WOODS HOLE OCEANOGRAPHIC INSTITUTION

WOODS HOLE, MASSACHUSETTS

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Woods Hole, Massachusetts

Ref. 52-61

Reference No. 52-61

NORTH ATLANTIC OCEANOGRAPHY

under Task Order I

conducted during the period

April 1, 1952 - June 30, 1952

Periodic Status Report No. 24
Submitted to Geophysics Branch, Office of Naval Research
Under Contract N6onr-27701 (NR-083-004)

July 1952

APPROVED FOR DISTRIBUTION _____
Director

According to the terms of Contract N6onr-27701 (NR-083-004), the work to be performed by the Contractor shall consist of the following:

1. The Contractor shall furnish the necessary personnel and facilities for and, in accordance with any instructions issued by the Scientific Officer or his authorized representative, shall

(a) conduct research, analyze, and compile data and technical information, prepare material for charts, manuals, and reports, and foster the training for military and civilian personnel in the following fields of oceanography:

(i) permanent currents;
(ii) interaction of the sea and atmosphere (including wind waves, swell, and surf);
(iii) the distribution of physical properties;
(iv) the distribution of chemical properties;
(v) the distribution of organisms;
(vi) the characteristics of the sea bottom and beaches;
(vii) tides, tidal currents, and destructive sea waves; and
(viii) the physics and distribution of sea and terrigenous ice.

The research shall include, but not necessarily be limited to, the following:

(1) studies of North Atlantic oceanography;
(2) wave observations and analyses;
(3) current measurements;
(4) studies of Arctic oceanography;
(5) development of unattended instruments;
(6) thermocline studies; and
(7) studies on inshore oceanography.

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INTRODUCTION

Two recent symposia have provided convenient opportunities for reassessing much of the research program carried on under Task Order I of recent years. At the spring meeting of the American Geophysical Union, a half day was spent in discussing the Gulf Stream System. Perhaps the chief result of this symposium was that Dr. William L. Ford of Canada pointed out that, in our recent Gulf Stream studies, we have been neglecting to take into account the small streaks of very fresh and cold water of coastal origin that are sometimes encountered at about 100 meter depths along the inshore edge of the Gulf Stream. This imposes a serious difficulty on Mr. F. C. Fuglister's multiple current hypothesis, recently published in Tellus, unless it is found that the relatively fresh water is moving toward the east, having become entrained with the Gulf Stream in the Cape Hatteras area.

Although during the last six months we have been neglecting the Gulf Stream in our field program, much thought has been given to these problems in the laboratory and we have been preparing for a renewed attack. Last autumn, a brief visit of Mr. M. S. Longuet-Higgins of Cambridge University stimulated Dr. W. V. R. Malkus and Mr. M. E. Stern to make a new theoretical study of the character of the induced electrical fields associated with the Gulf Stream's flow. This led to the conclusion that the electrical potential across the Florida Straits would vary with the total transport. Mr. G. Wertheim is now in Florida installing electrodes at the terminals of the telephone cables, and permission has been granted for the daily use of several of the telephone circuits for these measurements. Mr. Paul F. Smith, who has recently accepted a position at the Marine Laboratory of the University of Miami, will continue with these measurements once the value of this approach has been demonstrated. Here, we hope, is an independent method of evaluating the tide gauge observations as a means of measuring long period fluctuations in the flow through the Florida Straits. Thus, the possibility exists that we can prove out the value of old data, as well as to introduce a potentially more sensitive method.

Under a classified Bureau of Aeronautics contract, for more than a year we have been studying infra-red radiation coming from the sea surface. In this way, some of our staff have become familiar with infra-red detecting devices and with some of their limitations. Under this program Mr. D. Parsons, Jr., recently conceived a relatively simple instrument that would effectively measure sea surface temperature from a plane. His brilliant adaptation of a standard Gollay infra-red detector has recently been declassified. The oceanographic and meteorological applications of this instrument will be transferred to our Office of

Naval Research contract. The instrument has been housed in a streamlined body and it is expected that the first flights over the Gulf Stream will be undertaken before the end of July.

