SUMMARIZING FIXED STATION SEA TEMPERATURE DATA

by

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INTRODUCTION

I realize full well that the topic I have chosen is not the most fascinating on the program of this interesting symposium. However, I hope that when I have finished you will have a basis for understanding why it was chosen and will see that it is a topic of major importance. It concerns time series of observations for the surface layers of the ocean collected from fixed or nearly fixed positions at sea. Observations involved will be those of sea temperature-depth variations which are of a type likely to be associated with predictable atmospheric phenomena. Day-to-day variations, changes of synoptic type, will be considered.

THE PRESENT SITUATION

Those of us engaged in oceanography and the marine sciences in general have been busy making plans for the future. In these plans are many types of observational programs including networks of anchored buoys and instrumented platforms for continuous recording of various parameters. We may tend to forget that during the period of planning and for years prior to that, a valuable program of fixed station observations has been carried out from the weather ships operated by the U. S. Coast Guard. It seems that a major proportion of potentially interested users are not fully aware of the existence or nature of the data. There are several reasons for this.

For one thing, the normal procedure for processing bathythermograph data, which is the primary type of sea temperature data collected in the past by the weather ships, is to prepare only three photographic copies of the record. Two copies are usually retained at one center. In certain instances the temperatures are read from the photos (bathythermograms) and recorded on punched cards or in some other form for use in computation. Thus the distribution of the data is not wide and there are only a few relatively small research groups effectively analyzing bathythermograph data.

In some fields of science past data may be more easily obtained by the occasional user than in oceanography. In meteorology, for example, one might wish to find what the weather was in his hometown on the day he was born. He can do this because meteorologists have prepared and distributed sets of historical weather maps--one map for each day over a period of some sixty years. From these, information for any portion of the country on any day may be obtained. The information includes not only the general weather pattern but also such specific items as air temperature, humidity, wind speed and direction, cloud cover, precipitation and atmospheric pressure. In addition to this map series, there are also other forms of data summarization in meteorology such as the upper air records and the climatological series. Persons interested in oceanographic data are not so fortunate.

There should be no misunderstanding. Bathythermograph data are now available for anyone who requests them. However, it is probably true that many scientists do not ask for the data because they do not know what areas are represented, what time periods are covered, or what types of variations are indicated. Further, their initial requirement or interest in the data may not be extensive. Considerable effort is required to overcome the difficulties of obtaining and learning to interpret the data in the form in which it is now provided. A different form might be more widely used.

There are classes of problems related to forecasting sea temperature which may be effectively studied by small or relatively independent groups. Some which fall into this category are problems related to the diurnal variation in specific locations, to changes due to internal waves, and to limited area studies of synoptic change. It is not my purpose here to speak about data for these uses. However, valuable results of studies of this type have been illustrated in Mr. Corton's talk and other results are indicated by the titles and abstracts of the talks which are scheduled this afternoon by Captain Wolff and Mr. Thomasell. It is quite possible that implementation of the recommendation to be made here would stimulate interest in reports and forecasts based upon these studies and would lead to their broader utilization.

RECOMMENDATION

Forecasting the temperature structure of the sea is a broad and difficult undertaking. It is no more possible for a few research scientists to master this problem than it is for a few to develop all of the methods for predicting the weather. In oceanography an effort comparable to that in meteorology is needed and this can only come about when the basic sea temperature data are readily available

and widely distributed. It is therefore proposed that certain appropriate summaries be prepared.

SAMPLES OF PROPOSED SUMMARIES

In deciding what type of summaries might best fill the recognized needs there were many questions. These were considered one by one and a scheme was selected which seemed the best compromise of the various possibilities. The representations decided upon are meant to give the meteorologist a simple record which he can associate with past weather in learning to better understand the effects of atmospheric phenomena upon ocean temperatures. Also, it was attempted to plan the summary so that it would contain sufficient data to be useful in studies of underwater acoustics and in the analysis of time variations in sound ranges from day-to-day.

