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# DATA REPORT OF SIX FREE-DRIFTING BUOYS TRACKED BY THE EOLE SATELLITE IN THE WESTERN NORTH ATLANTIC OCEAN IN THE AUTUMN OF 1972

by J. W. Usry and J. W. Wallace




NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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16. Abstract

This report presents the data from two free-drifting buoy missions conducted in the autumn of 1972. The buoys were deployed on the Continental Shelf east of the Chesapeake Light and were tracked by the French EOLE satellite. Two buoys drifted for 11 days during the first mission and four buoys drifted for 14 days during the second mission. Trajectory and water temperature data are presented in tabular and graphical form with a discussion of the accuracy.

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# DATA REPORT OF SIX FREE-DRIFTING BUOYS TRACKED BY THE EOLE SATELLITE IN THE WESTERN NORTH ATLANTIC OCEAN IN THE AUTUMN OF 1972

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Langley Research Center

## SUMMARY

Two free-drifting buoy missions were conducted in the autumn of 1972. The buoys were tracked by the EOLE satellite via an active communications link which also communicated water temperature data at several depths along the drogue chain. Two buoys were deployed on October 26; buoy 1 drifted for six days, until October 31, and buoy 2 drifted for ten days, until November 4. Four buoys drifted for 14 days from December 1 to December 14. The buoys were deployed in the Continental Shelf waters east of the entrance to Chesapeake Bay. Trajectory and water temperature data are presented in tabular and graphical form with a discussion of the accuracy. Also presented are wind speed and direction at the Chesapeake Light, Oregon Inlet, and EB-01 environmental data buoy as determined by the National Weather Service during the times of the missions.

## INTRODUCTION

The application of existing and emerging space technology and capabilities to societal needs and environmental problems is one of the major goals of NASA for the 1970's. As part of this program the Langley Research Center has been working with state and other federal agencies in studying the use of satellites and free-drifting buoy systems for remote measurements of current, temperature, salinity, sea state and other ocean and air-sea interface parameters. These data are needed to develop and validate analytical models which may be used for predicting the general ocean circulation and surface currents, and their transport of mass, heat, and nutrients.

The Chesapeake Bight extending from Delaware Bay to Cape Hatteras plays an important role in commerce, fishing, national defense, and recreation. Adjacent land areas have a large concentration of industry and people. Energy requirements have focused attention to this area as a potential oil source or location for energy production plants. The problems that have been identified in this area are typical of those in other coastal zone areas and include problems associated with location of offshore ports, power plants, outfalls for sewage disposal, and the dispersion of undesirable by-products of these facilities. An understanding of the circulation and physical structure of the shelf waters in this region is vital to the development of analytical models and to a predictive capability for general use in the coastal zones.

Historically, there are few measurements, using free-drifting buoys, of the circulation in this area. Most circulation data were deduced from random ship drift reports and contain uncertainties due to the difficulties of locating the ship's position. Only recently have oceanographers used free-drifting buoy systems to study kinematical flow properties such as divergence, vorticity, deformation (ref. 1), regional current patterns (ref. 2), and circulation patterns in the open ocean (ref. 3). The general surface circulation pattern in the Chesapeake Bight is southerly with magnitudes between 5-20 cm/sec. This trend can be modified, however, by wind conditions and freshwater runoff from the Delaware and Chesapeake Bays (ref. 4).

The purpose of this paper is to present data from two drift buoy missions conducted in October-November 1972 and December 1972. The duration of the first mission was 11 days, from October 26 to November 5, and the duration of the second mission was fourteen days, from December 1 to December 14. The buoys were identified by numbers 1, 2, 3, and 4. Buoys 1 and 2 were used on the October-November mission and buoys 1-4 were used on the December mission. Histories of the positions of each buoy and water temperatures were obtained via satellite. These data are presented in tabular and graphical form without an analysis. Also presented are estimates of the accuracy of these data.

## BUOY DESCRIPTION

An artist sketch and photographs of the buoy system are shown as figures 1(a), 1(b), and 1(c), and a sketch with pertinent dimensions is shown as figure 2. The system had four major components: the floatation disk, instrument box, connector chain, and drogue plates. The system floated so that the top half of the floatation disk was above the water line and the top of the drogue plates was 5 (or 30) meters below the water line. The ratio of the drag area of the drogue plates to the drag area of the floatation disk and instrument box, below the water line, was six to one. The system mass was 254 kg.

The floatation disk had a diameter of 0.914 m, a maximum thickness at the center of 0.102 m, and a minimum thickness of 0.064 m at the periphery. A lifting bridle, used during deployment and retrieval operations, was attached to the disk and extended 0.732 m above the disk when in a raised position. The antenna used in the communications link with the satellite was mounted on the disk as shown in the photographs.

The instrument box had a length, width, and depth of 0.584, 0.541, and 0.483 m, respectively. The box housed the satellite transponder, power supply, radio beacons, relays, oscillators, and other related electronics. Three floatation blocks were mounted on the sides and four support legs were attached to the bottom. An access hatch allowed entry into the instrument compartment for checkout purposes.

A drogue consisting of crossed drag plates was suspended below the instrument box using a 0.63 cm (1/4 inch) galvanized chain. The chain was attached to a swivel at the top of the drag plates. Temperature sensors

were mounted along the length of the chain as illustrated in figure 1(c). The chain connections were designed so that different length chains could be installed in the field. The drag plates were 1.524 m square. Tie rods kept the plates at right angles respective to one another and lead ballast mounted on the plates kept the plates in line with the floatation disk.

## SYSTEMS DESCRIPTION

The Centre National D'Etudes Spatiales (CNES) of France designed and built the EOLE satellite launched by the NASA at Wallops Island, Virginia on August 16, 1971, using the NASA Scout Vehicle. The satellite was placed in a circular orbit at 800 km with an inclination of 50° to the equator and a period of 103 minutes. The purpose of the satellite was to observe the movements of a fleet of balloons floating at a constant altitude in the Southern Hemisphere. The satellite became available for use by other experimenters upon completion of that mission. The Langley Research Center proposed using the navigation and data collection satellite systems to track free-drifting buoys on the Continental Shelf of the Western North Atlantic and to measure the temperature of the water at selected depths. The EOLE satellite system is described in reference 5.

A functional diagram of the navigation and data collection system used in the free-drifting buoy program is shown in figure 3, and photographs of some of the buoy system components are shown as figure 4. The CNES developed a transponder-antenna system for use on free-drifting buoys which accepted four in situ data measurements (see fig. 4). The antenna (see fig. 1) was a cavity-backed spiral which allowed transmission to the satellite at low elevation angles.

The satellite continuously transmitted on a frequency at 464 MHz. Upon entering the zone of communications with the buoy, a two-way, phase-coherent link was established. The measured data were transmitted via the oscillator frequencies modulated onto a 402 MHz carrier. After transmission to the satellite, these data were stored onboard and later telemetered to ground receiving stations. The two-way, phase-coherent link allows a precise measurement of the propagation delay and Doppler shift. With these data, an accurate measurement of time, and the orbital parameters of the satellite, the buoy position can be determined. The CNES has estimated that the position can be determined with an accuracy of 1 to 2 km (ref. 6). The buoy transponder transmission period is 583 ms but since the satellite interrogates continuously, data will be transmitted for several minutes (as long as the satellite is in the field of transmission). Thus, nearly continuous data may be received during one orbit of the satellite. This provides several data points, both temperature and position, while the buoy is essentially in one position. From these data the mean position and temperature for one orbital pass were estimated.

Each buoy on both missions carried two radio beacons. These are shown mounted on the instrument tray in figure 4(c). One of the beacons transmitted continuously from the time of deployment to recovery. The second beacon could

be turned on through the communications link with the satellite, if the primary beacon failed. The beacons were search and rescue radio beacons of the type used in the Gemini training program, and transmitted on a frequency of 235 MHz. Wire antennas were located on top of the buoy as shown in figure 1(c). The antenna was a quarter-wavelength (at 235 MHz) wire coated with fiberglas and teflon tape.

Ocean water temperatures were measured using variable resistance thermistors on all of the buoys on both missions. The thermistors were designed to have a rapid and large change in resistance for a relatively small change in temperature.

## Data Presentation and Accuracy

Buoys 1 and 2 were deployed southeast of Wallops Island, Virginia at approximately 37.3° N, 74.7° W and 8 km apart on October 26 and data were first received on October 28. Buoy 1, drogued at 30 meters, drifted southwest and went aground after five days about 38 km from the point of deployment. The buoy was recovered and returned to Langley for repairs and preparation for redeployment. Buoy 2, drogued at 5 meters, drifted south, then east, intercepted the Gulf Stream, and was recovered 380 km east of Cape Charles.

Buoys 1-4 were deployed near Cape Henry about 2 km apart on a west-to-east line beginning 8 km from shore. The order of deployment from the shoreline was 4, 1, 2, and 3. Buoys 1, 2, and 4 drifted northeast across the Chesapeake Bay entrance, reversed direction, drifted back near the point of deployment, and from this point drifted south. Buoy 3 drifted east about 30 km, meandered briefly, and drifted south. All buoys were recovered near Cape Hatteras.

Histories of the position and temperature data, and wind data from the National Weather Service, are listed in Tables I and II. Water temperature was measured at 5 and 30 meters on buoy 1 and 0 and 5 meters on buoy 2. During the December mission, water temperatures were measured at a depth of 2 meters on all buoys. The position data were converted to rectangular coordinates from a reference point located at latitude 36° N and longitude 76° W where X, in km, is equal to (76.0 - longitude) times 89.014, and Y, in km, is equal to (latitude - 36.0) times 110.975. These data are listed in Tables I(a) and I(b) for the October/November mission and II(a) and II(b) for the December mission. The distance from the reference point, R ($R = \sqrt{X^2 + Y^2}$) and direction from north, $\theta$($\theta$ = arctan X/Y), are also listed in these tables. Wind speed and direction measured by the National Weather Service at the Chesapeake Light (36.9° N, 75.7° W), Oregon Inlet (35.8° N, 75.5° W), and the environmental data buoy EB-01 (36.5° N, 73.5° W) are listed in Tables I(c) and II(c). The convention for wind direction at Chesapeake Light and Oregon Inlet is taken as the direction from which the wind blows. For buoy EB-01 the wind azimuth is the angle, from north, from which the wind blows.

Trajectories and histories of the data listed in the tables are presented graphically in figures 5-9. The locations of the deployment positions for the two missions relative to the coastline are shown in figure 5 with histories of the wind speed and direction at Chesapeake Light, EB-01, and Oregon Inlet. Trajectories are plotted in figures 6 and 8. Lines between data points

are included for clarity and do not necessarily represent the trajectory. Data gaps with less than 10 hours duration usually occurred because of the orbit of the satellite and gaps with larger time intervals usually occurred due to the loss of data.

## Accuracy

The accuracy of the position and temperature data is dependent upon several error sources associated with orbital parameters, event timing, instrument and electrical components on the buoy and on the satellite, and data handling. Specific error sources contributing to uncertainties in the position data are discussed in references 6 and 7. Tests to determine the accuracy of the position data were conducted after completion of the missions reported here and after buoys 3 and 4 were lost during another experiment. For this paper, the accuracy of the position data was estimated by locating buoys 1 and 2 and two additional buoys, 5 and 6, at a known point (latitude and longitude) at Langley and having the satellite interrogate the buoys for several days. Similarly, buoy 1 was placed in a controlled temperature environment and interrogated to determine the accuracy of the temperature data.

The satellite interrogates the buoys continuously so that several position points are obtained during one pass. The average of these positions is assumed to be the best location for the pass. These data are plotted in figure 10 as the difference (d) in the actual location and the average location, as determined by the satellite versus the angle ($\psi$) between lines from the Earth's center to the buoy and to the point on the satellite ground track which is the point of closest approach to the buoy. Buoys 1, 2, 5, and 6 were interrogated for 5.5, 7, 7, and 4 days, and 27, 34, er, and 17 location points were obtained, respectively.

From these data the standard deviation in $\Delta X$ and $\Delta Y$ and a 50 percent circular probable error (CPE) were estimated. These data are shown in figure 11. It is apparent that a systematic error in the order of 1 to 1.5 km exists for buoys 1, 2, and 5. The error is larger for buoy 6, probably because of the scarcity of points. Also, it appears that the random error (CPE) is buoy dependent as might be expected (ref. 6 makes this point also) and is 1.4, 1.7, 2.3, and 1.6 km, respectively, for buoys 1, 2, 5, and 6.

The accuracy of the temperature data was buoy dependent since the sensors (thermistor-oscillator combination) were unique to each buoy, but errors associated with the satellite and data handling were common to all buoys. Since the buoys were usually deployed in close proximity to one another during a mission and cross checks were possible, only buoy 1 was used in the test to ascertain the accuracy of the temperature data. Each buoy carried four sensors or four data channels. In some cases the sensors were calibrated to measure different temperature ranges and in others the measurements were redundant. The thermistors were designed to operate below 75° C and to be accurate to $\pm 0.1°$ C over a range from 0° C to 70° C. The data in Table III indicate that the uncertainty due to all errors was probably $\pm 0.3°$ C. Additional interrogations would have provided a better estimate of this uncertainty.

## CONCLUDING REMARKS

Two free-drifting buoy missions were conducted in the autumn of 1972 in the Western North Atlantic Ocean and primarily in the Continental Shelf waters between Cape Charles and Cape Hatteras. Two buoys drifted for 11 days, from October 26 to November 5, and four buoys drifted for 14 days, from December 1 to December 14. Trajectory data and water temperature along the trajectory were obtained using the French EOLE satellite. These data have been presented in tabular and graphical form with a discussion of the accuracy.

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TABLE I.- LIST OF DATA, OCT.-NOV. 1972

(a) Buoy 1

| Time Mo/Day/Hr | Elapsed time, hr | Lat., North deg. | Long., West deg. | T,5m °C | T,30m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|---|
| 102806 | 0.0 | 37.15 | 74.78 | 14.8 | 14.2 | 108.2 | 127.5 | 167.2 | 40.3 |
| 102808 | 1.8 | 37.14 | 74.79 | 14.8 | 14.1 | 108.1 | 126.8 | 166.6 | 40.4 |
| 102809 | 3.5 | * | * | 14.8 | 14.3 | * | * | * | * |
| 102811 | 5.3 | 37.12 | 74.82 | 14.9 | 14.2 | 104.9 | 124.7 | 163.0 | 40.1 |
| 102900 | 18.2 | 37.13 | 74.83 | * | * | 104.1 | 126.0 | 163.4 | 39.6 |
| 102902 | 19.9 | 37.12 | 74.84 | 15.3 | 14.3 | 103.6 | 124.5 | 162.0 | 39.8 |
| 102904 | 21.7 | 37.12 | 74.84 | 15.4 | 14.3 | 103.6 | 124.5 | 162.0 | 39.8 |
| 102905 | 23.5 | 37.11 | 74.84 | 15.3 | 14.2 | 103.0 | 123.4 | 160.7 | 39.8 |
| 102907 | 25.3 | 37.10 | 74.85 | 15.5 | 14.3 | 102.2 | 122.4 | 159.5 | 39.9 |
| 102909 | 27.0 | * | * | 15.4 | 14.2 | * | * | * | * |
| 102911 | 28.8 | 37.08 | 74.88 | 15.3 | 14.2 | 99.7 | 120.2 | 156.2 | 39.7 |
| 103007 | 48.7 | 37.06 | 74.93 | 16.0 | 14.7 | 95.6 | 117.7 | 151.7 | 39.1 |
| 103008 | 50.5 | 37.07 | 74.91 | 15.7 | 14.7 | 97.0 | 119.1 | 153.6 | 39.2 |
| 103010 | 52.2 | 37.03 | 74.94 | 15.5 | 14.7 | 93.9 | 114.0 | 147.7 | 39.5 |
| 103102 | 68.6 | 36.92 | 74.92 | * | * | 95.8 | 102.1 | 140.0 | 43.2 |
| 103106 | 72.2 | 36.87 | 74.94 | 15.4 | 14.8 | 94.4 | 97.0 | 135.3 | 44.2 |
| 103108 | 73.9 | 36.88 | 74.94 | 15.3 | 14.7 | 94.5 | 97.4 | 135.8 | 44.1 |
| 103110 | 75.7 | 36.84 | 74.97 | 15.3 | 15.2 | 91.9 | 93.4 | 131.0 | 44.5 |

*No data.

TABLE I.- LIST OF DATA, OCT.-NOV. 1972 - Continued

(b) Buoy 2

| Time | Elapsed | Lat., North | Long., West | T,0m | T,5m | X, | Y, | R, | Azimuth, θ |
|---|---|---|---|---|---|---|---|---|---|
| Mo/Day/Hr | Time, hr | deg. | deg. | °C | °C | km | km | km | deg. |
| 102805 | 0.0 | 37.00 | 74.66 | 16.3 | * | 119.5 | 111.4 | 163.4 | 47.0 |
| 102808 | 1.8 | 36.99 | 74.64 | 16.2 | * | 121.1 | 109.4 | 163.2 | 47.9 |
| 102811 | 5.3 | 36.95 | 74.63 | 16.2 | * | 121.8 | 105.8 | 161.3 | 49.0 |
| 102900 | 18.2 | 36.82 | 74.58 | 16.5 | 16.9 | 126.8 | 90.6 | 155.9 | 54.5 |
| 102902 | 19.9 | 36.78 | 74.48 | 16.5 | 16.6 | 135.0 | 86.7 | 160.5 | 57.3 |
| 102904 | 21.7 | 36.78 | 74.48 | 16.5 | 17.4 | 135.0 | 86.7 | 160.5 | 57.3 |
| 102905 | 23.5 | 36.73 | 74.48 | 16.6 | 18.5 | 134.9 | 81.6 | 157.7 | 58.8 |
| 102907 | 25.3 | 36.71 | 74.50 | 16.6 | 16.9 | 133.8 | 78.7 | 155.2 | 59.5 |
| 102911 | 28.8 | 36.63 | 74.53 | 16.6 | 16.5 | 131.1 | 69.8 | 148.5 | 62.0 |
| 103007 | 48.8 | 36.32 | 74.46 | 17.4 | 17.3 | 137.4 | 35.6 | 142.0 | 75.5 |
| 103008 | 50.5 | 36.32 | 74.44 | 17.6 | 17.6 | 138.5 | 35.0 | 142.8 | 75.8 |
| 103010 | 52.2 | 36.26 | 74.49 | 17.7 | 17.6 | 134.9 | 29.0 | 137.9 | 77.9 |
| 103106 | 72.2 | 36.19 | 74.32 | 17.0 | 17.4 | 149.7 | 20.9 | 151.2 | 82.1 |
| 103108 | 73.9 | 36.22 | 74.29 | 17.1 | 18.2 | 152.6 | 24.5 | 154.5 | 80.9 |
| 103110 | 75.7 | 36.21 | 74.28 | 17.7 | 18.3 | 153.1 | 23.3 | 154.9 | 81.3 |
| 110106 | 95.6 | 36.40 | 73.93 | 17.9 | 17.9 | 184.2 | 44.7 | 189.5 | 76.4 |
| 110107 | 97.4 | 36.43 | 73.91 | 17.7 | 17.9 | 186.2 | 47.6 | 192.2 | 75.7 |
| 110109 | 99.1 | 36.42 | 74.02 | 17.9 | 17.9 | 175.8 | 47.2 | 182.0 | 75.0 |
| 110200 | 113.8 | 36.58 | 73.61 | 18.8 | 18.7 | 212.5 | 64.6 | 222.1 | 73.1 |
| 110201 | 115.5 | 36.62 | 73.59 | 18.7 | 18.6 | 214.5 | 69.1 | 225.4 | 72.1 |
| 110203 | 117.3 | 36.61 | 73.54 | 18.5 | 18.5 | 219.2 | 67.8 | 229.4 | 72.8 |
| 110205 | 119.1 | 36.63 | 73.50 | 20.5 | 19.1 | 222.4 | 70.0 | 233.2 | 72.5 |
| 110207 | 120.9 | 36.67 | 73.46 | 19.5 | 19.1 | 226.4 | 74.0 | 238.2 | 71.9 |
| 110209 | 122.6 | 36.66 | 73.45 | 19.0 | 18.8 | 226.7 | 73.2 | 238.3 | 72.1 |
| 110304 | 142.5 | 36.85 | 72.86 | 19.2 | 19.2 | 279.2 | 94.1 | 294.7 | 71.4 |
| 110308 | 146.1 | 36.85 | 72.75 | 19.1 | 19.1 | 289.1 | 93.9 | 304.0 | 72.0 |
| 110323 | 160.7 | 36.96 | 72.07 | 19.4 | 19.5 | 350.0 | 106.3 | 365.8 | 73.1 |
| 110400 | 162.4 | 37.01 | 71.99 | 19.6 | 19.6 | 358.9 | 112.5 | 374.3 | 72.5 |
| 110402 | 164.2 | 37.03 | 71.89 | 19.6 | 19.5 | 366.3 | 113.7 | 383.5 | 72.7 |
| 110404 | 166.0 | 37.06 | 71.81 | 19.5 | 19.5 | 373.4 | 117.2 | 391.4 | 72.6 |
| 110406 | 167.8 | 37.10 | 71.75 | 19.4 | 19.3 | 378.5 | 121.7 | 397.6 | 72.2 |
| 110407 | 169.5 | 37.12 | 71.72 | 19.4 | 19.4 | 381.1 | 123.8 | 400.7 | 72.0 |
| 110409 | 171.3 | 37.16 | 71.65 | * | * | 387.4 | 128.7 | 408.2 | 71.6 |

*No data.