This device opens up the exciting possibility of making synoptic studies of the large scale patterns of Gulf Stream flow. While during the summer months the temperature contrasts at the surface associated with the inshore edges of the currents are at a minimum, this should be the favorable period to work out the navigational procedure which will be essential if we s ɔ to map the Gulf Stream accurately during the colder parts of the year when stronger winds prevail.

At the recent three day symposium at Rancho Santa Fe, sponsored by the National Research Council, Mr. W. S. von Arx, Mr. A. C. Vine, and Dr. J. B. Hersey each presented a paper. Since practically all aspects of the instrumental needs were discussed, the symposium amounted to a short, intensive course in modern oceanography. There is no lack of new ideas about instruments. The problem is to persuade the men who are developing new instruments to use them sufficiently so that they can become part of the research program. Unfortunately, the debugging period is usually a very slow process and the practical sea-going oceanographers tend to confine their efforts to tried and proven methods.

STUDIES OF NORTH ATLANTIC OCEANOGRAPHY

Temperature and Salinity Data from the Trade Wind Cruise. All temperatures and depth calculations obtained with the reversing thermometers on the Trade Wind Cruise have been rechecked. A further check will be made when the water samples have been titrated for salinity. The ATLANTIS and ALBATROSS III returned to Woods hole with the water samples and bathythermograph records on the 28th of May. The lengthy task of titrating the samples did not get underway until the end of this quarter. The bathythermograph slides from the ALBATROSS III have been photographed, but the supplementary data have not been copied from the log sheets. Since the two ships brought back 2,326 samples of sea water to be titrated for salinity and over 3,000 bathythermograph observations, it is apparent that considerable time will elapse before all these data are in a form to be evaluated properly.

A comparison has been made of the 200-meter temperatures as shown on the temperature-depth profile drawn on shipboard and the average 200-meter temperature chart for the North Atlantic. Although this cruise covered large areas where no 200-meter temperatures have been obtained before, no marked temperature anomalies were observed.

North Atlantic Winds during the Trade Wind Cruise. A description of winds which were observed by the ALBATROSS III and ATLANTIS during the Trade Wind Cruise was contained in the quarterly report on North Atlantic Oceanography for the preceding quarter (WHOI Reference No. 52-47). To give a broader picture of the North Atlantic wind field during the cruise, a short description of North Atlantic isobaric patterns and winds for January through April 11th has been written. Briefly, the surface weather charts examined show:

January: (1) the Bermuda-Azores high north of its normal position, (2) a persistent N-S trough near 50°W;

February: a blocking high along the west coast of Europe during most of the month;

March: a pattern dominated by stagnant lows;

April: a return to a normal Bermuda-Azores high and general clockwise circulation;

In the general area of the ATLANTIS' drift station: a very large percentage of southeasterly winds for the 3-1/2 months.

Sea Surface Isotherms during the Trade Wind Cruise. Sea surface isotherms were drawn on a plot of bucket temperature observations made during the cruise. These isotherms were compared to the monthly means given in the U.S.W.B. Climatic Atlas of the Oceans. The cruise showed, in general, positive anomalies along the coast of Brazil and negative anomalies to the northeast. An interesting exception to the general plan, however, is a tongue of positive anomalies extending northeast from 10°N 50°W to about 30°N 30°W which is flanked by two tongues of negative anomalies which extend toward the southwest.

Winds Over the Guiana Current. A tabulation of average monthly wind force was made from the Deutsche Seewarte ships' observations for an area along the Brazilian and Guiana coasts. These were averaged over strips of 1° of latitude between 7°S and 8°N and compared with maximum currents for the same strips determined from H.O. Misc. No. 10,688, 1 to 12. Nearly all the winds reported were from the east half so it was deemed unnecessary to calculate components from the various directions. Little or no similarity appeared between the two sets of data and it was therefore assumed that if the Guiana current is wind-driven then the wind field which is involved must be larger than that examined.

