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THE MARINE OBSERVER

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Editorial

There seems little doubt that the last year in the first century of the life of the Meteorological Office—1954—was one of bad weather in and around the British Isles. It is a national characteristic of the Briton, whether ashore or afloat, to complain about the weather and there was undoubtedly justification for such complaints during 1954, though it does not seem that it was quite as exceptional as one might imagine from the newspaper reports. The controversy about the bad summer was the subject of an internal discussion at the Meteorological Office in Harrow during October, in the course of which various experts gave their views. Statistics showed that over England and Wales the general rainfall of the summer (June to August) was 3·1 in. more than the 1881–1915 average of 8·66 in., the mean temperature 2·5°F below and the mean daily sunshine 1·7 hours below the 1921–50 average. Over England and Wales there were six wetter summers (June to August) in the last 54 years; the two wettest in 1912 and 1879, with an average rainfall over England and Wales of 15·9 and 15·7 in respectively, being substantially wetter than 1954 with a total of 11·8 in. The mean temperature of the summer in the United Kingdom was about equal to the normal temperature of June and of the last 53 summers only two, 1922 and 1907, were cooler. Over England and Wales the only summer with less sunshine over the United Kingdom since 1906 was 1912. The statistics also suggest that this wet, cool and dull summer continued a trend which has been in evidence for some years past.

Anemograph (wind) records at six coastal land stations, Lerwick, Tiree, Holyhead, Scilly, Shoeburyness and South Shields, during the 20-year period 1935–54 were analysed to ascertain the years which had (i) the highest number of days with maximum mean hourly wind speed of force 8 or more; (ii) the highest number of hours with mean wind speed of force 8 or more; (iii) the highest mean hourly wind speeds; (iv) the highest gusts; (v) the greatest number of occasions of strong gale (mean hourly wind speed, force 9 or more).

Although 1953 and 1954 do appear in the results they do not by any means predominate, in fact the years 1936–38 appear to have had more extreme values. The highest gust (91 kt) at Scilly in 1954 was the highest in this period, but it was not the highest on record, this being one of 96 kt in 1929. Average wind-speed statistics show that in the past 20 years there were nine windier years than either 1953 or 1954 at Lerwick, six at Southport and five at Kew. At Oxford, however, 1954 was windier than any year since 1903.

The general opinion that 1954 was an unpleasant year is thus borne out by the statistics, but it is by no means the most unfavourable year that has occurred during the period for which records are available. Also, we cannot say that it was the worst year of the past century, because statistics prior to 1879 were not quoted in this discussion.

In other parts of the world conditions seem to have varied somewhat. In Western Europe, for example, the summer was in general cooler and rainier than normal, although in Russia it seems to have been warmer. In West Africa temperatures were some 2–4° below normal and rainfall 50 per cent above in many places, but in the United States the summer was on the whole warmer and drier than normal. There is evidence that the Indian monsoon rainfall in June and July was heavier than normal and so was rainfall in Japan and Malaya.

In the search for reasons for the unfavourable year in Britain, sea and air temperature observations provided by British selected ships and ocean weather ships in the North Atlantic provided some useful figures. It was shown that in general air and sea temperatures in the North Atlantic were above normal during the winter of 1953–54 and below normal during the summer of 1954. Some statistics as to the volume of ice on the Grand Banks during the season were also discussed—but it seems doubtful that this had any direct effect.

There seems little doubt that from the viewpoint of shipping the weather of 1954 had bad features, not only in European waters but also off the east coast of North America and in the China Sea area. An article in the *Journal of Commerce* in January 1955, commenting about the effects upon the marine insurance market of bad weather during the closing quarter of 1954 said: " Consequently, there were a fair number of total losses, many severe averages, and innumerable heavy weather claims."

The early months of 1953 were spectacular from the point of view of bad weather around the British coasts and heavy shipping casualties occurred, including the loss of the *Princess Victoria*, while at the same time very serious flooding caused heavy loss of life and property in the Netherlands and on the east coast of England. The weather during the latter months of 1954 around the British coasts also became notorious because of the violent and prolonged gales which resulted in the loss of such vessels as the South Goodwin Lightship, the *Tresillian*, which capsized in the Irish Sea, both with considerable loss of life, and the *World Concord* which broke in half, also in the Irish Sea. Several other vessels were also lost, but fortunately the loss of life in general was not as heavy as in 1953. It is specially tragic that during 1954 two casualties to lifeboats belonging to the R.N.L.I. occurred with a consequent loss of life. On the American coast two hurricanes in particular caused considerable damage at sea and ashore. Perhaps the most spectacular and tragic shipping casualty during the year occurred in Japanese waters during a typhoon, and involved the train ferry *Toya Maru*, which capsized just outside the harbour she was leaving, with a loss of 1,000 lives.

A glance through the monthly casualty returns issued by Lloyd's seems to emphasize the relatively serious casualties due directly or indirectly to weather which occurred in various parts of the world throughout the year. For example, 22 ships lost propellers on the high seas between January and November, two ships lost their rudders and five were fractured across the deck. Despite modern invention, the peril of the sea is always with us. Incidentally the number of lost propellers during 1954 is not excessively high, the figures for the five previous years being 36, 21, 19, 30 and 27.

It is impossible to say whether, provided similar meteorological conditions had prevailed during the year 1854, and the tonnage of world shipping had been similar to what it is today, the casualty rate would have been higher or lower. Ships certainly would not have been disabled due to lost propellers, and it seems doubtful that they would have sustained deck cracks or have broken in half, but lost rudders and dismasting were relatively common in those days, the danger of being off a lee shore was considerable and it seems probable that when a ship was sunk, loss of life had a tendency to be higher than at present owing to lack of radio communications, primitive arrangements for launching boats and other reasons.

Mechanical propulsion, modern navigational aids, improved rescue facilities and the extended use of radio, as well as the increased availability of weather information, have presumably all played their part in providing greater safety of shipping as the years have gone by. But it is difficult to say how much any one item has contributed.

As stated in Mr. Parkhurst's article in this number, FitzRoy had quite a struggle to persuade the authorities that even storm warnings were valuable to shipping, and it was a long time before money was made available for forecasting purposes. In those early days the only way of issuing storm warnings was by visual signals. There is little doubt that visual storm signals have still considerable value today not only in the United Kingdom but in other parts of the world, particularly for small craft which may not have a radio apparatus aboard. Even aboard an ocean-going ship it is not always convenient to be listening to the radio in harbour, and the hoisting of the north or south cone provides a useful warning to the master of a ship about to sail. Visual signals seem to be of particular value in places like the

China Sea and the West Indies, where tropical storms are liable to occur and there are many small and relatively primitive craft.

The first radio weather bulletin for merchant shipping from a British coast station was issued from Poldhu in 1919. This was a bulletin primarily for coastal shipping and it included storm warnings. What is known as the British " Weather Shipping " Bulletin came into force on 1st May, 1930. It contained a general statement, forecasts of wind and visibility for coastal areas, and an " outlook " in plain language, and also actual observations in code of 10 British and two foreign stations. This bulletin continued up to the outbreak of war in 1939. The B.B.C. forecasts for shipping were introduced in 1925.

Forecasts to and gale warnings for coastal shipping from the B.B.C. and G.P.O. coast stations were resumed soon after the war ceased. The present Atlantic Bulletin for shipping, which not only contains a statement of the existing weather and a forecast but also includes an analysis which enables the shipmaster to plot and study his own weather map, was first issued in 1946.

The meteorologist cannot do anything to change the weather; the best he can do is to describe the existing weather over as wide an area as possible and give as long notice as possible of impending changes.

The master of a small vessel in coastal waters on receipt of a radio storm warning can endeavour to reach shelter. In the open ocean all he can do is to make the vessel as snug as possible and heave-to when necessary, but in the open ocean as a general rule the seas are not so short and steep* and there is always plenty of sea room for manœuvring. What the master of a big ship can do, whether coasting or in the open ocean on receipt of a storm warning, inevitably depends on circumstances. The action which any mariner takes as a result of meteorological information, whether it be provided by visual signal or by radio, depends largely upon the judgment, experience and seamanship of the mariner himself. Meteorological information, whether it is in respect of fog, a temperate zone depression or a tropical storm can only be viewed as an aid to navigation, and like any other navigational aid, its interpretation and proper use calls for seamanship.

Sir Graham Sutton

In the New Year's Honours List this year Her Majesty the Queen honoured the Director of the Meteorological Office, Dr. O. G. Sutton, C.B.E., F.R.S., by conferment on him of the award of a knighthood.

MARINE SUPERINTENDENT.

EARLY DAYS

In the June, 1954, number of our contemporary journal, *The Meteorological Magazine*, appeared an article " Some Reminiscences of the Meteorological Office of the year 1902 ", by Mr. R. G. K. Lempfert, C.B.E., M.A., who joined the Office as long ago as May 1902 being the first science graduate to do so. It is thought that readers of *The Marine Observer* would be interested in some of his recollections.

In those days, he points out, the administration of the Office was the responsibility of the Royal Society, who carried it out on a Parliamentary grant-in-aid of £15,300. The staff on the pay-roll numbered about 40.

Mr. Lempfert writes:

" The Office was housed in Westminster, at No. 63 Victoria Street, the corner building at the junction with Strutton Ground. The passer-by could recognize it by a display of notice-boards on the first-floor balcony giving the latest reports of the weather and state of the sea in the Strait of Dover. The ground floor was occupied by a piano shop and we had the four floors above and also the basement

* Recent observations seem to dispute this (see page 115).

for storage. The piano shop and the itinerant musicians of Strutton Ground saw to it that we did not lack for musical entertainment.

" On the first floor was the office-keeper's den, which later became my room as Superintendent of Statistics. A large but extremely low room which ran from front to back of the building housed the Statistics Division. I was told that originally it had been two rooms, but the dividing partition had been removed and replaced by an iron girder to support the ever-increasing weight of the records accumulating on the floors above. The instrument store was also on this floor.

" On the next floor were the rooms of the Secretary and the Marine Superintendent, the ' office ' and the main working room of the Marine Division. . . .

" On the third floor two rooms were allotted to the Forecast Division of which more anon. The Observatory Division had the large front room and the Marine Division the remaining small one. On the top floor I had my room. The front room was occupied by four ladies attached to the Marine Division, the only women in an otherwise all-male staff."

We feel sure that our readers will not fail to notice that it is not only in the field of maritime meteorology that the Marine Branch were the pioneers!

Mr. Lempfert goes on to say:

" I saw little of the work of the Marine Division in those early days. Captain Campbell Hepworth was Marine Superintendent, with Charles Harding as his principal assistant. Another member of the staff was a retired sea captain, William Allingham, who revised and enlarged the fifteenth edition of Lecky's *Wrinkles in Practical Navigation,* which enjoyed a considerable sale in its day. Then, as now, the Division's task was to collect and discuss observations from the sea, the purpose for which the Office had been founded in 1854. It had agents in Southampton, Liverpool and other ports, but port meteorological officers had not been thought of. Its current output was *Monthly pilot charts of the North Atlantic and Mediterranean* which gave the average distribution of the meteorological elements and a lot of interesting miscellaneous information. The *magnum opus* then in hand was *Monthly wind charts of the South Atlantic,* which was published by the Admiralty in 1903. The Instrument Division was at this time part of the Marine Division. It was in the main an instrument store for the supply of instruments to the Navy, the Mercantile Marine and the telegraphic reporting stations. Questions of design or of testing new types, when they arose, were mostly farmed to outside bodies for study and report."

Regarding the early days of forecasting he writes:

" No part of the Office has seen greater changes than the Forecast Division. When I set foot in it Frederic Gaster was still the senior member of its staff. He was then close on the retiring age, and if my information that he joined the Office as a boy is correct he must have been there when telegraphic weather reporting started under Fitzroy in 1865. . . .

" Looking back on those days I cannot help wondering how they carried on, for I do not remember any reserve of experienced man-power in the Division to provide for sickness or leave or public holidays. After I had been in the Office for a year I was called on to take a share in forecasting, and about the same time Henry Harris was transferred from the Marine Division. Though the routine of that Division was mainly concerned with statistical work he had had plenty of synoptic experience. The contribution of the Office to the International Polar Year 1881–82 had taken the form of publishing daily synoptic charts of the North Atlantic Ocean from all available information that could be collected, not only from British ships but also from those of other co-operating nations. That task had been assigned to the Marine Division. It was a big job as all data had to be extracted from the logs.

" The forecasting was carried on in two rooms on the third floor which were used turn about, morning and evening, to give the cleaners an opportunity for sweeping and dusting. All information was received by Post Office telegram. The messages were paid for at normal rates and had no priority over those of the general public.

Liaison with the Post Office was by private wire from Victoria Street to the Central Telegraph Office, but that represented no concession to the importance of meteorology. Anybody doing much business by telegram could hire a private line but had to operate his own end of it himself. That meant that the forecast staff had to be proficient in sending and receiving morse. Teleprinters had not yet been invented.

" The hour for opening local post offices, 8 a.m., was the hour for the morning observations. At that hour the morning staff, three strong—forecaster, telegraphist and boy clerk—came on duty and soon after the reports began to trickle in. We received 25 from the British Isles and 30 from the Continent (Norway 4, Sweden 5, Germany 4, Denmark 2, France 10, Holland, Belgium, Spain, Portugal and the Azores each 1), but the latter were very often incomplete, as the gaps in the Daily Weather Report of those days show. All messages were in the international code, which had remained practically unchanged since its adoption by the International Meteorological Committee in 1874. There was, of course, no upper-air information, but it is rather surprising that there was no provision for reporting cloud motion or form. Only one figure, 10 possibilities, was allotted to ' present weather ' and ' past weather ' was ignored. Our own observers were instructed to supplement the code figures by adding groups of Beaufort letters to their inland messages, and they were encouraged to add short notes such as ' cirrus rapidly from west ', though my recollection is that little use was made of that discretion.

"As the reports were received by the telegraphist they were called out by the junior, after conversion of the foreign ones to British units (pressure was still given in inches or millimetres) for the forecaster to plot them on the working chart. The chart was usually reasonably complete by 9.30 a.m. or soon after. If it was not that was unfortunate, but one just had to do one's best. Storm warnings were the first consideration. In doubtful cases one could call on stations for ' special reports '. A reply to a telegram dispatched about 9.15 might be expected before 11. That disposed of, telegrams were drafted for certain Admiralty addresses and then came the ' General inference ' and the district forecasts for 11 districts. They were written by the forecaster in the forecast book. The instruction was that the inference should indicate the reasons for the district forecasts. The assistants then wrote them out in violet ink on special forms for manifolding by what we called ' jellygraph '. These press issues were collected by messengers from the news agencies and evening papers soon after 10 a.m."

We recently heard from Mr. H. E. Carter, who was in the Marine Branch even before Mr. Lempfert joined the Office and only retired quite recently. He writes:

" I have a clear-cut recollection of life in the Meteorological Office in those far-away days when I was just a boy clerk in the Marine Branch, passing rich on a wage of 12s. 6d. per week.

" I knew all the people mentioned in the article. Captain Hepworth was an autocrat but with a kindly nature, Charles Harding a strict disciplinarian who gave me a handsome volume of Shakespeare which I still treasure and read, and William Allingham a kind ' sailor-man ' who wrote a *Manual of Marine Meteorology* which, like Lecky's *Wrinkles in Practical Navigation* which he revised and enlarged, had a considerable sale. I have a copy of his *Marine Meteorology* inscribed, ' To H. E. Carter from his friend William Allingham, Xmas 1903 '.

" To a great extent the ladies were segregated from the male staff, few of whom had the entrée to their room. Tarrant or Keeton or I went there to take records necessary for their work or to collect the results. Charles Harding visited them once daily, usually in the late afternoon. In my six years at the Victoria Street Office I never saw the ladies in any other room but their own."

Some Landmarks in Meteorological Progress 1855–1955

By R. F. M. Hay, M.A.
(Marine Branch, Meteorological Office)

PART II

Part I of this article, dealing with advances in synoptic and climatological meteorology, was published in *The Marine Observer* for January, 1955.

Progress in the design of meteorological instruments

The past 100 years have seen very considerable progress in the development of instruments for investigating many new meteorological problems, and in the improvement and modification of existing instruments. Instruments shown at the Great Exhibition in 1851 included a standard open cistern barometer, a self-registering barometer, Rutherford's thermometer, Six's self-registering thermometer and various hygrometers. An early purchase by the Meteorological Department was that of 12 " barometers for fishermen " in 1858. The reader may be interested to know that as recently as 1950 five of these instruments were still in use and in good condition at various harbours in the United Kingdom. Although the design of the barometer has undergone little change in the past 100 years, the instrument has been better adapted for use by seamen by the incorporation of the Gold slide. This has enabled corrected barometer readings to be obtained much more easily and quickly. The Kew pattern marine barometer is now the standard instrument in all British selected ships for measuring the pressure of the air. However, improvements in the design of aneroid barometers, notably the development of the multiple chamber type and more recently of the oil-damped barograph, have resulted in such an increase in accuracy, and reduction in costs of production, that the aneroid may soon begin to compete with the mercury barometer for use at sea if trials now being undertaken are successful. It possesses, in addition, the advantage of being more robust and compact than the mercury barometer.

During the latter half of the nineteenth century great progress was made in anemometry. Arising out of the Tay Bridge disaster in 1879, when part of the bridge collapsed during a squall, carrying a train into the river with it, W. H. Dines, on behalf of the Meteorological Department, made a thorough investigation into the relation between Beaufort's notation of wind-force, the equivalent wind velocities and the corresponding pressures exerted upon structures, and reported his findings to a wind-force committee set up by the Meteorological Society in 1886. In the next few years Dines redetermined the value of the ratio between the run of the wind and the run of the cups of the Robinson anemometer and obtained a factor of 2·1, as compared with 3·0 found by Robinson himself, and subsequent experience has shown the Dines value to be correct. An accurate knowledge of this factor is essential for converting the rate of revolution of the cups on an anemometer of this type into wind speed. Cup-type anemometers are now used for wind measurement aboard ocean weather ships and aboard the larger warships, but very few merchant ships are so fitted. Dines was also responsible for developing the pressure-tube anemograph bearing his name which is used at land stations in the British Isles and by many meteorological services of the Commonwealth and other countries. The advantage of this instrument is that a permanent record showing the variations of the wind (gustiness) and its changes in direction can be obtained on charts by means of pens actuated by the moving parts of the instrument which indicate wind velocity and direction.

In recent years a notable improvement has been made in the accuracy with which sea temperature can be measured, both at the surface and to a depth of several hundred feet. Not many years ago the usual method was to lower a simple canvas bucket on a rope until it was just immersed in the sea, haul it on deck, insert a thermometer and read the temperature of the sample of sea water as quickly as possible. The results obtained by this simple method are liable to be somewhat in error due to several causes, the chief of which is the change in temperature of the sea water sample between the time the bucket leaves the sea and the thermometer is read by the observer. The largest errors will occur in strong winds when the air is markedly colder (or warmer) than the sea surface, or when the thermal insulation of the bucket is poor and the volume of the sample is small, or if there is any delay before the observer takes a reading. A bucket made to a design due to Ashford which substantially reduces these errors was adopted for use by British selected ships in 1950. Further work is in progress in the Meteorological Office with the object of producing a bucket which will be much smaller, lighter and cheaper than the Ashford bucket while retaining the same high standard of thermal insulation.

Another method of measuring sea temperature is by means of a thermometer fixed in the intake which supplies water for the condenser. This method is not accepted as standard practice aboard the British selected ships, since it is open to the objection that the water may be heated on entry through the ship's hull and errors may occur in transmitting the reading back to the bridge. More serious is the real difference which is found in quiet weather in the tropics at all seasons and in quiet weather in temperate latitudes in summer, between the sea temperature at the intake level and close to the sea surface as recorded by the bucket method. However, continuous records of sea temperature at intake levels are obtained by means of thermographs on board the ocean weather ships.

The measurement of sea temperature within a few hundred feet of the surface has been simplified by the invention of a bathythermograph which is light enough to be handled and launched by two men, and can be used to furnish a record of sea temperature at intervals down to a depth of 450 ft in a few minutes while the ship is under way. The whole instrument is encased in a solid metal body tube. The record is obtained by the point of a stylus scratching a small smoked glass slide. One axis of the record relates to pressure which is recorded hydrostatically, the other axis to sea temperature which is measured by means of connecting the stylus to a thermal element (liquid-filled copper tubing and bourdon gauge). The scratched record is held in a small clamp in the instrument and is afterwards fixed by dipping the plate in colourless lacquer, which coats the smoked surface and is afterwards allowed to dry off.

Until about 15 years ago our knowledge of upper winds had been limited to measurements by means of pilot balloons and smoke drifts from shell bursts, both of which could only give winds at levels below cloud. Upper-air pressures, temperatures and humidities had been mainly determined by means of meteorographs. In effect these were very small and light bimetallic thermographs and hair hygrographs and aneroids which recorded on small smoked-glass plates in the same way as described in the previous paragraph. In the last century meteorographs were carried upwards on kites; more recently large balloons have been used. W. H. Dines was one of the pioneer workers in this field. Only some of these meteorograph records were recovered, the remainder being lost in remote and uninhabited areas or over the sea, whilst the records of those recovered were often not available until days or weeks after the ascent, and even so the deciphering and calibration of the small smoked-glass trace was lengthy and tedious. Despite these handicaps, systematic studies of the upper air by Teisserenc de Bort at Trappes and Assmann at Lindenburg, at the end of the last century, using these methods, led to their discovering independently that above a certain height in the atmosphere there was always to be found a layer of considerable vertical thickness through which temperature remained constant or nearly so. Teisserenc de Bort termed this layer the " stratosphere " and its lower boundary (usually rather sharp) the " tropopause ". The layer between the tropopause and the surface he termed the " troposphere ". These terms have been used by meteorologists ever since.

