LORAN SURVEY OF GULF STREAM (*)

by Capt. William GRISWOLD.

Without doubt the Gulf Stream is the most discussed and publicized ocean current in the world - its existence and peculiarities having been of interest to oceanographers and navigators since the sixteenth century.

Although many theories have been advanced as to the origin and behavior of this ocean current little has been known of its exact nature. To the North of Cape Hatteras, during the past few years, scientific investigations have been making rapid inroads into its mysteries. However, along the eastern coast of the United States to the south of Cape Hatteras, knowledge of this stream was limited principally to that provided by Pillsbury over sixty years ago.

Most of the shipping traffic between the Gulf of Mexico and ports along the Atlantic Coast of the United States attempts to follow a course so as to obtain maximum advantage from the current to the North. Conversely, south bound traffic endeavors to stay out of the stream to avoid its retarding effect. A good approximation of the position of maximum current, as determined by Pillsbury, has been shown on Hydrographic and Coast and Geodetic Survey national charts. Recently much more accurate information as to the location and peculiarities of the Gulf Stream is being acquired through the use of Loran - a relatively new electronic navigational device which makes it possible to obtain fixes at all hours irrespective of visibility and the weather.

In the early spring of 1949 the motor vessel *Wanderer*, a 450 ton laboratory vessel operated by the Sperry Gyroscopic Company, was en route between New Orleans, Louisiana and Washington, D.C., with the writer as captain of the vessel. After rounding the Florida Keys the vessel was placed in what was indicated on the navigational charts as the mean position of the axis of the Gulf Stream. Loran coverage from a short distance north of Fowey Rock Light (Lat. 25°35'3 N.) along the Atlantic Coast to the north is excellent, and it was this medium of navigation that was used to position the vessel.

The MV *Wanderer* has a standard speed of 10 knots and hourly Loran fixes were obtained to determine the precise effect of the Gulf Stream. No attempt was made to maintain the *Wanderer* in the indicated axis of the stream and within five or six hours the vessel was to the right of the original track four miles and had dropped in speed something over a knot. After several attempts to regain the loss in current by altering the vessel's position with regard to the general flow of the stream it was found that the indicated axis still contained the highest velocity of movement. The vessel was maintained within this axis very simply by obtaining Loran fixes hourly until it was necessary to alter to the left for Diamond Shoals light vessel (Lat. 35°5' N.). The general strength of the stream was found to be almost as great off the region near Diamond Shoals as it was off Fowey Rocks.

This is in no manner an attempt to prove that the axis as indicated on coastal charts is the area of maximum current strength. On this particular voyage the

(*) See also *International Hydrographic Review*, Vol. XXVIII, n° 1, May 1951, page 107.

two happened to coincide. It did indicate, however, that within the movement of the Gulf Stream there existed a region of higher velocity than surrounding areas. Its detection depended primarily on a navigational system that permitted frequent fixes to record speed accurately.' Loran makes this possible.

To substantiate further this effect. Loran equipment was installed in the *SS Esso Concord* of the Esso Shipping Company, and *the SS Indiana* of the Texas Company. The writer made voyages on these vessels and detected an effect similar to that experienced on the *Wanderer*. Three such voyages, however, were insufficient to establish any conclusive facts concerning the behavior of the stream. What was needed was many voyages, covering all seasons of the year, and a group of interested and properly trained people to analyze the results obtained.

Two such groups, the U. S. Hydrographic Office and the U. S. Coast and Geodetic Survey, became interested in such an undertaking. At joint meetings early in 1950 between these two agencies and the Sperry Gyroscopic Company, plans were formulated to carry on an investigation of the Gulf Stream. The objective behind the survey was to determine the strength of the current in various locations, its constancy or, if it was variable, whether it was possible to predict its variations and the seasonal effect on strength and location.

The ships that most frequently travel this route from the Gulf are tank vessels carrying petroleum products to ports on the east coast of the United States. It was therefore decided that if eight or ten of these vessels could be equipped with Sperry Loran and supplied with charts and log forms from the above two federal agencies, the survey could be initiated. The Hydrographic Office undertook the job of providing suitable charts and report forms required for a one-year survey. The participating vessels were to record hourly positions obtained with Loran on the various tracks shown in figure 1. Tracks A through E are northbound routes while R, S and T are southbound routes. The outside route is an alternative to R, S and T.

Vessels equipped with Loran and participating in the survey were the *Cherry Valley, Esso Concord, W.C. Yeager, Lyon's Creek, Atlantic Sun, Seatrain Texas, Cantigny, Mormacfuel* and *Seatrain Havana*. In the period starting May 1, 1950, and ending May 1, 1951, 94 northbound and 62 southbound reports were submitted to the Hydrographic Office. Of the northbound reports over 60 per cent were on track C, the track coinciding with the charted mean position of the axis as it appears on chart H.O. 0943. In like manner nearly 60 per cent of the southbound reports were for outside route.

