TECHNICAL REPORT

ASWEPS REPORT NO. 8

STATISTICAL ANALYSIS OF
THE THERMAL STRUCTURE AT
OCEAN WEATHER STATION ECHO

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U. S. NAVAL OCEANOGRAPHIC OFFICE
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FOREWORD

Knowledge of the space-time variation of thermal structure parameters is prerequisite to development of prediction techniques for use in the Antisubmarine Warfare Environmental Prediction System (ASWEPS). Since this knowledge can be gained only through analysis of long series of data, historical bathythermograph (BT) observations from U.S. Coast Guard Ocean Station Vessels have been utilized. These observations, supplemented by high density time series data collected by Naval Oceanographic Office personnel aboard these vessels, form the basis of this report. The Oceanographic Office has assembled these data into the Sonar Experimental Research Card (SERC) deck, which is available to the scientific community for research purposes.

The statistical techniques of this report involve reduction of BT data to punchcard format suitable for thermal structure research. This report describes the environment at Ocean Weather Station ECHO (35N,48W) and is the first in a series. Subsequent reports will describe the environment at other Ocean Weather Stations.

DENYS W. KNOLL
Rear Admiral, U.S. Navy
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INTRODUCTION

Major problems in developing oceanographic forecasting techniques include: (1) formulation of a quantitative description of thermal structure variables in various areas; (2) determination of the size of an area that is covered by a point temperature structure forecast within statistical limits; (3) determination of the temporal extent of a point forecast within statistical limits; (4) whether assumed predictors can be isolated and ranked statistically; and (5) if so, whether the parameters of the predictors can be determined.

For examination of these and other thermal structure problems, the Sonar Experimental Research Card (SERC) deck of punchcards was created. The deck, as described below, includes bathythermographs (BT) and associated weather data from four experimental cruises, each of which was about three weeks in duration. These surveys covered each season between November 1958 and September 1959 at ocean weather station (OWS) ECHO located at 35N, 48W. ECHO was chosen for this study, because its location in the Sargasso Sea was thought to assure minimum advection and typical seasonal thermal structure cycles in the surface layers.

The experimental survey data from ECHO are composed of half-hourly BT's covering the entire cruise, some observations taken at 10-minute intervals for short periods of time, and several sets of simultaneous BT's. These data are supplemented by about 12 years of historical weather ship data (BT's and meteorological observations) from stations ECHO, BRAVO (56N, 51W), CHARLIE (52N, 35W), DELTA (44N, 41W), and HOTEL (36N, 70W). About 8,000 observations from CHARLIE, 5,000 from DELTA, 7,500 from ECHO, and 7,700 from HOTEL have been tabulated and punched on IBM cards. An additional 15,000 to 20,000 observations remain to be tabulated and punched on cards.

A large majority of the observations were taken with a 450-foot mechanical BT. Some 200-foot observations were included. The ECHO experimental cruises used the 900-foot mechanical BT.

SERC CODING AND THE DATATRON PROGRAM

After coding, BT and weather data from each observation are punched on a master and three detail IBM cards (figure 1). The first 17 columns of each card are reserved for latitude, longitude, date, and time. Columns 18 through 54 of the master card contain meteorological and additional identifying data. Detail card no. 1 contains the water temperature ($^{\circ}\text{F}$) at 20-foot increments from the surface to 360 feet and at 40-foot increments from 360 through 440 feet. Detail card no. 2 contains the temperature at 40-foot increments to the end of the trace. Space remains on the card for temperature data from the 1,300-foot electronic BT. Columns

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FIGURE 1 SONAR EXPERIMENTAL RESEARCH CARD

18 through 36 of detail card no. 3 are reserved for solar radiation data. Radiation data collected on the experimental cruises have not been tabulated and punched on the cards owing to shortage of manpower.

Various thermal structure parameters of importance in forecasting underwater sound can be defined in such a way that a computer can determine them by use of the temperature-depth data on the SERC cards. These parameters, shown in figure 2 and defined in appendix A, include surface effect, layer depth, surface temperature, maximum gradient (thermocline), mean gradient, and first gradient. For purposes of this study, the gradient is considered to be the rate of change ($^{\circ}\text{F}/100'$) as temperature decreases with increasing depth.

A program written for the Datatron 205 (appendix A) computed each of the above thermal structure parameters plus various numerical descriptions of the parameters. The results were then punched in columns 57 through 80 of the master card and in columns 46 through 75 of detail card no. 3. The numerical descriptions included the means of the gradients ($^{\circ}\text{F}/100'$), depths of the upper and lower bounds of the gradients, temperatures of the upper and lower bounds of the gradients, and thickness of the gradients.

Subsequent to preparation of this report (1961), the Datatron 205 was replaced by an IBM 7070, necessitating rewriting of the programs. A more extensive data error check was added, and an additional parameter, the ascendant (increasing temperature with increasing depth), is computed. The data relating to the ascendant is located in subsequent studies on detail card no. 3 in columns 40 through 45 and 76 through 80.

FIGURE 2 SCHEMATIC DIAGRAM OF THERMAL STRUCTURE PARAMETERS

Computation and storage of all these descriptive terms on the SERC deck were not necessary. However, it was envisioned that many statistical analyses using the SERC deck would be carried out on a computer with relatively slow input and output rates and a small memory. Thus considerable computer time and memory would be saved if the descriptive terms were stored on the punchcards.

Harvey (1) states that temperatures recorded at standard depths on the National Oceanographic Data Center geographical BT file do not reproduce a BT trace completely. As the SERC deck was originally intended for special research projects requiring a high degree of accuracy, it contains a finer gradation of the BT data. Although small depth-temperature intervals reproduce a BT trace more accurately, decrease of the intervals consumes more space on a punchcard. Intervals of 20 feet between the surface and 360 feet and intervals of 40 feet at depths below 360 feet were used as a compromise between the two extremes. Computation errors introduced by this choice of intervals as opposed to either a 5- or a 10-foot interval are a subject for a separate report.

ANALYSIS OF STATION ECHO DATA

Analysis of the Historical Data

In order to obtain a quantitative description of temporal and spatial variations in the thermal structure parameters, the ECHO historical deck was sorted into 1-degree quadrangles by months and years. The following parameters were chosen to adequately describe the thermal structure:

- (1) surface temperature
- (2) layer depth
- (3) maximum gradient
 - (a) average gradient
 - (b) temperature of the upper bound
 - (c) depth of the upper bound
 - (d) thickness
- (4) mean gradient
 - (a) average gradient
- (5) first gradient
 - (a) average gradient
 - (b) depth of the upper bound
 - (c) thickness

A Royal-McBee LGP-30 computer was programmed to compute the mean, standard error of the mean, variance, and standard deviation. These statistics were computed for the above-mentioned parameters for each 1-degree quadrangle by months for all years. Computations were not made for groups of less than 10 BT observations. Locations of observations were assumed to be accurate. Observations taken at 35°N, 48°W are arbitrarily assigned to the 1-degree quadrangle to the northwest.

Statistics of the chosen parameters are given in tables 1 through 10 (appendix B) which indicate maximum variations of the temporal means (over a period of years) and spatial means (from a given 1-degree quadrangle to the next). The period of time covered by the data is too short to determine any possible cycle or trend. Assuming normal distribution, confidence limits of the observations about the mean can be computed from $\bar{X} \pm 2S_x = 95\%$ confidence limits where S_x is the standard deviation. Likewise the confidence limits of the mean can be computed from $\bar{X} \pm t \cdot SE$, where t is the t distribution and SE is the standard error.

The ranges are indicative of year-to-year variation of the thermal structure during any given month. Unfortunately, a correlation exists between the magnitude of the ranges and the number of years of observations. For example, the mean of the ranges of all groups of 6 or more years of surface temperature observations is 4.4°F , and the mean of the ranges of all groups of 2 to 5 years of observations is 2.5°F .

Standard deviations and standard errors are more variable and are larger than expected in some cases, probably because of slide processing, reference temperature, instrumental, key punch, and coding errors. All data were carefully screened to minimize key punch and coding errors. The remainder of the standard deviation value after elimination of errors can be ascribed to variation in time and space. In mathematical terms if σ_s denotes the standard deviation of the observations, its components can be subdivided as follows:

$$\sigma_s^2 = \sigma_o^2 + \sigma_i^2 + \sigma_{kp}^2 + \sigma_c^2 + \sigma_{sp}^2 + \sigma_{rt}^2 + \sigma_{st}^2 \quad (1)$$

where the subscripts denote components due to field operator, instrumental, key punch, coding, slide processing, and reference temperature errors, and space and time variations, respectively.

Population means and standard deviations of the various parameters for the area were computed by the LGP-30 by sorting the SERC deck by months and years for the 20-minute quadrangle centered at $35^\circ\text{N}, 48^\circ\text{W}$. The statistics from this analysis are shown for the various thermal structure parameters in appendix B.

Instead of computing and then examining the data for significant spatial or temporal differences between the means of a given thermal structure parameter, a more powerful tool known as the 2-way analysis of variance (unequal numbers in subclasses) was employed. The technique, as outlined in Kendall (2), was programmed for the LGP-30.

The 2-way analysis of variance was considered to be only a gross technique, for example, checking computations for significant difference between 1-degree quadrangles over a number of years for a given month for a given thermal structure parameter (historical data). When no significant difference existed between means, a probability of 100 percent was assigned to it.

Computations frequently indicated significant differences between time periods and/or areas. If shorter time periods or fewer areas had been analyzed, it is probable that no significant differences might be found. In these cases the t test was used as a detail test to compare all possible combinations of pairs of means, based on the hypothesis that the two means were from the same population. The results of the analysis of variance and of t tests were converted into probabilities and are presented in tables 11 through 20 (appendix B).

In these tables the column headed " $\bar{X}$ " refers to the overall mean of pq, where p is the number of time periods, and q indicates the number of areas having data. The reliability of the probabilities increases as pq increases. The column "monthly mean in adjacent 1-degree quadrangles" contains the comparison of means of all data recorded during the indicated month within adjacent 1-degree quadrangles for the particular parameter of the thermal structure. The column "monthly mean in 1-degree quadrangle, year to year" refers to the comparison of means of particular parameters recorded over several years for the indicated month in the same 1-degree quadrangle. Therefore, table 11 may be interpreted as follows: mean temperature in January, based on 9 monthly means used in the analysis of variance, was 66.69°F. The probability that mean surface temperatures for the month of January in adjacent 1-degree areas are not significantly different is 60 percent, while the probability that January mean surface temperatures in the same 1-degree quadrangle are not significantly different from year to year is zero. In other words, there is continuity between areas but not between years.

For the remainder of the table, the conclusion can be drawn that mean surface temperatures are coherent or consistent spacewise in most months of the year but that they are rarely coherent from year to year, except in April. During April maximum convective activity may be expected, and, since OWS ECHO is in the area of 18-degree water discussed by Worthington (3), temperatures are consistent because of the annual water mass formation process.

Analysis of the Experimental Data

At the various ocean weather stations, two to four BT's were taken each day. The requirement of a minimum of 10 observations limited area size to 1-degree quadrangles and time periods to 1 month. During the four experimental surveys, BT's were taken every half hour. Thus, it was possible to reduce area size to 10-minute quadrangles and time division to 5-day periods.

The mean, standard error of the mean, and the standard deviation of the various thermal structure parameters were computed for each of the four experimental cruises and are presented in tables 21 through 24, (appendix B). The 2-way analysis of variance and the t test also were

applied to each 5-day-10-minute quadrangle sort. The resulting probabilities are presented in tables 11 through 20. The 5-day means of adjacent 10-minute quadrangles and alternate 10-minute quadrangles are results of testing means of all data recorded within adjacent and alternate 10-minute quadrangles during the same 5-day period. The successive 5-day and alternate 5-day means are results of testing means of all data recorded during successive and alternate 5-day time periods within the same 10-minute quadrangle. Blank spaces in the tables indicate lack of data.

If the data are assumed to have been taken at random over the 10-minute quadrangles during the same 5-day periods, the tests of adjacent and alternate 10-minute quadrangles indicate significant difference in the indicated thermal structure parameter over approximately 10- and 20-mile distances.