Pilot balloons and smoke drifts have now been almost completely superseded by the radiosonde for making observations of pressure, temperature and humidity, and by radar methods of wind measurement. In the British radiosonde a transmitter emits a signal whose audio frequency is controlled by an oscillating circuit in which the magnitude of the inductance is varied by sensitive elements actuated by the pressure, temperature and humidity of the air. These elements consist of a small aneroid capsule for pressure, a bimetallic strip for temperature and a length of goldbeater's skin (from the intestines of cows) under slight tension for humidity. The transmitter is repeatedly connected in turn with the pressure, temperature and humidity elements by means of a rotating switch actuated by a simple windmill which is attached to the side of the sonde and is rotated by the flow of the air past the ascending instrument. Before the instrument is used for an ascent it is calibrated in a special chamber, and each instrument is supplied with a calibration chart showing the pressure, temperature and relative humidity which correspond to various frequencies emitted by the transmitter. Radiosondes are also used to measure upper winds in many countries. In place of a theodolite a direction finder is used to determine the azimuth and elevation of the balloon and transmitter at regular intervals of time, usually one minute. The height of the balloon above the position of the direction-finding equipment is usually determined with the aid of pressure, temperature and humidity readings obtained from the transmitter during its ascent, or by assuming a constant rate of ascent of the balloon. The calculation of winds at the levels required is then a matter of routine.

For upper-wind observations by radar a reflector made from metallised paper or wire-mesh is normally carried aloft by a balloon. The slant range, elevation and azimuth of this reflector are measured at regular intervals by means of the radar equipment at the ground station, and this enables the position of the balloon to be determined and hence the wind. The sets in use at land stations normally allow ranges to be measured up to 90,000 yd and to the nearest 15 yd, whilst azimuths and elevations may be measured to better than 0·1° throughout the whole range of elevation 0° to 90°. This allows winds at 50,000 ft to be measured with, in general, a root mean square vector error of less than 5 kt at a land station; but the accuracy attainable with equipment on British ocean weather ships is of a rather lower degree, partly owing to the ship's movement, although the range attainable is similar.

In the latest radar wind-finding equipment which is being developed in the United Kingdom, a small transmitter-receiver, known as a " transponder ", will be used in place of the radar reflector attached to the ascending balloon. This transponder receives pulses from the ground station on one frequency and re-transmits them on a different frequency. The equipment at the ground station comprises radar units, computing and recording units and power supplies. The aerial unit includes transmitting arrays and receiving aerial, consisting of a scanning dipole and paraboloid reflector (see picture opposite page 112). Special arrangements have to be made through an error-signal fed to a servo system to keep the aerial aligned on to the transponder, in other words an " automatic follower " system is included. The azimuth and elevation of the transponder at any time are obtained from the azimuth and elevation angles of the aerial unit, and the slant range from the time which the pulse takes in travel to and from the transponder. The computer and recorder units automatically calculate and record the wind speed and direction and the height of the transponder directly from this information, for a time of flight of as much as 100 minutes if necessary.

The arrangements for translating (i.e. telemetering) the signals sent out from the pressure-, temperature- and humidity-sensitive units which are contained in the airborne sonde unit, in addition to the transponder, are more elaborate than in the radio-sonde. A motor-driven switch is used to connect the units to the circuit in sequence, together with a high-precision pulse delay circuit. This circuit is used to generate a pulse at a time interval after the ranging pulse of anything from 200 to 1,200 millionths of a second, depending on the value of the meteorological variable. The ground station sends 400 pulses every second and each meteorological unit is in circuit for three seconds. In practice the telemetering unit on the ground uses 1,000 of the intervals so that the system can record the meteorological information to an accuracy of 0·1 per cent of the range of variation experienced in the atmosphere. The design of more accurate pressure-, temperature- and humidity-sensitive elements is under way, but even using the sensitive elements which have been in service with the radio-sonde equipment, the accuracy of the radar-sonde is expected to be much higher than in any existing system.

The positions of thunderstorms have been determined in this country for some years by the use of cathode-ray direction-finding (C.R.D.F.) equipment at four stations. This equipment permits thunderstorms to be located with a fairly high degree of accuracy up to a range of 1,000 to 1,500 miles. Reports of these locations are known as sferics. The equipment at each station consists of the C.R.D.F. equipment, amplifiers and cathode-ray display tube, and a double system of vertical frame aerials or loops, one oriented in a true N–S plane and the other in a true W–E plane. The receivers are arranged to work on a frequency of about 10 kc/sec (30,000 m.) because the maximum energy from atmospherics is found between about 8 and 12 kc/sec. The output from the amplifier connected to the N–S frames is fed to the X plates of the cathode-ray tube and that from the amplifier connected to the E–W frames goes to the Y plates. Thus impulses picked up only on the N–S frames cause the spot of light on the tube to be drawn out into a N–S line, whilst a signal received on the E–W frames gives an E–W line. Signals from an intermediate direction will thus give a line on the tube in an intermediate direction, which can be determined to the nearest degree from a graduated circle around the glass face. The four stations are interconnected by telephone tie-lines to ensure that, on instruction from the observer at the control station, they all take bearings on the same flash. The position of the flash is readily determined by plotting the bearings from the four stations on a perspex-covered map, and such measurements are now made hourly at Dunstable throughout the day. The information is of great value to forecasters, particularly when it is received from sea areas such as the North Atlantic and the Mediterranean. It is also important for planning aircraft operations, since it assists in giving warning of the location of cumulonimbus clouds.

The electrical properties of the atmosphere have been investigated by numerous workers. C. T. R. Wilson dealt mainly with the ionisation of the atmosphere and the factors responsible for the maintenance and variations of its electric field. Our understanding of the electrical processes which generate electricity in thunderstorms, and in particular the distribution of electricity within thunder-clouds, was greatly extended by the researches of Simpson and his co-workers at intervals between 1908 and 1937. At the same time Schonland and others successfully investigated the properties of lightning discharges, using a camera invented by Boys for high-speed photographic recording which enabled stages in the discharge to be followed which lasted one or two millionths of a second.

Dense clouds within a short distance can be detected or plotted by the use of radar sets. The most convenient mode of presentation is on a plan-position-indicator (P.P.I.) which can be photographed. The echoes from precipitation can be easily distinguished from those of other objects, and there is a relationship between their intensity and the size of the drops in the precipitation. Under normal atmospheric conditions with a radar set at surface level, precipitation at a height of 20,000 ft can be detected to a maximum distance of 175 miles. For precipitation at 10,000 ft this distance reduces to about 120 miles. Used in this way radar is of great assistance for short-range forecasting, as it reveals in great detail the structure of shower clouds in the vicinity of the observer and the changes that are occurring. In certain parts of the world radar has now been used many times on reconnaissance flights by aircraft into the eye (or eyes) of tropical revolving storms, and has made a great contribution to forecasting the movements of these storms and to our basic knowledge of their structure and characteristics.

Space does not allow of more than a passing mention to be made of other instruments which have been developed, such as instruments for recording air temperature and humidity from aircraft in flight, and instruments for measuring cloud height such as cloud searchlights, or of rain-gauges and snow gauges and sunshine recorders among others.

In describing earlier the development of the forecasting services in individual countries and the more recent work of the World Meteorological Organisation, brief mention was made of the benefits which advances in meteorology can confer on the human race. In improving the accuracy of forecasts for short and long periods the meteorologist assists in saving lives and helps to effect economies in the costs of numerous public services. In carrying out climatological research he similarly provides valuable information for agriculture and industry and many other interests. A hundred years ago he could have justly complained that these tasks were beyond his powers with the means then at his disposal. Today relatively dense networks of stations exist on land, and many reports are received from ships, whilst recent developments in electronics have revolutionised methods of collecting and digesting data, and the use of aircraft allows observing and research stations to be established and maintained on the polar ice-caps. To maintain progress, however, meteorologists must continue to receive the utmost co-operation from observers of all nations, ashore, afloat and in the air, together with financial support concerted internationally and measuring up to the global character and magnitude of their problems.

Ocean Meteorology

A CENTURY OF SCIENTIFIC PROGRESS

By P. G. Parkhurst, M.B.E.

PART II

In Part I of this article, which appeared in the January, 1955, number of *The Marine Observer*, Mr. Parkhurst dealt with the history of the Meteorological Office from its formation in 1855 up to 1861.

Forecasts and Storm Warnings

Although at the commencement of the storm-warning system, Admiral FitzRoy had stated that little or no additional cost would be thrown upon his Department, yet in 1862 the question of the provision of additional funds arose in an acute form. Parliament had voted £4,600 for the year 1862–63 but for the following year Admiral FitzRoy asked for £5,600. The title of the Vote had been " Meteorological Observations at Sea ", but Admiral FitzRoy suggested that the words " at Sea " should be omitted.

The President of the Board found himself in considerable difficulty in presenting this increased estimate to the Treasury. The system of weather forecasting had proved popular with the public; it was also thought that with further experience they might become more accurate. He was reluctant to impede any progress in a system which might turn out to be of some practical value in saving life and property at sea, but he was far from satisfied that the system had arrived at a state of perfection sufficient to make him willing to approve an increase of £1,000 on the previous estimate. He thought it best to ask the advice of the Royal Society, who had been originally consulted when the Department had been established, pointing out to them how the work had changed and asking their advice on the new proposals. He did not think a small tonnage tax on shipping was desirable, as suggested by Admiral FitzRoy. The President also gave instructions that the forecasts should be checked daily with the actual weather; similar data were also collected regarding the storm warnings. He also agreed to omitting the words " at Sea " from the estimates. The check on the forecasts was not at first made known to Admiral FitzRoy but when it was brought to his notice he cordially approved.

During 1863, 1,288 reports were received from ports to which storm warnings had been sent; in 1,284 cases the storm arrived within 72 hours of the warning, including 462 cases in which the storm was already raging when the warning was received. In 271 cases the direction of the gale was given correctly.

On 30th April, 1865, Admiral FitzRoy committed suicide. The question of the future of the Meteorological Department was then fully reconsidered. General Sir E. Sabine, President of the Royal Society, suggested that the work of collecting data of observations at sea should be transferred to the Hydrographer and the duty of forecasting weather, if considered desirable, should be undertaken by the Astronomer Royal, with the assistance of Mr. Babington, who had been Admiral FitzRoy's able assistant.

In 1866 a small committee was set up, consisting of Mr. T. H. Farrer (afterwards Lord Farrer), Secretary to the Board of Trade, Mr. F. Galton, Secretary-General of the Royal Society, and Staff Commander F. J. Evans, the Hydrographer. They recommended that the data already collected regarding meteorology at sea, consisting of some 500,000 observations, the discussion of which had been carried out in an imperfect manner, should be again worked over by the staff. The work of collecting observations at sea should be carried on until a sufficient number had been obtained to fulfil the requirements for charting the accessible parts of the ocean.

The Committee considered that the system of forecasting weather was not in a satisfactory state; it was not carried on by precise rules and had not been established by a sufficient induction from facts and ought to be discontinued. The storm warnings had been to a certain degree successful and an endeavour should be made to improve them and to define the principles on which they were issued. Steps should be taken for establishing a full, constant and accurate system of observing changes of weather in the British Isles. The estimated cost of carrying out these suggestions was £10,500 per annum besides a sum of £2,500 for initial outfit.

The work of Admiral FitzRoy was summed up by the committee as follows:

" We feel that we should be doing great injustice to ourselves if we were to allow it to be supposed that we undervalue either what the late Admiral FitzRoy attempted or what he effected. To his zeal and perseverance is due the credit of establishing a system of storm-warnings, which is already highly prized by the seafaring class, and if a more scientific method should hereafter succeed in placing the practice of foretelling weather on a clear and certain basis, it will not be forgotten that it was Admiral FitzRoy who gave the first impulse to this branch of inquiry and who induced men of science and the public to take an interest in it and who sacrificed his life to the cause."

Meteorological Committee of the Royal Society

Later the Royal Society agreed to undertake the management of the Office. A committee of eight Fellows was appointed to supervise the work of some dozen clerks, the committee working gratuitously. General Sabine was the chairman and the Hydrographer a member of the committee. The committee definitely declined to prognosticate the weather.

The Treasury in giving formal approval to the committee's recommendations stated that they had no hesitation in giving general sanction to the estimate for the Meteorological Department. On the other hand, " My Lords could not consent to retaining a separate staff for the mere purpose of continuing the storm warnings ".

In the spring of 1867 the Board of Trade sent to the Treasury an estimate for the Meteorological Office amounting to £12,800. Of this sum £9,900 was for salaries of clerks and £2,900 for new instruments (rain gauges and sunshine recorders, invented by members of the committee) which were considered essential for a more perfect system of recording weather phenomena and for new buildings at Kew, where the instruments would be tested. Both the Royal Society and the

Board thought that in view of the Treasury's former approval of the scheme, it was but a matter of form in submitting the estimate, but they received a rude shock when they were informed by the Treasury some months later that a sum of £10,000 (instead of £12,800 asked for) had been inserted in the estimates submitted to Parliament. The Board pointed out to the Treasury that in view of their former approval a considerable amount of work had been undertaken by the committee, and if the full amount of their estimate was not voted the committee would have no building in which to test their instruments. The Treasury, however, declined to increase their grant above £10,000, except to add a sum of £570 which had been included in the Admiralty estimates for the supply of instruments for ships of the Royal Navy.

The Committee of the Royal Society took over their duties on 1st January, 1867. The Board of Trade decided to suspend the storm-warning system and the last one was sent in December, 1866.

But the storm-warnings had captured the imagination of the public and the demand for information was so strongly expressed and reiterated in the House of Commons that the committee consented to give advice on the actual state of weather prevailing on any part of the coast to other parts of the country. This information was sent free by post but if sent by telegram the recipient was asked to pay one half of the cost.

After an inspection of the instruments at the several ports the committee set about investigating the facts and to lay down rules with a view to reissuing regular storm warnings; they were in fact issued in January, 1868. During 1869 weather reports were sent to more than 100 stations in Britain and on the coast of Europe between Norway and Spain.

The laying of the trans-Atlantic cable enabled weather reports to be received from Newfoundland. The messages were transmitted free to Valentia; thus the weather over the Atlantic was brought under the observation of the committee. A special study of the weather in the North Atlantic was undertaken by the committee's Marine Superintendent, Captain H. Toynbee.* He explained the peculiarity of homeward (eastward) voyages being smoother than those outward (westward) by the fact that the atmosphere over the Atlantic was in a state of constant motion in an E'ly direction at a rate of progress of a full-powered steamer; a ship when outward bound met and passed through several of these systems, while on her homeward voyage she would run with one system of weather for days together.

In the meantime the committee continued its study of the observations sent in by the masters of ships. The committee had thought of issuing a monthly wind chart for every square degree over the entire surface of the sea, but practical experience proved that this was too small and the original 10° square was again reverted to. The bestowing of prizes for the best logs kept by masters, commenced by Admiral FitzRoy, was continued by the committee.

It was found that the most frequented 10° square was that bounded by the Equator and 10°N and between 20° and 30°W, known as Marsden square 3. Out of 124,600 observations received for the Atlantic, no less than 72,000 or 59 per cent fell in this single square. The abundance of this material enabled the committee to complete their observations on this particular area. The routes for Australia, the East Indies and America passed through this square, and although the Suez Canal had been opened for a few years steamships only could use it.

The weather before and after every gale was carefully examined with a view to improving the system of storm-warnings; so that at the end of 1872 the committee informed the Board of Trade that they were in a position to restore completely Admiral FitzRoy's system of storm warnings, i.e. warnings with an indication of the direction of the wind. The first improved storm warning was issued on 15th March, 1874. As with Admiral FitzRoy's warnings, the signals hoisted at

* Captain Toynbee, a Master Mariner, was Marine Superintendent of the Meteorological Office from 1867 to 1888.

ports likely to be affected by the gale were either a cone, hoisted point downwards to denote S'ly winds (SE round by S to NW), or point upwards for N'ly winds (NW round by N to SE), or a drum and cone denoting the approach of a very heavy gale from the direction indicated by the cone. The cone (without the drum) is used in visual gale-warning signals on the coasts of the United Kingdom to this day.

The committee also made privately forecasts of the weather, which were compared with the facts subsequently experienced. During the years 1872 and 1873 the committee's storm warnings were correct in 80 per cent of the forecasts. In 1873 Mr. Galton, one of the members of the committee, introduced a scheme whereby a weather chart showing, by means of isobars, the atmospheric pressure readings over the United Kingdom, was published in the daily papers.

Treasury Committee on Meteorology

For some years the Scottish Meteorological Society had been collecting from various stations in Scotland information regarding weather, and after the data had been reduced by the staff of the Astronomer Royal for Scotland, a report was published quarterly by the Registrar-General for Births. In 1867 the Scottish Society desired to add 16 new recording stations and asked the Treasury to authorise a payment of the usual fee of one shilling per month for each station to the Astronomer Royal. The Society told the Treasury that they had conferred with the Astronomer Royal and the Registrar-General and that " both gentlemen have not only cordially agreed to carry out this arrangement but have also authorised the Society to embody in their application an expression of the great importance they attach to the proposed addition to the number of stations ".

Both the Board of Trade and the Royal Society reported favourably on the Scottish Society's application and the Treasury agreed to paying the usual fee for the new stations. The correspondence was sent to the Astronomer Royal so that he could understand the new arrangement. He wrote to the Home Secretary as follows:

" On looking into the memorial of the Scottish Meteorological Society I am exceedingly surprised to find that they state that I authorised them to embody in their memorial an expression of the great importance which I attach to this proposed addition to the number of their stations. I say that I am surprised at this, because I am not aware that I ever gave them any such authorisation, and if they had asked me for my scientific opinion on the case I should have told them that they had too many stations already, were weakening their energies by spreading them over too many points, and whether for the purposes of high science or for the almost sacred object of meteorology of storm warnings for sailors, they would do well to reduce the number and improve the quality of their existing stations."

From 1867 till 1874 there was considerable argument about the payment of grants to the Scottish Meteorological Society. In 1874 the Treasury appointed a committee to advise them on meteorological matters and on the disposal of the £10,000 grant for meteorological observations.

The committee in their report dealt with the problem under two headings—Ocean Meteorology and Meteorology of the British Isles. They suggested that the work of ocean meteorology should be transferred to the Hydrographical Department of the Admiralty, for the reason that while the Department would be equally able as the Royal Society to collect data from merchant ships, it would be better able to collect data from ships-of-war. The experience of the Department in cartography and in kindred wants could be brought to bear upon the requirements of navigators generally.

Meteorological Council

With regard to meteorology of the British Isles, the committee expressed the opinion that the Royal Society should be invited to continue to supervise the work under the title of Meteorological Council. The members ought to be appointed for a limited period and to be paid by fees; the system of issuing daily weather reports and storm warnings should be continued and an endeavour should be made to issue the principles upon which the latter were based. The Council should be at liberty to appropriate part of their funds for special investigations, such as the connection between weather and agriculture. The expenses of the Council were fixed at £10,000 per annum.

With regard to the claim of the Scottish Meteorological Society, the committee recommended that no payment should be made to them nor to any other body except for results sought for by the Council.

The Admiralty expressed adverse opinion upon the transfer of the work of ocean meteorology to the Hydrographer. Their chief objection was lack of accommodation; any further increase in staff would cause the whole of the work to be removed to another building or to dividing the work, both events being objectionable. However, they suggested that the Hydrographer should be *ex-officio* a member of the Council.

The Royal Society was invited to criticise the report, particularly with regard to the petition of the Scottish Meteorological Society to be allowed to appoint a member on the proposed Meteorological Council. The Treasury were apparently not in favour of having on the Council anyone who lived in Scotland or Ireland—" the expenses of travelling are considerations to be borne in mind ".

The Royal Society agreed to appoint a chairman and four members to form the Meteorological Council; the appointments should be for five years, the chairman receiving a salary of £300 per annum and the members being paid by fees for attendance at meetings. They also agreed to the Hydrographer being appointed a member of the Council, which would bring the number of members to six. They definitely declined to allow any other body to nominate representatives on the Council. The Treasury accepted all the suggestions of the Royal Society with alacrity and offered to increase the sum of money to be placed at the disposal of the Council to £15,000 when they were in a position to spend it with advantage.

The Meteorological Council appointed by the Royal Society continued in being until 1905, when it was decided to transfer control to a body appointed by the Lords Commissioners of H.M. Treasury as from 1st April, 1905. The new body, known as the Meteorological Committee, with the Director of the Office as chairman, included two representatives of the Royal Society, the Hydrographer and representatives of the Treasury, the Board of Trade and the Board of Agriculture and Fisheries.

The Meteorological Committee functioned, with fresh members from time to time, until the Great War of 1914–18, after which it was decided to house the Meteorological Office in the Air Ministry, where it still is. Control of the general policy is, however, still exercised by the Meteorological Committee. The present committee, of which the Director of the Meteorological Office is a member, comprises representatives of the Royal Society, Colonial Office, British universities, Air Ministry, Ministry of Supply, Royal Society of Edinburgh, War Office, Admiralty, Ministry of Transport and Civil Aviation, Ministry of Agriculture and Fisheries and Scottish Office. The Under-Secretary of State for Air is chairman.

The Supply of Marine Barometers by the Meteorological Office

By P. N. Skelton, M.B.E.

(Mr. Skelton is in charge of the Instruments Provisioning and Accounting Branch of the Meteorological Office.)

Prior to the "official" establishment of the Meteorological Office as a Department of the Board of Trade, considerable preliminary investigations were made as to the best type of instruments to use aboard ship. The primary purpose of the new Department was to be the supply of reliable meteorological instruments to naval and selected merchant ships and the subsequent collection and discussion of the observations made aboard such ships.

On 27th March, 1854, the Board of Trade wrote to the Kew Committee of the British Association, requesting aid in procuring barometers and thermometers for the use of the Mercantile Marine, to which a reply, dated 3rd April, 1854, was received expressing willingness to help.* It had so happened that in the previous year the Kew Committee had been asked by Lieut. Maury of the United States to advise upon the best form of a marine barometer, and already had the matter under consideration when the Board of Trade's request for help was received. From several forms of instruments submitted for their consideration the Kew Committee selected one which they considered to have all the requisites for making correct observations at sea, and the next step was to test this instrument at sea. This was done by Mr. Welsh of Kew Observatory and Mr. Adie the maker, in a voyage from London to Leith in the steamers *Clarence* and *Leith* (both about 700 or 800 tons burden) between 15th and 21st March, 1854, and by Mr. Welsh on a voyage from Southampton to Jersey and back between 3rd and 25th May, 1854.

