-off. The data quality is considered very good for the purpose of model comparison.

It is also important to note that other measurements are available during the December 21st data as mentioned in the report. In addition, both sites have near bottom time series data available from other time periods including storms which shows favorable comparison with the results here. This data set is, to our knowledge, the only profile data available for tides. This is important because the tidal flows form the dominant background flow field in Buzzards Bay. In addition, bottom friction estimates corresponding to the data represented in these profiles is available for both sites. Thus, the ability of the model to reproduce these data should be considered as a significant test of the model.

TABLE 1: WIND DATA

**Wing's Neck Wind Data
December 21, 1985**

<u>TIME</u>	<u>SPEED</u>	<u>DIRECTION</u>
06:30	5	0
07:30	5	0
08:30	7	0
09:30	8	15

**New Bedford Harbor Wind Data
January 30, 1986**

<u>TIME</u>	<u>SPEED</u>	<u>DIRECTION</u>
06:00	8	345
07:00	6	315
08:00	8	320
09:00	13	345
10:00	12	340
11:00	8	355
12:00	5	325
13:00	3	335
14:00	5	290
15:00	7	300
16:00	8	305
17:00	5	285
18:00	3	255
19:00	3	280
20:00	2	310
21:00	1	285
22:00	2	325
23:00	4	345
24:00	5	345

