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Fine Structure Measurement of Temperature
and
Moisture over the Monterey Bay

by

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Fine Structure Measurement of Temperature and Moisture over the Monterey Bay

by

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Submitted in partial fulfillment of the
requirements for the degree of

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TABLE OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Definition
NPS	Naval Postgraduate School
FNWC	Fleet Numerical Weather Central
NALF	Naval Auxiliary Landing Field
fpm	feet per minute
RH	relative humidity
mb	millibar
m_s	saturated mixing ratio
m	mixing ratio
e_s	saturated vapor pressure
e	vapor pressure
R	gas constant for water vapor
L	latent heat of vaporization
C	degrees Celsius
SST	sea surface temperature

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I. INTRODUCTION

The accuracy of fog prediction in the Monterey area, as well as most other populated areas, has steadily improved over the past few years. This is a result of more experienced forecasters, readily available history over longer periods of time, a greater awareness of fog by everyone because of a dependence on flying as a major mode of transportation and research into the causes of fog and related weather. The dynamical and empirical methods for forecasting fog, plus the satellite observations which give the forecaster a broad overview of the current weather, have contributed to the forecasters' success.

Nevertheless, with all of these tools available, fog forecasters still aren't batting 1,000. With hopes of improving this average, this research examines the basic fog parameters over the Monterey Bay under varying conditions. Near vertical measurements of temperature, moisture and pressure in the fog layer over the Bay and nearby beaches over a wide range of weather conditions were required. To accomplish this task, an accurate inexpensive system was needed that could be used on short notice. Several such systems were tested in the scope of this study.

The above parameters, measured at known geographical locations, in addition to other known meteorological variables such as synoptic surface pressure, 500 mb pressure, sea-surface temperature and visibility, and the satellite data are used to describe the environmental conditions for a wide range of fog conditions.

The data collection period for this research began in October 1971 and ended in March 1972. As known from climatological data, this period is not the most favorable time for the type of weather conditions desired for this study. However, the collection period was determined strictly by the time allotted to thesis in the curriculum and could not be changed. Despite the lack of fog on a daily basis, as is the case in the late spring and early summer, measurements were taken over a fairly wide spectrum of conditions.

II. NATURE OF THE RESEARCH

A. DESCRIPTION OF MONTEREY BAY

The Monterey Bay as shown in Figure 3 is a large deep pool of relatively cold sea water as a result of the cold coastal currents that flow from the north. Previous studies also indicate a significant amount of upwelling in the bay which maintains the cool surface temperatures year round, (see Figure 33). The cool surface combined with the maritime northwesterly flow and local sea breeze produces fog almost continually during late spring and summer. The low dense stratus or "high fog" bank that parallels the California coast on most summer satellite photographs has a similar origin. This stratus or fog bank normally lies 10 to 20 miles offshore during the day and frequently moves in over the coast at night; however, during the stratus season, the fog may remain over the bay and adjacent coast for days and even weeks.

B. STRATUS TYPES AND CAUSES

In addition to the fog formed over the bay by the combination of cool surface temperature and warm air, other types of fog are found over the bay. During the summer, the Monterey Bay comes under the influence of two quasi-permanent pressure systems--the eastern lobe of the Pacific High and a thermal low centered over the southwestern United

States. Petterssen has shown that this thermal low exists only near the surface and with increasing altitude, the low vanishes and the Pacific High dominates. From this anti-cyclone, there is a lateral outflow and a resulting descending motion which warms the air adiabatically and reduces the relative humidity. The cool moist air below the inversion is usually referred to as the marine layer, and is of Pacific origin. In this marine layer below the inversion, stratus is formed. While advection is probably the single most important cause of fog, pre-frontal stratus and haze occur quite often during fall and early winter. Unlike the advection fog, prefrontal fog can be predicted based on frontal movement and strength.

Another type of fog forms out over the bay after one or more days of warm, dry easterly wind. The warm, dry air moves out over the bay and absorbs large amounts of moisture. This moist air is then cooled by the relatively cold water surface and forms mist or fog which is then carried inland by the sea breeze.

C. RESEARCH GOALS

1. To collect a significant number of vertical profiles of fog parameters over the Monterey Bay

2. To determine the least expensive, most accurate and convenient method of collecting this data.

3. To compile and present the data in an easily understood format, convenient for future analysis.

4. To use the data in conjunction with the general synoptic conditions at the surface and 500 mb level to present ideas and conclusions concerning the fog over the Monterey Bay.

III. EXPERIMENTAL PROCEDURES

A. DESCRIPTION OF EQUIPMENT

1. The Wiresonde

The AN/AMQ-3, or wiresonde, is built by Bendix Aviation Corporation and was approved and accepted by Buships in December 1949. The Wiresonde system is shown in Figures 40 and 41.

The wiresonde is a portable, manually operated system for measuring temperature and relative humidity in the lower atmosphere. The system was designed for use aboard a large ship with either a balloon or kite, but was adapted for use with the kytoon aboard a 40-foot Coast Guard boat.

Temperature and humidity are sensed by a thermal resistor and an electrolytic hygrometer which are in the small airborne package carried aloft by the kytoon. The kytoon is attached to a manually operated winch by a 3000-foot reinforced kite cord. Real time readings are available from dials connected to Wheatstone Bridge circuits of the temperature-humidity bridge. The dial readings must be converted to temperature and relative humidity using charts available with the wiresonde set. The complete system can be broken down into three different units. These units are: the airborne instrument package called the wiresonde, the cable reel which is a manually operated winch with 3000 feet of cable attached to the kytoon and the temperature-humidity bridge which is a manually adjusted instrument that measures temperature and humidity.

2. <u>The Kytoon</u>

Since one of the primary requirements was to collect the data in as near a vertical profile as possible, a kytoon (Figure 43) was used to lift the wiresonde. The kytoon is aerodynamically designed to resist horizontal displacement by the wind. It will give a near vertical data profile during calm to light wind conditions. The kytoon has a volume of 115 cubic feet and is 10.6 feet in length by 5 feet in width. It should be inflated with helium in a large protected area. Each normal size tank of helium will inflate two kytoons.

A completely inflated kytoon will lift 2.6 pounds in calm air and according to the manufacturer up to 46 pounds in 50 MPH winds. However, as the winds increase, the successive readings in the vertical become more displaced horizontally. The wiresonde is very light in weight; however, the maximum altitude is limited by the wind and the wiresonde line used to anchor the kytoon.

Collecting data in a vertical profile under any except controlled conditions requires a maneuverable platform that resists displacement by the wind. Two obvious choices are the kytoon and the helicopter, both of which require prior approval from the FAA to fly.

The kytoon is considered a moored balloon and is governed by Federal Aviation Regulation Volume VI, Part 101.

These regulations require a waiver for any moored balloons larger than 115 cubic feet.

This waiver prohibits operating a moored balloon:

a. within 500 feet of the base of any cloud,

b. more than 500 feet above the surface of the earth,

c. from an area where the ground visibility is less than three miles, or

d. within 5 miles of the boundary of any airport.

In addition, the regulations require the following information 24 hours prior to the operation:

a. name and address of the operator,

b. size and weight of the balloon,

c. the location of the operation,

d. height above the surface of the earth at which the balloon is to be operated,

e. date and exact time of operation.

Finally, the balloon must be moored on a line that has attached pennants every 50 feet and it must have a device that will automatically deflate the balloon if it escapes from its moorings.

These regulations resisted all attempts to use the kytoon to raise and lower the instrument package. The decision was made to limit the kytoon to less than 115 cubic feet, which only requires an informal agreement with the FAA personnel and notification of the FAA office prior to launch.

Two possibilities existed for providing a platform to launch the kytoon over Monterey Bay. The Naval Postgraduate School has a small boat that is available for this type of operation; however, the boat must be scheduled 15 days in advance, which makes coordination with fog almost impossible. The second alternative is a small Coast Guard boat operated within the bay for search and rescue. Arrangements were made with the local Coast Guard Commander to use the boat on a time-sharing basis with the search and rescue requirements. The boat crew requires one day notice and they are available for a half-day operation any time unless a search and rescue operation is in progress. Should this occur during an operation, the boat will proceed directly to the search and rescue area.

3. The Helicopter Aerograph Set

Initial work with the helicopter aerograph set or the AMQ-18 at NPS as a possible tool for collecting temperature, pressure and moisture data began in the summer of 1970. Lieutenant Commander Rodney Whalen adapted the AMQ-18 to the H-34 helicopter which is used for search and rescue at NALF, & training at the NPS. During the following year, LCDR Whalen overcame power supply problems, dangerous aerodynamic characteristics and many other smaller problems and pronounced the AMQ-18 eighty percent operational.

With the addition of an AT petty officer to the meteorology staff at NPS, the AMQ-18 has become fully operational and averages about 60 to 75 percent reliability.

The Aerograph Set is a streamlined package containing 50 feet of cable, a cable winch, pressure sensing bellows, and a temperature/humidity vortex tube sensor, shown in Figure 41. A fan forces air through the vortex tube at high velocities. Condensed water, if present, is forced to the outside walls of the tube away from the temperature sensor eliminating the wet-bulb effect, and preventing the washing of the electrolyte from the humidity sensor.

The tolerance limits specified by the manufacturer are:

Temperature: $\pm$ 0.5°C

Relative Humidity: $\pm$ 6%

Pressure: $\pm$ MB

The aerograph set transmits data to an Indicator Recorder (I-A) (AN/AMA-2) within the aircraft cabin by an electro-mechanical servo system. The I-A unit gives a continuous display of measured parameters and additionally prints the reading every eight seconds.

B. EMPLOYMENT OF EQUIPMENT

1. Employment of the Wiresonde

The first flight of the wiresonde using the kytoon was scheduled October 1, 1971. (Most flights were scheduled on Friday due to availability of NPS and Coast Guard support personnel.)

All required equipment was picked up at the NPS and transported to the Coast Guard pier using a Navy truck. The equipment was set up and checked prior to the 0800 departure of the boat. After a one-hour delay due to an overheating engine, the boat proceeded to Alpha buoy which was to be the first launch site.

Due to the very heavy fog with near zero visibility and weak radar, another hour was lost searching for the buoy. After failing to locate the buoy, it was decided to fix the boat's position by radio bearings and launch the kytoon while steaming in a tight circle at five knots. In preparing the kytoon for launch, the nozzle of the blatter inside the nylon cover of the kytoon blew off and ended the operation at that point.

After a close look at the handling procedures and a discussion with a technical representative of the kytoon manufactor, new blatters were ordered and a second operation was scheduled.

There was only a slight haze over the bay for the second operation; however, the operation proceeded smoothly until the kytoon reached approximately 440 feet. At this point, the lifting capacity of the kytoon was exhausted and the cable went limp.

In an effort to get more height from the kytoon, the boat was headed into the wind at approximately 12 knots. Instead of creating more lift and a higher altitude, the vertical profile was completely lost as the kytoon drifted farther and farther behind the boat with no increase in altitude.

Two sets of readings were taken up to 440 feet and since they were very similar, operation was discontinued.

2. The Radiosonde

Due to the limited lift available from the kytoon, a second method was tried using a radiosonde launched from the Coast Guard boat in the harbor and NPS tracking system located on the roof of Spanagel Hall.

By acquiring the radiosonde signal prior to launch and choosing a launch time when the low level winds were small, it was felt that a good vertical data profile could be obtained.

Direct communication with the Monterey Airport was necessary before the radiosonde could be released. This was done by using two walkie-talkies on loan from the security department and a phone line to the Monterey tower.

The first operation was scheduled on a cloudy day with light wind and occasional light rain. The radiosonde was base line checked in the meteorology laboratory and loaded on the boat. The boat then proceeded to a prearranged site that was visible to the receiver operator at Spanagel Hall and the 300-gram balloon was inflated. The radiosonde transmitter was then turned on in an effort to pick up the signal prior to release. Even though the transmitter was visible and only about two miles away, the signal could not be received at all. A check of the radiosonde revealed a broken temperature resistor caused by rough seas and whipping of the balloon during the inflating. Even though good data would not be forthcoming, the decision was made to release the radiosonde in order to evaluate the operation as a means of collecting vertical profile data.

The signal was initially picked up 35 seconds after release of the radiosonde and lock on was obtained 45 seconds after lift off. By that time, the balloon was above 900 feet and had encountered a strong west wind which carried it over the beach toward Fort Ord.

Due to the large cost of such launches plus the low probability of getting data below 1000 feet or even good data in a vertical profile above 1000 feet, the decision was made to use the AMQ-18 and a helicopter as a means of further data collection.

3. The AMQ-18

The AMQ-18 had been adapted to operate with the H-34 helicopter at NALF. The helicopters are normally scheduled to fly at 0800, 1300, and 1800. The flights are used as proficiency training for the pilots and can normally be scheduled any day.

Recent moves by the Navy indicate the H-34 will not be available at NALF in the future. This will mean going to the Army at Fort Ord or to other Navy bases for helicopter support. It may also require adapting the AMQ-18 to a different type of helicopter.

The fl ts were scheduled one day prior to the flight with NALF schedules and if possible, the pilot was briefed the day prior to the flight in order to prevent any conflict with other planned activities on the flight.

Two hours prior to take off, the AMQ-18 was installed on the helicopter and checked with ground power. The AMQ-18 pod was designed to be attached to the helicopter using its winch and other permanent structures of the aircraft. Cables were then used to connect the sensors in the pod to the read-out equipment which is strapped down inside the helicopter. The pod must also be connected to the 28-volt power supply of the aircraft.

The most critical part of installing the AMQ-18 is replacing the relative humidity element, which must be done prior to each flight. A special tool is required for this purpose and care must be taken to insure that it is correctly installed. Two operations were cancelled because of broken or improperly installed elements.

After the helicopter has been started and is supplying its own electrical power, the pod should be checked again. Also, prior to take-off, the station pressure and AMQ-18 readings of pressure, temperature, and relative humidity were recorded. The exact location where these surface readings were taken was also recorded since the elevation of the field varies over 100 feet and this elevation correction was used to get an accurate instrument correction.

The routine for collecting the data varied depending on the type of flight plan required for the helicopter, local air traffic over the bay and local weather. Ideally, the helicopter would proceed to the heaviest concentration of fog over the bay and make a slow tight orbital climb from 200 feet to 2000 feet. Readings were taken approximately every 100 feet. The procedure would then be repeated several times in areas of different fog concentration over the bay.

The helicopter was always under control of Monterey Airport tower, and due to the heavy traffic over the bay, was limited to short flights within assigned areas. During the data collection, visual estimates of sea state and visibility were recorded.

C. DATA REDUCTION

The data reduction for the wiresonde was very simple. Temperature and moisture dial readings were converted directly to temperature in degrees Celsius and percent relative humidity respectively. Pressure calculations were made by using the surface pressure and the conversion ratio of 7.5 meters per millibar. The temperature readings were cross checked with a hand-held thermometer and the relative humidity was checked by measuring the wet and dry-bulb temperatures and computing the relative humidity.

The pressure readings were usually in error, requiring a correction to all readings. This correction was computed using an AMQ-18 reading on the runway, the runway altimeter and height of the runway.

1. Pressure Calibration Correction

Runway height is 164 feet or 50 meters at take off location.

PS is station pressure in mb.

PI is instrument reading in mb.

Each mb of pressure is equivalent to approximately 7.5 meters of altitude.

Pressure Correction = PS - (PI - 50/7.5)

2. Saturated Vapor Pressure

The saturated vapor pressure e_s can be read directly from a thermodynamic diagram or computed by the following formula.

$e_s = 6.11\ e\ A(1/T_o - 1/T)$

A = L/R or the latent heat of vaporization divided by the gas constant for water vapor.

$T_o = 273^o$ Kelvin

T = temperature in degrees Kelvin

3. Saturated Mixing Ratio

The saturated mixing ratio m_s can read directly from a thermodynamic diagram or computed by the following formula:

$m_s = (.622\ e_s)/(p - e_s)$

p is the atmosphere pressure.

4. Mixing Ratio

The mixing ratio m was computed by the following formula.

$m = (m_s)(RH)(100)$

RH is the relative humidity read directly from the AMQ-18 or the wiresonde.

IV. PRESENTATION OF DATA

The data available for comparison are pressure, temperature and mixing ratio from 200 feet to 2000 feet, synoptic maps at 500 mb and at the surface, the Oakland radiosonde sounding, surface data at KALF ~~and subjective estimates~~ of visibility.

Vertical cross sections of temperature and mixing ratio were used to display the data. In addition, tables were compiled for each day which compare water temperature, inversion height and thickness, surface pressure, time and position of readings and surface visibility.

The data were recorded in 100 feet intervals in an attempt to present a very fine structured profile in the fog layer. This is in contrast to the Oakland sounding which is normally used when forecasting fog in the Monterey area.

A. DATA COLLECTED OCTOBER 15, 1971

This data was collected just prior to a weak frontal passage. The surface front was associated with a 500 mb trough. No precipitation was forecast; however, the visibility was estimated to be 6-8 miles with light haze and the wind was about 5 knots from the west with two-foot waves.

Both profiles, Figures 1 and 2, were limited to 440 feet altitude by the lifting capacity of the kytoon; however, a very slight but definite inversion appeared in both profiles near the 1000-mb layer. The mixing ratio decreased slightly just above this inversion in the first profile; however, it fluctuated one gram per kilogram within the 400 foot layer on the second profile. The beginning of a stronger inversion is noted at the top of both soundings.

B. DATA COLLECTED NOVEMBER 19, 1971

This sounding follows a typical profile for this area during late fall and early winter. It has a weak inversion about 15 mb thick at the 995 mb level and a slight positive lapse rate upward to the top of the sounding. With the exception of a very slight increase at the top of the inversion, the mixing ratio was very stable throughout the layer.

C. DATA COLLECTED NOVEMBER 24, 1971

The local area is under the influence of a surface front 200 miles to the north and an associated 500 mb trough. The visibility, estimated subjectively, ranged from one-half to one mile with light fog. The visibility was approximately one mile near the beach and decreased progressively to the west. Northward, the Oakland sounding indicates a high moisture content at low levels, but a rapid decrease above 850 mb.

The temperature and moisture traces for the first profile shown in Figure 12, are very similar; that is, the mixing ratio varies directly with temperature. In general, the temperature increases with height, but two inversions are noted in this profile with bases at 1002 mb and 972 mb. In each case, the mixing ratio increased within the inversion layer.

Profile number two, shown in Figure 13, is closer to saturation as suggested by the lower visibility; however, it follows the pattern of profile number one. The inversion in profile number one almost disappears in a four-mb layer at 960 mb. In contrast, at the same level, the temperature gradient merely decreases in the second profile. In addition, the second profile has a single, much thicker inversion instead of two thin ones. Several variations from the first two profiles are noted in the third profile shown in Figure 14. The third sounding is only five miles north of the second and yet the lower layer temperatures are less and the upper layer temperatures are higher, resulting in an even stronger inversion. The air is saturated over much of the lower inversion and approaches saturation in the upper inversion. The fluctuation in the temperature has completely disappeared in the upper inversion.

A comparison of the three profiles taken on a nine-mile triangle shows that large changes can occur over a very short distance.

Profiles one and three show two inversions, while profile number two has a much thicker inversion with fewer lapse rate changes within the inversion layer. All profiles have colder temperatures in the lower layers where saturation has occurred. As a result of these colder temperatures, a steep lapse rate exists near the top of the saturated layer.

D. DATA COLLECTED DECEMBER 1, 1971

The visibility conditions over Monterey Bay varied from moderate to slight haze with a slight sea breeze. There had been coastal fog earlier,-but most of it had burned off by operation time.

With the exception of a slight inversion at 990 mb, the first sounding, shown in Figure 19, has a stable lapse rate throughout the layer and the mixing ratio decreases directly with the temperature and the altitude. The second sounding, shown in Figure 20, was also taken just off the beach about five miles from sounding number one. These soundings are very similar, the only difference being the higher mixing ratio of the second sounding near the surface.

The helicopter moved about 15 miles out over the bay for the third sounding, shown in Figure 21, and the stable lapse rate had almost disappeared. A thin but strong inversion appeared at 995 mb and ended suddenly at 980 mb. A second small inversion also appeared at 975 mb. The mixing ratio decreased continuously through the lower inversion but increased markedly at the second smaller inversion before beginning to decrease at a slow stable rate near the top of the sounding.

Sounding number four, shown in Figure 22, was taken even farther out in the bay. Unexpectedly, the temperature is warmer throughout the layer and the inversion is lower, at least down to 1000 mb and possibly lower. The mixing ratio has become stable again with a slight decreasing value upward through the layer.

The fifth sounding, shown in Figure 23, is north of the fourth sounding and also about 20 miles from the beach. The temperature through the sounding has increased slightly and the inversion has been reduced to a slight negative lapse rate about three-mb thick at 992 mb. The mixing ratio again has a lapse rate with an unexplained change to steep negative at 965 mb through a five-mb layer and then a return to a positive lapse rate.

E. DATA COLLECTED JANUARY 8, 1972

Four soundings were taken; two were approximately one mile from the beach west of Fort Ord and the other two were taken eight miles inland directly east of the first two soundings.

The first profile, shown in Figure 28, has a weak inversion near the surface and a strong inversion beginning at 980 mb. Visual conditions were broken with patches of fog at ground level. Bases of low level clouds were 1200 to 1400 feet. The moisture content varied directly with the temperature. There was a marked increase in mixing ratio in the layer where the inversion occurred.

The second profile covered less altitude, and had only one detectable inversion at 985 mb. In this case, the mixing ratio shows a marked decrease at the inversion base and a slight negative lapse rate approximately eight mb thick within the inversion. Above the isothermal layer the temperature again begins to increase and the mixing ratio decreases.

If the isothermal layer is included, the inversion layer starts at 985 mb and continues to the top of the sounding. Within this layer, the mixing ratio varied over a wide range and had three very abrupt changes. This may be explained by the broken cloud conditions at operation time. The helicopter was in and out of clouds during this run.

Even though the third sounding was only eight miles from the first soundings, its character is completely different. There is a slight inversion near the surface and a small decrease in temperature and moisture up to 975 mb, where the temperature decreases two degrees very abruptly and then becomes isothermal at a level where the mixing ratio remains constant at 6.85 gm/kg.

The fourth sounding is also inland and east of the first two soundings and is a repeat of the third sounding.

The soundings over the bay and inland had a definite inversion at low levels; however, the inversion had disappeared up to the 950 mb level on both inland soundings.

The mixing ratio increased directly with temperature in some instances and decreased with temperature increases at other times. No change in mixing rates was noted upon entering the cloud layers in run number one; however, abrupt changes were noted during run number two.

V. RESULTS

A. DISCUSSION

The Oakland soundings are included to show the broad picture of the vertical structure of the atmosphere. In contrast, the data gathered in this study magnifies the lower layer of the atmosphere many times. Instead of a moderate lapse rate with one or more inversions, one finds small isothermal layers, many lesser fluctuations in the lapse rate and several degrees of positive lapse rate that would not show up in a normal sounding.

No correlation could be found between the inversion height and thickness and the amount of fog present. The height of the inversion varied from 150 feet to 1200 feet during clear weather and averaged 500 to 700 feet with one reading at 1200 feet during periods of fog.

The SST varied about 2.5 C over the four-month data gathering period. As shown by the SST charts, the SST is very stable and only decreased about three degrees from fall until late winter. While SST is a factor in the formation of fog, it is felt that it isn't a variable parameter that determines the occurrence of fog from day to day.

Two of the profiles taken in November are interesting in that the humidity is less than 100 percent above and below the strong inversion at 500 feet but the layer within the inversion is saturated. The one profile taken nearer the coast has no saturation points at all. This is probably a result of the heating effect along the coast. Also, a second inversion is shown on the first profile that has a marked increase in moisture.

In profiles where fog is present, there is a marked increase in mixing ratio at the inversion base. On the other hand, in profiles where no fog is present, there is a marked decrease of mixing ratio within the inversion. One very obvious exception to this is the second profile on January 8. Here, a large decrease in the mixing ratio occurs within the inversion. As would be expected from physical considerations, no fog occurred within the inversion. Fog was observed, however, below the inversion.

In most of the profiles, the surface values of mixing ratio and temperature do not blend in with the upper level readings. The cause of this possibly lies to some degree in the time difference between recording the surface data and the vertical profile data, normally one to two hours.

It is interesting to note that the fluctuations, very apparent in the fine detail of all the profiles over water, are almost nonexistent in the profiles over land. Turbulent mixing over the land would tend to remove the fine structure temperature variations in the vertical.

In an effort to relate the small variations of the many parameters associated with fog to the occurrence of fog, numerical values were assigned to the various descriptive terms used to identify these parameters, as shown in Table

1. The sum of these numerical substitutes in each vertical profile gives an indication of the probability of fog. Table 3 compares these numerical values on clear days and on days with fog or haze. No fog was observed near any profile with a fog index of 20 or less. Patches of fog or haze were observed near profiles with an index of 24-27 and fog was observed at profiles with an index of 30 or more.

Many more samples of data must be observed before any firm conclusion can be drawn; however, these few comparisons indicate that small variations in fog parameters can be associated with the occurrence of fog.

The size of the sample examined here is quite limited; consequently, further study may show that some of the parameters may have little correlation with the occurrence of fog. On the other hand, some newly-discovered parameters may prove even more useful in forecasting fog.

B. CONCLUSIONS

There are many small scale fluctuations in the fine structure of the lower layers of the atmosphere that affect the formation of fog in small localized areas.

The data indicate a close relationship between the inversion layer and fog formation; for example, fog formation occurred at the base of the inversion on four different profiles.

Evidently, fog is not triggered by a large change in one of its associated parameters, but rather by very small changes in one or several of these parameters. These small changes may be local and shortlived resulting in limited fog, or they may be of synoptic scale and result in widespread fog.

Large areas in which fog is prevalent can normally be predicted from the daily upper soundings now available; however, more knowledge and data on a finer scale appears to be necessary to predict fog accurately on a local basis.

C. RECOMMENDATIONS FOR FUTURE INVESTIGATIONS

Additional fog studies of this type should be conducted during late spring and summer, which is the foggy season for the Monterey Bay.

Since the helicopter is limited in its capability during periods of dense fog and in areas of heavy air traffic, and the small kytoon is limited to about 450 feet of altitude, a waiver should be obtained from the FAA for the use of the large kytoon. While the large kytoon will be harder to handle and will require more helium, it has no altitude limitation as far as this type of study is concerned. With proper storage, the large kytoon could be used several times without the need to deflate it between operations.