File of Historical Weather Maps. North Atlantic maps for the quarter have been added to the file. The gaps still remaining in the file are:

February 1899

July 1939 through December 1943

October and December 1945

Seasonal Frequency of North Atlantic Tropical Storms. A correlogram has been made (Fig. 1) of the number of tropical storms per year versus an index of Trade Winds for the previous year. Measurements of the NE Trades were made with a geostrophic template from monthly mean pressure maps for January through June of each year from 1899 through 1950 (except 1940). The monthly values were multiplied by coefficients and added by years to get "Trade Indices". The coefficients are: Jan: 1.0; Feb: 1.5; Mar: 2.0; Apr: 2.5; May: 3.0 and June: 3.5; i.e., roughly corresponding to the altitude of the sun over the North Atlantic. The number of tropical storms per year was taken from "Hurricanes" by I. R. Tannehill, Princeton University Press, 1943, the H. O. "Pilot Charts", and the "Monthly Weather Review", U.S.W.B. Some of the yearly frequencies were adjusted by examination of our file of historical weather maps. The maps show some storms not listed in the sources above and also make possible the elimination of some easterly waves and frontal lows. The envelope drawn about the plots is fairly narrow, parallel to the storm frequency scale. Because of some uncertainty in the number of storms which occurred in the earlier years, we cannot yet be sure of having sufficient data to establish a firm relationship. Nor has any theory been put forth to explain such a relationship.

Surface Temperature in Gulf Stream Area. To investigate any possible correlation between surface temperature gradients and the patterns of the Gulf Stream as determined by 100 and 200 meter temperature gradients, a start has been made in analyzing suitable bathythermograph sections. Thirty-five of the 42 sections plotted so far lie between 65°W and 75°W and in general they have been made in north-south or northwest-southwest directions. The procedure has been to plot, for each section, temperature versus distance at the surface, at 100 meters, and, where possible, at 200 meters; the graphs starting near the 100 fathom line and continuing out where possible until the deep temperatures show the Stream has been passed.

It has become apparent that surface temperature changes do not always reflect the changes at 100 and 200 meters either in magnitude or position, although no quantitative method has yet