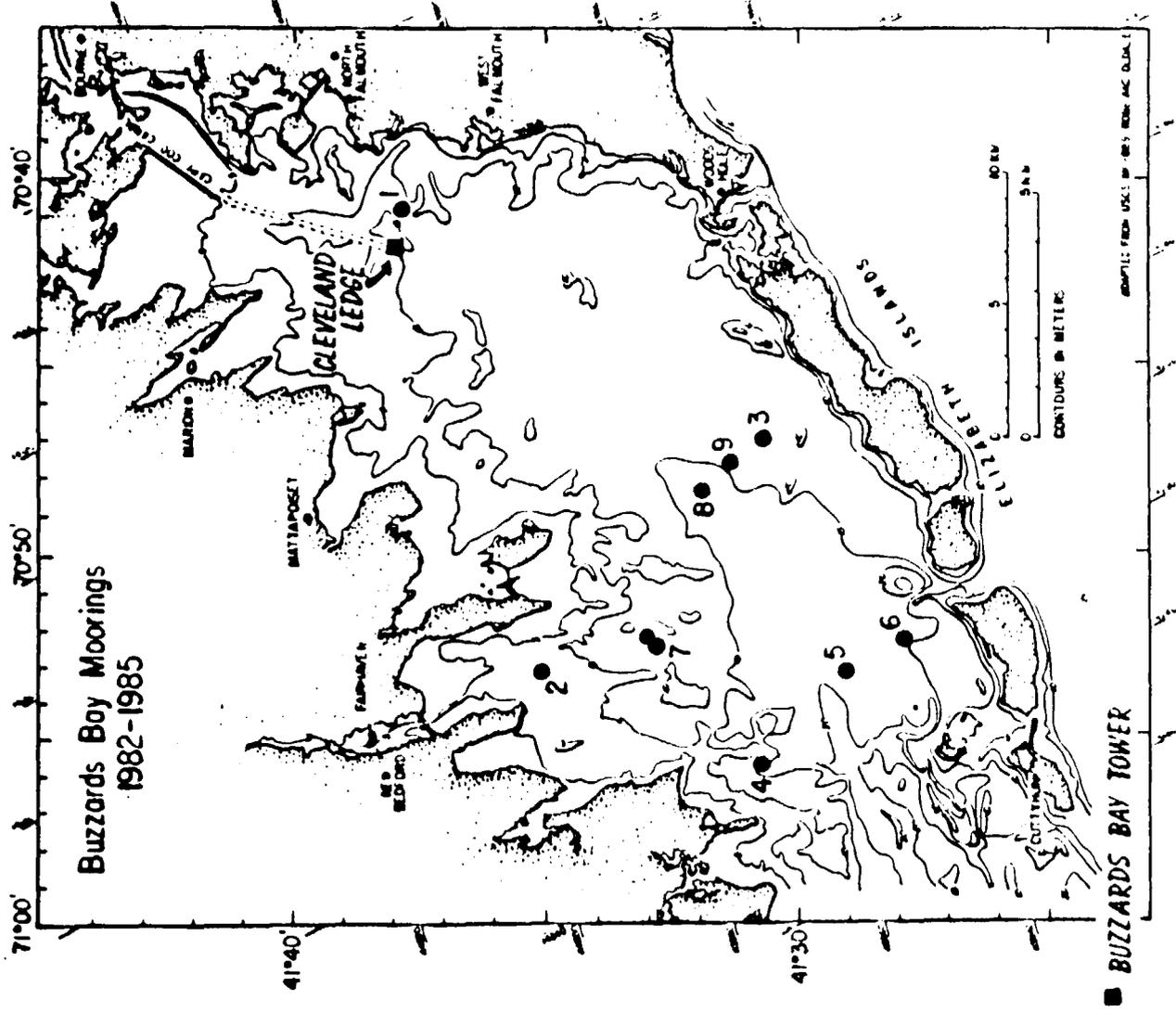


FIGURE 1: Buzzards Bay and Location Study Profiling Stations. Station 1 is the December 21st 1984 site and Station 2 is the January 30th 1985 site.

Battelle New Bedford Harbor Field Project
dec21*avg.dat (north up)