It is suggested that a series of data be collected in conjunction with SST measurement in the bay in order to determine its effect on the formation of fog.

Additional studies using the fog index should use a more accurate means of determining the visibility due to the difficulty of subjectively estimating the visibility, as evidenced by the large variations that occur when two or more individuals are making the estimate.

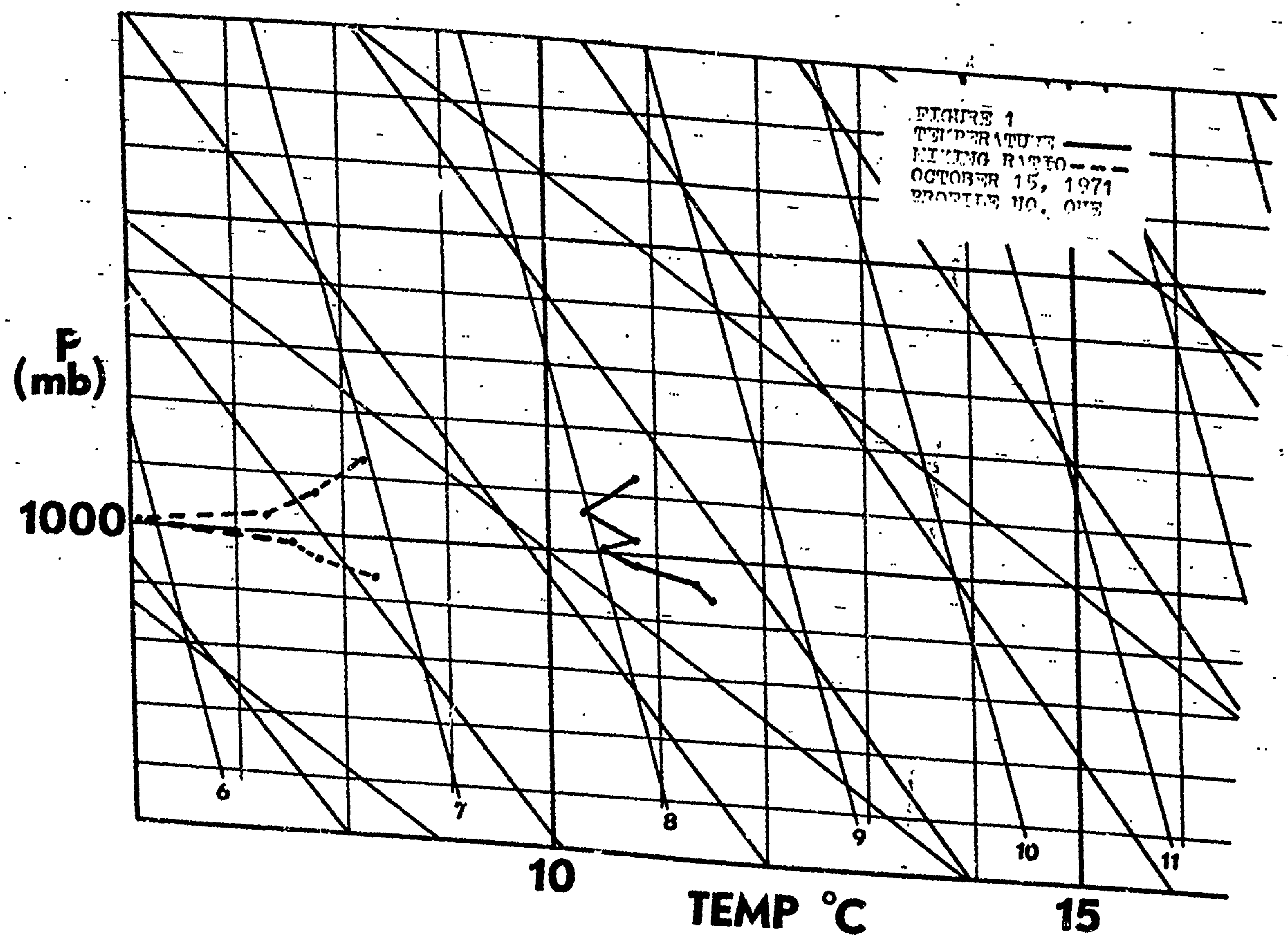
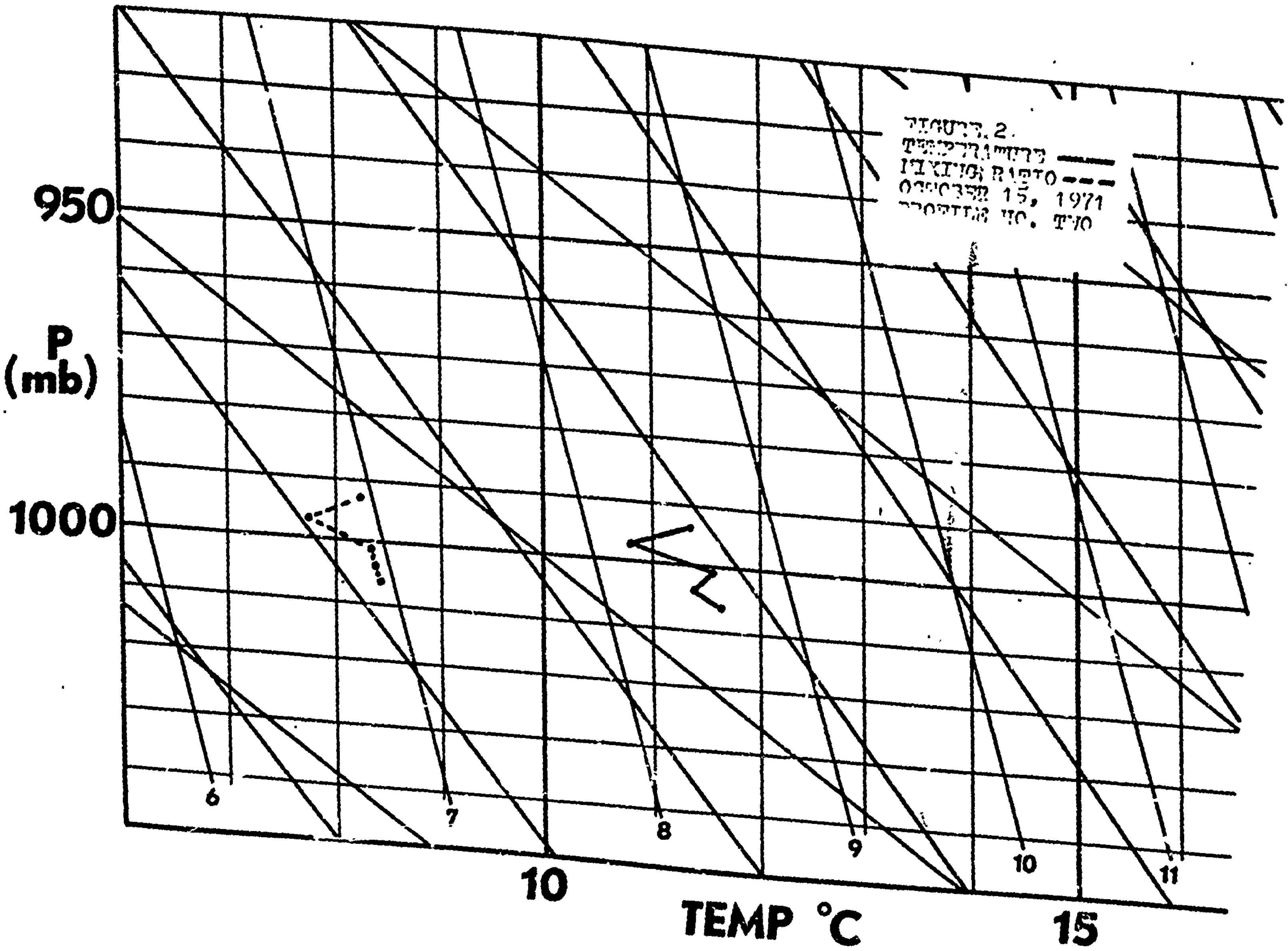