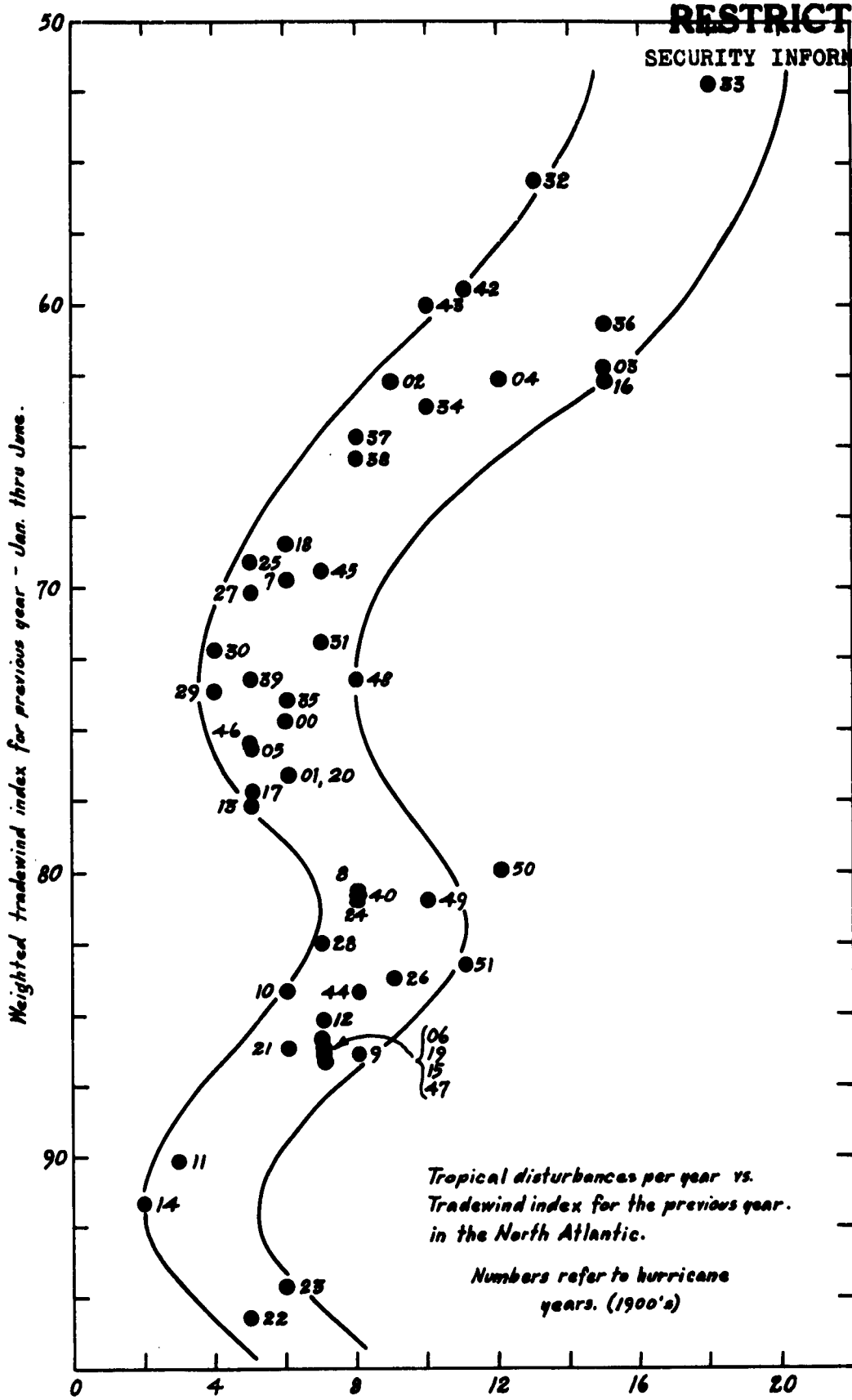

FIG. 1

been devised for comparing these changes. In particular, a comparison of the surface and 200 meter temperature contours for the eddy "Edgar" found in Operation Cabot revealed little obvious connection between the two. Some of the cruises have been found to go only out to where warm surface water was first observed and then either return or cease observations, no doubt assuming that the Stream had been reached. However, in the deeper temperatures later plotted up in the laboratory, no gradients can be observed and it is clear that the Stream had not been reached.

While these extreme cases suggest that the surface temperature is a poor indicator for the Gulf Stream, it must be noted that in many graphs there is a fair correspondence between the surface and 100-meter temperature gradients--certainly enough to hope that surface temperature observations over a large area may be useful if interpreted in conjunction with bathythermograph sections in a small part of that area.

ERRATA:

Comparison of Winds, Tide Gauge Readings, and Surface Currents. In the quarterly report on Oceanographic Research for the period October 1, 1951 - December 31, 1952 (WHOI Reference No. 52-11), the graph of the three months running mean of the height of sea level at Galveston has been found in error for the period December 1935 through October 1936. The Galveston values shown for that period should be 5 cm nearer to the top of the illustration (e.g., the value for August 1936 shown as -17.5 cm should be at -12.5 cm, etc.).

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Current Measurements by G.E.K. Recent work with the G.E.K. in equatorial Atlantic and Pacific waters has shown that the slope of the standard cable towed behind the ship is large enough (about 4 degrees at 10 knots) to give rise to an important signal due to the progress of the ship across the horizontal component of the earth's magnetic field. The effect is present in all magnetic latitudes where the horizontal field intensity is not zero, but is pronounced in equatorial regions because of the greater strength of the horizontal magnetic field component and the higher recorder sensitivities employed in the relatively weak vertical component of the magnetic field. The signal due to the cable slope is calculable and can be eliminated from the observations, provided the slope of the interelectrode length is known. The horizontal magnetic field intensity is charted, and the ship's speed and magnetic heading are ordinarily recorded in the log.

