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The Marine Observer

*A quarterly journal of Maritime
Meteorology*



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THE MARINE OBSERVER

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prepared by the Marine Division of the
Meteorological Office

Vol. XLV

1975

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*Letters to the Editor, and books for review, should be sent to the Editor, "The Marine Observer,"
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Editorial

The 1974 Test Series between the M.C.C. and Pakistan provided some of the most exciting test cricket we have seen for some years; it was most unfortunate that all the matches were marred by the English weather and consequently each ended in a draw. When play ceased in the second test it was anybody's match and a few more hours without rain could easily have decided not only that match but the series as well. Even those who take only a casual interest in the game will realize that when teams are evenly matched the final result of the match could be determined, before commencement of play, by the toss of a coin and the Captain's decision. This is not to say that spectators, television viewers and radio listeners will be deprived of many hours of pleasure. Before a Captain who wins the toss can make his decision it is essential that he knows the state of the ground and has at least some idea of the weather likely to be experienced within the days of play which are to follow.

Before laying a course on a chart the experienced navigator takes similar care to that of the cricket Captain, his decisions at the time may well have a very real effect on the voyage and can make the difference between a successful and profitable passage or one of adverse weather, making poor speeds and suffering unnecessarily high fuel consumption. It is essential if one is to navigate economically that due regard be paid to the weather forecasts for the area. Professional navigators are only too well aware that many other factors must be taken into account before laying off courses and in these days of modern electronic aids to navigation it is possible to pass closer to unlit hazards during the hours of darkness than we could several decades ago when we were obliged to make more use of the 3 Ls. We are also aware that the opportunity now exists for ships to avoid the worst of the weather when navigating in areas where suitable prognostic charts are available and/or a reliable weather routing service exists. The development of modern electronic aids to navigation, good weather forecasting and weather routing services all contribute to economic navigation and in these competitive days when vessels are navigating at greater speeds and consuming large quantities of expensive fuel it is not sufficient for a Master simply to take his ship safely from one port to another. If his ship is to return maximum profit very great care must be taken in selecting the most suitable route to follow. Like the cricket Captain who knows the state of the ground the shipmaster must be aware of the state of the tide and meteorological conditions.

As a result of much research and many thousands of observations made in major and minor ports and on parts of exposed coastlines tidal constants had been derived and navigators are now in the fortunate position of being able to calculate, with reasonable accuracy, the state of tide at any time in most ports of the world. The work of Hydrographic Services and Tidal Observatories has proved to be invaluable to shipping and prudent navigators who must, of necessity, accept all navigational information with a certain degree of caution and would never consider entering or leaving a port, where draughts are restricted, without consulting tide tables. This is obtaining an appreciation of 'the state of the ground'. The World Meteorological Organization is now encouraging its member countries to extend and improve the meteorological services to shipping but to accomplish further progress and reach a stage where 24-hour forecasts can be considered as near reliable as tidal predictions requires the acquisition of more meteorological data of high quality. When this is accomplished, mariners will have an even better knowledge of the ground.

During the last few years a number of meteorological exercises have been carried out at sea with the principal object of learning more about the state of the atmosphere in parts of the world and the interaction between the atmosphere and the sea surface. Many nations and large numbers of ships have been involved. The Meteorological Office have, on occasions, requested the assistance of ships of the Voluntary Observing Fleet and it has been most gratifying to see the willing response from those at sea. Many ships passing through the tropical Atlantic belt in the summer of last

year agreed to make additional meteorological observations and copy all their 6-hour observations so that they may be added to the vast amount of data obtained in the Atlantic Tropical Experiment of the Global Atmospheric Research Programme, possibly the largest scientific experiment undertaken and employing approximately 40 experimental and research ships; 12 research aircraft from many nations, buoys, satellites and computers were also employed. Meteorologists and oceanographers have been developing and using Ocean Data Acquisition Systems (ODAS) in many forms and the United Kingdom are currently employed in a buoy project with the intention of gleaning more information from the Atlantic. These efforts are to assist in assessing the 'state of the ground' and although being pleased with the part observers at sea have played there is no room for complacency if further progress is to be made.

Observing networks, whether of Land Stations, Voluntary Observing Fleets, Ocean Weather Ships, ODAS or satellites, are of vital importance to weather forecasting services and further efforts by the World Meteorological Organization through the Commission for Marine Meteorology and by individual nations to extend and improve these networks would reap little benefit if world telecommunication services are unable to transmit data from the observing positions to the meteorological centres and, after the processing of data and the production of synoptic and prognostic charts and accompanying forecasts, to be capable of transmitting the detailed information to the user in sufficient time for it to be of real value. We are only too well aware that without the broadcasting and television media many millions of people in the United Kingdom and other parts of the world would be unable to enjoy Test Matches to the extent they do today. The complex telecommunication networks of the world therefore play a role equal in importance to that of the observing networks.