FIGURE 1
TEMPERATURE
MIXING RATIO
OCTOBER 15, 1971
PROFILE NO. ONE
P
(mb)
1000
6
7
8
9
10
11
10
TEMP °C
15


15, 1971
950
P
(mb)
1000
6
7
8
9
10
11
10
15
TEMP °C

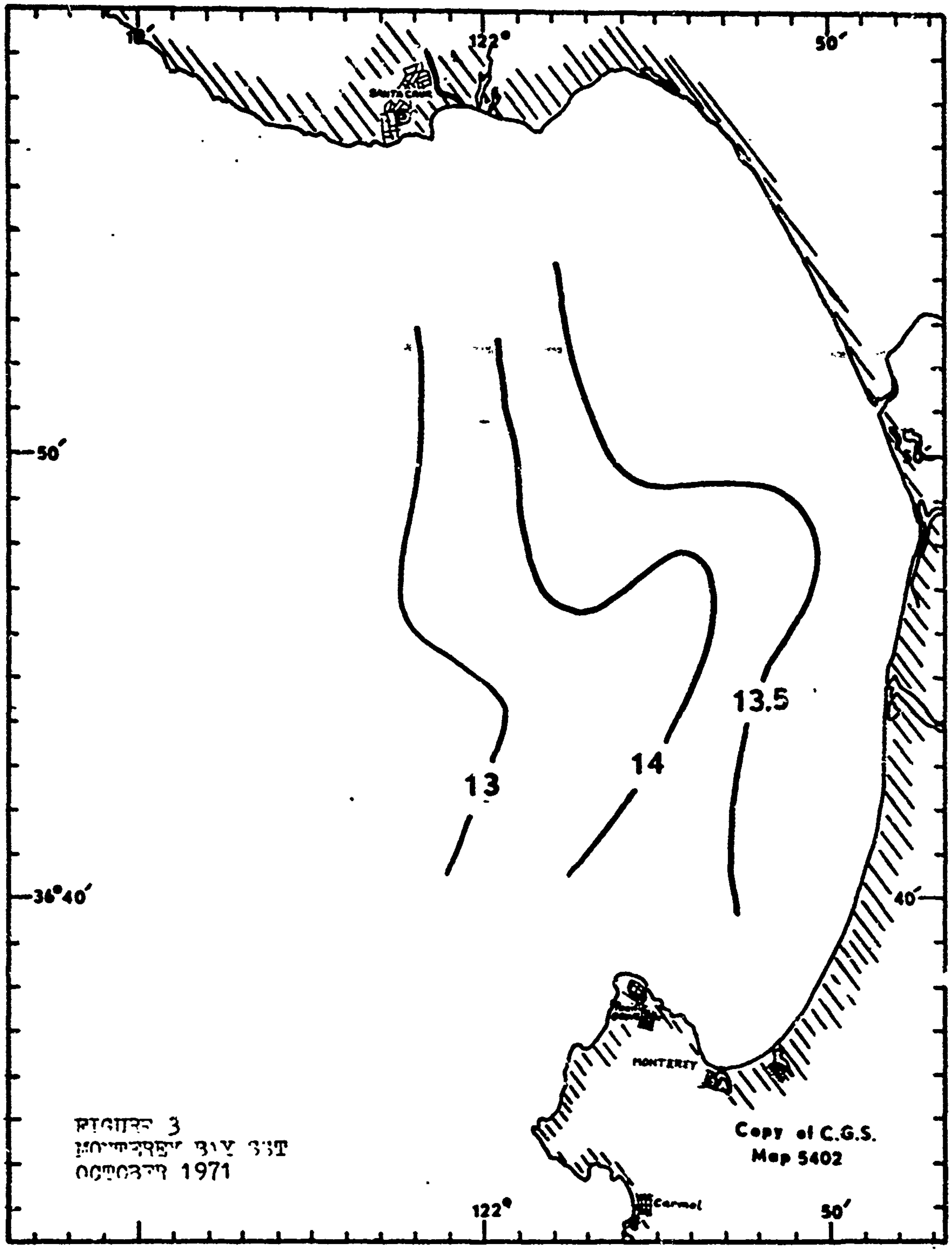


FIGURE 3
MONTEREY BAY SST
OCTOBER 1971

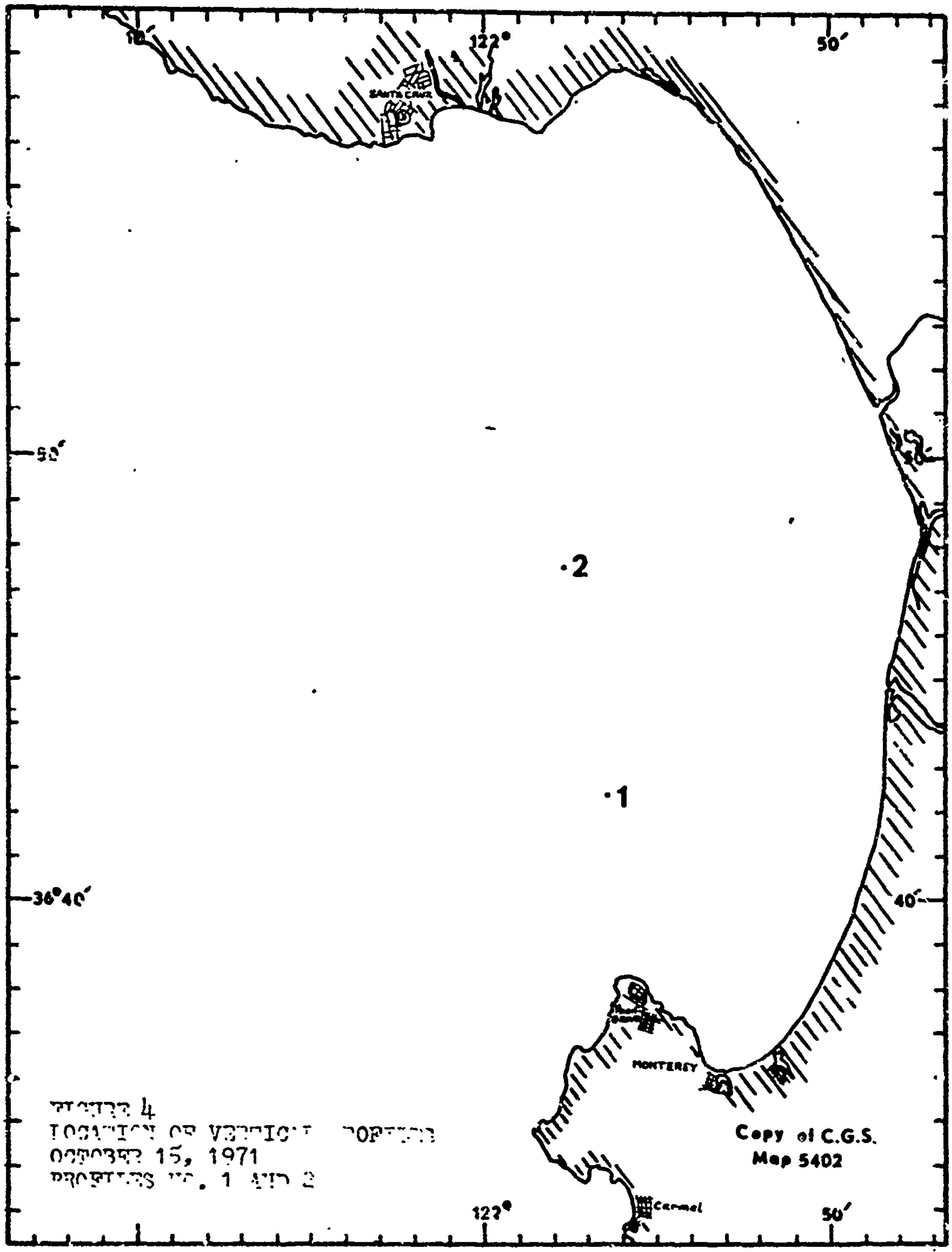


FIGURE 4
LOCATION OF VERTICAL PROFILES
OCTOBER 15, 1971
PROFILES NO. 1 AND 2

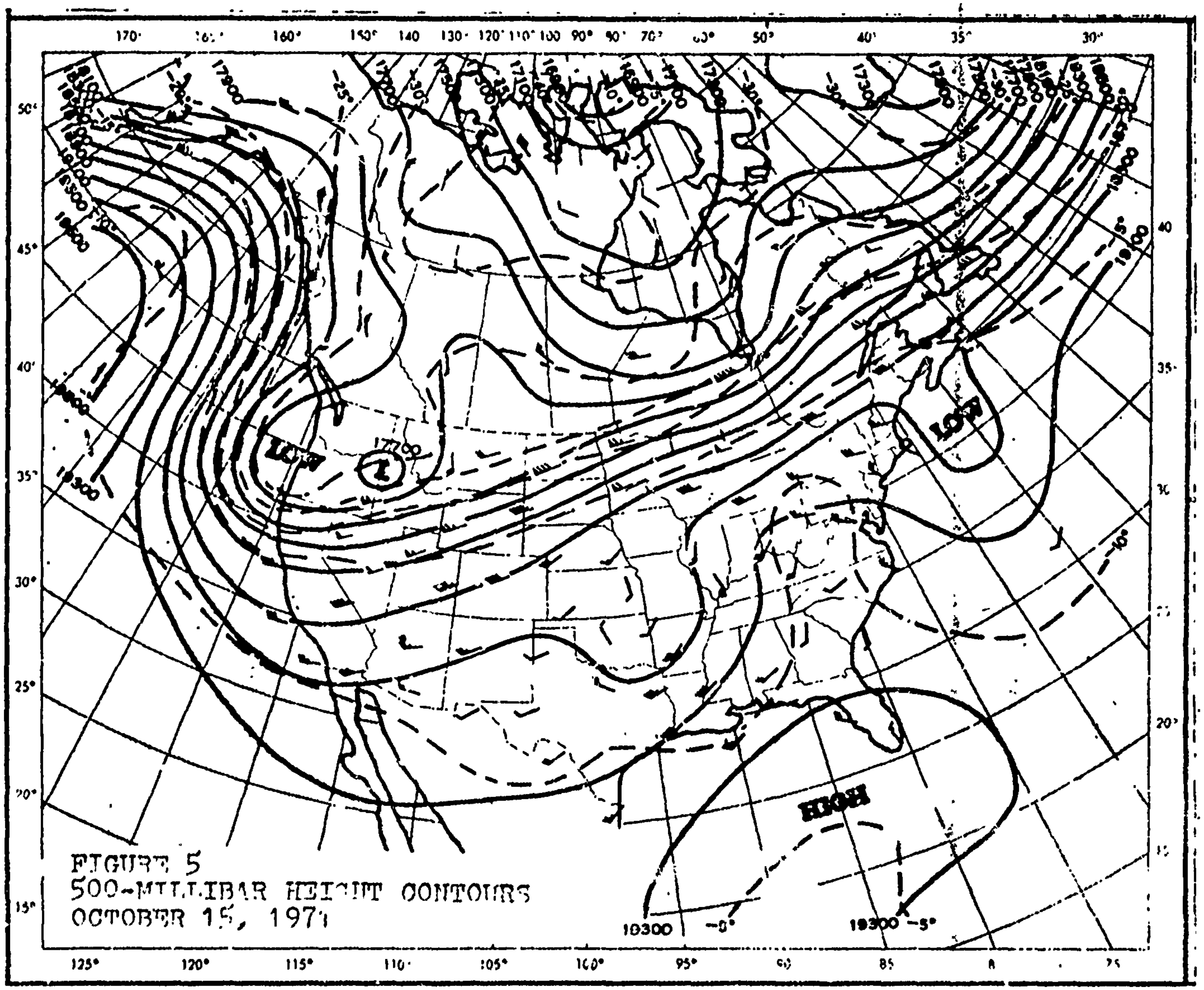


FIGURE 5
500-MILLIBAR HEIGHT CONTOURS
OCTOBER 15, 1971

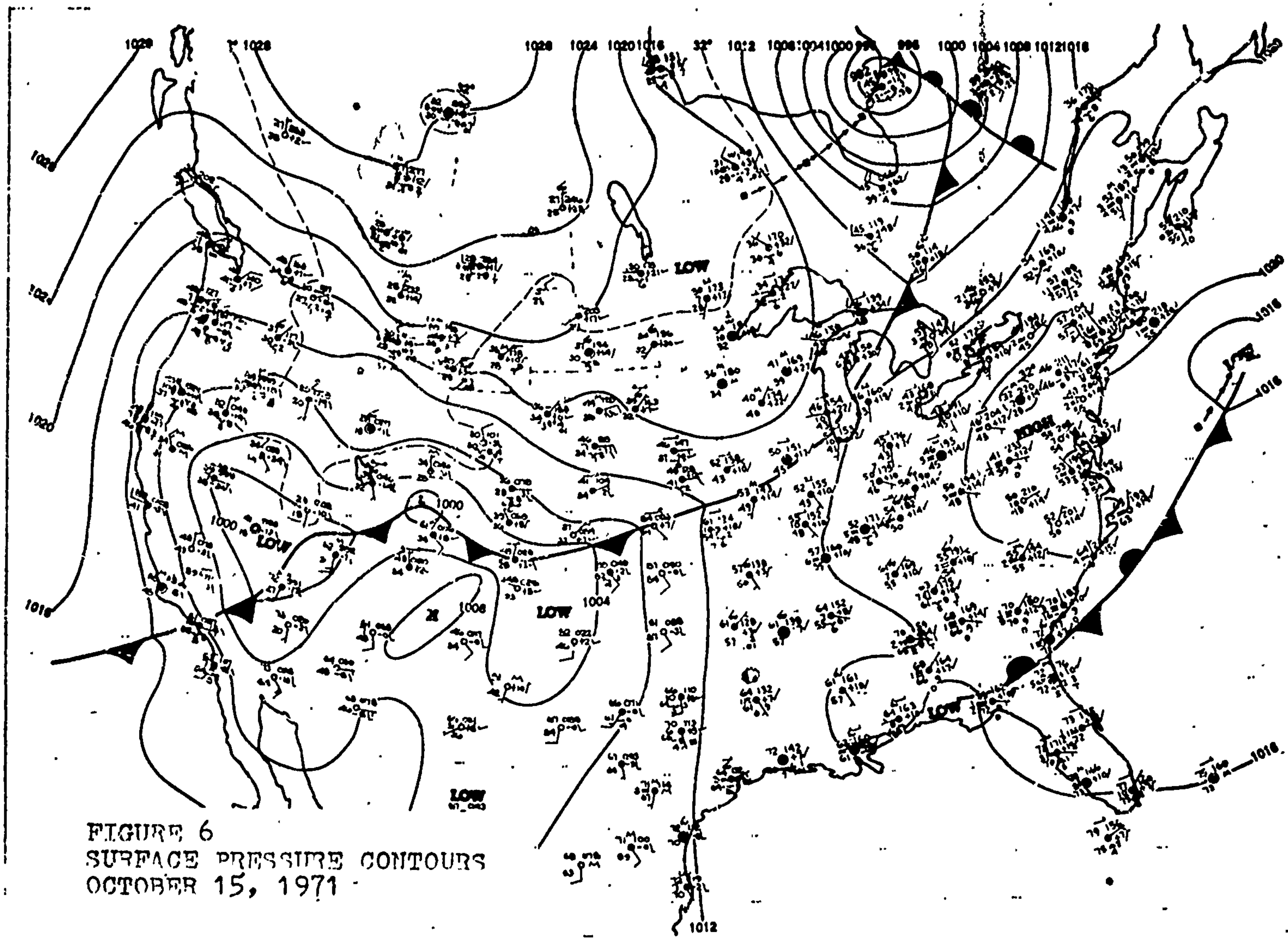


FIGURE 6
SURFACE PRESSURE CONTOURS
OCTOBER 15, 1971

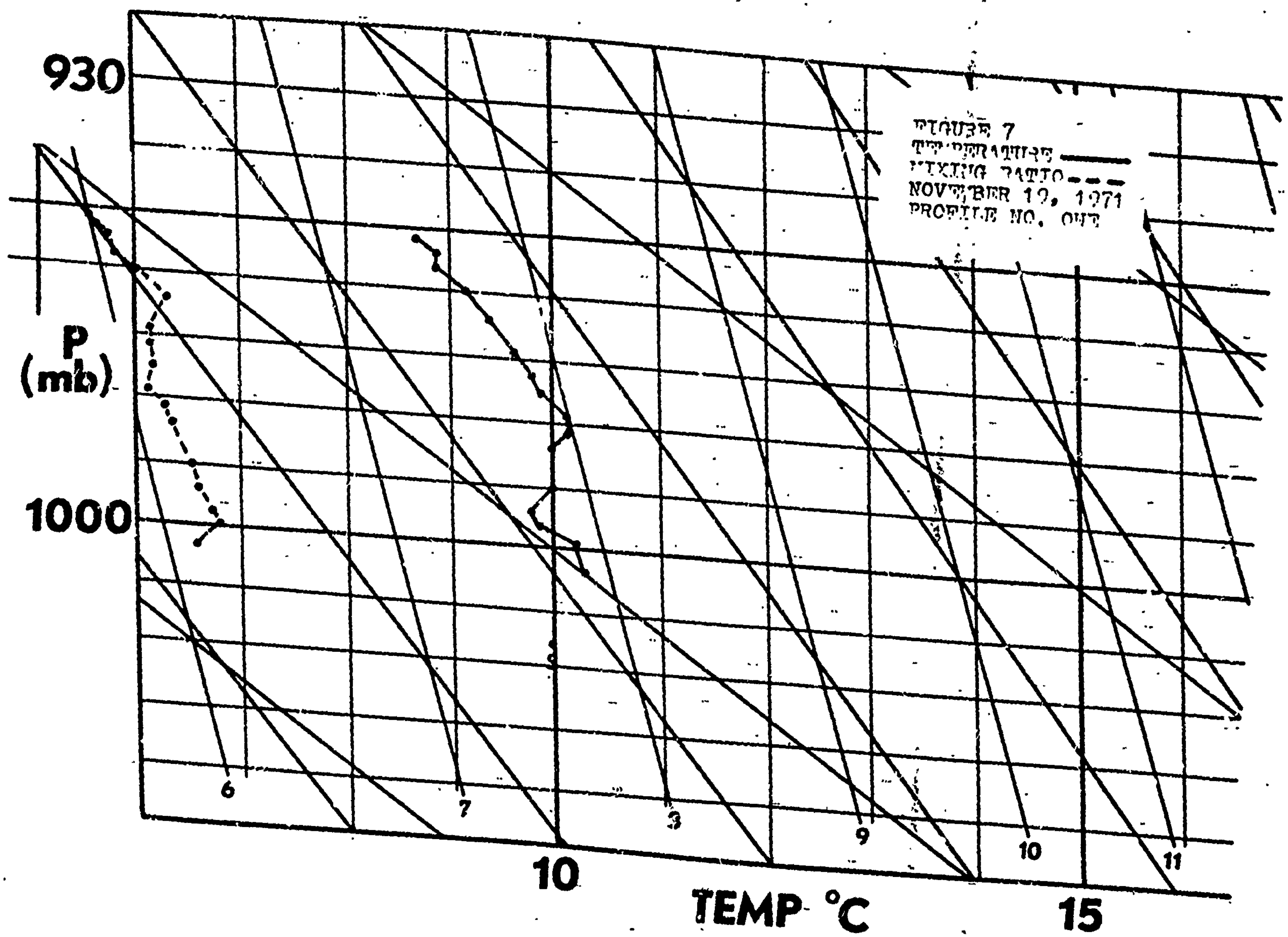


FIGURE 7
TEMPERATURE
MIXING RATIO
PROFILE NO. ONE
930
1000
P
(mb)
6
7
8
9
10
11
10
15
TEMP °C

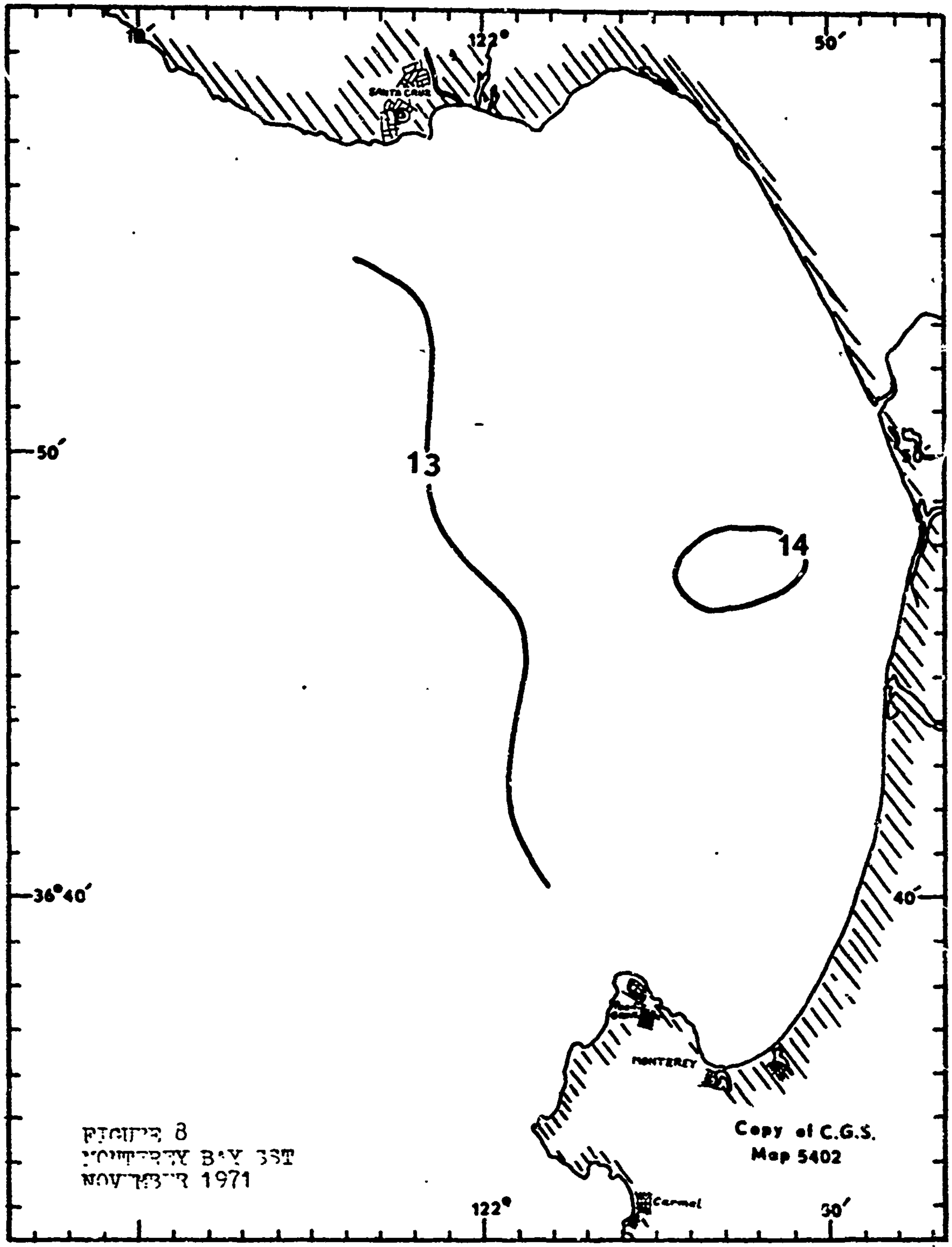


FIGURE 8
MONTEREY BAY SST
NOVEMBER 1971

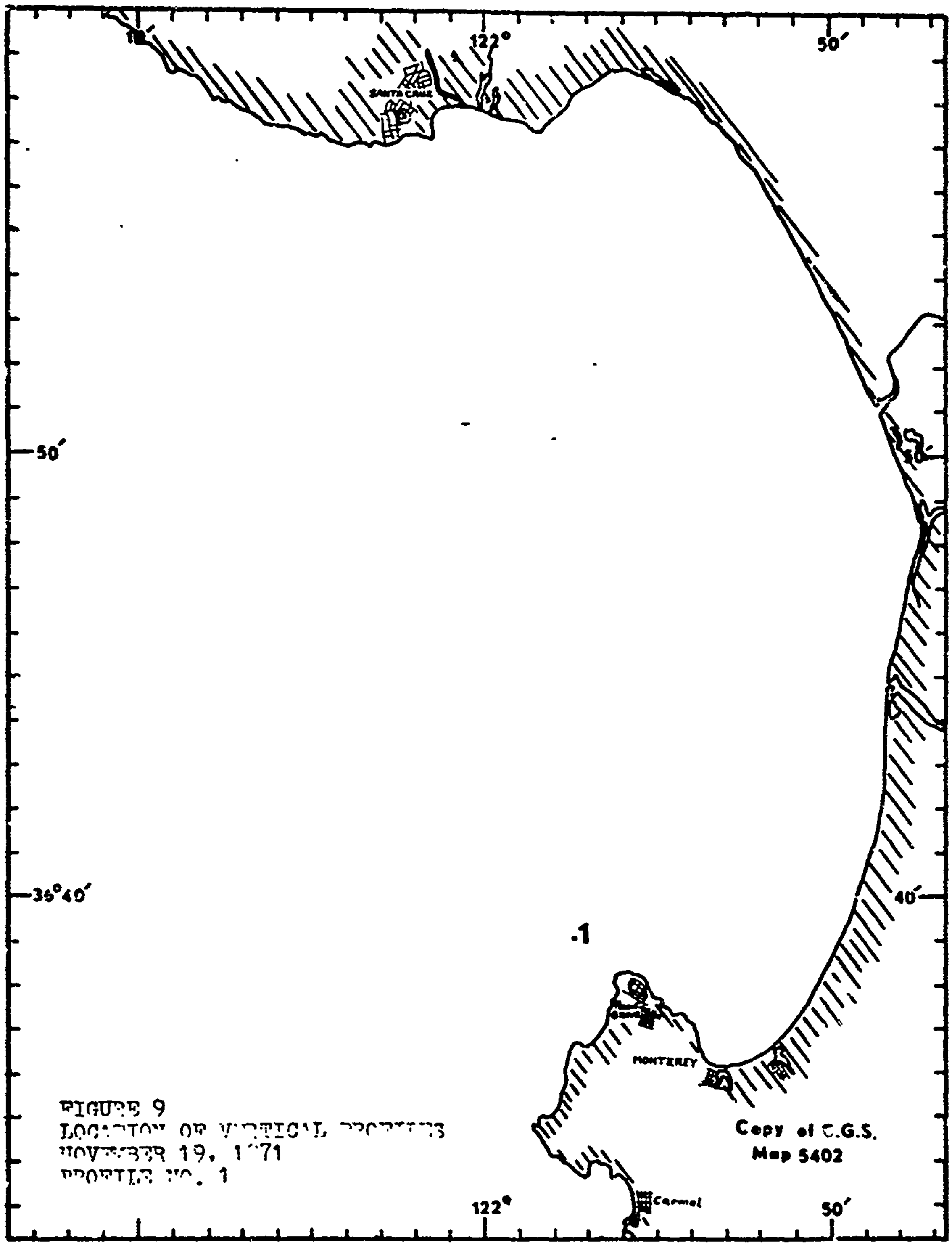


FIGURE 9
LOCATION OF VERTICAL PROFILES
NOVEMBER 19, 1971
PROFILE NO. 1

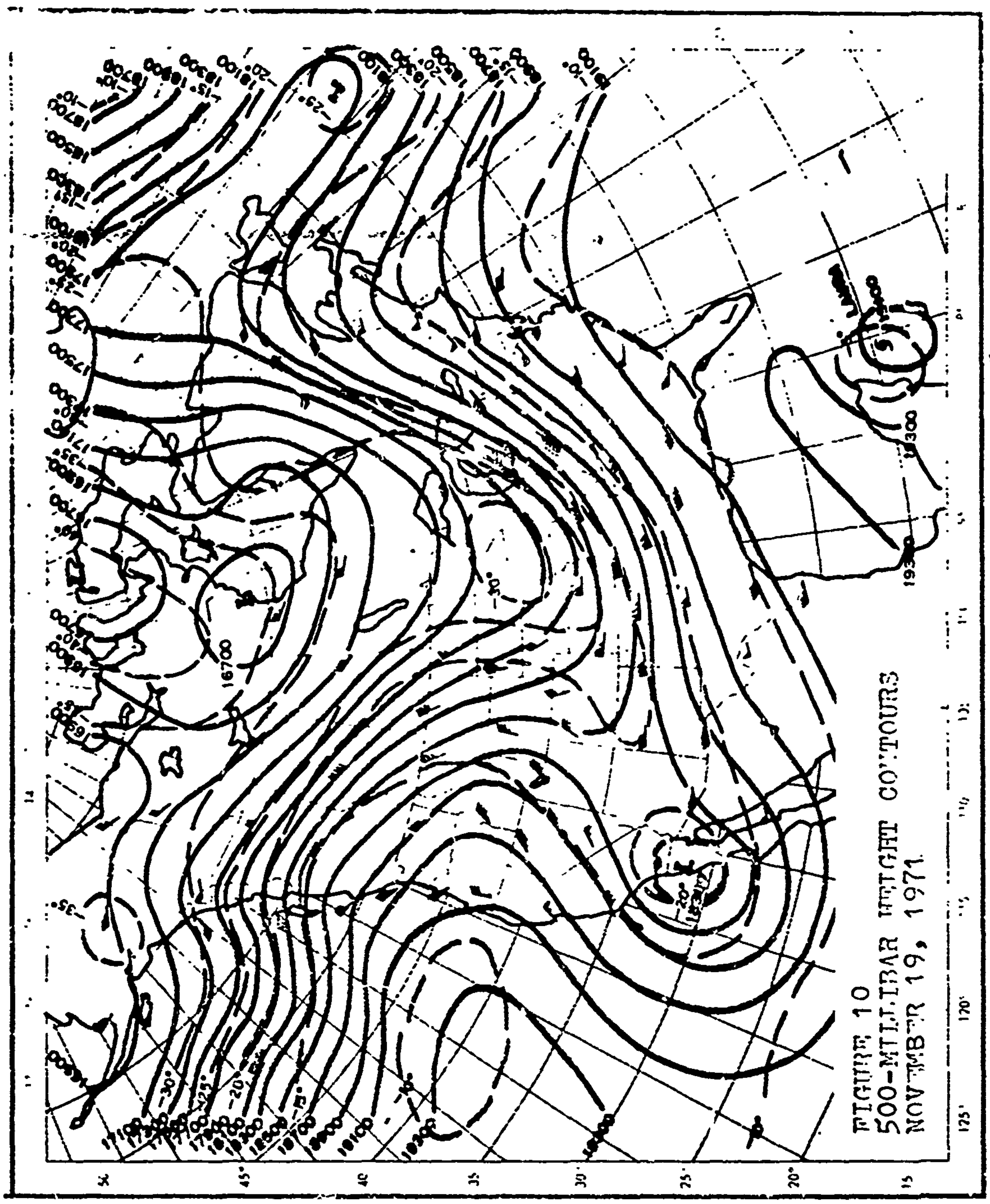


FIGURE 10
500-MILLIBAR HEIGHT CONTOURS
NOVEMBER 19, 1971

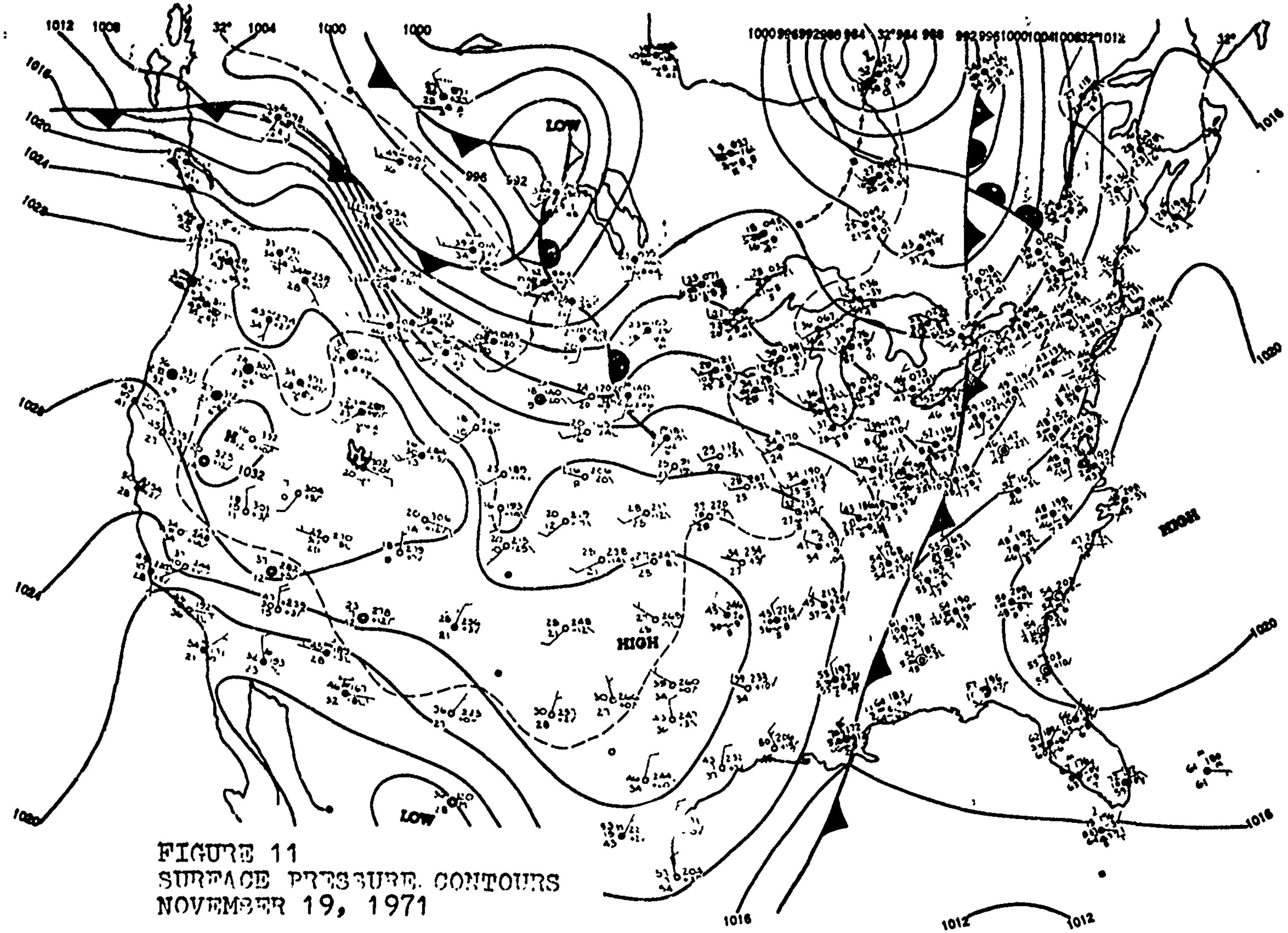


FIGURE 11
SURFACE PRESSURE CONTOURS
NOVEMBER 19, 1971

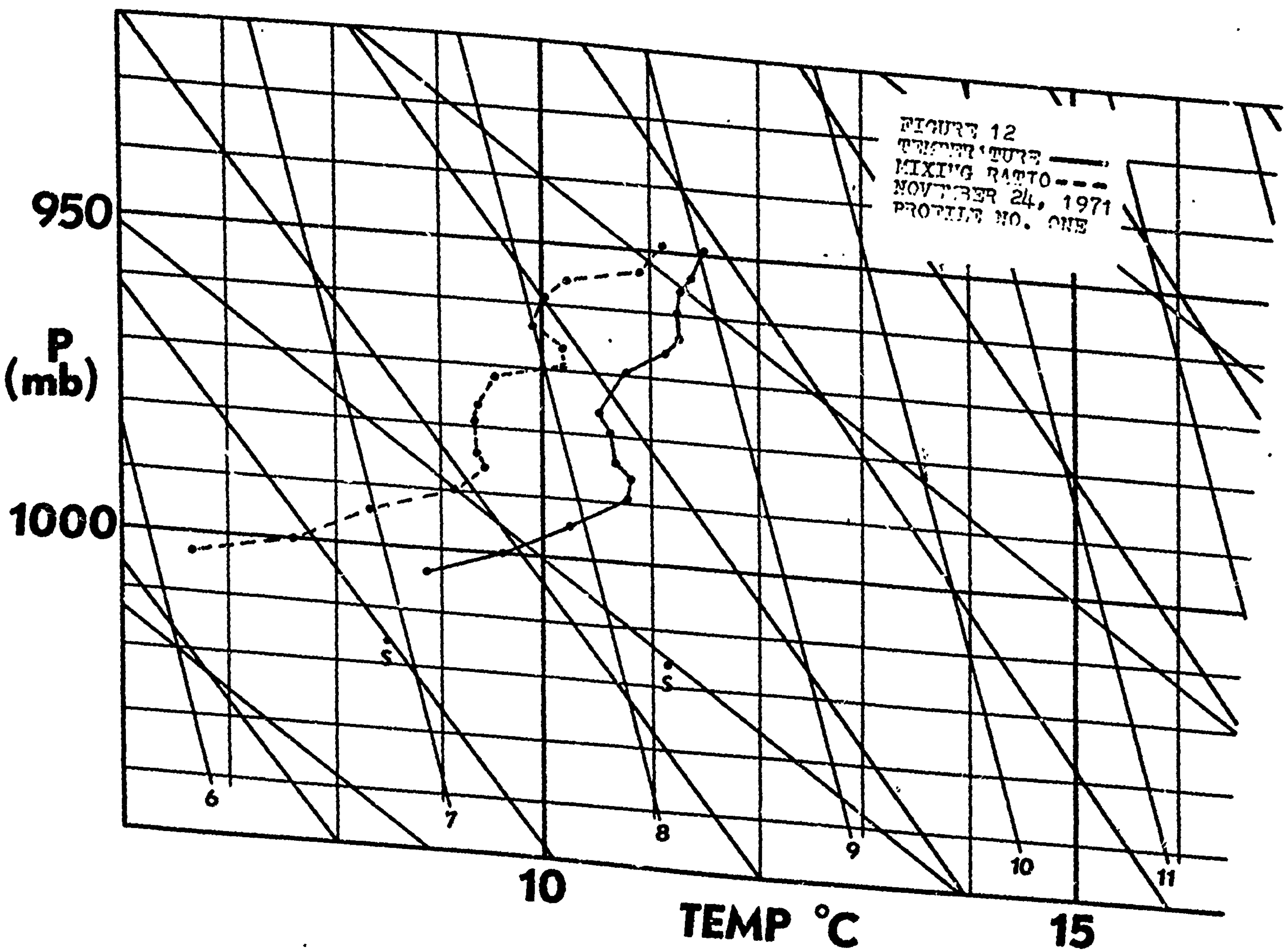


FIGURE 12
TEMPERATURE ——
MIXING RATIO - - -
NOVEMBER 24, 1971
PROFILE NO. ONE
950
P
(mb)
1000
6
7
8
9
10
11
10
TEMP °C
15