TABLE I.- LIST OF DATA, OCT.-NOV. 1972 - Continued

(c) Wind Data

| Time | Chesapeake Light | | Oregon Inlet | | EB-01 | |
|---|---|---|---|---|---|---|
| Mo/Day/Hr | Direction | Speed kts | Direction | Speed kts | Azimuth deg | Speed kts |
| 102803 | ENE | 10 | NE | 15 | * | |
| 102806 | SE | 10 | NE | 15 | | |
| 102809 | E | 20 | NE | 18 | | |
| 102812 | SE | 10 | NE | 15 | | |
| 102815 | SE | 26 | SW | 12 | | |
| 102818 | SE | 12 | SW | 15 | | |
| 102821 | SE | 16 | SSW | 10 | | |
| 102900 | W | 10 | NE | 10 | | |
| 102903 | W | 10 | SW | 12 | | |
| 102906 | NW | 10 | Calm | | | |
| 102909 | W | 10 | SW | 5 | | |
| 102912 | SW | 10 | Calm | | | |
| 102915 | SW | 8 | Calm | | | |
| 102918 | WSW | 4 | SW | 5 | | |
| 102921 | Calm | | Calm | | | |
| 103000 | WSW | 2 | Calm | | | |
| 103003 | NW | 20 | Calm | | | |
| 103006 | NNW | 26 | NE | 10 | | |
| 103009 | NNW | 20 | NE | 15 | | |
| 103012 | NNW | 20 | NE | 18 | | |
| 103015 | NNW | 16 | NE | 18 | | |
| 103018 | N | 12 | NE | 20 | | |
| 103021 | NE | 5 | NE | 20 | | |
| 103100 | N | 8 | NE | 15 | | |
| 103103 | NE | 8 | NE | 15 | | |
| 103106 | NNE | 10 | NE | 15 | | |
| 103109 | NNE | 10 | NE | 15 | | |
| 103112 | NNE | 10 | NE | 15 | | |
| 103115 | N | 10 | NE | 18 | | |
| 103118 | N | 8 | ENE | 20 | 8 | 8 |
| 103121 | NNE | 1 | NE | 20 | 9 | 13 |

*No data.

TABLE I.- LIST OF DATA, OCT.-NOV. 1972 - Concluded

(c) Wind Data.- Concluded

| Time | Chesapeake Light | | Oregon Inlet | | EB-01 | |
|---|---|---|---|---|---|---|
| Mo/Day/Hr | Direction | Speed kts | Direction | Speed kts | Azimuth deg | Speed kts |
| 110100 | N | 7 | NE | 20 | 24 | 12 |
| 110103 | NE | 8 | NE | 12 | 31 | 11 |
| 110106 | NNE | 6 | NE | 10 | * | * |
| 110109 | NE | 4 | NE | 10 | 29 | 8 |
| 110112 | NNE | 6 | NE | 15 | 28 | 8 |
| 110115 | NE | 12 | NE | 15 | 29 | 10 |
| 110118 | NNE | 10 | NE | 10 | 29 | 13 |
| 110121 | ENE | 8 | NE | 15 | 13 | 9 |
| 110200 | E | 4 | NE | 15 | 36 | 7 |
| 110203 | ENE | 9 | Calm | | 54 | 6 |
| 110206 | ENE | 10 | Calm | | 92 | 10 |
| 110209 | E | 10 | Calm | | 169 | 14 |
| 110212 | SE | 10 | Calm | | 199 | 19 |
| 110215 | S | 8 | SW | 5 | 184 | 20 |
| 110218 | Se | 10 | W | 5 | 163 | 10 |
| 110221 | SE | 16 | SW | 8 | 247 | 7 |
| 110300 | SSE | 18 | SW | 5 | 76 | 2 |
| 110303 | S | 20 | SW | 5 | 233 | 18 |
| 110306 | S | 12 | SW | 5 | 237 | 23 |
| 110309 | S | 20 | SW | 5 | 242 | 27 |
| 110312 | S | 20 | SW | 5 | 244 | 36 |
| 110315 | SSW | 18 | SW | 10 | 239 | 34 |
| 110318 | SSW | 12 | SW | 10 | 241 | 38 |
| 110321 | S | 7 | SW | 10 | 248 | 43 |
| 110400 | N | 6 | SW | 10 | 255 | 25 |
| 110403 | NE | 20 | Calm | | 59 | 32 |
| 110406 | NE | 18 | SW | 10 | 65 | 6 |
| 110409 | E | 30 | SW | 10 | 77 | 12 |
| 110412 | NNE | 24 | SW | 10 | 53 | 38 |
| 110415 | NE | 30 | SW | 8 | 66 | 28 |
| 110418 | NNE | 6 | SW | 5 | 90 | 44 |
| 110421 | NNW | 6 | SW | 5 | 257 | 11 |
| 110500 | NW | 14 | SW | 8 | 57 | 30 |
| 110503 | NNW | 16 | NE | 10 | 303 | 14 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972

(a) Buoy 1

| Time, Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120116 | 0 | 36.86 | 75.86 | 10.3 | 12.4 | 95.0 | 95.8 | 7.4 |
| 120118 | 1.7 | 36.84 | 75.84 | 10.2 | 13.9 | 92.9 | 93.9 | 8.5 |
| 120120 | 3.5 | 36.80 | 75.87 | 10.2 | 11.2 | 89.2 | 89.9 | 7.2 |
| 120122 | 5.3 | 36.80 | 75.87 | 10.3 | 11.2 | 89.2 | 89.9 | 7.2 |
| 120212 | 19.9 | 36.89 | 75.79 | 9.6 | 18.6 | 98.9 | 100.6 | 10.7 |
| 120214 | 21.7 | 36.90 | 75.75 | 9.7 | 21.9 | 99.4 | 101.8 | 12.4 |
| 120216 | 23.4 | 36.92 | 75.73 | 9.7 | 23.8 | 102.7 | 105.4 | 13.0 |
| 120218 | 25.8 | 36.93 | 75.69 | 9.9 | 27.1 | 103.3 | 106.8 | 14.7 |
| 120219 | 27.0 | 36.94 | 75.68 | 9.9 | 28.6 | 104.5 | 108.4 | 15.3 |
| 120221 | 29.0 | 36.90 | 75.73 | 10.1 | 24.1 | 99.9 | 102.7 | 13.6 |
| 120319 | 50.5 | 37.07 | 75.61 | 10.3 | 34.4 | 119.2 | 124.1 | 16.1 |
| 120322 | 54.0 | 37.09 | 75.64 | 10.1 | 31.7 | 120.6 | 124.7 | 14.7 |
| 120411 | 66.8 | 37.09 | 75.65 | 10.1 | 31.1 | 121.3 | 125.2 | 14.4 |
| 120416 | 70.4 | 37.16 | 75.61 | 10.2 | 34.3 | 125.3 | 129.9 | 15.3 |
| 120417 | 72.1 | 37.16 | 75.53 | 10.3 | 42.2 | 129.2 | 135.9 | 18.1 |
| 120418 | 73.9 | 37.12 | 75.60 | 10.2 | 35.5 | 124.1 | 129.1 | 16.0 |
| 120420 | 75.7 | 37.15 | 75.58 | 10.4 | 37.5 | 127.4 | 132.8 | 16.4 |
| 120422 | 77.4 | 37.10 | 75.63 | 10.6 | 32.7 | 122.1 | 126.4 | 15.0 |
| 120511 | 90.3 | 37.04 | 75.66 | * | 30.5 | 115.7 | 119.7 | 14.8 |
| 120516 | 95.6 | 37.04 | 75.66 | 10.6 | 30.4 | 115.9 | 119.8 | 14.7 |
| 120518 | 97.4 | 37.04 | 75.66 | 10.8 | 30.7 | 115.5 | 119.5 | 14.9 |
| 120521 | 100.9 | 37.04 | 75.67 | * | 29.4 | 114.9 | 118.6 | 14.3 |
| 120614 | 117.3 | 37.09 | 76.66 | 10.7 | 30.1 | 120.4 | 124.1 | 14.0 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(a) Buoy 1 - Concluded

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg | Long. West deg | T,2m °C | X, km | Y, km | R, km | Azimuth θ deg |
|---|---|---|---|---|---|---|---|---|
| 120616 | 119.1 | 37.08 | 76.65 | 10.7 | 31.5 | 120.1 | 124.1 | 14.7 |
| 120617 | 120.8 | 37.08 | 76.64 | 10.8 | 32.0 | 120.1 | 124.3 | 14.9 |
| 120619 | 122.6 | 37.08 | 75.64 | 10.8 | 31.8 | 119.7 | 123.9 | 14.9 |
| 120717 | 144.3 | 36.94 | 75.70 | 10.8 | 26.6 | 104.2 | 107.6 | 14.3 |
| 120720 | 147.8 | 36.89 | 75.74 | 10.8 | 22.9 | 99.1 | 101.7 | 13.0 |
| 120811 | 162.5 | 36.87 | 75.82 | 10.6 | 16.1 | 96.3 | 97.7 | 9.5 |
| 120813 | 164.2 | 36.89 | 75.84 | 10.6 | 14.2 | 99.1 | 100.1 | 8.2 |
| 120814 | 166.0 | 36.89 | 75.84 | 10.8 | 14.2 | 98.3 | 99.3 | 8.2 |
| 120816 | 167.8 | 36.89 | 75.87 | 10.8 | 11.8 | 98.7 | 99.4 | 6.8 |
| 120818 | 169.5 | 36.87 | 75.88 | 10.8 | 10.4 | 96.3 | 96.9 | 6.2 |
| 120820 | 171.3 | 36.87 | 75.88 | 10.9 | 10.4 | 96.3 | 96.9 | 6.2 |
| 120822 | 173.0 | 36.87 | 75.87 | * | 11.8 | 96.7 | 97.4 | 7.0 |
| 120910 | 185.9 | 36.86 | 75.83 | 10.5 | 15.2 | 95.2 | 96.4 | 9.1 |
| 120914 | 189.4 | 36.87 | 75.83 | 10.5 | 15.1 | 96.3 | 97.5 | 8.9 |
| 121013 | 212.9 | 36.88 | 75.75 | 11.0 | 22.3 | 97.8 | 100.3 | 12.8 |
| 121020 | 220.0 | 36.90 | 75.78 | * | 19.9 | 100.0 | 101.9 | 11.2 |
| 121212 | 259.8 | 36.57 | 75.78 | 10.4 | 19.1 | 63.7 | 66.5 | 16.7 |
| 121214 | 261.6 | 36.56 | 75.79 | * | 19.0 | 61.8 | 64.7 | 17.1 |
| 121219 | 266.9 | 36.48 | 75.78 | * | 19.2 | 53.8 | 57.2 | 19.7 |
| 121308 | 280.0 | 36.25 | 75.71 | 10.2 | 25.5 | 27.3 | 37.3 | 43.0 |
| 121310 | 281.5 | 38.21 | 75.68 | 10.3 | 28.0 | 23.5 | 36.6 | 50.0 |
| 121413 | 308.5 | 35.26 | 75.26 | 16.1 | 72.8 | -82.0 | 109.7 | 138.4 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(b) Buoy 2

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120117 | 0.0 | 36.87 | 75.83 | 10.7 | 15.0 | 96.2 | 97.4 | 8.9 |
| 120118 | 1.8 | 36.85 | 75.82 | 10.7 | 16.0 | 94.2 | 95.6 | 9.7 |
| 120120 | 4.5 | 36.82 | 75.85 | 10.6 | 13.6 | 90.6 | 91.6 | 8.6 |
| 120122 | 5.3 | 36.82 | 75.85 | 10.6 | 13.6 | 90.6 | 91.6 | 8.6 |
| 120212 | 19.9 | 36.89 | 75.74 | 10.6 | 23.3 | 99.0 | 101.7 | 13.3 |
| 120214 | 21.7 | 36.90 | 75.71 | 10.5 | 26.0 | 99.5 | 102.9 | 14.6 |
| 120216 | 23.5 | 36.92 | 75.68 | 10.4 | 28.1 | 101.9 | 105.7 | 15.4 |
| 120218 | 25.2 | 36.92 | 75.67 | 10.4 | 29.8 | 102.3 | 106.6 | 16.2 |
| 120220 | 27.0 | 36.93 | 75.65 | 10.5 | 31.2 | 103.3 | 107.9 | 16.8 |
| 120221 | 28.8 | 36.90 | 75.70 | 10.5 | 26.8 | 99.7 | 103.2 | 15.0 |
| 120319 | 50.5 | 37.04 | 75.60 | 10.5 | 35.8 | 115.0 | 102.4 | 17.3 |
| 120322 | 54.0 | 37.05 | 75.63 | 10.2 | 33.1 | 116.4 | 121.0 | 15.9 |
| 120411 | 66.8 | 37.05 | 75.66 | 10.2 | 30.4 | 117.4 | 121.3 | 14.5 |
| 120415 | 70.4 | 37.08 | 75.63 | 10.6 | 32.9 | 119.5 | 124.0 | 15.4 |
| 120417 | 72.1 | 37.07 | 75.62 | 10.5 | 33.6 | 118.7 | 123.4 | 15.8 |
| 120418 | 73.9 | 37.07 | 75.63 | 10.3 | 33.4 | 118.5 | 123.1 | 15.7 |
| 120420 | 75.7 | 37.09 | 75.61 | 10.3 | 34.4 | 121.0 | 125.8 | 15.9 |
| 120422 | 77.4 | 37.06 | 75.66 | 10.3 | 30.7 | 117.4 | 121.4 | 14.7 |
| 120511 | 90.3 | 37.01 | 75.66 | 10.6 | 28.7 | 112.0 | 115.6 | 14.4 |
| 120516 | 95.6 | 37.01 | 75.68 | 10.6 | 28.8 | 111.8 | 115.4 | 14.5 |
| 120618 | 97.4 | 37.00 | 75.67 | 10.5 | 29.1 | 111.3 | 115.1 | 14.7 |
| 120621 | 100.9 | 37.00 | 75.68 | 10.6 | 28.4 | 111.0 | 114.6 | 14.4 |
| 120614 | 117.3 | 37.05 | 75.68 | 10.6 | 28.2 | 116.4 | 119.8 | 13.6 |

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(b) Buoy 2 - Concluded

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120616 | 119.1 | 37.04 | 75.07 | 10.5 | 29.4 | 115.9 | 119.5 | 14.2 |
| 120617 | 120.8 | 37.04 | 75.66 | 10.5 | 30.0 | 115.7 | 119.6 | 14.5 |
| 120619 | 122.6 | 37.05 | 75.67 | 10.6 | 29.8 | 116.2 | 120.0 | 14.4 |
| 120621 | 124.3 | 37.05 | 75.67 | 10.6 | 29.8 | 116.2 | 120.0 | 14.4 |
| 120715 | 142.5 | 36.94 | 75.72 | 10.7 | 25.0 | 104.0 | 106.9 | 13.5 |
| 120717 | 144.3 | 36.90 | 75.74 | 10.7 | 22.9 | 100.2 | 102.8 | 12.9 |
| 120719 | 146.1 | 36.85 | 75.78 | 10.8 | 19.2 | 94.8 | 96.7 | 11.5 |
| 120720 | 147.8 | 36.85 | 75.78 | 10.8 | 19.2 | 94.8 | 96.7 | 11.5 |
| 120811 | 163.0 | 36.79 | 75.84 | 10.8 | 14.6 | 88.1 | 89.3 | 9.4 |
| 120812 | 164.3 | 36.81 | 75.85 | 11.2 | 13.7 | 89.7 | 90.7 | 8.7 |
| 120814 | 166.0 | 36.79 | 75.84 | 10.8 | 13.9 | 88.0 | 89.1 | 9.0 |
| 120816 | 167.8 | 36.78 | 75.85 | 10.8 | 13.1 | 87.0 | 88.0 | 8.6 |
| 120818 | 169.5 | 36.78 | 75.88 | 10.8 | 10.9 | 83.9 | 84.6 | 7.4 |
| 120820 | 171.3 | 36.76 | 75.88 | 10.8 | 10.9 | 83.9 | 84.6 | 7.4 |
| 120821 | 173.0 | 36.77 | 75.88 | * | 12.0 | 84.9 | 85.7 | 8.1 |
| 120910 | 185.9 | 36.74 | 75.87 | 10.9 | 11.8 | 81.9 | 82.8 | 8.2 |
| 120921 | 196.5 | 36.75 | 75.88 | 11.2 | 11.0 | 83.1 | 83.8 | 7.6 |
| 121013 | 212.9 | 36.73 | 75.81 | 11.2 | 17.1 | 80.7 | 82.5 | 12.0 |
| 121020 | 220.0 | 36.74 | 75.81 | * | 16.6 | 82.6 | 84.2 | 11.3 |
| 121212 | 254.8 | 36.14 | 75.67 | 11.0 | 29.8 | 15.9 | 33.8 | 62.0 |
| 121214 | 261.6 | 36.09 | 75.67 | * | 29.4 | 10.2 | 31.1 | 70.8 |
| 121219 | 266.9 | 36.00 | 75.62 | 11.0 | 33.6 | -.4 | 33.6 | 90.8 |
| 121413 | 308.6 | 36.43 | 75.37 | 11.8 | 56.2 | -63.7 | 84.9 | 138.6 |
| 121417 | 312.1 | 35.45 | 75.32 | 15.0 | 60.2 | -61.5 | 86.0 | 135.6 |
| 121418 | 314.0 | 35.64 | 75.34 | 12.5 | 59.1 | -39.7 | 71.2 | 123.9 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(c) Buoy 3