The signal due to cable slope in volts is $(H_x z v)\sin\theta \times 10^{-8}$, where H_x is the intensity of the horizontal component of magnetic flux in oersteds, z is the vertical component of the interelectrode

length of the towed cable in cm., v is the ship's speed in cm/sec, and θ is the magnetic heading of the ship. Values of z for various ship's speeds have been measured for standard demolition cable and electrode housings spaced 100 meters apart. In the speed range 6 to 12 knots, the product zv, the area swept per unit time, is approximately constant at 34 m^2/sec. and may remain so over a somewhat wider range of ship speeds. It was found in these experiments that the slope of the cable is nearly 50 per cent less when the distant electrode case is free to yaw than when its motion is steadied by the standard 5 meter length of rope as a drogue. Two cable manufacturers are considering the design and cost of neutrally buoyant cable that will remain level while in tow.

Mr. Lansing P. Wagner has begun a catalog of all surface potential measurements made with G.E.K., or similar equipment, since 1946. These observations will be referred to a level cable, but otherwise remain unchanged so as to be available for study and interpretation. Insofar as possible, observations will be assembled in sections as they were made, but cross-referenced geographically and seasonally so that the effects of weather on the surface circulation may be revealed. These data may be transferred to a punch card system later on. It will be appreciated if those having G.E.K. observations will communicate with Mr. Wagner.

STUDIES OF ARCTIC OCEANOGRAPHY

Arctic Field Observations. During the second quarter of 1952, the salinity samples from the winter cruises of the ice-breakers, USS EDISTO and USS ATKA, were titrated, and the routine working up of the data is being carried out. The data from the cruises of 1951 and 1952 by these ice-breakers represent the largest accumulation of modern winter oceanographic data from the important area east of Greenland thus far obtained.

The hydrographic data from Project Skijump suggests that Nansen's theory of the circulation of the Polar Sea, based on data available only in the eastern half of the basin, is over-simplified. Nansen proposed that the Atlantic water rotated slowly as one cyclonic gyral.

It appears from the Skijump data that there is an eddy north of Alaska with an independent circulation. Dynamic computations show this eddy to have a transport of 3.76 x $10^6 m^3$/sec. and velocities of the order of about 0.08 knots. The eddy is anticyclonic, the transport being southerly off Prince Patrick Island and westerly off the Canadian mainland and Alaska.

Surface water in the center of the eddy is more deeply mixed with Atlantic water than that at any other published station in the Polar Sea. This suggests that the eddy is a permanent feature of the circulation as such mixing presumably takes considerable time. The data will be presented in more detail in a forthcoming technical report.

In the meantime, reports from the "ice island" (T-3) close to the North Pole and at present occupied by U. S. Air Force weather observers and geophysicists, indicate that this island may be usable as a platform for certain oceanographic studies. The possibility of sending one or more observers to this unique "vessel" is being carefully considered.

At the end of June, a symposium on Oceanographic Instrumentation under the auspices of the National Research Council was attended by Mr. J. F. Holmes and Mr. W. G. Metcalf who discussed a paper on Sea Ice Problems. This symposium did much to bring together and clarify the ideas of the various groups working on Arctic problems in this country.

A. Relations between North Atlantic Ice and Arctic Weather. Comparison of the ice off Iceland with the precipitation in Iceland, southernmost Greenland, and northernmost Europe for the decade 1941-1950.

The average 10-yearly values of the annual precipitation in Iceland, southernmost Greenland, and northernmost Europe, previously analyzed for the period ending with the decade 1931-1940 (WHOI Reference No. 52-47), were compared with the ice in the general area of Iceland for the recently ended decade, 1941-1950. An analysis of the precipitation figures for each of these regions, and the area as a whole, shows the precipitation in Iceland (mean of 3 stations) to have been 100 per cent, in southernmost Greenland (2 stations) 98 per cent, in northernmost Europe (6 stations) 102 per cent, and in the area as a whole 101 per cent, of their respective long-term averages, based on the period 1881-1940. The area value of 101 per cent for the decade 1941-1950 compares with 105 per cent and 110 per cent, respectively, for the two previous decades 1921-1930 and 1931-1940, both of which were characterized by light ice conditions. Thus, the recent decade marks a reversal in the precipitation trend in that general area from the two preceding decades and is in keeping with a similar reversal in the ice conditions from very light to moderate for the same decade.