Figure 2 represents a typical hourly plot of current on track D northbound and the outside route southbound. Direction does not appear to be as constant as supposed but strength is certainly more consistent, with only a slight decrease in the northerly portion.

For easier analysis, the Gulf Stream in this section was divided into zones as indicated in figure 1. Figure 3 gives the average current strength (dashed line) for each zone over a period of one year. The circles represent individual trips on track C; the triangles, track D; and the squares, track B. Figure 4 graphically illustrates the current average for the year according to zones. The preference of most ship masters to remain on track C (charted axis of the Gulf Stream) is not substantiated by the results plotted in zones 4, 3 and 2. These zones indicate a greater current velocity by nearly a knot over that found on track C. One interesting feature in figure 4 is the counter current in the area of track T and S in zones 1, 2, 3 and 4.

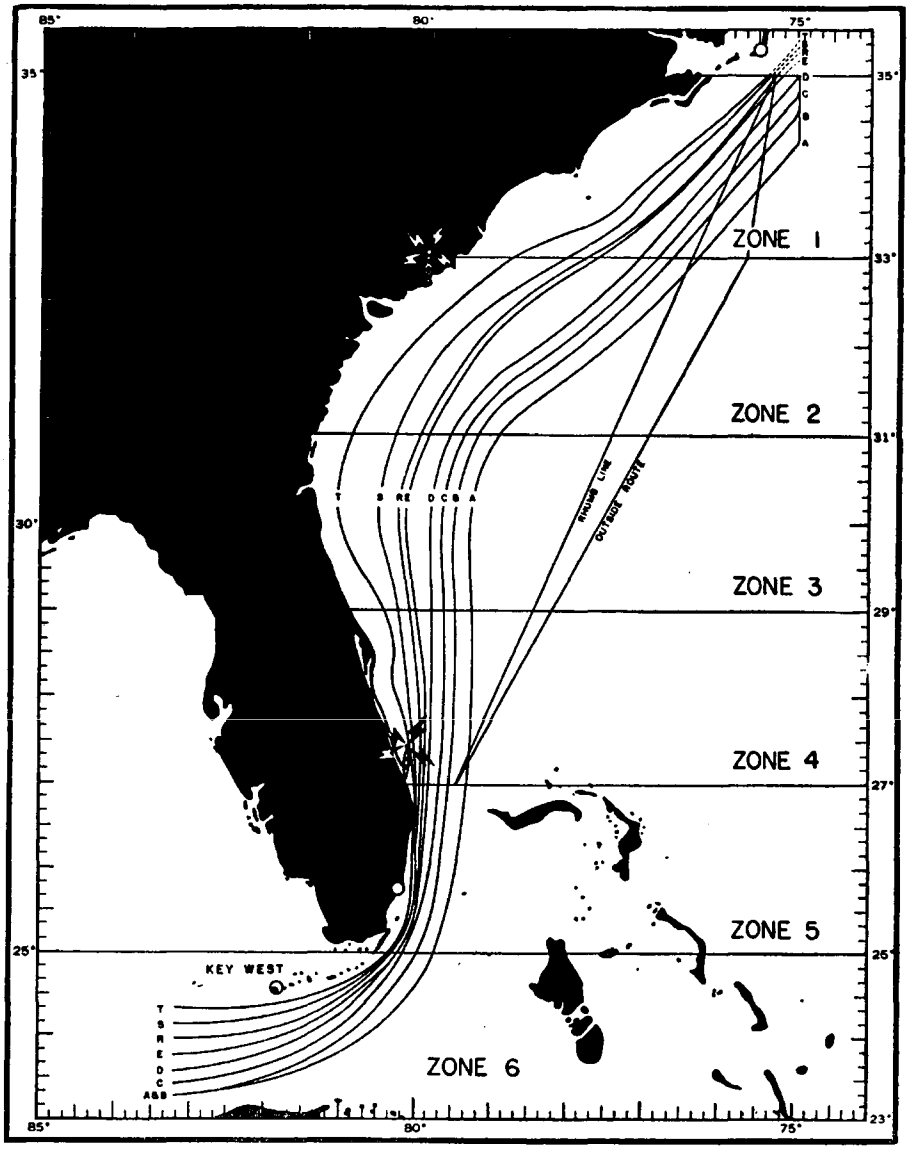

Fig. 1

An illustration of the tracks selected for the Gulf Stream Tanker Survey. Tracks A to E are for northbound trips. Tracks R, S, T, and the « Outside Route » are for southbound trips. The rhumb line was not actually followed by the tankers but is shown for comparison. The area studied is divided into 6 zones for convenience of computation.