The type of instrument selected was, in fact, the now well-known Kew pattern barometer, and the main object of the trials was to find out what was the best amount of contraction of the tube for the prevention, within limits, of the pumping of the mercury. On the first voyage three barometers were taken, with 5, 10 and 15 min for the times required for the mercury to sink from the top of the tube to its true height due to the contraction of the tube. The one "contracted" to 15 min was broken while being carried aboard the ship, so that only the two least contracted in the tube were used. The conclusion reached was briefly that the barometers could be used for observations at sea with a probable error of 0·005 in. or at most 0·007 in., but that the contraction should be 20 min at least. On the second voyage, to Jersey, five barometers were taken with contractions in the tube of 5, 10, 18, 21 and 35 min, and as a result of the observations made it was recommended that the amount of contraction should be 18 to 25 min. Nowadays we have a different definition for the "contraction in the tube" and specify that all marine barometers should have a "falling time", from 50 mb to 18 mb above the true reading, between 6 and 9 min.

Thus, on 2nd June, 1854, the chairman of the Kew Committee, Mr. John P. Gassiot, wrote both to the Board of Trade and to the Admiralty recommending a barometer made by Mr. Adie of 395 Strand, London. The price of the instrument, including cost of packing case, 10s. for verification at Kew Observatory, carriage to Kew and subsequent delivery to London was £3 15s. 6d., and Adie was prepared to supply any quantity.

Orders for barometers for both the Admiralty and the Mercantile Marine were handled by the Meteorological Department; those for the Admiralty being bought by the Meteorological Office, paid for by the Admiralty and stored when not in use in the Meteorological Office. This arrangement continues in much the same form to this day.

* Report of the Kew Committee for 1853-54.

Records which still exist in the Instruments Branch of the Meteorological Office show that by May, 1855, 190 marine barometers had been issued to the Navy, together with quantities of aneroids, thermometers and other equipment, and by the end of 1856 22 sets of equipment had been issued to the Mercantile Marine. By 1868 this had increased to 212 barometers afloat in the Navy and 58 afloat in the Mercantile Marine, and in 1898 the figures were 509 in the Navy and 488 in the Mercantile Marine. Today there are 703 barometers in use in the Merchant Navy, but figures for the number used in the Royal Navy are not available.

The history of barometer B.T. No. 1 made by Adie is shown below as a matter of interest.

History of Marine Barometer B.T. No. 1

Issued			Returned		
Agency	*Date*	*Ship*	*Date*	*Agency*	*Remarks*
Glasgow	29.10.56	*City of Benares*	27.7.57	London	
London	3.8.57	*Bosworth*	— 58	Bristol	
Bristol	8.11.58	*Bosworth*	19.8.59	B. of Trade	
B. of Trade	4.10.59	*Rival*	28.10.59	B. of Trade	Broken, sent to Adie for repair 8.3.1860.
B. of Trade	25.1.61	Leith Telegraphic Station	28.8.68	M.O.*	Repaired by Adie 13.3.69.
M.O.	21.1.70	*Halley*	17.7.73	Liverpool	
Liverpool	7.1.75	*Burdwan*	5.10.75	Liverpool	
Liverpool	9.12.75	*Whittington*	4.1.77	Liverpool	
Liverpool	24.1.78	*Knowsley Hall*	24.3.79	M.O.	Repaired by Adie 2.4.79.
M.O.	19.6.79	*Belle Isle*	29.1.80	M.O.	Repaired by Adie 19.2.80.
Liverpool	6.2.83	*Toronto*	17.11.85	Liverpool	
Liverpool	14.12.85	*British Envoy*	24.11.86	M.O.	Repaired by Adie.
Glasgow	8.3.87	*Aline*	12.3.88	Liverpool	
Liverpool	29.3.88	*M. C. Smith*	1.1.90	Liverpool	Returned to M.O. 24.3.90. Repaired by Adie 25.3.90.
Liverpool	3.6.91	*Evesham Abbey*	29.2.93	Liverpool	
Liverpool	10.4.93	*Garfield*	19.4.94	Liverpool	To M.O. 6.10.94. Repaired by Adie 12.11.94.
M.O.	2.4.95	*Blengfell*	31.5.97	M.O.	Repaired by Adie 9.7.97.
Liverpool	28.9.97	*Port Adelaide*	11.6.98	Cardiff	Returned to M.O. 5.5.1902.
Glasgow	8.10.02	*Sarmation*	1.6.03	Glasgow	Repaired by Adie 1.7.1903.
Liverpool	27.10.03	*Darien*	12.4.04	Liverpool	
Liverpool	2.12.04	*Sierra Susema*	26.11.06	Liverpool	
Liverpool	13.3.07	*Manchester Corporation*	5.10.10	M.O.	Repaired by Adie 6.10.10.
Cardiff	Broken in transit				Repaired by Adie 6.1.11.

From 1911 to 1953 this barometer was in the Meteorological Office Museum, but was sent in 1954 to the National Maritime Museum at Greenwich, where it now is.

* Meteorological Office.

Having initiated the service of supplying barometers for the Mercantile Marine in 1856 it was also necessary to provide a service for checking their accuracy, and for this reliance was made on Kew Observatory. The site of Kew Observatory has a long history going back to 1414, when King Henry V erected a Carthusian Priory there, but in 1769 all the previous buildings were demolished and an Observatory built for astronomical and general scientific work. In 1842 it was taken over by the British Association for the Advancement of Science, and a larger part of the work was devoted to the improvement and testing of scientific instruments, including sextants. Thereafter, until 1910, when the work was transferred to the National Physical Laboratory, the testing and certifying of all types of scientific instruments was gradually built up and the reputation of Kew Observatory and of Kew certificates became world renowned.

The scheme for certifying and checking barometers is the same as when it was started in 1856. New barometers are sent by the makers to the National Physical Laboratory at Teddington (previously to Kew) for certification before being delivered to the Meteorological Office, where they are stored until required for issue. Agencies, established at the main ports of the United Kingdom, held small stocks of barometers for issue to ships coming into the port. Each agency and port meteorological office has an accurate barometer for checking the readings of barometers both before their issue to ships and during a ship's visit to the port. Barometers which are found to be inaccurate are returned to the Meteorological Office for repair or adjustment and, if necessary, retest at the National Physical Laboratory.

In the early days of the scheme facilities for checking barometer readings were also available at principal ports in the British Empire, e.g. Hong Kong, Aden, Cape Town and others. Such facilities are still available, but responsibility for the arrangements now lies with the national meteorological services of the ports concerned.

Old Time Marine Observer's Log

The following are extracts from the meteorological log of the ship *Pizarro*, Captain Samuel White Sweet, on passage from Honolulu to Bremen, 1859, with copies of two of the many drawings with which this log is illustrated.

10th July, 1859. 10 p.m. The mate reports a splendid meteor in the heavens, it was to the northward of the ship and shot about 30°, position 44°S, 47°W.

13th July. 4 p.m. 39°S, 43°W. The water is full of living marine insects, and I suppose the whole of the sea is! and when there is wind they are obscured from sight; even in a calm you can scarcely see some of them as they are mostly nothing but jelly and nearly the colour of the water.

17th July. 4 a.m. 35°S, 34°W. Rising at 4 this morning I found the glass of the barometer broken. No one knows anything about the matter, the ship was plunging very heavy all night and the tube and frame strikes hard against the sides of the arm; it requires a gimbal for the ship's rolling motion. I have always had a piece of rag round to catch the blow but it worked off last night. They are very bad to read off at sea owing to its oscillating motion; one can't see how much it goes below the index exactly.

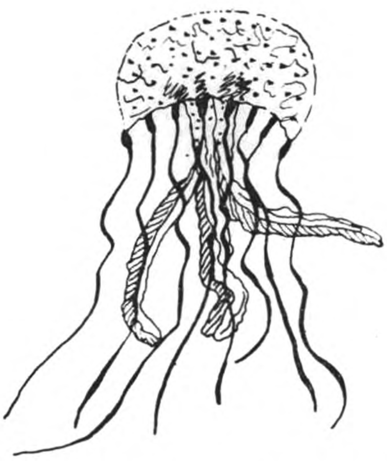
22nd July. 8 p.m. 27°S, 28°W. Wind gradually hauled round to SE, which by the glass I presume it is the trades.

4th August. 8 p.m. 9°S, 31°W. Much phosphorus in the sea tonight. This phosphorus is like lucifer matches, wants friction to bring out its latent light; it's only seen in the wake and on crests of waves and in a bucket of water when it is stirred. I have tried hard to find it out but I want a good microscope for the marine insects.

17th August. Noon. 17°N, 35°W. I notice that almost all the Portuguese Men of War that pass if 3 or 4 inches long have got a few small fish swimming about them. These fish are striped straight across them.

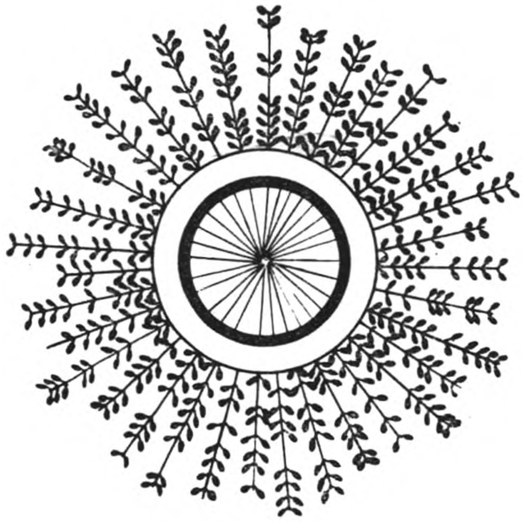
4th September. 4 p.m. 42°N, 33°W. Heavy shower and sudden shift of wind to NNW and cleared up a little (a regular Cape Horn shift only more moderate).

11th August. 8° 44′N, 30° 22′W. Cause of phosphoric light in the sea. This afternoon the water had immense quantities of " Polypus " in it and I noticed it this past day or two but the sea was rather too rough to see them distinctly. I caught six and put them into separate vessels, and when in the dark especially when agitated give off much phosphoric light, sometimes the head appeared full of sparks and others the head was one mass of light, other times I could see none scarce. I let one fall on the deck when the whole head was one mass of lovely silver light.



It consists of a kind of jelly transparent and lightly shaded with a very delicate pink colour, with dark pink spots over it. It has eight (feelers I presume) round the edge which are of a reddish brown, it moves itself by drawing in its edge or lower part of its head and sticking it out again. I cannot say how long the feelers are for in getting them into the bucket they got broke, but I should think 2 or 3 feet. The three suckers with which they stuck to the sides of the glass are joined together for about one-third of the whole length, and where they separate they have a fringe one side of each like a frill on old ancient shirts. I saved two in a bottle when they died in 12 hours and rapidly decomposed, and I found with their death so also died the light for there was not a vestige of light as soon as they were dead.

18th August. 18°N, 35°W. Caught a small crab this morning, also a very beautiful marine insect. The white circle is a beautiful sky blue and the inked one is a prussian blue. The centre is just like grey and silvery hair and is rather convex, the outer part consists of short and long (feelers I will call them) like very delicate glass hair and small round bulbs from the ends. Sometimes drops them down into the water and then again spreads them flat. (See illustration below.)



THE MARINE OBSERVERS' LOG

April, May, June

The Marine Observers' Log is a quarterly record of the most unusual and significant observations made by mariners.

The observations are derived from the logbooks of marine observers and from individual manuscripts. Photographs or sketches are particularly desirable.

Responsibility for each observation rests with the contributor.

FLOATING SUBSTANCE

Gulf of Guinea

M.V. *Duke of Athens*. Captain T. Walton. Lagos to London. Observer, Mr. D. F. Montague, 3rd Officer.

7th April, 1954, 0915 G.M.T. The vessel passed from a rippled sea into a calm. The calm sea was covered for miles around with what appeared to be a thick dust. The ship cut a line through the thick dust and the track astern was a clear line where there was clear water. The dust continued on the surface for a further 6 to 7 miles when it became patchy and eventually disappeared.

Position of ship: 05° 20′N, 00° 00′.

Note. The appearance of a finely divided substance floating on the sea is observed from time to time. Thus on 27th April, 1946, in 14° 05′N, 60° 30′W, S.S. *Highland Park* saw a patch of discoloured water about 50 yd wide and a quarter of a mile long. At the western end the substance was of a bright yellow colour—appeared to be almost dry, so that it could easily have been mistaken for a dry sand bar. At the eastern end of the main patch the substance was more thinly spread; millions of small objects about the size of coarse sawdust were observed floating and also in suspension in the water as far down as could be seen.

It is suggested that in such observations the substance probably consists of the eggs of fish or other marine creatures. Many, though not all, kinds of fish produce eggs which float and for the time being, until the fish larvae appear and become mobile, form part of the drifting plankton of the sea. Other marine creatures such as sea cucumbers, nereid worms, barnacles, etc., also produce floating eggs. Each fish or other creature that produces eggs that float is very prolific, since the majority of the eggs will be preyed upon. Furthermore, there appears at times to be a sort of general impulse to spawn at about the same time over a considerable region, so that the total number of eggs produced might be enormous.

CURRENT RIP

Off mouth of the Amazon

The following observation, made by H.M.S. *Bigbury Bay*, has been forwarded to us by the Hydrographer of the Navy.

On Sunday morning, 30th May, at about 0830, when the ship was in 14 fathoms approximately 120 miles NNE of the western mouth of the River Amazon, a line of disturbed water was noted about 2 miles to seaward. After divisions and church at 1035, the ship was alongside this very remarkable current line which extended from horizon to horizon in a 135°–315° direction. The wind was force 3 from seaward and on the landward side of the line was causing quite a disturbed sea.

The water to seaward was smooth and almost oily, and lay in 12 or more continuous parallel and very clearly defined lines which were regularly spaced at about 40 yd and extended to the horizon. Course was shaped to run along this autobahn and the lines were crossed several times and no change in soundings, which remained steady at 14 fathoms. At this time the ship was steaming at 12 kt and 12° to 15° to starboard of the current line in order to make good a course along it. The current line curved slowly to a 120°–300° direction and was followed until 1300, when it had become less marked and was curving further to the eastward.

PHOSPHORESCENCE

Atlantic Equatorial Waters

M.V. *British Endeavour.* Captain E. L. Mitchinson. Lourenço Marques to Port de Bouc. Observer, Mr. G. R. Grey, 2nd Officer.

3rd May, 1954, 0240 G.M.T. The wind suddenly increased from E's, force 2, to ENE, force 5 to 6, and the vessel ran into a moderate to heavy rain squall. As this cleared several lines of phosphorescence were seen; these later proved to be emanating from a central hub. This was situated slightly forward of the port beam at an estimated distance of 500 yd. In the "spokes" of the wheel were numerous splashes of brighter phosphorescence usually associated with jellyfish when seen at night. The phenomenon lasted about 10 min. Air temp. 77°F, wet bulb 75°, sea temp. 82°.

Position of ship: 1° 58'N, 23° 2'W.

Note. There are two special points of interest about this observation. The first is that while the form of the phosphorescence is that of the phosphorescent wheel no mention is made of the movement of the spokes. In all previous observations the wheel has appeared to rotate. Secondly there is, so far as we know, no record of the observation of a phosphorescent wheel in the Atlantic Ocean; the phenomenon appears to be confined to the north Indian Ocean, Malacca Strait, the China Sea and possibly also the waters of the Eastern Archipelago.

West African Waters

S.S. *Rookwood.* Captain A. Dover. Grangemouth to Monrovia. Observer, Mr. A. Broadwith, 2nd Officer.

3rd May, 1954, 0320 G.M.T. An extensive band of phosphorescence, about 6 or 8 ft in width and extending for several miles was observed. As the band was fairly straight and in almost a fore and aft line ahead, the vessel crossed it several times. The bow wave was an extremely bright silver and the band itself had a silver-green cloudy appearance, while at the same time there was a strong aroma of fish. At 0350 the phenomenon passed and the sea resumed its natural appearance. Sea temp. 67°F.

Position of ship: 16° 15'N, 17° 53'W.

Note. In connection with the strong aroma of fish referred to above, it is interesting to note that while this is apparently not often noticed during the occurrence of phosphorescence, we have a previous observation by M.V. *Cheshire,* in the Red Sea, which speaks of "a strong, oily, fishy odour". This was published on page 7 of the January, 1952, number of this journal.

Gulf of Guinea

M.V. *Delphic.* Captain C. L. Carroll, D.S.C. Las Palmas to Cape Town. Observer, Mr. D. A. Rogers, 3rd Officer.

5th June, 1954, 2230 G.M.T. Large patches of sea were observed bright with phosphorescence. The patches had the appearance of small points of light in violent motion. The largest patch seen was estimated to be 6 ft by 4 ft. A sample of the water was obtained and on agitating the bucket points of blue light were observed in the water. The phenomenon lasted for 20 min.

Position of ship: 2° 43'S, 7° 33'W.

S.S. *Arawa*. Captain L. J. Hopkins. Las Palmas to Cape Town. Observers, Mr. W. J. Stanger, Chief Officer, and Mr. E. B. Creese, 4th Officer.

13th June, 1954, 0500 G.M.T. Clearly distinguished bands of phosphorescence were observed, each about 10 ft wide and spaced about 600 ft apart, in a N–S direction. The bands were evenly spaced and the ship passed through them for about 20 min until morning twilight made them difficult to see. The bands glowed a dull green, but the disturbed water when vessel passed through a band was a brilliant emerald. The pieces of phosphorescence were oval in shape and varied in size up to an estimated 6 in. Wind SE's, force 4. Sky overcast. Slight sea, low swell.

Position of ship: 3° 34'N, 12° 32'W.

Red Sea

M.V. *City of Chester*. Captain R. L. Stewart. India to Canada. Observer, Mr. K. L. Murray, 3rd Officer.

2nd April, 1954, 1800 G.M.T. There had been a strong following wind which dropped very suddenly, and the vessel seemed to be surrounded by calm water which extended for a mile or so all round. In this calm water phosphorescent ripples were observed, rather faint in luminosity but passed very quickly from E–W. They were similar to shoals of small fish, except that they were about a mile in extent and moved far too quickly for shoals of fish.

Position of ship: approaching Hamish Islands.

Pacific Ocean

S.S. *Captain Cook*. Captain A. Bankier. Balboa to Wellington. Observer, Mr. A. Maclean, 2nd Officer.

3rd May, 1954, 0300 G.M.T. Two large areas of very bright phosphorescence were observed. The first and larger was sighted ahead and on passing it was seen to be oval in shape, at least 200 ft long and 30 ft wide. The glow given off was extremely bright with greatest intensity at the centre, becoming dimmer towards the ends. A shimmer of light appeared to lie over the whole area and bright flashes were frequently given off. No movement could be discerned. The second area, although smaller, had the same characteristics as the first.

Position of ship: 04° 13'S, 99° 24'W.

VERIFICATION OF POSITION BY BAROMETER

North Atlantic Ocean, Grand Banks

S.S. *Andria*. Captain A. G. Cuthill. London to New York. Observer, Mr. P. A. A. James, 2nd Officer.

7th–8th April, 1954. The sky had not been seen since 1900 (ship's time) on 6th, and the vessel proceeded by D.R. alone, having reduced speed because of adverse weather conditions, but at midnight (6th) a sounding was obtained as the vessel crossed the 100-fathom line. Within 7 min the vessel was off soundings, but after a further 12 min soundings were again obtained which dropped rapidly to 30 fathoms and remained constant. This seemed to put the vessel some way astern. By this time stars were visible, and although the horizon was not good enough for a proper fix, a " snap " of Polaris was obtained. This put the vessel 40 miles N of the position obtained by D.R., but coincided with such soundings as were obtainable. Other factors to use to verify position were the barograph and the synoptic chart. A barometer minimum was reached at 2215 (7th), 1007·5 mb. We knew from reports and our synoptic chart that the centre of the depression would pass 60 miles N of us, therefore if the vessel was N of the D.R. position, as deduced from soundings and the " snap " of Polaris, the barograph trace was in agreement.

Sights were obtained at noon (ship's time) on 8th and, disregarding the slight s'ly set on the banks, the various courses were plotted back and came within 5 miles of our assumed position.

A similar report was once made by the United States Hydrographic Office in regard to an American ship which had crossed the Atlantic without obtaining sights; the captain of the ship had fixed his vessel's position by means of barometer readings and a synoptic chart.

Position of ship at 1200 G.M.T. on 8th: 42° 48'N, 52° 00'W.

Note. This shows great ingenuity on the part of Captain Cuthill and illustrates a rather unusual application of a synoptic map aboard ship. Another instance of a ship's position being fixed by a meteorological element comes from M.V. *Hertford* (Captain Lawson). On the run from New Zealand to Panama the captain takes a Great Circle course as far as the Equator in 83°W, but as soon as the Humboldt Current is reached (sea surface temperature falling abruptly) course is set for Malpelo Island.

ST. ELMO'S FIRE

South China Sea

M.V. *Lotorium*. Captain A. Thomson. Fukuoka (Japan) to Singapore. Observers, the Master and Mr. A. Wareing, 2nd Officer.

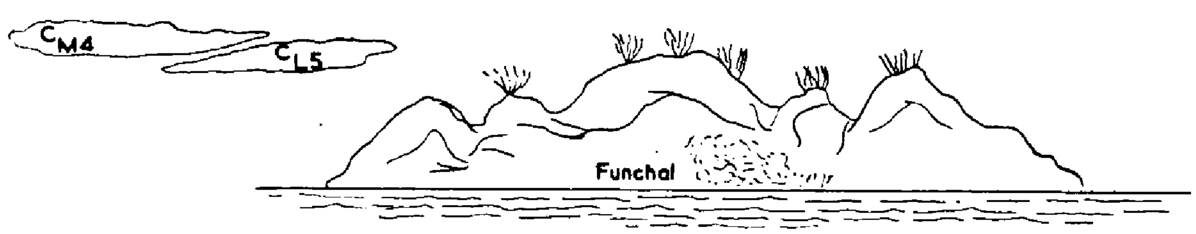
15th May, 1954, 0000 G.M.T. During a violent thunderstorm with very heavy rain and visibility half a mile, St. Elmo's Fire was observed in the form of a steady white glowing ball about 3 in. or 4 in. in diameter on the top of the jackstaff forward. Steady white lights were also observed on the fore and main trucks, also on the wireless aerial insulators and on the signal halyard blocks on the jumper stay. The lights varied in intensity and lasted about one hour.

The vessel has a steel jackstaff and steel telescopic topmasts fitted with lightning conductors consisting of a spike and copper wire earthed at deck level. No "fire" was observed on ends of the wooden yard on foremast.