B. Verification of the foreshadowing of the severity of the iceberg season off Newfoundland in 1952.

In the report covering th period January to March 1952 (WHOI Reference No. 52-47), an application of the earlier derived foreshadowing formula to the 1952 iceberg season was made. On the basis of considerably above-normal temperatures in the general area of Newfoundland during December 1951 to March 1952, but otherwise close to normal conditions as defined by this formula, the expected iceberg count for the 1952 season was to have been below the normal. The computed departure from the long-term average 1880-1926 was -0.9 on a scale of 10, the average being 4.8 on the same scale.

According to the weekly ice chartlets published by the U. S. Hydrographic Office during the iceberg season, the iceberg count in 1952 appears to have been well below the normal, the actual departure not yet being available.

C. Preparation of seasonal, annual, and 10-yearly pressure maps in the North Atlantic for developing circulation indices in relation to the ice in the Atlantic-Arctic.

In the attempt being made to develop indices of circulation in relation to the following ice in the Atlantic-Arctic, an indirect measure of the warm water transported northward each year in the North Atlantic is being considered from a determination of the geostrophic winds in several areas in the North Atlantic. As a first step, the historical series of sea-level pressure data has been tabulated for the northeastern North Atlantic for December to March immediately preceding the general ice season in the Atlantic-Arctic. The data obtained are being plotted on maps from which the geostrophic winds to be correlated with the ice are to be determined after the pressure analysis has been completed.

In addition to the effect of the warm water in the northeastern North Atlantic on the ice in the Arctic, a consideration of the warm waters to the southwest embracing the Caribbean and the area east of Florida is also being made. In connection with this study, the annual pressure distribution in the southwestern North Atlantic is being determined year by year beginning with 1899. These pressure distributions are later to be used for determining the geostrophic winds similarly to be correlated with the ice in the Atlantic-Arctic.

Pressure maps are also being prepared by decade, embracing the Arctic as a whole and the area south to 50°N, to provide material for supplementing the decadal analysis of temperature and precipitation analyzed earlier.

DEVELOPMENT OF INSTRUMENTS

Unattended Instruments. Two Klebba 400-day Temperature Recorders have been placed by the Coast Guard on offshore buoys. In the next week three more will be placed on the shelf, to be recovered a year hence by grappling.

Design of an explosive-actuated release device and an acoustic signalling buoy for the deep sea recovery program is proceeding. The first models are designed for test purposes only, and will be actuated while suspended from a cable on the ship. This will be done during the summer, and the final design will follow the test program. It is anticipated that several buoys can be manufactured for planting in the fall, to be recovered early in 1953.

THERMOCLINE STUDIES

Mr. Gunther Wertheim has set up electrodes both at Key West and Havana to measure the electric potentials across the Florida current, using a submarine cable by the kind permission of the Western Union Telegraph Company. Preliminary testing of the electrodes in place seems to be satisfactory, and further work there awaits the repair of the cable itself, which recently failed.

MODEL STUDIES OF OCEANS

In the last quarterly report (WHOI Reference No. 52-47), mention was made of the results of experimental control of the effective planetary vorticity tendency in the rotating basin. Through more careful adjustment of this and the wind stress vorticity, circulation patterns have begun to resemble field observations more closely. For example, a standing or slowly progressive wave pattern of Gulf Stream meanders has occurred quite regularly in recent experiments.

It is found that the rate of rotation most suitable for flow patterns in mid-latitudes may be slightly different from those most suitable for reproducing high or low latitude occurrences. The bottom topography of the basin is, at present, limited to the equivalent of the 200 meter isobath. This depth was chosen since attempts to introduce the major basins and swells of the deep ocean produced too much effect on the circulation. The surface circulation, thought to be represented in the basin, is confined, in nature, to the levels above the main thermocline. It may be that this interface is of importance to the wind-driven circulation and a desirable one to represent in the model. A bottom

surface having the topography of the main thermocline would influence the local effective planetary vorticity tendency and may alter the circulation pattern in instructive ways.

Recently, Dr. Henry Kierstead has been retained to study the mathematical transformation of the Stommel-Munk vorticity theory to the experimental conditions of the rotating basin. Both the vertically integrated and horizontally layered cases are being examined, since it has been shown experimentally that the surface and bottom circulations in the basin are not identical.