Within the next few years, finances permitting, we may see a number of developments being introduced into the observing and telecommunication networks at sea. Some further changes are bound to be made to the Ocean Weather Station network in the North Atlantic. A number of Voluntary Observing Ships may be fitted with semi-automatic means to display certain principal meteorological elements on the bridge and a further improvement to this system could be the fitting of a 'blackbox' so that the semi-automatic weather observing equipment would have the capability of being interrogated by satellite, thus relieving the Officer of the Watch and the Radio Officer of some of their present duties. The more conventional transmission of observations as we know them at present may be made by satellite to coast radio stations and hopefully some delays in transmissions might be avoided. Although we continue to strive for improvements it is imperative to maintain our well-trying and proved systems as many of the newer and more sophisticated methods are only to supplement those that have existed for years. We are still far from a stage when satellites and high-speed computers can replace the valuable observer at sea and the much needed Radio Officer.

Gentlemen, it is now 1975, cold and wet in the United Kingdom, and still many months from the next Test Series but I have the pleasure of wishing you a Happy New Year, may your voyages be safe and successful.

G.A.W.



January, February, March

The Marine Observers' Log is a quarterly selection of observations of interest and value. The observations are derived from the logbooks of marine observers and from individual manuscripts. Responsibility for each observation rests with the contributor.

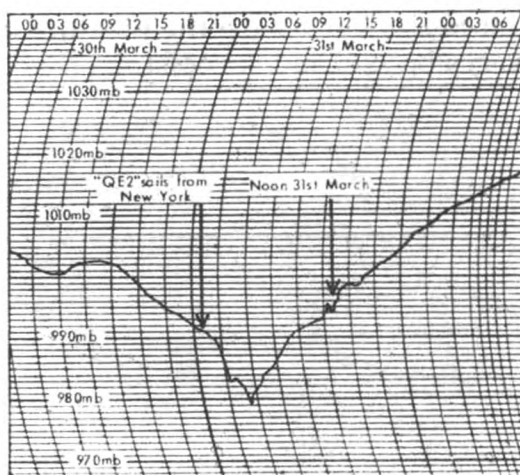
Observing officers are reminded that preserved samples of discoloured water, luminescent water, etc. considerably enhance the value of such an observation. Port Meteorological Officers in the U.K. will supply bottles, preservative and instructions on request.

SEVERE STORM

Western North Atlantic Ocean

R.M.S. *Queen Elizabeth 2*. Captain P. Jackson. New York to Puerto Rico. Observers, the Master, Mr. R. W. Warwick, 1st Officer and Mr. N. B. Bamford, 2nd Officer.

31st March 1974. At 0100 GMT the ship left the berth at New York for a cruise to the West Indies with 1,648 passengers on board. At the time the barometer was falling steadily and a strong wind blowing from ENE. As the ship left the comparative shelter of the harbour and approached the pilot station at Ambrose Tower the wind became gale force NE and was building up a big sea and swell. Under the circumstances it was impossible to disembark the New York pilot. As the ship steamed on a SSE'ly course the barometer fell rapidly, the wind veered to East and increased to force 10 with frequent heavy rain, which reduced visibility at times. Course was altered 30 deg. to port to ease the ship's motion.

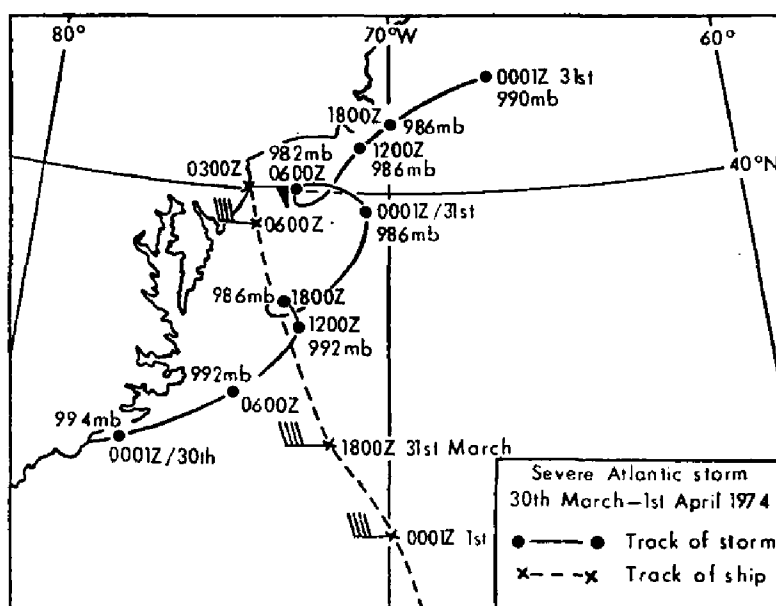


At 0500 during a violent rain squall the wind veered rapidly to sw and the barometer started to rise in the traditional manner associated with passing the centre of a depression. Gale force winds and high seas continued until about 0700, at which time the wind veered steadily to the NW and all conditions of wind, sea and swell moderated very quickly.

Twelve hours later, the ship having resumed course for Puerto Rico, and steaming at 26 knots, the weather conditions had changed to flat calm with a brilliantly clear, cloudless sky.