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120117 | 0.0 | 36.86 | 75.80 | 10.9 | 17.6 | 95.2 | 96.8 | 10.5 |
| 120118 | 1.7 | 36.84 | 75.79 | 11.1 | 18.8 | 93.1 | 95.0 | 11.4 |
| 120120 | 3.5 | 36.82 | 75.80 | 10.8 | 17.5 | 91.3 | 93.0 | 10.9 |
| 120122 | 5.3 | 36.82 | 75.80 | 11.1 | 17.5 | 91.3 | 93.0 | 10.9 |
| 120200 | 7.0 | 36.90 | 75.81 | 11.0 | 16.7 | 99.5 | 100.9 | 9.5 |
| 120212 | 19.9 | 36.67 | 75.88 | 11.1 | 28.5 | 96.8 | 100.9 | 16.4 |
| 120214 | 21.6 | 36.88 | 75.65 | 11.1 | 31.0 | 97.3 | 102.1 | 17.7 |
| 120216 | 23.5 | 36.67 | 75.61 | 10.8 | 34.3 | 96.4 | 102.3 | 19.6 |
| 120218 | 25.2 | 36.86 | 75.60 | 11.3 | 35.3 | 95.9 | 102.2 | 20.2 |
| 120220 | 27.0 | 36.87 | 75.60 | 11.1 | 35.7 | 96.7 | 103.0 | 20.3 |
| 120221 | 28.7 | 36.86 | 75.63 | 11.2 | 33.2 | 95.0 | 100.6 | 19.3 |
| 120319 | 50.5 | 36.92 | 75.47 | 11.3 | 47.1 | 102.7 | 112.9 | 24.6 |
| 120322 | 53.9 | 36.93 | 75.49 | 11.3 | 45.2 | 103.7 | 113.1 | 23.6 |
| 120411 | 66.8 | 36.93 | 75.53 | 11.1 | 42.2 | 102.9 | 111.2 | 22.3 |
| 120416 | 70.4 | 36.94 | 75.50 | 11.3 | 44.7 | 104.2 | 113.4 | 23.2 |
| 120417 | 72.1 | 36.93 | 75.49 | 11.3 | 45.3 | 103.3 | 112.8 | 23.7 |
| 120418 | 73.9 | 36.92 | 75.50 | 11.4 | 44.9 | 102.2 | 111.6 | 23.7 |
| 120420 | 75.7 | 36.93 | 75.50 | 11.3 | 44.3 | 102.9 | 112.0 | 23.3 |
| 120422 | 77.4 | 36.91 | 75.52 | 11.3 | 42.3 | 101.5 | 110.0 | 22.6 |
| 120511 | 90.3 | 36.86 | 75.55 | * | 40.2 | 94.9 | 103.1 | 23.0 |
| 120516 | 95.6 | 36.83 | 75.53 | 11.5 | 41.6 | 92.4 | 101.4 | 24.2 |
| 120518 | 97.4 | 36.83 | 75.54 | 11.8 | 41.1 | 91.7 | 100.5 | 24.2 |
| 120521 | 100.9 | 36.82 | 75.56 | 12.1 | 39.5 | 90.6 | 98.8 | 23.6 |
| 120614 | 117.3 | 36.81 | 75.57 | 11.7 | 38.7 | 89.9 | 97.9 | 23.2 |
| 120616 | 119.0 | 36.81 | 75.55 | 11.9 | 40.0 | 89.4 | 98.0 | 24.1 |
| 120617 | 120.8 | 36.80 | 75.54 | 11.9 | 40.8 | 89.2 | 98.1 | 24.6 |
| 120619 | 122.6 | 36.80 | 75.55 | 12.0 | 40.0 | 88.3 | 97.0 | 24.3 |
| 120621 | 124.3 | 36.80 | 75.55 | 12.0 | 40.0 | 88.3 | 97.0 | 24.3 |
| 120713 | 140.7 | 36.65 | 75.53 | * | 41.5 | 71.9 | 83.0 | 30.0 |
| 120715 | 142.5 | 36.61 | 75.54 | 11.8 | 40.9 | 67.9 | 79.3 | 31.1 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(c) Buoy 3 - Concluded

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120717 | 144.3 | 36.55 | 75.54 | 11.7 | 40.8 | 64.1 | 76.0 | 32.4 |
| 120719 | 146.0 | 36.53 | 75.56 | 11.7 | 39.2 | 58.3 | 70.2 | 33.9 |
| 120720 | 147.8 | 36.53 | 75.56 | 13.2 | 39.2 | 58.3 | 70.2 | 33.9 |
| 120811 | 162.4 | 36.44 | 75.57 | 11.7 | 37.9 | 49.3 | 62.2 | 37.6 |
| 120813 | 164.3 | 36.44 | 75.57 | 11.9 | 38.1 | 48.4 | 61.6 | 38.2 |
| 120814 | 166.0 | 36.43 | 75.57 | 11.9 | 38.2 | 47.4 | 60.9 | 38.9 |
| 120816 | 167.8 | 36.41 | 75.57 | 12.0 | 37.9 | 45.7 | 59.4 | 39.7 |
| 120818 | 169.5 | 36.38 | 75.59 | 11.8 | 3618 | 42.5 | 56.2 | 40.9 |
| 120820 | 171.3 | 36.38 | 75.59 | 12.0 | 36.8 | 42.5 | 56.2 | 40.9 |
| 120910 | 185.9 | 36.31 | 75.56 | 12.1 | 39.3 | 34.6 | 52.4 | 48.7 |
| 120914 | 189.5 | 36.30 | 75.55 | 12.1 | 40.3 | 33.3 | 52.3 | 50.5 |
| 120921 | 196.5 | 36.30 | 75.57 | * | 38.5 | 33.1 | 50.7 | 49.3 |
| 121013 | 212.9 | 36.24 | 75.52 | 12.0 | 43.1 | 27.2 | 50.9 | 57.7 |
| 121020 | 220.0 | 36.24 | 75.51 | * | 44.0 | 26.9 | 51.5 | 58.6 |
| 121212 | 259.8 | 35.82 | 75.48 | 12.3 | 48.2 | -20.2 | 52.3 | 112.7 |
| 121219 | 266.9 | 35.77 | 75.46 | 12.5 | 47.7 | -26.1 | 54.4 | 118.7 |
| 121308 | 279.8 | 35.62 | 75.41 | 12.4 | 52.7 | -41.7 | 67.2 | 128.4 |
| 121310 | 281.5 | 35.69 | 75.38 | 12.2 | 54.9 | -45.1 | 71.0 | 129.4 |
| 121312 | 283.3 | 35.57 | 75.38 | 12.5 | 56.9 | -48.3 | 74.6 | 130.3 |
| 121314 | 285.0 | 35.54 | 75.36 | 12.3 | 57.1 | -51.6 | 77.0 | 132.1 |
| 121315 | 286.8 | 35.52 | 75.37 | 12.4 | 56.3 | -53.8 | 77.9 | 133.7 |
| 121319 | 290.3 | 35.51 | 75.38 | 12.4 | 55.5 | -54.5 | 77.7 | 134.5 |
| 121413 | 308.5 | 35.46 | 75.32 | 12.6 | 60.9 | -60.0 | 85.5 | 134.6 |
| 121417 | 312.1 | 35.43 | 75.33 | 13.2 | 59.5 | -62.7 | 86.4 | 136.5 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(d) Buoy 4

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120117 | 0.0 | 36.86 | 75.89 | 10.6 | 10.1 | 95.4 | 96.0 | 6.1 |
| 120118 | 1.7 | 36.84 | 75.88 | 10.3 | 11.0 | 92.9 | 93.5 | 6.8 |
| 120120 | 3.5 | 36.80 | 75.91 | 10.1 | 8.3 | 88.7 | 89.1 | 5.3 |
| 120122 | 5.3 | 36.80 | 75.91 | 9.9 | 8.3 | 88.7 | 89.1 | 5.3 |
| 120212 | 19.9 | 36.86 | 75.84 | 9.5 | 13.9 | 95.5 | 96.6 | 8.3 |
| 120214 | 21.6 | 36.86 | 75.81 | 9.5 | 17.2 | 95.4 | 97.0 | 10.2 |
| 120216 | 23.5 | 36.87 | 75.78 | 9.6 | 19.2 | 97.0 | 98.9 | 11.2 |
| 120218 | 25.2 | 36.87 | 75.76 | 9.8 | 21.2 | 96.5 | 98.8 | 12.4 |
| 120220 | 27.0 | 36.86 | 75.75 | 9.8 | 22.1 | 95.9 | 98.4 | 13.0 |
| 120318 | 50.5 | 36.98 | 75.67 | 10.2 | 29.0 | 108.8 | 112.6 | 14.9 |
| 120322 | 53.9 | 36.98 | 75.69 | 10.2 | 27.7 | 108.8 | 112.2 | 14.3 |
| 120415 | 70.4 | 37.01 | 75.74 | 9.6 | 23.3 | 112.2 | 114.6 | 11.7 |
| 120417 | 72.1 | 37.01 | 75.73 | 9.9 | 24.3 | 111.9 | 114.5 | 12.3 |
| 120418 | 73.9 | 37.00 | 75.72 | 10.0 | 24.6 | 111.3 | 114.0 | 12.4 |
| 120420 | 75.7 | 37.03 | 75.50 | 10.1 | 26.3 | 114.2 | 117.2 | 13.0 |
| 120422 | 77.4 | 36.99 | 75.74 | 10.2 | 22.8 | 110.3 | 112.6 | 11.7 |
| 120511 | 90.3 | 36.96 | 75.78 | 10.2 | 19.8 | 107.0 | 108.8 | 10.5 |
| 120516 | 95.6 | 36.98 | 75.79 | 10.5 | 18.6 | 109.0 | 110.6 | 9.7 |
| 120518 | 97.4 | 36.98 | 75.78 | 10.6 | 19.7 | 108.5 | 110.3 | 10.3 |
| 120521 | 100.8 | 36.98 | 75.77 | 10.9 | 20.3 | 108.4 | 110.3 | 10.6 |
| 120614 | 117.3 | 37.05 | 75.75 | 10.5 | 21.9 | 116.7 | 118.8 | 10.6 |
| 120616 | 119.0 | 37.04 | 75.74 | 10.6 | 22.8 | 115.9 | 118.1 | 11.1 |
| 120617 | 120.8 | 37.04 | 75.73 | 10.8 | 24.1 | 115.6 | 118.1 | 11.8 |
| 120619 | 122.6 | 37.05 | 75.74 | 10.8 | 23.1 | 116.6 | 118.9 | 11.2 |

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(d) Buoy 4 - Concluded

| Time Mo/Day/Hr | Elapsed Time, hr | Lat. North deg. | Long. West deg. | T,2m °C | X, km | Y, km | R, km | Azimuth, θ deg. |
|---|---|---|---|---|---|---|---|---|
| 120621 | 124.3 | 37.05 | 75.75 | 10.9 | 23.1 | 116.6 | 118.9 | 11.2 |
| 120713 | 140.8 | 36.99 | 75.76 | 10.7 | 21.5 | 110.4 | 112.5 | 11.0 |
| 120715 | 142.5 | 36.96 | 75.77 | 11.0 | 20.2 | 107.0 | 108.9 | 10.7 |
| 120717 | 144.3 | 36.94 | 75.78 | 10.9 | 19.1 | 104.2 | 105.9 | 10.4 |
| 120719 | 146.1 | 36.89 | 75.81 | 10.9 | 17.1 | 98.9 | 100.3 | 9.8 |
| 120720 | 147.8 | 36.89 | 75.81 | 10.9 | 17.1 | 98.9 | 100.3 | 9.8 |
| 120811 | 162.4 | 36.87 | 75.87 | 10.4 | 11.8 | 96.2 | 96.9 | 7.0 |
| 120813 | 164.3 | 36.88 | 75.87 | 10.4 | 11.4 | 97.4 | 98.1 | 6.7 |
| 120814 | 166.0 | 36.88 | 75.89 | 10.8 | 10.1 | 97.1 | 97.6 | 6.0 |
| 120816 | 167.8 | 36.88 | 75.90 | 10.8 | 9.3 | 97.1 | 97.6 | 5.5 |
| 120818 | 169.5 | 36.85 | 75.92 | 10.8 | 7.6 | 94.1 | 94.4 | 4.6 |
| 120820 | 171.3 | 36.85 | 75.92 | 11.1 | 7.6 | 94.1 | 94.4 | 4.6 |
| 120910 | 185.9 | 36.82 | 75.87 | 10.6 | 11.2 | 91.3 | 92.0 | 7.0 |
| 120914 | 189.5 | 36.84 | 75.87 | 10.4 | 11.9 | 92.7 | 93.4 | 7.3 |
| 120921 | 196.5 | 36.85 | 75.90 | 11.0 | 9.3 | 94.1 | 94.6 | 5.6 |
| 121013 | 212.9 | 36.79 | 75.83 | 10.2 | 14.7 | 87.1 | 88.3 | 9.6 |
| 121212 | 259.8 | 36.20 | 75.73 | 10.8 | 24.4 | 22.6 | 33.3 | 47.1 |
| 121219 | 266.9 | 36.09 | 75.69 | 11.0 | 27.7 | 9.7 | 29.3 | 70.8 |
| 121308 | 279.8 | 35.80 | 75.50 | 10.9 | 44.2 | -22.6 | 49.7 | 117.1 |
| 121310 | 281.5 | 35.75 | 75.47 | 10.9 | 47.1 | -27.4 | 54.5 | 120.2 |
| 121312 | 283.3 | 35.73 | 75.46 | 11.0 | 48.2 | -30.1 | 56.9 | 121.9 |
| 121314 | 285.1 | 35.69 | 75.44 | 11.1 | 49.4 | -34.3 | 60.1 | 124.8 |
| 121316 | 286.8 | 35.66 | 75.44 | 11.3 | 49.5 | -37.2 | 61.9 | 126.9 |
| 121319 | 290.3 | 35.63 | 75.45 | 11.5 | 49.1 | -41.1 | 64.0 | 129.9 |
| 121413 | 308.5 | 35.49 | 75.42 | 11.5 | 51.5 | -57.0 | 76.9 | 137.9 |
| 121417 | 312.0 | 35.44 | 75.33 | 14.5 | 60.0 | -61.9 | 86.2 | 135.9 |

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(e) Wind Data

| Time, Mo/Day/Hr | Chesapeake Light | | Oregon Inlet | | EB-01 | |
|---|---|---|---|---|---|---|
| | Direction | Speed kts | Direction | Speed kts | Azimuth deg. | Speed kts |
| 120118 | SW | 16 | NW | 20 | 263 | 25 |
| 120121 | SW | 20 | NW | 15 | 256 | 20 |
| 120200 | SW | 20 | NW | 10 | 226 | 21 |
| 120203 | SSW | 22 | NW | 14 | 219 | 20 |
| 120206 | SW | 22 | NW | 16 | 251 | 22 |
| 120209 | SW | 20 | NW | 16 | 233 | 21 |
| 120212 | * | * | * | * | 275 | 15 |
| 120215 | W | 7 | NW | 11 | 272 | 7 |
| 120218 | W | 6 | SW | 10 | 311 | 3 |
| 120221 | SE | 10 | SW | 10 | 214 | 6 |
| 120300 | SE | 10 | SW | 10 | 198 | 11 |
| 120303 | S | 12 | SW | 11 | 213 | 11 |
| 120306 | S | 15 | SW | 11 | 231 | 16 |
| 120309 | S | 18 | SW | 11 | 223 | 20 |
| 120312 | SSW | 12 | SW | 15 | 221 | 19 |
| 120315 | SSW | 18 | SW | 15 | 225 | 18 |
| 120318 | SSW | 16 | SW | 15 | 224 | 19 |
| 120321 | S | 10 | SW | 15 | 242 | 15 |
| 120400 | SW | 2 | SW | 5 | 242 | 7 |
| 120403 | SW | 10 | SW | 5 | 280 | 5 |
| 120406 | SW | 15 | SW | 5 | 288 | 7 |
| 120409 | SSW | 7 | SW | 5 | 45 | 6 |
| 120412 | SSE | 4 | S | 3 | 96 | 10 |
| 120415 | * | * | * | * | 88 | 4 |
| 120418 | SE | 4 | * | * | 145 | 11 |
| 120421 | SE | 9 | SW | 10 | 179 | 19 |
| 120500 | SE | 10 | SW | 10 | 241 | 12 |
| 120503 | S | 10 | SW | 10 | 271 | 10 |
| 120506 | S | 10 | SW | 15 | 250 | 10 |
| 120509 | SSW | 10 | SW | 15 | 280 | 11 |
| 120512 | SSW | 10 | SW | 15 | 292 | 6 |
| 120515 | S | 10 | SW | 10 | 164 | 11 |
| 120518 | SSE | 10 | SW | 8 | 197 | 10 |
| 120521 | SSE | 12 | SW | 8 | 174 | 15 |
| 120600 | SE | 18 | SW | 8 | 166 | 18 |
| 120603 | SE | 10 | SW | 7 | 167 | 22 |
| 120606 | SSE | 10 | SW | 10 | 170 | 23 |
| 120609 | SSE | 18 | * | * | 143 | 28 |
| 120612 | SSE | 15 | SSE | 10 | 164 | 35 |
| 120615 | SSE | 15 | SW | 15 | 164 | 34 |
| 120618 | SE | 19 | SSW | 15 | 161 | 37 |
| 120621 | SSE | 8 | SW | 18 | 170 | 38 |

*No data.