Position of ship: 11° 05'N, 111° 25'E.

Madeira

S.S. *Tribulus*. Captain G. Robson. Las Piedras to Algiers. Observer, Mr. R. W. Lumsden, Chief Officer.



7th June, 1954, 1800 G.M.T. On approaching Madeira from SW the island was completely covered with low cloud, St and Sc. On arriving within 16 miles of the island the cloud rapidly lifted and numerous brilliant white flashes were observed at frequent intervals on various mountain peaks. At the time of these occurrences the cloud was clear of the island, although there was some Sc to NW. After the flashes had continued for some 20 min a low rumbling was heard like distant thunder.

Note. The brush-like discharge of electricity from objects on the earth's surface is normally a small-scale phenomenon visible only at relatively small distances, such as when it is seen on ships' masts or aerials, etc., from the deck. There are several observations on record, however, of it having been seen on clouds, both at night and by day, in which case the phenomenon must have been on a larger scale to be visible at cloud distance. We can think of no other explanation of the above remarkable observation. The discharges must have been very large and bright to be visible at 16 miles, and if it really was St. Elmo's Fire the observation is probably unique.

CYCLONE

South Indian Ocean

M.V. *English Star*. Captain L. Vernon, M.B.E. Adelaide to Cape Town.

14th April, 1954. Noon position: 32° 47′S, 85° 20′E. Course 270°(T). Speed 15·75 kt. The following is an account of observations made during the passage of the centre of a cyclone close to ship.

At about 2200 G.M.T. on 13th the wind backed to 020°(T) with the barometer falling steadily. At 0230 on 14th the wind began to freshen. The sky was then about half covered with detached Cu. At 0630 Ns and Fs appeared from the NW and began to develop steadily. By 1000 sky was completely overcast with St, about 1,000 ft. 1220: Commenced heavy driving rain which persisted with visibility becoming very poor. Barometer was then 1007·6 mb and still falling. Wind was 030°, force 6. 1300: Bar started to fall rapidly and the following table of observations was made.

Time (G.M.T.)	*Barometer* (*mb.*)	*Wind* *Dir.*	*Force*	*Temp.* (°F)	*Remarks*
1300	1005·6	020°	6	70	Sea rising. Sky heavily overcast with Fs below 1,000 ft. Heavy driving rain. Visibility ½ mile.
1400	1002·2	020°	7	70	Atmosphere very humid. Continuous driving rain. Visibility ½ mile.
1500	998·6	020°	9	70	Very rough sea.
1530	996·6	020°	11	70	Sea becomes confused and high. Wind backs
1540		360°	10		to N. Ship reduced speed. Altered course to N. D.R. position 32° 47′S, 82° 19′E.
1600	995·8	360°	10	70	Waves now tumultuous. Estimated height at least 30 ft. Heavy confused swell develops.
1615					Barometer commences to rise.
1630	996·6	320°	9	70	Wind backs to NW. Rain becomes intermittent.
1700	997·0	320°	9	70	Rain ceases. Sky still very overcast. Visibility moderate.
1715					Cloud begins to break from NW. Moon shows clear.
1718		320°	7		Sky completely clear. Wind temporarily moderates.
1740		320°	9		Sky again overcast with St below 1,000 ft moving very rapidly.
1800	997·8	320°	8–9	69	Sea and swell very heavy and confused. Sky becoming alternately clear and overcast.
1900	1002·4	290°	9	69	Wind backs to WNW.
2000	1004·1	280°	8	69	
2100	1006·1	270°	8	69	
2200	1007·8	270°	7–8	69	Sea and swell moderating.
2230					Ship resumed course 270°.
2300	1008·8	250°	7–8	65	Temperature falls when wind shifts S of W. Air becomes less humid.
15th:					
0000	1009·6	250°	7	65	Conditions improving
0100	1010·5	225°	7	64	Wind backs to SW.
0150					Ship resumed full speed.

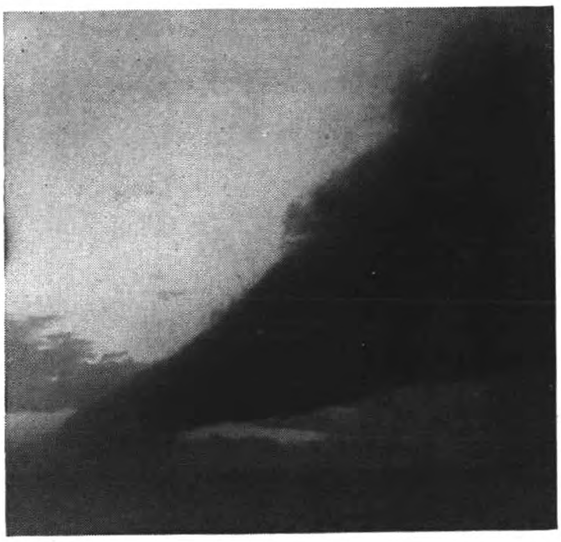
A strong SW wind persisted for several hours with a heavy swell running. Wind finally backed to S about 1000 on 15th and settled weather followed with a high barometer.

Note. This observation was referred to the Director of the Australian Meteorological Branch, who commented as follows:

" Regular observations were received from the ship *English Star* from 9th to 13th April

[Photos by L. R. Page

Mammatocumulus cloud seen from M.V. *British Might* at 35° 00′N, 20° 00′E, on 20th April, 1954 (see page 99).



[*Photo by F. Botham*

Arch squall seen from S.S. *Trochiscus* on 8th April, 1954: (1) looking towards land; (2) looking seawards (see page 98).

[*Photo by A. W. B. Chalmers*

Peculiar formation of cirrus cloud observed from S.S. *Pacific Unity* at 26° 05′N, 113° 53′W, on 28th April, 1954 (see page 99).

on her passage westward until about longitude 90°E. After this one or two 0600 G.M.T. observations, collected by Amsterdam Island, were retransmitted to Australian stations.

"A surface analysis of the Indian and Southern Oceans is prepared for 0600 G.M.T. daily and emitted at 1900 G.M.T. on the National Broadcast, AXM Canberra. From these analyses it appears that the cyclone originated as a wave on a cold front to the NW of Amsterdam Island some time before 0600 G.M.T. on 13th April. At this time the *English Star* was about 1,300 nautical miles to the ENE on a high-pressure ridge. The cold front passed Amsterdam Island around 0900 G.M.T., when the pressure was 1009·1 mb and the wind SW, 30 kt. By 0600 G.M.T. on 14th the Amsterdam Island wind had veered to SE and the pressure was 1016·7 mb. At this time the wave cyclone centre was shown NNE of Amsterdam Island and about 300 nautical miles W of the ship's position (then approximately 32·8°S, 85°E), having a central pressure below 1005 mb, and moving E.

" The detailed observations from the ship show that:

(*a*) the cold front passed the ship about 10 hours later (1630 G.M.T.) with the wind backing to NW; and

(*b*) that the cyclone must have deepened further, to a central pressure below 996 mb.

" The chart for 0600 on 15th shows the cyclone centre at about latitude 34°S, longitude 93°E, with pressure below 1000 mb. Plotting of the storm was much assisted by two ship reports for 0600 G.M.T., namely, the *Saxon Star*, in approximate position 40·8°S, 107·2°E, and a ship observation in approximate position 32°S, 86·5°E, the latter received through Amsterdam Island radio.

" When ship reports collected by Amsterdam Island are retransmitted the names of the ships are omitted, and as the last-mentioned one for 0600 G.M.T. on 15th was from a position further E than that in the same vicinity 24 hours earlier (which we now know to be the *English Star*), and since the *English Star* gave a D.R. position of 32° 47′S, 82° 19′E, at 1545 G.M.T. on 14th, this other report must have been from a different vessel also steaming W.

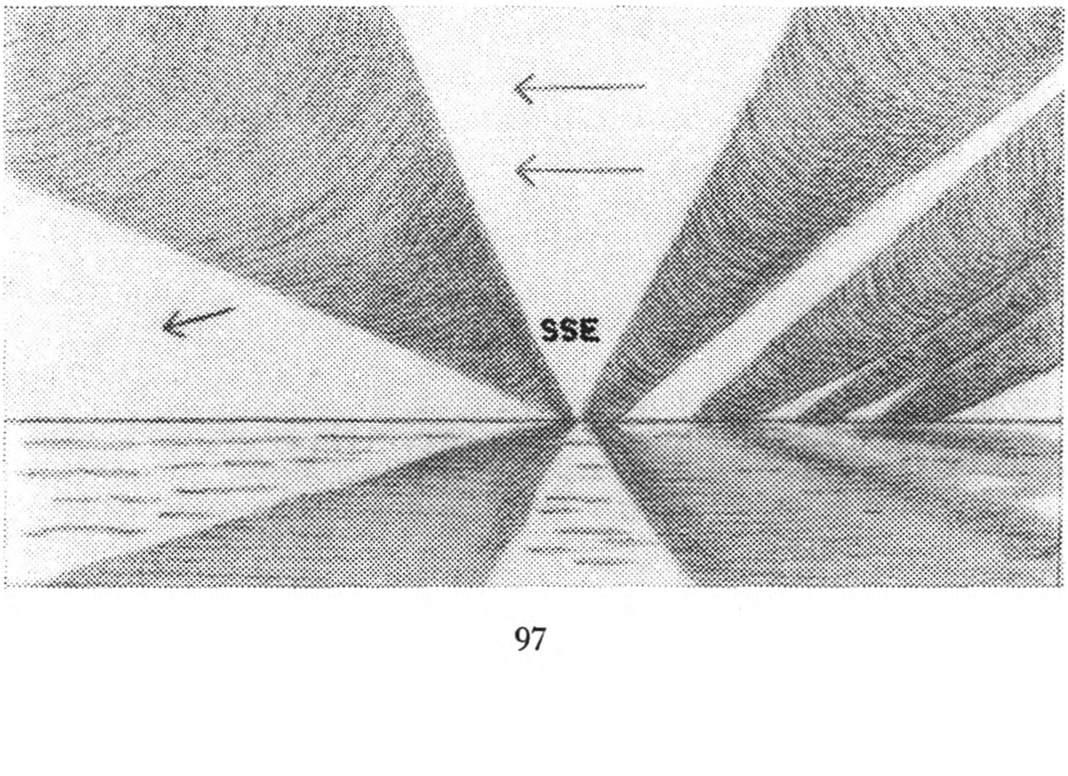
"At 0600 G.M.T. on 16th the cyclone had moved SSE to approximate position 42°S, 96°E. Observations from the *Clan McDougall* and *Ceramic* were available. It is interesting to note that a new wave formed further northward along the cold front by 17th April, about 700 nautical miles W of Fremantle. Meanwhile the original cyclone continued to move south-eastward across the Southern Ocean, and the charts show it reaching the vicinity of the Balleny Islands on 20th April."

ARCH SQUALL

South Atlantic Ocean

S.S. *Umzinto*. Captain R. Harber. London to Cape Town. Observers, the Master and Mr. J. G. Campbell, 2nd Officer.

13th June, 1954, 1600 G.M.T. An arched cloud, of clear-cut formation, was observed extending from horizon to horizon in a SSE–NNW direction to the W of the



ship. Its transit over the ship was rapid, but it maintained its well-defined extremities, and when directly overhead appeared to terminate in two very sharp points. A temporary change of wind from SSE, force 2, to SW, force 4, occurred when the cloud was overhead. The cloud's passage over the ship was followed shortly by a second and similar cloud, although its extremities were not so well-defined, and the sky which before had been cloudless now became heavily overcast. The cloud appeared to be of Sc structure at about 1,500 ft. Soon afterwards fog was observed. Successive positions of the first cloud are shown in the sketch.

Position of ship: 27° 08′S, 12° 43′E.

Note. This appears to have been a very well-defined roll of cloud. There was no general fall of the barometer on this day or the previous one, such as would indicate the passage of a depression, with its accompanying cold front, at which such a cloud might have been observed. It must therefore be assumed that some minor air mass discontinuity passed over the ship.

Arabian Sea

S.S. *Trochiscus.* Captain J. R. Petrie. Mena al Ahmadi to Suez. Observer, Mr. Botham, Extra 3rd Officer.

8th April, 1954, 1330–1400 G.M.T. After rounding Ras al Hadd, 5 miles from the coast, vessel steering 180°(T), a squall was seen to form over the land. Barometer steadying at 30·00 in. after steep climb; air temp. 85°F at 0900, 81° at 1700, visibility over 10 miles.

The squall subsequently stretched from horizon to horizon with a very distinct " rolling " appearance. Other clouds, mainly Ac, formed shortly afterwards, until about 5/8 of sky was covered at 1600. The squall moved over the vessel in a SW'ly direction, without giving any rainfall. It maintained its shape and still very distinct over SW horizon at 1800. The other clouds then dispersed for a short time, after which Cu and Sc with patches of Fn formed, sky about 4/8 covered. The squall was seen to be breaking up at 1830 and merging with these clouds.

The wind was S'ly throughout, reaching its maximum force, 4, when the squall was near the vessel, decreasing to 1–2 at 1800. Lightning was observed over the land after the passage of the squall. The visibility was unchanged throughout.

The first photograph was taken looking towards the land, showing the main body of the squall, the second to seaward. (See opposite page 97.)

Note. This squall was an indication of the passage of an air-mass discontinuity. It is not possible to say with certainty how the discontinuity came into being. It might have been connected with a local thermal depression over the Oman Peninsula, produced by convection in the process of the general warming up of the land in progress at this season.

WATERSPOUT

Atlantic Ocean

S.S. *Mataroa.* Captain R. G. James, R.D., R.N.R. Auckland to Southampton. Observers, Mr. J. P. Miller, 3rd Officer, and Mr. L. Mounsey, 5th Officer.

14th May, 1954. At 1250 G.M.T. slight fine rain started, wind 210°, force 5. The rain intensified at 1315 and visibility deteriorated to less than 4 miles. At 1348 wind veered sharply from 210° to 270°, while visibility to windward decreased to 800 to 1,000 yd and cloud base lowered to about 200 ft. A waterspout was observed to be forming at 1350 about 400 ft away, 5 points on the port bow. The cloud base above the area of disturbed water fell to 80 or 90 ft, and one minute after being first observed the lower part of the spout was of water to a height of 20 ft and fine spray from thence to the cloud base. The spout moved to leeward, rotating with an anticlockwise movement, and passed about 150 ft ahead of the ship. By 1357 the spout had dispersed 6 points on the starboard bow about ½ mile away. At 1405 rain ceased and visibility increased to 10 miles.

Position of ship at 1250: 33° 24′N, 46° 22′W.

MAMMATOCUMULUS CLOUD

Mediterranean Sea

M.V. *British Might*. Captain W. O. Armstrong. Port Said to Land's End. Observer, Mr. L. R. Page, 2nd Officer.

20th April, 1954, 1600–1630 G.M.T. The sky was covered with 8/8 cloud, mainly straggly Cb and Cu, the base of which was estimated to be at about 2,500 ft. The cloud was moving fast to NE, obliquely to the surface wind. The lower surface of the cloud had a remarkable form of rounded shapes which had never before been seen by the master or the officers or by other persons on board who witnessed it.

The rounded protuberances appeared to consist of watery, opaque, grey cloud of uniform consistency, thinner than the general cloud. They formed out of the bottom of the normal cloud to SW; by the time they were overhead almost the whole sky was taken up with them. When first formed they resembled bunches of elongated grapes, all of perfect curvature, closely massed together. When overhead the sky appeared to be covered with perfect circles of large diameter, or arcs of circles, ellipses and regular curves of various kinds, each curve being clearly defined through another where they overlapped. The shapes changed continually and included several small " puff-balls " which, contrary to the rest, appeared to have a certain turbulence and to be of a thicker type.

Mr. Page took a number of photographs, some of which are here reproduced (see opposite page 96). The first shows the elongated grape form, about 20 of which were usually visible at one time. The altitude of the centre of this photograph is about 50°. The second and third photographs were taken when the rounded forms had spread overhead, but show the sky at a lower altitude, the horizon being slightly below the bottom of the picture. Photography was difficult owing to bad light conditions and photographs of the whorls and circles in the zenith at this time did not come out well. Wind E'ly, force 5–6. Air temp., sheltered but in open air, 60°F.

Position of ship: 35° 00'N, 20° 00'E.

Note. This is the mammatus type of cloud formation, a descriptive prefix given to all clouds the lower surfaces of which hang in festoons, with an udder-like or mamillated appearance. Such clouds being generally of the Cu type, the formation is usually called mammatocumulus. These clouds bulge downwards in a somewhat similar way to the upward curvature of the tops of ordinary Cu clouds. Traces of downward bulges are not uncommon in lower cloud forms, but the fully developed mammatus type, as described in the above observation, is rare and is always seen on the lower surface of Cb cloud, in the disturbed conditions which accompany the close of a thunderstorm. The writer of this note saw well-developed cloud of this type many years ago in southern England. On this occasion the whole sky was covered with large rounded forms 15°–20° in diameter.

Because of the infrequent occurrence of well-developed and regularly formed mammatocumulus, good descriptions of this type of cloud are rare and good photographs are rarer still. Mr. Page's " bunches of elongated grapes " fits it perfectly and we must congratulate him on the photographs which show the cloud admirably in spite of being rather dark owing to the poor light and consequent thinness of the negatives.

Mammatus formation is seen on rare occasions on the under-surface of the anvil cirrus cloud which spreads out from the tops of fully developed Cb. On account of the much greater height of this cloud the rounded forms then appear as small globules.

CLOUD FORMATION

North Pacific Ocean

S.S. *Pacific Unity*. Captain E. A. Kemp. Colon to Los Angeles. Observers, Mr. J. T. Sheffield and Mr. A. W. B. Chalmers, 2nd Officers.

28th April, 1954, 2300 G.M.T. A peculiar Ci formation was observed in a S'ly direction. Clumps of dense Ci of distinctly circular formation, about 10 to 12 in number, were seen in two lines, one behind the other, extending in a NW–SE direction. They were moving N and gradually elongating in a N–S direction until they formed "twisted sheaves" of dense Ci. The cloud was observed for approximately one hour. (See photograph opposite page 97.)

Position of ship: 26° 05'N, 113° 53'W.

DUST

Mediterranean Sea

S.S. *Velletia*. Captain J. Thornton. London to Port Said. Observer, Mr. J. A. Forbes, 2nd Officer.

21st April, 1954, daybreak (0400 G.M.T.). The windward side of the vessel was found to have a fine coating of sand or dust. The nearest land was Morea, 200 miles away. Wind throughout the night ENE, force 5–6.

Position of ship: 35° 00'N, 19° 20'E.

ABNORMAL REFRACTION

North Atlantic Ocean

M.V. *Cingalese Prince*. Captain B. R. Simons. Port Said to Halifax, N.S. Observers, the Master and Mr. P. Norwood, 2nd Officer.

1st June, 1954, 2030 G.M.T. An object was sighted about 3 points on the port bow, estimated to be about 8 miles, but it was found by radar to be only 4½ miles distant. Even so it was impossible to decide what the object was, in spite of the use of binoculars. The irregular shape and the way it appeared to be moving up and down led one to assume it was an iceberg. It was about 3½ miles off before the object was identified, and by then two images could be clearly seen of ships, one inverted immediately above the other, masts and funnels touching. Above the waterline of the inverted image of the ship the tops of the masts and funnel (making much smoke) were clearly and normally seen. The observer's height of eye was 50 ft, the other vessel about 3,000 tons, which passed about 3 miles off, when the inverted image had disappeared. There was still considerable refraction, which made the derricks and bridge structure much depressed at regular and frequent intervals. When the vessel was about 2 points abaft the beam all mirage effects disappeared. Sky clear, and there was a very bright sun at altitude 18°, 1 point on the starboard bow.

Position of ship: 41° 25'N, 48° 02'W.

South African waters

S.S. *Arawa*. Captain L. J. Hopkins. Cape Town to Las Palmas. Observer, Mr. K. D. Billinghurst, 2nd Officer.

14th April, 1954, 1200–1500 G.M.T. The sky was cloudless, and what at first appeared to be a fog bank proved to be a mirage. With the coastline on the starboard side, distant 15 miles, a dark-blue mass, having every appearance of land with undulations as of hills, was seen on the port bow from about 4 points to 1 point off the bow where it faded into a white band above the horizon. It bore no resemblance to the neighbouring coastline that the eye could see.

As the vessel proceeded the dark-blue mass faded completely and the band above the horizon ahead deepened. Very soon a number of dark pillars were seen on the forward horizon and as the vessel came up to them they widened out and were found to be a whaling fleet with an inverted image above each craft. There was no wind at the time and it was noticed that the smoke from these whalers and from our own ship did not rise above mast height, but flattened out and hung in the atmosphere in a great band about 100 ft above sea level.

Dassen Island next appeared on the starboard bow, also with an inverted image above it and at first as a solid block, but on closer approach the low part of the island took definite shape in the inverted image and was detached upside down on the upper edge of the white band, but the high land and the lighthouse remained as a solid block throughout the observation, causing the lighthouse to be completely unidentifiable, even though it is painted with red and white bands. When the island came abeam at 10 miles distance the very top of the lighthouse could be seen just above the upper edge of the white band but could still not be identified below it. Also at this stage waves were seen with the unaided eye to be breaking downwards from the image of the low part of the island, but even with the telescope were not visible at the horizon level, and with a rise in height of 8 ft by the observer the whole thing appeared to flatten out considerably, so that a concertina effect could be caused just by walking up and down a ladder.

As the island was left astern it regained its normal shape except for the lighthouse, which appeared double, two images alongside each other, until it dipped. The whalers ahead retained their inverted images during the period of three hours until we came up with them and they gained their normal appearance. Air temp. 60°F, dew point 58°, sea temp. 59°.

Position of ship: 33° 34′S, 17° 57′E.

Note. Abnormal refraction, often very marked, is frequently reported in this region. The change in the appearance of objects produced by a change of a few feet in the height of the observer, described above, is quite a frequent experience when abnormal refraction is present, but the resulting changes probably differ in degree on different occasions.

Persian Gulf

S.S. *San Felix.* Captain G. R. Pearson. Suez to Mena al Ahmadi. Observers, Mr. P. W. Hodges, 2nd Officer, Mr. S. D. Mayl, 3rd Officer.