It was in these latter, perfect conditions, that the *Queen Elizabeth 2* came to a complete stop with oil contamination in all boilers and the subsequent story of how all passengers were safely transferred to the cruise ship *Sea Venture* in the open sea was reported by news media all over the world. Fortunately the excellent weather conditions held in our favour during the whole operation, the barometer remaining high with variable light winds, and the transfer of passengers and more than three thousand pieces of baggage was accomplished without accident or injury to any passenger.

Position of ship at 0600: 39° 18'N, 73° 48'W.



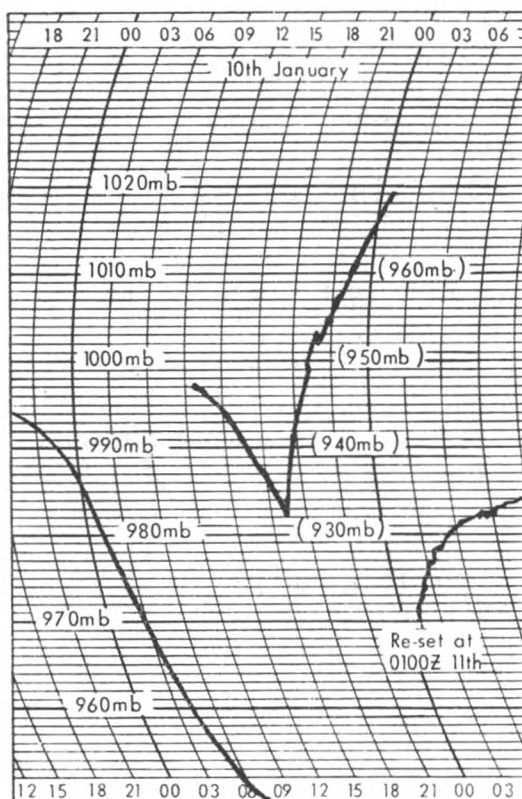
Note. The oceanic track of the depression which affected the *Queen Elizabeth 2* is shown on the accompanying diagram. By the time the storm was performing its second loop it had become almost elliptical in shape with sharp troughs to the east and west. The passage of the western trough at about 0500 accounts for the sharp change from storm force E'ly to gale force sw'ly and later w'ly winds. The sharpness of the trough is clearly indicated on the ship's barograph trace.

North Atlantic Ocean

s.s. *Atlantic Conveyor*. Captain B. O'Brien. Greenock to Halifax. Observers, the Master and ship's company.

9th-11th January 1974. We had received advanced warning of this storm from weather maps transmitted from Bracknell and reports received by the Radio Officer. By the morning of the 9th the sea was already rough, the wind sw'ly, force 6-7 and pressure slowly rising from 988 mb. The vessel was pitching heavily and taking light water for'ard.

At 1128 GMT on the 9th speed was reduced to 50 r.p.m. and course altered to 300°T to effect repairs on the starboard anchor pocket which had been holed by the anchor in the heavy pitching.



By 1800 the pressure began to fall and during the next 21 hours it fell by 62 mb to 932 mb. Wind w'ly, force 6. Sea and swell were still rough and the vessel continued to ship water for'ard, but more frequently. Visibility was good.

By 2359 the wind had backed to ssw and increased to force 7-8. Air temp. was 6.5°C and did not vary more than 2 degc throughout the storm. By now the vessel was back on course 254°T and making 80 r.p.m. The sea was rough with a heavy w'ly swell and frequent moderate rain showers reduced visibility to a few miles.

In the early hours of the 10th the wind continued to back through south to ESE, force 8 until at 0520 it veered to wsw, force 10 in 55 min. Meanwhile at 0330 the stabilizing fins had been extended to ease the rolling; although we were turning 95 r.p.m. (19 kt) we were only making 15 kt due to the very rough seas.

At 0920 speed was reduced to 90 r.p.m. and the vessel brought round to course 280°T to ease the pitching.

At 1500 the wind veered from sw'ly to w's and increased to force 11 by 2000.

At 1600 the pressure reached its lowest point and had to be reset higher up the scale to show the full extent of the reduction. In the weather reports additional groups 99PPP had to be used to show the tendency.