TABLE II.- LIST OF DATA, DEC. 1972 - Continued

(e) Wind Data - Continued

| Time, Mo/Day/Hr | Chesapeake LIght | | Oregon Inlet | | EB-01 | |
|---|---|---|---|---|---|---|
| | Direction | Speed kts | Direction | Speed kts | Azimuth deg | Speed kts |
| 120700 | S | 12 | SW | 18 | 239 | 28 |
| 120703 | SW | 13 | SW | 15 | 273 | 23 |
| 120706 | NW | 30 | SW | 15 | 315 | 26 |
| 120709 | NW | 30 | NE | 25 | 346 | 28 |
| 120712 | NNW | 28 | NE | 25 | 6 | 27 |
| 120715 | NNW | 26 | NE | 25 | 3 | 24 |
| 120718 | NNW | 18 | NE | 25 | 11 | 21 |
| 120721 | NNE | 18 | NE | 25 | 20 | 18 |
| 120800 | NE | 18 | NE | 20 | 31 | 13 |
| 120803 | N | 20 | NE | 20 | 2 | 14 |
| 120806 | NE | 16 | NE | 10 | 113 | 8 |
| 120809 | NNE | 10 | NE | 15 | 112 | 13 |
| 120812 | NNE | 10 | NE | 15 | 119 | 13 |
| 120815 | N | 10 | NE | 10 | 140 | 16 |
| 120818 | WNW | 7 | SW | 10 | 150 | 16 |
| 120821 | SE | 13 | SE | 10 | 153 | 21 |
| 120900 | SE | 22 | SE | 10 | 163 | 21 |
| 120903 | SSE | 16 | SE | 12 | 160 | 27 |
| 120906 | NW | 8 | SE | 15 | 187 | 27 |
| 120909 | W | 10 | SW | 10 | 201 | 26 |
| 120912 | S | 10 | SW | 15 | 211 | 24 |
| 120915 | SSW | 10 | SW | 10 | 217 | 27 |
| 120918 | S | 18 | SW | 15 | 218 | 22 |
| 120921 | SSW | 14 | SW | 15 | 218 | 19 |
| 121000 | SSW | 14 | SW | 15 | 229 | 20 |
| 121003 | SSW | 7 | SW | 15 | 226 | 18 |
| 121006 | SE | 6 | SW | 15 | 203 | 19 |
| 121009 | SW | 6 | SSW | 12 | 230 | 21 |
| 121012 | S | 10 | SW | 15 | 231 | 20 |
| 121015 | S | 15 | SW | 18 | 201 | 24 |
| 121018 | S | 22 | SW | 15 | 214 | 27 |
| 121021 | SW | 14 | SW | 15 | 222 | 25 |
| 121100 | SW | 14 | SW | 16 | 231 | 18 |
| 121103 | SSW | 10 | SW | 15 | 242 | 23 |
| 121106 | W | 17 | SW | 15 | 317 | 15 |
| 121109 | NNW | 20 | SW | 15 | 354 | 24 |
| 121112 | NNW | 22 | NE | 18 | 349 | 19 |
| 121115 | N | 20 | NE | 20 | 1 | 7 |
| 121118 | NNW | 10 | NE | 20 | 346 | 17 |
| 121121 | N | 11 | NE | 20 | 2 | 12 |

TABLE II.- LIST OF DATA, DEC. 1972 - Concluded

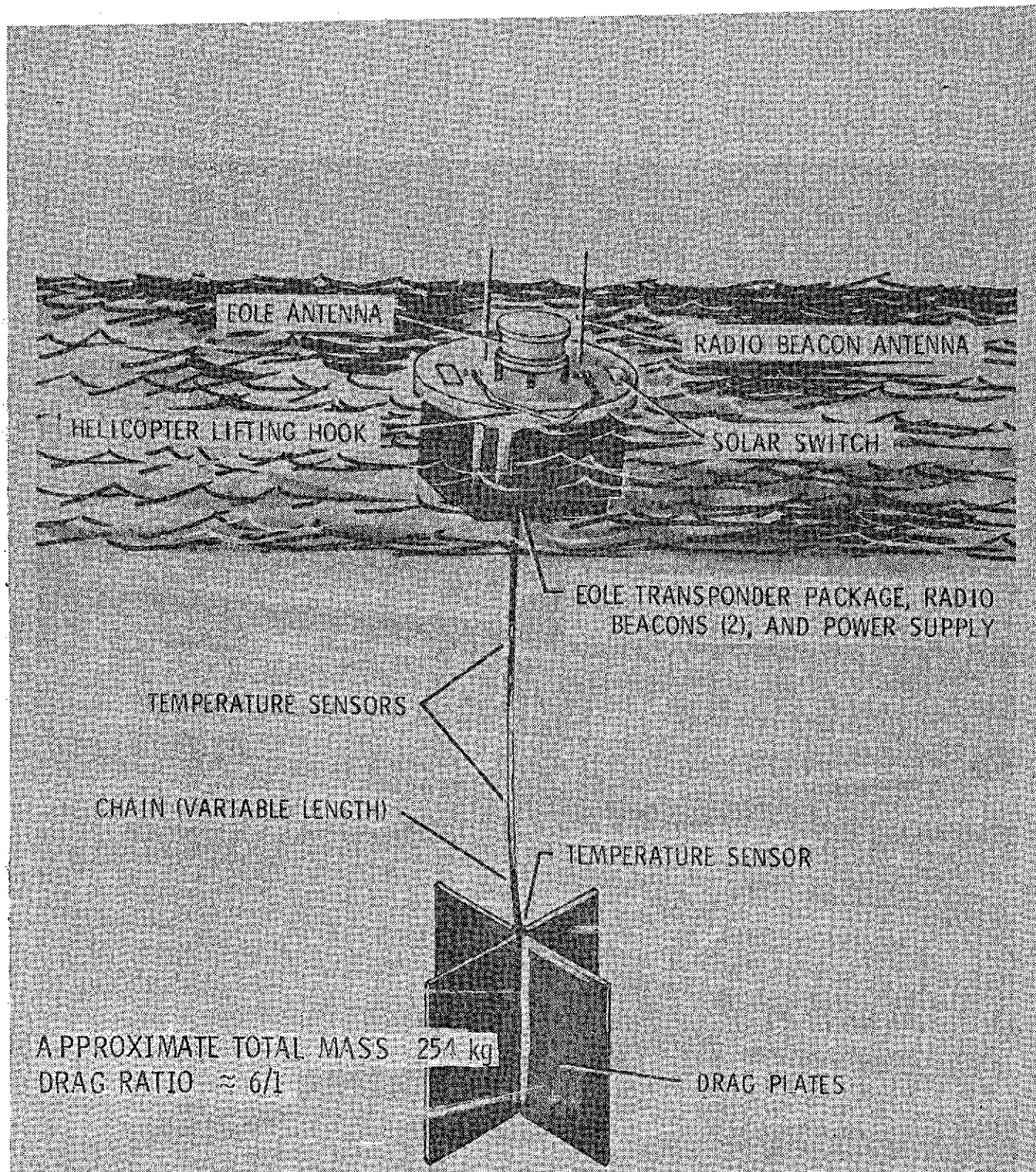
(e) Wind Data - Concluded

| Time, Mo/Day/Hr | Chesapeake Light | | Oregon Inlet | | EB-01 | |
|---|---|---|---|---|---|---|
| | Direction | Speed kts | Direction | Speed kts | Azimuth deg | Speed kts |
| 121200 | N | 10 | NE | 20 | 14 | 11 |
| 121203 | NNE | 10 | NE | 20 | 25 | 15 |
| 121206 | NNE | 10 | NE | 20 | 25 | 15 |
| 121209 | NNE | 10 | NE | 20 | 64 | 11 |
| 121212 | NNE | 20 | NE | 20 | 118 | 14 |
| 121215 | NE | 20 | NNE | 15 | 137 | 17 |
| 121218 | NNE | 13 | NNE | 15 | 156 | 20 |
| 121221 | NNE | 13 | NE | 22 | 162 | 25 |
| 121300 | NNW | 10 | NE | 20 | 219 | 19 |
| 121303 | W | 10 | NE | 5 | 218 | 24 |
| 121306 | SSW | 8 | NE | 10 | 226 | 26 |
| 121309 | S | 10 | NE | 2 | 218 | 26 |
| 121312 | SSW | 12 | NE | 5 | 260 | 25 |
| 121315 | SW | 15 | NE | 5 | 242 | 20 |
| 121318 | SW | 10 | W | 10 | 286 | 14 |
| 121321 | W | 10 | SW | 12 | 354 | 14 |
| 121400 | N | 14 | SW | 10 | 9 | 17 |
| 121403 | N | 22 | * | * | 23 | 15 |
| 121406 | NNE | 10 | * | * | 39 | 12 |
| 121409 | NNE | 20 | * | * | 95 | 15 |
| 121412 | NNE | 20 | * | * | 44 | 13 |
| 121415 | NNE | 16 | NE | 7 | 20 | 22 |
| 121418 | NNW | 16 | NE | 15 | * | * |
| 121421 | NNW | 17 | NE | 18 | * | * |

*No data.

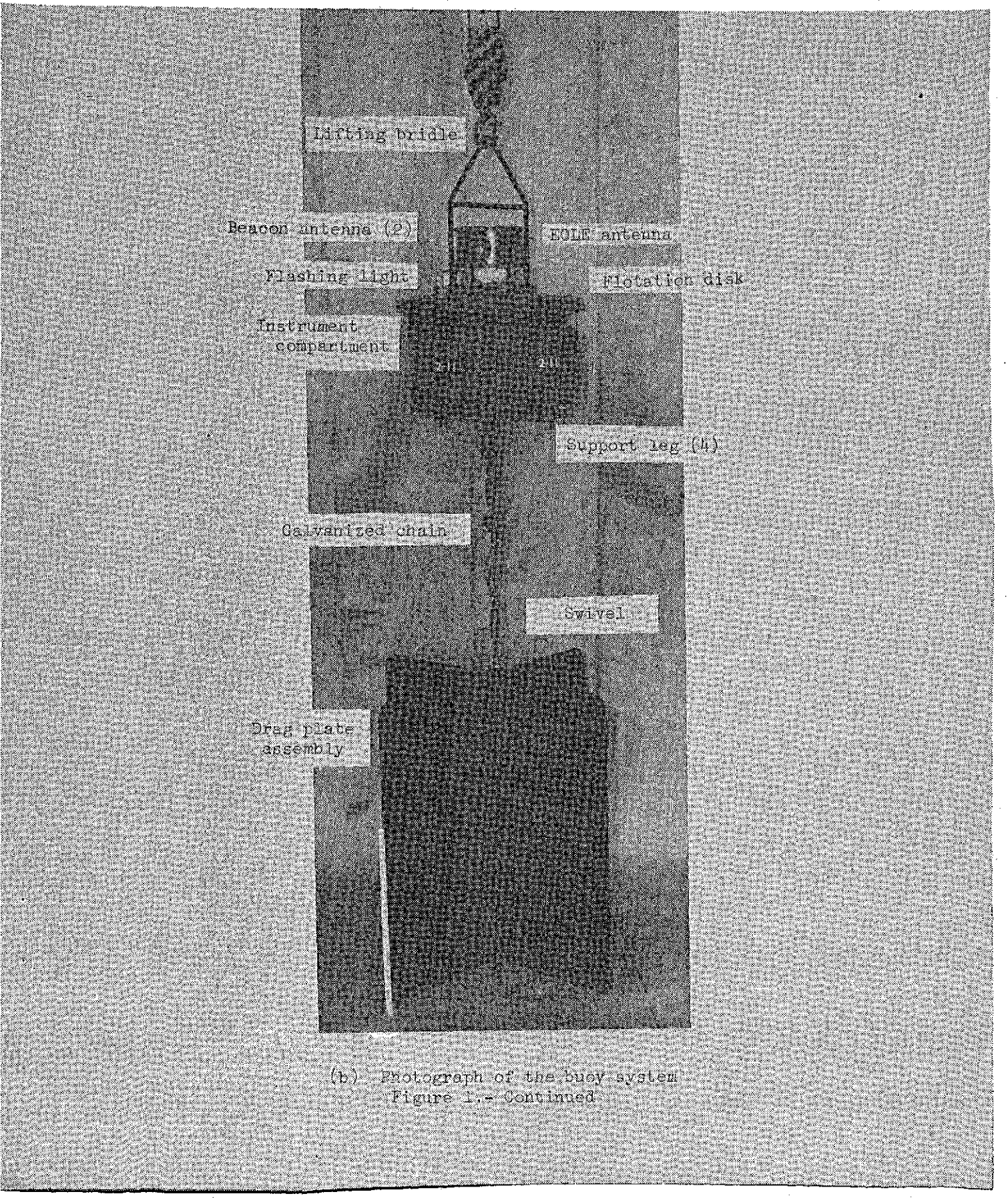
TABLE III - TEMPERATURE DATA ACCURACY

| Channel Number | Actual Temperature, °C | Measured Temperature, °C | ΔTemperature (error), °C |
|---|---|---|---|
| #1 | 10.009 | 10.162 | +.153 |
| | | 10.024 | +.015 |
| | | 10.162 | +.153 |
| | | 10.162 | +.153 |
| | | 10.302 | +.293 |
| | | 10.024 | +.015 |
| | | 10.302 | +.293 |
| #2 | 12.007 | 12.001 | -.006 |
| | | 11.881 | -.126 |
| | | 11.998 | -.008 |
| | | 11.864 | -.143 |
| | | 11.998 | -.008 |
| | | 12.116 | +.109 |
| | | 12.130 | +.123 |
| | | 11.998 | -.008 |
| #3 | 21.977 | 21.910 | -.067 |
| | | 21.800 | -.177 |
| | | 21.907 | -.070 |
| | | 21.907 | -.070 |
| | | 21.907 | -.070 |
| | | 22.013 | -.036 |
| | | 21.807 | -.170 |
| #4 | 13.953 | 13.774 | -.179 |
| | | 13.889 | -.064 |
| | | 13.774 | -.179 |
| | | 14.002 | +.049 |
| | | 13.889 | -.064 |
| | | 14.002 | +.049 |
| | | 13.889 | -.064 |
| | | 14.002 | +.049 |



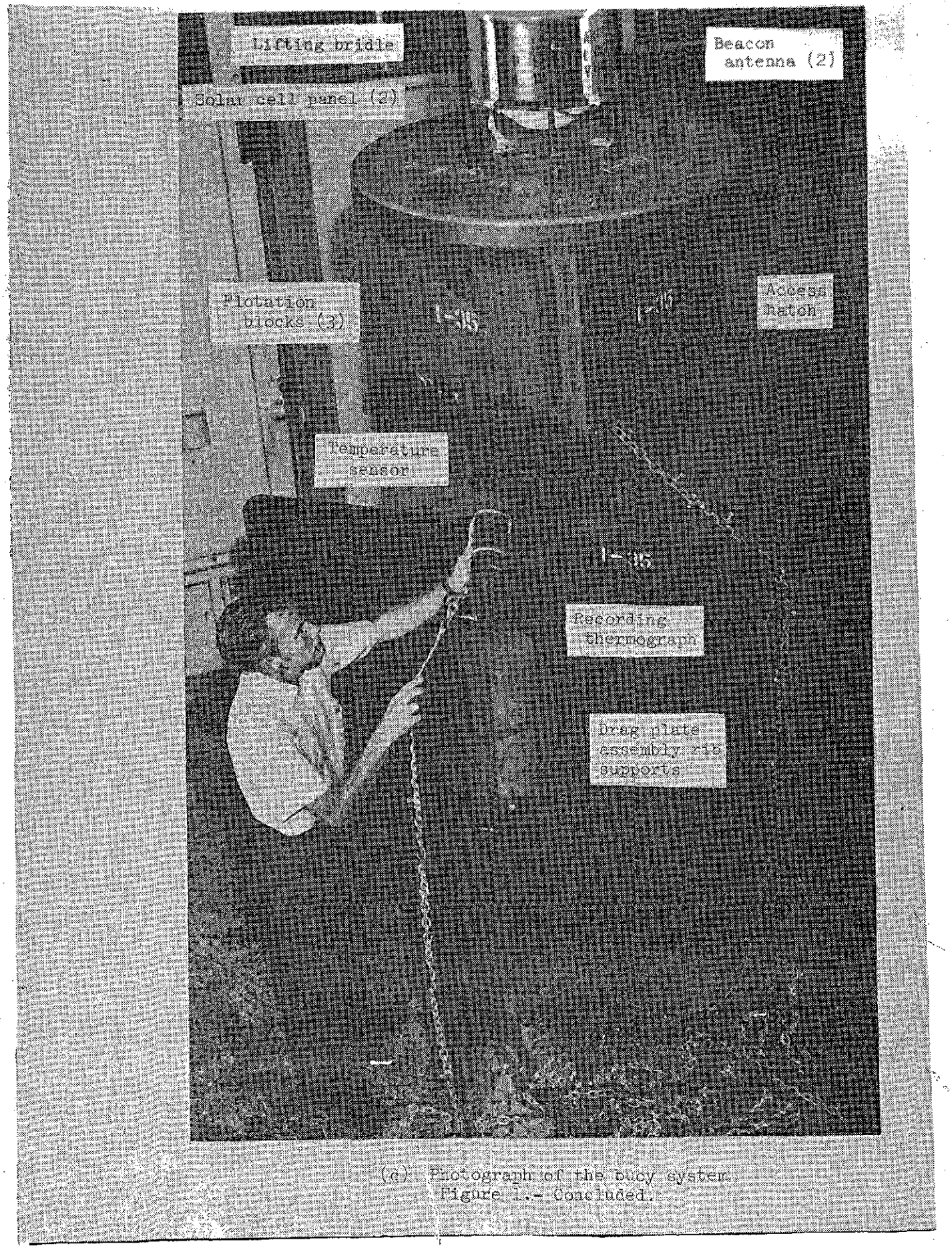

(a) Artist sketch of buoy system.

Figure 1. - Buoy system sketch and photographs.




(b) Photograph of the buoy system

Figure 1.- Continued




(c) Photograph of the buoy system.

Figure 1.- Concluded.

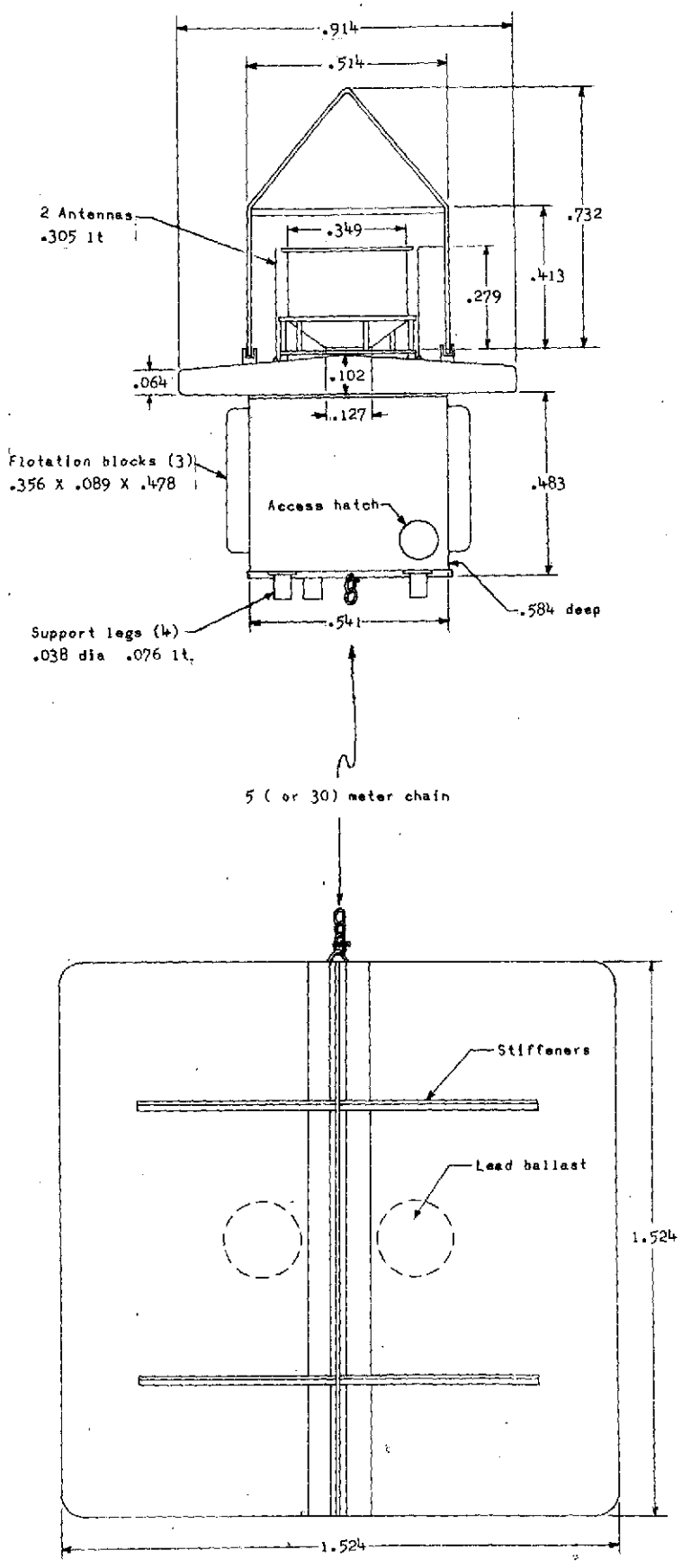



Figure 2.- Sketch of the buoy system. (All dimensions in meters.)