Fig. 2

Typical hour-by-hour currents on track D (northbound) and the outside route (southbound)

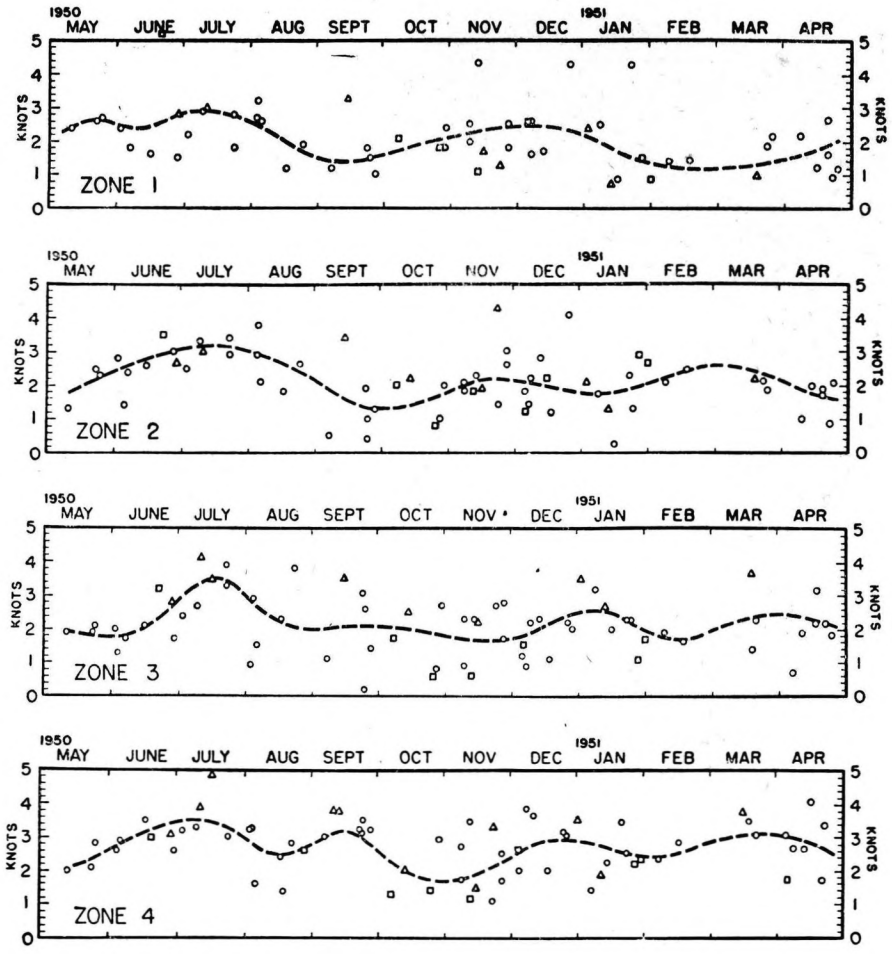

Fig. 3

Mean effective currents (dashed lines) by zones for the 12 months of the year. The circles represent individual trips on track C; the triangles, track D; and the squares, track B.