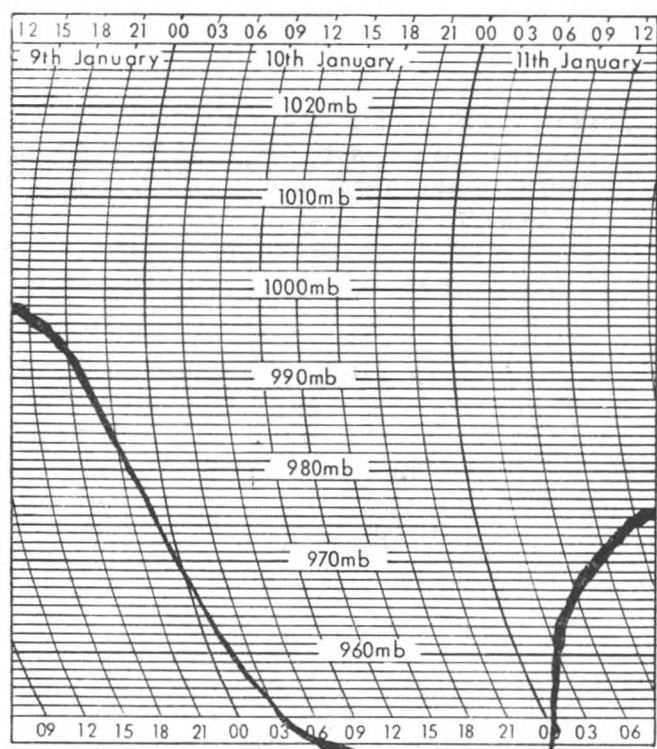
Between 1555 and 2115 course was altered from 260°T to 180°T, then back to 220°T to reduce heavy pitching and possible damage to the vessel. Throughout the night the wind was force 11, veering to the NW at 1600 and remaining thus as the depression passed north of the vessel.

As the pressure rose steadily the wind strength died down until by 1200 on the 11th it was w'ly, force 5. The vessel resumed course for Nova Scotia unscathed but for the damaged anchor pocket and the loss of the for'ard anchor light which had been carried away during the storm.

Position of ship on the 10th at 1800: 54° 54'N, 23° 48'W.

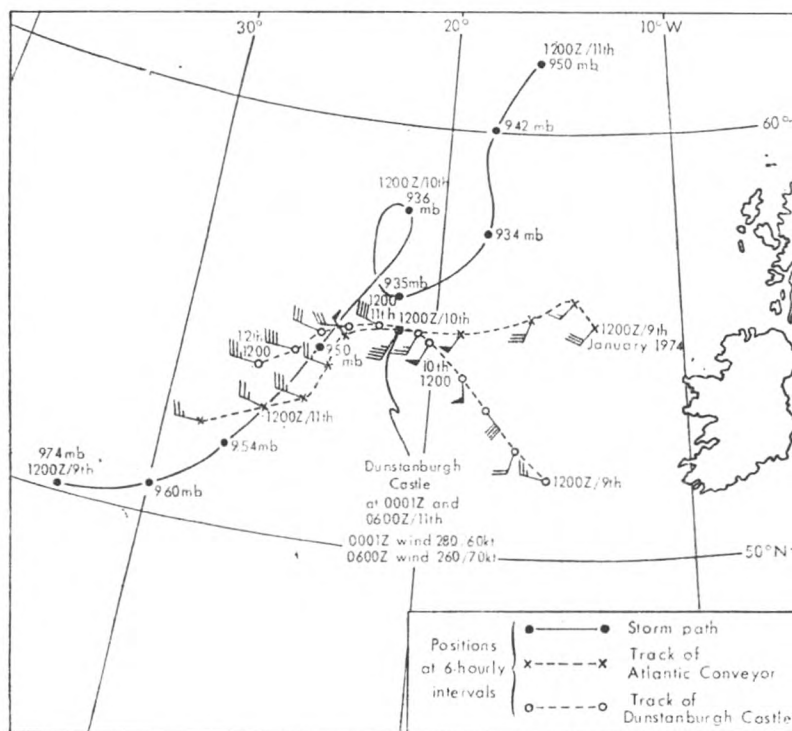
m.v. *Dunstanburgh Castle*. Captain J. MacVean. Rotterdam to Seven Islands. Observers, the Master, Mr. K. Henderson, 3rd Officer and ship's company.

9th-11th January 1974. During this period whilst on ballast passage across the North Atlantic, the vessel encountered a storm centre forecast as 934.0 mb. On 9th



January at 1600 GMT, the pressure at 996 mb started to fall rapidly and by 0001 on the 10th it had fallen 27 mb. At 0800 on the 10th, the needle of the barograph had left the bottom of the drum and by 1000 it was noticed that the needle was resting on the base of the instrument and the barometer was still falling rapidly. At 1600 the barometer levelled off at 938.4 mb and started to increase rapidly, the needle of the barograph returning to the drum at 2330. The vessel experienced gale force w'ly winds throughout, becoming w'ly force 11-12 between 2000 on the 10th and 1000 on the 11th. The barometer eventually levelled off at 976 mb on the 11th at 1330. I have enclosed a photograph of the barograph in a state of depression at 1200 on the 10th (between pages 16-17) and the barograph sheet for the relevant period.

Position of ship at 0001 on the 10th: $53^{\circ} 30'N$, $17^{\circ} 48'W$.