Referring to entries in table 11 reflecting results of experimental observations (columns involving 5-day means and 10-minute quadrangles), there is good probability of no significant difference between adjacent areas for all four experiments, whereas there is probably a significant difference between 5-day means for the experiments in March, May, and November, indicating significant short-term thermal changes which affected all areas more or less simultaneously. These short-term changes are of broad scope affecting major portions of the ocean.

RESULTS OF ANALYSIS

Appendix C contains graphs of the population mean monthly values of each parameter of the thermal structure (historical data from the 20-minute quadrangle centered at 35°N, 48°W).

Experimental data were used as a reliability check of the historical data. If the means of the experimental data fell within the range of the historical maximum and minimum means, the historical data were considered to be reliable. Means for March generally were not valid because of the lack of data, or because comparisons indicated that the historical data were in error. Comparisons also indicated that the mean gradient is dependent on the type of BT employed (450 or 900 feet). Thus, parameters of the mean gradient of the historical data are not accurate. All comparisons can be observed in the graphs in appendix C. They are also listed in column 5 of table 25 (appendix B).

When the population mean monthly values were plotted the resulting curves were sinusoidal. If the comparison of the means (historical versus experimental data) indicated reliable historical data for all months, the parameter curve was smoothed by Fourier analysis on the LGP-30 computer.

The results of the Fourier fitting are:

Surface Temperature

(2)

$$y = 71.60 - 6.61 \sin x - 2.68 \cos x + 1.29 \sin 2x + 0.36 \cos 2x$$

Maximum Gradient-Gradient (3)

$$y = 4.81 - 1.328 \sin x - 1.068 \cos x + 0.456 \sin 2x - 0.034 \cos 2x$$

Maximum Gradient-Thickness (4)

$$y = 91.0 - 44.9 \sin x - 35.2 \cos x + 18.3 \sin 2x + 9.0 \cos 2x$$

Maximum Gradient-Temperature of the Upper Bound (5)

$$y = 71.90 - 5.36 \sin x - 2.12 \cos x + 1.63 \sin 2x - 0.20 \cos 2x$$

First Gradient-Thickness (6)

$$y = 107.0 - 80.6 \sin x - 66.2 \cos x + 22.7 \sin 2x + 8.0 \cos 2x$$

where y = the desired parameter mean for a given month,
 $x = 15^\circ$ for January,
 $= 45^\circ$ for February,
 $= 75^\circ$ for March, etc.

Minimum and maximum values could be determined from these curves. These values usually occur 6 months apart; however, month of occurrence varies from parameter to parameter. Minimums and maximums of some parameters may persist for a period of 2 months, as shown in columns 2 and 3 of table 25 (appendix B). This indicates that thermal structure change occurs at a relatively slow rate during maximum and minimum periods. The minimums and maximums of certain parameters, however, do not consistently occur in the same month from year to year.

Owing to use of a 450-foot BT to obtain the historical data, minimums and maximums of certain parameters could not be computed with any degree of reliability during January, February, March, and April.

Maximum surface temperature can be expected during August or September. The minimum occurs during March or April. The layer depth and depths of the upper bound of the maximum gradient and first gradient are maximum in January or February and are minimum about 6 months later. The minimum gradients occur in winter — usually a month or two after the maximum depths. The gradients and their thicknesses are usually maximum during August.

The maximum standard deviations for surface temperature, as recorded in appendix B, were compared month by month for each parameter. This comparison showed that November surface temperatures yielded the largest standard deviations, indicating that temperature changes were greatest during this month. April had the next largest standard deviations; however, these were not nearly as large as those for November, indicating that spring warming occurs at a slower rate than autumnal cooling. Months of minimum surface temperature change are January, February, August, and September.

Although the probability values given in tables 11 through 20 are only approximate, the indicated trends probably are valid. A study of the individual probabilities indicates considerable variation. This may be

a true condition or may be due to lack of adequate data samples. To eliminate the variation and to obtain a clearer picture of trends, means of the probabilities for all months were computed (table 20). The results indicate that probability of persistence is highest for all thermal structure parameters when comparing means of areas during the same time periods. The highest probability is found by comparing monthly means of adjacent 1-degree quadrangles. With exception of surface temperature, all parameters have a mean probability greater than 90 percent that no significant difference exists (95% level of significance). This indicates that variability between adjacent 1-degree quadrangles is partially masked by the use of monthly means.

The next highest mean probability resulted from comparison of 5-day mean adjacent 10-minute quadrangles. However, this probability was only slightly higher than that for the comparison of 5-day means of alternate 10-minute quadrangles. Thus, the variability within a 10-minute quadrangle over a 5-day period is nearly the same in an area roughly 20 miles away as in one 10 miles away. In general, all thermal structure parameters varied more from one 5-day period to the next in one area than they do between 10-minute quadrangles during the same 5-day time period. The lowest mean probability of all parameters was recorded for 10-minute quadrangle, alternate 5-day means. It was the only recorded parameter with mean probability below 50 percent.

Parameters exhibiting greatest spatial persistence are the gradients of the first and maximum gradients and the thickness of the maximum gradient. Parameters exhibiting least spatial persistence are the gradient of the mean gradient, the layer depth, and the temperature of the upper bound of the maximum gradient. As mentioned previously, the magnitude of the mean gradient is related to the BT type (450 or 900 feet) and is not a reliable statistic.

The only parameter exhibiting a high degree of temporal persistence is the thickness of the first gradient. The gradients of the first and maximum gradients apparently persist from one 5-day period to the next but vary from year to year. Surface temperature and the temperature of the upper bound of the maximum gradient show the greatest temporal variability.

One objective of this study is determination of area size for which a point temperature structure forecast is applicable within statistical limits. A direct solution of this problem necessitates comparison of individual observations. Since locations of individual observations may be in error by as much as 5 miles, such comparisons may be invalid. It is hoped that errors may be minimized through processing of large amounts of data. Thus, the quantity of data available may indicate the analysis potential or limitations.

If the spatial variation in the thermal structure occurring at any given instant within a 10-minute quadrangle is assumed to be equal to or less than the variation in a 5-day period within the same area, table 26 can be used to give an estimate of the spatial variation. For example, variation in surface temperature during March within a 10-minute quadrangle is ($\pm 3 \times .37$) or $\pm 1.11^{\circ}\text{F}$ for 100 percent probability; and

($\pm 2 \times .37$) or $\pm .74^{\circ}\text{F}$ for 95 percent probability. This estimate should be fairly accurate, because errors in the method tend to cancel each other.

Months of maximum and minimum variability for each thermal structure parameter are listed in table 26 (appendix B). These values were determined by computing the mean standard deviation for all 5-day, 10-minute quadrangles and 3-week, 10-minute quadrangles. The results were checked against historical data and found to be in approximate agreement. However, both sets of data were insufficient for determining months of maximum and minimum variability.

QUALITY OF THE DATA AND STATISTICAL ANALYSIS

The magnitude of the various errors involved in the methods of obtaining, processing, reading, and analyzing the data properly are of sufficient importance to warrant a separate study. Thus only a brief qualitative discussion is presented here.

A number of reports dealing with BT errors are available. The most comprehensive study is probably that of Bralove and Williams (4). By use of their qualitative report and the SERC deck, some of the errors associated with BT data can be quantitatively analyzed. They result from instrument limitation (limited accuracy), calibration (malfunctions), operational (human error), reference temperature, data processing, and location error.

The magnitude of the location error, which cannot be determined, varies from cruise to cruise and from station to station and certainly reduces the reliability of the analyses.

Conclusions based on the analysis of variance technique are valid if observations are randomly chosen from normally distributed populations having approximately equal variances. However, the observations were not taken at random over any given area (e.g., a 1-degree quadrangle), rather they tend to be concentrated about the central location of $35^{\circ}\text{N}, 48^{\circ}\text{W}$. Also, times of observation are not random within each area. Fortunately, investigation shows that the results of the analysis are changed little by moderate departure from the assumptions. Distribution curves were plotted for each month and parameter. The analysis of variance and the t test were applied only to groups of data having approximately normal distributions and equal variances.

Because of extreme care exercised on the four experimental cruises, instrument and operator errors were assumed to be minimal for comparison purposes.

To obtain an indication of the magnitude of the instrument errors, the ratios of the standard deviations of the historical data to the experimental data for the 20-minute quadrangle centered at $35^{\circ}\text{N}, 40^{\circ}\text{W}$ were computed. If the size of the area and the time period were the same for both sets of data, the standard deviations should be approximately the same for any given parameter. If a ratio of the two standard deviations did not approach unity,

the excess of one deviation over the other was attributed to causes other than space and time variations, e.g., instrument error or data processing error. Normally, both experimental and historical data might contain instrument error. The standard deviations were not directly comparable, because the time periods of the experimental data were only two-thirds those of the historical data.

The ratios (table 25) for various parameters related only to depth varied from 0.95 to 1.14, well within the 33 percent variation that can be attributed to the difference in length of the time periods. Thus, the magnitude of error incorporated into the standard deviations is approximately the same for the historical and experimental data. However, the standard deviation ratios of various parameters related to temperature consistently fell beyond the 33 percent tolerance and varied between 1.45 and 2.66. This indicates that standard deviations of historical data related to temperature contain a large error factor.

CONCLUSIONS

Conclusions drawn from analysis of the data are pertinent to variations in the thermal structure only at ocean weather station ECHO. Studies are contemplated for other stations. The following specific conclusions are made:

1. Because experimental cruise data are of much greater value than historical data, samples should be collected at other ocean weather stations for comparison purposes.
2. Monthly means of parameters of the thermal structure show sinusoidal annual curves.
3. The temperature element of the 450-foot BT appears to be subject to considerable error; the pressure element appears to be relatively stable. Temperature errors may indicate reference temperature errors.
4. The probability of persistence for all thermal structure parameters is highest when comparing means of all observations taken over a period of a month within adjacent 1-degree quadrangles. This result supports the persistence theory explained by Perlroth and Simpson (5).
5. The probability of persistence is quite low when comparing year-to-year mean monthly values of all observations within a 1-degree quadrangle.
6. The probability of persistence for any parameter during the same 5-day period is generally greater between adjacent 10-minute quadrangles than it is between consecutive 5-day time periods within the same 10-minute quadrangle.
7. The gradients of the first and maximum gradients and the thickness of the maximum gradient exhibit greatest spatial persistence.
8. The only parameter exhibiting high temporal persistence is the thickness of the first gradient.

9. Conclusions 4 through 8 are limited to months and parameters that exhibit normal distribution.

ACKNOWLEDGEMENTS

All historical BT and weather observations were collected by U.S. Coast Guard personnel at ocean weather stations. Appreciation is also due various personnel of the Oceanographic Office who provided helpful suggestions, who carried out the field surveys, or who assisted in the many phases of data processing and programming. Special acknowledgement is due Mr. R. Bolton who wrote the SERC thermal structure program for Datatron use (appendix A).

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APPENDIX A
DESCRIPTION OF THE
DATATRON 205
PROGRAM

APPENDIX A

DESCRIPTION OF THE DATATRON 205 PROGRAM

The five main functions of this program are:

1. Determination of the depth at which speed of sound is maximum. This level is defined as the layer depth. Sound velocity is computed from the following polynomial:

$$\text{Sound velocity} = a + T_i \left[b + T_i (-c + d T_i) \right] + e Z_i$$

where $a = 4742.2473$
 $b = 15.316241$
 $c = .18545565$
 $d = .00103379$
 $e = .05938308$

T_i = Temperature ($^{\circ}\text{C}$) at Z_i
 Z_i = Water depth in meters

If the maximum computed sound velocity is at the lowest depth on the BT trace; this depth is recorded as the layer depth with an X overpunch in column 58.