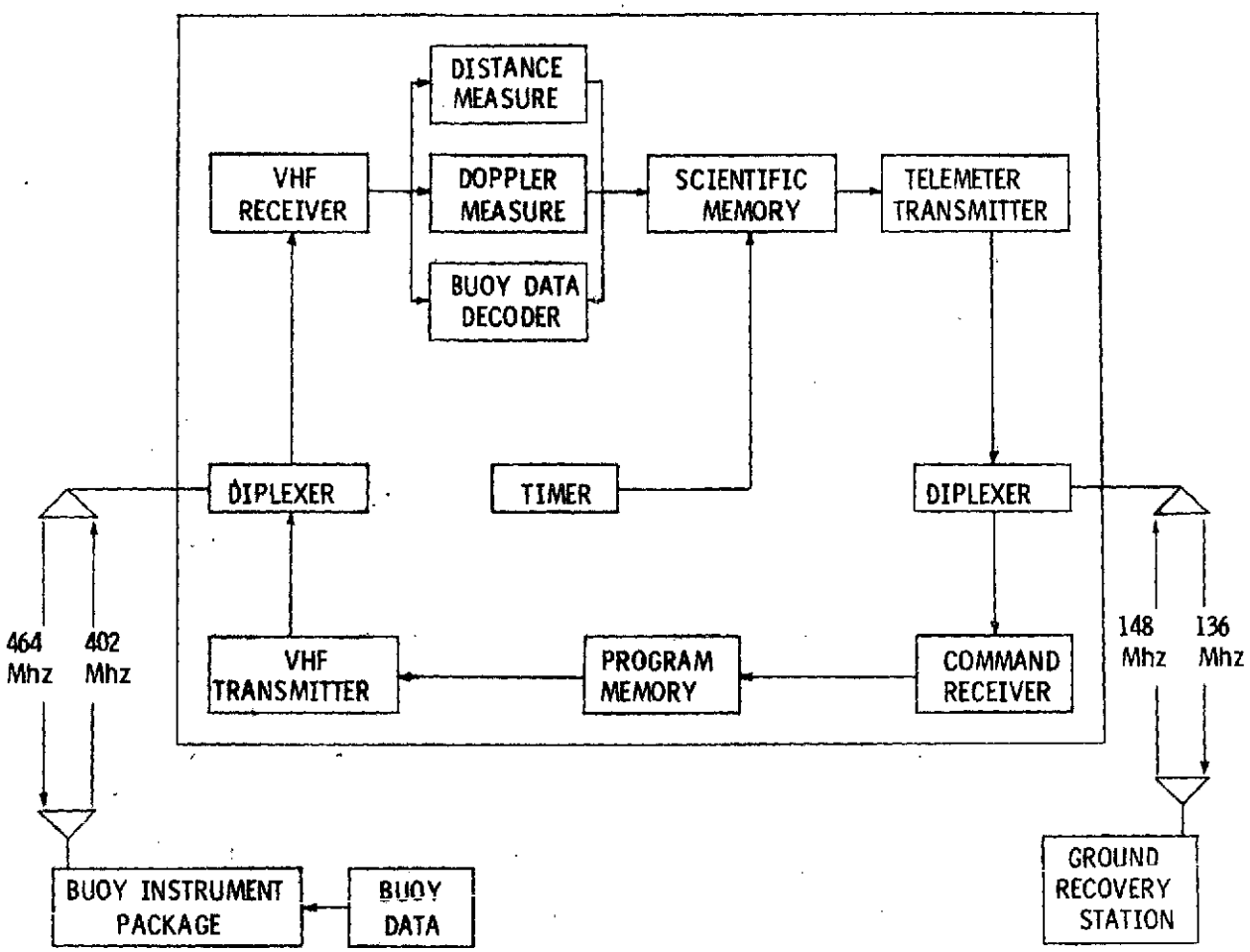
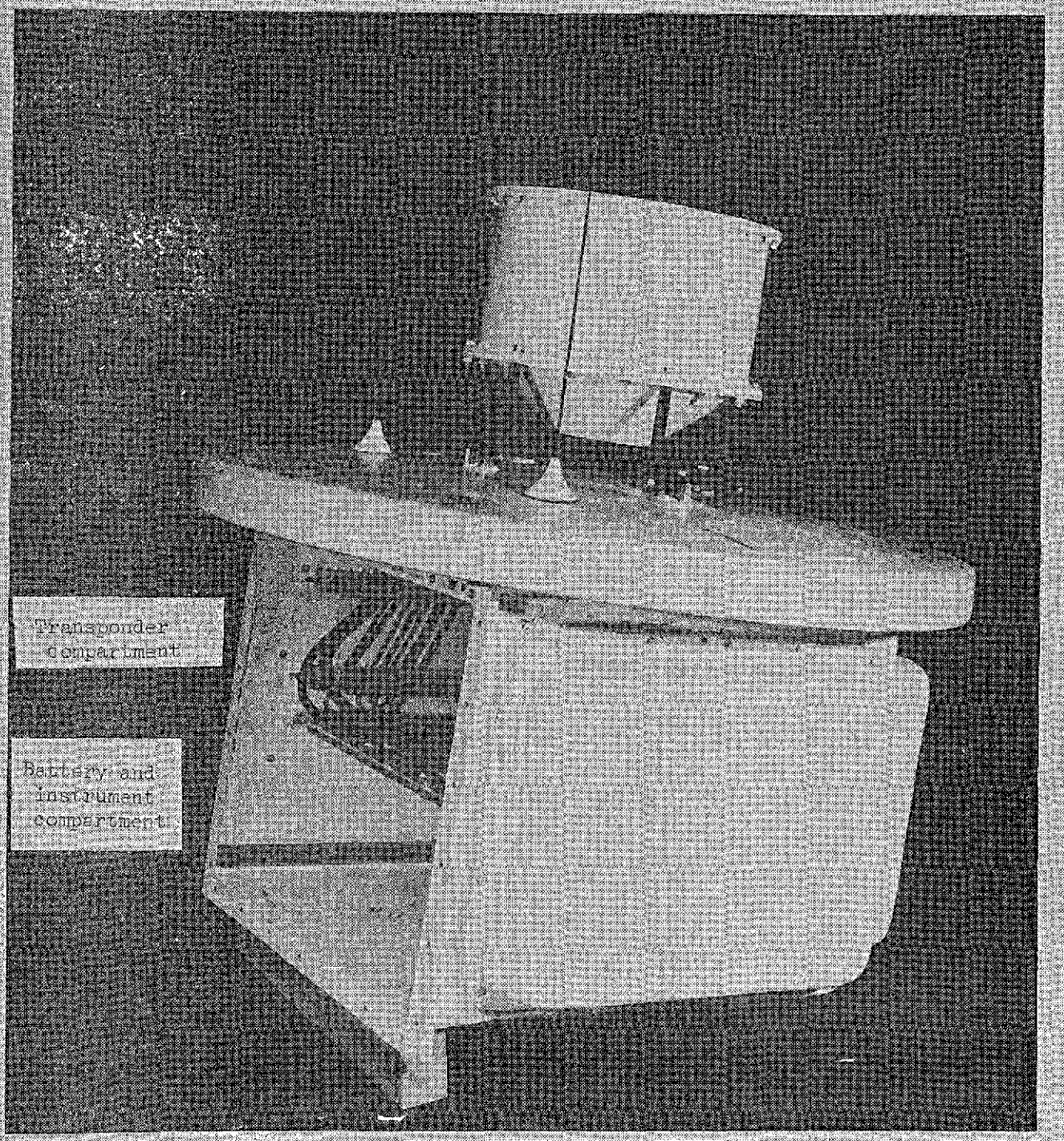
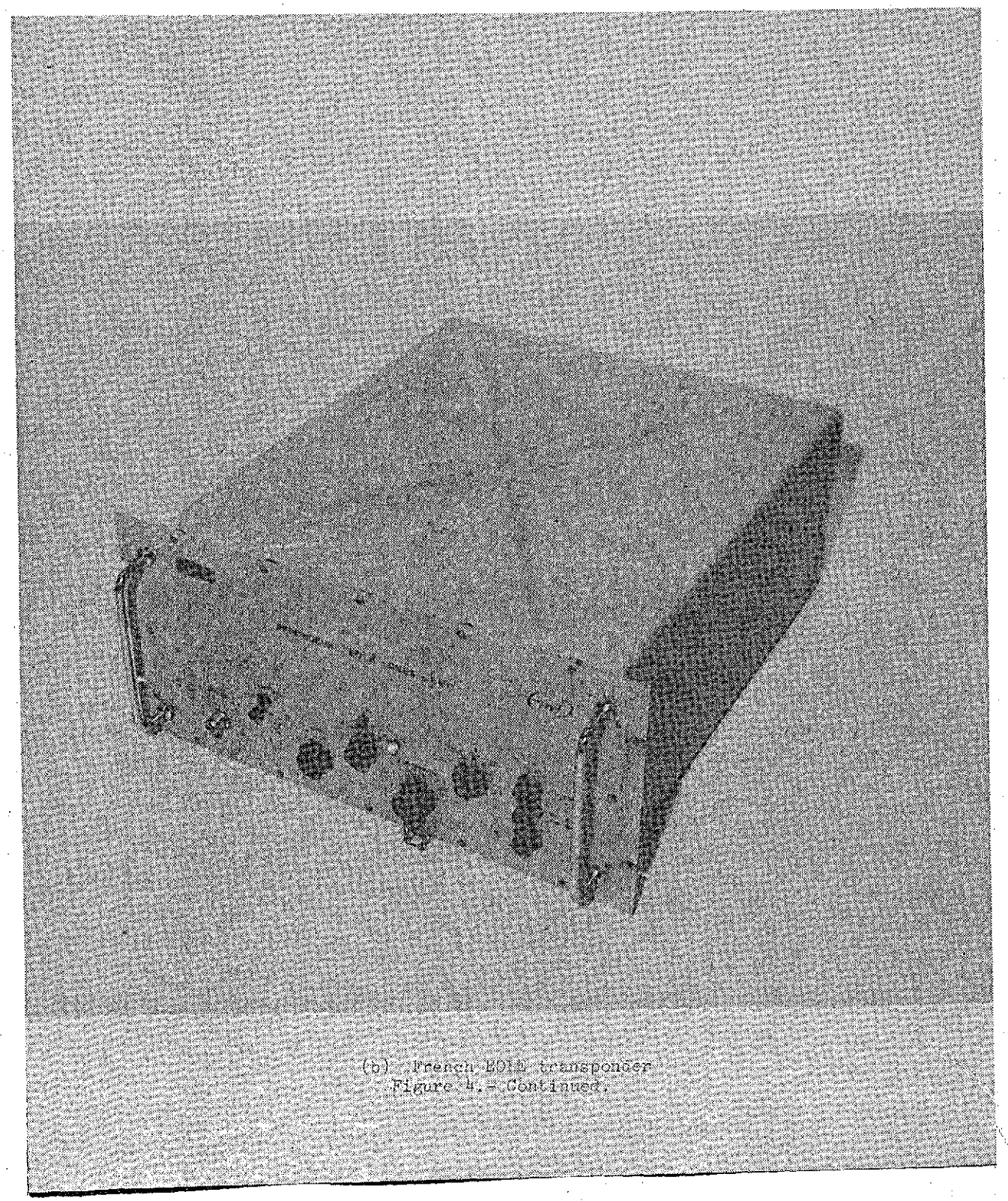



Figure 3. - Buoy-satellite-ground station communications concept.

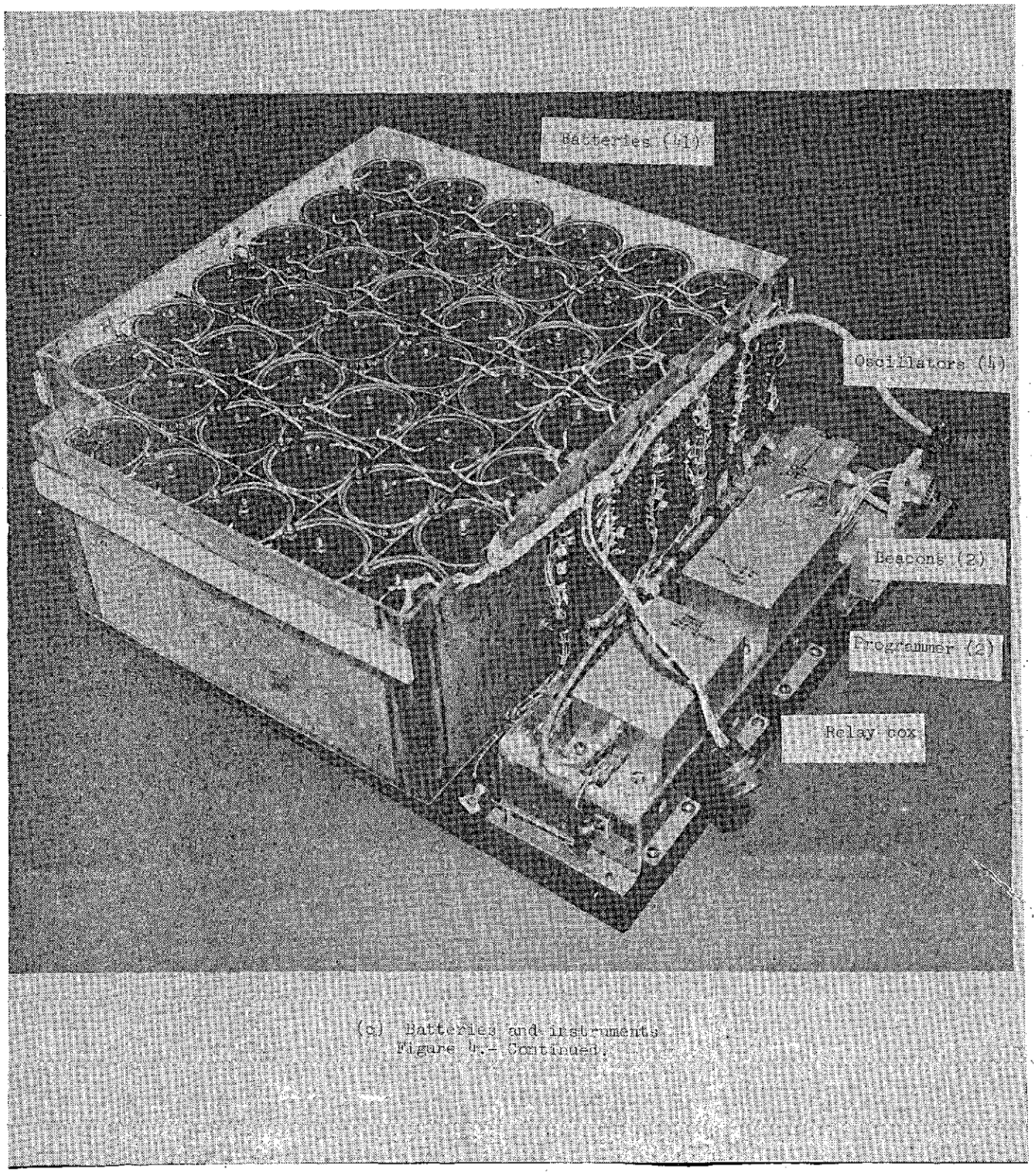



(a) Empty instrument compartment.

Figure 4.- Photographs of the instrument compartment and components.

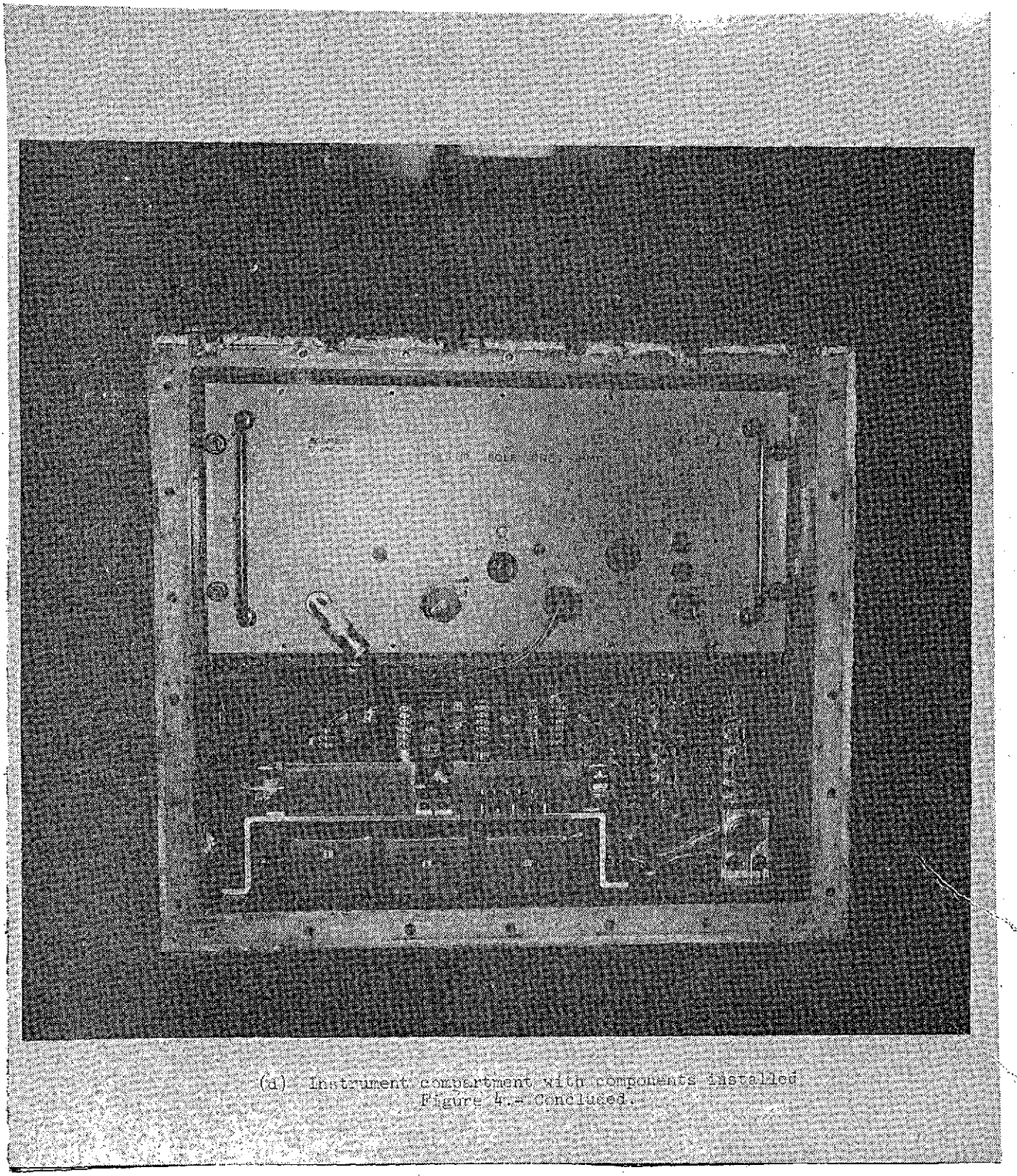


(b) French EOLE transponder
Figure 4.- Continued.