The observations available up to 1950 in the Atlantic Ocean and those to 1952 in the Pacific Ocean have been compiled under sponsorship of the Office of Naval Research in the suggested form, Leipper and Adams (1952) and Leipper (1954). Up to these times, there were many gaps in the data. There was no single station at which a complete picture of the annual temperature variation could be obtained. However, for some periods of several months there were sufficient observations to indicate how the summaries would look and how the observational program should be improved.

I will show some samples of the summary charts. There are two reasons for doing this. First, before trying to find a way to have the summary series brought up to date, it seems essential to have a reaction from persons such as yourselves concerning the suitability of the sea temperature data in this form for your particular application. Secondly, an expression of possible interest in obtaining such data summaries would help to indicate the desirability of proceeding with their preparation.

It would be my thought that such summaries would be printed and distributed to every meteorologist forecasting for ocean areas, to every research unit utilizing sea temperature information for the open ocean, and to other interested scientists. The distribution should be as wide as that for the corresponding meteorological data. Not only would the collection of historical sea temperature charts be made available but each year a supplement would be issued giving the corresponding data for that year.

For a sample station, the weather ship assigned to Lat. 56°30'N and Long. 51°00'W has been chosen. This station is designated by the letter B in Figure 1, taken from Lumby (1957). Station B is