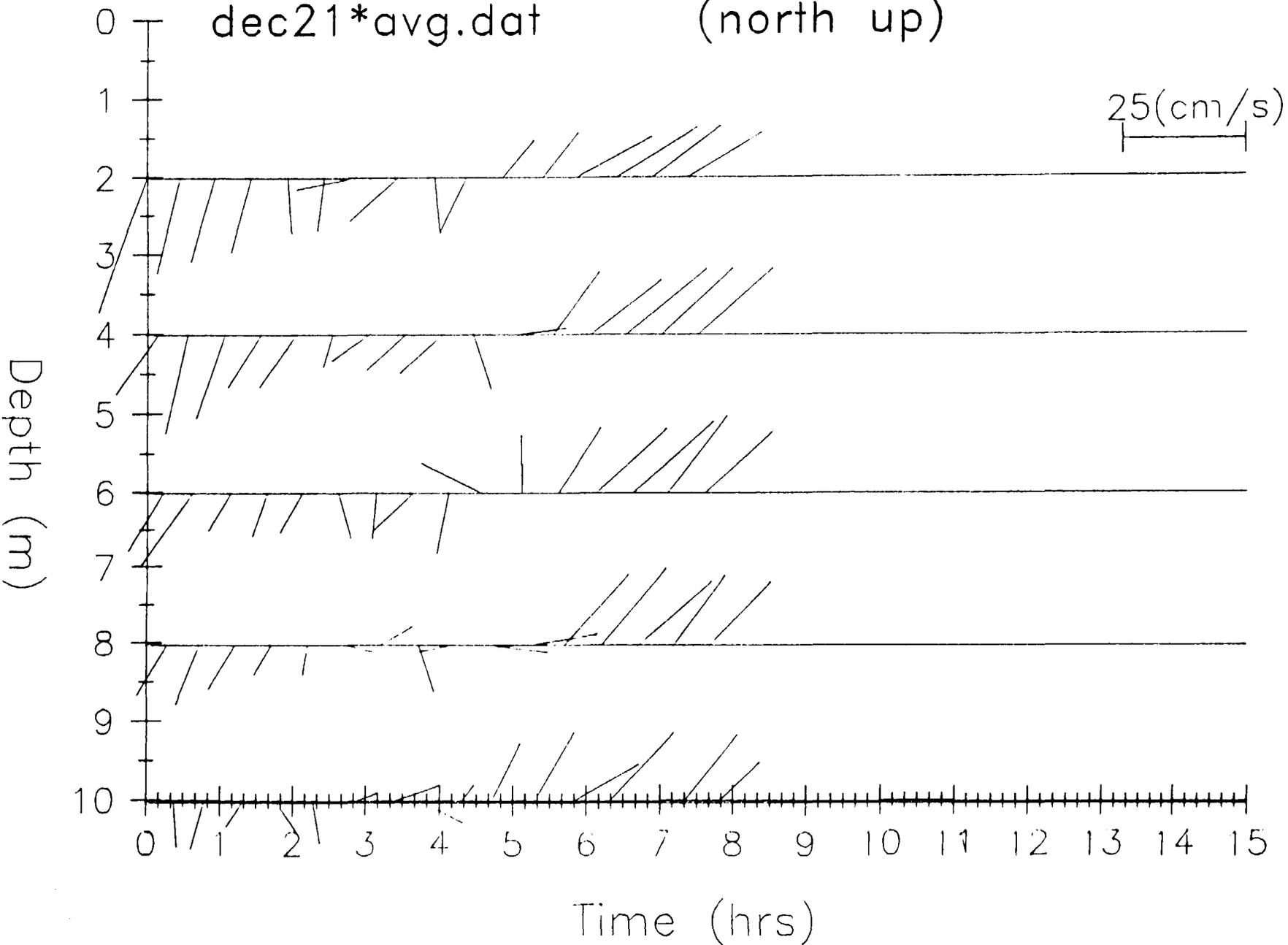


FIGURE 2: December 21st 1984 Cleveland Ledge Profiles: Vector plots of time averaged velocity.