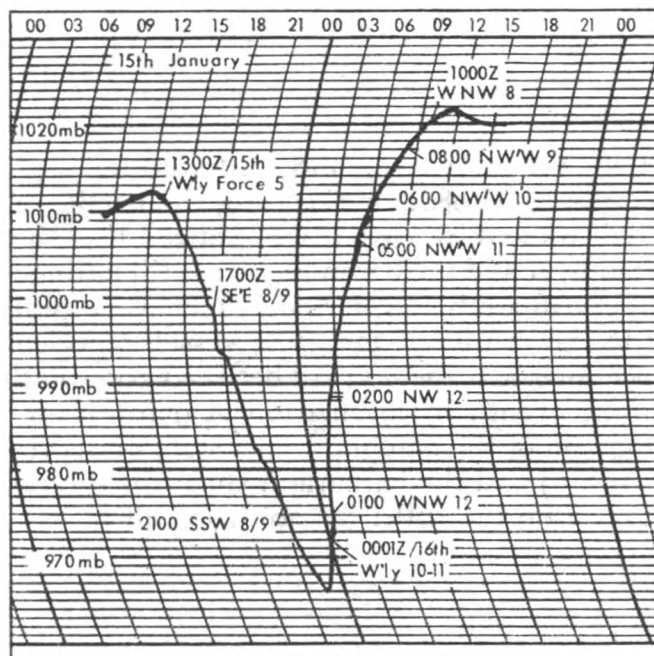


Note. The *Atlantic Conveyor* and *Dunstanburgh Castle* encountered a particularly deep depression; not many central pressures fall below 940 mb. The tracks of both vessels and the path of the storm are shown on the accompanying chart. The very low pressure is not the only unusual feature of this storm. On turning NE, the speed of the storm increased from about 20 kt to over 30 kt and it maintained this speed even while undergoing further deepening whereas most depressions slow down as they turn 'left' and deepen. Another unusual feature is the loop performed during the 10th.

North Atlantic Ocean

m.v. *Tacoma City*. Captain D. C. Griffith-Jones. Flushing to Baltimore. Observers, the Master and Mr. B. T. Hernaman, 3rd Officer.

15th–16th January 1974. The following observations were taken from the vessel's Deck Log whilst on light passage, fully ballasted. Barometer readings were taken from a Precision Aneroid Barometer, height 15.9 m, correction applied +2.0 mb.



15th January

GMT

- 1300: Wind w'ly, force 5. Air temp. 9.8°C. Pressure 1014.7 mb. Course 240°T. Vessel rolling and pitching heavily at times in moderate to rough seas. Heavy swell from the west. Sky overcast and clear.
- 1700: Wind SE'E, force 8–9. Air temp. 9.2°. Pressure 1002.2 mb. Course 240°T. Very rough seas and heavy swell. Vessel rolling moderately and pitching very heavily. Sky overcast with rain. Spraying overall.
- 2100: Wind ssw, force 8–9. Air temp. 8.0°. Pressure 975.3 mb. Course 250°T. Very rough seas, heavy swell. Vessel rolling and pitching. Shipping water overall. Cloudy, overcast and showers.
- 2148: Stopped engines. Engine-room requirements.
- 2200: Pressure 970.7 mb.
- 2248: Pressure 968.6 mb. Resumed full speed. Vessel rolling and pitching very heavily in mountainous seas and swell. Spraying heavily overall. Water on deck. Overcast with fierce rain squalls. Poor visibility.
- 2400: Wind w'ly, force 10–11. Vessel hove to on Master's orders.

16th January

0100: Wind WNW, force 12. Air temp. 6.8° . Pressure 987.0 mb. Vessel hove to under Master's orders.

0200: Wind NW, force 12. Pressure 993.7 mb.

0300: Wind NW, force 12. Pressure 996.3 mb. Mountainous seas and swell. Vessel rolling and pitching very heavily. Spraying heavily. Vessel still hove to under Master's orders.

0400: Wind NW, force 12. Pressure 1003.5 mb. Vessel hove to.

0500: Wind NW'w, force 11. Pressure 1008.9 mb. Vessel hove to.

0600: Wind NW'w, force 10. Air temp. 6.6° . Pressure 1013.3 mb. Partly cloudy and clear. Vessel hove to under Master's orders.

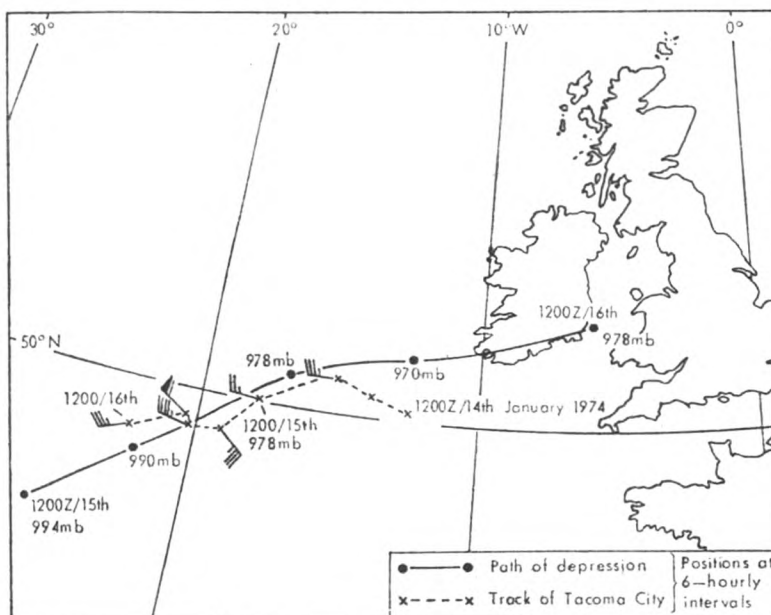
0700: Wind NW'w, force 10. Pressure 1016.0 mb. Vessel hove to. Very rough seas and heavy swell. Vessel rolling violently at times and pitching heavily.