7th May, 1954. During the morning the horizon appeared like a roller-coaster track, especially when viewed through binoculars. Occasionally the horizon appeared broken up and whole sections seemed to be above or below the normal. At one time a large ocean-going tanker was sighted well within the horizon. It appeared as a mere speck and was at first thought to be a very small vessel. Although on opposite courses it was over an hour before we finally passed. The vessel must have been seen at a distance of approximately 25 miles but was not hull down. (See drawing opposite page 112.)

Position of ship at 0900 G.M.T.: 28° 52′N, 49° 00′E.

LUNAR RAINBOW

North Atlantic Ocean

S.S. *Captain Cook.* Captain A. Bankier. Glasgow to Curaçao. Observers, the Master and Mr. A. Maclean, 2nd Officer.

20th April, 1954, 0200 G.M.T. A clear lunar rainbow was observed. Rain was approaching from NNW and the moon was bearing 150°(T) and altitude 17°. The rainbow was a complete semicircle and attained an altitude 20° with extremities at 270° and 350°. The bow appeared to move nearer the vessel until one end appeared to be on the foredeck. The colour was white, with tinges of red and blue. A very faint supernumerary bow was also discernible.

Position of ship: 30° 00′N, 46° 59′W.

Indian Ocean

M.V. *Timaru Star.* Captain H. W. McNeil. Aden to Brisbane. Observer, Mr. J. P. Maidment, 3rd Officer.

21st April, 1954, 1730 G.M.T. A lunar rainbow was observed with arc of base extending from 270° to 333° and approximate altitude of 17°. The rainbow was a distinct orange colour on its upper edge, becoming a very pale green-blue on its lower edge. Shortly after the rainbow (1800) the aureole of a corona about 2° in diameter appeared round the moon. The inside of the ring was almost white, turning to a red-orange on the outer edge.

Position of ship: 03° 07′N, 84° 15′E.

TRIPLE CORONA

West Pacific Ocean

M.V. *Ajax*. Captain S. G. Llewellyn. San Francisco to Manila. Observer, Mr. J. K. Marshall, 3rd Officer.

20th April, 1954, 1030 G.M.T. The moon rose behind a bank of Cu and first appeared at about altitude 3½°, looking like a rugby ball on its side and twice its normal size. Coronae were observed around the moon, and at 1330 a triple spectrum was seen for 1½ min. The Cu present were usually too small to show more than one set of spectrum colours or else too dense to show any at all.

Position of ship: 17° 47′N, 140° 58′E.

Note. As stated in the note on page 35 of the January number of this journal, it is rare to see more than two series of spectrum colours in a corona, so that the above observation is of interest.

SOLAR HALO

Caribbean Sea

S.S. *Esso Glasgow*. Captain A. M. Canner. At Amuay Bay. Observers, Mr. R. Hutt, 2nd Officer, and Mr. M. Clent, 3rd Officer.

23rd April, 1954, 1630 G.M.T. A solar halo was observed of radius 22°, with very distinct spectrum colours ranging from violet on the inside through red, orange, green and pale blue shading off to white. The colours at times were almost as bright as those observed in a rainbow. The altitude of the sun was approximately 84°. The appearance of the sky inside the halo was quite dark. The halo was observed for over two hours in varying degrees of intensity, finally obscured by As. Cloud 7/8 Cs.

Position of ship: 12° 55′N, 70° 00′W.

Note. The observation of violet colour on the inside of the halo spectrum is remarkable since by the theory of halo formation violet is on the outer edge, though it is not very often actually seen. It is presumed that both observers saw the violet, in which case it would be very unlikely to be due to some abnormality of personal colour vision. The only possible explanation is that the Cs veil forming the halo was very thin and uniform, so that the neighbouring sky had its normal blue colour only slightly dimmed. The violet inner edge of the spectrum would then be due to a mixture of some of the red light of the halo and the blue light of the sky. Though no remarks about the cloud are given, this state of affairs seems likely in view of the observed brilliancy of the spectrum colours.

If this explanation be correct, it would be supposed that the inner violet ring would be seen more often, since halos with bright colouring are not uncommon. We can, however, only find one previous similar observation, that of S.S. *Orduna* on 25th October, 1927, published in the October, 1928, number of this journal. The colours from inside outwards were purple, orange, yellow and green, so that no pure red was actually seen. The observer on this occasion put forward the same explanation for the purple colour as is given above.

Red Sea

M.V. *Bellerophon*. Captain A. R. McDavid. Aden to Suez. Observer, Mr. J. H. Watterson, 4th Officer.

26th April, 1954, 1530 G.M.T. A double solar halo was observed. The outer halo was incomplete, with a radius of 47°. The radius of the inner halo was 23°, and all the spectrum colours could be identified easily, viz. violet, indigo, blue, green, yellow, orange and red. The only colours visible in the outer halo were blue, yellow and red. The phenomena lasted approximately 15 min. Cloud 8/8 Cs.

Position of ship: 18° 15′N, 40° 00′E.

LUNAR HALO

South Atlantic Ocean

S.S. *Cairnavon*. Captain G. H. Percy. St. Vincent C.V.I. to Montevideo. Observer, Mr. A. R. Fairley, 2nd Officer.

19th April, 1954, 0300 G.M.T. A lunar halo was observed, radius 22½°, moon's altitude 78°. At first the halo appeared as a ring of yellowish tinge, but at 0400 it attained greatest brilliance and the spectrum colours were visible. The halo remained till 0500 when it became obscured by Cu. Sky covered with thin Cs.

Position of ship: 31° 14′S, 49° 29′W.

South Pacific Ocean

M.V. *Windsor*. Captain D. V. Cameron. Sydney to Nauru. Observer, Mr. I. Murchison, 3rd Officer.

11th May, 1954. At 0430 G.M.T. a lunar halo commenced to form and was completely formed by 0500. The halo remained clear until 1200 when the moon's altitude was 30°. The radius of the halo was approximately 18°. The halo had completely disappeared by 1430. Cloud 1/8 Cu, 4/8 Cs, at 1200.

Position of ship at 0430: 04° 00′S, 165° 54′E.

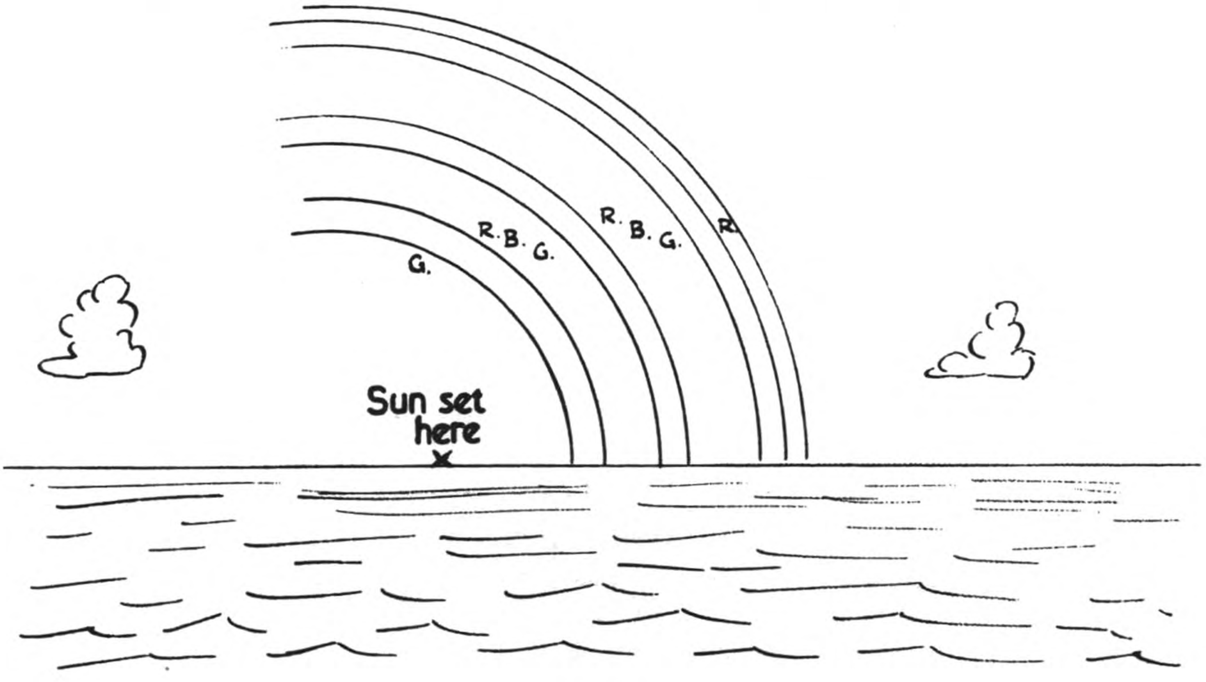
Note. Halos of 17° and 19° radii are known, the measurements of which in actual observation vary over a small range, 16¾°–18° and 18½°–20° respectively. The above observation is probably therefore of the halo of 17°. Both halos were formerly considered very rare but observations are more frequent recently, probably on account of more interest being taken in halos and their measurement. Thus we had only two observations in the first 21 volumes of this journal, while there are seven observations in the volumes for 1952, 1953 and 1954.

IRIDESCENCE

West Pacific Ocean

M.V. *Ajax*. Captain S. C. Llewellyn. San Francisco to Manila. Observer, Mr. J. K. Marshall, 3rd Officer.

21st April, 1954, 0930 G.M.T. The sun set at 0900, and at 0930 a beautiful rainbow effect was seen in the W, although the arc did not appear to have the sun



as centre. It consisted of a greenish patch surrounded by three red quarter arcs enclosing two spectra. These arcs lasted for about 3 min. Apart from a few light Cu on the horizon, there appeared to be no cloud in the vicinity. Later Canopus gave a wonderful exhibition of scintillation, the white flash at times looking like the loom of a light.

Position of ship: 15° 59′N, 135° 38′E.

Note. This is a very interesting and valuable observation, since it appears to be of something new which cannot yet be explained. There is only one known cause of iridescence in the western sky after sunset. This occurs when the clouds known as mother-of-pearl clouds are present in the stratosphere, at an average height of 15 miles. The iridescence on these may be very brilliant, particularly just before sunset, and may continue visible for about two hours after sunset. In the above observation no clouds were visible. Furthermore, observation of mother-of-pearl clouds has so far been confined to NW Europe, when an extensive deep depression lies over northern Scandinavia in winter.

GREEN FLASH

South Pacific Ocean

M.V. *Rangitoto.* Captain C. R. Pilcher, O.B.E. Balboa to Wellington. Observers, Mr. A. W. Finch, 2nd Officer, and Mr. B. Anstey, 3rd Officer.

18th April, 1954, 1845 L.M.T. A bright green flash was observed with the unaided eye at the setting of Venus; the flash lasted for several seconds. Whilst taking stellar observations half an hour previously, considerable difficulty was found in observing bodies in the western sky because of a light red tinge in the heavens. At 2100 L.M.T. Jupiter was observed through binoculars (6x) to be setting, bearing approximately 300°. For a period of 5 min before setting the planet had an orange glow and at the moment of setting a green flash was observed. Visibility excellent. Cu 1/8 to 3/8.

Position of ship at 1845: 31° 20′S, 149° 49′W; at 2100: 31° 32′S, 150° 29′W.

Note. While the green flash at the setting of Venus and Jupiter has been quite often observed with binoculars, it is rare for conditions to be so favourable that this can be seen with the unaided eye. It could probably only be so observed in the case of the brightest planet Venus. A previous observation of this kind, made by M.V. *San Veronico*, will be found in page 202 of the October, 1953, number of this journal.

ZODIACAL LIGHT

North Atlantic Ocean

S.S. *Manistee.* Captain R. A. Laycock. Port Antonio to Garston. Observers, Mr. G. Wallis, Chief Officer, and Mr. R. Dover, Senior Apprentice.

25th April, 1954. At 1½ hours after sunset (1900 S.T.) a cone of zodiacal light was observed in a W'ly direction. The base of the cone covered an arc of the horizon of 5° and reached to an altitude of approximately 50°. The cone had the appearance of leaning slightly towards the southward of the observer. The light was white and very much brighter than that from the Milky Way.

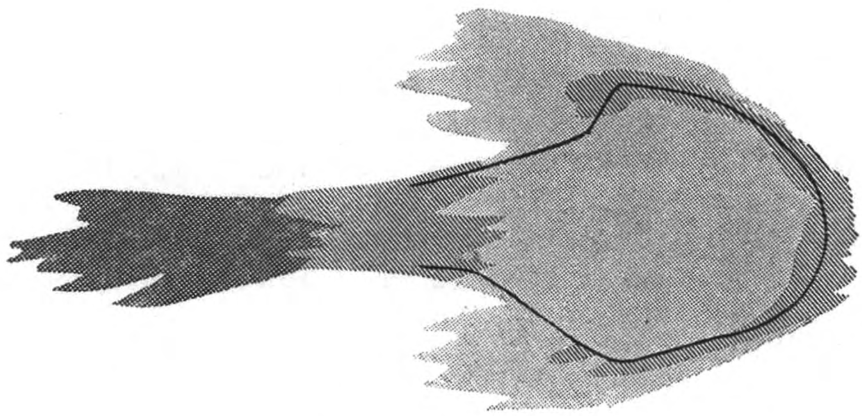
Position of ship: 30° 40′N, 61° 30′W.

Note. It is a long time since we have received an observation of the zodiacal light. In the iatitude and season of this observation the ecliptic makes a very steep angle to the horizon, Inclining slightly to the S with increase of altitude. As the axis of the light is very nearly, though probably not quite, in the line of the ecliptic this would account for the slight tilt of the light observed.

METEOR

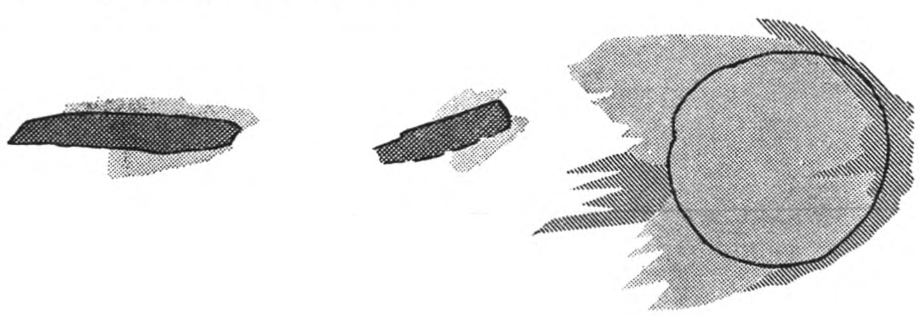
Arabian Sea

R.M.S. *Dara.* Captain J. H. Curry. Pasni to Karachi. Observers, the Master, Mr. D. P. L. Smith, 2nd Officer, Mr. A. Hunt, Chief Engineer Officer, also quartermaster, lookout and various passengers.



27th April, 1954, 1430 G.M.T. When S of Ras Ormara, on the Makran coast, a ball of light was observed bearing 110° approximately at an altitude of 30° (close to Arcturus). It was then 20 times the magnitude of Venus. It travelled rapidly in a WSW'ly direction; as it approached the ship it gained quickly in brilliance and size every second, while its altitude decreased by about 5°. As it passed above Spica a reddish trail became visible and the head of the meteor was then as brilliant as the sun. It had a shape like a long-stemmed pear, with blue colouring round most of the head, particularly at the fore end and at the after end, at the root of the reddish trail. On reaching Sirius, at an altitude of about 25°, the trail separated from the head and divided into two brilliant parts. These and the head travelled in the same direction for about 2 sec more, after which the whole disintegrated and appeared to fall into the sea. There was at no time any sound or evidence of a splash although it appeared to be quite close. The phenomenon was visible for about 20 sec.

Position of ship: 24° 57′N, 64° 20′E.



Note. This was a fireball of great apparent size and exceptional brilliancy and it may well have been large enough for solid pieces to fall into the sea, though these might not have been sufficiently big to make an appreciable splash. Furthermore, the distance from the ship of a luminous phenomenon at night is apt to be deceptive, so that it may have been further away than it appeared to be. The sun is about 575,000 times brighter than the full moon and the meteor cannot really have been as bright as this, otherwise it would have been impossible to look at, except perhaps momentarily, and every star in the sky would have been blotted out, with an appearance of full daylight. No doubt it was many times brighter than the full moon. It must be remembered that bright lights appearing suddenly at night look brighter than they really are since the pupils of the eyes are at their greatest size, being adapted to night vision.

Indian Ocean

M.V. *Port Townsville*. Captain E. W. R. Young. Aden to Adelaide. Observer, Mr. R. C. W. Marr, 3rd Officer.

22nd April, 1954, 2126 G.M.T. A brilliant meteor, almost as bright as the moon, was observed falling diagonally towards the pole star. Although visible for less than 1 sec, it left a bright trail about 4½° long, all of which remained visible for

12 sec and the brightest parts for 45 sec before finally fading from sight. First visible at altitude 36½°, bearing 027°, disappeared at altitude 33°, bearing 023°.

Position of ship: 4° 13′N, 62° 19′E.

M.V. *King William*. Captain J. C. Davies. Port Pirie to Aden. Observer, Mr. D. R. Parr, 3rd Officer.

12th June, 1954, 1430 G.M.T. A brilliant meteor was observed which illuminated the sky and ship. It was visible for 2 sec, of approximate diameter 2′ and with a trail of 5°. It described an arc through the sky to SE of the ship and disappeared behind some towering Cu at an altitude of 30°. The nearest identified star was Rigel Kent which bore to the E of the meteor's path. The meteor appeared to be spherical in shape and oxygen blue in colour, with some distortion near the trail.

Position of ship: 29° 08′S, 100° 07′E.

North Atlantic Ocean

S.S. *Esso Glasgow*. Captain A. M. Canner. Amuay Bay to Fawley. Observer, Mr. M. Clent, 3rd Officer.

28th April, 1954, 0240 G.M.T. An exceptionally brilliant meteor was observed at an altitude of approximately 28° to the S of Vega. It travelled in a SW'ly direction and finally disappeared at an altitude of about 10° as suddenly as it had appeared. It left no appreciable trail during its flight, which lasted nearly 3 sec; the meteor was of a dazzling whiteness and caused the ship to be well illuminated. No clouds were visible and the moon had not yet risen.

Position of ship: 30° 46′N, 53° 22′W.

UNIDENTIFIED OBJECT

Gulf of Oman

M.V. *Auricula*. Captain G. E. Hunt. Suez to Bahrein. Observers, Mr. W. T. Copeland and Mr. R. G. Foster, Apprentices.

26th May, 1954, 0810 S.A.T. An object was seen travelling across the sky at great speed far beyond that of any known piloted machine. When first observed, the object was approximately abeam to port at an altitude of 40° and appeared in the form of an ellipse revolving at high speed. It travelled over what appeared to be a perfectly horizontal course of 125°, eventually disappearing astern, making no audible sound and leaving no visible trace of its path. The object was silver in colour, and although observed at an unquestionably great distance it was comparable in size to a silver threepenny piece at a distance of 10 ft, held so as to appear elliptical. Course of vessel 325°(T), speed 13 kt. Wind NW, force 3. Very little Cs cloud.

Position of ship (D.R.): 25° 08′N, 57° 37′E.

Note. In forwarding this observation Captain Hunt states that the observers could not accurately state the interval of time during which the object was visible, but that after careful consideration of their verbal accounts he estimated it to be about 10 sec.

The only point not made clear in the observation is how the rotation of an object uniform in colour, with no mention of any markings seen, could be perceived.

The object may possibly have been a meteor bright enough to be visible in daylight. The main objection to this explanation is that, while not impossible, it is unlikely that the meteor would maintain a perfectly horizontal course. Another possible explanation is that the object was a meteorological balloon such as is released by numerous meteorological stations all over the world for the purpose of studying upper-air conditions. The appearance of these balloons when airborne is very deceptive, especially when the sun is low. At such times it has been found quite impossible to judge their height or distance by eye, so that any estimate of their speed is conjectural.

However when the observation was made the vessel was about 120 miles almost due E of Sharjah, Arabia (25 21′N, 55° 23′E) from which a balloon is sent up at 0200 G.M.T. Since the object was seen at about 0410 G.M.T. the mean wind speed through the layers traversed by the balloon would need to have been nearly 40 kt for the balloon to have originated from Sharjah. No data are available for Sharjah but the ascent at Bahrein at 0200 showed that winds were less than 10 kt up to 30,000 ft. Since balloons can seldom remain aloft for more than a few hours it is unlikely that the phenomenon was caused by a balloon released from either station at 1400 G.M.T. the previous day.

Enquiries have elicited the fact that one of H.M. ships was in the vicinity at the time and it is just possible that this had a bearing on the incident.

Some more sketches from those drawn by observing officers of M.V. *Port Wellington* on the cover of a meteorological logbook. Other sketches have appeared on pages 81 and 130 of Vol. 24 of *The Marine Observer*.

ERRATA

The Marine Observer, Vol. XXIV, No. 165, July, 1954, page 169. It has been brought to our notice by an " Old Conway " that in the review of John Masefield's book *The Conway* there was no mention of H.M.S. *Winchester*. This ship replaced the first *Conway* in 1861 and was in turn replaced by the *Nile* in 1876.

The photograph of sea fog opposite page 205 of the October, 1954, number was taken on 11th December, 1953, not 4th as printed. Position of S.S. *City of Delhi*, 24° 55′N, 51° 31′E, at anchor off Umm Said. Height of the fog was 150–200 ft.

The Loss of the Sao Paulo

By P. R. Brown, M.Sc., A.R.C.S., D.I.C.
(Marine Branch, Meteorological Office.)

Many formal investigations into the loss of British-owned ships are ordered by the Minister of Transport when he and his technical advisers are not completely satisfied as to the cause of the loss. Before such an enquiry there is usually no doubt as to the fate of the ship concerned, but whether the *Sao Paulo*, with eight men on board, sank on the 4th or 5th November, 1951, almost immediately after she broke away from her tugs, or whether she was still afloat well away from the traffic lanes, or had stranded on some isolated part of the coast of West Africa, was still an open question in the minds of some people for some time after her loss. The formal investigation conducted by Mr. R. F. Hayward, Q.C., sitting with two nautical assessors, commenced on the 4th October, 1954, and the court, after hearing all the available evidence, found that the ship had foundered shortly after parting from her tugs.