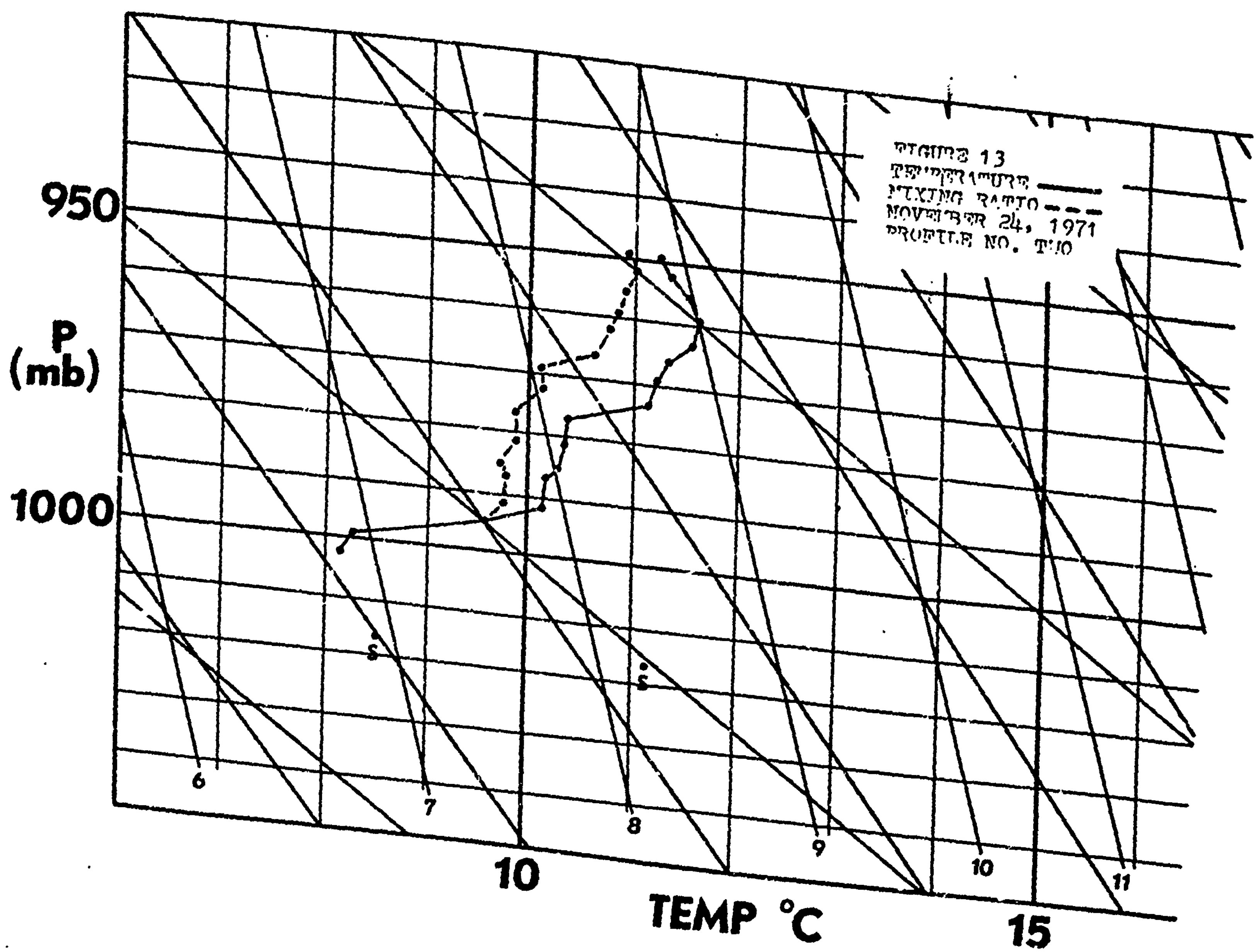


FIGURE 13
TEMPERATURE ———
MIXING RATIO - - -
NOVEMBER 24, 1971
PROFILE NO. TWO

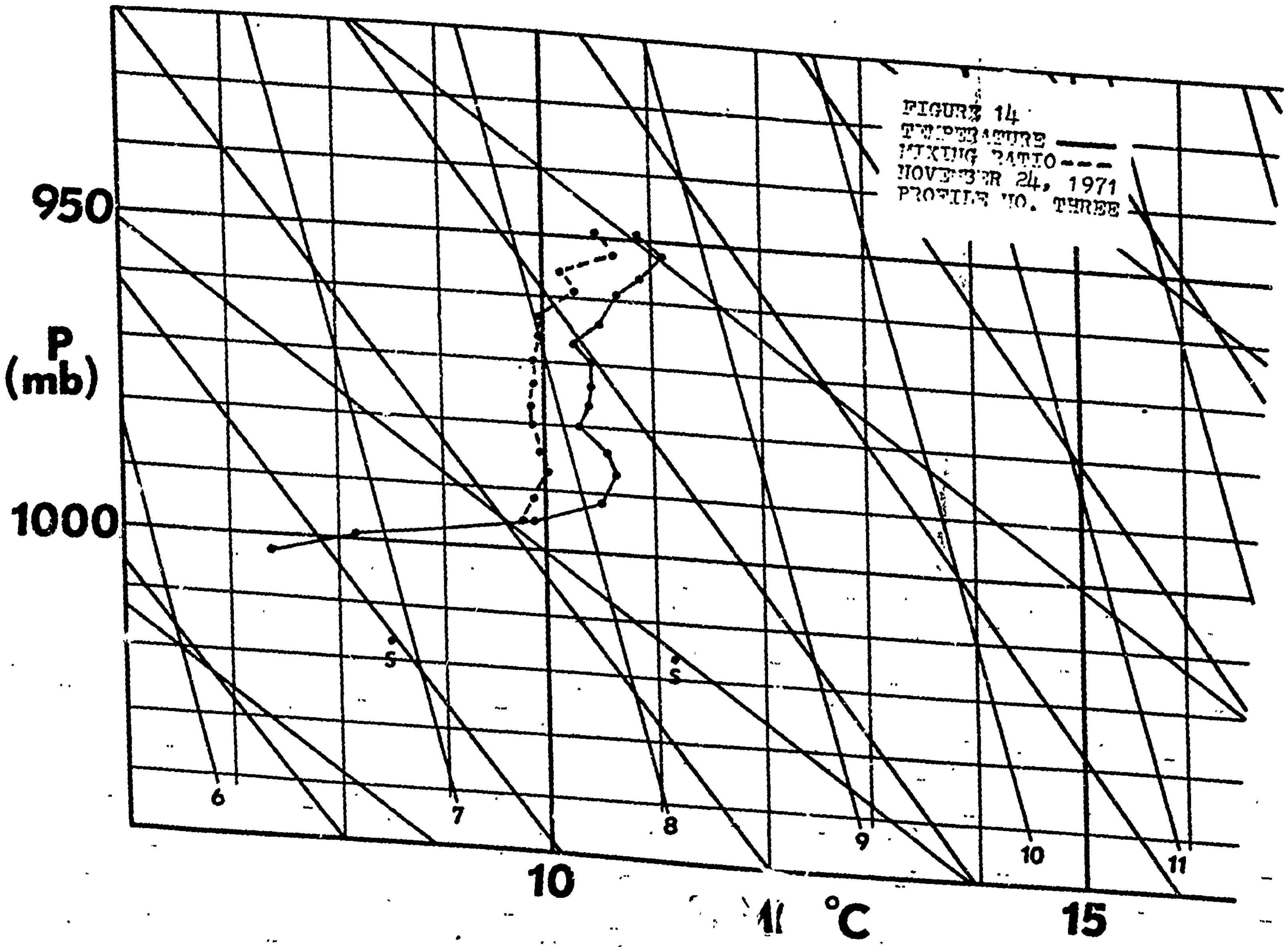


FIGURE 14
TEMPERATURE ———
MIXING RATIO - - -
NOVEMBER 24, 1971
PROFILE NO. THREE

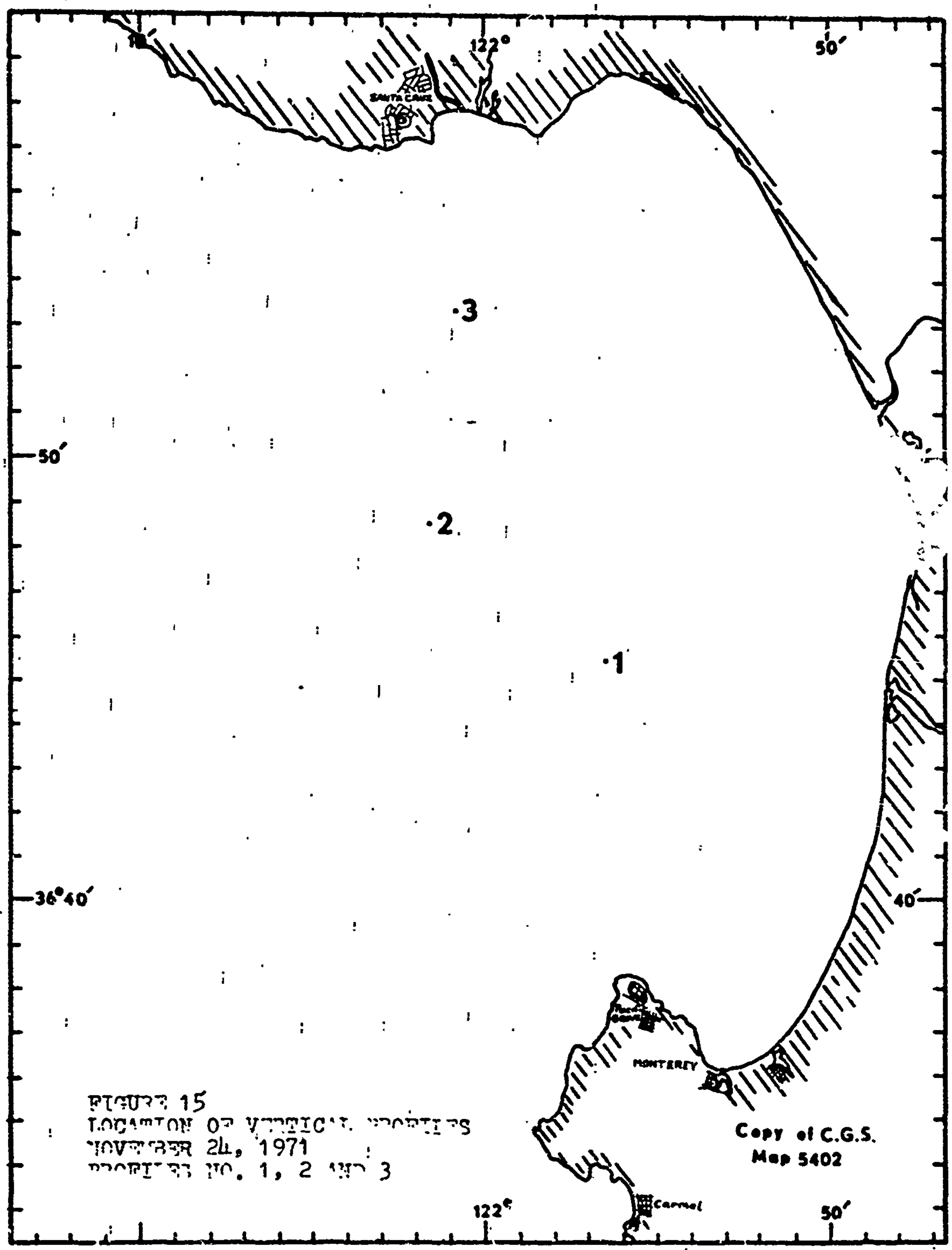


FIGURE 15
LOCATION OF VERTICAL PROFILES
NOVEMBER 24, 1971
PROFILES NO. 1, 2 AND 3

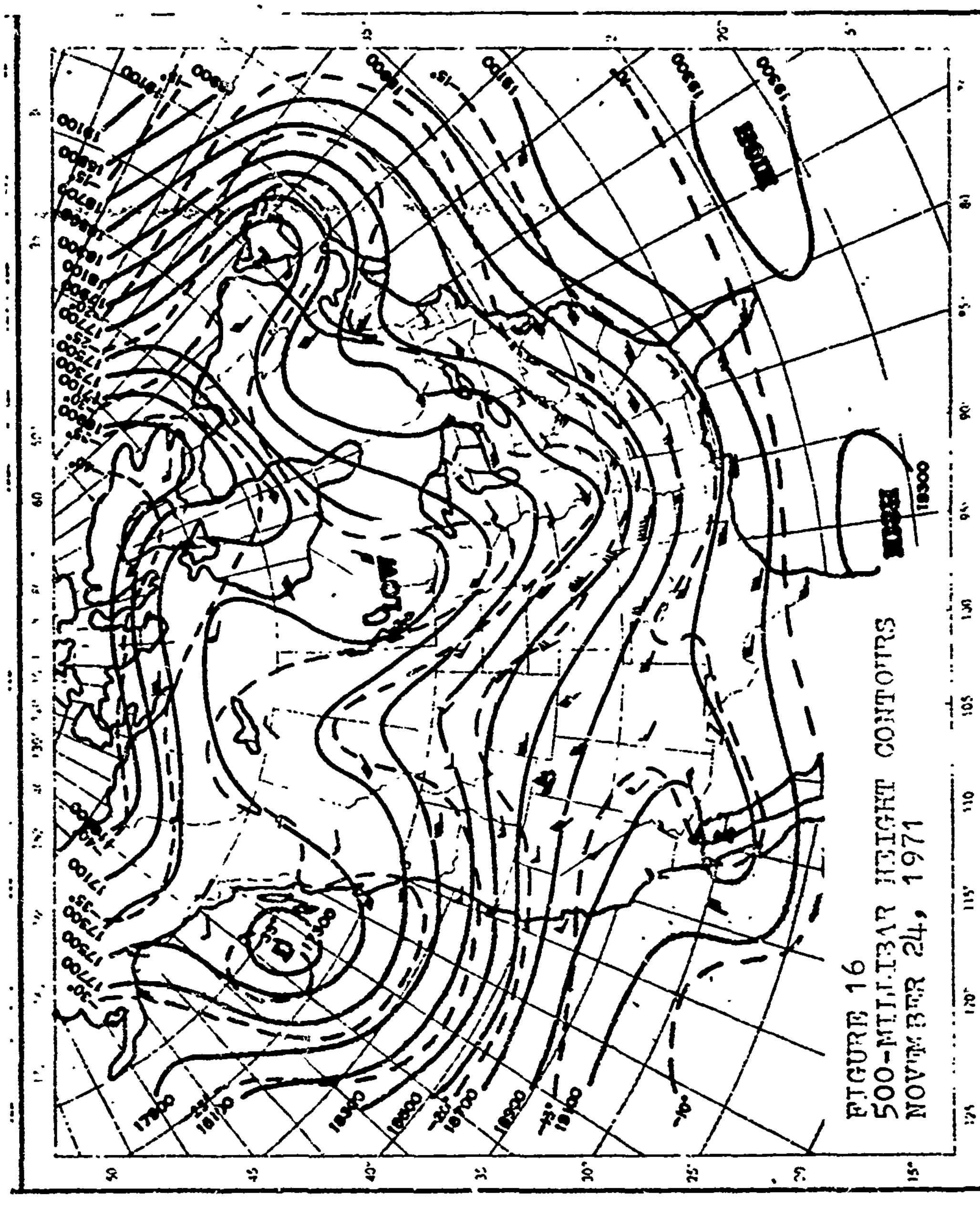


FIGURE 16
500-MILLIBAR HEIGHT CONTOURS
NOVEMBER 24, 1971

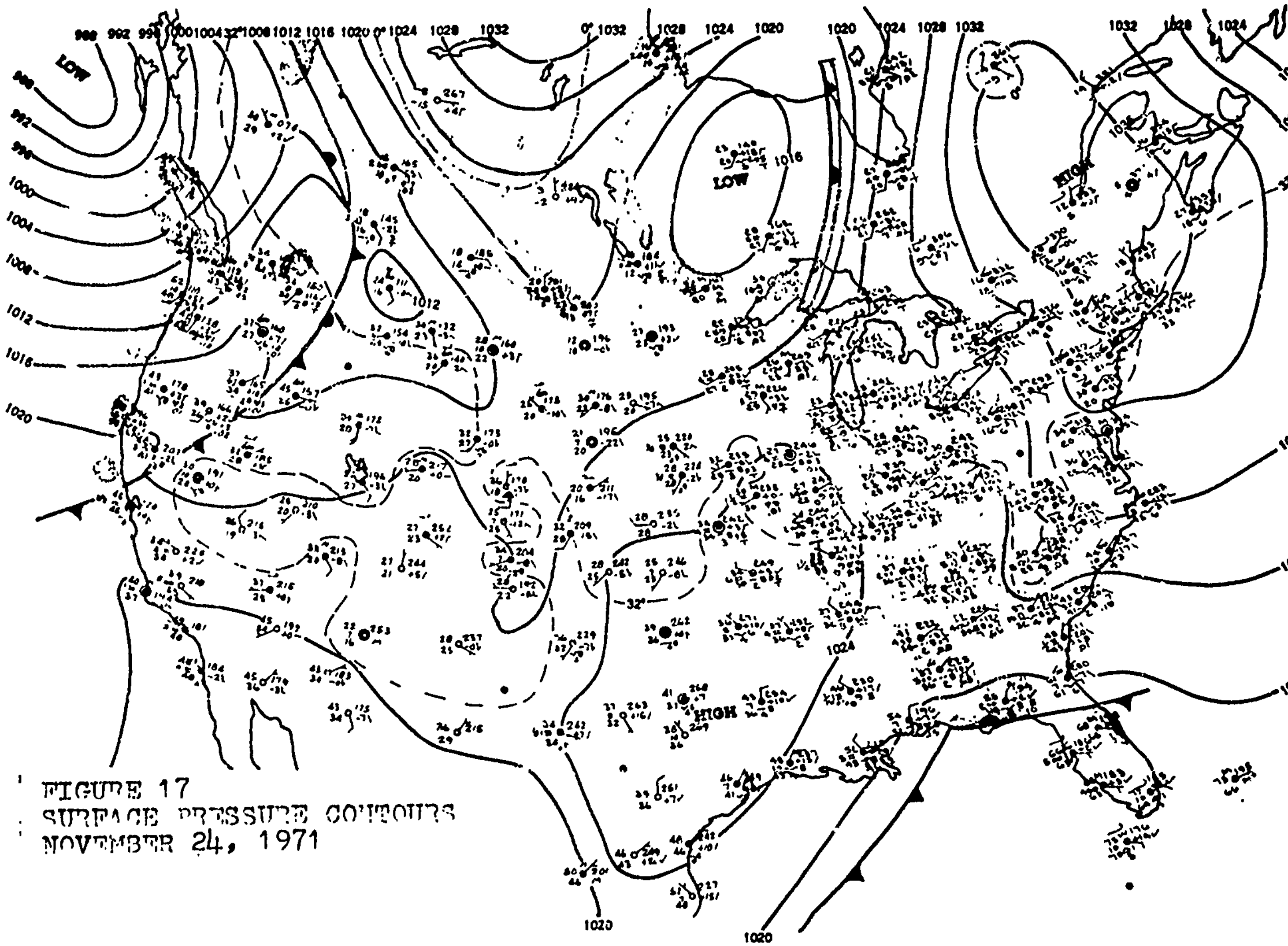


FIGURE 17
SURFACE PRESSURE CONTOURS
NOVEMBER 24, 1971

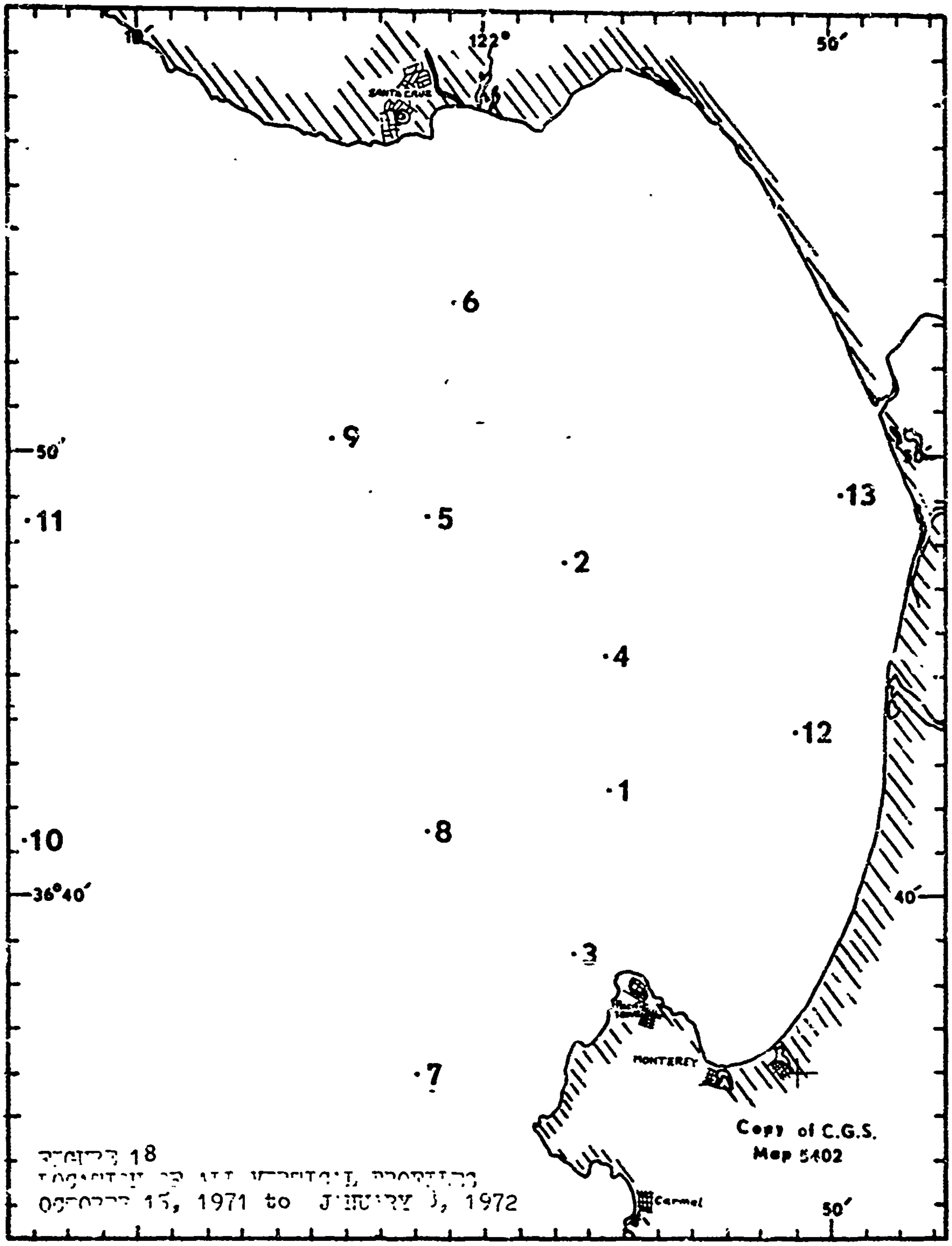


FIGURE 18
LOCATION OF ALL VERTICAL PROFILES
OCTOBER 15, 1971 to JANUARY 3, 1972

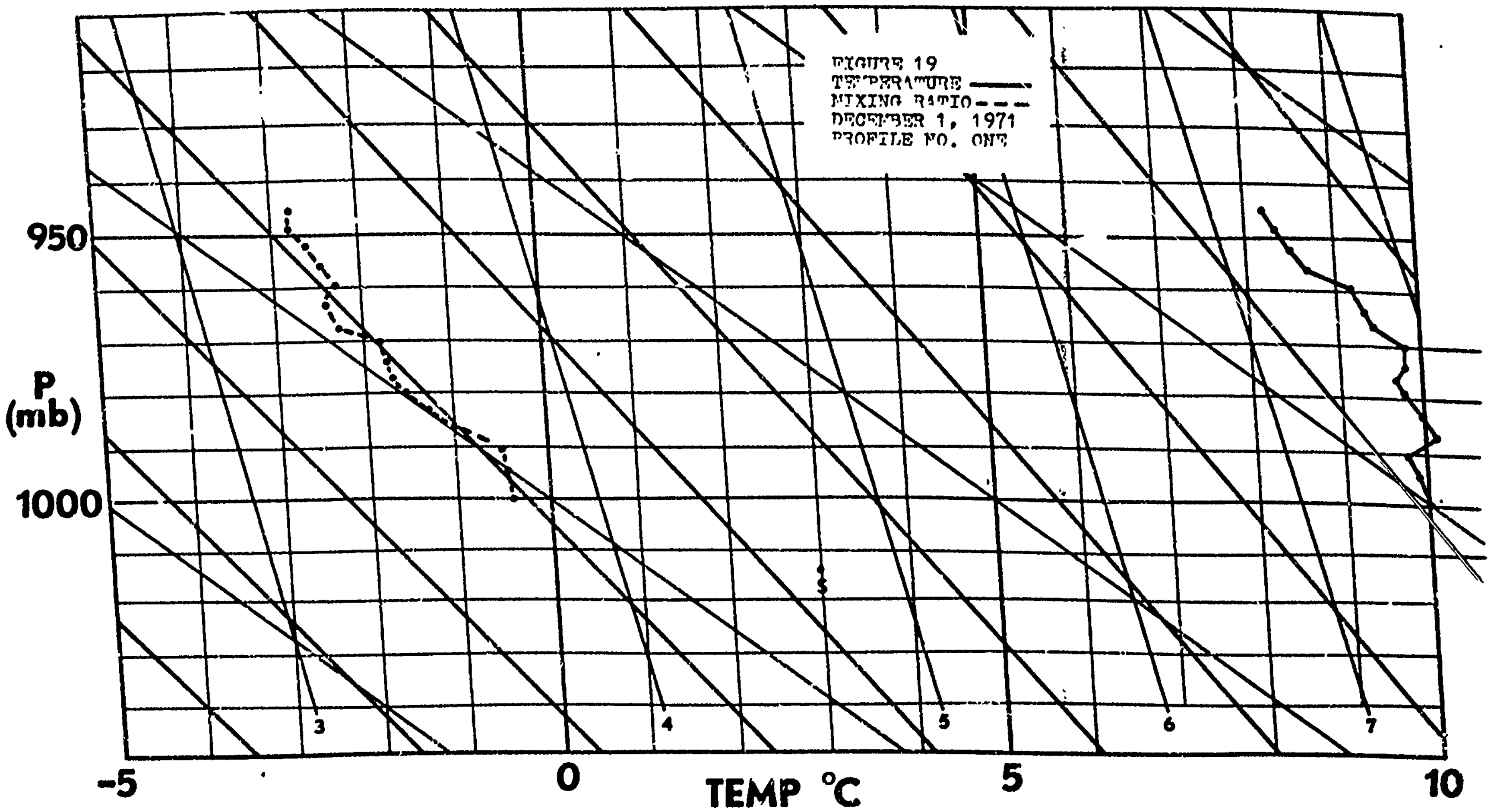


FIGURE 19
TEMPERATURE
MIXING RATIO
DECEMBER 1, 1971
PROFILE NO. ONE
950
P
(mb)
1000
3
4
5
6
7
-5
0
5
10
TEMP °C

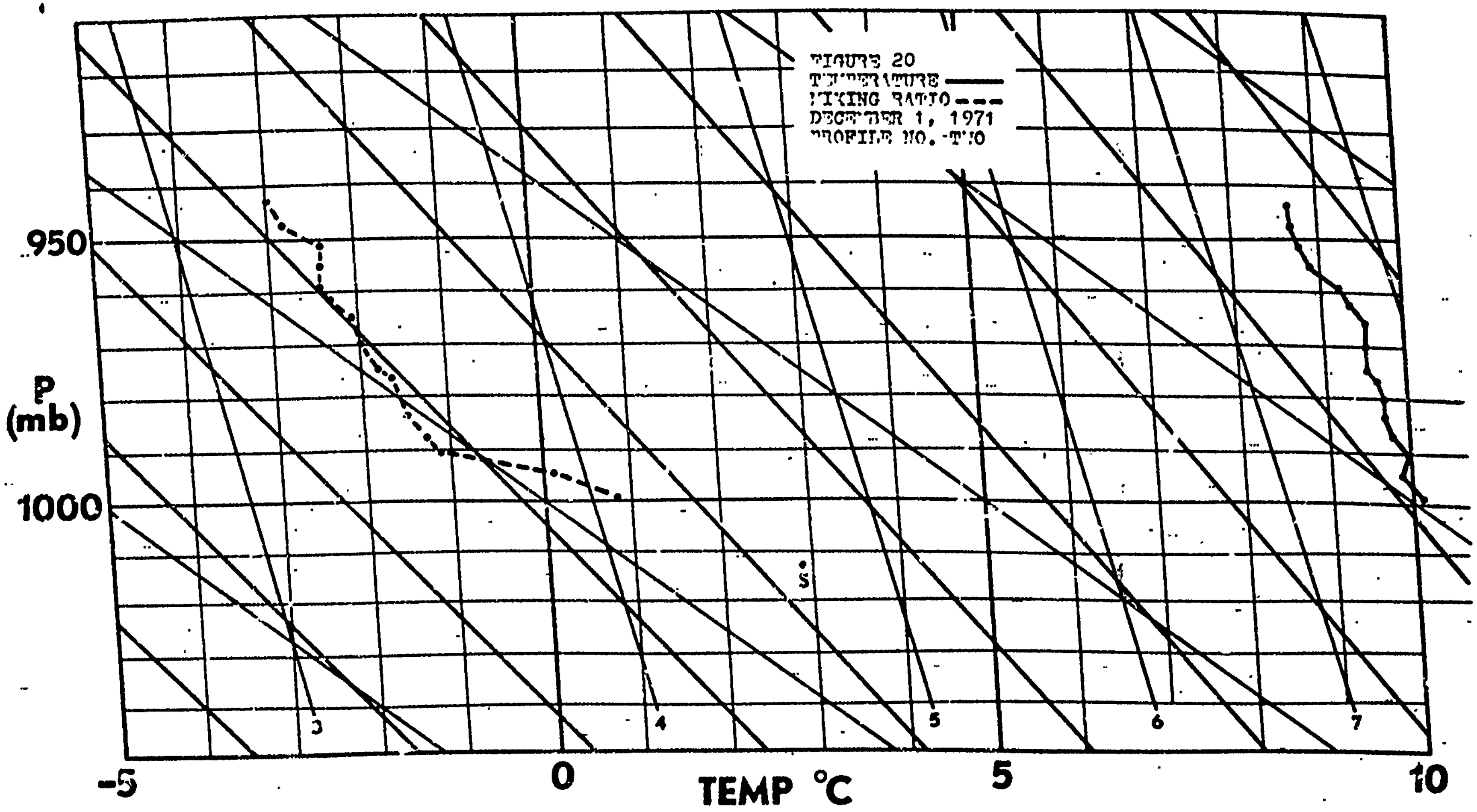


FIGURE 20
TEMPERATURE ——
MIXING RATIO - - -
DECEMBER 1, 1971
PROFILE NO. TWO
950
1000
P
(mb)
-5
0
5
10
TEMP °C
3
4
5
6
7

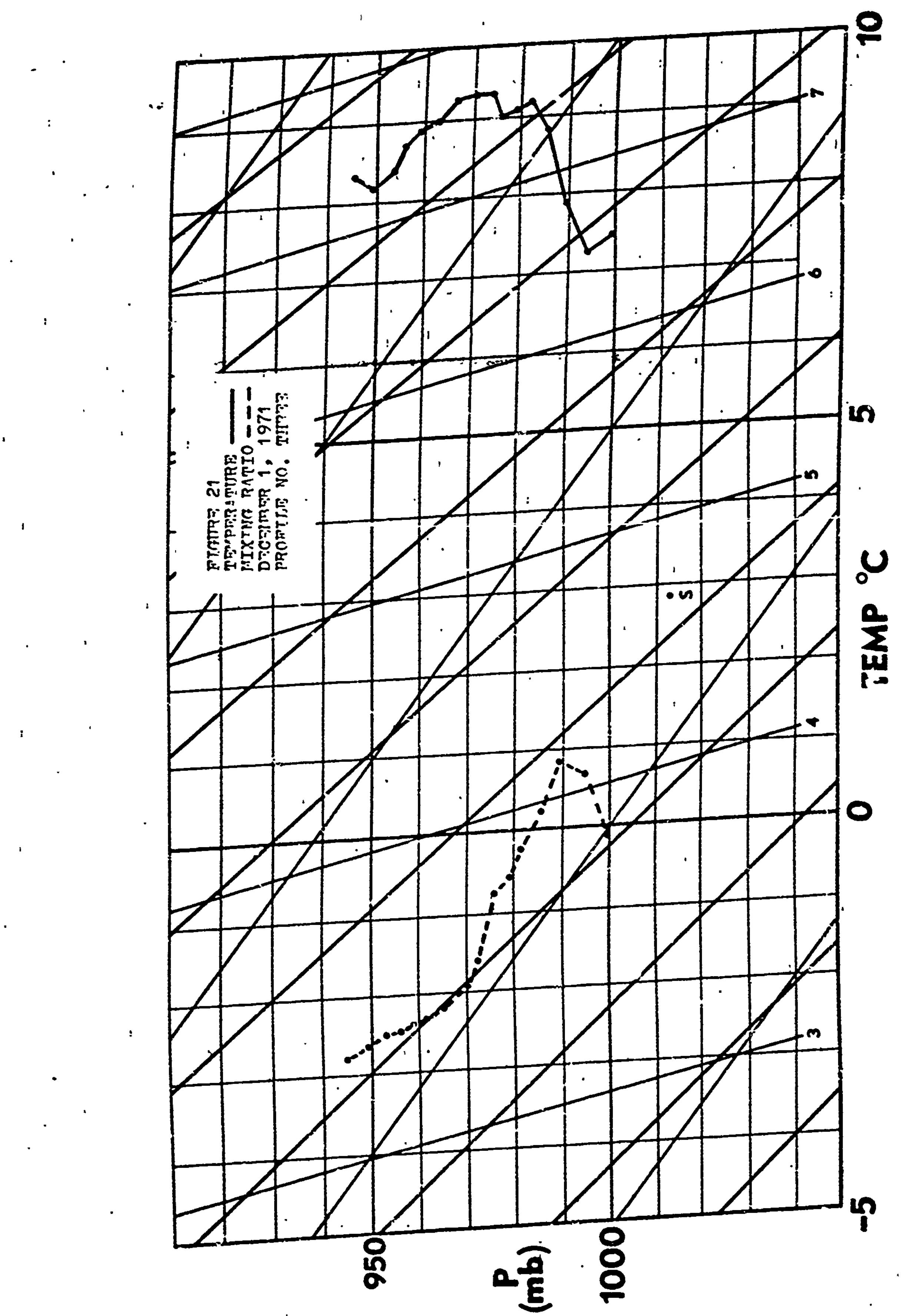


FIGURE 21
TEMPERATURE ———
MIXING RATIO - - - -
DECEMBER 1, 1971
PROFILE NO. THREE
P (mb)
950
1000
TEMP °C
-5
0
5
10
3
4
5
6
7
S