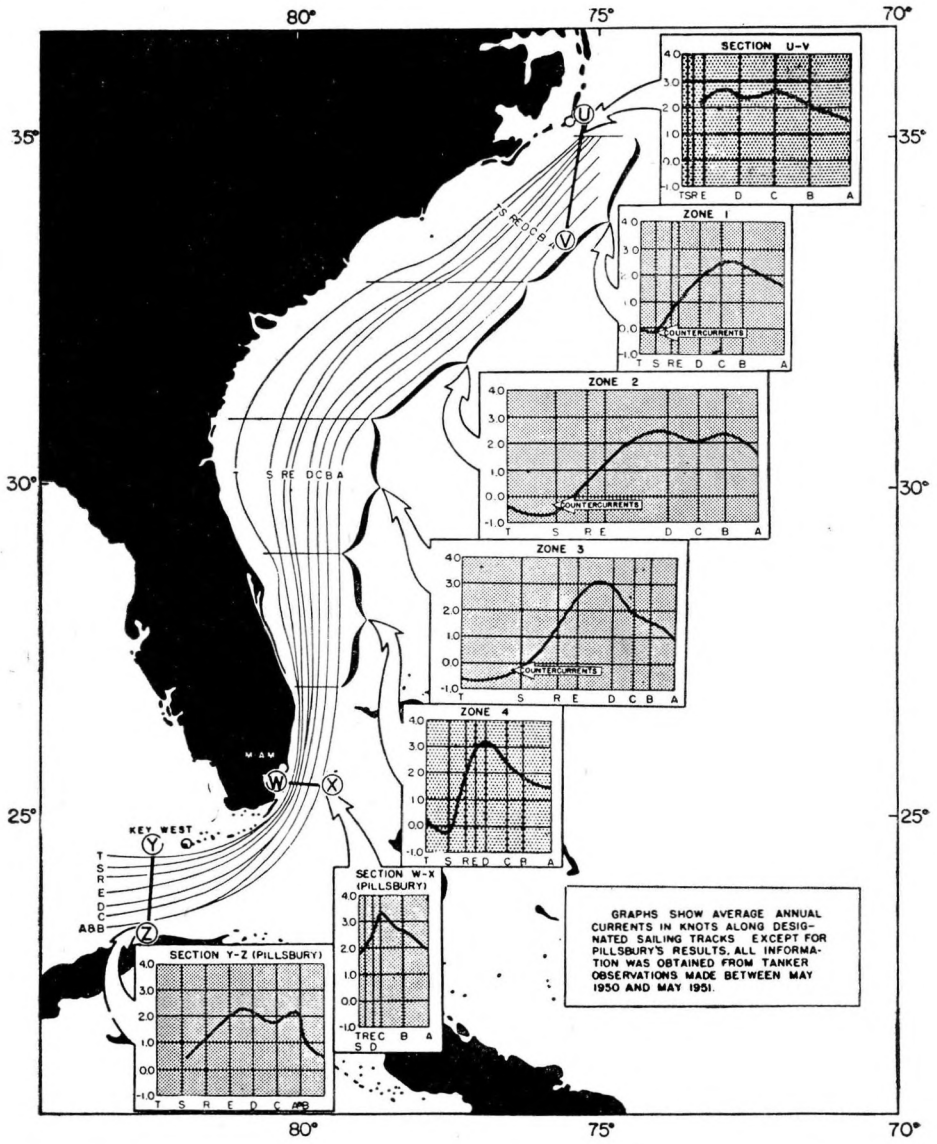

Fig. 4

Sections accross the various tracks by zones, showing relative current velocities

Figure 5 is a plot of individual running times versus the average speed for each northbound track. Track D appears to be the best northbound route on the average; however the difference between tracks D and E is only about 3 hours. Figure 6 gives the same comparison for southbound tracks. Here it is readily apparent that the outside route is by far the most efficient. Comparing figure 5 and 6 it becomes evident that as the basic speed of a vessel is increased beyond 16 knots to 24 or 25 knots, the saving by remaining in the Gulf Stream over that incurred by selecting the outside route is immaterial.

In the log forms that were turned in by each vessel for each voyage along with the charted positions of the vessel during the voyage was pertinent information concerning sea temperatures and tide rips experienced. The Hydrographic Office analyzed this information along with bottom topography and current « sets » experienced by the vessel in the stream. Thus in figure 7 the white arrows indicate what they believe to be the predominant position of the stream in the summer months, while the black arrows indicate a probable shift in position for winter months. In addition to this probable seasonal shift in the position of maximum strength of the stream there is shown, in figure 8, a comparison of the effect on current strength along track C with tidal phase. Zones 1, 2 and 3 are in phase with one another 4 is distinctly out of phase.

A mean for checking the validity of the survey was afforded by comparison of the sea level at Miami, Florida, with the current observations in zone 4. The comparison is illustrated by figure 9 where it can be seen that a current increase at this location is a function of sea level.

Figure 10 shows the state of the sea as plotted against the various routes selected for the survey. This verifies that the inshore route is more advantageous weatherwise than the outside route. However, when compared with figure 6, there is considerable advantage in time saved by taking the outside route. It should be noted that the winds over the outside route are on the average over force 4, 16 per cent of the time; while the winds on the inside route are over force 4, 18 per cent of the time. The seas are not as high on the outside or inside routes as within the Gulf Stream region where a very bad chop can exist when the wind is against the current.

To summarize, it would appear that from a short distance north of Fowey Rocks to Hatteras, track D is on the average the best for maximum current. Track D is on the average about 8 miles to the west of the track C which previously had been assumed to be the approximate mean position of the axis of the Gulf Stream. Sufficient information has not been obtained to allow predictions as to the best track to follow by seasons. Despite heavier weather that may be experienced on the outside route it appears to be the most efficient from the point of time saved. This is true despite the fact that a vessel on the inside route may experience the helpful effect of a counter current.

The results of the data accumulated during the first year of the survey, which is by no means complete, have been summarized on the back of several of the Hydrographic Office pilot charts, including chart No. 4000 (March 1952) and chart No. 3500 (April 1952). Illustrations from these charts were provided for use in this article through the courtesy of the Hydrographic Office.