0800: Wind NW'w, force 9. Pressure 1019.2 mb. Course 285° T. Spraying over-all. Water over decks.

0900: Wind NW'w, force 8-9. Pressure 1021.1 mb.

1000: Wind WNW, force 8. Air temp. 8.0° . Pressure 1022.8 mb. Course 285° T. Cloudy, fine and clear.

Position of ship at 1200 on the 15th: $50^{\circ} 00'N$, $18^{\circ} 00'W$.



Note. The *Tacoma City* encountered a vigorous depression which was not only moving rapidly towards the ship, but was also deepening (see chart). The sharp trough shown on the accompanying barograph trace is the result of these two factors: during the 12-hour period following 1800 on the 15th the average speed of the depression was over 35 kt. After the passage of the storm, during the period of storm force 10 or stronger winds, the ship reported wave heights in excess of 12 m. It should be noted that the 0001 observation from the ship (pressure 973 mb and rising) was not received at Bracknell.

COLD FRONT

North Atlantic Ocean

m.v. *Booker Venture*. Captain C. H. J. Allister. London to St. Vincent, Cap Vert Isles. Observer, Mr. S. Monk, Chief Officer.

4th January 1974. At 1715 GMT the vessel passed through a cold front. On the approach of the front, the wind increased from ssw, force 7 to ssw, force 9-10 with such torrential rain that visibility was reduced to zero; spray also being a major

contributor to this. At the front, the wind veered sharply to the west but maintained its force of 9–10. The pressure rose sharply by 2 mb; air temp. dropped from 12.7°C to 10° . Once the vessel was through the front which was visible on the radar lying NE–SW, the wind moderated to w'ly, force 3–4, pressure continued to rise, the temperature rose to 11° and visibility increased to approx. 5 miles. Layer-type cloud, occasional light showers.

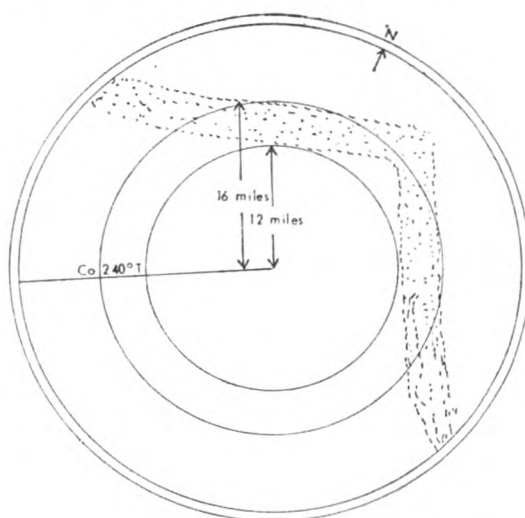
Position of ship: $43^{\circ} 28' \text{N}$, $13^{\circ} 36' \text{W}$.

Note. The unusually strong winds encountered by the *Booker Venture* several hundred miles from the depression centre, are accounted for by a wave on the front which moved NNE at about 45 kt.

North Atlantic Ocean

m.v. *Dart America*. Captain M. J. Butler. Southampton to Halifax. Observers, the Master and Mr. C. E. Walford, 2nd Officer.

28th January 1974. Between 1730 and 1755 GMT an unusual and very distinct echo of two bands of precipitation was observed on the 24-mile range of the ship's radar. The two bands were almost at right angles to one another and were moving in a general E'ly direction (see sketch). As the ship passed through the first band which



appeared on the screen bearing $150^{\circ}/340^{\circ}\text{T}$, the wind veered to SW'W and a period of moderate rain lasting some 5 min occurred. After the rain had ceased, signs of a clearance were observed with breaks in the low cloud logged as C_L7 . After another few minutes, the second band of precipitation $070^{\circ}/250^{\circ}\text{T}$ was encountered. This time the precipitation was much heavier and consisted of rain and hail, again lasting only a few minutes. About 15 min after the passing of this band at about 1810, the low cloud gave way to medium and high cloud with patches of clear sky and the wind veered sharply to WNW, force 11 with the pressure beginning to rise. Reference to the facsimile maps for the time indicated that the centre of the depression through which the ship was passing was well to the north and the main fronts in the storm were indicated in a different position to the ship at that time. It was therefore assumed that the radar picture showed perhaps two minor fronts forming part of a secondary low within the main circulation of the depression. Pressure 1002.0 mb steady. Wind SW'ly, force 11 (at 1730). Course 240°T at 5 kt. Vessel in very heavy weather.