Battelle New Bedford Harbor Field Project dec21*pro.dat

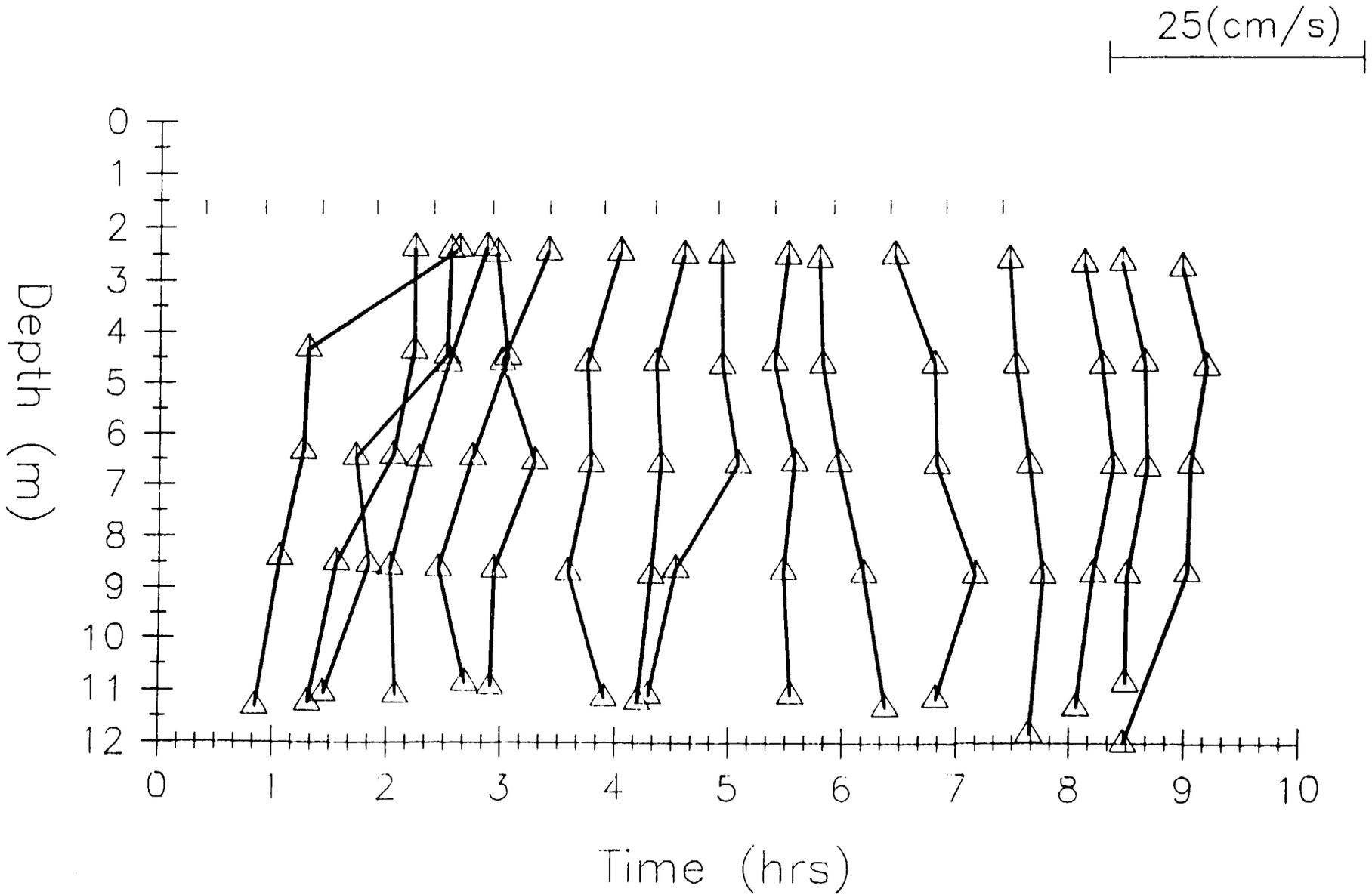


FIGURE 3: December 21st 1984 Cleveland Ledge Profiles: Plots of time averaged speed profiles.

Battelle New Bedford Harbor Field Project
jan30*edtavg.dat (north up)