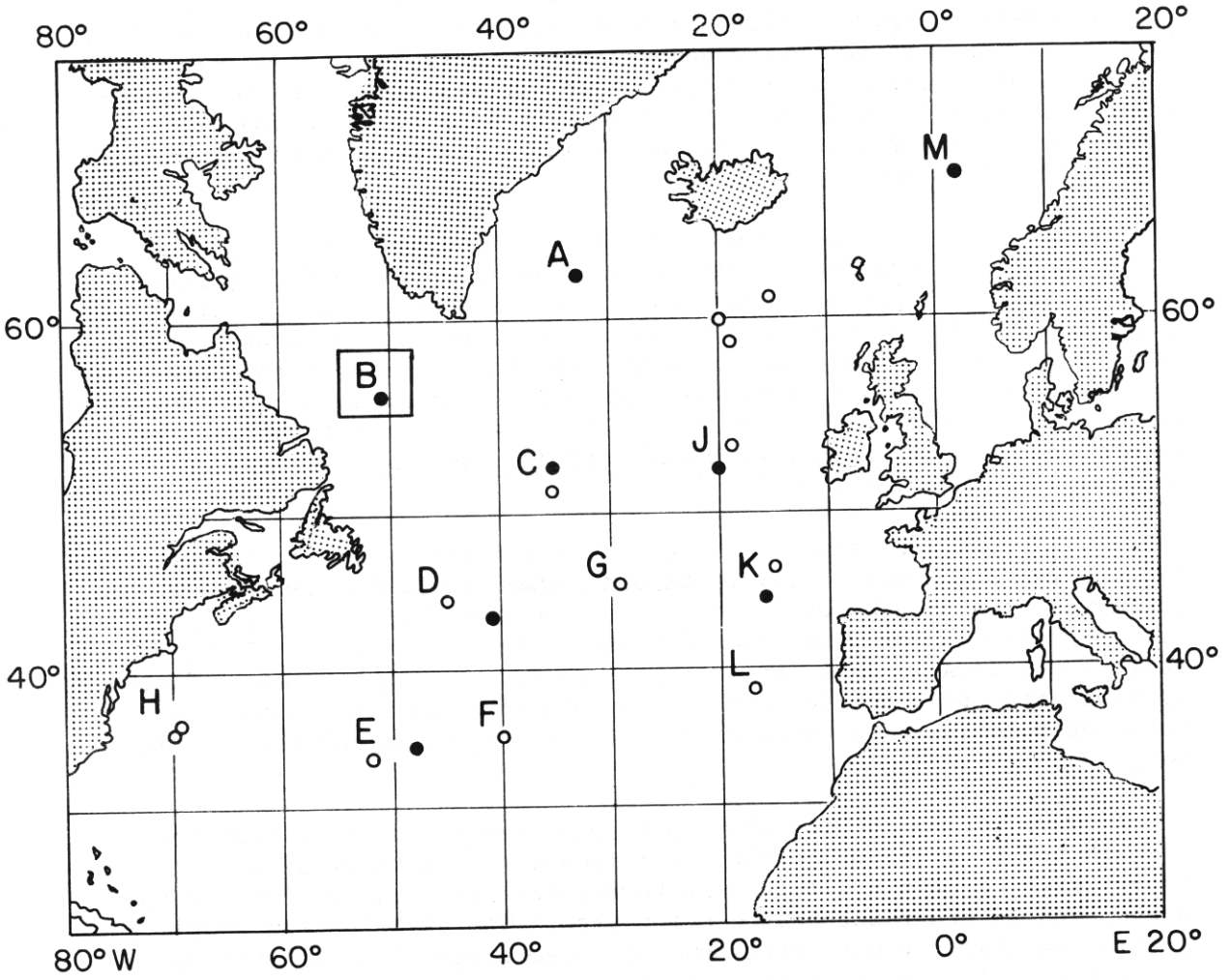

FIGURE 1 LOCATION OF WEATHER STATIONS, NORTH ATLANTIC. LUMBY, 1957

approximately on the eastern edge of the Labrador current which flows from the northwest. The period of observation for which the sample is prepared is the full year beginning July 1, 1951. At the time of Lumby's publication in 1957, the stations shown as open circles had been abandoned but those shown by closed circles including station B were in operation.

The summary charts are designed to cover the full annual cycle of variation. For the purposes of this presentation it has seemed best to show only one-half of a year so that the data might be more readily distinguishable on the projected slides (Fig 2). This slide represents temperatures at selected depths, the curves being for sea temperature at the surface and at depths of 100, 200, and 350 feet. Days of missing data are indicated by dots at the bottom of the graph. One interesting feature in this case is that nearly all summer heating occurs above 200 feet. It can be seen that the ships at station B did obtain a fairly complete picture of the temperature variations in the upper 350 feet for a six-month period.

It is apparent that the curves in Figure 2 have been smoothed. Since day-to-day variation was sought, one bathythermogram was selected to represent each day. It was chosen at a particular time of day and a check was made to ascertain that it was typical of the true situation for that day. To emphasize the features of the curves which might be related to changes in synoptic weather patterns, the smoothing was done using continuous five-day running averages. Further details concerning the methods for handling the data are given by Leipper and Adams (May 1952).

The point is that here at a glance one may see what data are available for this particular station, how complete they are, and what the general features of the variations are. Copies of such summaries may readily be printed, bound, and distributed for wide, general information and use.

There are two other forms of presentation which are proposed to supplement Figure 2. One of these, see Figure 3, shows the depth to selected differences from sea surface temperature. The curves are again smoothed. This is a graph of the vertical temperature gradients. As you are well aware, it is the gradient which is critical in physical exchange processes and in the calculation of sound refraction patterns. Interestingly enough, early studies of these data summaries give some indication that the time variation of the gradients may be more predictable than the temperature values themselves.