2. To search the digitized BT trace between the surface and 80 feet for the surface effect. The surface effect must have a nearly constant slope with an absolute value greater than $1^{\circ}\text{F}/100$ ft between its lower bound and the surface. A leeway factor of $0.5^{\circ}\text{F}/100$ ft is allowed between slopes. If this slope extends below a depth of 60 feet, the surface effect is recorded as 60 feet with an X overpunch in column 76 of the master card for card output and is preceded by a negative sign on print out. In all other cases the depth of the surface effect is recorded as the upper bound of the first slope interval that fails to meet the stipulated requirements. The mean gradient of the surface effect in $^{\circ}\text{F}/100$ ft is also recorded. If the search indicates no surface effect, zero is entered in all appropriate columns of the master card.

3. To determine the maximum gradient, each depth interval below the recorded surface effect is examined.* The BT depth intervals are always considered to be 20 feet. Thus all 40-foot intervals (360 to 880 feet) are linearly interpolated into two 20-foot intervals. The upper bound of the first interval having a slope equal to or less than $-2^{\circ}\text{F}/100$ ft is recorded (in the computer program -3°F , etc., are less than -2°F).

*When this program was written, temperature data were assumed to be continuous. Occasionally a temperature value was omitted from the punch card at an intermediate depth. The card was punched 000, indicating no data. The Datatron program recognized this depth as the last recorded interval and accordingly computed the gradients only to this depth. Experience shows that a linear interpolation over the adjacent depths should be made. Gradients computed by use of the interpolated values are more realistic.

When two consecutive intervals are found with a slope greater than $-2^{\circ}\text{F}/100$ ft or when one interval is found with a slope greater than $0^{\circ}/100$ ft, the lower bound of the last slope with value less than $-2^{\circ}\text{F}/100$ ft is recorded. The slope between the two recorded bounds is computed and recorded as a gradient. An identical search is begun at the last examined interval. When all such gradients have been examined, the data for the gradient with the greatest absolute value is recorded for output as the maximum gradient.* If no gradient meets the requirement, all columns for the maximum gradient are recorded as zero on the master card. Exceptions to this procedure are:

a. Gradients less than 40 feet thick are not recorded unless the slope is less than $-25^{\circ}\text{F}/100$ ft.

b. If a maximum gradient continues to the end of the trace and the last interval meets the requirements for inclusion in the gradient, the depth of that interval is recorded as the lower bound of the maximum gradient. If the last interval has a negative slope but does not meet the requirements of a maximum gradient and the next to the last interval is included in the maximum gradient, the lower depth of the latter interval is recorded as the lower bound of the maximum gradient. In either event, column 68 of the master card is X overpunched and the value of the maximum gradient is preceded by a minus sign on print out.

4. To determine the mean gradient the digitized trace is searched for the first interval below a recorded surface effect with slope less than $-1^{\circ}\text{F}/100$ ft. The upper bound of this interval is recorded as the upper bound of the mean gradient. A search is made below this point for the lowest temperature of the digitized trace. The depth of the lowest temperature is recorded as the lower bound of the mean gradient. The slope between the upper and lower bounds is computed and recorded as the mean gradient. If positive gradients exist in the mean gradient, column 49 of detail card no. 3 is X overpunched, and the mean gradient is preceded by a negative sign on print out.** If no gradient meets the requirement, all columns for the mean gradient are recorded as zero.

5. To determine the first gradient the portion of the digitized trace below the recorded surface effect is searched for the first gradient with slope less than $-1^{\circ}\text{F}/100$ ft. The upper bound of this gradient is recorded and the remainder of the trace is examined until either slopes in two adjacent intervals equal to or greater than $-1^{\circ}\text{F}/100$ ft are found or until a slope greater than $0^{\circ}/100$ ft is found. If the first gradient is not found in the digitized BT trace, all columns for that entity are recorded

*Some key punch and coding errors escaped a cursory check. The program was written to reject any observation as being in error when the computation resulted in a gradient greater than $100^{\circ}\text{F}/100$ ft. Experience has shown that this threshold value should be reduced to $20^{\circ}\text{F}/100$ ft.

**Experience shows that positive gradients are never detected by this search. The entire BT trace should be searched for a positive gradient, as well as the mean gradient.

as zero. The bottom bound of the last interval with slope less than $-1^{\circ}\text{F}/100\text{ ft}$ is then recorded. The slope between the upper and lower bounds is computed and recorded as the first gradient. The following are exceptions to this procedure:

a. A gradient with thickness less than 40 feet and slope greater than $-2^{\circ}\text{F}/100\text{ ft}$ is discarded, and a new search is begun from the last interval examined.

b. If the first gradient persists to the end of the trace and the last interval meets the requirements for inclusion in the first gradient, the depth of the last recorded temperature is designated as the lower bound of the first gradient. If the last interval of the digitized graph has a negative slope but does not meet the requirements of a first gradient, and the next to the last interval is included in the first negative gradient, the lower depth of this interval is designated as the lower bound of the first gradient. In either event, column 68 of detail card no. 3 is X overpunched and the first gradient is preceded by a minus sign print out.

APPENDIX B
STATISTICAL ANALYSIS OF PARAMETERS

Table 1

Statistical Analysis of Historical Data for Chosen Parameters

Monthly Sea Surface Temperature ($^{\circ}\text{F}$)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JANUARY						
34N,47W	3	67.7	66.0	1.7	.17	.64
34N,48W	4	67.8	65.9	1.9	.27	.96
35N,47W	3	68.7	65.1	3.6	.45	1.34
35N,48W	8	70.3	65.0	5.3	.29	1.62
35N,48W *	8	69.9	65.0	4.9	.34	1.92
FEBRUARY						
34N,47W	1	65.8	65.8	--	.24	.77
34N,48W	4	67.6	64.8	2.8	.27	.96
35N,47W	3	67.4	64.7	2.7	.31	1.27
35N,48W	7	67.5	64.4	3.1	.28	1.68
35N,48W *	7	71.2	64.3	6.9	.29	1.71
MARCH						
35N,47W	4	65.7	64.7	1.0	.26	1.15
35N,48W	6	66.7	64.2	2.5	.28	1.45
35N,48W *	7	66.8	63.7	3.1	.48	2.01
APRIL						
34N,47W	2	66.7	66.3	0.4	.24	1.06
34N,48W	3	66.0	65.3	0.7	1.00	3.31
35N,47W	3	66.3	65.1	1.2	.24	1.29
35N,48W	7	67.0	61.5	5.5	.40	2.82
35N,48W *	7	66.7	61.9	4.8	.34	2.83
MAY						
34N,47W	2	70.0	65.4	4.6	.29	1.06
34N,48W	2	69.1	67.3	1.8	.42	1.32
35N,47W	5	68.3	65.0	3.3	.29	1.34
35N,48W	8	69.6	64.4	5.2	.43	2.45
35N,48W *	9	69.6	66.8	2.8	.32	2.12
JUNE						
34N,47W	3	75.3	72.4	2.9	.45	1.90
34N,48W	4	74.9	72.2	2.7	.64	1.92
35N,47W	3	74.1	71.7	2.4	.47	1.49
35N,48W	6	74.2	67.8	6.4	.43	2.50
35N,48W *	6	74.5	67.8	6.7	.41	2.52

* 20-minute square centered at this location

Table 1 (con)

<u>One-Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JULY						
34N47W	2	77.5 ^o	77.0 ^o	0.5 ^o	.27	1.10
34N48W	5	79.5	76.8	2.7	.60	1.91
35N47W	3	79.6	77.2	2.4	.36	1.52
35N48W	7	78.8	75.4	3.4	.31	2.13
36N48W	1	76.8	76.8	--	.24	.88
35N48W*	8	78.8	75.7	3.1	.27	2.19
AUGUST						
34N47W	2	79.7	79.1	0.6	.49	1.61
34N48W	4	80.7	78.1	2.6	.45	1.50
35N48W	8	80.2	76.0	4.2	.16	1.65
35N48W*	8	80.1	77.3	2.8	.19	1.68
SEPTEMBER						
34N47W	2	80.8	78.2	2.6	.56	1.78
34N48W	6	81.8	76.4	5.4	.41	1.41
35N47W	3	79.2	77.0	2.2	.41	1.41
35N48W	7	80.3	77.2	3.1	.27	1.65
35N48W*	8	80.6	77.2	3.4	.28	1.67
OCTOBER						
34N47W	1	76.2	76.2	--	.66	2.08
34N48W	2	79.5	79.5	--	.55	1.92
35N47W	2	77.9	74.9	3.0	.27	1.13
35N48W	7	78.6	74.6	4.0	.44	2.51
35N48W*	7	78.4	74.2	4.2	.48	2.25
NOVEMBER						
34N47W	3	77.1	72.7	4.4	.85	3.60
34N48W	5	76.0	72.3	3.7	1.28	4.23
35N47W	5	75.5	71.9	3.6	.74	3.79
35N48W	6	76.7	71.9	4.8	.61	4.09
35N48W*	8	76.8	69.1	7.7	.45	3.86
DECEMBER						
34N47W	2	69.3	69.2	0.1	.38	1.21
34N48W	3	73.5	68.2	5.3	.91	2.87
35N47W	4	72.3	69.1	3.2	.63	2.19
35N48W	7	72.3	69.4	2.9	.33	2.06
35N48W*	7	72.2	69.3	2.9	.31	2.06

* 20-minute square centered at this location

Table 2

Statistical Analysis of Historical Data for Chosen Parameters

Monthly Layer Depth (ft)

<u>One-Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	3	357	200	157	17.1	45.4	70
34N48W	4	370	327	43	53.3	92.4	72
35N47W	3	400	365	35	23.9	47.3	72
35N48W	8	380	273	107	66.3	162.3	57
35N48W*	8	376	289	87	49.2	147.7	60
FEBRUARY							
34N48W	6	377	180	197	77.5	154.9	78
35N47W	3	370	250	120	21.3	212.1	76
35N48W	7	347	90	257	83.5	166.9	90
35N48W*	7	360	72	288	67.1	150.1	80
MARCH							
34N48W	1	300	300	--	23.1	40.0	70
35N47W	4	360	220	140	86.0	172.0	84
35N48W	6	360	153	207	83.3	144.2	80
35N48W*	7	360	129	231	101.1	202.2	67
APRIL							
34N47W	2	273	91	182	33.3	110.4	40
34N48W	3	298	8	290	49.9	141.2	50
35N47W	3	208	91	117	115.7	200.3	54
35N48W	7	306	55	251	146.6	165.5	57
35N48W*	7	303	48	255	32.1	150.7	55
MAY							
34N47W	2	70	51	19	40.2	98.6	34
34N48W	2	62	62	--	10.5	33.3	0
35N47W	5	120	28	92	50.4	142.6	13
35N48W	8	111	20	91	17.6	98.0	4
35N48W*	9	151	33	118	21.7	119.0	2
JUNE							
34N47W	3	20	6	14	6.8	26.2	0
34N48W	4	51	6	45	10.9	30.0	0
35N47W	3	33	18	15	2.8	30.4	0
35N48W	6	47	10	37	7.3	42.3	0
35N48W*	6	32	4	28	9.7	63.7	0

* 20-minute square centered at this location

Table 2 (con)

<u>One-Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JULY							
34N47W	2	32	20	12	7.5	30.9	0
34N48W	5	27	8	19	7.0	29.2	0
35N47W	3	44	12	32	8.9	38.6	0
35N48W	7	27	10	17	3.2	26.8	0
36N48W	1	4	4	--	2.3	8.5	0
35N48W*	8	31	4	27	2.3	30.1	0
AUGUST							
34N47W	2	32	27	5	8.2	27.2	0
34N48W	4	44	29	15	9.5	31.5	0
35N48W	8	41	17	24	7.3	35.3	0
35N48W*	8	37	18	19	4.8	34.2	0
SEPTEMBER							
34N47W	2	80	27	53	11.3	40.8	0
34N48W	6	104	44	60	11.8	49.6	0
35N47W	3	103	77	26	14.9	51.8	0
35N48W	7	98	26	72	11.5	58.8	0
35N48W*	8	96	48	48	7.7	55.5	0
OCTOBER							
34N47W	1	138	138	--	21.6	68.3	0
34N48W	2	140	140	--	7.4	25.6	0
35N47W	2	199	117	82	22.1	98.5	0
35N48W	7	202	106	96	14.7	68.7	0
35N48W*	7	171	120	51	10.0	68.7	0
NOVEMBER							
34N47W	3	234	219	15	12.6	65.7	0
34N48W	5	280	162	118	23.0	74.8	0
35N47W	5	278	203	75	22.2	70.2	9
35N48W	6	269	207	62	14.7	77.8	4
35N48W*	8	278	147	131	15.5	79.4	2
DECEMBER							
34N47W	2	318	263	55	8.7	27.4	19
34N48W	3	366	274	92	32.5	103.0	28
35N47W	4	329	264	65	20.2	70.0	5
35N48W	7	374	203	171	12.3	75.6	25
35N48W*	7	367	284	83	13.1	67.9	26