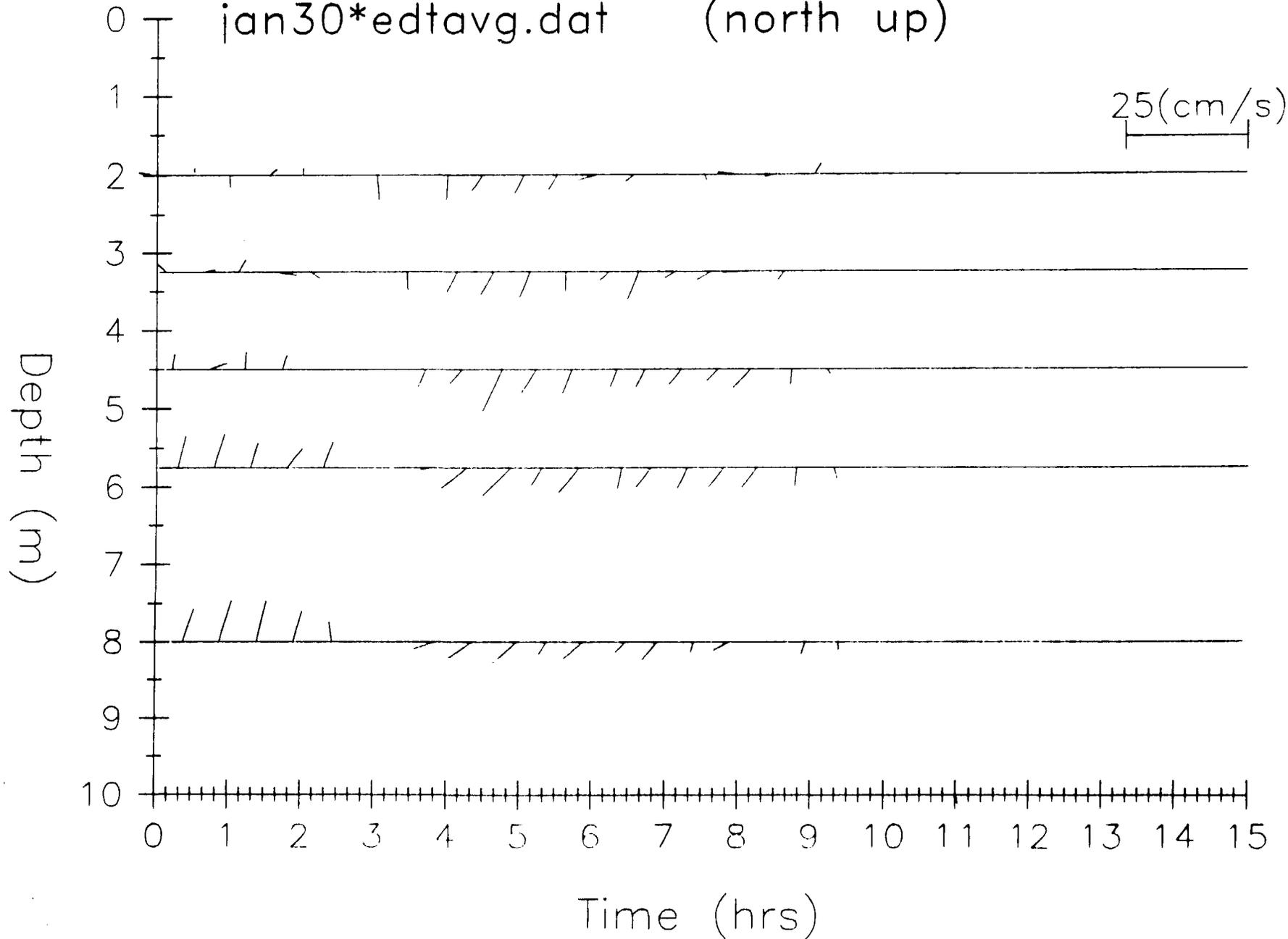


FIGURE 4: January 30th 1985 New Bedford Outer Harbor Profiles:
Plots of time averaged speed profiles.

Battelle New Bedford Harbor-Field Project

jan30*edtavg.dat

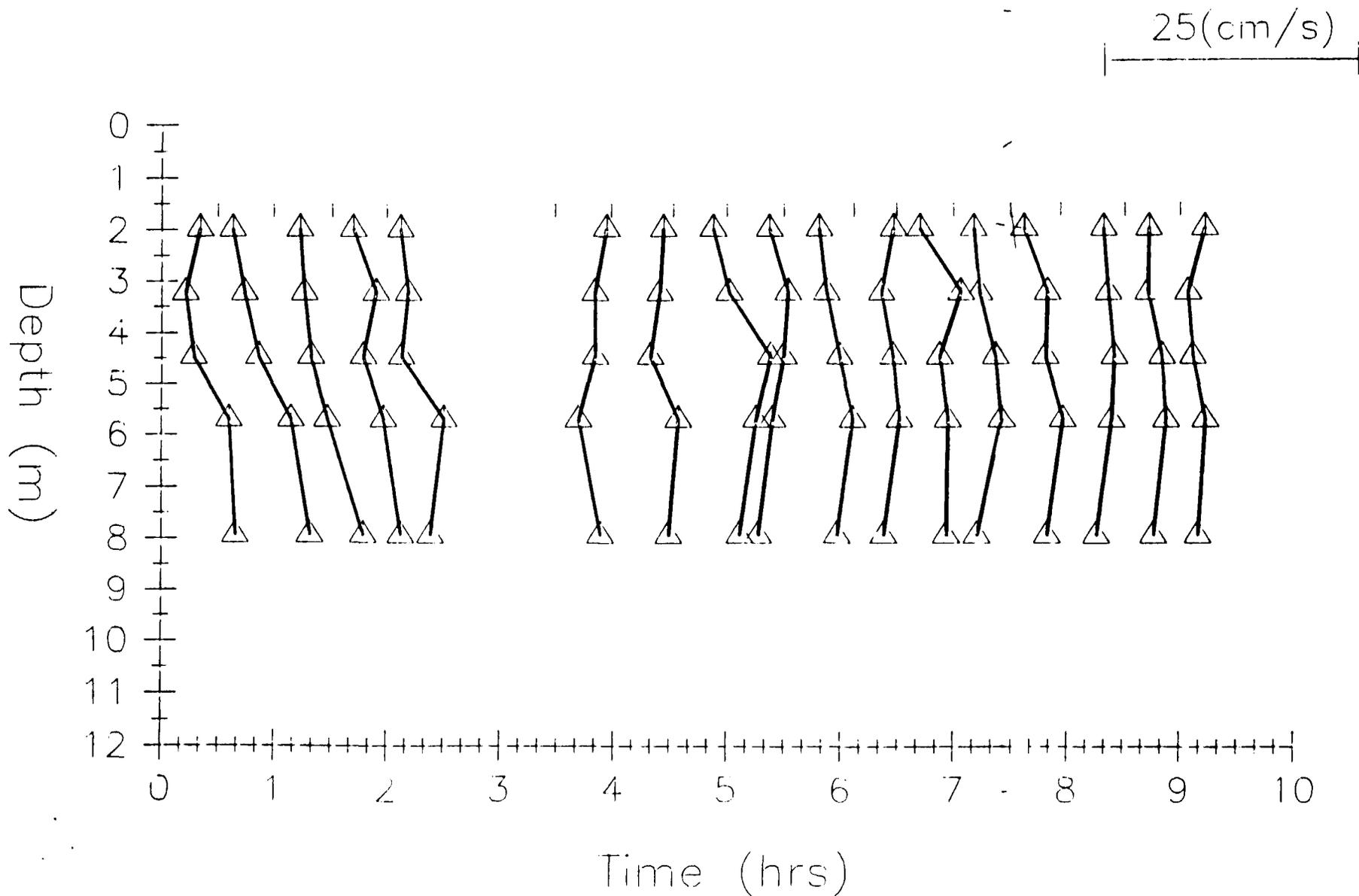


FIGURE 5: January 30th 1985 New Bedford Outer Harbor Profiles:
Plots of time averaged speed profiles.