The third and last graph proposed for the summarization of the

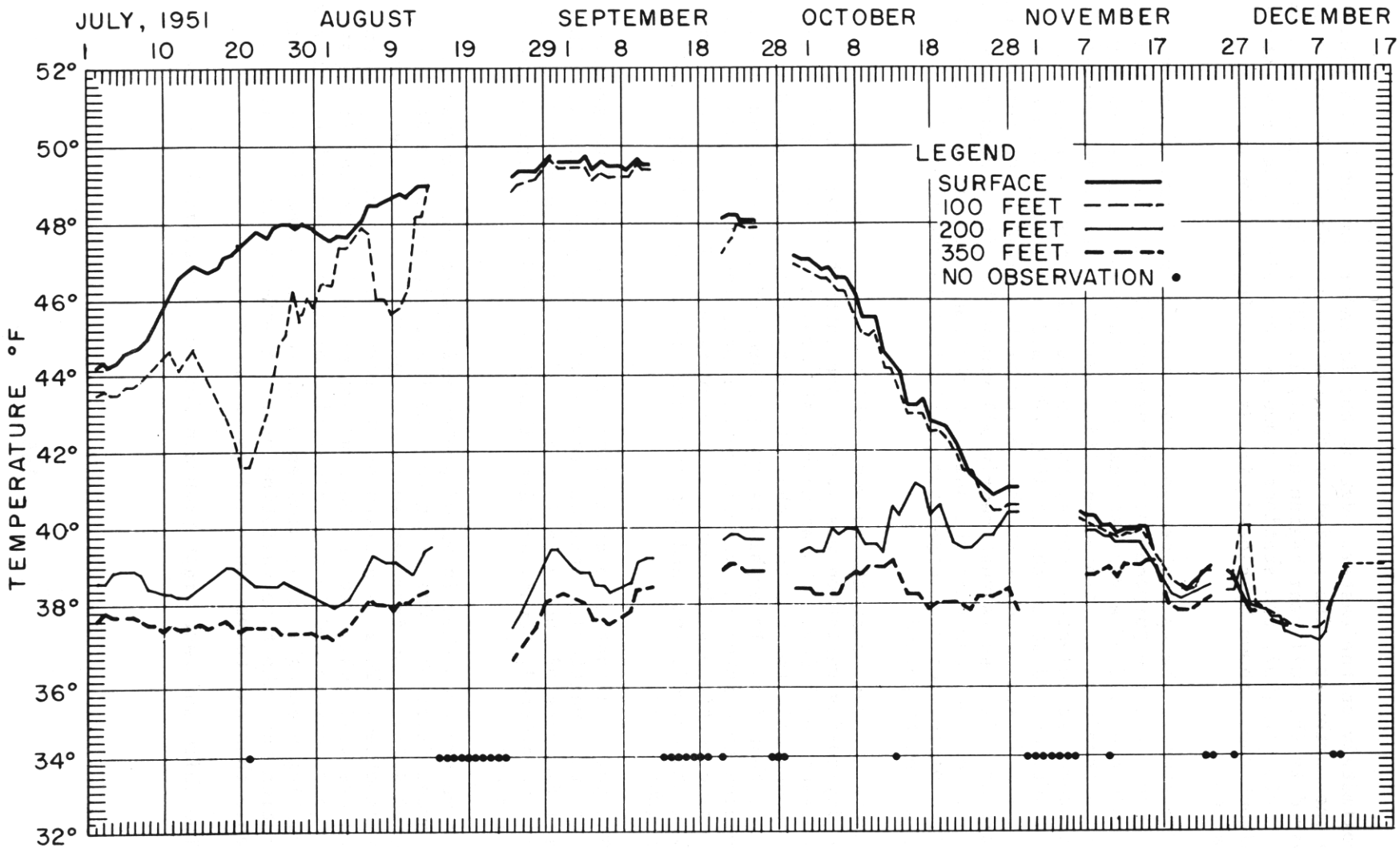

FIGURE 2 TEMPERATURES AT SELECTED DEPTHS (CURVES SMOOTHED) STATION B (SEE FIG 1), 56°30'N, 51°00'W