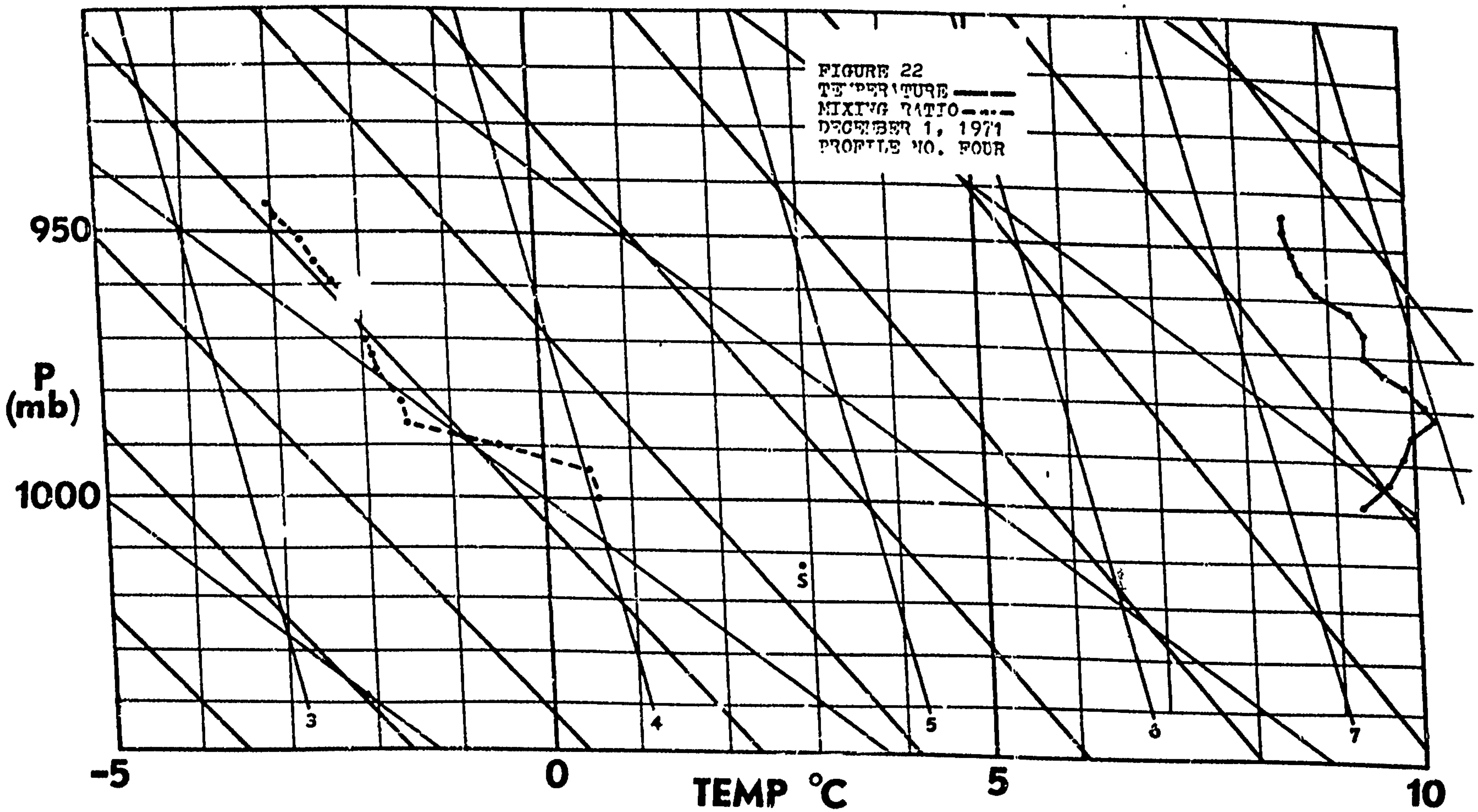


FIGURE 22
TEMPERATURE
MIXING RATIO
DECEMBER 1, 1971
PROFILE NO. FOUR
950
P
(mb)
1000
3
4
5
6
7
S
-5
0
5
10
TEMP °C

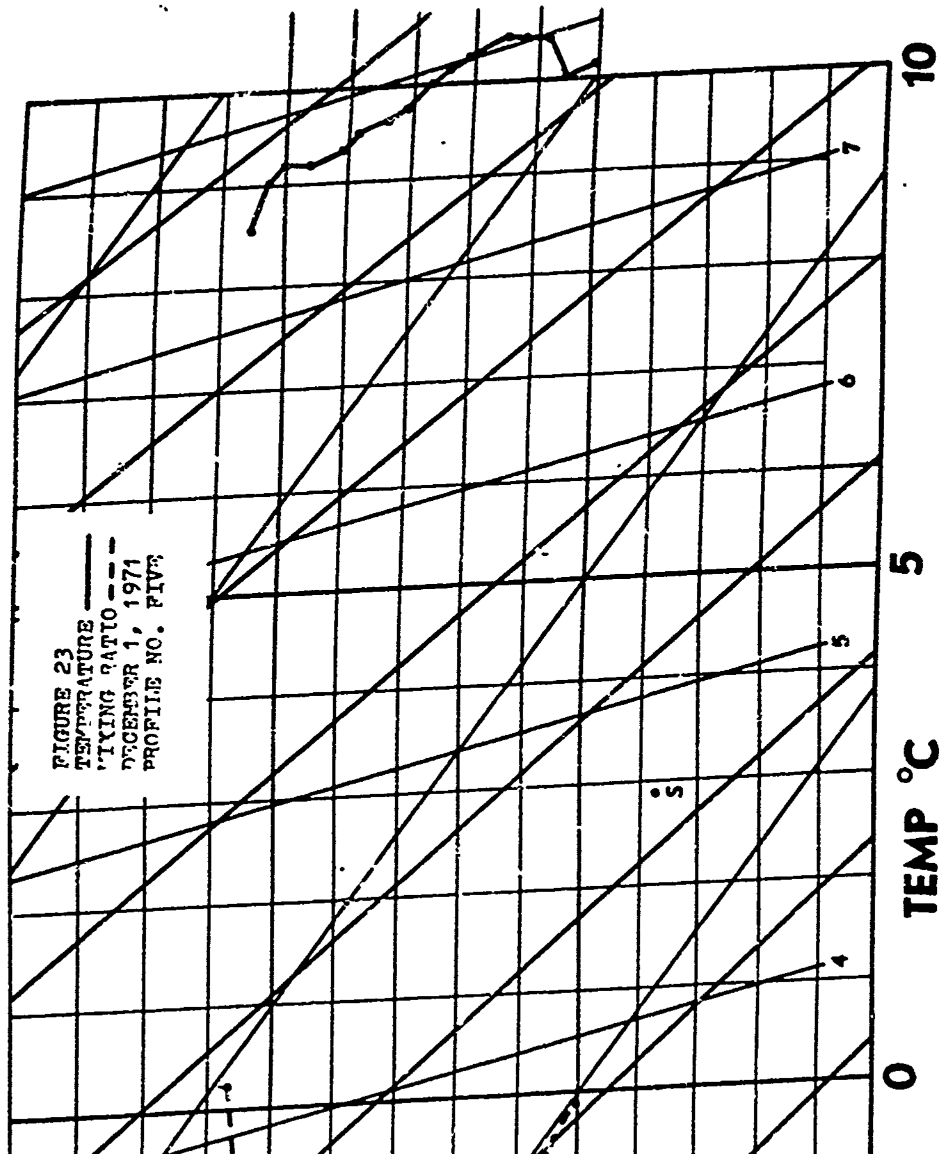


FIGURE 23
TEMPERATURE
MIXING RATIO
DECEMBER 1, 1971
PROFILE NO. FIVE
TEMP °C
P (mb)
950
1000
-5
0
5
10
3
4
5
6
7
S

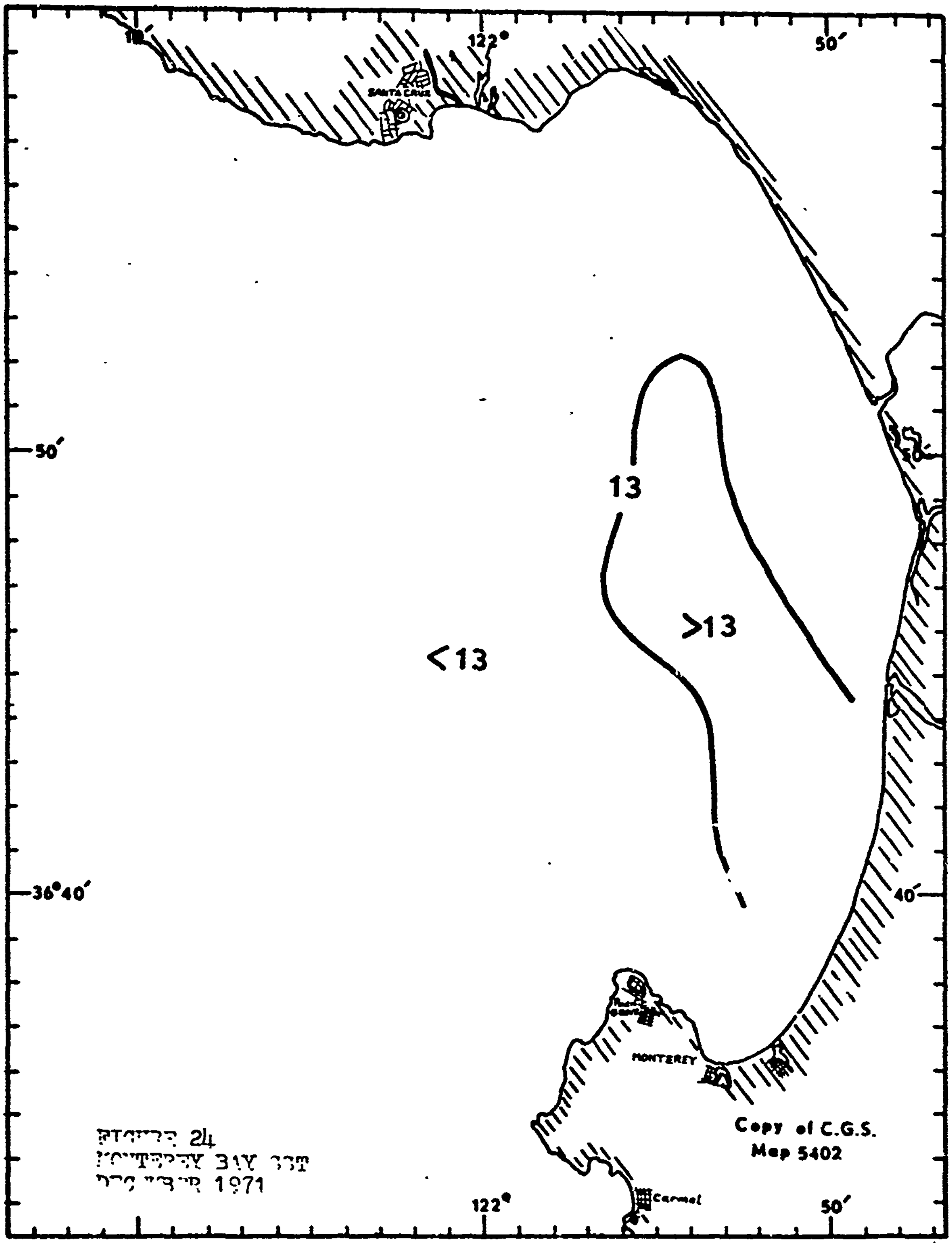


FIGURE 24
MONTEREY BAY SST
DECEMBER 1971

FIGURE 25
LOCATION OF VERTICAL PROFILES
DECEMBER 1, 1971
PROFILES NO. 1, 2, 3, 4 AND 5

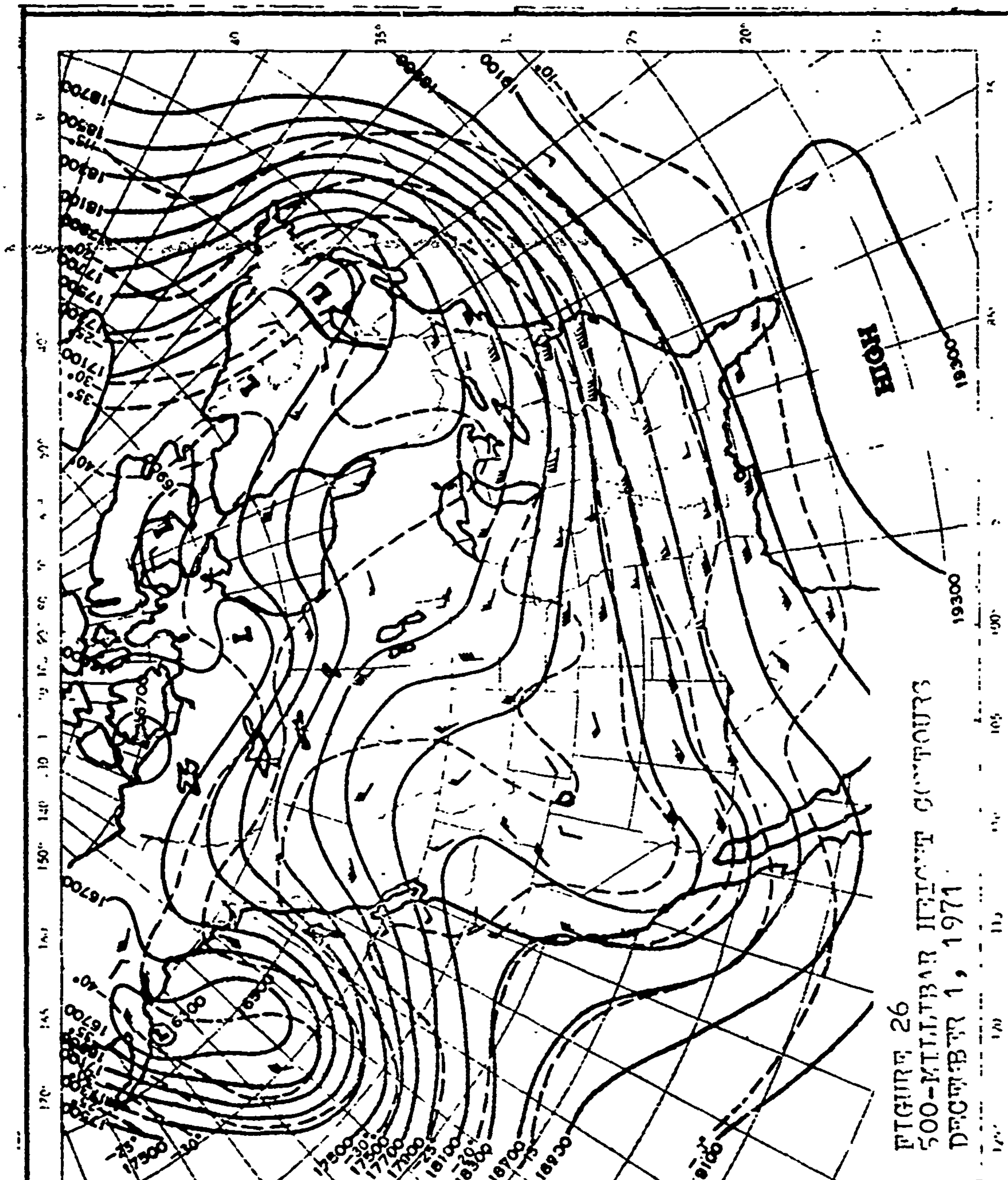


FIGURE 26
500-MILLIBAR HEIGHT CONTOURS
DECEMBER 1, 1971

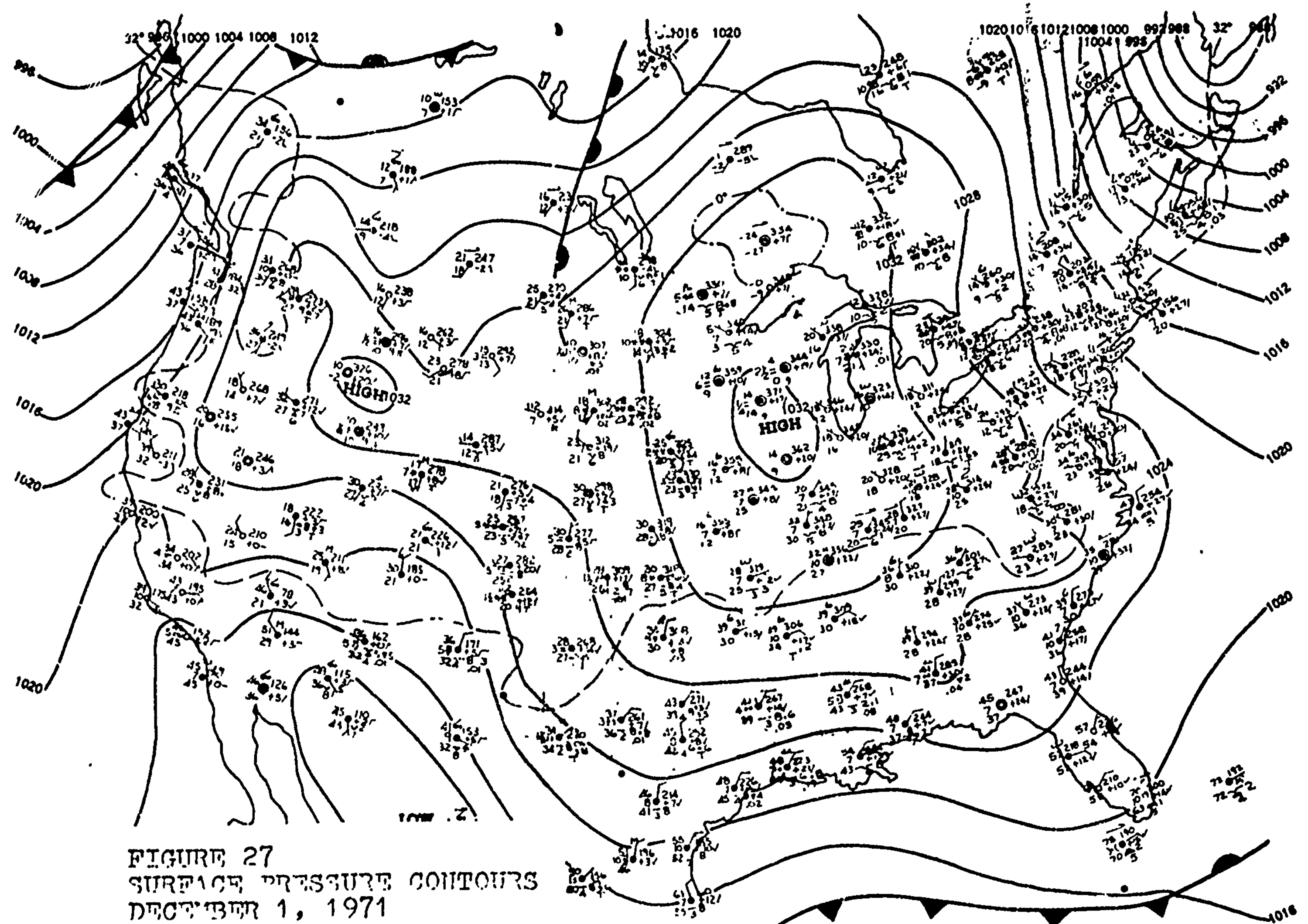


FIGURE 27
SURFACE PRESSURE CONTOURS
DECEMBER 1, 1971