The *Sao Paulo* was a 19,200 ton battleship built for the Brazilian Navy by British shipbuilders in 1910, and had been lying in Rio de Janeiro harbour since 1946 and had last been in dry dock in 1948. She was bought by the British Iron and Steel Corporation (Salvage) Ltd. for scrap and was to be towed to Greenock. She had her 12-in. guns aboard, but her secondary armament, including fourteen 4·7-in. guns, had been removed together with all ammunition, war stores and practically all brass and non-ferrous metal fittings.

Mr. Painter, at that time managing director of a rigging company, flew to Rio to supervise the preparation of the ship for towage. He arranged for certain work to be done, including the closing of the seven gun ports on each side of the ship from which the 4·7-in. guns had been removed. In some of these gun ports the original metal shields were left in position and here the shields were closed, which left a round hole a little larger than the gun barrel; these holes were covered by two circular pieces of wood held by a central bolt. In the case of the gun ports which had no metal shields, the whole of the outside of the gun port was covered with 2-in. battens of a very strong local wood, the battens being bolted to steel strong backs, which in turn were welded to the ship's skin. Mr. Painter with seven other men formed the rigger crew of the ill-fated ship who were lost with her.

Some of the tanks were filled with between 1,000 and 1,500 tons of water ballast for the purpose of trimming the battleship by the stern. She had no engines and was not capable of being steered; her rudder was therefore locked in the midway position. She had no wireless but had a walkie-talkie set and an Aldis lamp for communication with the tugs. The towing was to be done by the Admiralty-owned tug *Bustler* (1,118 tons displacement) on time charter to Metal Industries Ltd., and the *Dexterous* (599 tons gross); the *Bustler* is one of the small group of the most powerful tugs in the world.

Mr. Painter was given a certificate of seaworthiness by the surveyor of a classification society known as the Bureau Veritas from their Rio de Janeiro office, and rather later than had been hoped the *Bustler* towed the *Sao Paulo* out of Rio de Janeiro on 20th September, 1951. Two men deserted from the *Dexterous* and she had to try to get replacements and so sailed afterwards, and she did not, in fact, commence to tow with the *Bustler* until the second day out.

One man of the rigger crew named De Vos intended to sail, but met with an accident when a mooring rope broke at the commencement of the towing voyage and he had to be left behind in hospital. This accident saved his life.

The tugs and their tow made reasonable progress towards the Azores at 3–4 kt, and up to about 19th October the weather remained reasonably good. Then there was some deterioration with a spell of unfavourable weather for towing purposes, and about the 23rd it was noticed from the tugs that the *Sao Paulo* appeared to

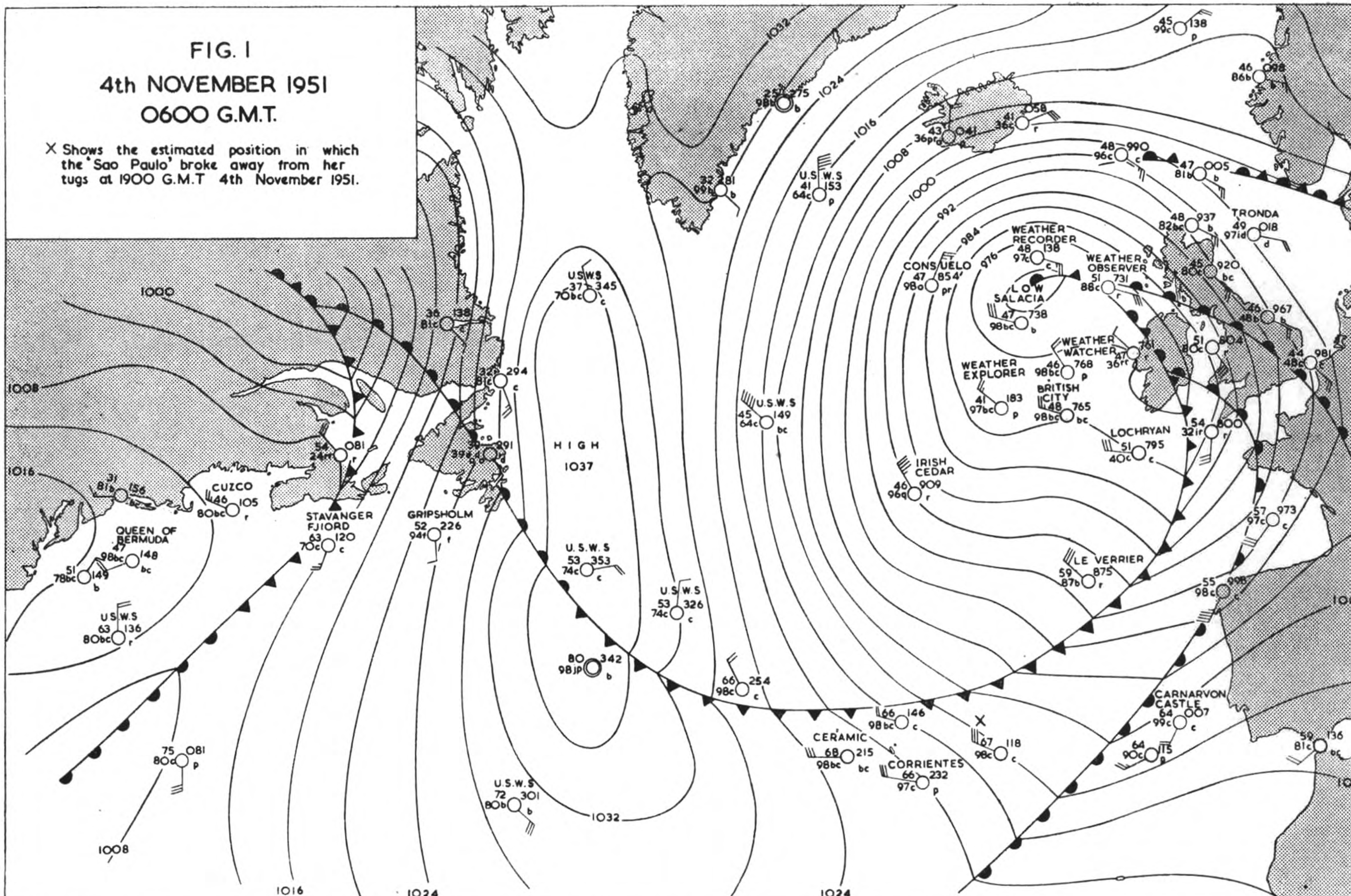


FIG. I
4th NOVEMBER 1951
0600 G.M.T.

X Shows the estimated position in which the 'Sao Paulo' broke away from her tugs at 1900 G.M.T 4th November 1951.

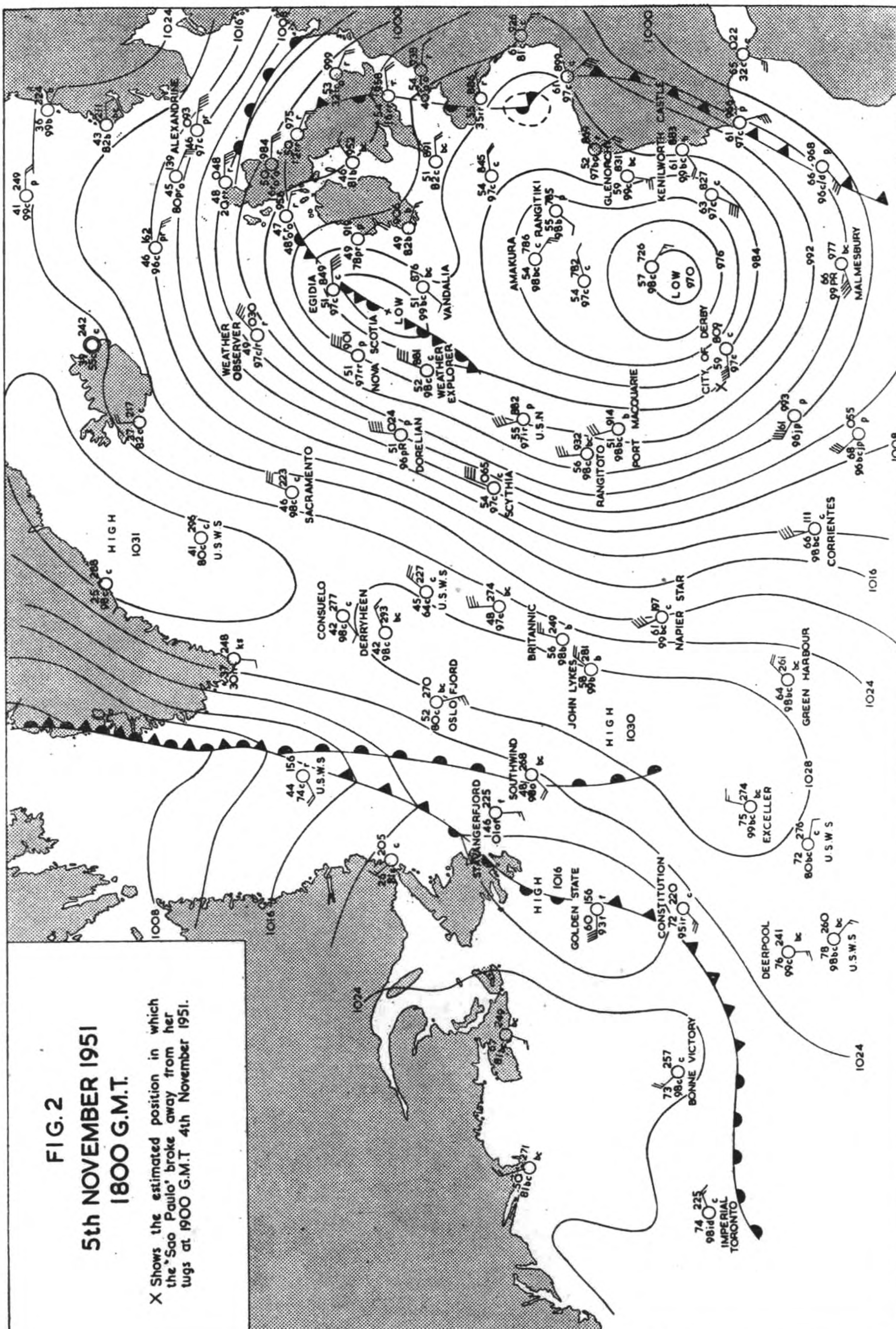


FIG. 2

5th NOVEMBER 1951

1800 G.M.T.

X Shows the estimated position in which the "Sao Paulo" broke away from her tugs at 1900 G.M.T 4th November 1951.

have a slight list estimated at something up to 4°. It was learned from Mr. Painter that water had come out of one of the ballast tanks owing to a loose manhole cover and had run to the side of the ship, causing the list. It is understood that the rigger crew got the water back into the ballast tank by hand baling. They then replaced the manhole cover and put a cement box on top to keep it in position. Some experts connected with the investigation found it difficult to believe that an amount of water great enough to cause such a hulk to list 4° could have been recovered by that small rigger crew by hand baling and got back into the tank. However, the evidence was given by people on board the tugs to the effect that there was a time when the *Sao Paulo* was listing and there was a later time when she was upright again.

During the night of 3rd–4th November the weather deteriorated seriously. An area of low pressure, with two centres at 57½°N, 16½°W and 53°N, 8°W at 0600 G.M.T. on the 4th, was surrounded by a very extensive cyclonic circulation covering eastern Atlantic N of 35°N, over much of which the circulation was intense (see Fig. 1). This low-pressure area had been moving slowly south-eastwards. At 0600 on the 4th a cold front was approaching the *Sao Paulo*, which was now near the estimated position in which she parted from her tugs at 1900 G.M.T., i.e. 39° 47'N, 23° 21'W. The NW'ly winds, which had already strengthened in the early hours to fresh or strong, backed and strengthened before the front, becoming strong W'ly or WNW'ly, and possibly reaching gale force at times at the *Sao Paulo* before the passage of the front shortly before 1200 G.M.T. on the 4th. After the passage of the front the wind veered, becoming NW'ly, and soon reached gale force. Another centre had formed in the area of low pressure in association with a wave on the cold front and was situated at 47½°N, 10°W, at 1200 G.M.T.: the principal cause of increasing pressure gradient and winds in the area of the *Sao Paulo*, however, was a low-pressure centre situated at 49°N, 18½°W, at 1800 G.M.T., moving south-south-eastwards. This latter depression eventually moved to 41°N, 17°W by 1800 on the 5th (see Fig. 2), before it gradually took a NNE'ly track, and this depression was the direct cause of the weather responsible for this casualty. Although no voluntary observing ships were in the immediate vicinity of the *Sao Paulo* there were several reports of Beaufort force 10 within a few hundred miles, including those of the M.V. *Rangitoto*, Captain C. R. Pilcher, at 1800 on the 4th at 44° 14'N, 26° 57'W and at 0600 on the 5th at 44° 52'N, 26° 57'W and it is probable that the wind reached force 11 or 12 in squalls and gusts during the night of the 4th–5th near the *Sao Paulo*.

Some of the difficulties of the two tugs with a 19,200 ton battleship without power or steering during such weather can be imagined. Although the forecasts and storm warnings issued by the British Meteorological Office in the Atlantic Weather Bulletins broadcast by Portishead Radio gave good warning of the high winds and bad weather, the tug-masters had no means of escape from the weather; as the master of the *Bustler* said at the investigation, the preparation for the voyage was made bearing in mind that they might have to meet heavy weather.

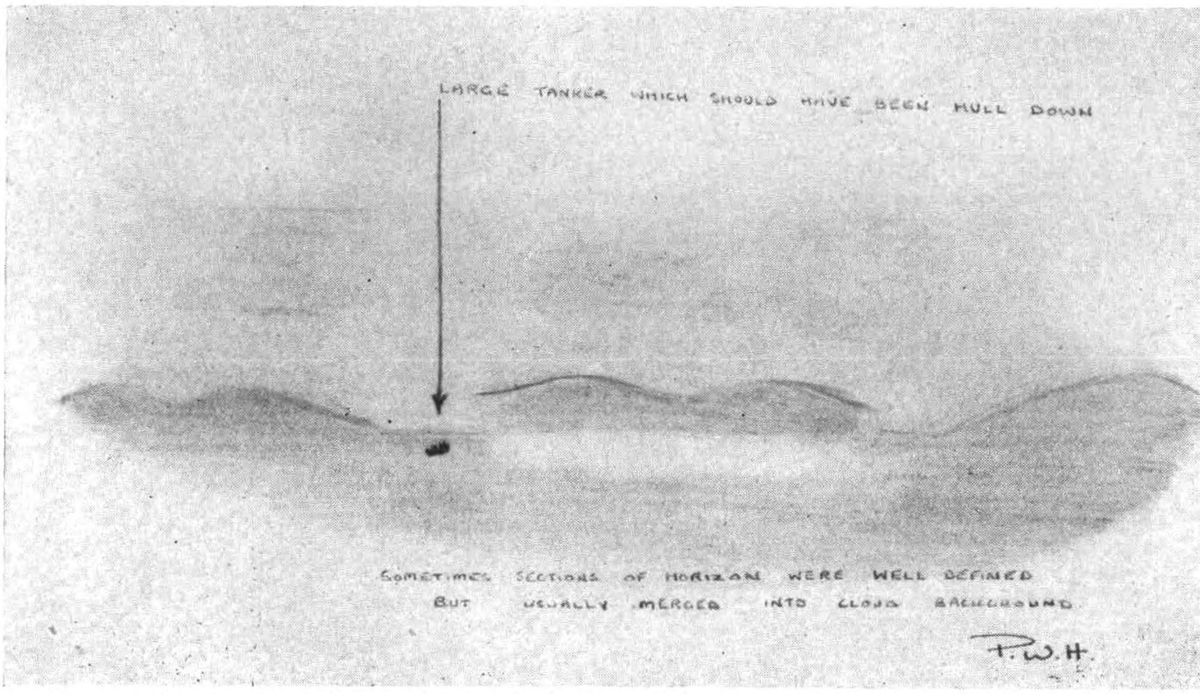
The waves had already reached great heights during the 4th and there were several reports of 30 ft or more from ships within a few hundred miles, and somewhat to the N the S.S. *Gracia*, Captain J. McInnes, while hove-to at 46° 30'N, 26° 0'W, reported 40 ft at 1200 and 50 ft at 1800 on the 4th, while the M.V. *Norfolk*, Captain T. A. S. Moncrieff, reported 40 ft at 42° 53'N, 20° 49'W at 0600 on the 5th. Already by 0930 on the 4th the tugs had decided to heave to. At about 1900 the *Sao Paulo* sheered substantially to starboard in a heavy squall and the tugs were pulled astern and very close together. The tug-masters had an arrangement that the *Dexterous* should slip her tow in any emergency, and the master of the *Dexterous* decided to slip hers at this time. In the course of slipping her tow the hawser parted: the hawser of the *Bustler* also parted and was cut by her own propeller. Before this happened there had been several communications between the *Bustler* and Mr. Painter, who said everything seemed all right aboard the battleship, although in the last communication, two hours before the parting, he said there were a few trickles of water through the gun ports. When the *Sao Paulo* was last seen by the tugs there was nothing apparently wrong with her trim.

The *Sao Paulo* had life-jackets and two lifeboats aboard but no line-throwing equipment. The *Bustler's* radar was switched on shortly after the parting and showed something which may have been the *Sao Paulo* about five to six miles away, but this was soon lost again. Because the weather was so bad the *Bustler* remained hove-to all night and returned when daylight came on the 5th to the position where the master estimated that the hawser had parted. The master of the *Bustler* said at the investigation that he would have tried to stay nearer the *Sao Paulo* in the dark had he had any anxiety about the ship or those on board her. The weather continued severe all through the 5th over the search area with NW'ly gales, probably of force 9 or 10 at times; a gradual lessening and slight backing of the winds took place during the 6th. The winds generally moderated during the 7th to 20th, but reached gale force occasionally for short periods in the N of the search area, where they were generally between SW and NNW. The *Bustler* continued to search from the morning of the 5th until the 20th, following the presumed SE'ly line of drift of the *Sao Paulo*, and a day and night radar search was kept. The *Dexterous* was unable to join the search as she was too badly damaged by heavy weather on the night of the 4th–5th, and she had to put into Ponta Delgada, Azores, for repairs. On her homeward voyage to Barry for permanent repairs she lost one of her crew overboard. The tug *Turmoil* came from the United Kingdom to join the search. The R.A.F. organised an air search from Gibraltar and obtained landing and refuelling facilities in the Azores, which enabled their aircraft to spend more time over the search area: the R.A.F. covered an estimated area of 136,800 square miles between the 7th and 10th November. The United States and Portuguese Air Forces operating from the Azores also searched from the 7th to the 10th, the Portuguese stating that they covered an area of approximately 475,000 square miles. No contact was made with the *Sao Paulo* and it was decided not to continue to search unless there was further evidence to suggest that some purpose would be served by doing so. On 13th November it was suggested by the tug owners that the ship might have capsized and be still afloat. She might, in that case, remain afloat as a danger to shipping for some time. The opinion of the Admiralty was sought by the R.A.F., and it was decided to search a new area into which it was considered that the winds and ocean currents might have carried the hulk since the original search was completed. This last air search was made by the R.A.F. from Gibraltar on 14th and 15th November and covered an area of approximately 85,200 square miles, but no trace of the *Sao Paulo* was found.

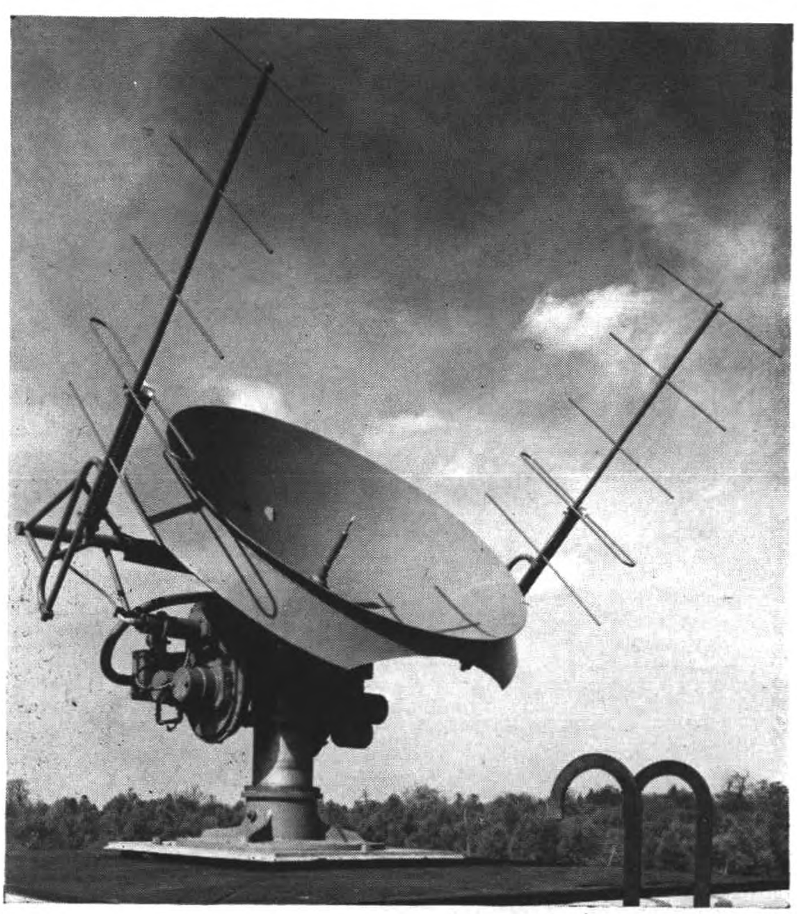
On 5th November the *Bustler's* third engineer saw a length of wood in the sea which was not identified. The *Bustler's* senior wireless operator saw an object in the water which resembled a lifeboat, but nobody else saw it. Two ships reported having seen flashing lights in the area on the 9th, but to quote the master of the *Bustler*, " Moonlight breaking on the water on occasions gives the impression of lights. It is quite common ".

Mr. E. M. Smith, Senior Ships' Surveyor, Ministry of Transport, said at the investigation that the amount of water necessary to turn the ship over would be tremendous. He found it difficult to imagine what happened if she turned over or foundered by an ingress of water. An 18° list would be necessary to bring the gun ports on the waterline.