* 20-minute square centered at this location

Table 3

Statistical Analysis of Historical Data for Chosen Parameters

Gradient of the Thermocline (Maximum Gradient)

($^{\circ}\text{F}/100\text{ ft}$)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	3	--	--	--	--	--	100
34N48W	4	--	--	--	--	--	100
35N47W	3	--	--	--	--	--	100
35N48W	8	4.22	2.42	1.80	.52	2.17	84
35N48W*	8	4.25	3.42	.83	.49	2.67	84
FEBRUARY							
34N48W	6	2.35	2.35	--	--	--	94
35N47W	3	--	--	--	--	--	100
35N48W	7	2.00	2.00	--	--	--	98
35N48W*	7	4.67	2.75	1.92	.31	.93	96
MARCH							
34N48W	1	--	--	--	--	--	100
35N47W	4	--	--	--	--	--	100
35N48W	6	--	--	--	--	--	100
35N48W*	7	--	--	--	--	--	100
APRIL							
34N47W	2	--	--	--	--	--	96
34N48W	3	--	--	--	--	--	100
35N47W	3	3.40	3.37	.03	.29	1.64	96
35N48W	7	4.00	2.50	1.50	.12	1.02	96
35N48W*	7	3.44	2.50	.94	.68	2.18	95
MAY							
34N47W	2	7.13	4.25	2.88	.85	3.07	50
34N48W	2	5.09	3.70	1.39	.94	2.98	30
35N47W	5	4.80	2.74	2.06	.60	2.56	52
35N48W	8	5.38	3.16	2.22	.29	3.06	50
35N48W*	9	5.85	3.30	2.55	.56	2.67	39
JUNE							
34N47W	3	8.30	5.67	2.63	1.07	3.05	0
34N48W	4	8.30	4.23	4.07	.71	2.35	0
35N47W	3	7.27	5.78	1.49	.86	2.72	0
35N48W	6	6.65	4.06	2.59	.57	2.62	4
35N48W*	6	7.00	4.63	2.37	.76	5.00	2

* 20-minute square centered at this location

Table 3 (con)

One - Degree Quadrangle	Number of Years of Data	Maximum Mean	Minimum Mean	Range	Maximum Standard Error	Maximum Standard Deviation	Percentage of Obs. > Max BT Depth
JULY							
34N47W	2	6.01	4.74	1.27	.29	1.20	0
34N48W	5	6.44	5.17	1.27	.37	1.63	0
35N47W	3	6.85	5.42	1.43	.46	3.04	0
35N48W	7	8.27	6.07	2.20	.38	3.21	0
36N48W	1	7.38	7.38	--	.45	1.67	0
35N48W*	8	8.10	5.43	2.67	.32	2.57	0
AUGUST							
34N47W	2	6.99	6.62	0.37	.38	1.27	0
34N48W	4	8.15	4.83	3.32	.63	2.07	0
35N48W	8	8.99	5.51	3.48	.37	3.61	0
35N48W*	8	9.10	5.43	3.67	.34	3.57	0
SEPTEMBER							
34N47W	2	8.49	5.25	3.24	2.31	7.30	0
34N48W	6	8.27	5.65	2.62	.76	2.65	0
35N47W	3	8.16	5.57	2.59	.62	2.40	0
35N48W	7	8.50	4.92	3.58	.49	4.64	0
35N48W*	8	8.43	5.15	3.28	.76	4.52	0
OCTOBER							
34N47W	1	6.07	6.07	--	1.33	4.21	0
34N48W	2	7.31	7.31	--	.26	.90	0
35N47W	2	6.69	3.83	2.86	.41	1.60	0
35N48W	7	7.94	3.98	3.96	.22	2.31	0
35N48W*	7	8.06	3.57	4.49	.49	3.69	0
NOVEMBER							
34N47W	3	7.90	4.93	2.97	.88	3.72	0
34N48W	5	6.10	4.05	2.05	.90	2.97	7
35N47W	5	5.75	3.78	1.97	.45	2.22	12
35N48W	6	6.71	4.04	2.67	.46	2.93	10
35N48W*	8	6.79	3.66	3.13	.37	2.38	11
DECEMBER							
34N47W	2	4.18	4.18	--	.24	1.21	10
34N48W	3	4.98	4.78	0.20	.58	2.04	18
35N47W	4	5.00	3.44	1.56	.35	2.19	19
35N48W	7	4.71	3.17	1.54	.41	2.49	26
35N48W*	7	4.72	2.79	1.93	.32	2.12	48

* 20-minute square centered at this location

Table 4

Statistical Analysis of Historical Data for Chosen Parameters

Depth of the Upper Bound of the Maximum Gradient (ft)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JANUARY						
34N47W	3	--	--	--	--	--
34N48W	4	--	--	--	--	--
35N47W	3	--	--	--	--	--
35N48W	8	390	322	68	12.2	40.5
35N48W*	8	390	346	44	9.8	36.3
FEBRUARY						
34N48W	6	360	360	--	--	--
35N47W	3	--	--	--	--	--
35N48W	7	--	--	--	--	--
35N48W*	7	313	271	42	6.8	20.3
MARCH						
34N48W	1	--	--	--	--	--
35N47W	4	--	--	--	--	--
35N48W	6	--	--	--	--	--
35N48W*	7	--	--	--	--	--
APRIL						
34N47W	2	--	--	--	--	--
34N48W	3	--	--	--	--	--
35N47W	3	92	92	--	13.7	43.4
35N48W	7	133	100	33	37.1	64.2
35N48W*	7	117	72	45	40.0	56.6
MAY						
34N47W	2	85	70	15	14.4	49.8
34N48W	2	92	89	3	14.4	65.0
35N47W	5	140	80	60	17.7	50.1
35N48W	8	143	71	72	22.6	83.4
35N48W*	9	218	77	141	29.8	98.9
JUNE						
34N47W	3	71	42	29	18.1	82.8
34N48W	4	82	52	30	14.7	44.1
35N47W	3	86	74	12	31.0	98.0
35N48W	6	116	56	60	12.7	74.0
35N48W*	6	111	63	48	10.7	66.0

* 20-minute square centered at this location

Table 4 (con)

<u>One - Degree Quadrangle</u>	<u>Number of Year of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JULY						
34N47W	2	74	56	18	16.1	66.2
34N48W	5	74	28	46	7.0	48.4
35N47W	3	72	58	14	8.7	56.4
35N48W	7	66	38	28	7.0	59.0
36N48W	1	26	26	--	4.4	16.5
35N48W*	8	72	38	34	7.9	58.6
AUGUST						
34N47W	2	70	65	5	9.5	31.1
34N48W	4	76	69	7	10.2	32.4
35N48W	8	98	56	42	5.8	32.6
35N48W*	8	89	49	40	5.8	44.5
SEPTEMBER						
34N47W	2	148	135	13	23.3	43.3
34N48W	6	141	122	19	10.9	37.6
35N47W	3	124	122	2	7.6	29.5
35N48W	7	131	106	25	11.0	51.4
35N48W*	8	145	110	35	6.9	45.9
OCTOBER						
34N47W	1	190	190	--	18.0	56.8
34N48W	2	152	152	--	8.0	27.6
35N47W	2	287	149	138	12.9	54.9
35N48W	7	261	141	120	14.0	57.6
35N48W*	7	270	144	126	10.5	59.2
NOVEMBER						
34N47W	3	270	223	47	9.8	39.3
34N48W	5	349	233	116	18.6	67.1
35N47W	5	312	239	73	23.4	70.1
35N48W	6	276	237	39	14.8	72.6
35N48W*	8	344	235	109	13.4	75.9
DECEMBER						
34N47W	2	331	331	--	9.5	28.5
34N48W	3	400	320	80	13.3	40.0
35N47W	4	350	248	102	11.9	40.9
35N48W	7	400	262	138	10.7	44.2
35N48W*	7	391	321	70	11.3	43.7

* 20-minute square centered at this location

Table 5

Statistical Analysis of Historical Data for Chosen Parameters

Thickness of the Maximum Gradient (ft)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	3	--	--	--	--	--	100
34N48W	4	--	--	--	--	--	100
35N47W	3	--	--	--	--	--	100
35N48W	8	56	40	16	4.8	16.7	86
35N48W*	8	56	40	16	4.8	16.3	92
FEBRUARY							
34N48W	6	--	--	--	--	--	100
35N47W	3	--	--	--	--	--	100
35N48W	7	--	--	--	--	--	100
35N48W*	7	--	--	--	--	--	100
MARCH							
34N48W	1	--	--	--	--	--	100
35N47W	4	--	--	--	--	--	100
35N48W	6	--	--	--	--	--	100
35N48W*	7	--	--	--	--	--	100
APRIL							
34N47W	2	--	--	--	--	--	100
34N48W	3	--	--	--	--	--	100
35N47W	3	60	60	--	8.8	26.5	88
35N48W	7	47	40	7	6.7	11.5	94
35N48W*	7	49	40	9	5.9	15.7	96
MAY							
34N47W	2	57	40	17	6.9	23.9	55
34N48W	2	66	52	14	7.2	19.0	39
35N47W	5	55	55	--	16.3	21.1	54
35N48W	8	79	43	36	8.6	43.3	42
35N48W*	9	74	49	25	6.7	29.8	40
JUNE							
34N47W	3	108	70	38	18.6	39.3	11
34N48W	4	171	72	99	14.6	41.4	9
35N47W	3	108	100	8	14.3	59.2	5
35N48W	6	131	54	77	10.8	53.6	15
35N48W*	6	117	86	31	10.9	65.2	12

* 20-minute square centered at this location

Table 5 (con)

<u>One -- Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JULY							
34N47W	2	194	180	14	25.0	85.9	13
34N48W	5	188	149	39	12.4	60.6	0
35N47W	3	192	152	40	14.0	59.9	8
35N48W	7	185	149	36	8.5	71.3	13
36N48W	1	171	171	--	13.9	51.9	0
35N48W*	8	186	150	36	8.9	65.7	11
AUGUST							
34N47W	2	188	174	14	21.9	69.3	7
34N48W	4	219	175	44	18.1	53.8	9
35N48W	8	215	149	66	18.1	78.3	22
35N48W*	8	215	181	34	10.4	75.4	22
SEPTEMBER							
34N47W	2	204	133	71	25.6	62.8	30
34N48W	6	210	158	52	13.4	59.3	16
35N47W	3	188	151	37	16.8	52.8	17
35N48W	7	198	167	31	16.3	65.3	16
35N48W*	8	200	153	47	9.2	64.1	15
OCTOBER							
34N47W	1	134	134	--	18.4	48.6	30
34N48W	2	169	169	--	8.6	22.7	42
35N47W	2	172	172	--	13.1	41.3	33
35N48W	7	173	114	59	17.1	59.4	37
35N48W*	7	168	115	53	12.6	59.2	34
NOVEMBER							
34N47W	3	120	85	35	20.0	35.9	59
34N48W	5	98	40	58	15.0	39.8	35
35N47W	5	117	56	61	17.4	44.0	36
35N48W	6	106	72	34	10.8	47.2	34
35N48W*	8	108	57	51	8.0	41.6	24
DECEMBER							
34N47W	2	65	65	--	18.9	37.9	80
34N48W	3	67	40	27	6.7	11.5	88
35N47W	4	77	63	14	6.1	23.0	44
35N48W	7	80	53	27	8.9	20.3	68
35N48W*	7	80	52	28	11.5	23.1	76