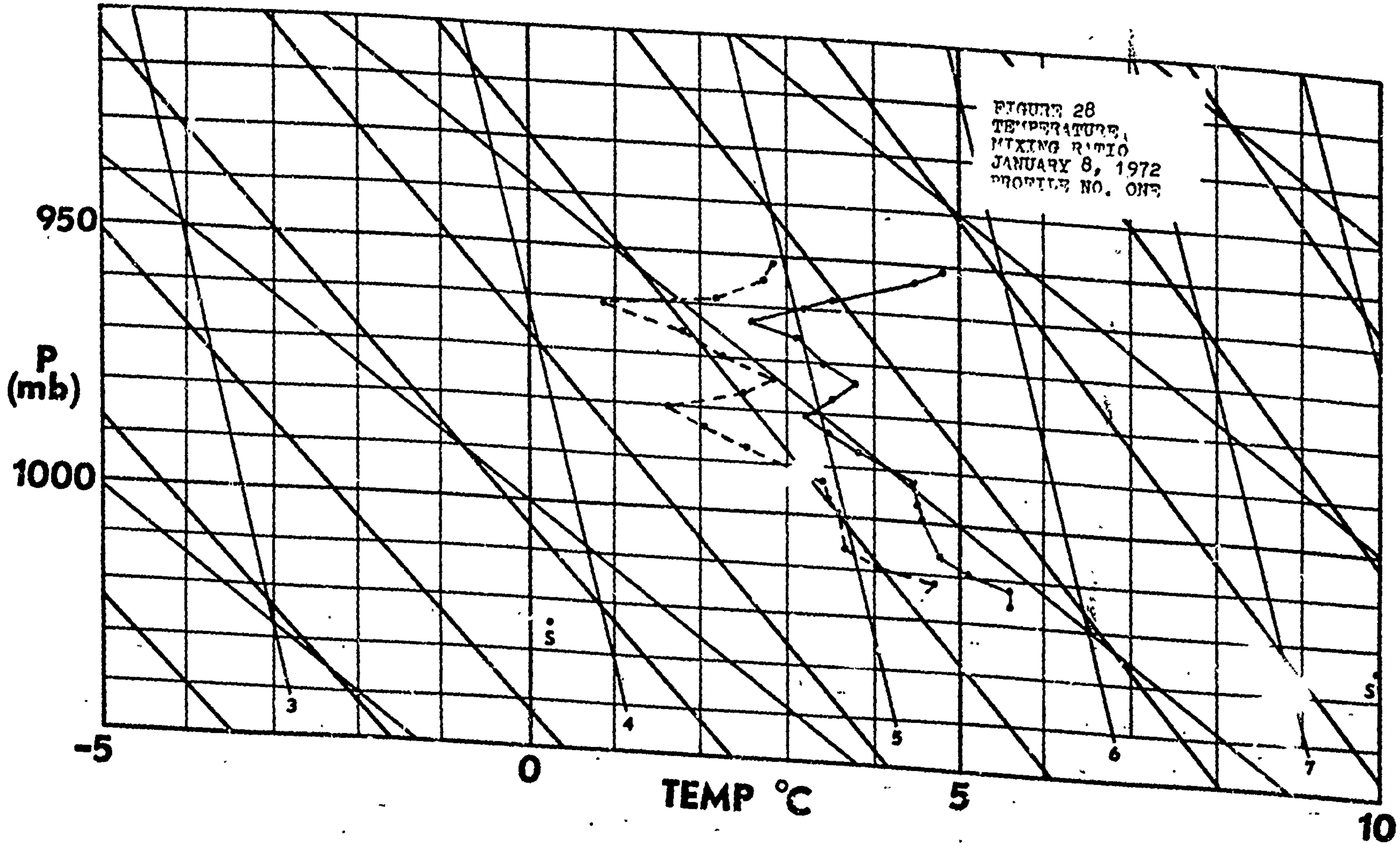


FIGURE 28
TEMPERATURE, MIXING RATIO
JANUARY 8, 1972
PROFILE NO. ONE

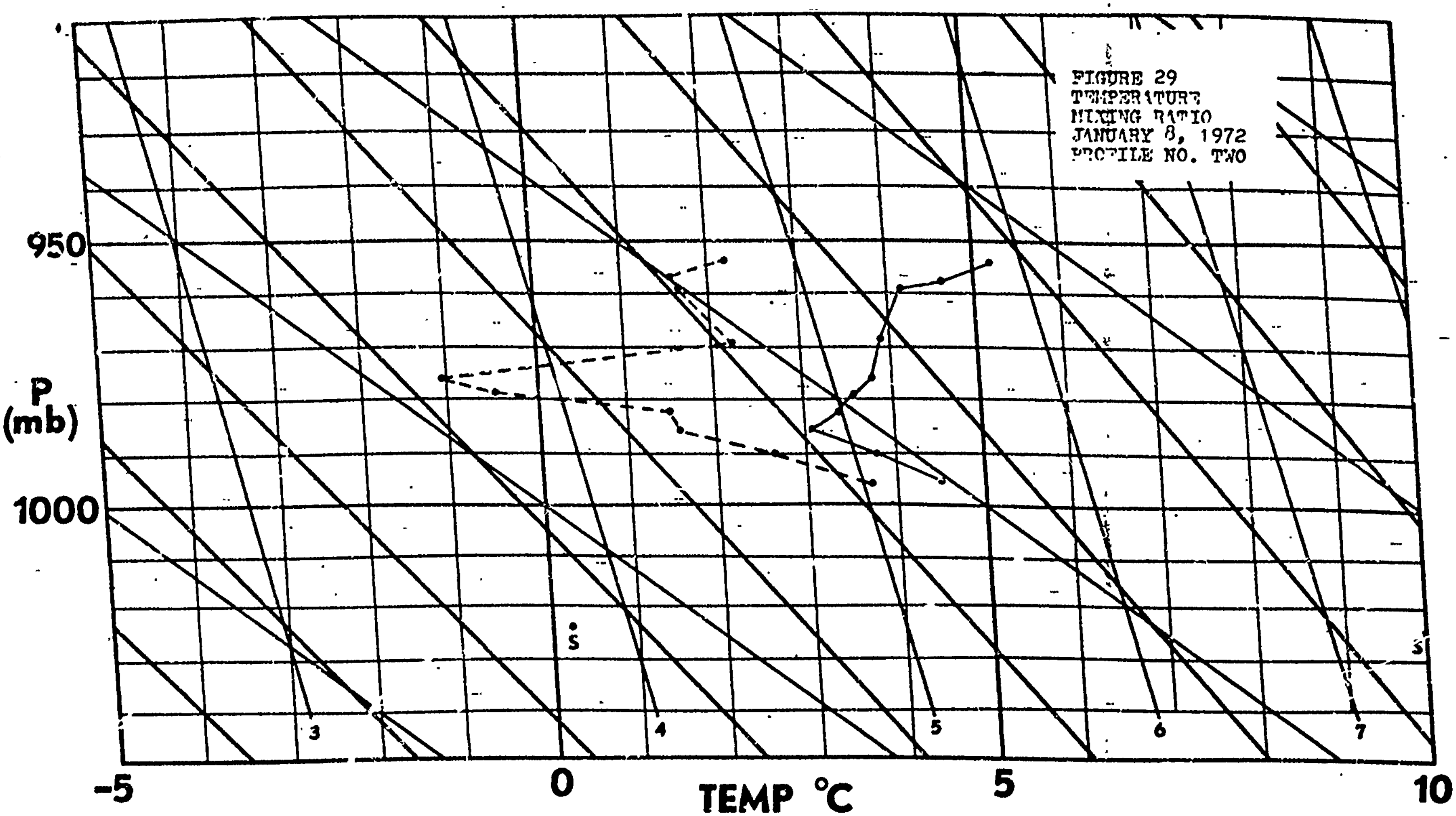


FIGURE 29
TEMPERATURE
MIXING RATIO
JANUARY 8, 1972
PROFILE NO. TWO

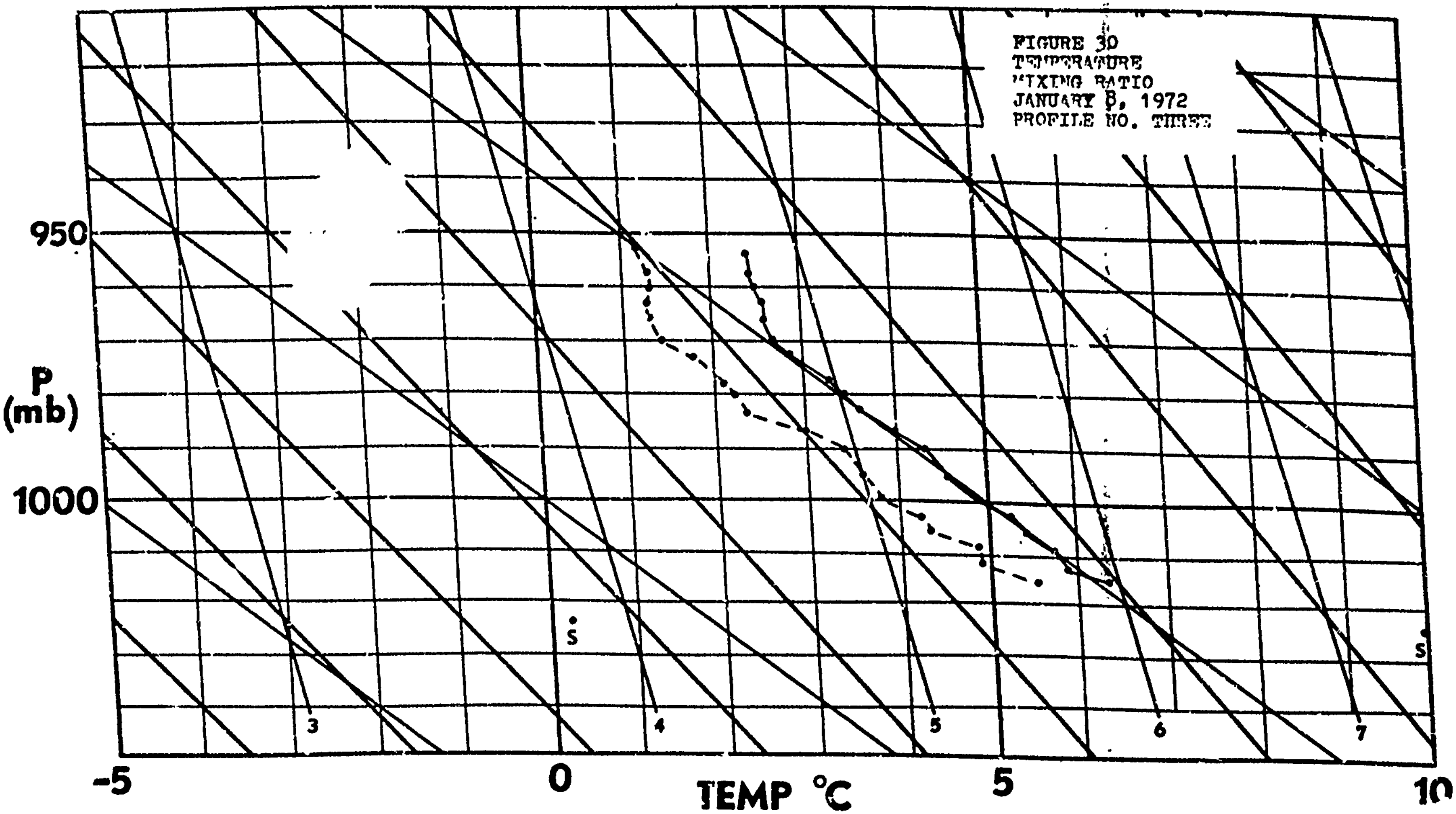


FIGURE 30
TEMPERATURE
MIXING RATIO
JANUARY 8, 1972
PROFILE NO. THREE

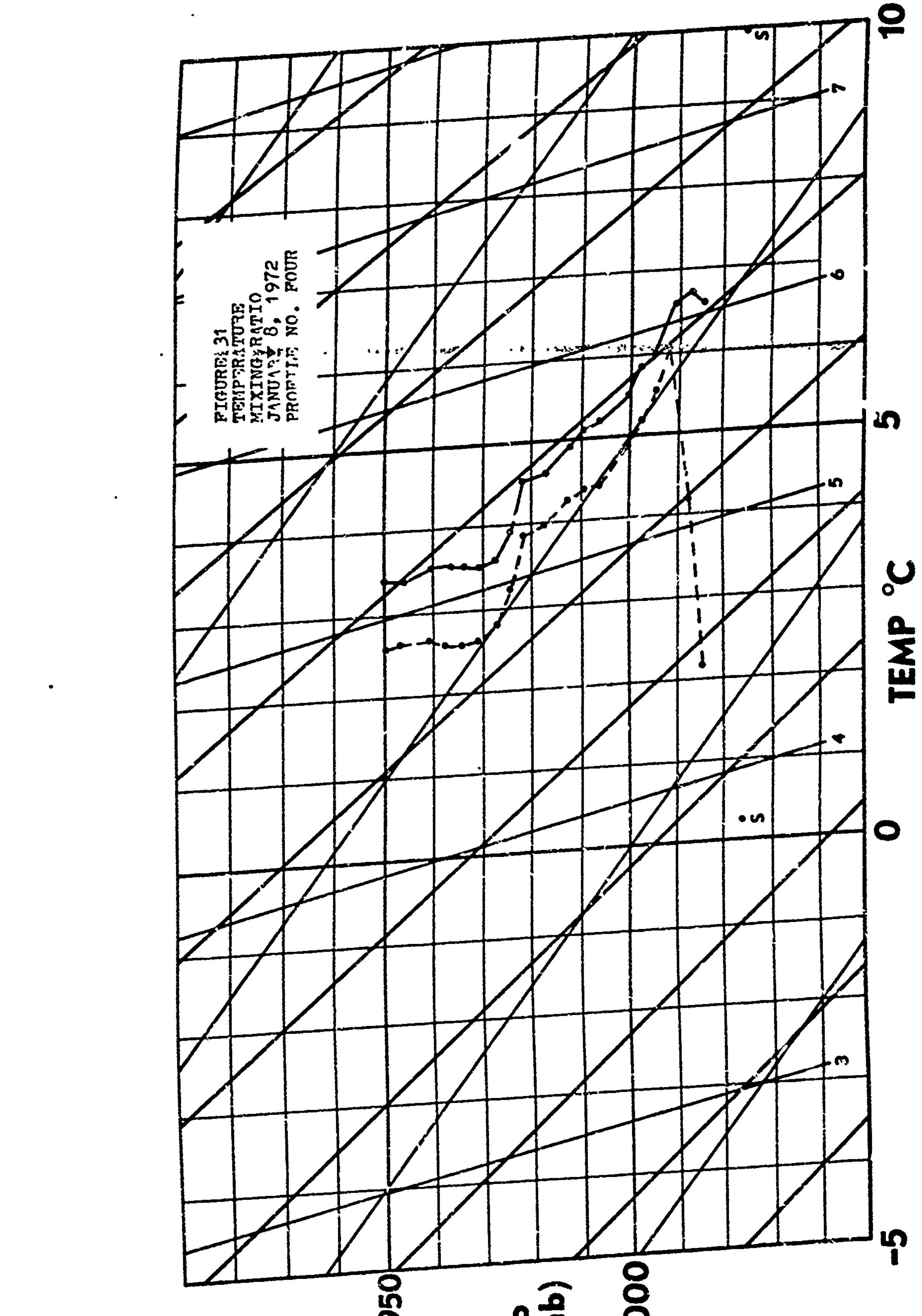


FIGURE 31
TEMPERATURE
MIXING RATIO
JANUARY 8, 1972
PROFILE NO. FOUR

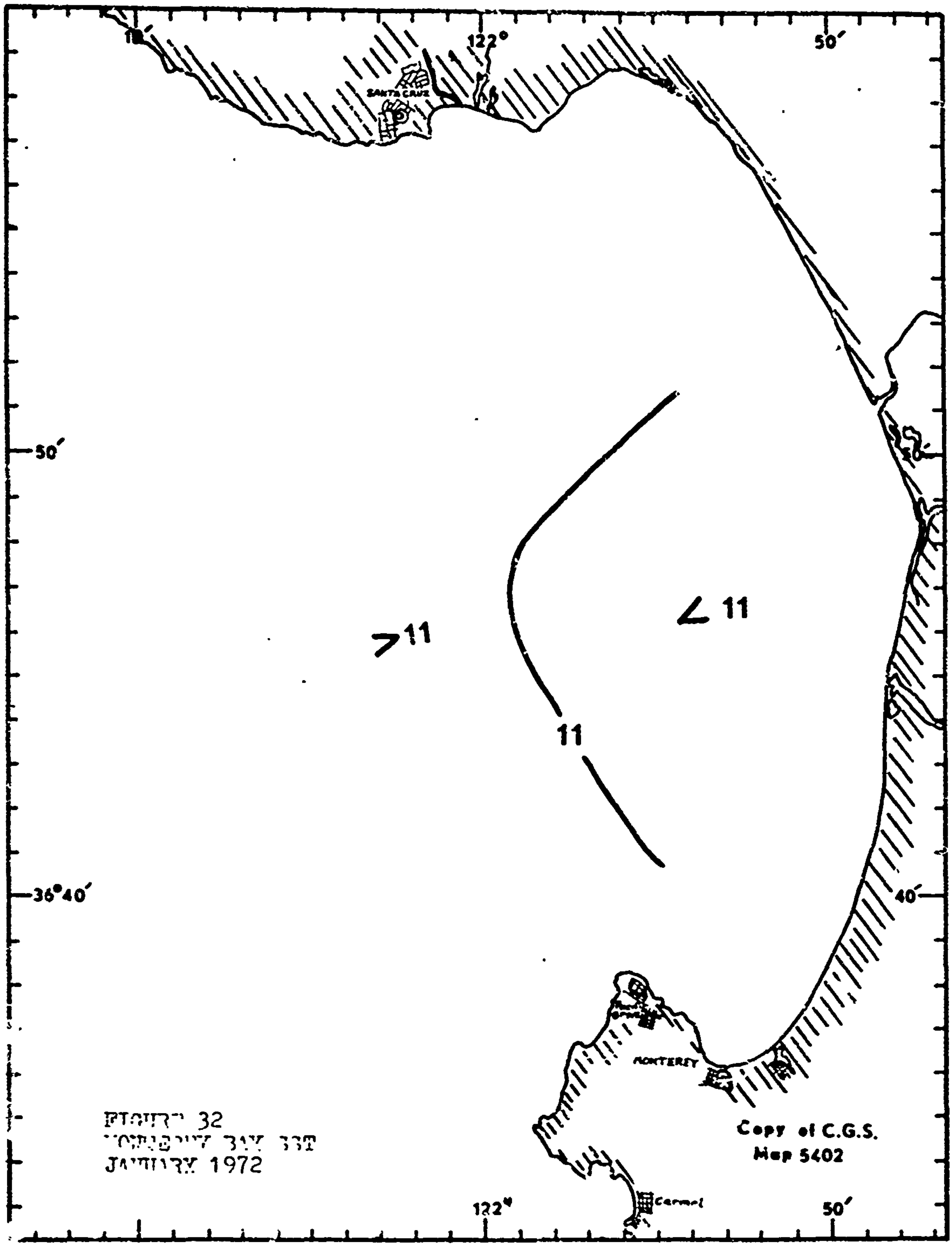


FIGURE 32
MONTEREY BAY SST
JANUARY 1972

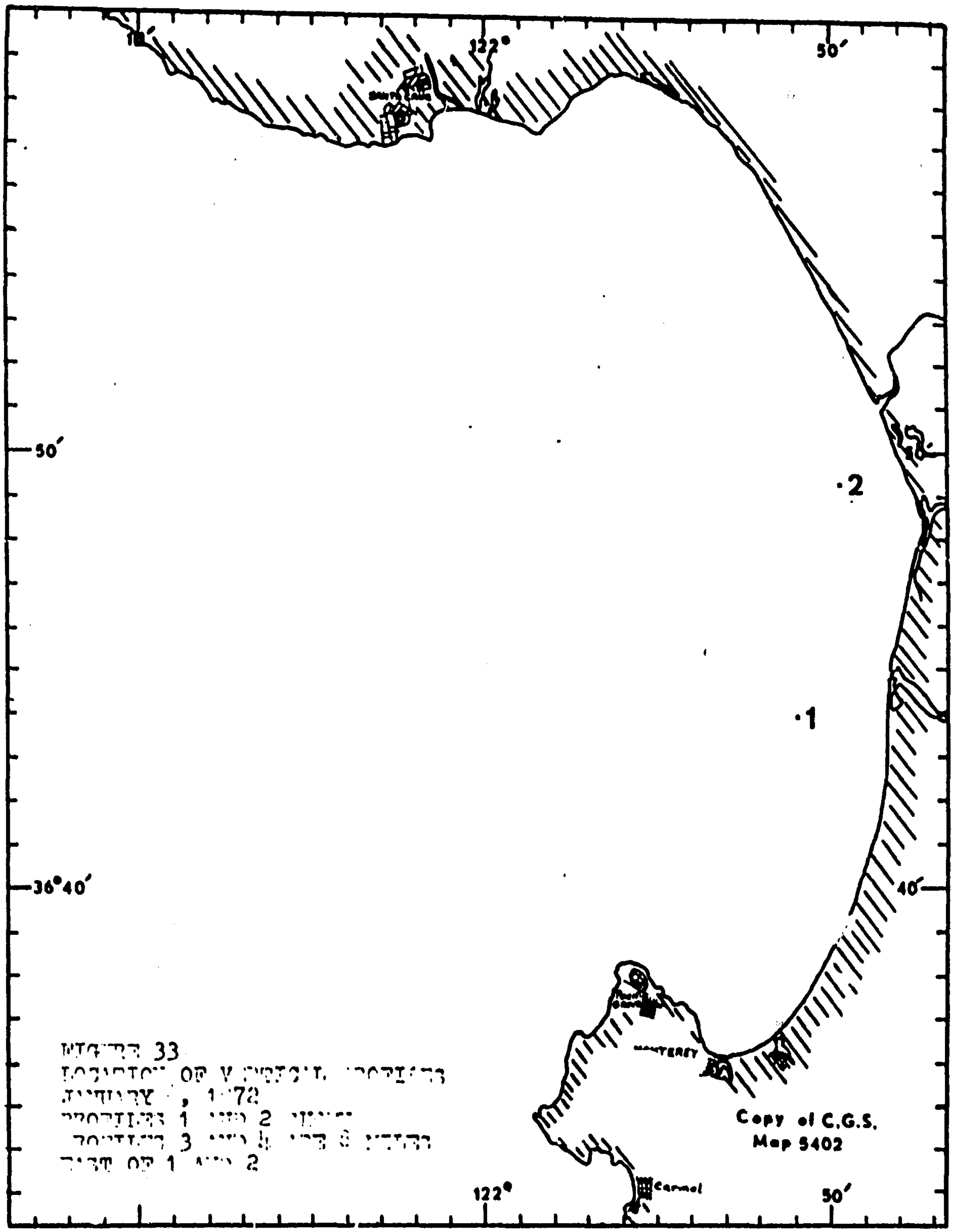


FIGURE 33
LOCATION OF VERTICAL PROFILES
JANUARY [illegible], 1972
PROFILES 1 AND 2 [illegible]
PROFILES 3 AND 4 ARE 8 MILES
EAST OF 1 AND 2