Battelle New Bedford Harbor Field Project
dec21*avg.dat
temperature

5deg C

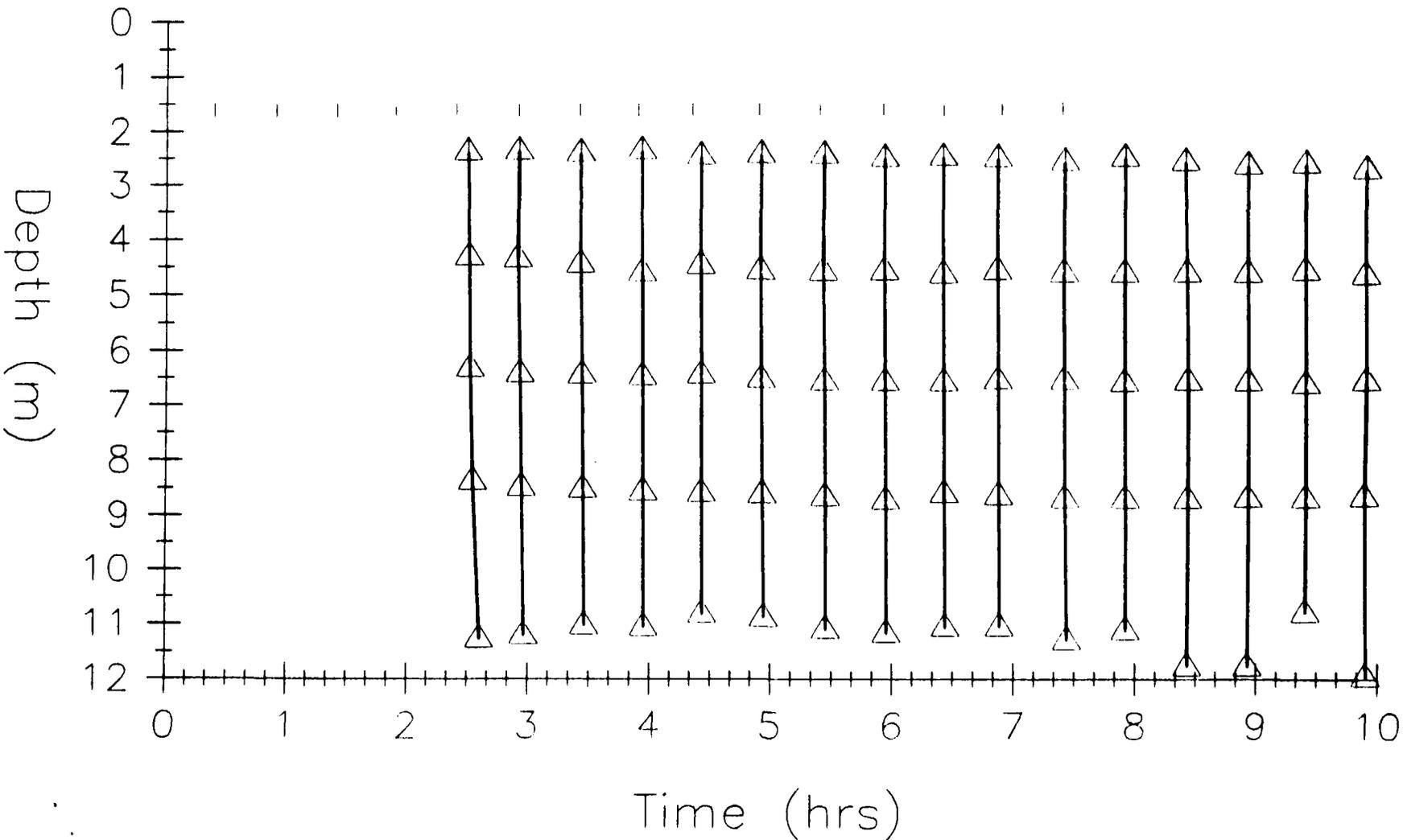


FIGURE 6: December 21st Cleveland Ledge temperature profiles.