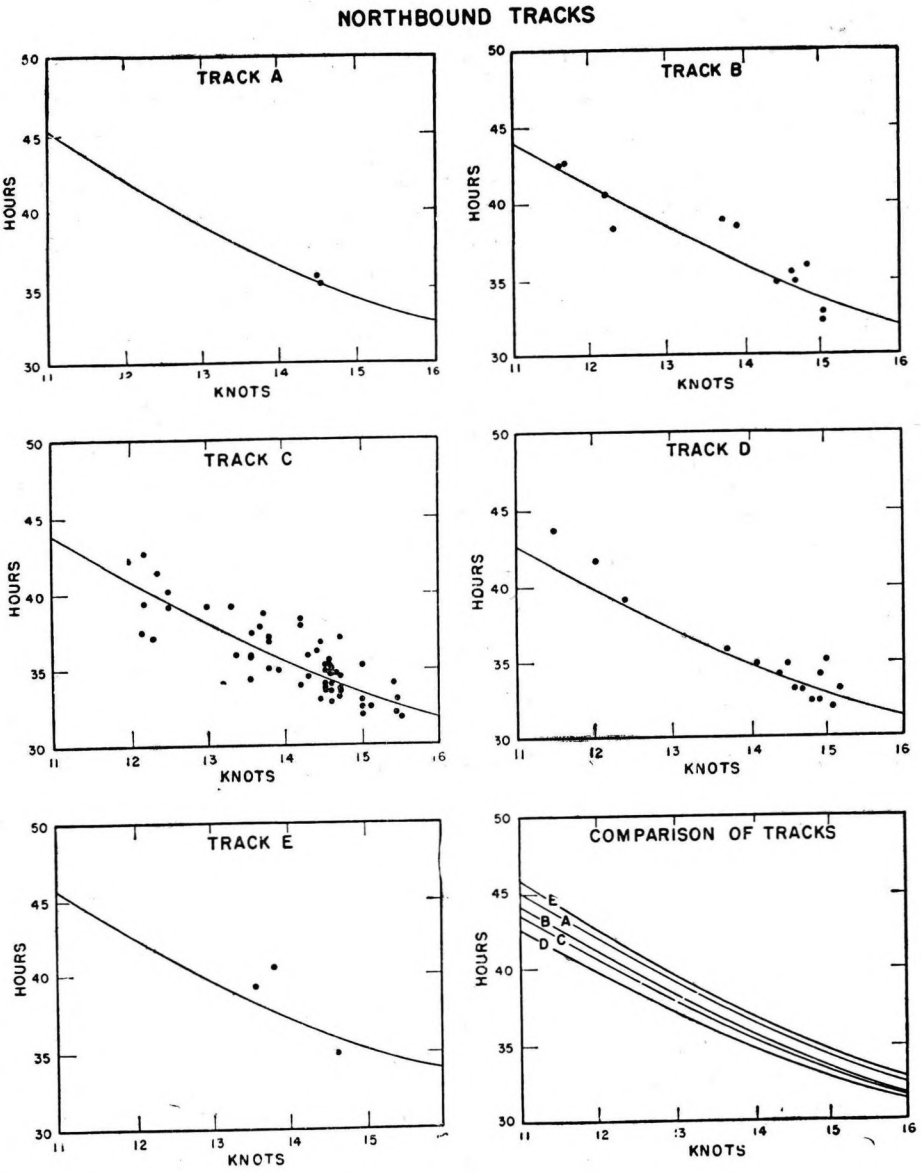

Fig. 5

A comparison of the relative efficiency of the northbound tracks between latitude 27° N. and 35° N. The plotted points are the running times of the individual tankers on the track under study.