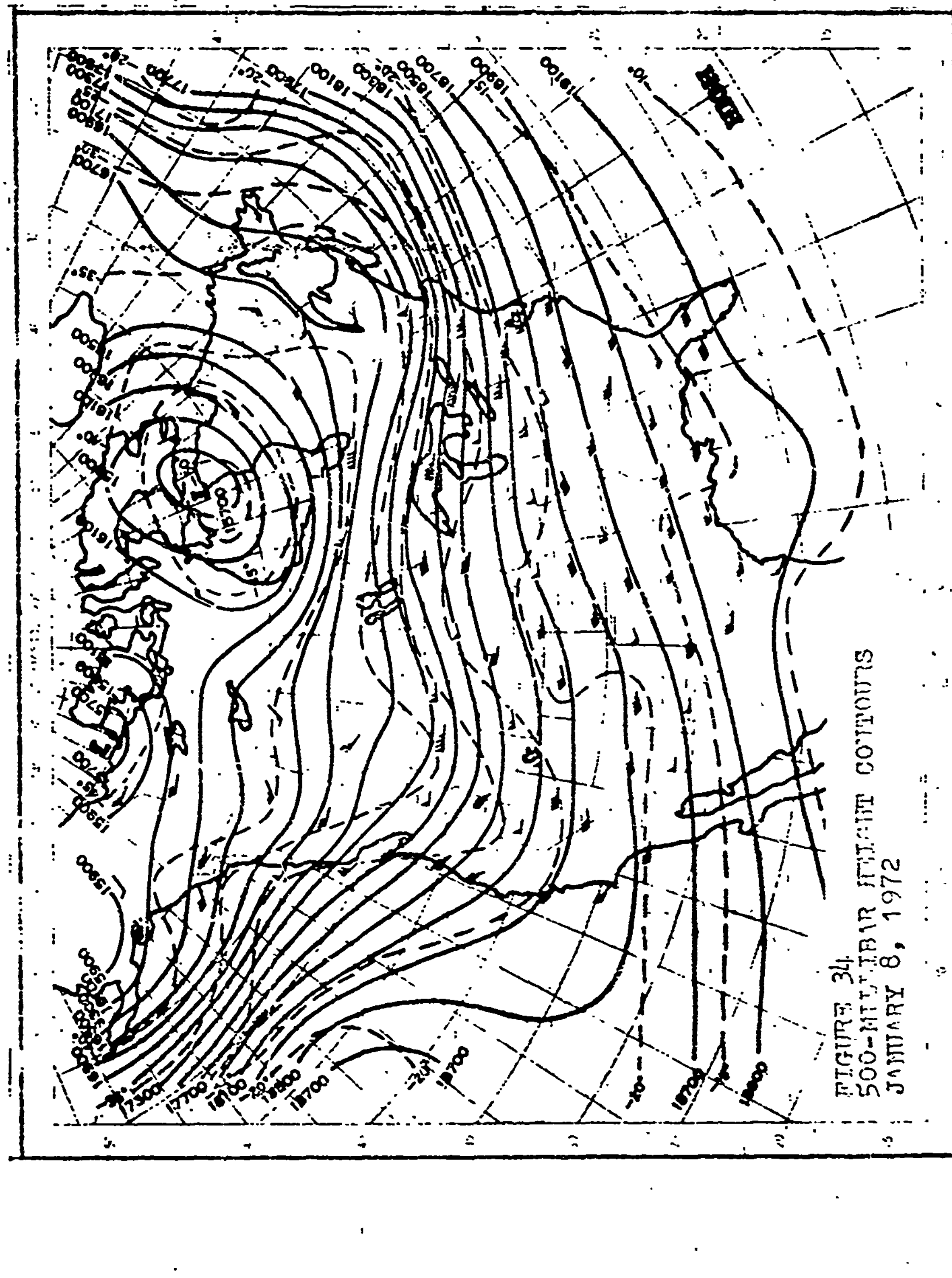


FIGURE 34
500-MILLIBAR HEIGHT CONTOURS
JANUARY 8, 1972

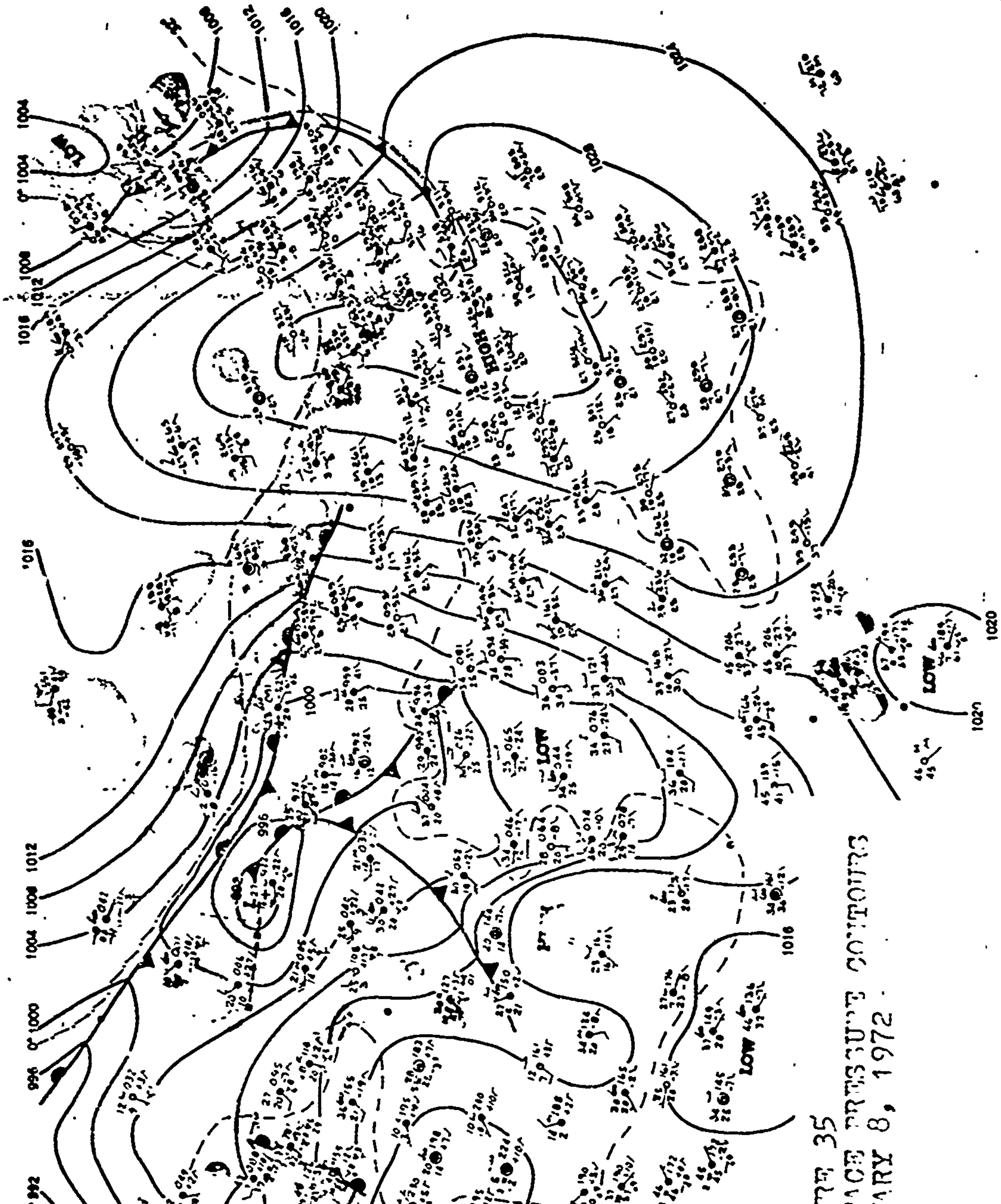


FIGURE 35
SURFACE PRESSURE CONTOURS
JANUARY 8, 1972

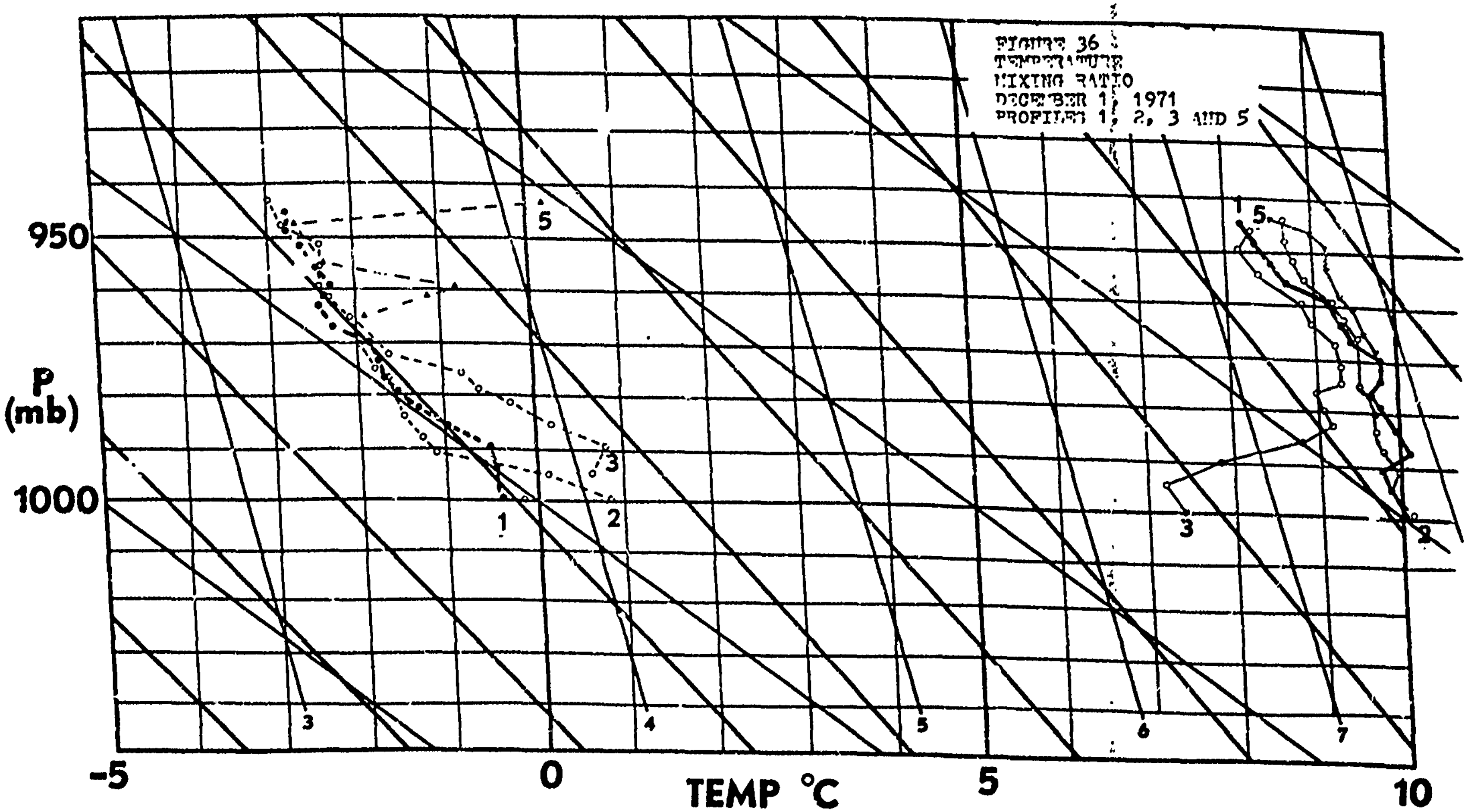
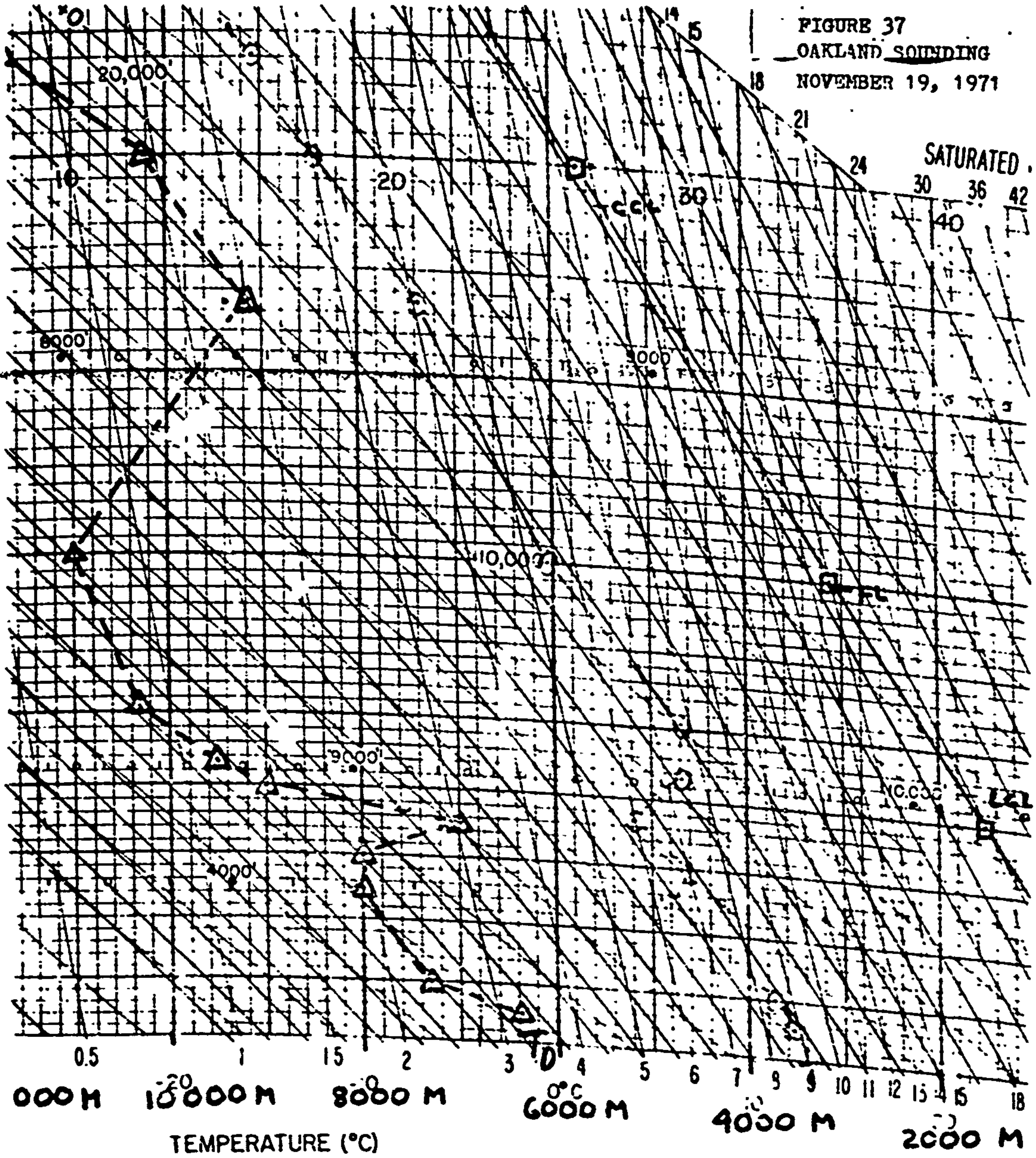


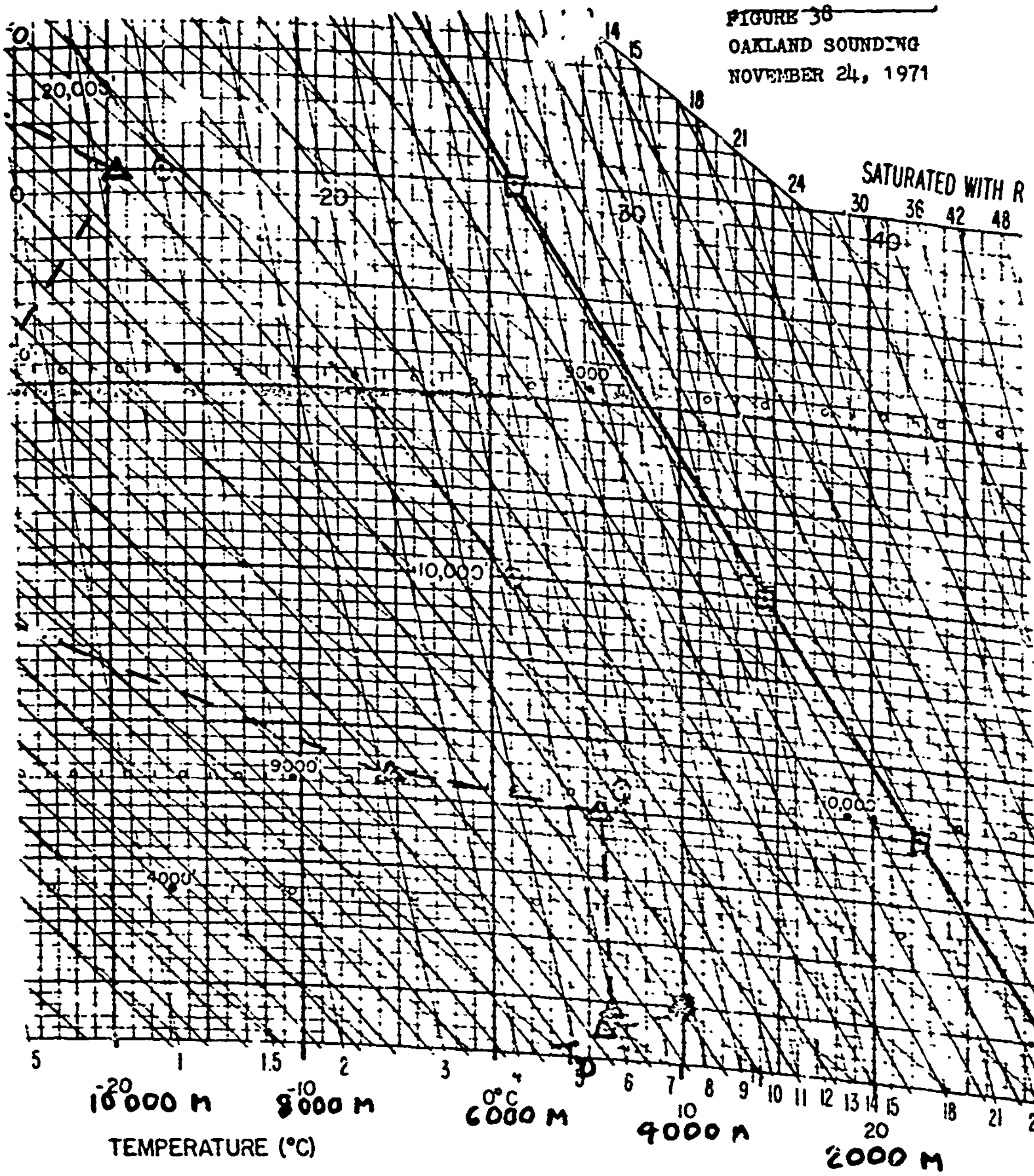
FIGURE 36
TEMPERATURE
MIXING RATIO
DECEMBER 1, 1971
PROFILES 1, 2, 3 AND 5



LCL	1700 M
CCL	5420 M
MCCL	6140 M
K INDEX	-12

SHIP OR STATION NPS
DRAWN BY
VERIFIED BY

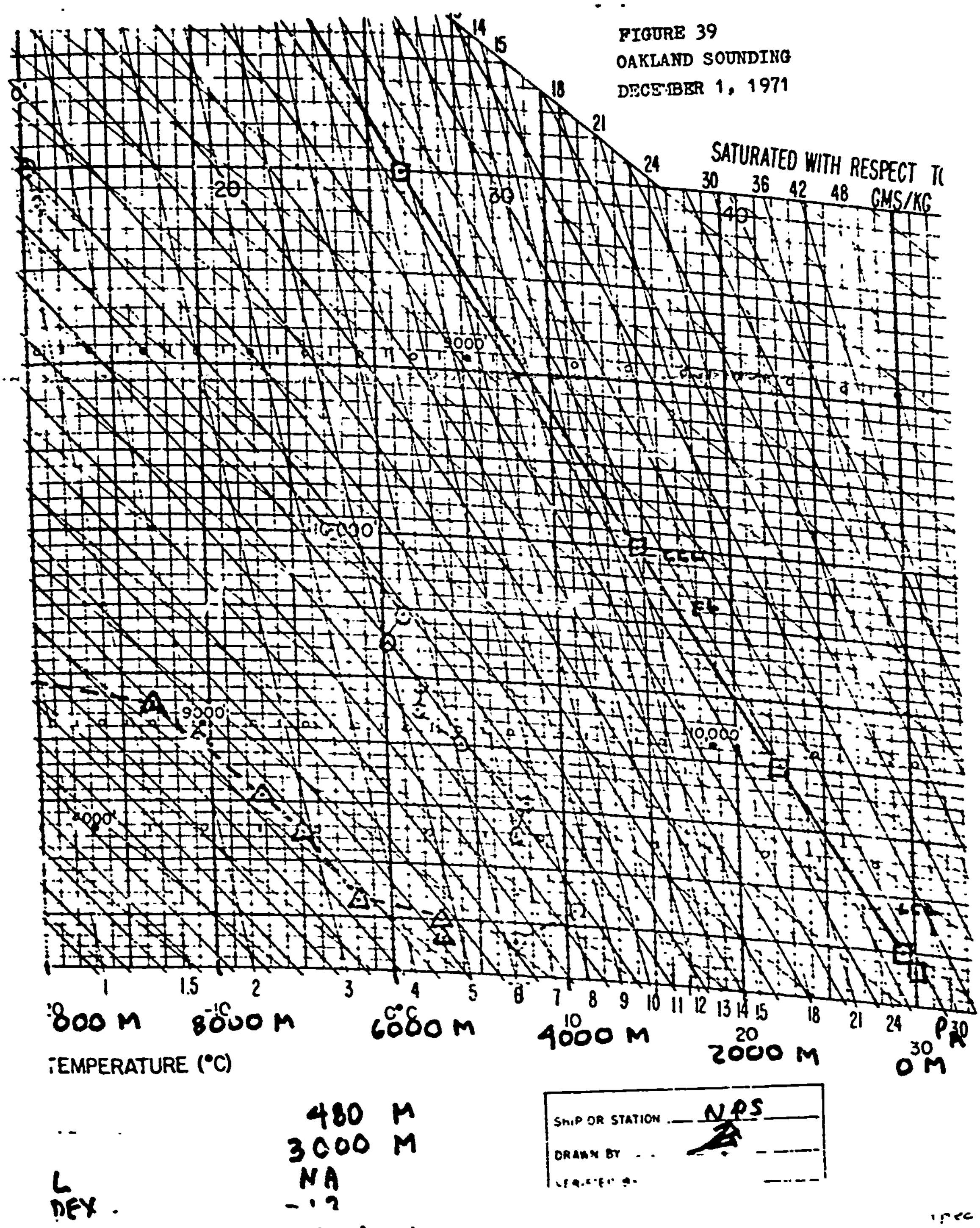
FIGURE 38
OAKLAND SOUNDING
NOVEMBER 24, 1971



.CL 30 M
:CL 3200 M
MCCL N. A

SHIP OR STATION NPS
DRAWN BY

FIGURE 39
OAKLAND SOUNDING
DECEMBER 1, 1971



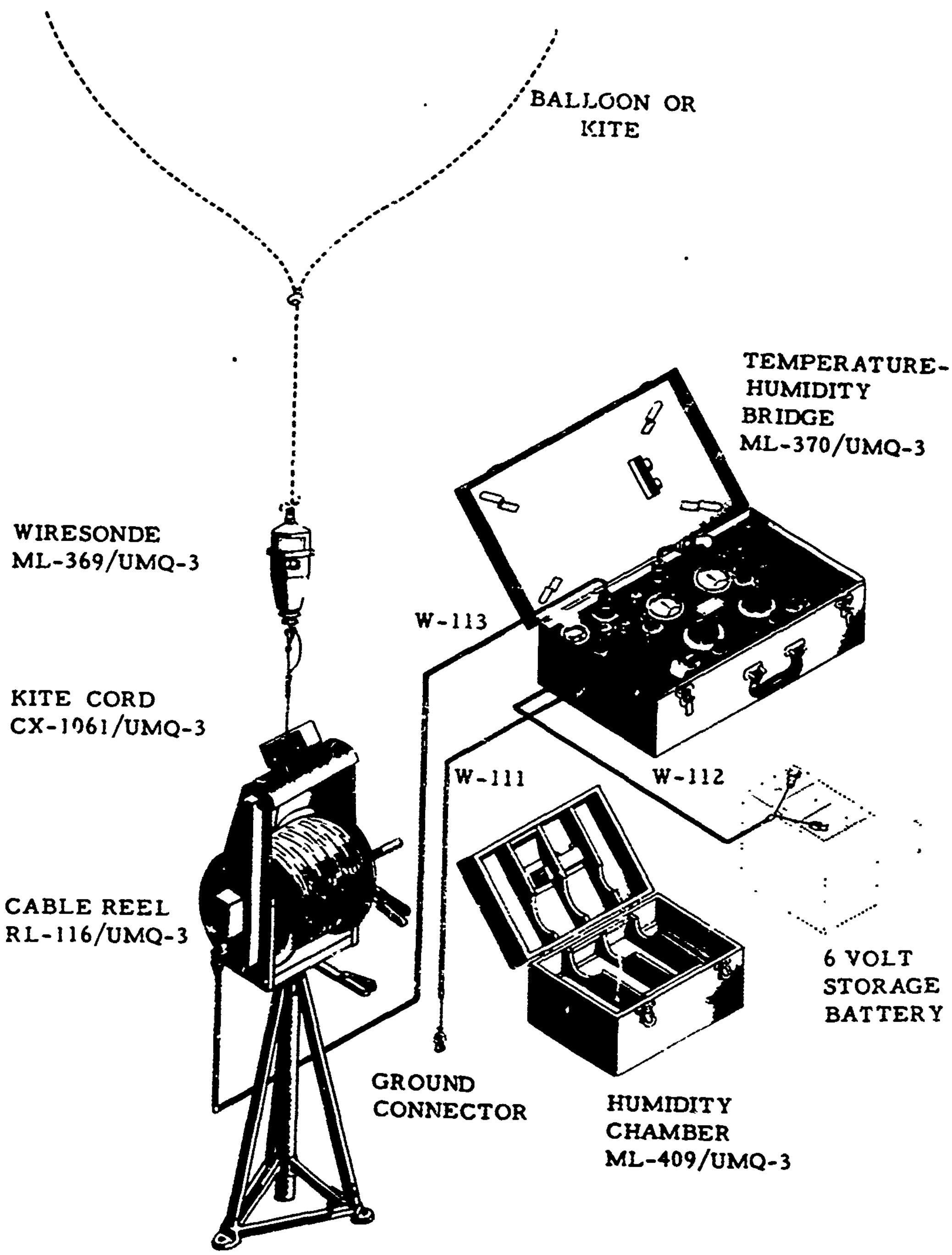

BALLOON OR
KITE
TEMPERATURE-
HUMIDITY
BRIDGE
ML-370/UMQ-3
WIRESONDE
ML-369/UMQ-3
W-113
KITE CORD
CX-1061/UMQ-3
W-111
W-112
CABLE REEL
RL-116/UMQ-3
6 VOLT
STORAGE
BATTERY
GROUND
CONNECTOR
HUMIDITY
CHAMBER
ML-409/UMQ-3

FIGURE 40.

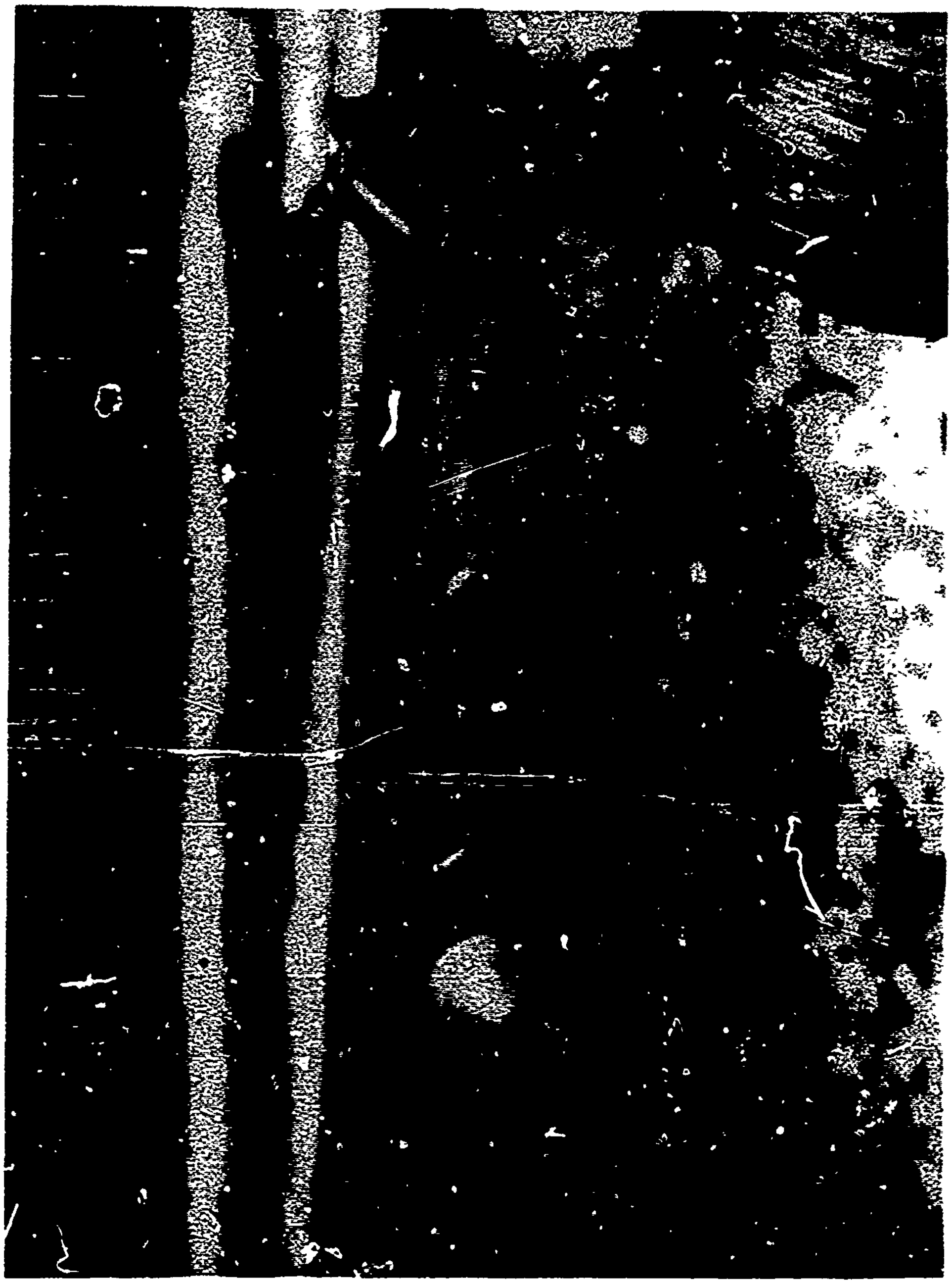


Figure 41.

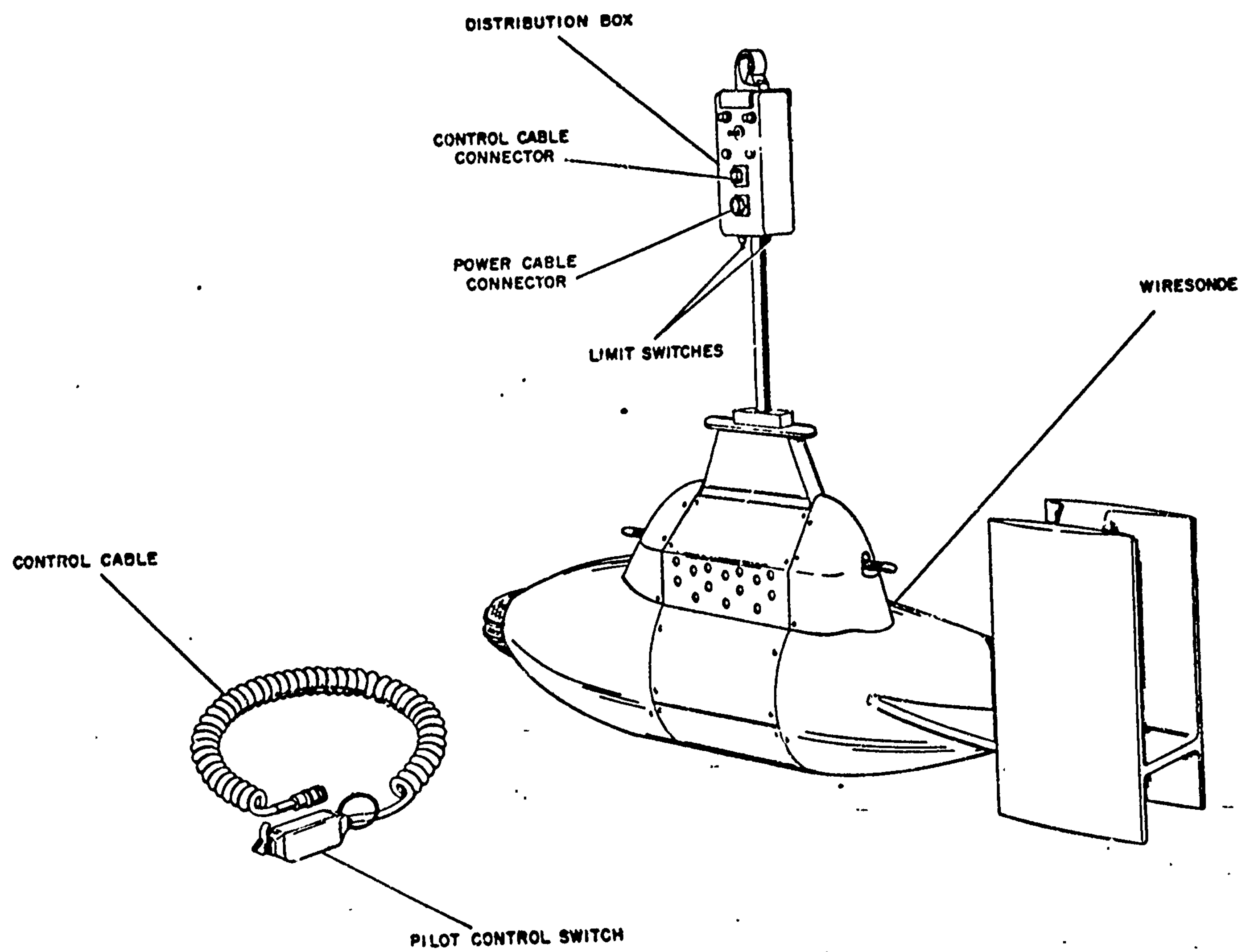

DISTRIBUTION BOX
CONTROL CABLE CONNECTOR
POWER CABLE CONNECTOR
LIMIT SWITCHES
WIRESONDE
CONTROL CABLE
PILOT CONTROL SWITCH

FIGURE 42.