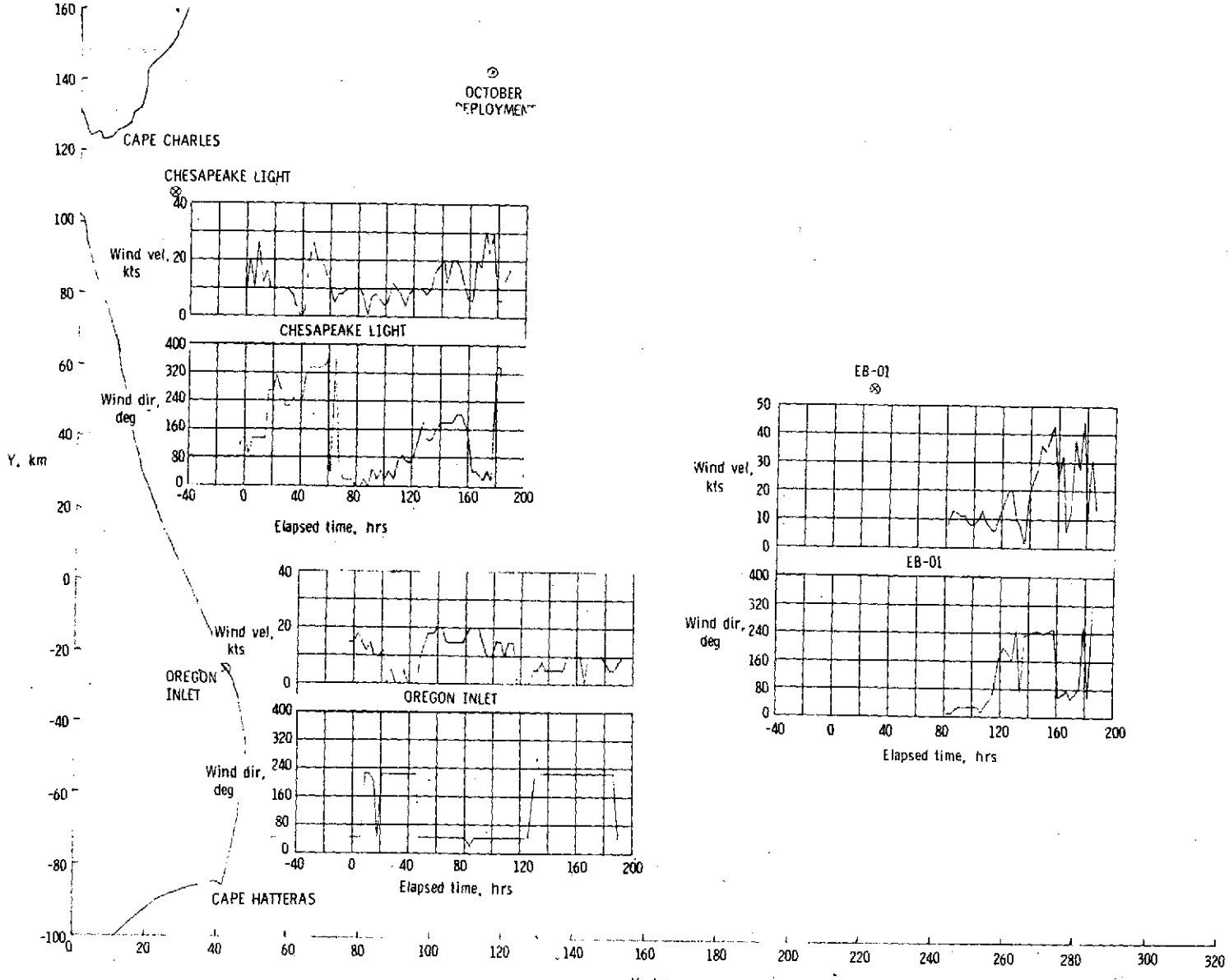

(c) Batteries and instruments.

Figure 4.- Continued.



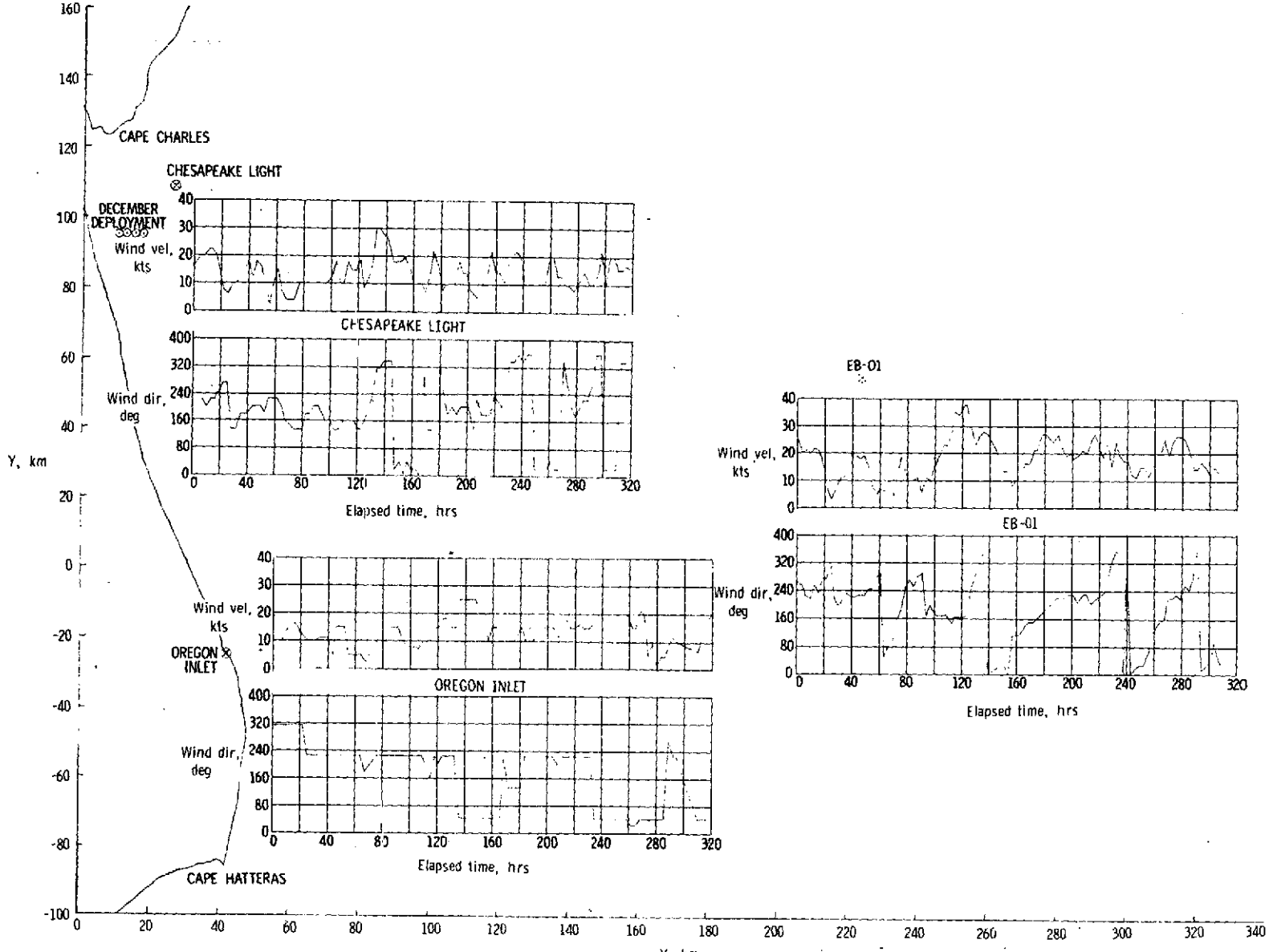
(d) Instrument compartment with components installed.

Figure 4.- Concluded.




(a) October-November Mission.

Figure 5. - Deployment positions and histories of the wind speed and direction at Chesapeake Light, EB-01, and Oregon Inlet.




(b) December Mission.

Figure 5. - Concluded.

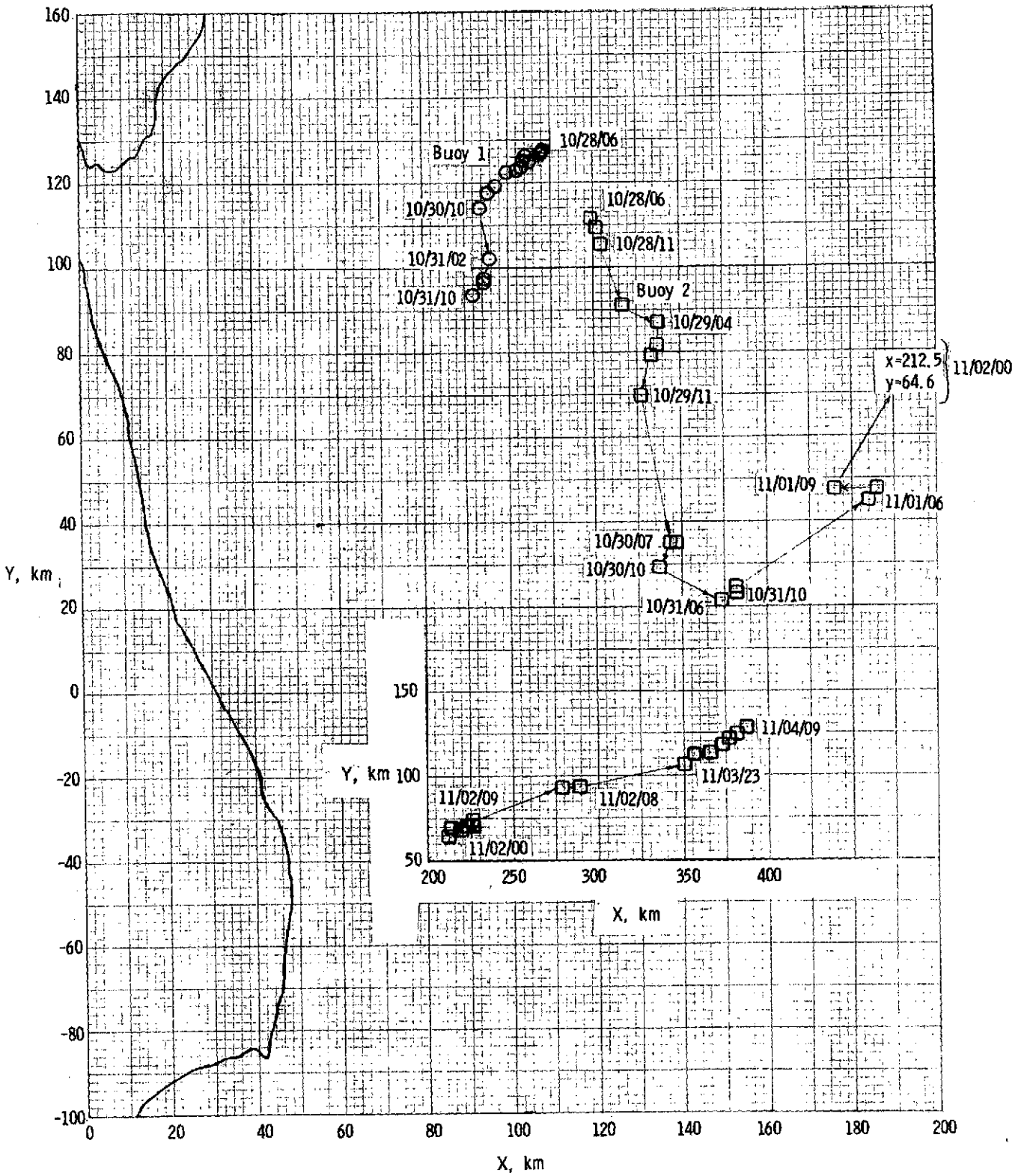
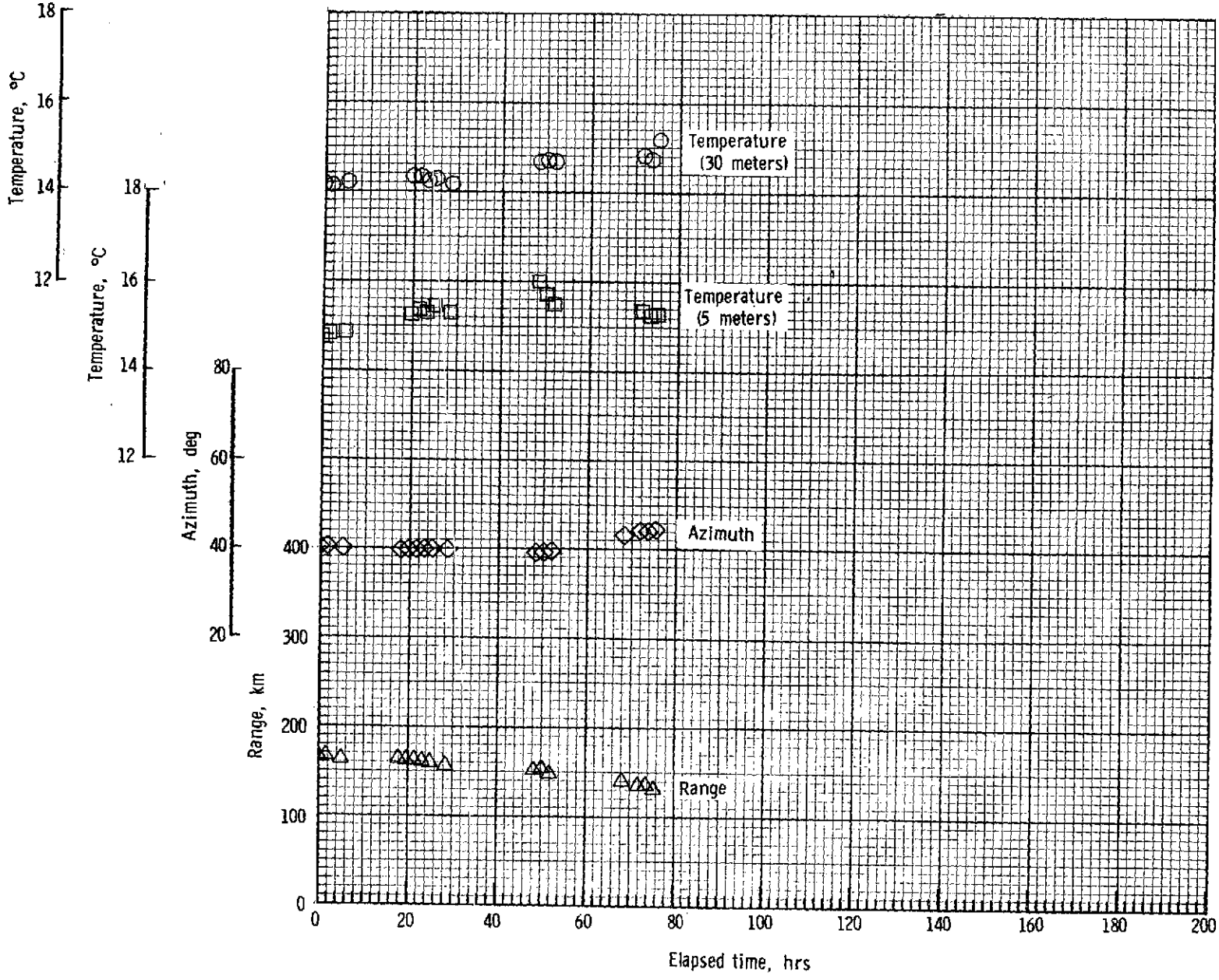
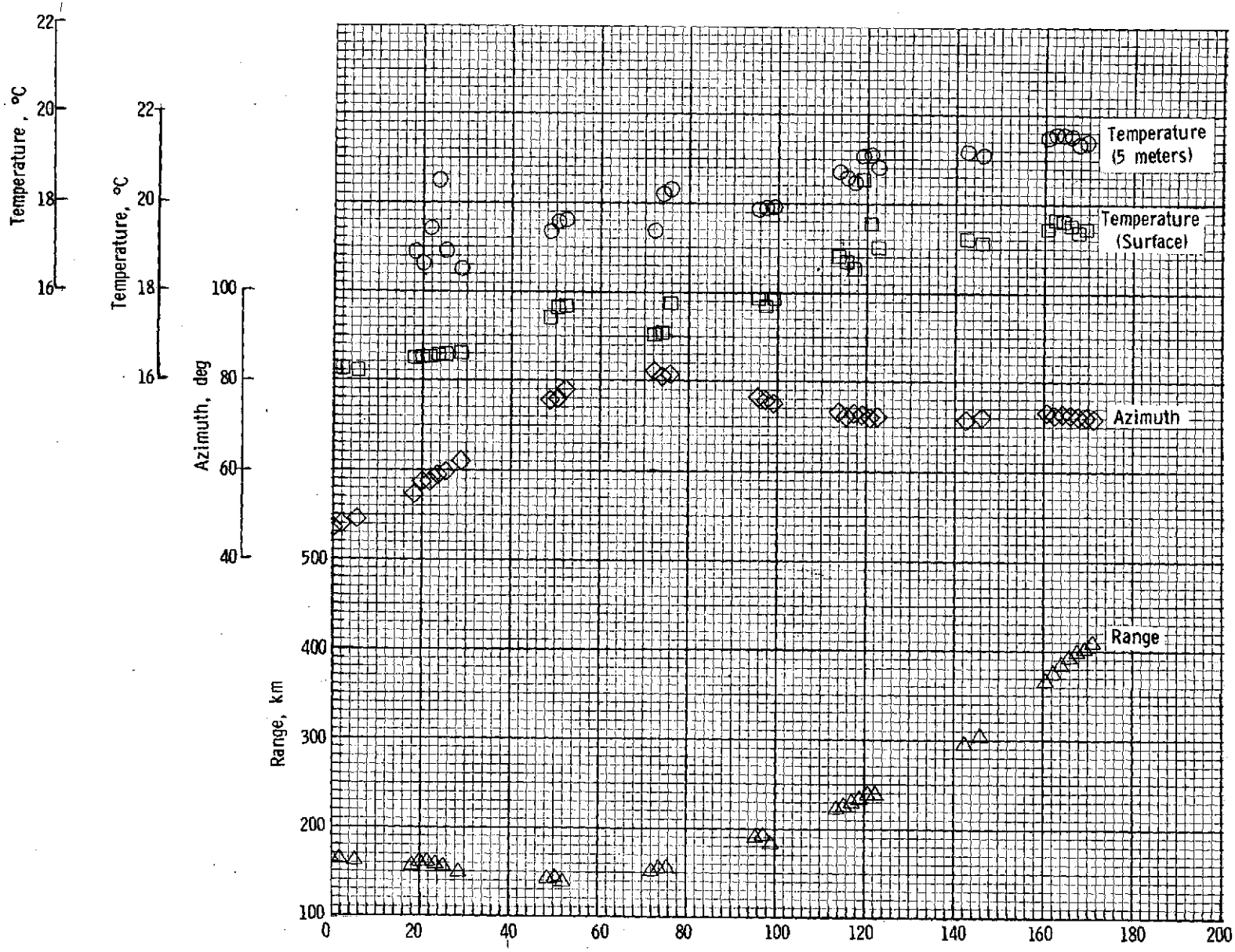



Figure 6. - Buoy trajectories for October - November 1972.