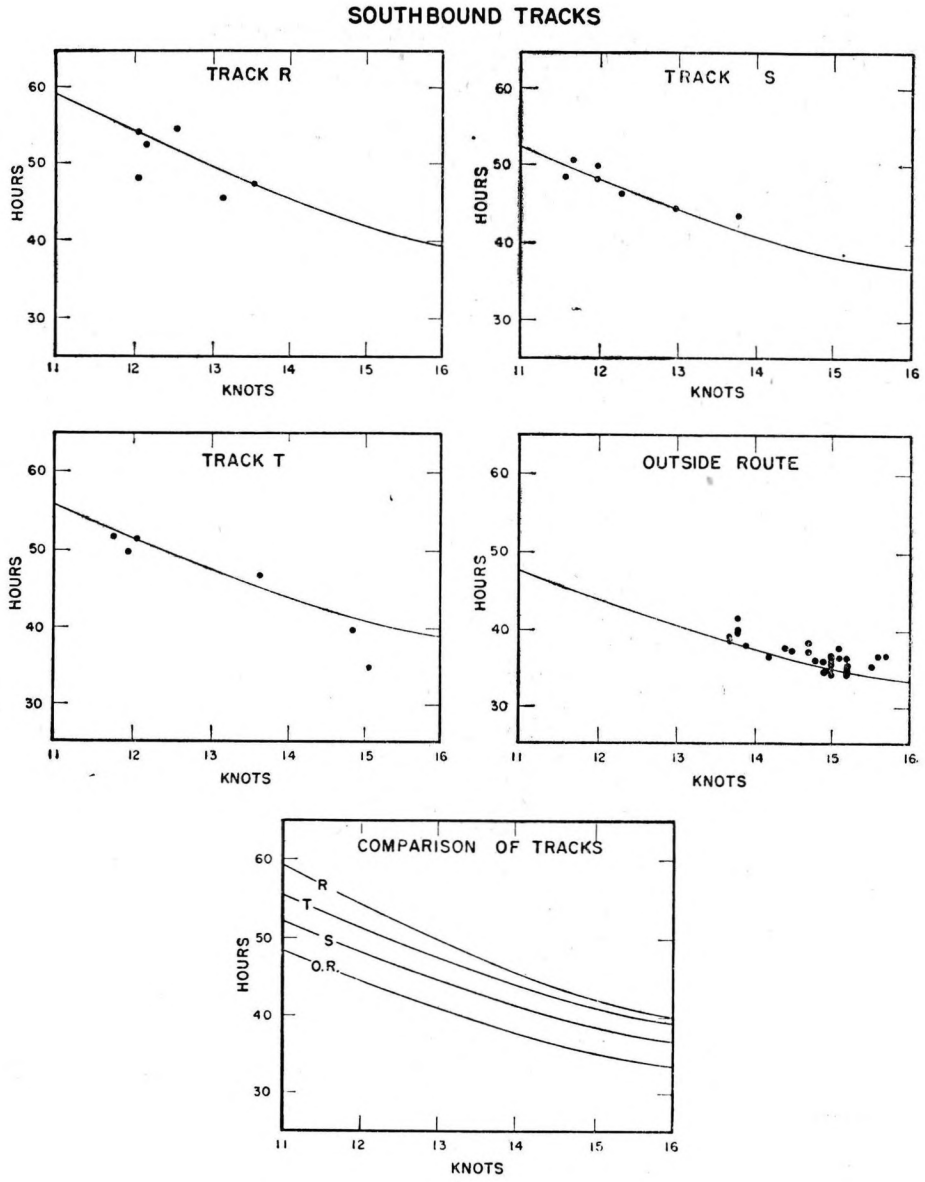

Fig. 6

A comparison of the relative efficiency of the southbound tracks between latitude 35° N. and 27° N.