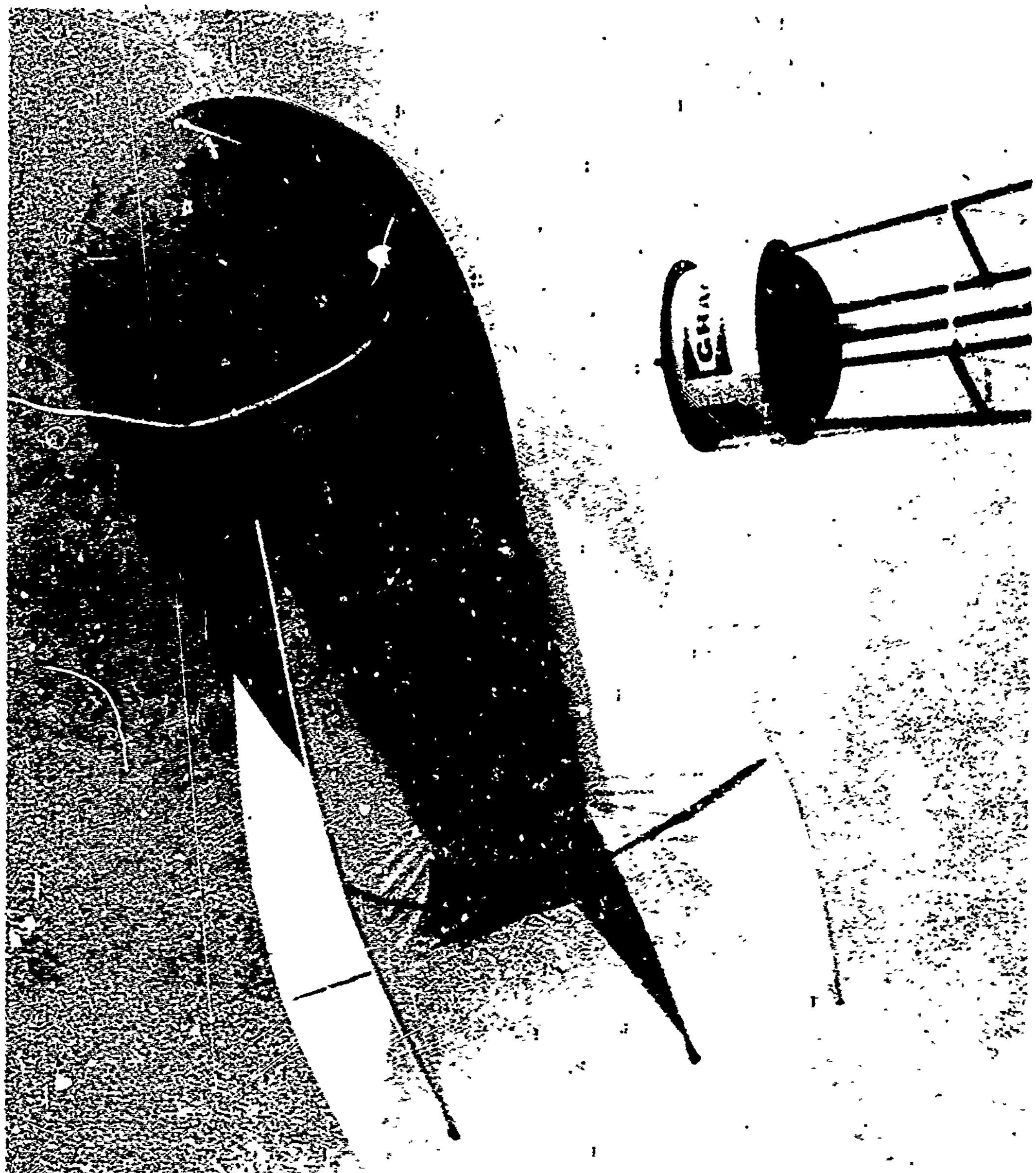


Figure 43.

APPENDIX A

All data collected during the period of this research are presented in tabular form in tables four through 18. The instrument correction has been applied to the pressure readings and the saturated mixing ratio was read from a thermodynamic diagram.

Tables 19 through 23 present all other information that was used in conjunction with the data as a basis for the conclusions in this research paper. The tables were prepared on a daily basis; however, each profile was included since some of the parameters varied from one profile to the next.

TABLE 1

Weighted Numerical Equivalent	Surface Winds Kts	Surface Pressure mb	SST-Surface Temperature Degrees C	Strength of Inversion	Oakland Sounding % Humidity	Surface Pressure Gradient	Vertical Gradient of m in the Inversion	Time of Data Collection
1	>20	< 995	<-1.5	None or very weak	60 or less	Very strong	Strong decrease	After 1200
2	15-20	995 to 1005	-1.5 to -0.5	Weak	70	Strong	Decrease	1000 to 1200
3	10-15	1005 to 1015	-0.5 to 0.5	Moderate	80	Moderate	Constant	0900 to 1000
4	5-10	1015 to 1025	0.5 to 1.5	Strong	90	Weak	Increase	0800 to 0900
5	< 5	>1025	> 1.5	Very strong	100	Very weak	Strong increase	Before 0800

TABLE 2

VISIBILITY CONDITION	SURFACE WIND KTS	SURFACE PRESSURE mb	SST-SURFACE TEMPERATURE DEGREES C	STRENGTH OF INVERSION	OAKLAND SOUNDING % HUMIDITY	SURFACE PRESSURE GRADIENT	VERTICAL GRADIENT OF m IN THE INVERSION	TIME OF DATA COLLECTION
Clear	12-15	1016	-1.8	Very weak	60	Weak	Decrease	0920
Slight haze	5	1006	1.0	Moderate	75	Moderate	Strong increase	1000
Haze	5	1006	1.0	Moderate	75	Moderate	Constant	0850
Haze	6-8	1012	-1.9	Weak	85	Strong	Decrease	0830
Haze	6-8	1012	-1.9	Very weak	85	Strong	Strong decrease	[illegible]45
Haze	6-8	1012	-1.9	Strong	85	Strong	Strong increase	0900
Haze	6-8	1012	-1.9	Moderate	85	Strong	Strong decrease	0915
Haze	6-8	1012	-1.9	Moderate	85	Strong	Decrease	0930
Fog	5	1016	0.4	Strong	100	Moderate	Strong increase	0830
Fog	5	1016	0.4	Strong	100	Moderate	100%	0845
Fog	5	1016	0.4	Strong	100	Moderate	100%	0900
Patches of fog	12-15	1023	0.5	Weak	85	Moderate	Strong increase	1210
Patches of fog	12-15	1023	0.5	Moderate	85	Moderate	Strong increase	1220
Patches of fog	12	1023	0.5	None	85	Moderate	Constant	1230
Patches of fog	12	1023	0.5	None	85	Moderate	Constant	1240

TABLE 3

Visibility Condition	Surface Wind	Surface Pressure	SST-Surface Temperature	Strength of Inversion	Oakland Sounding	Surface Pressure Gradient	Vertical Gradient of m in the Inversion	Time of Data Collection	Fog Index
Clear	2	4	1	1	1	4	2	3	18
Slight haze	4	3	4	3	3	3	5	2	27
Haze	4	3	1	2	3	3	2	4	22
Haze	4	3	4	3	3	3	2	4	26
Haze	4	3	1	1	3	3	1	4	20
Haze	4	3	1	4	3	3	5	3	26
Haze	4	3	1	3	3	3	1	3	21
Haze	4	3	1	3	3	3	2	3	22
Fog	5	4	4	4	5	3	5	4	34
Fog	5	4	4	4	5	3	5	4	34
Fog	5	4	4	4	5	3	5	4	34
Patches of fog	3	4	5	2	4	3	5	1	27
Patches of fog	3	4	5	3	4	3	5	1	28
Patches of fog	3	4	5	1	4	3	3	1	26
Patches of fog	3	4	5	1	4	3	3	1	26

TABLE 4

PROFILE NO. 1 OCTOBER 15, 1971

Ht (ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1005.8	11.5	80.8	6.92	8.55
50	1003.3	11.3	79.0	6.70	8.47
100	1001.7	10.8	80.0	6.55	8.18
150	999.3	10.5	73.8	5.95	8.06
200	997.6	10.8	79.0	6.49	8.22
300	993.0	10.3	84.0	6.70	7.98
440	987.5	10.8	84.3	6.98	8.28

TABLE 5

PROFILE NO. 2 OCTOBER 15, 1971

Ht (ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1005.8	11.6	80.7	6.95	8.60
50	1003.3	11.3	82.3	6.95	8.45
100	1001.7	11.5	82.2	6.95	8.45
200	997.6	10.8	81.5	6.70	8.22
300	993.0	11.3	81.3	6.95	8.55

TABLE 6

PROFILE NO. 1 NOVEMBER 19, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1016.0	10.0	66.0	5.05	7.65
500	1003.0	10.3	78.0	6.14	7.88
600	999.0	10.2	79.0	6.22	7.88
700	997.0	9.9	80.0	6.20	7.75
800	994.0	9.8	80.0	6.17	7.71
900	990.0	10.0	79.0	6.17	7.82
1000	983.0	10.0	78.0	6.14	7.87
1100	981.0	[illegible]	77.0	6.13	7.96
1200	979.0	10.1	76.0	6.07	7.98
1300	975.0	9.9	78.0	6.15	7.89
1400	972.0	9.8	78.0	6.15	7.89
1500	969.0	9.6	79.0	6.16	7.80
1600	964.0	9.3	81.0	6.25	7.73
1700	960.0	9.1	81.0	6.16	7.61
1800	957.0	8.9	80.5	6.07	7.55
1900	954.0	8.9	80.5	6.07	7.53
2000	951.0	8.7	80.0	6.00	7.50

TABLE 7

PROFILE NO. 1 NOVEMBER 24, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1016	11.1	83	6.9	8.23
500	1003	8.9	86.6	6.18	7.20
600	1000	9.6	87.0	6.60	7.58
700	994	10.2	88.0	6.98	7.93
800	989	10.8	89.0	7.34	8.24
900	986	10.8	91.0	7.56	8.31
1000	984	10.7	91.0	7.51	8.25
1100	979	10.6	92.0	7.58	8.24
1200	977	10.5	93.0	7.64	8.22
1300	972	10.5	94.0	7.75	8.25
1400	969	10.8	96.0	8.12	8.47
1500	966	11.1	94.0	8.14	8.68
1600	963	11.2	92.0	8.00	8.71
1700	959	11.2	93.0	8.13	8.75
1800	956	11.2	94.0	8.26	8.79
1900	953	11.3	98.0	8.70	8.88
2000	949	11.4	98.0	8.80	8.98

TABLE 8

PROFILE NO. 2 NOVEMBER 24, 1971

Ht(Ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1016	11.1	83	6.9	8.23
500	1002	8.1	100	6.80	6.80
600	999	8.2	100	6.90	6.90
700	995	9.6	100	7.58	7.58
800	991	10.1	98.0	7.70	7.86
900	987	10.1	98.0	7.76	7.92
1000	985	10.2	97.0	7.70	7.95
1100	981	10.3	97.0	7.80	8.03
1200	977	10.4	97.0	7.80	8.13
1300	973	11.1	94.0	8.07	8.59
1400	969	11.15	93.0	8.09	8.70
1500	966	11.3	95.0	8.35	8.79
1600	962	11.5	95.0	8.49	8.94
1700	959	11.6	95.0	8.58	9.03
1800	956	11.5	96.0	8.64	9.00
1900	952	11.3	98.0	8.73	8.92
2000	949	11.2	98.0	8.71	8.88

TABLE 9

PROFILE NO. 3 NOVEMBER 24, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1016	11.1	83	6.9	8.23
500	1002	7.4	100	6.53	6.53
600	999	8.1	100	6.86	6.86
700	995	9.9	99.0	7.66	7.74
800	991	10.5	96.0	7.77	8.10
900	987	10.7	95.0	7.82	8.23
1000	984	10.6	95.0	7.79	8.20
1100	980	10.3	96.0	7.77	8.10
1200	977	10.4	96.0	7.80	8.13
1300	973	10.4	97.0	7.88	8.13
1400	970	10.4	97.0	7.94	8.19
1500	967	10.2	98.0	8.00	8.16
1600	963	10.5	97.0	9.04	9.32
1700	959	10.7	97.0	9.23	9.51
1800	956	10.9	95.0	8.26	8.63
1900	952	11.1	97.0	8.53	8.80
2000	949	10.9	98.0	8.48	8.65

TABLE 10

PROFILE NO. 1 DECEMBER 1, 1971

Ht (ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1012	13.3	48	4.7	9.50
500	999	10.1	47.5	3.75	7.88
600	994	9.9	48.0	3.75	7.84
700	990	9.8	48.1	3.75	7.80
800	987	10.1	46.0	3.64	7.92
900	983	10.0	45.0	3.60	7.90
1000	979	9.8	45.2	3.55	7.86
1100	977	9.7	45.2	3.52	7.81
1200	973	9.8	44.7	3.52	7.89
1300	970	9.8	44.7	3.53	7.92
1400	967	9.4	44.3	3.44	7.77
1500	963	9.3	44.3	3.42	7.72
1600	959	9.1	45.1	3.45	7.65
1700	956	8.7	45.6	3.41	7.48
1800	952	8.5	45.9	3.39	7.40
1900	948	8.3	46.2	3.37	7.32
2000	945	8.2	46.7	3.40	7.28

TABLE 11

PROFILE NO. 2 DECEMBER 1, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1012	13.3	48	4.7	9.5
500	999	10.2	51.5	4.08	7.93
600	994	9.9	50.0	3.90	7.80
700	990	10.0	46.0	3.63	7.88
800	987	9.8	45.8	3.58	7.81
900	983	9.7	45.8	3.56	7.76
1000	980	9.7	45.8	3.56	7.78
1100	977	9.6	45.7	3.56	7.78
1200	975	9.5	45.5	3.51	7.72
1300	970	9.5	45.2	3.49	7.75
1400	965	9.5	44.8	3.49	7.82
1500	962	9.3	44.3	3.43	7.75
1600	959	9.2	44.2	3.39	7.68
1700	955	8.9	45.1	3.42	7.57
1800	951	8.8	45.5	3.44	7.55
1900	947	8.7	44.5	3.36	7.55
2000	943	8.7	43.5	3.30	7.58

TABLE 12

PROFILE 3 DECEMBER 1, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1012	13.3	48	4.7	9.5
500	999	7.4	58.5	3.82	6.53
600	994	7.2	62.5	4.06	6.49
700	989	7.9	60.0	4.11	6.85
800	985	8.8	54.5	3.98	7.31
900	982	9.2	51.5	3.86	7.50
1000	979	9.1	50.4	3.77	7.48
1100	976	9.0	50.2	3.73	7.44
1200	973	9.3	46.8	4.[illegible]0	9.61
1300	970	9.3	46.1	4.41	9.60
1400	966	9.2	45.8	4.38	9.55
1500	962	9.0	45.8	4.36	9.52
1600	959	8.9	45.7	4.33	9.50
1700	956	8.7	45.7	4.32	9.48
1800	953	8.4	46.4	4.33	9.34
1900	949	8.1	46.9	4.31	9.20
2000	946	8.3	45.5	4.26	9.38

TABLE 13

PROFILE 4 DECEMBER 1, 1971

Ht (ft)	Press mb	Temp (^{o}C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1012	13.3	48	4.[illegible]	9.5
500	999	9.3	54.0	4.03	7.46
600	994	9.7	52.8	4.03	7.62
700	989	9.9	47.5	3.72	7.84
800	985	10.0	45.2	3.56	7.90
900	982	10.2	44.5	3.56	8.00
1000	979	10.1	44.2	3.53	7.97
1100	976	9.9	44.0	3.48	7.91
1200	973	9.7	44.6	3.50	7.85
1300	970	9.4	45.1	3.49	7.75
1400	966	9.4	45.2	3.48	7.72
1500	962	9.2	45.0	3.46	7.69
1600	959	8.9	45.1	3.42	7.58
1700	955	8.7	45.2	3.39	7.50
1800	951	8.6	45.0	3.37	7.47
1900	947	8.5	44.5	3.30	7.42
2000	945	8.5	44.0	3.29	7.48

TABLE 14

PROFILE 5 DECEMBER 1, 1971

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1012	13.3	48	4.7	9.5
500	999	10.1	49.0	3.85	7.86
600	994	10.0	49.4	3.72	7.83
700	991	10.4	45.2	3.65	8.1
800	988	10.4	44.8	3.60	8.05
900	985	10.4	45.3	3.64	8.03
1000	979	10.2	44.6	3.57	8.01
1100	976	10.1	44.2	3.52	7.95
1200	972	10.0	44.1	3.50	7.92
1300	969	9.8	44.0	3.48	7.90
1400	966	9.7	43.8	3.45	7.87
1500	961	9.5	47.6	3.73	7.83
1600	959	9.3	48.5	3.79	7.81
1700	954	9.1	44.0	3.41	7.75
1800	950	9.1	43.5	3.37	7.75
1900	947	9.0	43.3	3.34	7.71
2000	944	8.6	43.1	4.11	9.55

TABLE 15

PROFILE 1 JANUARY 8, 1972

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1023	10	50	3.8	7.5
200	1015	5.6	79.0	5.25	6.65
300	1011	5.6	79.0	5.35	6.78
400	1009	5.1	79.0	5.08	6.44
500	1006	4.8	79.5	4.98	6.26
600	999	4.6	79.6	4.99	6.23
700	997	4.5	79.7	4.94	6.19
800	993	4.4	80.0	4.94	6.17
900	990	4.0	80.0	[illegible]76	5.95
1000	987	3.8	80.1	4.72	5.88
1100	983	3.4	80.7	5.65	5.65
1200	980	3.2	80.8	4.45	[illegible].50
1300	977	3.5	81.0	4.69	[illegible].80
1400	974	3.8	81.0	4.86	6 00
1500	970	3.4	80.5	4.67	5.80
1600	966	3.1	80.0	4.51	5.70
1700	962	2.6	79.5	4.30	5.42
1800	958	3.5	79.0	4.71	5.97
1900	954	4.5	74.0	4.90	6.63
2000	051	4.8	69.0	4.74	6.87

TABLE 16

PROFILE 2 JANUARY 8, 1972

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
2000	953	5.2	67.0	4.73	7.06
1900	957	4.7	68.0	4.56	6.70
1800	959	4.1	72.0	4.56	6.33
1700	969	3.9	77.0	4.67	6.08
1600	976	3.8	60.0	3.65	6.08
1500	979	3.6	65.0	3.82	5.89
1400	982	3.3	78.0	4.38	5.62
1300	985	3.1	80.0	4.40	5.50
1200	990	3.8	80.5	4.74	5.89
1100	995	4.5	81.0	5.02	6.20

TABLE 17

PROFILE 3 JANUARY 8, 1972

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1023	10	50	3.8	7.5
200	1015	6.3	78.0	5.63	7.21
300	1012	5.9	78.1	5.41	6.92
400	1008	5.8	78.6	5.43	6.92
500	1006	5.4	79.0	5.23	6.63
600	1003	5.3	79.1	5.21	6.59
700	999	4.9	79.5	5.07	6.39
800	995	4.6	79.9	5.00	6.26
900	990	4.3	80.2	4.95	6.17
1000	987	4.0	80.4	4.82	5.98
1100	983	3.6	80.7	4.68	5.80
1200	980	3.4	81.2	4.66	5.75
1300	978	3.3	81.2	4.63	5.70
1400	973	3.0	81.8	4.51	5.52
1500	970	2.7	81.7	4.41	5.40
1600	966	2.6	81.5	4.38	5.38
1700	963	2.6	82.0	4.41	5.39
1800	960	2.5	82.3	4.44	5.40
1900	957	2.4	82.5	4.43	5.36
2000	953	2.4	82.5	4.41	5.34

TABLE 18

PROFILE 4 JANUARY 8, 1972

Ht(ft)	Press mb	Temp (°C)	Humidity (%)	Mixing Ratio	Sat Mixing Ratio
0	1023	10	50	3.8	7.5
200	1015	6.6	60.0	4.42	7.37
300	1012	6.7	69.0	5.12	7.43
400	1008	6.6	79.0	5.90	7.48
500	1004	6.0	79.0	5.59	7.08
600	1002	5.8	80.0	5.60	7.00
700	999	5.5	80.0	5.50	6.87
800	993	5.2	80.3	5.30	6.60
900	990	5.1	80.6	5.32	6.58
1000	987	4.9	80.7	5.28	6.53
1100	982	4.6	80.7	5.22	6.45
1200	978	4.5	81.0	5.18	6.40
1300	975	3.9	81.5	4.95	6.06
1400	972	3.6	81.2	4.80	5.91
1500	969	3.5	81.2	4.78	5.88
1600	966	4.5	81.2	4.80	5.91
1700	963	3.5	81.0	4.81	5.94
1800	959	3.5	81.0	4.83	5.96
1900	953	3.4	81.0	4.84	5.97
2000	950	3.4	81.0	4.85	5.98

TABLE 19

October 15, 1971 Observations

Run Number	1	2
Local Time	0850	1000
Position Number	1	2
Visibility (Miles)	8	6-8
Water Temperature (Degrees C)	12.5	12.5
Surface Winds (Kts)	5	5
Lower Inversion Height (Ft)	135	50
Lower Inversion Thickness (Ft)	65	50
Upper Inversion Height (Ft)	300	200
Upper Inversion Thickness (Ft)	---	---
Isothermal Height (Ft)	---	---
NALF Pressure (mb)	1005.8	1005.8
NALF Humidity (%)	81	81
Surface Temperature (Degrees C)	11.5	11.6

TABLE 20

November 19, 1971 Observations

Run Number	1
Local Time	0920
Position Number	3
Visibility (Miles)	8-10
Water Temperature (Degrees C)	11.6
Surface Wind (Kts)	12-15
Lower Inversion Height (Ft)	700
Lower Inversion Thickness (Ft)	450
Upper Inversion Height (Ft)	---
Upper Inversion Thickness (Ft)	---
Isothermal Height (Ft)	1300
NALF Pressure (mb)	1016
NALF Humidity (%)	66
Surface Temperature (Degrees C)	13.4

TABLE 21

November 24, 1971 Observations

RUN NUMBER	1	2	3
Local Time	0830	0845	0900
Position Number	4	5	6
Visibility (Miles)	0.5	0.5	0.5
Water Temperature (Degrees C)	11.5	11.4	11.4
Surface Wind (Kts)	5-6	5-6	5-6
Lower Inversion Height (Ft)	500	550	500
Lower Inversion Thickness (Ft)	450	275	400
Upper Inversion Height (Ft)	1300	1250	1475
Upper Inversion Thickness (Ft)	700+	425	425
Isothermal Height (Ft)	---	825	1100
NALF Humidity (%)	50.0	50.0	50.0
Surface Temperature (Degrees C)	11.1	11.1	11.1
NALF Pressure (mb)	1016.2	1016.2	1016.2

TABLE 22

December 1, 1971 Observations

Run Number	1	2	3	4	5
Local Time	0830	0845	0900	0915	0930
Position Number	7	8	9	10	11
Visibility (Miles)	3	4	2.5	5	9
Water Temperature (Degrees C)	11.4	11.4	11.4	11.4	11.4
Surface Wind (Kts)	6-8	6-8	12-15	8-10	5-6
Lower Inversion Height (Ft)	700	600	575	500	625
Lower Inversion Thickness (Ft)	200	200	325	425	225
Upper Inversion Height (Ft)	1300	---	1100	---	1700
Upper Inversion Thickness (Ft)	125	---	100	---	175
Isothermal Height (Ft)	---	1200	1800	1350	---
NALF Pressure (mb)	1011.8	1011.8	1011.8	1011.8	1011.8
NALF Humidity (%)	48.0	48.0	48.0	48.0	48.0
Surface Temp. (Degrees C)	13.3	13.3	13.3	13.3	13.3

TABLE 23

January 8, 1972 Observations

RUN NUMBER	1	2	3	4
Local Time	1210	1220	1230	1240
Position Number	12	13	14	15
Visibility (Miles)	0-1	0-1	0-2	0-2
Water Temperature (Degrees C)	10.5	10.5	10.5	10.5
Surface Winds (Kts)	15-18	15-18	12-15	12-15
Lower Inversion Height (Ft)	1200	---	---	200
Lower Inversion Thickness (Ft)	225	---	---	150
Upper Inversion Height (Ft)	1700	1300	---	---
Upper Inversion Thickness (Ft)	---	---	---	---
Isothermal Height (Ft)	---	1500	1500	1400
NALF Pressure (mb)	1022.5	1022.5	1022.5	1022.5
NALF Humidity (%)	50	50	50	50
Surface Temperature (Degrees C)				
Level of Zero Visibility (Ft)	1200	---	---	---

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