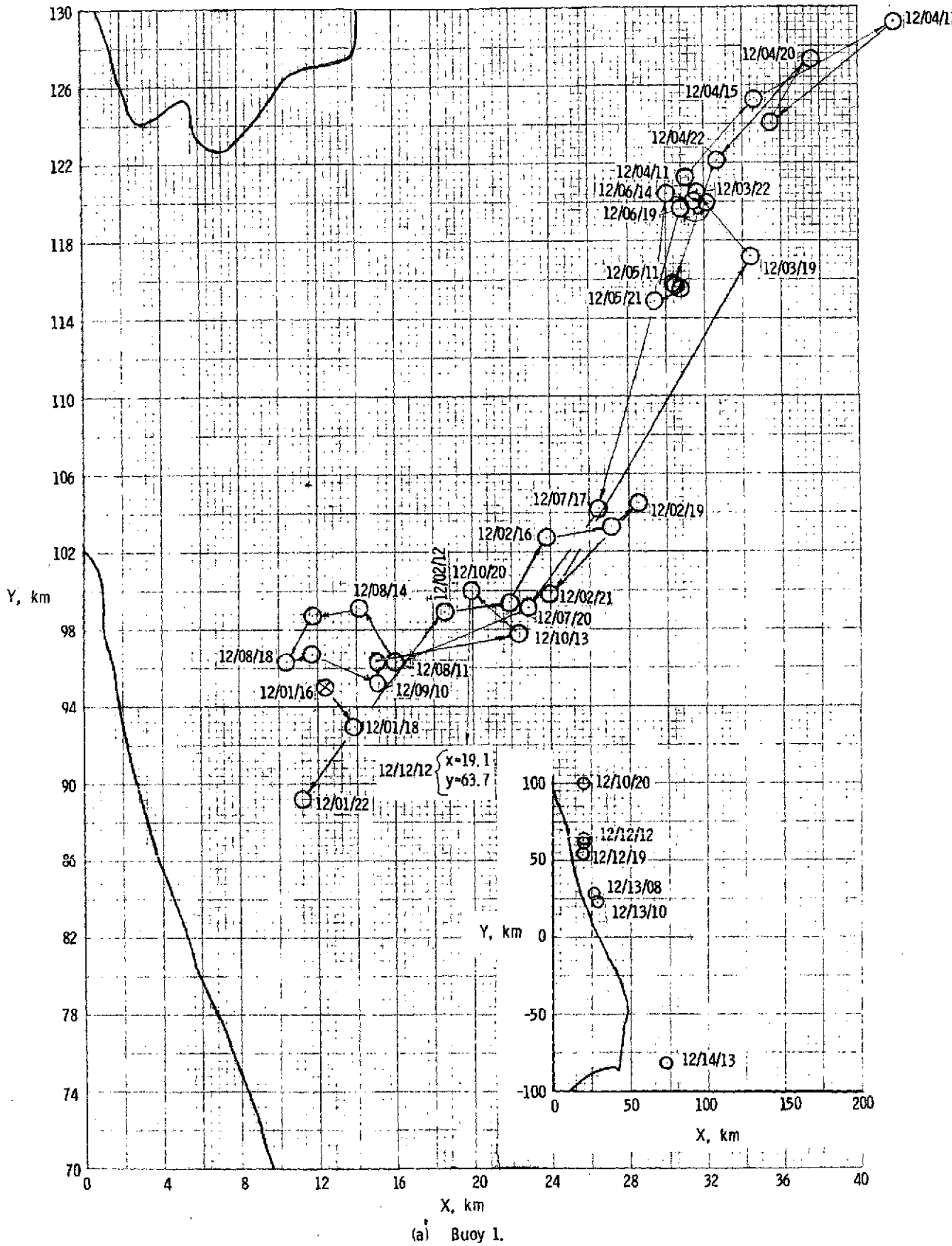

(a) Buoy 1.

Figure 7.- Time histories of the temperature and position data, Oct - Nov 1972.



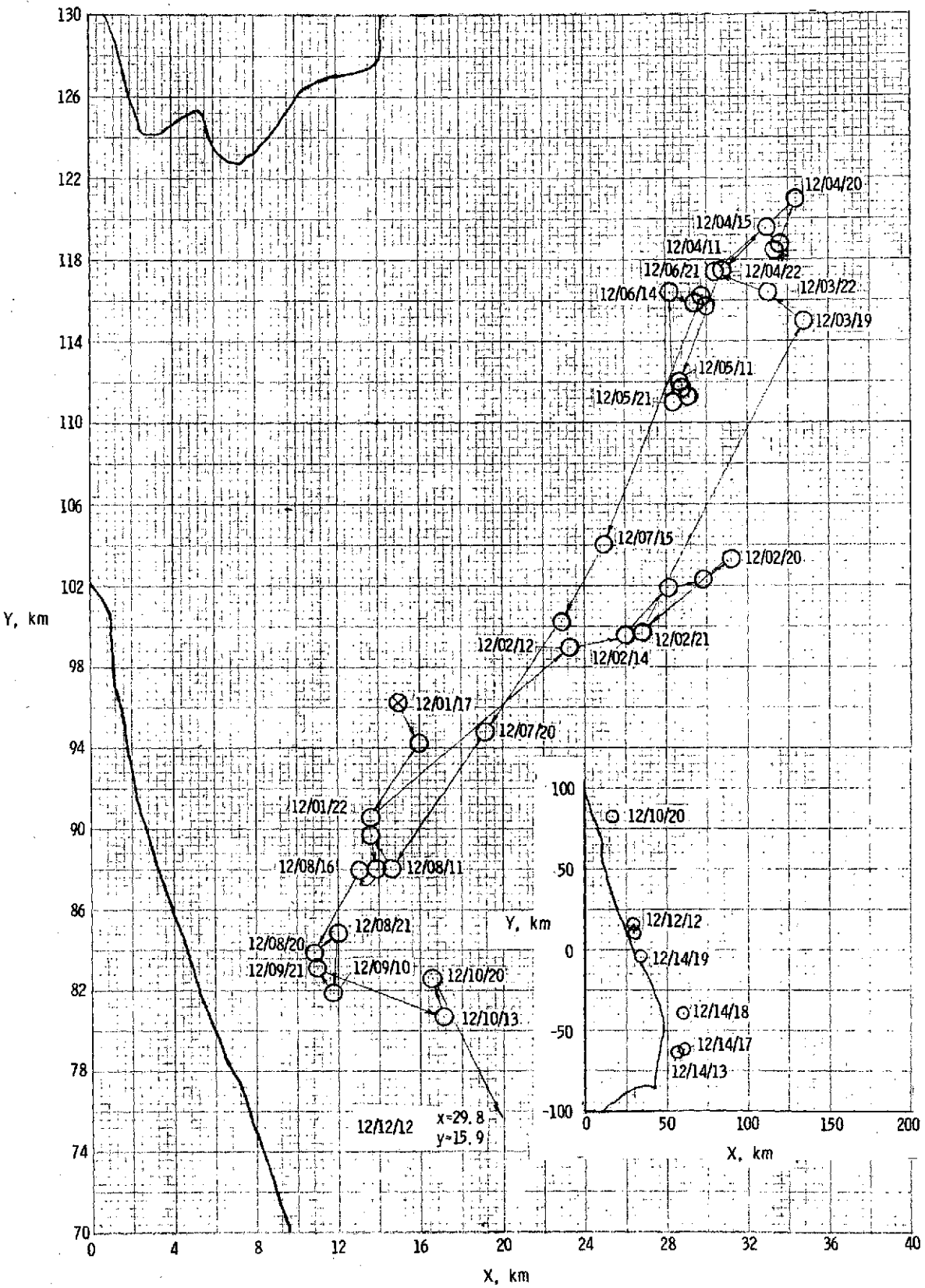

(b) Buoy 2.

Figure 7.- Concluded.



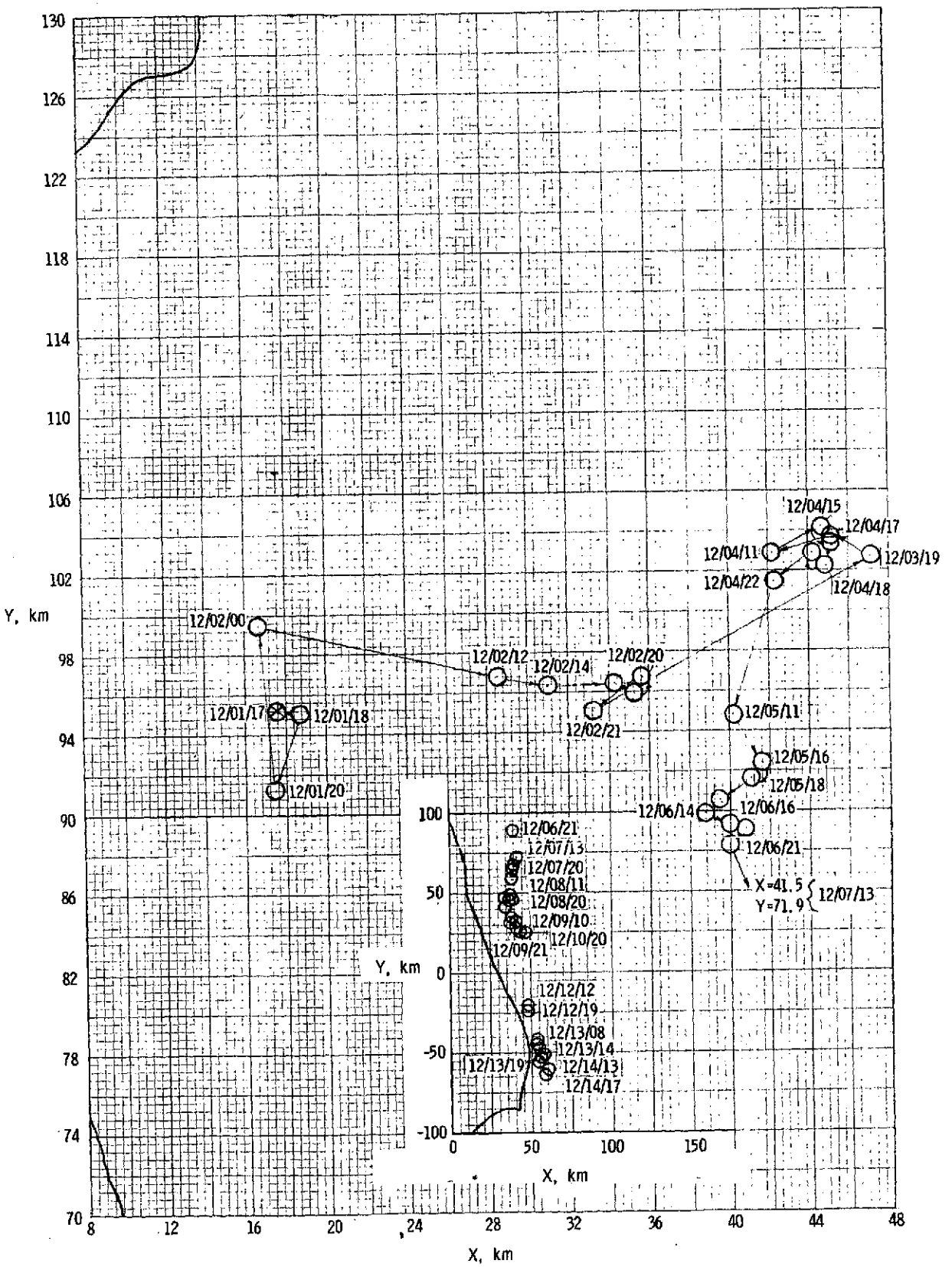

(a) Buoy 1.

Figure 8.- Buoy trajectories for December 1972.



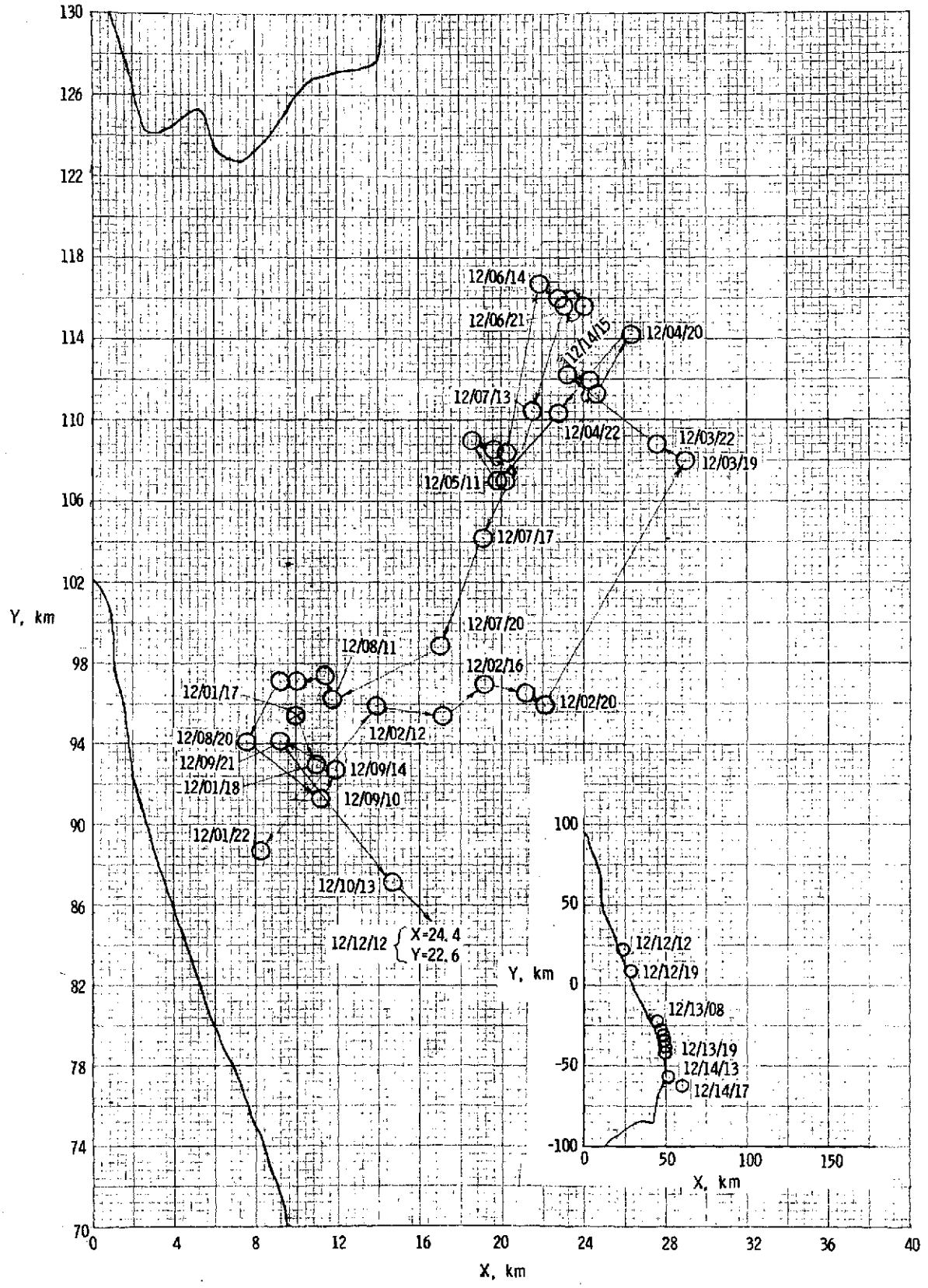

(b) Buoy 2.

Figure 8. - Continued.



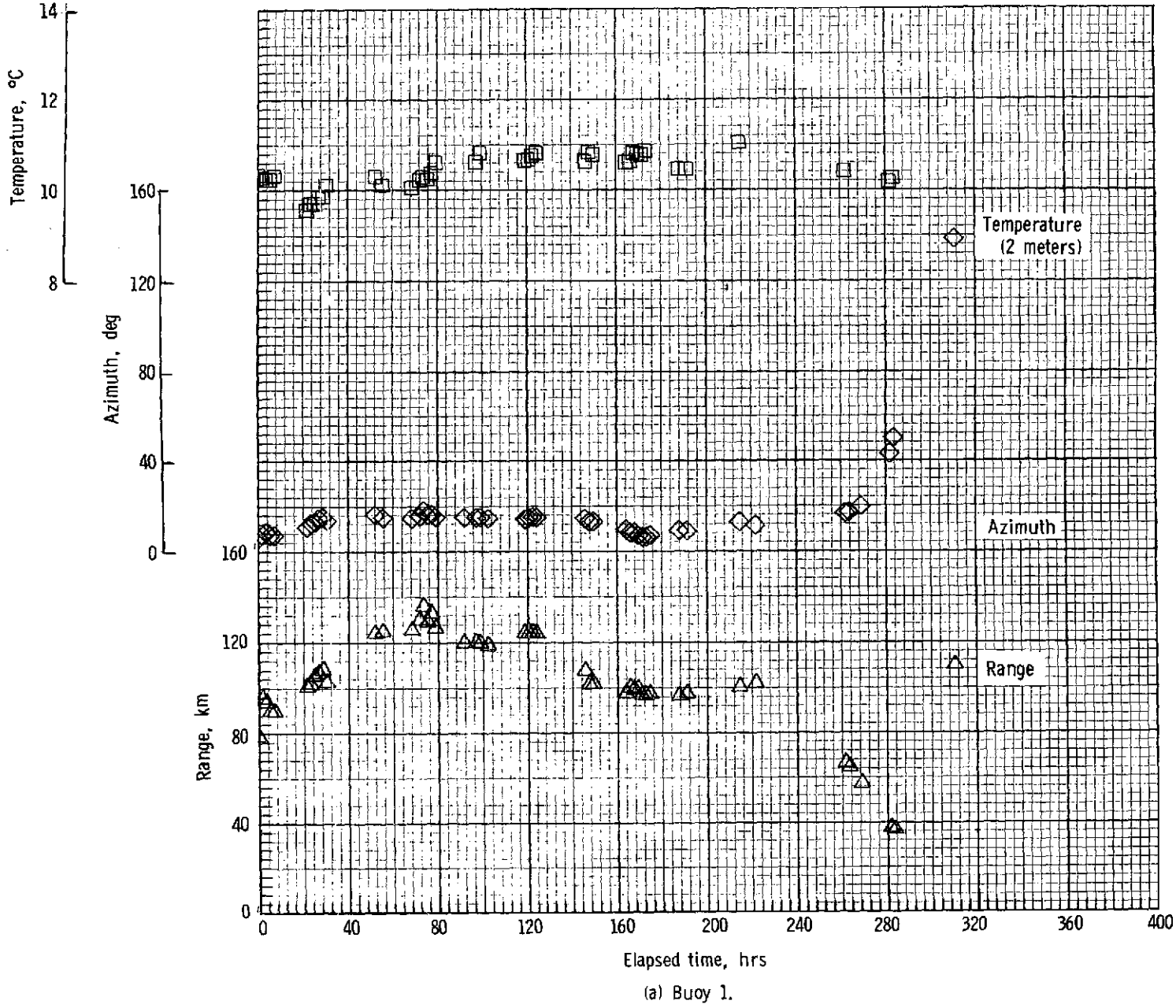

(c) Buoy 3.

Figure 8. - Continued.