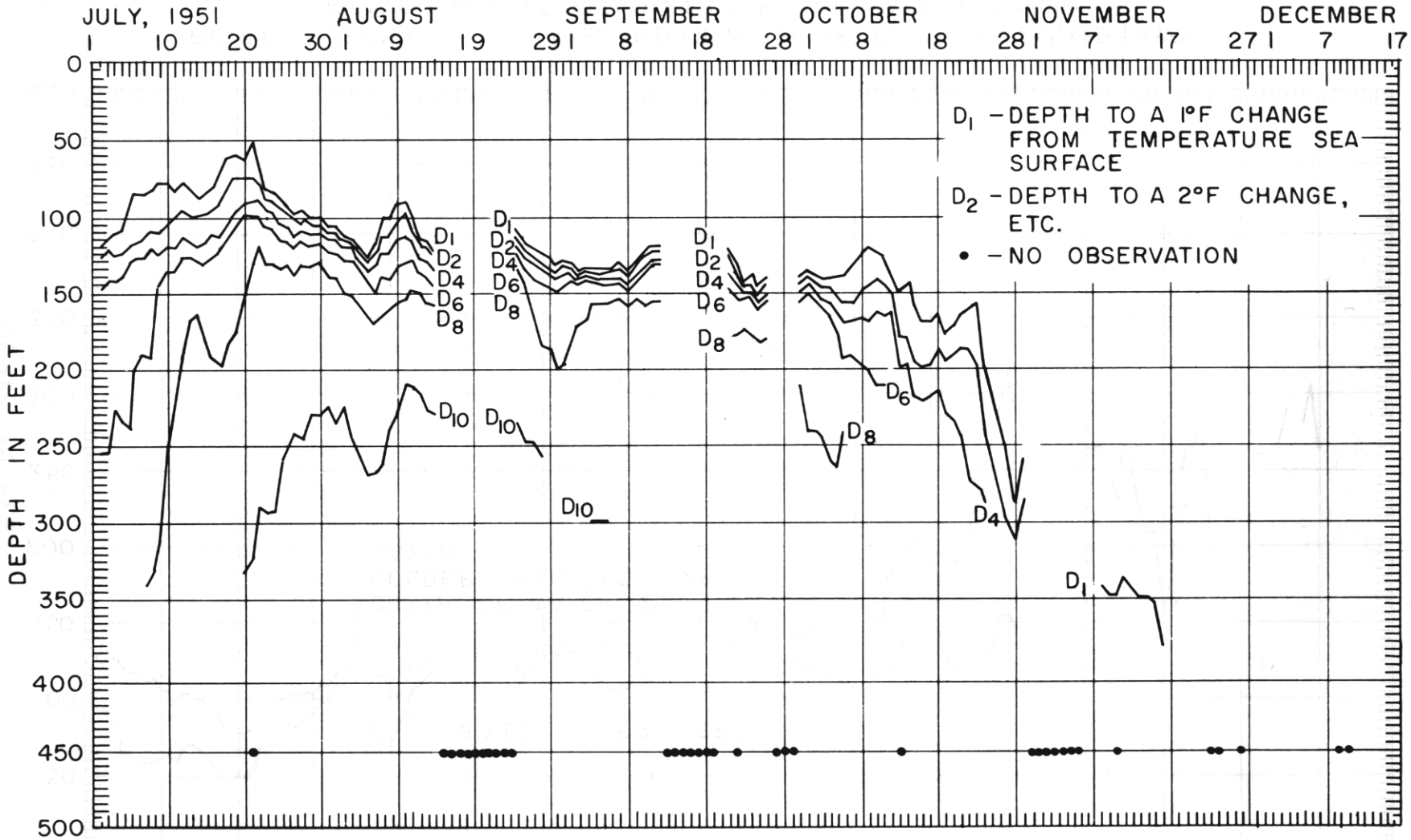

FIGURE 3 DEPTHS TO SELECTED DIFFERENCES FROM SEA SURFACE TEMPERATURE (CURVES SMOOTHED) STATION B (SEE FIG 1), 56°30'N, 51°00'W