MODEL STUDIES OF ESTUARIES

A paper by Mr. Henry Stommel and Mr. Harlow G. Farmer, Jr., (WHOI Contribution No. 616), entitled "Abrupt Change in Width in Two Layer Open Channel Flow", has been submitted to the Journal of Marine Research for publication. This paper covers in detail the experimental study of hydraulic transitions and controls in two layer flow. This phase of the study of estuaries has now been completed.

Chapters 1 and 2 (WHOI Reference No. 52-51), titled "Introduction" and "Transition and controls (in a two layer system)", and Chapter 7, "Description and classification of estuaries", of the general technical report by Henry Stommel and Harlow G. Farmer, entitled "On the Nature of Estuarine Circulation" have been completed, and are being duplicated for distribution to the regular mailing list.

An experimental series of runs on a process which we have called "overmixing" are now being made in the flume. This process appears to be a fairly important one in determining the salinity structure of a large number of slightly stratified estuaries. (Examples are, the Columbia River; St. Johns, New Brunswick; Savannah River; and St. Johns, Florida). The term "overmixing" is used because in estuaries such as these it appears that the degree of mixture of salt and fresh water in the estuary is determined, not by the exact nature of the mixing process, but by the control exerted by the mouth of the estuary on the relative amounts of discharge in the two layers passing through it. The effect of tides on this process of overmixing is being investigated theoretically and experimentally in the flume.

Mr. Lincoln Ekstrom has been employed for the summer to develop a salinity measuring instrument (by conductivity) for use in our flume. It is believed that such an instrument is needed to further assist our experimental program.

Mr. Nicholas Fofonoff, who has been awarded an Institution fellowship, is engaged in a program making measurements of diffusion of clusters in Cape Cod Canal from the Bourne and Sagamore bridges. These observations are being made to supplement a recent theory by L. F. Richardson (in press, Proc. Roy. Soc.).

MISCELLANEOUS

Salinity Titrations. The following groups of salinity samples have been titrated:

USS EDISTO	200
USS ATKA	560
STIRNI - Cruise #3	250
Great South Bay	136
HAZEL III - Cruise #12	250
ASTERIAS - New York Cruise #3	350
BLUE DOLPHIN	50
Skijump II	100
Vineyard Sound	14
Miscellaneous	20
Total	1,930

During the quarter Mr. Charles Powers was trained and afterwards titrated salinity samples from the ASTERIAS on New York Cruise #3. Mr. Powers is working for Dr. John C. Ayers of Cornell University. Miss Dona Nelson, a permanent technician started to work at the end of May and is still in training.

Six carboys of sea water of varying amounts of salinity were prepared for the firm of Wallace and Tiernan according to their instructions.

Thermometer Calibrations. In April, 1952, as a result of the erratic and malfunctional behavior previously noted in a group of eleven new design reversing thermometers made by the Taylor Instrument Cos. and tested by this Institution for the U. S. Coast Guard, Mr. Whitney made a trip to the Rochester, New York, plant of the Taylor Instrument Cos. to confer with personnel of their Glass Products Research and Engineering Division on the problems raised during the tests. It is felt that this trip and conference were very much worth while and of mutual benefit to both parties.

As a result of this conference, the Taylor Instrument Cos. initiated an intensive investigation into the underlying causes

of the difficulties noted in the thermometers in an effort to locate and correct the trouble. As of the end of the second quarter, no report of progress had been received from Taylor Instrument Cos.

During the Trade Wind cruise of the R/V ALBATROSS III and R/V ATLANTIS, three reversing thermometers were lost and two damaged beyond repair. Three others suffered minor damage and are currently being repaired. As the result of unsatisfactory behavior during this cruise, one unprotected reversing thermometer was returned to the manufacturer for replacement in accordance with an agreement made by him.

All of the reversing thermometers returned from the Trade Wind and Skijump II operations in good condition have been given ice point checks, and the pressure factors of the unprotected thermometers rechecked to detect any possible change in the pressure factors since their original determination. This is part of a long range program to attempt to discover any pattern of pressure factor change that may exist. (See WHOI Reference No. 52-30).