* 20-minute square centered at this location

Table 6

Statistical Analysis of Historical Data for Chosen Parameters

Temperature of the Upper Bound of the Maximum Gradient ($^{\circ}\text{F}$)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JANUARY						
34N47W	3	--	--	--	--	--
34N48W	4	--	--	--	--	--
35N47W	3	--	--	--	--	--
35N48W	8	69.6	65.6	4.0	.39	.96
35N48W*	8	69.6	65.6	4.0	.39	.96
FEBRUARY						
34N48W	6	67.0	67.0	--	--	--
35N47W	3	--	--	--	--	--
35N48W	7	--	--	--	--	--
35N48W*	7	70.7	67.8	2.9	3.44	5.97
MARCH						
34N48W	1	--	--	--	--	--
35N47W	3	--	--	--	--	--
35N48W	6	--	--	--	--	--
35N48W*	7	66.3	66.3	--	.41	1.00
APRIL						
34N47W	2	--	--	--	--	--
34N48W	3	--	--	--	--	--
35N47W	3	66.9	66.9	--	.51	1.62
35N48W	7	68.3	60.7	7.6	.15	.26
35N48W*	7	71.6	62.4	9.2	.75	2.99
MAY						
34N47W	2	69.7	69.7	--	.44	1.51
34N48W	2	69.5	67.0	2.5	.54	1.65
35N47W	5	68.0	64.7	3.3	1.14	2.54
35N48W	8	69.2	66.2	3.0	.63	2.18
35N48W*	9	69.4	66.4	3.0	.39	1.38
JUNE						
34N47W	3	74.1	71.7	2.4	.56	2.59
34N48W	4	74.1	70.7	3.4	.76	2.29
35N47W	3	72.9	72.3	.6	.49	1.54
35N48W	6	74.1	66.5	7.6	.49	2.88
35N48W*	6	74.0	66.5	7.5	.47	2.90

* 20-minute square centered at this location

Table 6 (con)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>
JULY						
34N47W	2	77.2	77.0	.2	.42	1.71
34N48W	5	79.2	76.4	2.8	.60	2.07
35N47W	3	79.1	76.6	2.5	.49	2.24
35N48W	7	78.4	74.6	3.8	.34	2.46
36N48W	1	76.3	76.3	--	.33	1.22
35N48W*	8	78.4	75.0	3.4	.29	2.47
AUGUST						
34N47W	2	79.1	78.8	.3	.49	1.33
34N48W	4	79.9	77.4	2.5	.46	1.44
35N48W	8	79.4	76.7	2.7	.21	1.21
35N48W*	8	79.5	76.8	2.7	.17	1.82
SEPTEMBER						
34N47W	2	79.8	79.1	.7	.83	2.63
34N48W	6	80.8	76.5	4.3	.46	1.60
35N47W	3	79.0	76.8	2.2	.36	1.26
35N48W	7	79.9	76.7	3.2	.33	1.61
35N48W*	8	80.1	76.7	3.4	.33	1.92
OCTOBER						
34N47W	1	75.4	75.4	--	.79	2.48
34N48W	2	79.3	79.3	--	.55	1.92
35N47W	2	77.6	74.0	3.6	.30	1.17
35N48W	7	78.5	74.2	4.3	.44	3.06
35N48W*	7	78.3	74.0	4.3	.68	2.05
NOVEMBER						
34N47W	3	77.6	72.3	5.3	.89	3.46
34N48W	5	75.8	71.9	3.9	1.48	4.44
35N47W	5	75.3	71.9	3.4	1.15	4.06
35N48W	6	77.0	71.5	5.5	.62	4.04
35N48W*	8	76.9	68.7	8.2	.48	3.93
DECEMBER						
34N47W	2	69.0	69.0	--	.31	.93
34N48W	3	73.0	69.2	3.8	1.17	2.47
35N47W	4	72.6	67.4	5.2	.60	2.00
35N48W	7	72.6	68.0	4.6	.88	2.14
35N48W*	7	72.9	68.8	4.1	.55	2.15

* 20-minute square centered at this location

Table 7

Statistical Analysis of Historical Data for Chosen Parameters

Gradient of the Mean Gradient

($^{\circ}\text{F}/100\text{ ft}$)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	2	--	--	--	--	--	100
34N48W	3	3.07	1.35	1.72	2.38	4.76	77
35N47W	1	--	--	--	--	--	100
35N48W	6	2.94	.92	2.02	.69	1.82	56
35N48W*	8	3.10	.50	2.60	1.80	4.06	70
FEBRUARY							
34N48W	2	1.97	.70	1.27	.50	.71	88
35N47W	3	2.20	.82	1.38	1.04	2.08	77
35N48W	5	1.03	.70	.33	.27	.61	90
35N48W*	7	1.75	.94	.81	.86	2.84	88
MARCH							
35N47W	4	1.00	1.00	--	.36	.62	91
35N48W	5	5.67(?)	.45	(?)	5.52(?)	9.56(?)	85
35N48W*	8	3.50(?)	.40	(?)	3.30(?)	7.38(?)	83
APRIL							
34N47W	2	.53	.51	.02	.10	.31	25
34N48W	4	.82	.34	.48	.12	.25	46
35N47W	3	1.05	.34	.71	.20	1.01	32
35N48W	5	1.23	.30	.93	.13	.82	57
35N48W*	6	1.20	.35	.85	.17	1.38	54
MAY							
34N47W	2	1.99	1.71	.28	.18	.65	27
34N48W	1	1.32	1.32	--	.16	.51	0
35N47W	4	2.17(?)	.62	(?)	.61(?)	2.43(?)	19
35N48W	6	1.59	.98	.61	.16	1.21	3
35N48W*	9	1.50	.60	.90	.12	.88	4
JUNE							
34N47W	3	4.20	1.86	2.34	.24	.95	0
34N48W	4	3.83	1.89	1.94	.21	.86	0
35N47W	3	3.09	1.95	1.14	.18	.95	0
35N48W	5	3.69	1.71	1.98	.18	1.88	0
35N48W*	6	3.51	1.66	1.85	.18	1.88	0

* 20-minute square centered at this location

(?) Original data believed to be in error

Table 7 (con)

One - Degree Quadrangle	Number of Years of Data	Maximum Mean	Minimum Mean	Range	Maximum Standard Error	Maximum Standard Deviation	Percentage of Obs. > Max. BT Depth
JULY							
34N47W	3	4.14	2.88	1.26	.32	1.00	0
34N48W	4	3.50	3.05	.45	.25	1.47	0
35N47W	4	4.06	3.11	.95	.36	1.42	0
35N48W	6	6.78	2.87	3.91	.30	3.38	0
35N48W*	7	4.76	2.93	1.83	.23	1.89	0
AUGUST							
34N47W	2	3.78	3.75	.03	.14	.45	0
34N48W	4	4.13	3.59	.54	.17	.55	0
35N47W	1	3.89	3.89	--	.11	.30	0
35N48W	4	6.78	3.68	3.10	.30	3.38	0
35N48W*	7	6.49	3.77	2.72	.25	3.06	0
SEPTEMBER							
34N47W	2	4.50	4.03	.47	.29	.92	0
34N48W	6	4.53	4.09	.44	.21	.73	0
35N47W	2	6.00	3.92	2.08	.41	1.42	0
35N48W	6	5.32	3.66	1.66	.18	1.53	0
35N48W*	7	5.40	3.70	1.70	.26	1.49	0
OCTOBER							
34N47W	1	3.59	3.59	--	.33	1.05	0
34N48W	2	5.36	5.36	--	.31	1.09	0
35N47W	1	5.22	5.22	--	.29	1.11	0
35N48W	7	5.30	3.16	2.14	.56	2.31	0
35N48W*	7	5.36	2.84	2.52	.21	1.60	0
NOVEMBER							
34N47W	2	6.61	3.12	3.49	.79	3.32	0
34N48W	5	4.97	1.95	3.02	.75	2.48	0
35N47W	4	4.51	2.64	1.87	.38	1.47	7
35N48W	5	5.56	2.76	2.80	.37	.79	9
35N48W*	8	3.98	1.31	2.67	.32	2.68	3
DECEMBER							
34N47W	2	3.05	.96	2.09	.31	.93	5
34N48W	3	3.79	1.46	2.33	.54	1.79	36
35N47W	3	3.35	1.29	2.06	.28	1.02	13
35N48W	5	3.57	2.17	1.40	.35	1.82	36
35N48W*	7	3.37	1.91	1.46	.36	2.19	30

* 20-minute square centered at this location

Table 8

Statistical Analysis of Historical Data for Chosen Parameters

Gradient of the First Gradient

($^{\circ}\text{F}/100\text{ ft}$)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	3	2.00	--	--	--	--	92
34N48W	3	3.80	1.40	2.40	2.22	4.76	77
35N47W	1	--	--	--	--	--	100
35N48W	6	4.43	1.92	2.51	3.54	7.08(?)	66
35N48W*	8	3.68	1.98	1.70	1.80(?)	4.02(?)	73
FEBRUARY							
34N48W	2	2.10	1.25	.85	1.49	1.77	88
35N47W	3	2.35	1.34	1.01	1.08	2.17	82
35N48W	5	4.50	1.40	3.10	2.98	1.49	93
35N48W*	7	3.75	1.66	2.09	1.13	2.54	89
MARCH							
35N47W	2	--	--	--	--	--	100
35N48W	5	12.5(?)	1.47	(?)	10.25(?)	17.76(?)	88
35N48W*	8	8.4(?)	.70	7.7(?)	6.15(?)	13.80(?)	89
APRIL							
34N47W	2	2.50	1.00	1.50	.34	1.13	29
34N48W	3	3.80	1.70	2.10	.72	1.54	61
35N47W	3	3.15	1.87	1.28	.44	1.40	59
35N48W	6	2.71	2.05	.66	.44	1.74	71
35N48W*	6	2.73	2.05	.68	.21	1.20	61
MAY							
34N47W	2	4.68	3.70	.98	.63	1.67	35
34N48W	1	3.91	3.91	--	.67	2.13	0
35N47W	3	4.16	2.57	1.59	.54	2.18	22
35N48W	6	3.78	1.28	2.50	.67	2.24	6
35N48W*	9	3.85	2.34	2.51	.27	2.00	6
JUNE							
34N47W	3	5.25	3.57	1.68	.81	3.15	0
34N48W	4	5.79	3.11	2.68	.73	2.52	0
35N47W	3	5.47	3.90	1.57	.50	2.46	0
35N48W	5	5.12	3.18	1.94	.30	1.49	0
35N48W*	6	5.30	3.39	1.91	.35	1.96	0

* 20-minute square centered at this location

Table 8 (con)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JULY							
34N47W	3	6.40	4.11	2.29	.68	2.15	0
34N48W	4	5.46	4.08	1.38	.45	1.57	0
35N47W	4	5.63	4.67	.96	.36	1.23	0
35N48W	6	7.29	4.80	2.49	.37	3.08	0
35N48W*	7	7.30	4.34	2.96	.79	2.67	0
AUGUST							
34N47W	2	5.65	5.00	.65	.38	1.27	0
34N48W	4	6.92	4.50	2.42	.43	1.57	0
35N47W	1	6.02	6.02	--	.66	1.85	0
35N48W	4	7.00	4.65	2.35	.29	3.33	0
35N48W*	7	7.81	4.56	3.25	.52	4.02	0
SEPTEMBER							
34N47W	2	5.92	4.19	1.73	.89	2.80	0
34N48W	6	6.27	4.25	2.02	.90	3.13	0
35N47W	2	6.84	4.32	2.52	.52	1.80	0
35N48W	6	6.55	4.16	2.39	.36	3.38	0
35N48W*	7	6.71	4.16	2.55	.49	3.24	0
OCTOBER							
34N47W	1	3.80	3.80	--	.34	1.07	0
34N48W	2	6.46	6.46	--	.21	.73	0
35N47W	2	6.00	6.00	--	.37	1.43	0
35N48W	7	5.99	3.36	2.63	.25	1.78	0
35N48W*	7	6.16	3.53	2.63	.59	3.22	0
NOVEMBER							
34N47W	2	6.69	3.78	2.91	1.78	3.25	0
34N48W	5	5.08	2.83	2.25	.74	2.45	3
35N47W	4	4.75	3.52	1.23	.39	1.69	8
35N48W	5	5.87	3.03	2.84	.37	2.43	11
35N48W*	8	5.89	2.55	3.34	.31	2.62	5
DECEMBER							
34N47W	2	3.24	1.73	1.51	.34	1.03	10
34N48W	3	4.74	1.86	2.88	.38	1.21	39
35N47W	3	3.78	1.37	2.41	.34	1.72	17
35N48W	5	3.91	2.21	1.70	.27	1.69	37
35N48W*	7	4.19	1.94	2.25	.35	1.81	30