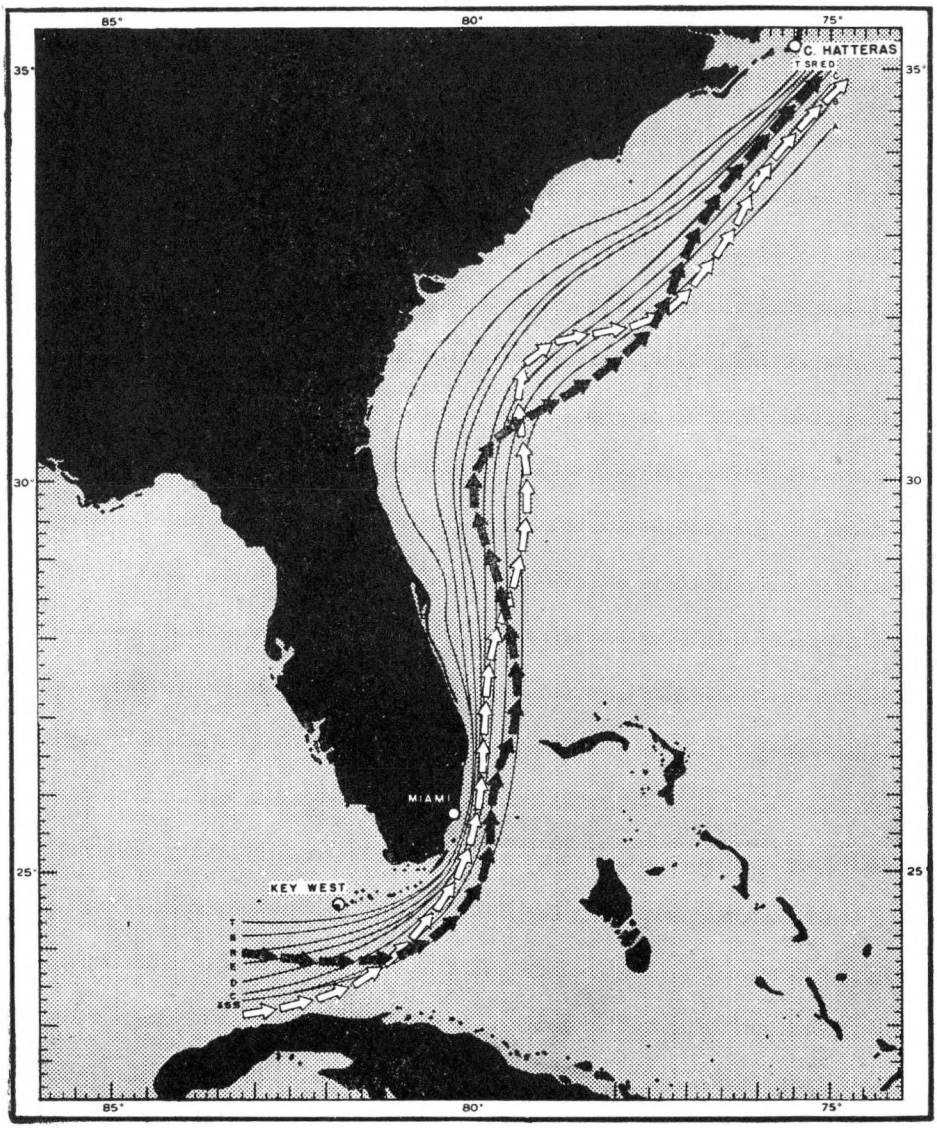

Fig. 7

The predominant positions of the Gulf Stream as determined from a study of the reports of the tankers

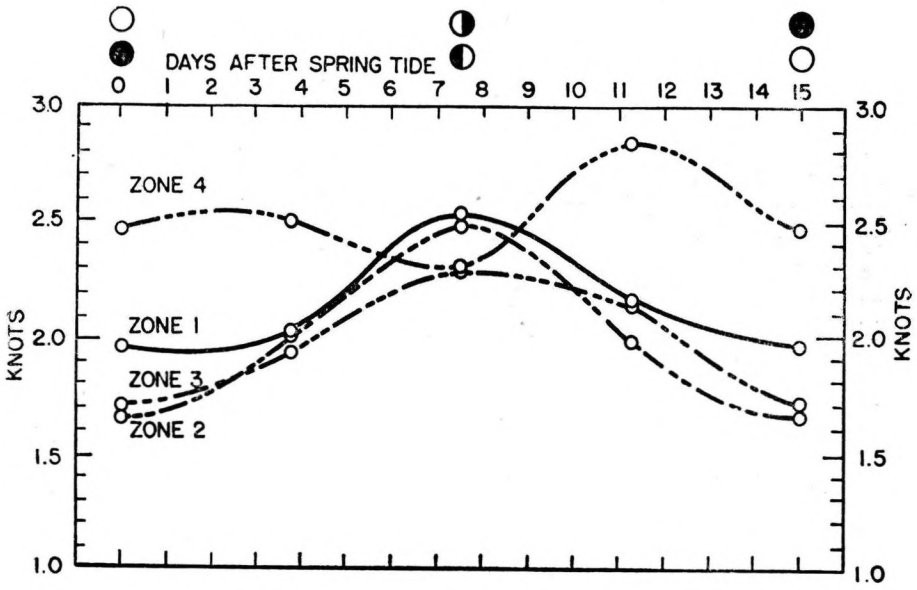

Fig. 8

The relationship of the tidal phase with current speed in four zones

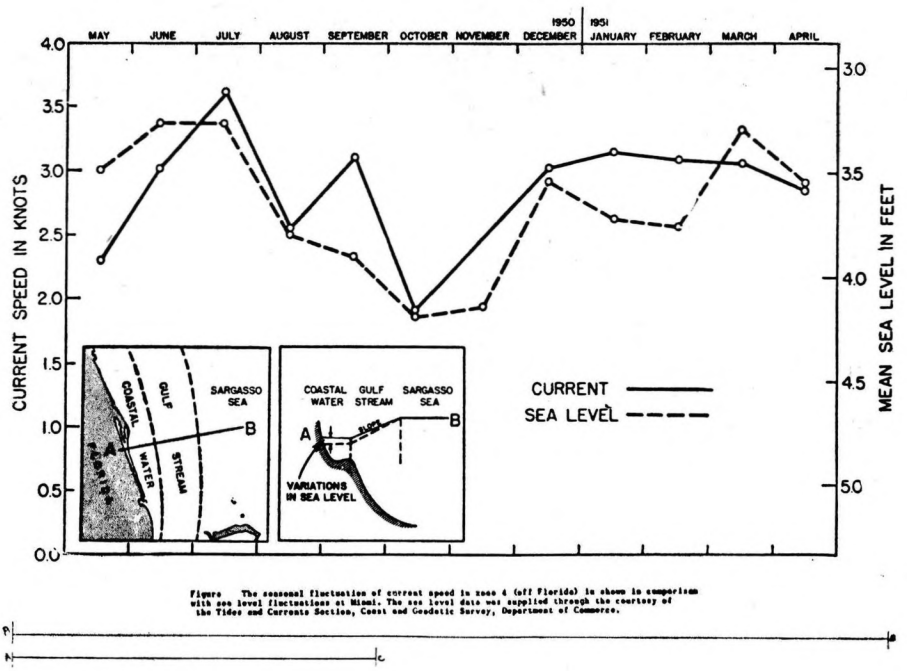

Fig. 9

A comparison of the mean sea level at Miami, Florida, with the current speed in zone 4