Position of ship at 1800: $42^{\circ} 54' \text{N}$, $39^{\circ} 30' \text{W}$.

Note. Though the parent depression passed eastwards well to the north of the *Dart America*, its cold front, trailing to the south-west, passed through the ship's position at about 1800. From the configuration of the precipitation echo on the radar and from earlier observations made by the ship, it would appear that what was observed on the radar was the tip of an incipient wave which moved rapidly ENE along the front.

WATERSPOUT

North Atlantic Ocean

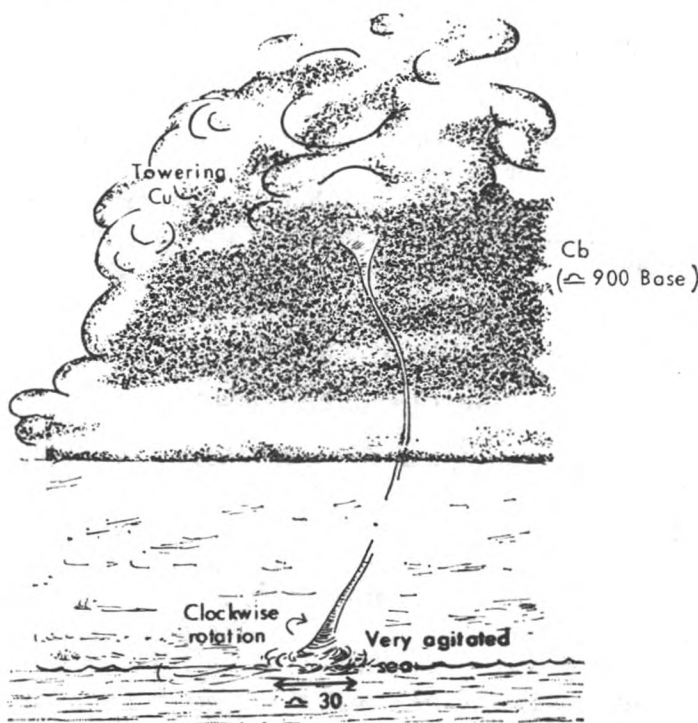
m.v. *Port Alfred*. Captain G. D. Williams. Liverpool to Cape Town. Observers, the Master and Mr. R. Hamilton, 3rd Officer.

26th March 1974. At 1030 GMT, a waterspout was sighted close on the starboard beam and the relevant weather conditions were as follows: from favourable conditions two hours earlier with small Cu and Ac covering $\frac{3}{8}$ of the sky, the clouds had become considerably more developed with Cb, towering Cu and Ac spreading out of Cu, now covering $\frac{5}{8}$ of the sky. The wind had remained steady ssw'ly, force 3-4. Occasional squalls were encountered about 4 hours earlier and visible evidence showed that these were still in the vicinity as rain could be seen falling from Cb clouds beyond 3 miles from the ship. The pressure was 1008.2 mb, rising steadily. There was a slight sea running and a confused but predominantly moderate, long NW'ly swell with the ship rolling easily.

The first indication of a waterspout was the agitated sea and swirling spray (no rushing wind heard) about 8 cables from the ship visible to a height of approx. 30.5 m, the lower 'spout' was about 9 m in diameter and appeared to be rotating clockwise as seen from above. The top of the spout was a funnel shape, whitish in colour stemming from the dark grey base about 274.3 m of a Cb cloud without anvil; surrounding this cloud were white towering Cu clouds again without anvil. On passing the base of the spout, the wind increased slightly in strength from force 2-3 to force 4 and veered from s to ssw. The narrow column tapered soon after leaving the cloud base and was 'bent' ESE before bending back again; there appeared to be a break before this column joined with the uplifted sea spray.

The waterspout was lost to sight astern of the ship 10 min after the first sighting. Air temp. 16.1°C, wet bulb 14.5°, sea 15.9°. Course 199°T at 16 kt.

Position of ship: 34° 18'N, 13° 24'W.