* 20-minute square centered at this location

Table 9

Statistical Analysis of Historical Data for Chosen Parameters

Depth of the Upper Bound of the First Gradient (ft)

<u>One-Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	2	340	340	--	--	--	92
34N48W	3	390	190	200	10.0	20.0	77
35N47W	1	--	--	--	--	--	100
35N48W	6	384	300	84	48.1	127.4	66
35N48W*	8	385	100	285	53.9	161.8	73
FEBRUARY							
34N48W	2	387	250	137	--	--	88
35N47W	3	373	210	163	100.6	174.3	82
35N48W	5	313	40	273	55.9	137.3	93
35N48W*	7	344	77	267	62.3	153.0	89
MARCH							
35N47W	2	--	--	--	--	--	100
35N48W	5	327	60	267	110.2	190.8	88
35N48W*	8	320	43	277	63.4	141.8	89
APRIL							
34N47W	2	129	116	13	31.4	91.4	29
34N48W	3	140	25	115	52.7	126.5	61
35N47W	3	105	53	52	34.0	137.2	59
35N48W	6	203	40	163	52.4	128.3	71
35N48W*	6	205	58	147	40.3	122.0	61
MAY							
34N47W	2	83	72	11	35.9	89.8	35
34N48W	1	86	86	--	7.9	25.1	0
35N47W	5	100	93	7	37.3	111.8	22
35N48W	6	132	48	84	9.1	99.6	6
35N48W*	9	112	51	61	10.1	87.1	6
JUNE							
34N47W	3	51	27	24	7.3	28.2	0
34N48W	4	67	38	29	10.9	43.5	0
35N47W	3	58	45	13	6.8	28.6	0
35N48W	5	67	41	26	7.7	34.2	0
35N48W*	6	67	25	42	10.7	53.3	0

* 20-minute square centered at this location

Table 9 (con)

One - Degree <u>Quadrangle</u>	Number of Years of Data	Maximum Mean	Minimum Mean	Range	Maximum Standard Error	Maximum Standard Deviation	Percentage of Obs. > Max. BT Depth
JULY							
34N47W	3	48	45	3	7.3	30.4	0
34N48W	4	51	25	26	6.7	31.4	0
35N47W	4	68	30	38	8.3	36.1	0
35N48W	6	46	35	11	4.7	43.0	0
35N48W*	7	49	30	19	2.6	31.1	0
AUGUST							
34N47W	2	53	49	4	9.9	32.7	0
34N48W	4	71	54	17	8.1	29.7	0
35N47W	1	60	60	--	11.3	32.1	0
35N48W	4	88	42	46	6.5	33.5	0
35N48W*	7	80	42	38	5.0	33.4	0
SEPTEMBER							
34N47W	2	126	111	15	11.6	36.6	0
34N48W	6	114	93	21	11.9	41.3	0
35N47W	2	118	106	12	8.3	28.9	0
35N48W	6	122	97	25	8.0	42.7	0
35N48W*	7	113	38	75	6.4	50.3	0
OCTOBER							
34N47W	1	162	162	--	12.5	39.4	0
34N48W	2	145	145	--	7.0	24.3	0
35N47W	1	147	147	--	4.6	18.0	0
35N48W	7	236	135	101	11.1	56.4	0
35N48W*	7	215	117	98	14.3	78.1	0
NOVEMBER							
34N47W	2	244	198	46	18.6	77.2	0
34N48W	5	261	229	32	32.6	108.2	3
35N47W	4	270	225	45	28.5	106.3	8
35N48W	5	266	228	38	15.2	75.9	11
35N48W*	8	281	180	101	21.7	104.0	5
DECEMBER							
34N47W	2	326	197	129	56.6	133.5	10
34N48W	3	400	317	83	29.6	72.6	39
35N47W	3	332	240	92	56.6	150.1	17
35N48W	5	379	290	89	18.1	92.1	37
35N48W*	7	382	237	145	22.2	121.0	30

* 20-minute square centered at this location

Table 10

Statistical Analysis of Historical Data for Chosen Parameters

Thickness of the First Gradient (ft)

<u>One- Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JANUARY							
34N47W	2	20	20	--	--	--	96
34N48W	3	40	20	20	--	--	99
35N47W	1	--	--	--	--	--	100
35N48W	6	69	20	49	9.6	35.0	89
35N48W*	8	69	20	49	9.0	34.0	85
FEBRUARY							
34N48W	2	120	20	100	--	--	95
35N47W	3	33	20	13	--	--	90
35N48W	5	32	26	6	11.6	26.0	93
35N48W*	7	31	11	20	7.5	19.5	93
MARCH							
35N47W	2	--	--	--	--	--	100
35N48W	5	34	20	14	6.7	15.1	91
35N48W*	8	40	13	27	9.9	24.2	89
APRIL							
34N47W	2	36	36	--	6.8	27.8	37
34N48W	3	45	23	22	12.4	25.2	50
35N47W	3	53	29	24	8.2	36.9	46
35N48W	6	80	23	57	5.9	27.1	70
35N48W*	6	37	13	24	4.6	32.2	59
MAY							
34N47W	2	106	40	66	13.1	47.2	34
34N47W	1	76	76	--	8.8	28.0	0
35N47W	5	89	51	38	23.3	69.9	28
35N48W	6	107	40	67	11.6	65.6	19
35N48W*	9	108	44	64	11.4	121.5	10
JUNE							
34N47W	3	157	112	45	27.9	96.8	21
34N48W	4	191	103	88	24.3	97.3	17
35N47W	3	156	118	38	17.8	77.9	8
35N48W	5	193	121	72	25.1	105.0	14
35N48W*	6	167	121	46	16.6	83.0	12

* 20-minute square centered at this location

Table 10 (con)

<u>One - Degree Quadrangle</u>	<u>Number of Years of Data</u>	<u>Maximum Mean</u>	<u>Minimum Mean</u>	<u>Range</u>	<u>Maximum Standard Error</u>	<u>Maximum Standard Deviation</u>	<u>Percentage of Obs. > Max. BT Depth</u>
JULY							
34N47W	3	238	222	16	30.8	110.6	21
34N48W	4	244	209	35	22.9	90.1	7
35N47W	4	224	218	6	17.8	68.7	11
35N48W	6	222	199	23	12.2	99.4	16
35N48W*	7	228	202	26	10.7	96.4	15
AUGUST							
34N47W	2	249	233	16	29.9	89.6	6
34N48W	4	285	214	71	25.0	73.4	20
35N47W	1	245	245	--	21.3	60.2	0
35N48W	4	282	112	170	28.2	126.0	43
35N48W*	7	281	147	134	16.0	101.4	38
SEPTEMBER							
34N47W	2	270	148	122	41.3	92.3	61
34N48W	6	208	131	77	37.2	123.4	51
35N47W	2	260	217	43	23.9	58.5	60
35N48W	6	218	170	48	52.6	105.2	43
35N48W*	7	220	170	50	24.7	110.7	43
OCTOBER							
34N47W	1	207	207	--	69.6	120.4	70
34N48W	2	200	200	--	8.2	16.3	67
35N47W	1	204	204	--	19.4	43.4	67
35N48W	7	214	81	133	30.9	87.5	58
35N48W*	7	193	81	112	27.8	100.4	58
NOVEMBER							
34N47W	2	89	73	16	63.6	110.2	61
34N48W	5	130	43	87	37.0	73.9	65
35N47W	4	147	40	107	20.0	54.2	63
35N48W	5	125	75	50	21.3	67.4	64
35N48W*	8	118	59	59	18.6	69.3	63
DECEMBER							
34N47W	2	100	20	80	--	--	70
34N48W	3	80	35	45	18.3	36.5	78
35N47W	3	82	27	55	10.0	28.8	66
35N48W	5	80	47	33	14.3	37.8	84
35N48W*	7	95	33	62	14.3	42.7	76

* 20-minute square centered at this location

Table 11
Analysis of Variance Results
Sea Surface Temperature

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)			Probability (%) of No Significant Difference Between Time Periods (Constant Area)		
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10° Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10° Quadrangles	Alternate 10° Quadrangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{x}..(F)$	pq						
Jan.	66.69	3x3			60			0
Feb.	66.00	3x3			100			33
March	64.65	3x3			100	33	0	40
		4x2	67					
Apr11	65.98	2x4			75			100
May	67.35	2x3			40	60		40
		5x2	75					
June	73.27	3x4			100			33
July	77.51	3x3			56			33
Aug.	79.30	4x2			75			50
		4x3						
Sept.	78.61	3x3	100	100	100	100	100	11
Oct.	76.79	2x3			100			0
Nov.	72.84	2x3			67	29		33
		4x3	58					
Dec.	69.90	4x2			100			17
Mean Probability All Months			75	100	81	56	50	33

$\bar{x}..$ = mean of the monthly mean 1-degree quadrangle for all years

p = number of years having 10 or more observations

q = number of 1-degree quadrangles having 10 or more observations

During March, May, September, and November when an "experimental" cruise occurred, interpret column pq as follows:

pq = number of 5-day periods x number of 10-minute quadrangles

pq = number of years of observations x number of 1-degree quadrangles

Table 12

Analysis of Variance Results

Layer Depth

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad-rangles	Alternate 10' Quad-rangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{x}_{..}(f+t)$	pq						
Jan.			54% of layer depths	below BT range	(> 440')			
Feb.			55% of layer depths	below BT range	(> 440')			
March	630	3x3	100	(90% of obs. >440')	100			
April			90% of layer depths	below BT range	(> 440')			
May	71	2x3	100	(50% of obs. <20')	100			
June	212	3x4		100				83
July	22	3x3		100				67
Aug.	29	4x3	90% of obs. = 0'					
Sept.	78	6x2	63	100	30			93
Oct.	117	2x3		100				33
Nov.	235	2x3	67	56	100	50	50	80
Dec.	321	4x3	26% of obs. >440'					
Mean Probability All Months			77	56	100	70	50	71

Table 13

Analysis of Variance Results

Gradient of the Maximum Gradient (Thermocline)

$(^{\circ}\text{F}/100 \text{ ft})$ ↓ Month $\bar{x}..(^{\circ}\text{F})$ pq			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad-rangles	Alternate 10' Quad-rangles		Successive 5-Day Means	Alternate 5-Day Means	
Jan.	3.50		88% of max.	grad. below BT range	(>440')			
Feb.	3.60		97% of max.	grad. below BT range	(>440')			
March	4.00		98% of max.	grad. below BT range	(>440')			
April	3.10		96% of max.	grad. below BT range	(>440')			
May	4.20		38% of max.	grad. below BT range	(>440')			
June	6.32	3x4			100		50	
July	6.03	3x3			100		56	
Aug.	3.34	4x2 4x3			100		41	
Sept.	7.03	5x2	100		100	100	25	
Oct.	5.57	6x2	Distribution of observations is positive skewed					
Nov.	4.68	4x3	100		83	75	56	
Dec.	3.61		60% of max.	grad. below BT range	(>440')			
Mean Probability All Months			100		97	88	75	46