Credit for what has been accomplished to date must be given to the various shipping companies participating in the survey and to the Hydrographic Office for the exacting work of compiling the data carried on under the direction of Mr J.-E. O'Hare. The survey should continue for sufficient time so that all that is to be learned about the effect of seasons, tides and weather upon the velocities that exist within the stream can be documented and made available for the navigation of vessels affected by the stream. If, by using this information, two to three hours per voyage can be saved by vessels regularly following the Gulf Stream between Fowey Rocks and Cape Hatteras, the overall saving to a commercial company with a fleet of 25 vessels making the voyage each month would be six to seven thousand dollars per month. This is in addition to the possibility of having made the tide at a specific port and thus saving 12 hours.

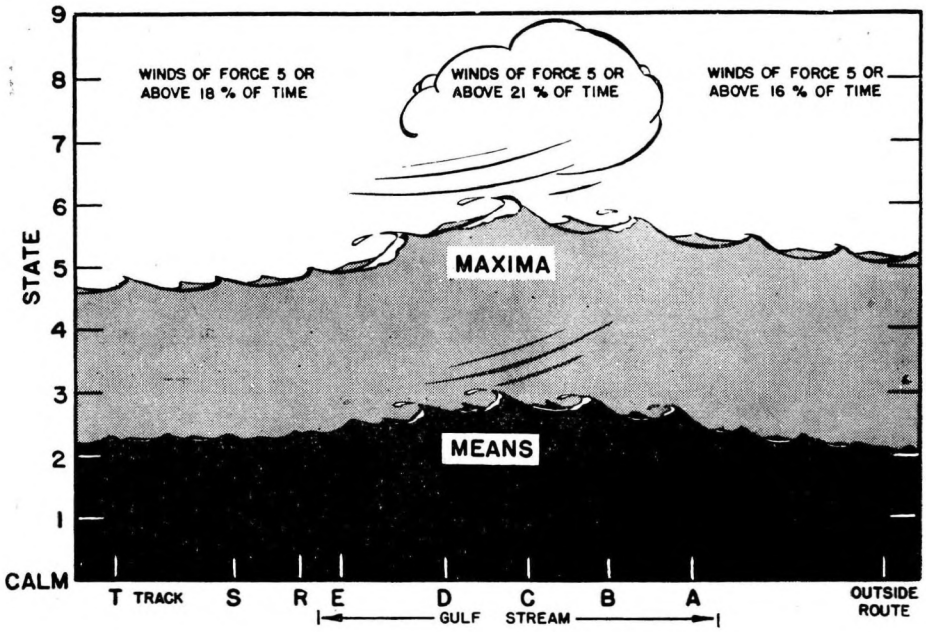

Fig. 10

A comparison of the mean sea state along the Gulf Stream axis with the sea state along the inshore and « outside » routes

Loran has made possible the study of the Gulf Stream in areas where heretofore only an intelligent guess could be made. Information learned about this warm water current can certainly be applied to other such currents throughout the world. Eventually, enough may be learned about the origin of flow of the stream so that predictions can be made of its probable effect upon the general climate of Europe. It should certainly be true that the information gained within this area, coupled with what the Woods Hole Oceanographic Institution is doing beyond Cape Hatteras, would supply enough data so that fairly accurate predictions of the behavior of the stream can be made and relied upon in the daily operations of commercial and government vessels.

SOUTH WEST PACIFIC

Tracing showing soundings obtained on an extensive bank north of the Ellice Island of Niulakita. Least depths of 11 and 11₂ were found in positions 10° 26·2′ S., 179° 33·3′ E., and 10° 28·8′ S., 179° 27·4′ E. respectively.

H.M.S. CHALLENGER

25th September 1951

SOUNDINGS in FATHOMS and FEET

No tidal reductions have been applied (See Note)

○ *Star Observed positions*

↗ *Sun position lines*

NOTE

Soundings should be reduced as follows
by 4ft (1 fathom) from 1127 to 1630
by 3ft " until 1845
by 2ft until the end.

0520/25

Kosciusko Bank (P.D.) (16)

(10) P.D.

(14) Martha Bank (P.D.)

1820/25

1153/25

1127/25 (Sun-Moon)

10° 10′ 20′ 30′ 40′

20′ 30′ 40′ 50′ 180°

Longitude 179° 30′ East from Greenwich