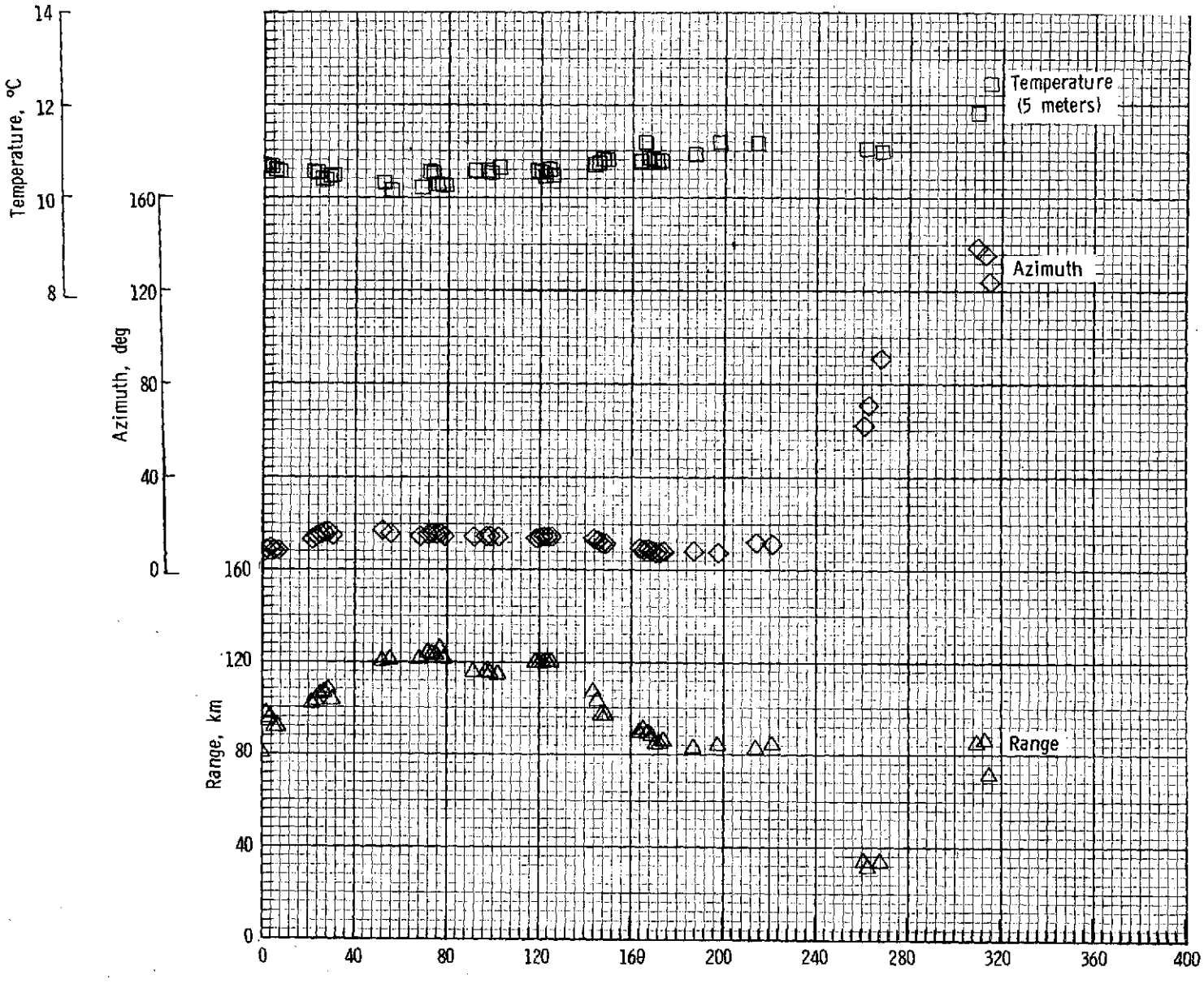

(d) Buoy 4.

Figure 8. - Concluded.



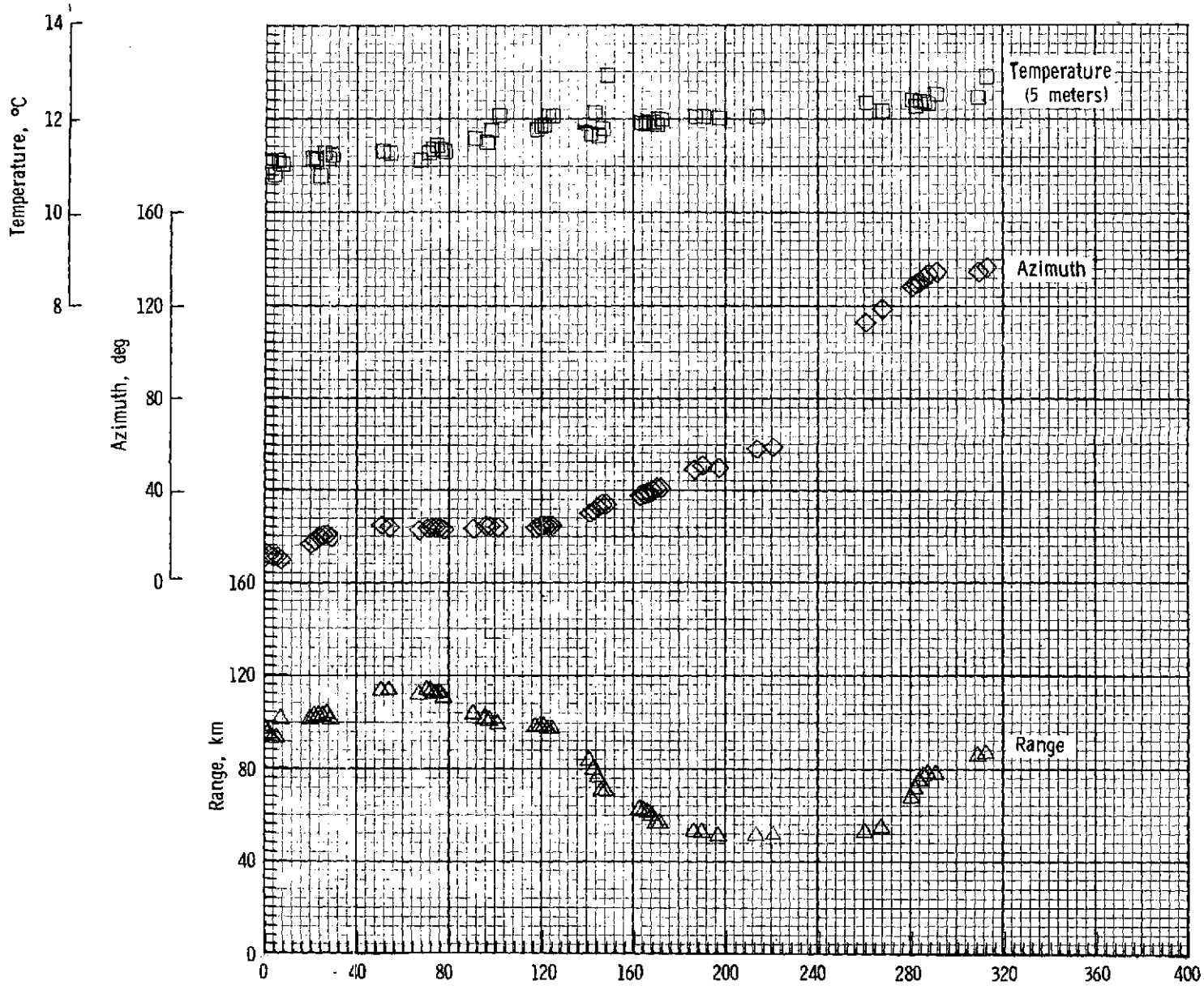

(a) Buoy 1.

Figure 9. - Time histories of the position and temperature data, Dec. 1972.



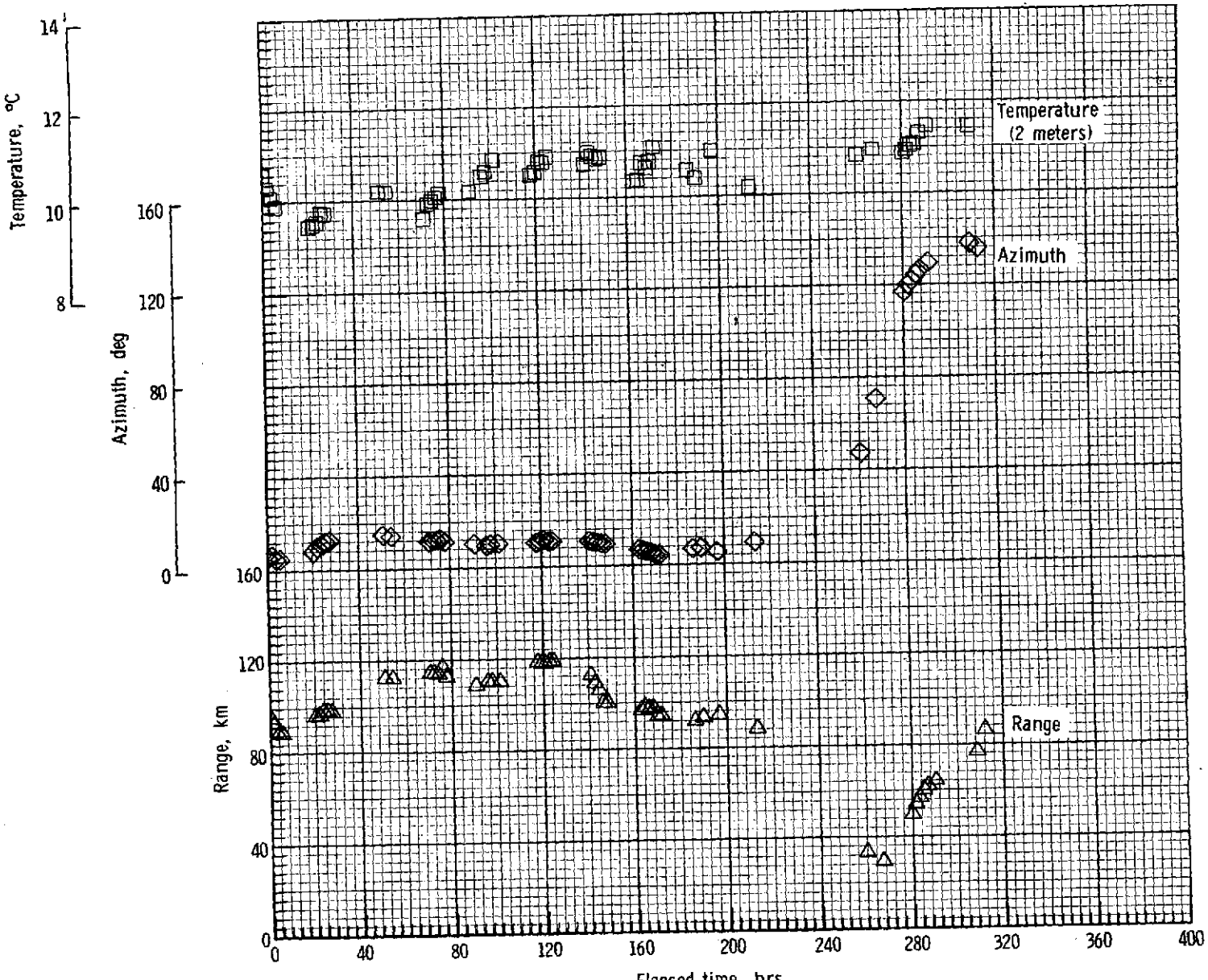

(b) Buoy 2.

Figure 9. - Continued.



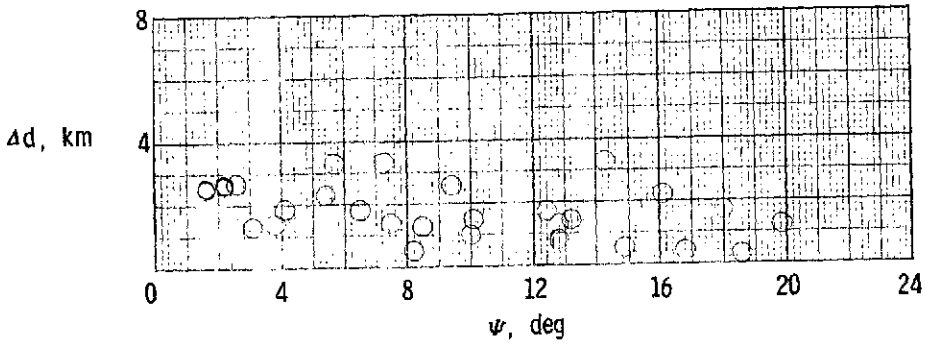

(c) Buoy 3.

Figure 9. - Continued.

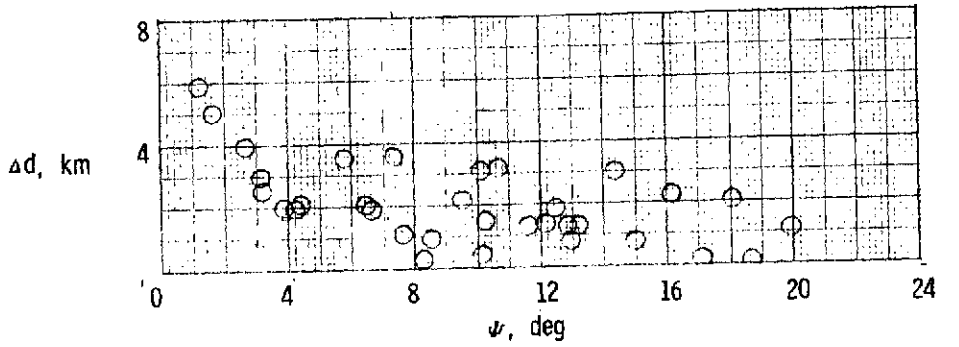



(d) Buoy 4.

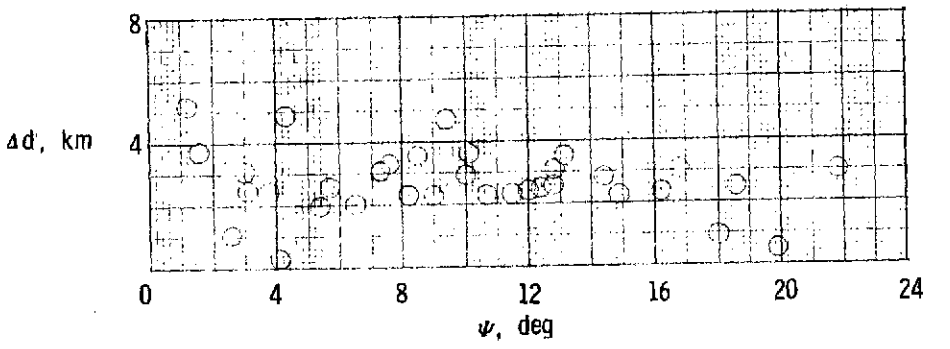
Figure 9. - Concluded.



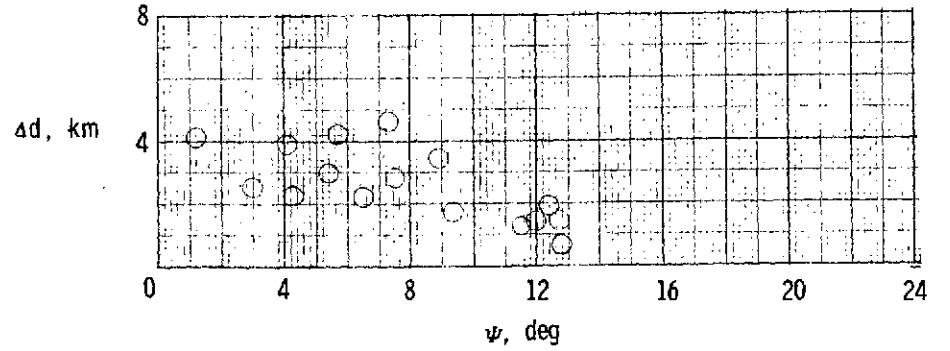

(a) Buoy 1.




(b) Buoy 2.




(c) Buoy 5.




(d) Buoy 6.

Figure 10. - Errors in Buoy locations as a function of ground track distance.

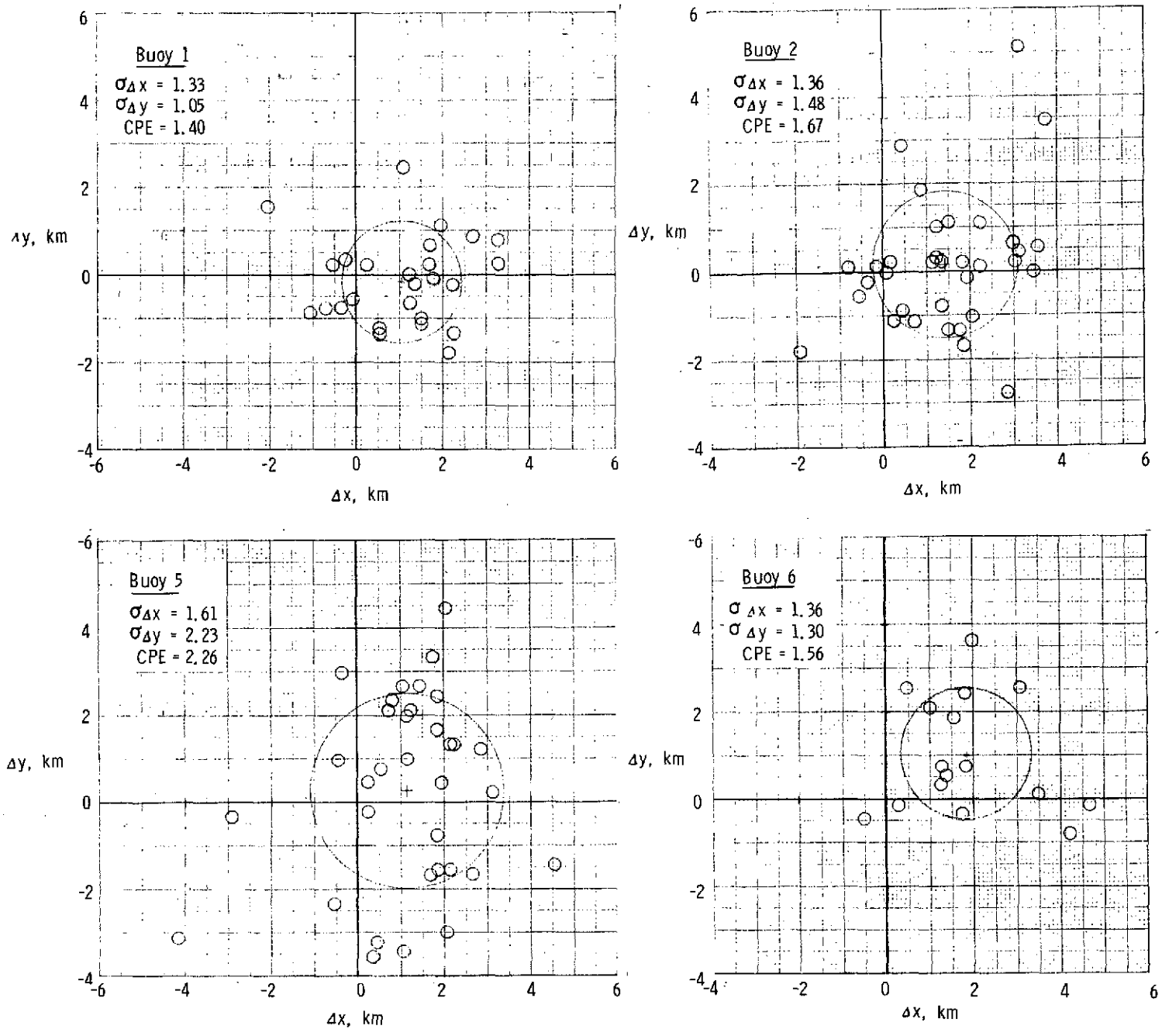



Figure 11. - Systematic and random errors associated with the position data.