An interesting theory was put forward by Mr. Osborn Hirst, a naval architect and ships' surveyor, who served some of his early years of training in the drawing office of the yard in Barrow-in-Furness where the *Sao Paulo* was built, and is now employed by the Bureau Veritas. Mr. Hirst said that after seeing the ship's stability calculations and remembering that she broke adrift when the wind was force 10 or 11 with corresponding seas, he would expect the period of such sea waves to be approximately 15 sec from crest to crest; the stability and displacement of the ship



Abnormal refraction observed from S.S. *San Felix* on 7th May, 1954, in the Persian Gulf (see page 101). Drawing by Mr. P. W. Hodges.



[*Photo by Mullards Ltd.*

Radar-sonde aerial unit, showing transmitting arrays and receiving dipole and reflector.

Opposite page 113

[*Crown Copyright Reserved*

Captain P. MacMillan, of the Clan Line, and Sir Graham Sutton, Director of the Meteorological Office, examining the barograph after presentation aboard the head-quarters' ship *Wellington* on 7th January, 1955 (see opposite).

[*Crown Copyright Reserved*

Mr. S. P. Peters, Deputy Director of the Meteorological Office, presenting the inscribed barograph to Captain A. E. Lettington, O.B.E., D.F.C., on board the head-quarters' ship *Wellington*, 17th November, 1954 (see opposite).

was such that the period of roll would be about 15 sec and there would thus be a possibly of synchronism. Mr. Hirst thought it was likely that the *Sao Paulo* capsized while lying beam-on to the seas. He thought she would have rolled heavily for a period coinciding with the period of each wave and would have a greater inclination to roll more with the impulse of each succeeding wave.

In addition to the main finding of the court as mentioned above, the court also found that the loss of the *Sao Paulo* was not caused or contributed to by the wrongful act or default of any person or persons.

Presentation of Barographs

As mentioned in the October, 1954, number of *The Marine Observer*, inscribed barographs were awarded to four captains of selected ships in recognition of the long period during which they have done particularly good voluntary meteorological work at sea on behalf of this Office.

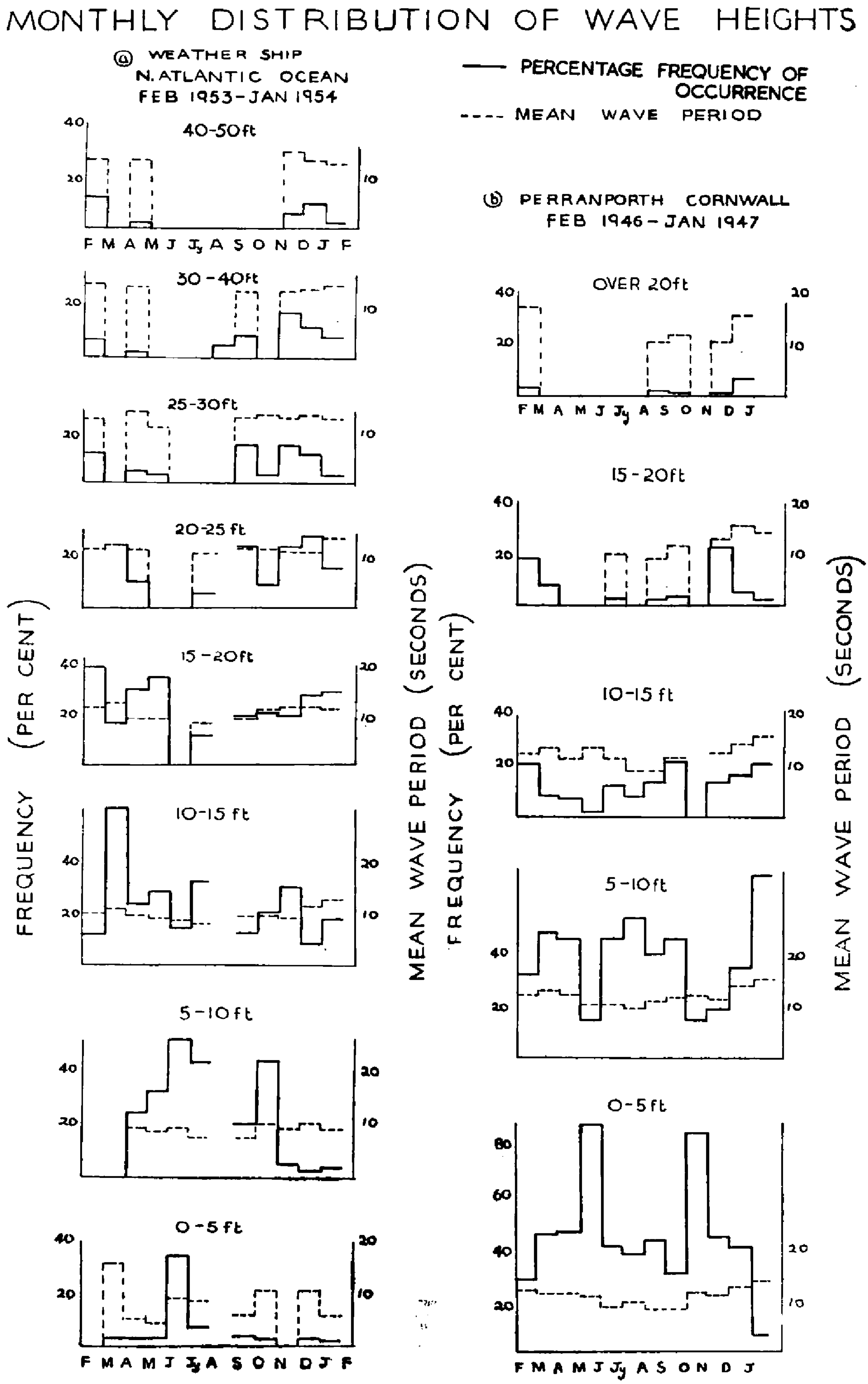
The presentation to Captain Lettington, of the New Zealand Shipping Co. steamer *Rangitiki*, was made aboard the *Wellington*, headquarters' ship of the Honourable Company of Master Mariners, on 17th November, 1954, by Mr. S. P. Peters, Deputy Director of Forecasting in the Meteorological Office. As the occasion coincided with a meeting of the Court of the Honourable Company a considerable number of members were present at this little ceremony, and Sir Frederick Bowhill, Deputy Master, was in the chair. In making the presentation Mr. Peters spoke of the considerable number of reports received from merchant ships in the North Atlantic and the value of these reports for forecasting purposes. He stressed that these voluntary observations of surface conditions were just as important as the upper-air reports received from the weather ships. He also referred to the increased number of reports from merchant ships at the various meteorological centres in the Southern Hemisphere, particularly in the area between South Africa and Australia during the last eight years.

Captain Lettington also received from Mr. Peters a barograph for Captain H. E. Riley, who recently retired from the New Zealand Shipping Co. to reside in New Zealand. This barograph was taken to Wellington aboard the *Rangitiki* for formal presentation by the Director of the New Zealand Meteorological Service. We regret to say that news has since been received of Captain Riley's death; the barograph was presented informally to his widow.

The presentation to Captain Caunce of the Cunard liner *Caronia* was made in November, 1954, at an informal luncheon party aboard the *Caronia*, by Commander C. E. N. Frankcom, Marine Superintendent of the Meteorological Office. He was accompanied by Commander Cresswell, the Port Meteorological Officer in Liverpool.

Sir Graham Sutton, Director of the Meteorological Office, made the presentation to Captain MacMillan, Clan Line steamer *Clan Cameron*, aboard the *Wellington* on 7th January, 1955. Among those present were Captain Elvish, Marine Superintendent of the Clan Line, and Captain Chase, a Warden of the Honourable Company.

In making the presentation the Director explained that even the North Atlantic Ocean, although one of the busiest sea highways, was in fact sparsely covered by meteorological observations, even taking into account the weather ships. In other parts of the world the number of available reports from ships was considerably less, and it was only the selected ships which could provide the necessary information. He pointed out that the Clan Line had done this voluntary work since 1889 and, owing to the world-wide nature of their trade, the ships of this company provided a very valuable contribution to international meteorology. C. E. N. F.



MONTHLY DISTRIBUTION OF WAVE HEIGHTS
(a) WEATHER SHIP N. ATLANTIC OCEAN FEB 1953–JAN 1954
— PERCENTAGE FREQUENCY OF OCCURRENCE
---- MEAN WAVE PERIOD
(b) PERRANPORTH CORNWALL FEB 1946–JAN 1947
40-50ft
30-40ft
25-30ft
20-25 ft
15-20ft
10-15 ft
5-10ft
0-5ft
OVER 20ft
FREQUENCY (PER CENT)
MEAN WAVE PERIOD (SECONDS)
F M A M J Jy A S O N D J F

Fig. 1

Wave Statistics in the North Atlantic Ocean and on the Coast of Cornwall

By J. DARBYSHIRE
(National Institute of Oceanography)

Since February, 1953, the Marine Division of the Meteorological Office has taken deep-sea wave records with a wave recorder fitted by the National Institute of Oceanography in the ocean weather ship *Weather Explorer*. The recorder has been described in detail by Tucker (1952): it consists essentially of an accelerometer and a pressure-measuring unit fixed to the hull of the ship, more or less amidships and about 10 ft below the waterline. The pressure recorder measures the water pressure through a ½-in. hole in the hull and gives the height of the sea surface above the instrument, whilst the movement of each accelerometer, converted into an electrical output and doubly integrated, gives the height of the instrument above an arbitrary fixed-reference level. This is combined with the electrical output from the pressure recorder, and the sum of the two heights is the height of the sea surface above the arbitrary reference level. The variations in this height give the wave heights. Two instruments, one on each side of the ship, are used to allow for reflection of waves and sheltering. Owing to the rapid attenuation of very-short-period waves with depth, corrections have to be applied when the wave periods are less than 8 seconds, but the periods of most ocean waves are longer than this and then no corrections need be made.

The *Weather Explorer* takes wave records eight times a day while she is at sea. These records are normally taken when the ship is lying stationary. When she is moving (up to a maximum speed of 9 kt) no correction need be applied for the height as only the wave period is affected. The results will add greatly to our knowledge of deep-sea waves, and a preliminary examination indicates that they are higher than those recorded in shore, waves of 40–50 ft in height not being very unusual. The wave periods measured are somewhat shorter than those recorded for the same sort of waves in coastal regions. Predictions of wave height and period based on recordings made in an exposed position one mile from the coast of north Cornwall give heights 15 per cent lower, and periods 15 per cent longer, than those obtained in deep water, and the question of the generation of waves by wind in storm areas needs review. Now that a year's record of waves in deep water is available, it is interesting to make a statistical survey of the wave characteristics from month to month. The *Weather Explorer* occupied in turn the two positions INDIA (61° 00'N, 15° 20'W) and JULIETT (52° 30'N, 20° 00'W), and observations at both positions have been combined as representative of conditions generally in this part of the North Atlantic Ocean. Since she is the only ship fitted with a recorder observations are not available for every day of each month, and there are no observations for the month of August during her refit. Records are available for 9 days of February, 16 days of March, 27 days of April, 18 days of May, 15 days of June, 20 days of July, 14 days of September, 17 days of October, 25 days of November, 20 days of December, 1953, and 15 days of January, 1954. To obtain some comparison with waves in coastal areas a similar analysis is presented of monthly wave heights and wave periods obtained from recordings at Perranporth, Cornwall, between February, 1946, and January, 1947. (This recorder was not in action during the period February, 1953, to January, 1954.)

The percentage of time during which the maximum wave height is between 40 and 50 ft, 30 and 40 ft, 25 and 30 ft, 20 and 25 ft, 15 and 20 ft, 10 and 15 ft, 5 and 10 ft and 0 and 5 ft, is found for each month and the mean wave periods of the waves in each height range are shown as histograms in Fig. 1. The full lines represent the percentages in each height range, and the broken line the mean periods. Fig. 2 shows the corresponding distribution of wave periods, but this time

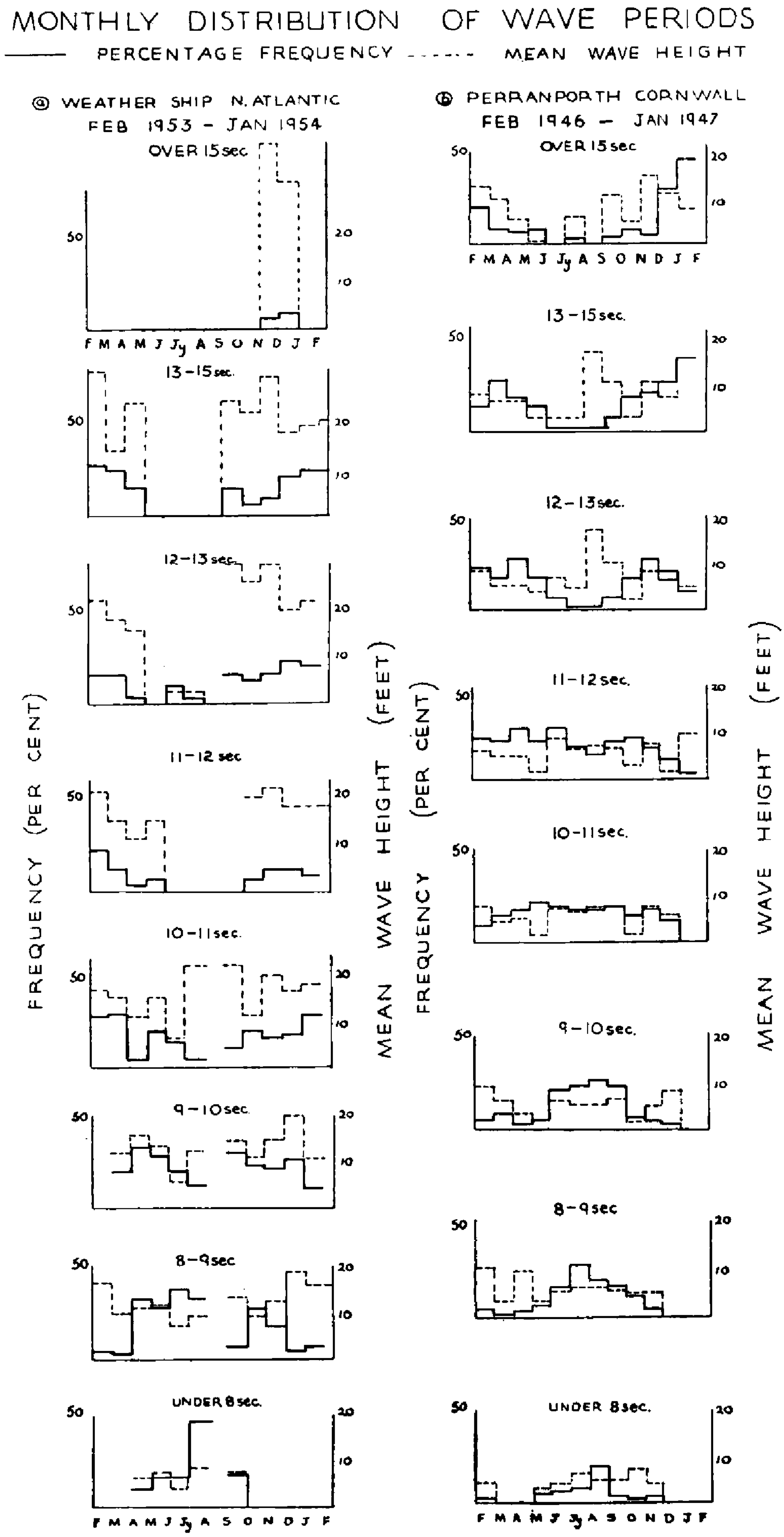

MONTHLY DISTRIBUTION OF WAVE PERIODS
PERCENTAGE FREQUENCY
MEAN WAVE HEIGHT
(a) WEATHER SHIP N. ATLANTIC
FEB 1953 - JAN 1954
(b) PERRANPORTH CORNWALL
FEB 1946 - JAN 1947
OVER 15 sec
13-15 sec.
12-13 sec.
11-12 sec.
10-11 sec.
9-10 sec.
8-9 sec
UNDER 8 sec.
F M A M J Jy A S O N D J F
FREQUENCY (PER CENT)
MEAN WAVE HEIGHT (FEET)

Fig. 2

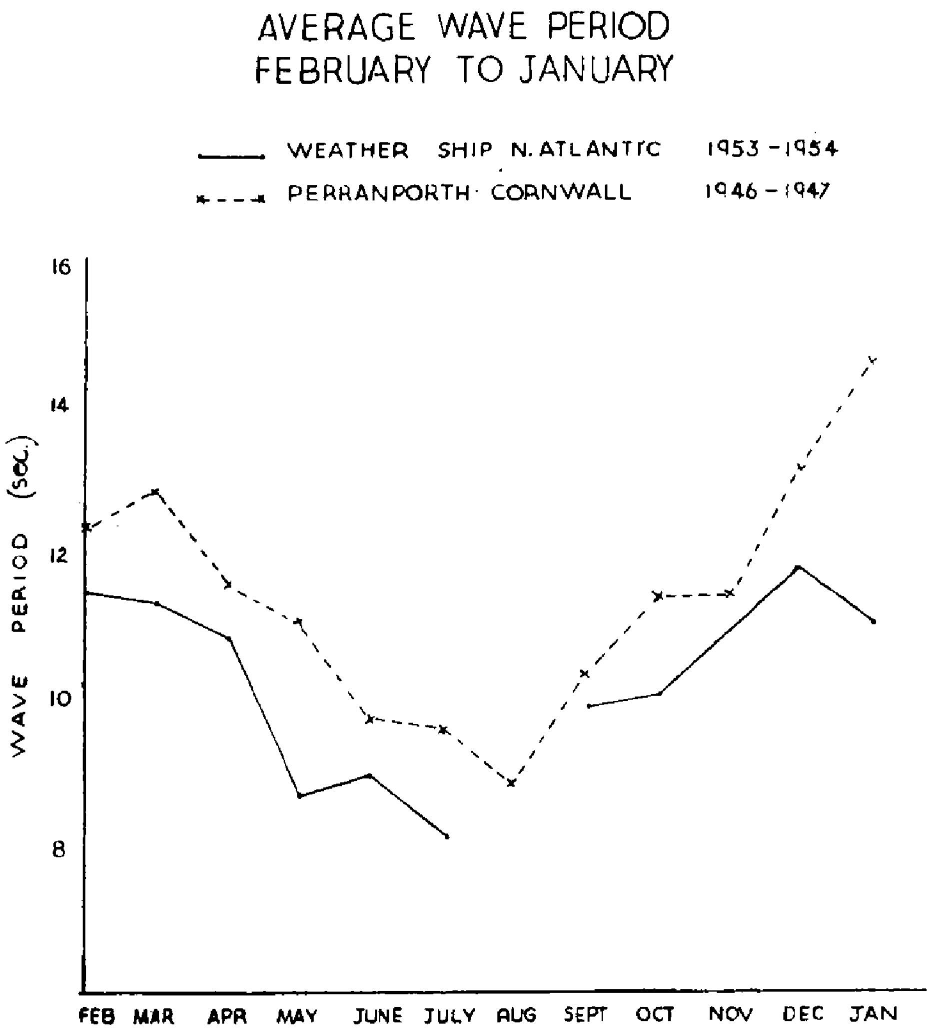

AVERAGE WAVE PERIOD
FEBRUARY TO JANUARY
WEATHER SHIP N. ATLANTIC 1953 - 1954
PERRANPORTH CORNWALL 1946 - 1947
WAVE PERIOD (sec.)
16
14
12
10
8
FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN

Fig. 3A

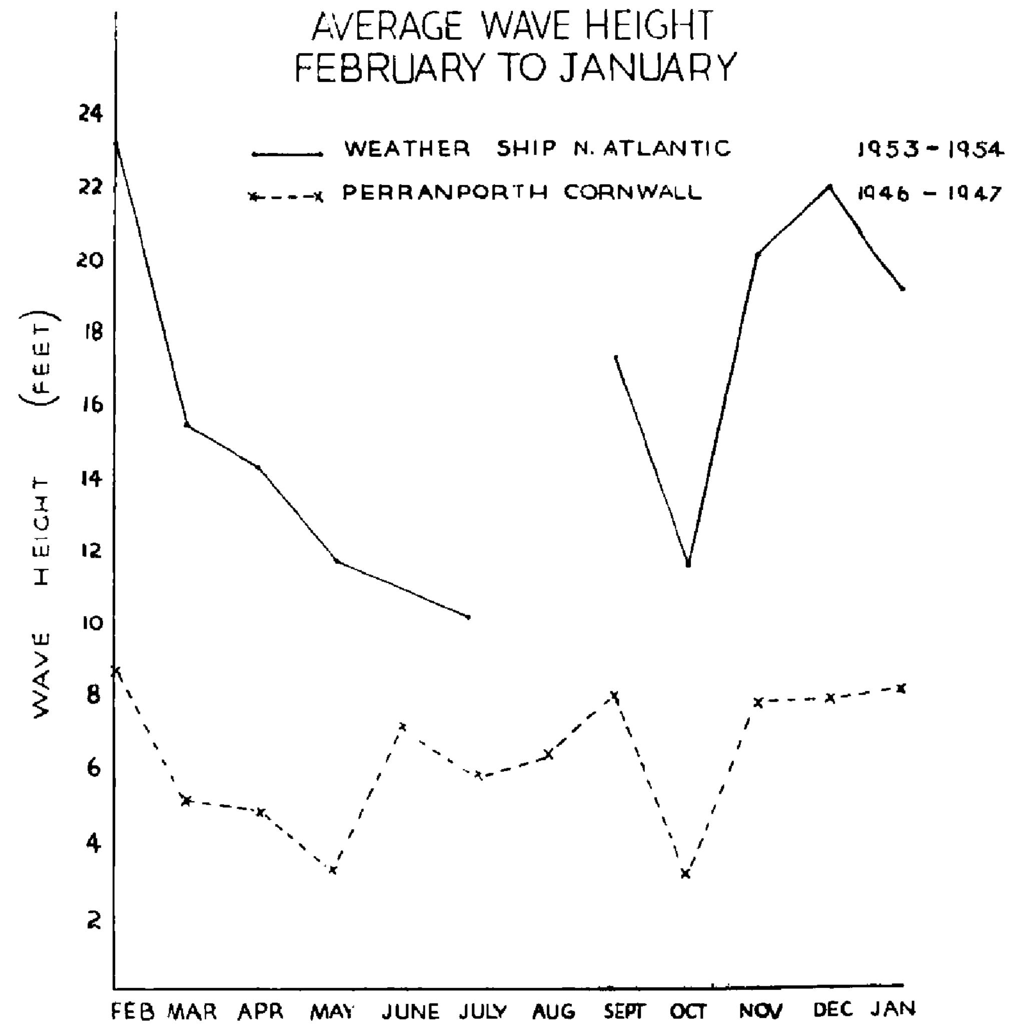

AVERAGE WAVE HEIGHT
FEBRUARY TO JANUARY
WEATHER SHIP N. ATLANTIC 1953 - 1954
PERRANPORTH CORNWALL 1946 - 1947
WAVE HEIGHT (FEET)
24
22
20
18
16
14
12
10
8
6
4
2
FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC JAN

Fig. 3B

the wave period is the mean period of the highest third of the waves on the record examined and is usually called the " significant " wave period. The percentage of time the significant wave period falls into classes of over 15 sec, 13 to 15 sec, 12 to 13 sec, 11 to 12 sec, 10 to 11 sec, 9 to 10 sec, 8 to 9 sec and under 8 sec are given for every month, and also the mean maximum height of the waves which fall into these classes. The percentage is represented by a full line and the mean height by a broken line. Fig. 3A shows the mean maximum wave height for every month for the North Atlantic between February, 1953, and January, 1954, and at Perranporth from February, 1946, to January, 1947. Similarly Fig. 3B shows the mean significant period.