This thermometric work has been carried out by Mr. G. G. Whitney, Jr., under the supervision of Mr. Bumpus. During the greater part of the second quarter, Mr. Whitney has been engaged in work of another nature which is not within the scope of this report.

BIBLIOGRAPHY

Papers Submitted for Publication. The following papers were submitted for publication:

Iselin, C. O'D.: The Gulf Stream System. Am. Phil. Soc.

Stommel, Henry, and Harlow G. Farmer: Abrupt changes in width in two-layer open channel flow. J. Mar. Res.

Ford, W. L., and A. R. Miller: The surface layer of the Gulf Stream and adjacent waters. J. Mar. Res.

Published Papers. The following paper was published during the quarter:

Schell, I. I.: On the role of ice off Iceland in the decadal air temperatures of Iceland and other areas. J. du Conseil, Cons. Perm. Int. Expl. Mer., 18:11-36, 1 text fig.

Technical Reports. The following technical reports were distributed during the quarter:

Reference No. 52-28. A Pattern of Surface Coastal Circulation Inferred from Surface Salinity-Temperature Data and Drift Bottle Recoveries. By Arthur R. Miller. April 1952.

Reference No. 52-29. Notes on Malfunctional Behavior and its Behavior in Deep Sea Reversing Thermometers. By G. G. Whitney, Jr. May 1952.

Reference No. 52-30. Comments on the Determination of the Pressure Factor, "Q", of Unprotected Reversing Thermometers. By G. G. Whitney, Jr. May 1952.

Reference No. 52-31. Applications of Radioactivity to Oceanography. By Henry A. Kierstead. May 1952.

Reference No. 52-39. Recent Temperature Surveys of the Gulf Stream System. By Frederick C. Fuglister. May 1952.

Reference No. 52-51. On the Nature of Estuarine Circulation, Part I (Chapters 1 and 2). By Henry Stommel and Harlow G. Farmer. June 1952.

PERSONNEL

The following personnel were engaged in either full or part-time activity under this contract. Not included in this list but contributing to the work were shop workers, maintenance personnel, crews of vessels, and the administrative staff of the Business Office.

Assignment	Name	Title
DIRECTION AND ADMINISTRATION	Ed. H. Smith	Director
	C. O'D. Iselin	Sr. Physical Oceanographer
	A. C. Redfield	Associate Director
	R. A. Veeder	Assist. to the Director
	Jeanne M. Backus	Secretary
HYDROGRAPHIC OBSERVATIONS AND ANALYSES	Nellie Andersen	Senior Technician
	A. B. Arons	Associate in Physics
	D. F. Bumpus	Oceanographer
	J. Chase	Res. Assoc. in Oceanography
	H. G. Farmer, Jr.	" " " Engineering
	F. C. Fuglister	Oceanographer
	C. R. Hayes	Res. Assist. in Oceanography
	S. F. Hodgson	" " " Engineering
	J. F. Holmes	Res. Assoc. in Oceanography
	C. O'D. Iselin, Jr.	" Assist. " "
	J. M. Kemp	" " " "
	B. H. Ketchum	Marine Microbiologist
	H. A. Kierstead	Physical Chemist
	W. V. R. Malkus	Physicist
	W. G. Metcalf	Res. Assist. in Oceanography
	I. I. Schell	Meteorologist
	H. M. Stommel	Oceanographer
	L. A. Thayer	Research Engineer
	Evangeline Tollios	Senior Technician
	W. S. von Arx	Oceanographer
	L. P. Wagner	Res. Assist. in Oceanography
	L. V. Worthington	" Assoc. " "
PHOTOGRAPHY DRAFTING AND TITRATING	F. A. Bailey	Draftsman
	Gloria Gallagher	Multilith Operator
	Marion O'D. Lane	Technical Assistant
	D. M. Owen	Res. Assoc. in Oceanography
	F. C. Ronne	Photographer
	Eva Shelnut	Draftsman
	J. W. Stimpson	Draftsman
	Phyllis Vail	Technical Assistant
	Nancy H. Williams	" "
	G. G. Whitney, Jr.	Senior Technician

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