Table 14

Analysis of Variance Results

Depth of the Upper Bound of the Maximum Gradient

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad- rangles	Alternate 10' Quad- rangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{x}..(ft)$	pq						
Jan.			88% of max.	grad. below BT range	(> 440')			
Feb.			97% of max.	grad. below BT range	(> 440')			
March			98% of max.	grad. below BT range	(> 440')			
April			96% of max.	grad. below BT range	(> 440')			
May			38% of max.	grad. below BT range	(> 440')			
June	Bimodal	Distribution	20% of obs. at $\bar{x}_1 =$		20'; 22% of obs. at $\bar{x}_2 = 80'$			
July	51	3x3			100		33	
Aug.	75	4x2			100		67	
Sept.	125	4x3 6x2	100		100	70	40	
Oct.	190	3x2			100		33	
Nov.	265	2x3 4x3	56	86	100	57	50	
Dec.			52% of max.	grad. below BT range	(> 440')			
Mean Probability All Months			78	86	100	64	40	
							51	

Table 15

Analysis of Variance Results

Thickness of the Maximum Gradient

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad- rangles	Alternate 10' Quad- rangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{X}_{..}(\text{ft})$	pq						
Jan.			88% of max.	grad. below BT range	(>440')			
Feb.			97% of max.	grad. below BT range	(>440')			
March			98% of max.	grad. below BT range	(>440')			
April			96% of max.	grad. below BT range	(>440')			
May			38% of max.	grad. below BT range	(>440')			
June	97	3x4			100		91	
July	164	3x3			100		100	
Aug.	Bimodal Distribution $X_1 = 60'$ and $X_2 = 220'$							
Sept.	182	$\frac{4 \times 3}{6 \times 2}$	100		100	61	20	
Oct.	153	$\frac{3 \times 2}{4 \times 3}$			100		100	
Nov.	92	$\frac{4 \times 3}{4 \times 3}$	88	100	100	86	25	
Dec.			52% of max. grad. below BT range		(>440')			
Mean Probability All Months			94	100	100	74	22	
							90	

Table 16

Analysis of Variance Results

Temperature of the Upper Bound - Maximum Gradient

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad- rangles	Alternate 10' Quad- rangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{x}_{..} (^{\circ}F)$	pq						
Jan.			88% of max. grad. below BT range					
Feb.			97% of max. grad. below BT range					
March			98% of max. grad. below BT range					
April			96% of max. grad. below BT range					
May			38% of max. grad. below BT range					
June	72.5	3x4			100		25	
July	77.0	3x3			56		33	
Aug.	79.9	4x2 4x3			100		50	
Sept.	78.4	6x2	67		100	30	33	
Oct.	76.0	3x2			100		17	
Nov.	72.5	4x3			100		17	
Dec.			52% of max. grad. below BT range					
Mean Probability All Months			67		93	30	33	30

Table 17

Analysis of Variance Results

Gradient of the Mean Gradient

(°F/100 ft) ↓ Month $\bar{x}..(oF)$ pq			Probability (%) of No Significant Difference Between Areas (Constant Time Period)		Probability (%) of No Significant Difference Between Time Periods (Constant Area)			
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad-rangles	Alternate 10' Quad-rangles		Successive 5-Day Means	Alternate 5-Day Means	
Jan.	1.71		77% of grad. below BT range					
Feb.	1.27		90% of grad. below BT range					
March	1.22		90% of grad. below BT range					
April	.61		90% of grad. below BT range					
May	1.12		35% of grad. below BT range					
June	2.33		56% of obs. $\leq 1^{\circ}/100$					
July	3.14	3x3			89		100	
Aug.	4.38	4x2 4x3			100		100	
Sept.	4.23	6x2	50	67	100	30	29	50
Oct.	3.93	3x2 6x2			100			33
Nov.	3.30	4x3	87	67	89	100	100	17
Dec.	2.73		30% of grad. obs. below BT range		(> 440')			
Mean Probability All Months			69	67	96	62	65	60

Table 18

Analysis of Variance Results

Gradient of the First Gradient

(°F/100 ft) ↓ Month $\bar{x}..(°F)$ pq			Probability (%) of No Significant Difference Between Areas (Constant Time Period)			Probability (%) of No Significant Difference Between Time Periods (Constant Area)		
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10° Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10° Quadrangles	Alternate 10° Quadrangles		Successive 5-Day Means	Alternate 5-Day Means	
Jan.	2.75		77% of grad. below BT range					
Feb.	3.92		90% of grad. below BT range					
March	1.40		90% of grad. below BT range					
April	1.70		60% of grad. below BT range					
May	3.02	2x3 3x2	88	100	100	100		33
June	4.74	3x4			100			33
July	5.02	3x3			100			67
Aug.	5.32	4x2 4x3			100			58
Sept.	5.21	6x2	100		83	100		26
Oct.	4.40	3x2 6x2			100			33
Nov.	4.03	4x3	100		100	100		39
Dec.	Bimodal	Distribution	46% of obs. = $2.5^{\circ}F/100 \pm .5^{\circ}$; 33% of obs. have grad. > BT range					
Mean Probability All Months			96	100	98	100		41

Table 19

Analysis of Variance Results

Depth of the Upper Bound - First Gradient

			Probability (%) of No Significant Difference Between Areas (Constant Time Period)			Probability (%) of No Significant Difference Between Time Periods (Constant Area)		
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad- rangles	Alternate 10' Quad- rangles		Successive 5-Day Means	Alternate 5-Day Means	
Month	$\bar{x}..(ft)$	pq						
Jan.			77% of grad. below BT range					
Feb.			90% of grad. below BT range					
March			90% of grad. below BT range					
April			60% of grad. below BT range					
May	86	$\frac{2 \times 3}{5 \times 2}$	83	67	100	67		90
June	46	$\frac{3 \times 4}{3 \times 4}$			100			90
July	40	$\frac{3 \times 3}{3 \times 3}$			100			90
Aug.	62	$\frac{4 \times 2}{4 \times 3}$			100			90
Sept.	108	$\frac{6 \times 2}{6 \times 2}$	100	75	100	36	43	100
Oct.	172	$\frac{3 \times 2}{6 \times 2}$			100			33
Nov.	248	$\frac{4 \times 3}{4 \times 3}$	81	70	100	83		61
Dec.	210		33% of grad. below BT range					
Mean Probability All Months			88	71	100	62	43	79

Table 20

Analysis of Variance Results

Thickness of the First Gradient

Month	$\bar{x}..$ (ft)	pq	Probability (%) of No Significant Difference Between Areas (Constant Time Period)			Probability (%) of No Significant Difference Between Time Periods (Constant Area)		
			5-Day Mean		Mean Monthly in Adjacent 1-Degree Quadrangles	10' Quadrangle		Mean Monthly in 1-Degree Quadrangle Year to Year
			Adjacent 10' Quad-rangles	Alternate 10' Quad-rangles		Successive 5-Day Means	Alternate 5-Day Means	
Jan.			77% of grad. below BT range					
Feb.			90% of grad. below BT range					
March			90% of grad. below BT range					
April			60% of grad. below BT range					
May	76	$\frac{2 \times 3}{5 \times 2}$	87	67	80	100		90
June	143	$\frac{3 \times 4}{3 \times 4}$			83			92
July	217	$\frac{3 \times 3}{3 \times 3}$			100			100
Aug.	256	$\frac{3 \times 2}{3 \times 2}$			100			100
Sept.	Bimodal Distribution $\bar{x}_1 = 20'$ and $\bar{x}_2 = 260'$ $13\% \leq 20'$							
Oct.	168		20% of obs. $\leq 40'$					
Nov.	119		20% of obs. $\leq 40'$					
Dec.			33% of grad. below BT range					
Mean Probability All Months			87	67	91	100		96
Mean of All Parameters			83.1	80.8	95.6	70.6	47.2	59.6

Table 21

Statistics of Parameters

Experiment #20 - November 1958

Area*	Surface Temperature			Layer Depth			Gradient			Depth Upper Bound			Thickness			Temp. Upper Bound		
	N**	$\bar{X}$	SE	Sx	SE	Sx	$\bar{X}$	SE	Sx	$\bar{X}$	SE	Sx	$\bar{X}$	SE	Sx	$\bar{X}$	SE	Sx
34.1x48.0	13	67.6	.11	.40	289	7.0	25.3	0	2.88	.23	.83	366	11.0	39.5	52	5.3	19.2	66.7
34.5x47.3	16	69.5	.38	1.50	259	14.9	59.9	0	3.88	.31	1.25	276	12.0	48.0	98	6.8	27.2	69.8
34.5x47.4	46	69.7	.21	1.39	188	13.4	89.6	0	3.67	.26	1.74	274	5.5	36.4	71	4.6	30.3	69.0
34.5x47.5	37	69.9	.23	1.40	204	22.1	134.5	0	3.74	.24	1.47	295	12.6	75.8	84	7.2	43.0	68.9
34.5x48.0	18	68.4	.18	.75	296	9.5	40.3	0	4.46	.31	1.31	328	10.2	43.5	59	5.0	21.1	68.0
34.5x48.1	17	68.5	.33	1.36	291	10.0	41.9	0	3.59	.40	1.69	316	12.3	49.1	78	9.1	36.4	68.5
35.0x47.3	31	69.3	.20	1.13	227	24.1	134.2	0	4.86	.71	3.94	301	16.7	93.2	88	4.9	27.2	68.8
35.0x47.4	170	69.1	.10	1.34	228	6.2	80.9	0	4.67	.15	1.98	296	3.6	45.4	75	2.5	32.1	68.5
35.0x47.5	141	68.9	.10	1.12	268	6.8	80.1	0	4.00	.12	1.40	318	4.6	53.8	85	2.8	33.4	68.6
35.0x48.0	53	69.2	.16	1.19	259	9.3	67.8	0	3.84	.19	1.36	302	6.2	43.9	92	4.6	32.6	69.0
35.0x48.1	137	68.5	.08	.91	262	4.4	51.8	0	3.17	.17	1.93	297	4.5	46.9	76	2.7	28.7	68.4
35.1x47.4	125	68.7	.05	.59	225	7.5	83.6	0	5.40	.27	3.02	268	5.6	62.1	79	2.7	30.2	68.6
35.1x47.5	52	69.8	.16	1.11	257	10.8	77.5	0	5.31	.47	3.39	304	8.2	59.0	102	5.0	36.1	69.2
35.1x48.0	60	68.5	.18	1.37	246	8.9	69.1	0	3.97	.22	1.73	295	6.7	50.2	79	4.4	32.8	68.4
35.1x48.1	47	69.4	.21	1.42	237	8.9	60.7	0	3.20	.19	1.31	282	5.6	36.2	89	5.0	32.2	69.3
35.1x48.2	23	68.6	.18	.85	251	10.6	50.7	0	3.03	.22	1.07	297	10.1	47.5	79	5.5	25.8	68.2
35.2x47.4	17	68.5	.08	.32	239	4.9	20.6	0	4.99	.28	1.18	253	5.1	28.1	85	5.2	25.8	68.6
35.2x47.5	12	69.4	.12	.41	252	8.3	28.9	0	7.13	2.23	7.72	333	29.7	102.8	92	13.6	47.1	68.2
Total	1015																	
number of observations																		
Mean of the Column		69.0	17	1.03	249	10.4	66.5		4.21	.39	2.12	300	9.5	53.4	81	5.4	31.2	68.6

* Denotes area 34° 40'N - 34° 49'N, 48° 00'W - 48° 09'W, etc.