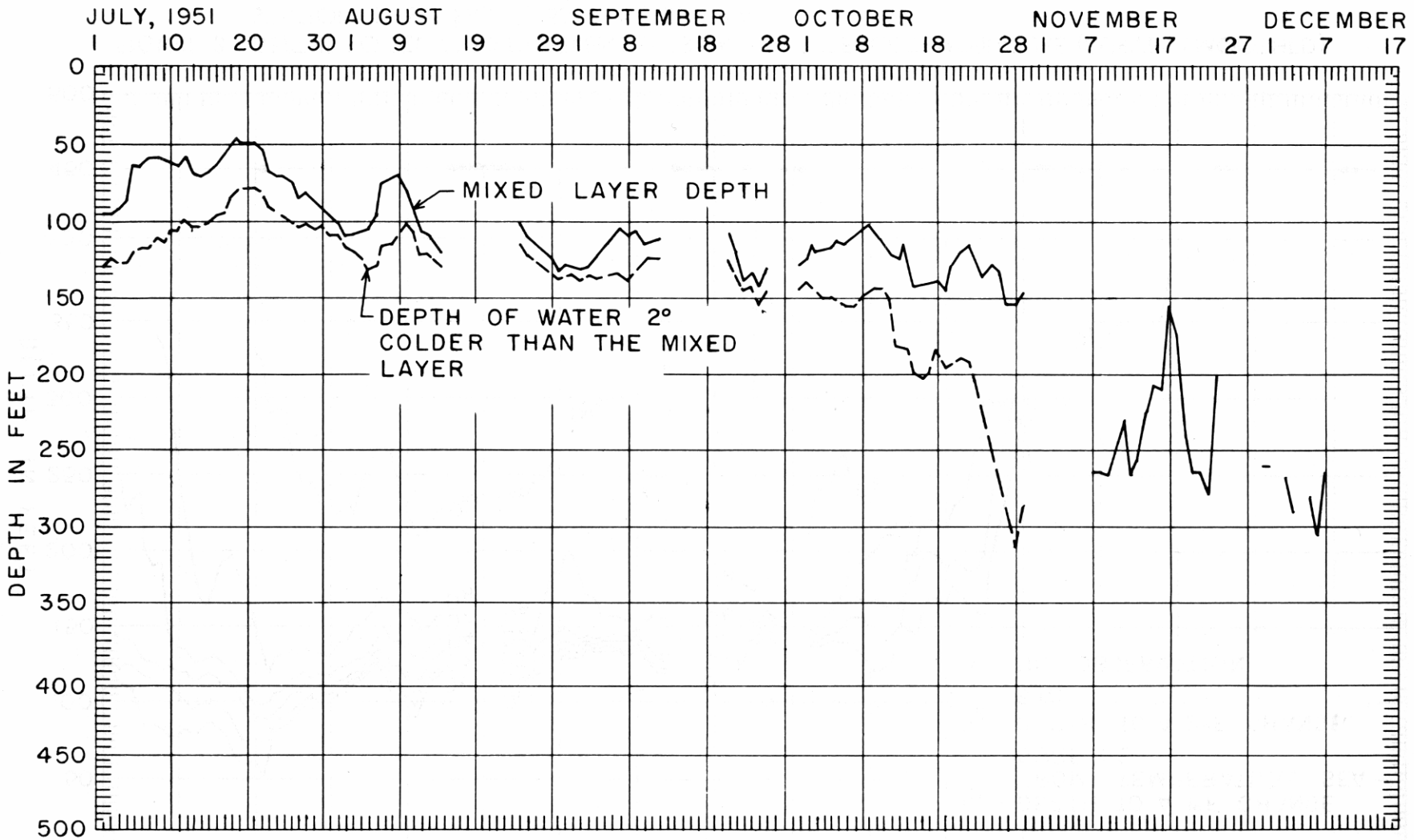

FIGURE 4 DEPTH OF MIXED LAYER AND OF WATER 2°F COLDER THAN MIXED LAYER (CURVES SMOOTHED) STATION B (SEE FIG 1), 56°30'N, 51°00'W

temperature-depth data from fixed positions, Figure 4, shows the annual variation of the depth of the mixed layer and of water 2°F colder than the mixed layer. The five-day running average is used for smoothing the curves. The mixed layer depth is defined as the depth at which the temperature falls to 0.3°F lower than the sea surface temperature. The curve showing the depth of water 2°F colder than the mixed layer gives an indication of the strength of the thermocline or, in other words, of the stability of the water column at that depth.

CONCLUSION

It is proposed then that, for each fixed position station at which appropriate data are available, three graphs showing the full annual variation of sea temperature in the surface layers be prepared, that these graphs be printed in conjunction with each other--possibly in loose-leaf form and on transparent paper, that the compilation be widely distributed, and that annual supplements be prepared and distributed. The three graphs for each station are:

Temperatures at selected depths

Depths to selected differences from sea surface temperature, and

Depth of mixed layer and of water 2°F colder than the mixed layer.

The purpose of this presentation is to obtain from persons such as those in attendance at this First U. S. Navy Symposium on Military Oceanography reactions to the two questions posed on page 163, paragraph 4. Your comments and suggestions will be most helpful.

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