An examination of Fig. 1 shows that the percentage of waves over 20 ft high is much greater in the open Atlantic than in the coastal region where the wave generation is limited to winds blowing from certain directions. Fig. 2 shows that while waves of over 15 sec significant period can be present for 45 per cent of the time for some months at Perranporth, the percentage is never more than 5 per cent for the North Atlantic. Although the two years are not the same it is reasonable to assume that there is some effect, probably that of tidal streams, which makes the process of wave generation less efficient in coastal regions and also may attenuate the shorter lower-period waves as they approach the coast, so that the longer-period waves become predominant.

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TUCKER, M. J. 1952. *Nature*, 170, 657.

Reporting Locust Swarms at Sea

The Meteorological Office has been asked by the Anti-Locust Research Centre, London, and the Desert Locust Survey, which is based on Nairobi, to thank the masters and deck officers of ships which are now providing an increasing number of reports of locust swarms at sea. Such reports, signalled to the Desert Locust Survey, are of immediate value in the direction of locust control operations, particularly in areas, such as parts of Arabia, where it is difficult to secure reliable and timely reports of swarm movements. Furthermore, the corresponding entries in the meteorological logbook (often containing more detailed information, for example, on the behaviour of the locusts) are subsequently extracted at the Marine Branch of the Meteorological Office and passed on to the Anti-Locust Research Centre, and have been found to throw considerable light on the relationship between swarm movements and weather, a question of substantial practical importance. A recent series of ships' reports has, for example, made possible a detailed analysis of the exceptional weather involved in the invasion of the Canary Islands in October last by swarms of which a few stragglers reached the Irish coast and the Scilly Islands two days later. Another ship report of special interest last year was the first recorded radar sighting of a locust swarm, in the northern Persian Gulf in March, which provided evidence of flight in swarm formation in darkness; further observations on this point would be of particular value.

The current desert locust plague is now at its height—last year swarms ranged from the Canary Islands to India and from Tanganyika to Syria and Persia—and the continued co-operation of ships is particularly needed in reporting locusts seen over the Atlantic, Mediterranean, Red Sea, Gulf of Aden, Persian Gulf and Arabian Sea. Ships encountering locusts are asked to report them by radio to DESLOC NAIROBI, through the most convenient coastal radio station, as promptly as possible; the cost of these messages will be borne by the Desert Locust Survey, P.O. Box 5152, Nairobi, Kenya. Reports should include:

(*a*) Date and time (specifying G.M.T. or zone time) when locusts first seen.

(*b*) Latitude and longitude, if possible to nearest minute, where locusts first seen.

(*c*) Time and position at which locusts last seen.

(*d*) Whether dense, thin or scattered swarms; individual fliers; or floating dead locusts, many or few.

(*e*) Colour of locusts (yellow, pink, grey).

(*f*) Wind direction and speed.

Typical messages would read as follows:

12th. 1030 G.M.T., 18° 05'N, 39° 33'E to 1215, 18° 32'N, 39° 18'E. Thin swarm yellow locusts, wind NW, 15 kt.

15th. 2000 G.M.T., 35° 18'N, 14° 54'W to 0730 16th, 35° 50'N, 10° 40'W. Scattered flying red locusts, wind SSW, 20 kt.

7th. 0310 G.M.T., 28° 47'N, 50° 31'E to 0335, 28° 55'N, 50° 27'E. Many floating dead red locusts, wind variable, 5 kt.

Details of such reports or, if it has not been possible to send a radio report, details of the occurrence, should be entered in the "Additional remarks" pages of the meteorological log.

Book Reviews

Sailing: Wind and Current. By Ian Proctor. 8¾ in. × 5¾ in. pp. 199. *Illus.* Adlard Coles Ltd., 1953.

The author's standpoint in writing this book is set out in his Preface—"The ability to understand the behaviour of moving airstreams and currents in water is obviously of vital importance to everyone who wishes to win sailing races"—and his book is addressed to helmsmen having every variety of experience. He achieves this object with considerable success and gives some admirable explanations of tides and currents and waves, for the most part assisted by straightforward and lucid diagrams. He also includes a great deal of sound practical advice on how to utilise these elements to best advantage while actually racing.

The three chapters devoted to meteorological matters are frankly much less successful. While the author was unlucky to publish his book just before changes were made in the boundaries of the forecast districts and in the times of B.B.C. broadcasts, this would not matter for any regular user of the forecasts, who would probably know about the changes already. But there are numerous minor and a few major errors of fact which mar the usefulness of these chapters. For instance, the statement that thunderstorms are nearly always preceded by a sky covered by a thick layer of cirrus cloud sometimes accompanied by cirrostratus is by no means correct, while the statement that if cirrus is drifting from a SW'ly direction it is likely to herald the advent of a depression should surely have referred to a drift from a NW'ly direction. The figures also are rather misleading, e.g. Fig. 56, which suggests that the only region within a depression where rain falls is just north of the centre. (This is not the case, although in many depressions the largest amounts of rain are in fact recorded in that region of a depression.) The cloud types of Fig. 57 are over-simplified.

In a book written in the era of the television weather announcer some reference to fronts and air masses is surely expected, since these ideas have now been part of the stock-in-trade of the amateur meteorologist for about a quarter of a century. Before bringing out a second edition the author would be well advised to rewrite the meteorological chapters in consultation with a qualified meteorologist, since at present the scientific standard in these chapters does not compare with the standard reached in the chapters dealing with waves, tides, currents and other subjects in the remainder of the book.

Some useful information is contained in six appendices at the end of the book, but it would be an advantage to complete the wind table up to force 12, even though it might be advisable to explain that no dinghy should be at sea in any wind in the upper part of the Beaufort scale. The printing of the tidal constants in

Appendix 5 is surely unconventional, since it would not be obvious to a novice at first glance that the figure—5·05 for Tynemouth referred to 5 hours 5 minutes before high water at Dover.

R. F. M. H.

The Mathematical Practitioners of Tudor and Stuart England. By Professor E. G. R. Taylor. $8\frac{3}{4}$ in. × $5\frac{3}{4}$ in. pp. xi + 432. *Illus.* Cambridge University Press, 1954. 55s.

As an introduction to a review of this scholarly and fascinating book one cannot do better than to quote from the Foreword written by the Astronomer Royal.

" Navigation up to and even beyond the sixteenth century was almost entirely a practical art, in which success depended upon experience, sound common sense and good seamanship. The navigator had for his use the compass, the log, and some form of cross-staff; he had to allow as best he could for the strength of the wind and the set of the tide or current, and had to estimate his position by a crude method of dead reckoning. Practically nothing was known about the variation of the compass.

" The education given in English schools was based almost entirely on Latin grammar; little, if any, mathematics was taught, while simple arithmetic, which was considered suitable only for clerks, was entirely neglected.

" . . . There was in fact for long a complete divorce between practice and theory: the seamen were ignorant of mathematics and the mathematicians had no practical experience. . . . This need was supplied in some measure, though inadequately, by the mathematical practitioners of London long before it began to be provided by the universities."

In her Preface the author says: " This book is a chronicle of lesser men—teachers, text-book writers, technicians, craftsmen—but for whom great scientists would always remain sterile in their generation."

Professor Taylor must have put an enormous amount of effort and research into this book, for she manages to give quite lengthy biographical notes of nearly 600 of these " lesser " men and she refers to no less than 628 mathematical works of the period.

The book is divided into three sections: (1) a narrative; (2) biographies of the individuals concerned; and (3) an annotated list of contemporary works.

Professor Taylor is well qualified to talk about this subject, as anybody who has listened to her fascinating lctures at the Institute of Navigation well realises, and this is very evident from the technical details which she gives in the narrative.

The narrative shows that the first original English printed publication on navigation was published in England about 1550. In view of the rudimentary educational methods of the period, one wonders at the skill which these early instrument makers displayed and at the mathematical and geographical knowledge they acquired.

The first navigational school in England seems to have been founded at Christ's Hospital in about 1672, but the primary aim of this was to train teachers, and the author shows something of the extraordinary difficulties this early training school had. There were no navigation schools in England specifically for seamen, but in France and Spain such schools had long been in existence. When one considers the lack of navigational training it says a lot for the courage of the British seaman of this age that he accomplished so much in the way of exploration.

The first " Pilot " of the waters around the British coasts (the English Pilot) was published privately in 1693, for there was no Hydrographic Department in those days.

The book brings out the various methods which were considered for finding longitude prior to the invention of Harrison's chronometer. In the early part of the period dealt with in this book the phenomenon of magnetic variation was discovered, and various possibilities were considered as to how this might be utilised to find a ship's longitude. Some unusual suggestions which are described include a method involving sound ranging on cannon-fire from hulks moored out at sea; the use of powerful lighthouses from which signals could be flashed on to the clouds which would be visible from distances up to 200 miles; and the use of the barometer associated with the rise and fall of the tides in the open ocean.

The author emphasises the strenuous efforts which Samuel Pepys made in an endeavour to improve the navigational education of naval officers. Pepys, during his voyage to Tangiers as a passenger aboard a warship, was impressed, for example, with the scanty knowledge about ocean currents which ships' officers had at that time.

Meteorology naturally finds its place in this book (as in any navigational work), and the author shows that as early as 1677 Robert Hooke, a Fellow of the Royal Society, wrote concerning the barometer: "The observations of the weather may perhaps in great measure be timely enough discovered by the inquisitive and diligent mariner." The earliest British meteorological publication seems to have been *A Discovery of the Secrets of Nature which are found in the Mercurial Weather Glass*, by George Sinclair in 1683.

The author shows that by about 1700, as a result of the work done by these mathematical practitioners, a seaman could purchase such items as azimuth and amplitude compasses, quadrants, cross-staffs, lodestones to retouch their needle and also Mercator's charts and various navigational books.

The numerous biographical notes are particularly fascinating because of the insight they give into the background of these mathematical practitioners' work.

The book contains a number of interesting photographs and includes an index.

There is no doubt that this work of Professor Taylor's will not only prove a valuable book of reference but that it will provide interesting reading to all students of navigation.

C. E. N. F.

Klimatologie der Nordwesteuropaischen Gewasser (Climatology of North-west European Waters), produced under the direction of Professor Dr. Kuhlbrodt. Part 1: *Sea Surface Temperature and Air-Sea Temperature Difference.* By Dr. H. J. Bullig and Dipl. Met. P. Bintig. Part 2: *Wind.* By Dr. H. Markgraf and Dipl. Met. P. Bintig. Einzelveroffentlichungen No. 4. Deutscher Wetterdienst, Seewetteramt, Hamburg, 1954. 7.00 DM.

Parts 1 and 2 of this atlas deal with sea-surface temperature, air-sea temperature difference and wind, while Part 3, to be published separately, will contain information on the distributions of cloud, visibility and precipitation as well as that of air temperature.

As ships' observations are more plentiful in the waters off north-west Europe than in many other parts of the world, it has been possible to compute reliable values of mean sea temperature for 1° squares which have been chosen. The actual values of the means for each square are shown as well as the isotherms. The annual variation of sea-surface temperature is shown diagrammatically for 18 chosen areas.

The maximum and minimum sea temperature values shown are the five percentiles, and isopleths of the range, or the difference between these values, are also shown for four representative months together with the standard deviation. Seasonal charts of air-sea temperature difference are given together with the annual variation for selected areas.

To complete Part 1 charts are given showing the change of mean sea temperature between the periods 1906–13 and 1922–39 for the four seasons for selected areas. This idea of climatic fluctuation is an innovation for such atlases, which it is hoped will be carried further in others.

Part 2 commences with monthly charts of the mean of the Beaufort wind forces for 2° squares, followed by the representation of the frequencies of groups of Beaufort forces for each month for 18 chosen areas: the annual variation of these frequencies is then shown graphically. Monthly charts of wind roses are then shown and these are followed by charts for four months of the year of the predominant wind direction and the direction of the predominant sector of winds for 19 areas: a chart of the annual variation of predominant wind direction for the same 19 areas follows.

Charts of mean monthly wind components for the W–E and N–S directions come next, followed by charts of the direction and speed of the mean vector wind for four months. These charts are followed by ones for four months of the constancy of the wind, defined here as the ratio of the mean vector wind speed to the mean scalar wind speed expressed in tenths. To complete Part 2 the annual variation of the vector wind and the percentage constancies are given for 18 areas.

This atlas is well produced and forms a useful addition to the publications on the meteorology of the area. P. R. B.

The Great Storm. By J. Lennox Kerr. 8 in. × $5\frac{1}{2}$ in. pp. 213. *Illus.* Harrap & Co., Ltd., London, 1954. 12s. 6d.

The villain of this true drama of the seas around the British coast is the weather, and the heroes are numerous seamen and ex-seamen both afloat and ashore. It is the story of the vicious storm which swept across Britain and North-West Europe during the last day of January and the first few days of February, 1953, causing numerous casualties to shipping and catastrophic flooding in the Netherlands and the Fenlands of Eastern England, with consequent loss of life both at sea and ashore.

It is evident from the style and technical standard of this book that the author is himself a seaman. Enquiry showed that Mr. Lennox Kerr had served at sea from 1915 to 1926 both in the R.N.V.R. and in the Merchant Navy.

Mr. Lennox Kerr has contrived with considerable skill to give a graphic and enthralling word-picture of the history and progress of this storm, of how it affected certain ships in particular in the Irish Sea and the North Sea, and of the steps which were taken ashore in an endeavour to save life. The most spectacular case dealt with in this story is that of the British Railway's steamer *Princess Victoria*, which foundered in the Irish Sea *en route* from Stranraer to Larne with a loss of 133 lives. This tragedy is described faithfully and without heroics but with its human touches, and the author manages in a few words to bring before the reader not only a vivid picture of the scene aboard the ship at various stages of her ill-fated voyage, but also the anxieties ashore and enormous efforts which were made by the various authorities and by rescuing vessels as the worsening situation became evident from the radio messages.

The author graphically describes the first casualty of this gale, which was that of the *Clan Macquarrie* on a coastal voyage from Hull to the Clyde. With the gale blowing strongly from the SW her master found it undesirable to proceed through the Minch and sought more sea room outside the Island of Lewis, where a sudden veer of the wind from SW to NW drove her ashore near the village of Borve. After dealing with the loss of the trawler *Michael Griffith* off the Irish coast, Mr. Lennox Kerr then takes the reader into the unbelievable chaos which occurred in the North Sea during this spectacular storm. He describes, amongst others, the adventures which befell the Swedish steamer *Selene*, the trawler *Loch Awe*, the fishing vessel *Coronia* and the tug *Englishman* with a tanker in tow. In each case the author gives us pictures of scenes aboard the vessels concerned and then takes us ashore to see how the staff of the G.P.O. radio station, the coastguards and the voluntary life-saving appliance crews and the lifeboats deal with the various emergencies as they arise. The gale warnings issued by the Meteorological Office through the B.B.C. and G.P.O. coast stations play their part in the scene, and the author shows the uses that these warnings serve on such occasions.

One of the most inspiring descriptions in this book is that of the scenes aboard the Swedish steamer *Selene*, which developed a dangerous list during the early part of the storm due to her deck cargo of timber shifting and her steering gear becoming jammed. The author graphically describes the lengthy ordeal aboard this ship and the ingenious jury rig with which her master eventually managed to bring her safely into harbour.

The book has some excellent photographs. C. E. N. F.

Personalities

OBITUARY.—It is with regret that we record the death, which occurred at the end of December last, of CAPTAIN SIR ROBERT BEAUFIN IRVING, O.B.E., R.D., R.N.R. (Retd.), at the age of 77. Robert Irving was a cadet in the *Conway* in 1891, the present Poet Laureate, Mr. John Masefield, being a fellow cadet. After serving for some years in sailing ships Captain Irving joined the Cunard Line as a Fourth Officer in 1904. He was Chief Officer of the *Lusitania* before the 1914–18 War. As a Lieutenant, R.N.R., he was called up at the outbreak of war and served with the Royal Navy throughout hostilities, being promoted to Commander and awarded the O.B.E. Returning to the Cunard Line in 1919 he was appointed Staff Commander of the *Aquitania*. He later commanded a number of the Company's ships. In September, 1937, he was given command of the *Queen Mary*, and the next year was made a Commodore of the Company. He was created a knight in June, 1943, and retired from the sea in 1944. Captain Irving was a member of the Corps of Voluntary Marine Observers from 1921 to 1939, contributing many excellent logs to the Meteorological Office. C. H. W.

RETIREMENT.—At the end of January this year Mr. A. C. BRAWN retired from the service of the Meteorological Office owing to ill-health.

Alfred Charles Brawn joined the Air Ministry shortly after being demobilised from the Army after the 1914–18 War, in which he had been wounded, and was appointed to the Marine Branch of the Meteorological Office in 1923. At that time ships in the Port of London were visited by an officer from the Marine Branch, which was then in Adastral House, Kingsway, and Mr. Brawn at times assisted in this. When the Port Meteorological Office was opened in 1930 he was appointed there as assistant to the Port Meteorological Officer. During the Second World War the Port Office at London was closed and Mr. Brawn was transferred to the Port Meteorological Office at Liverpool, returning to the London Office when it was reopened in 1945.

During his many years at the Port Meteorological Office Mr. Brawn developed a considerable interest in ships and shipping, and made a number of excellent scrapbooks of press cuttings and photographs of nautical matters.

He will no doubt be remembered for his cheerful and tactful manner by a number of officers of the Merchant Navy, among whom he had many good friends. These officers will no doubt join us in wishing Mr. Brawn a speedy recovery to good health and a happy retirement. C. H. W.

Notices to Marine Observers

International Meteorological Codes

Voluntary observers aboard British ships will now be in possession of the amendments to M.O.509 (*International Meteorological Code—Decode for use of shipping*). These amendments, which came into force on 1st January, 1955, were previously referred to in the October, 1954, and January, 1955, numbers of *The Marine Observer*. A preliminary roneod notice of this Notice was issued in July, 1954, and an Admiralty Notice to Mariners about them has also been issued.

These amendments may look a bit formidable at first glance but it will be found that apart from the change in the specification of " characteristic of barometric tendencies " and the deletion of the group containing the " dewpoint " in the selected shore station reports which are included in radio bulletins for shipping (e.g. the Atlantic Bulletin), most of the changes are of a relatively minor nature.

In other words the International Meteorological Code for use aboard ships, which came into force in 1948 and which all marine observers have now become used to, remains substantially the same.

A new edition of the " Decode " is in the press and will be published shortly.

Weather Reports from Ships in Home Waters

Mention has been made in this journal from time to time of the need for voluntary observing ships to carry out their meteorological observations throughout the voyage as far as is possible. It is realised in the Marine Branch of the Meteorological Office that when a ship is in home waters other matters occupy the attention of the officer of the watch, and that the safety of the ship must be his first consideration. Nevertheless, weather messages from ships in home waters are very valuable, particularly in the central and northern part of the North Sea when outside of 10 miles or so from the coast. Such messages are always much appreciated by the Meteorological Office. It is thought that there may be among ships' officers a belief that weather reports are not needed from ships when within the 100 fathom line, and it has become customary aboard the majority of ships to then cease observing and reporting. This is not desirable. Whenever possible weather observations and reporting should be continued in areas such as the Western Approaches, the Irish Sea and the North Sea. If, however, observations cannot for some reason be coded and transmitted in these areas, it is desirable that they be entered in the meteorological logbook. On the other hand, it may be found practicable to code and transmit a brief weather message without going to the trouble of recording it in the logbook—and such a procedure will be very acceptable. The severe gales round the British coasts during the latter part of 1954 were the cause of several shipping casualties. Investigations which follow such casualties are greatly helped if accurate information of the weather at sea in the vicinity can be obtained either immediately by radio or later on from any ship's meteorological logbook. Conditions at sea, even a few miles from the land, can be very different from those ashore and such observations as wind direction and force, and estimates of the height and period of waves should be noted in the meteorological log, whether the coded messages are sent or not.

As we mentioned in a note in the July, 1954, number, from a series of 50 consecutive meteorological logbooks received from ships and chosen at random, it was found that only two contained observations made east of a line Ushant to Scilly and only one contained observations north of a line Fastnet to Scilly. A single weather report, even if only in the abbreviated form FM 22 (the first six groups) from such relatively open sea areas as the western end of the English Channel or the southern approaches to the Irish Sea could at times be of great usefulness, particularly during very bad weather or when unexpected sudden changes have occurred.

Voluntary observing ships are therefore asked to commence making their observations as soon as is reasonably possible after sailing on their outward voyages and to continue them into home waters on their return voyages whenever navigational circumstances permit.

Marine Observer's Handbook

7th Edition, 1950

(reprinted 1952)

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