Battelle New Bedford Harbor Field Project
jan30*edtavg.dat
temperature

10deg C

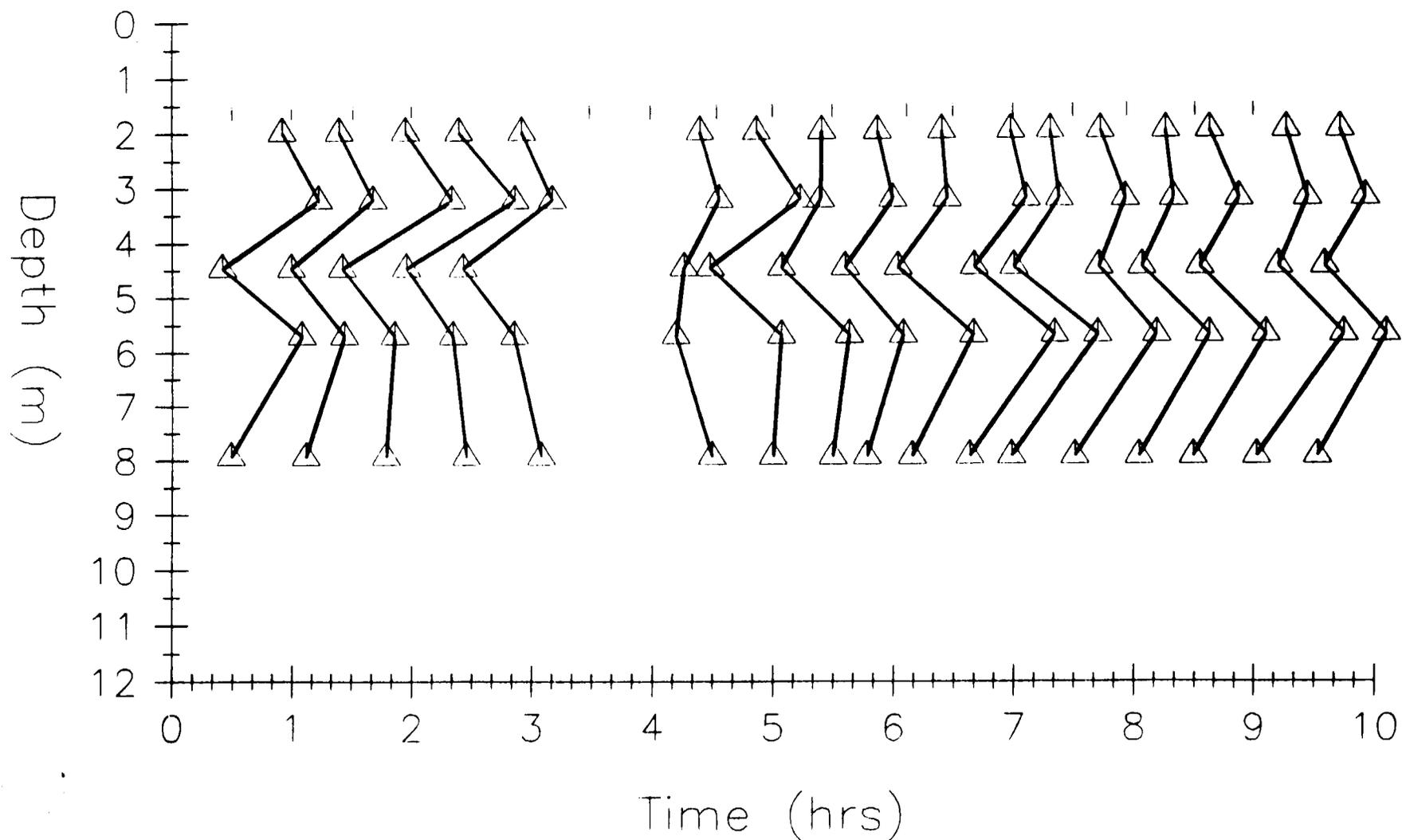


FIGURE 7: January 30th New Bedford Outer Harbor temperature profiles.