** See table 22 for explanation of symbols

Table 22

Statistics of Parameters

Experiment #21 - March 1959

Area*	Surface Temperature				Layer Depth						Gradient				
	N	$\bar{X}$	SE	S_x	N	$\bar{X}$	SE	S_x	N'	$\bar{X}'$	Depth Temp.	Upper Bound	Upper Bound	Upper Bound	N''
35.0X47.1	15	63.8	.14	.55	11	753	15.1	50.1	4	720	0	--	--	--	15
35.0X47.4	32	63.5	.09	.49	14	660	18.6	69.7	18	704	0	--	--	--	32
35.0X47.5	23	63.5	.10	.48	16	613	25.0	99.8	7	651	0	--	--	--	23
35.0X48.0	11	63.9	.12	.39	7	651	29.9	79.0	4	740	0	--	--	--	11
35.1X47.3	48	63.7	.07	.49	22	685	16.1	75.4	26	778	0	--	--	--	48
35.1X47.4	156	63.7	.04	.45	80	659	9.3	82.7	76	754	0	--	--	--	156
35.1X47.5	73	63.5	.06	.48	61	645	8.4	65.4	12	670	0	--	--	--	73
35.1X48.0	72	63.5	.05	.41	55	623	12.5	92.6	17	774	0	--	--	--	72
35.2X47.4	12	64.2	.12	.42	5	736	9.8	21.9	7	760	0	--	--	--	12
35.2X47.5	12	64.0	.13	.46	7	697	17.1	45.4	5	783	0	--	--	--	12
35.2X48.0	<u>14</u> 468	<u>63.8</u>	<u>.10</u>	<u>.34</u>	<u>11</u> 289	<u>658</u>	<u>21.3</u>	<u>56.6</u>	<u>3</u> 179	<u>573</u>	<u>0</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>14</u> 468
Total Number of Observations															
Mean of the Column	63.7 .09 .45				671 16.6 67.1						719				

N = Number of observations

N' = Number of observations in which the layer depth could not be computed because it was beyond the end of the BT trace.

N'' = Number of observations in which the maximum gradient could not be computed because it was beyond the end of the BT trace.

 $\bar{X}$ = Mean of the parameter $\bar{X}'$ = Mean based on N' S_x = Standard deviation of the mean

SE = Standard error of the mean

* Denotes area 35° 00'N- 35° 09'N, 47° 10'W - 47° 19'W, etc.

Table 23
Statistics of Parameters
Experiment #22 - May 1959

Area*	Surface Temperature			Layer Depth			Gradient			Depth Upper Bound			Thickness			Temp. Upper Bound					
	N**	<u>X</u>	<u>SE</u>	<u>Sx</u>	<u>N</u>	<u>X</u>	<u>SE</u>	<u>Sx</u>	<u>N</u>	<u>X</u>	<u>SE</u>	<u>Sx</u>	<u>N</u>	<u>X</u>	<u>SE</u>	<u>Sx</u>	<u>N</u>	<u>X</u>	<u>SE</u>	<u>Sx</u>	
34.5x48.0	10	67.5	.25	.78	26	6.0	19.0	0	---	3	3.83	.59	1.85	93	29.1	50.3	7	47	6.7	11.5	1.61
34.0x47.4	49	67.5	.07	.49	80	23.4	164.1	6	880	13	3.55	.27	1.99	137	26.4	95.2	42	52	2.8	10.1	.58
35.0x47.5	12	67.4	.14	.48	73	11.4	39.4	0	---	2	3.40	--	--	250	--	--	10	--	--	--	--
35.0x48.0	14	67.8	.19	.70	47	12.9	48.1	0	---	6	3.03	.42	1.57	97	17.5	42.7	8	50	6.8	16.7	.70
35.0x48.1	11	66.9	.21	.68	107	11.5	38.2	0	---	3	3.33	--	--	160	--	--	8	47	6.7	11.5	.89
35.1x47.4	52	67.0	.09	.73	66	5.8	41.4	19	859	12	2.75	.13	1.06	112	9.4	32.4	59	55	5.6	19.3	.93
35.1x47.5	53	67.2	.08	.57	75	4.7	34.2	0	---	26	2.72	.22	1.64	110	5.4	27.3	27	48	2.2	11.4	.46
35.1x48.0	16	67.2	.13	.51	84	6.6	26.5	0	---	6	3.35	.43	1.72	110	12.4	30.3	10	50	4.5	11.0	.67
Total	217								25								171				
number of observations																					
Mean of the Column		67.3	.14	.62	70	10.3	51.4			3.24	.34	1.64		134	16.7	46.4	35	5.0	13.1		.83

* Denotes area 34° 50' N - 34° 59' N, 48° 00' W - 48° 09' W, etc.
** See table 22 for explanation of symbols.

Table 24

Statistics of Parameters

Experiment #23 - September 1959

Area*	Surface Temperature			Layer Depth			Gradient			Depth Upper Bound			Thickness			Temp. Upper Bound		
	N**	$\bar{X}$	SE	$\bar{S}_x$	$\bar{X}$	SE	$\bar{S}_x$	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{S}_x$	$\bar{X}$	SE	$\bar{S}_x$	$\bar{X}$	SE	$\bar{S}_x$
34.5X47.5	69	76.7	.05	.40	68	4.5	37.0	0	--	4.8	.11	.94	127	2.9	23.9	170	5.5	45.8
34.5X48.0	160	77.3	.05	.61	68	4.1	51.5	0	--	4.7	.06	.71	143	2.5	31.3	179	3.7	46.0
34.5X48.1	40	77.5	.12	.75	82	8.8	55.9	0	--	4.8	.13	.83	163	9.8	61.9	184	7.4	45.8
35.0X47.4	14	77.7	.09	.34	111	8.8	33.0	0	--	4.3	.10	.38	140	6.6	24.8	207	12.0	44.8
35.0X47.5	95	77.6	.08	.80	84	5.8	56.5	0	--	4.6	.08	.77	146	3.0	29.4	177	5.7	53.0
35.0X48.0	426	77.5	.05	.67	87	3.9	57.7	0	--	4.9	.15	3.09	148	1.9	39.1	181	2.6	54.5
35.0X48.1	33	77.9	.13	.76	97	9.6	54.5	0	--	4.4	.22	1.26	156	4.5	25.6	201	11.1	62.8
35.0X48.2	10	76.4	.12	.38	66	15.2	48.1	0	--	5.2	.37	1.18	174	13.4	42.2	150	23.9	75.6
35.1X48.0	12	77.3	.13	.47	77	14.7	51.0	0	--	5.1	.34	1.16	142	7.6	26.2	162	15.7	54.2
35.1X48.1	42	77.4	.43	.82	90	11.3	73.2	0	--	4.3	.21	1.35	165	7.1	45.1	185	8.3	53.1
Total	901																	
number of observations																		
Mean of the Column		77.5	.13	.60	83	8.7	51.8			4.7	.18	1.17	150	5.9	35.0	1.80	9.6	53.6
																76.7	.22	1.26

* Denotes area 34° 50'N - 34° 59'N, 47° 50'W - 47° 59'W, etc.

** See table 22 for explanation of symbols.

Table 25

Months of Maximum and Minimum Values for each Parameter

<u>Parameter</u>	<u>Maximum Value</u>	<u>Minimum Value</u>	<u>Instrument Error¹</u>	<u>Comparison of Means²</u>	<u>Fourier Analysis</u>
1. Surface Temperature	August or September	March or April	1.90	Yes	Yes
2. Layer Depth	Jan, Feb, or March	June or July	1.10	March - No May, Sept, Nov - Yes	No
3. Gradient Maximum Gradient	August	Feb, March, or April	1.35	March, May, Nov - Yes Sept - No	Yes
4. Depth Upper Bound Maximum Gradient	January or February	July	1.14	March, Sept - No May, Nov - Yes	No
5. Thickness - Maximum Gradient	August	Jan, Feb, March, or April	1.04	Yes	Yes
6. Temperature Upper Bound Maximum Gradient	August or September	March or April	1.46	Yes	Yes
7. Gradient - Mean Gradient	September	April	2.66	No	No
8. Gradient - First Gradient	August	February	1.45	March, May, Nov - Yes Sept - No	No
9. Depth Upper Bound First Gradient	December or January	June or July	0.98	May, Sept, Nov - Yes March - No	No
10. Thickness of the First Gradient	August	Jan, Feb, March, or April	0.95	Yes	Yes

¹ Mean Standard Deviation of the Historical Data
Mean Standard Deviation of the Experimental Data

² Yes or No indicates whether the data from experimental cruises fall within the range established by historical data.

Table 26

Mean Standard Deviations Within 5-Day and 3-Week Periods

For a 10-Minute Quadrangle Area (Experimental Data)

Parameter	5-Day Month of Cruise				3-Week Month of Cruise			
	<u>March</u>	<u>May</u>	<u>Sept.</u>	<u>Nov.</u>	<u>March</u>	<u>May</u>	<u>Sept.</u>	<u>Nov.</u>
Surface Temperature ($^{\circ}\text{F}$)	.37	.58	.54	.61	.45	.62	.60	1.03
Layer Depth (ft)	68	54	42	56	67	51	52	67
Gradient	N.D.	.49	.80	1.36	N.D.	1.64	1.17	2.12
Maximum Gradient ($^{\circ}\text{F}/100\text{ ft}$)								
Depth Upper Bound	N.D.	37	31	43	N.D.	46	35	53
Maximum Gradient (ft)								
Thickness -	N.D.	13	46	29	N.D.	13	54	31
Maximum Gradient (ft)								
Gradient -	.48	.19	.43	.25	.59	.14	.46	.39
Mean Gradient ($^{\circ}\text{F}/100\text{ ft}$)								
Gradient - First	.58	.83	.94	.93	.60	.81	1.22	1.08
Gradient ($^{\circ}\text{F}/100\text{ ft}$)								
Depth Upper Bound	237	44	37	55	238	41	51	60
First Gradient (ft)								
Thickness of the	17	33	96	54	27	34	116	58
First Gradient (ft)								
Temperature	N.D.	.61	.73	.73	N.D.	.83	1.26	1.11
Upper Bound								
Maximum Gradient ($^{\circ}\text{F}$)								

APPENDIX C

ANNUAL STATISTICS FOR VARIOUS THERMAL STRUCTURE PARAMETERS

FIGURE C-1 SEA SURFACE TEMPERATURE

FIGURE C-2 LAYER DEPTH

FIGURE C-5 THICKNESS OF THE MAXIMUM GRADIENT

FIGURE C-6 TEMPERATURE OF THE UPPER BOUND OF THE MAXIMUM GRADIENT

FIGURE C-7 GRADIENT OF THE MEAN GRADIENT

FIGURE C-8 GRADIENT OF THE FIRST GRADIENT

FIGURE C-9 DEPTH OF THE UPPER BOUND OF THE FIRST GRADIENT

FIGURE C-10 THICKNESS OF THE FIRST GRADIENT

U.S. Naval Oceanographic Office STATISTICAL ANALYSIS OF THE THERMAL STRUCTURE AT OCEAN WEATHER STATION ECHO, by John B. Haselworth, JULY 1964. 63 P. including 12 figs. (TN-146, ASWERS REPORT No. 6)	U.S. Naval Oceanographic Office STATISTICAL ANALYSIS OF THE THERMAL STRUCTURE AT OCEAN WEATHER STATION ECHO, by John B. Haselworth, JULY 1964. 63 P. including 12 figs. (TN-146, ASWERS REPORT No. 6)
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The Sonar Experimental Research Card (SERC) deck, consisting of numerous bathythermographs and associated weather data from various ocean weather stations, and a computer program utilizing SERC deck data for computing temporal and spatial persistence of various oceanographic parameters are described. Monthly means computed for 10 thermal structure parameters result in sinusoidal curves. Fourier fitted curves were computed for certain parameters. Analysis of variance and the t test were employed to compare areal and time means for persistence.	The Sonar Experimental Research Card (SERC) deck, consisting of numerous bathythermographs and associated weather data from various ocean weather stations, and a computer program utilizing SERC deck data for computing temporal and spatial persistence of various oceanographic parameters are described. Monthly means computed for 10 thermal structure parameters result in sinusoidal curves. Fourier fitted curves were computed for certain parameters. Analysis of variance and the t test were employed to compare areal and time means for persistence.
1. Thermal structure	1. Thermal structure
2. Oceanography	2. Oceanography
3. Ocean Weather Station ECHO	3. Ocean Weather Station ECHO
4. ASWERS	4. ASWERS
5. BT Analysis	5. BT Analysis
1. title: Statistical analysis of the thermal structure at ocean weather station ECHO	1. title: Statistical analysis of the thermal structure at ocean weather station ECHO
11. author: John B. Haselworth	11. author: John B. Haselworth
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