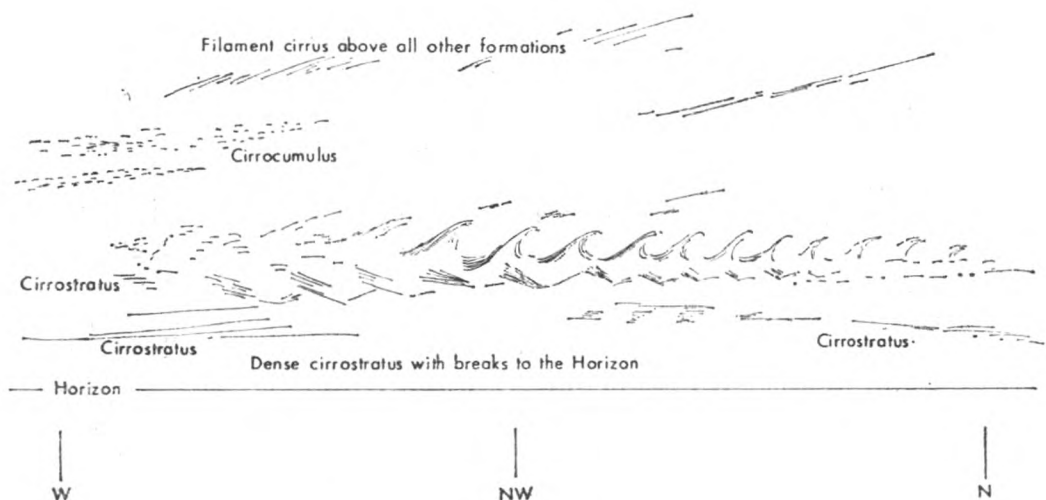


UNUSUAL CLOUD FORMATION

South Atlantic Ocean

R.R.S. *John Biscoe*. Captain E. M. S. Phelps. South Georgia to Buenos Aires. Observers, Mr. D. J. Bray, 2nd Officer, Mr. C. Christiansen, Radio Officer and Mr. B. Jones, A.B.

15th January 1974. At 1700 GMT, an unusual high cloud formation was observed consisting of Cirrostratus, dense Cirrostratus, Cirrocumulus and Cirrus. At the time there was no low or medium cloud present. The wave-like formation (see sketch) was first observed in a bank of dense Cirrostratus and developed into the state shown in the sketch by about 1730. The individual waves rapidly isolated themselves and disintegrated into filament Cirrus by about 1750 becoming Cirrostratus and dense Cirrostratus of the original cloud bank. This bank of cloud lay in approx. NNE-SSW direction, the axes of the individual waves running at right angles



to it. Above the bank of Cirrostratus just described lay small patches of Cirrocumulus and, further above, filament Cirrus. Further to the NW lay more banks of Cirrostratus, with breaks. Air temp. 9.0°C , wet bulb 7.0° , sea 8.2° . Pressure 998.4 mb. Wind NW'ly, force 7. Course 321°T at 10 kt.

Position of ship: $49^{\circ} 07'\text{S}$, $42^{\circ} 45'\text{W}$.

Note. The photographs illustrate Billow Clouds. Such clouds may develop at the surface separating two dissimilar air layers having different velocities. Rolls of cloud form on axes normal to the relative direction of movement.

Suitable conditions for the formation of Billow Clouds are found occasionally in the vicinity of jet streams, and, although it is unlikely in this case, topographical features may also induce their development.

ROLL CLOUD

North Pacific Ocean

m.v. *Prince Rupert City*. Captain J. S. Murray. Panama to Tokyo Bay. Observers, the Master, Mr. W. D. Howell, 2nd Officer and Mr. G. Thomas, Radio Officer.

14th March 1974. At 0425 GMT (1525 SMT), while the vessel was steering a course of 288°T the line of low cloud shown in the photograph between pages 16-17 was observed stretching from horizon to horizon. The cloud edge was orientated $045^{\circ}/225^{\circ}\text{T}$.

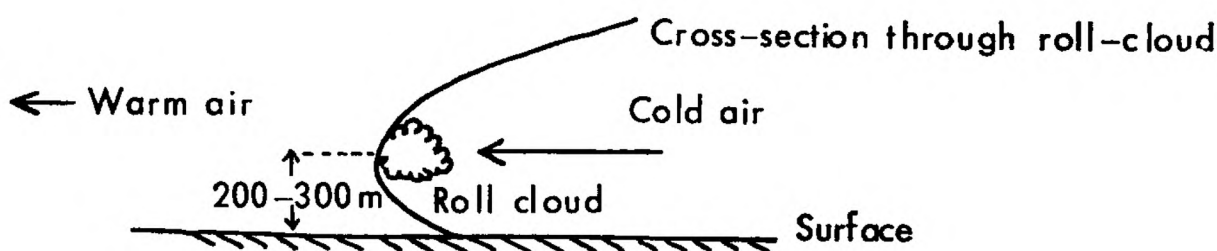
Prior to reaching the cloud edge, the sky was $4/8$ covered by semi-transparent *Alto*cumulus and the wind was SW'ly force 3, the air temperature being 21.3°C .

Within 20 min of the passage of the front, the wind had veered to NW'N remaining at force 3 but apparently increasing slightly. The air temperature was observed to have fallen to 19.0° .

No obvious change was observed on the barograph, the pressure beginning to rise about an hour previously and maintaining a steady rise throughout.

Position of ship: $28^{\circ} 06'\text{N}$, $164^{\circ} 20'\text{E}$.

Note. The photograph between pages 16-17 shows a good example of roll cloud. This cloud formation is normally associated with more vigorous cold fronts and line squalls, when the



passage of the roll cloud is almost immediately followed by a squall and heavy rain. The atmospheric conditions leading to the formation of this type of cloud are shown in the accompanying diagram.

The cold air, moving more quickly and being more dense, attempts to undercut the warm air ahead of the front. However, friction slows up the cold air near the surface so that the vertical profile of the leading edge of the cold air takes on the shape of a nose, as indicated in the diagram. The nose itself is a turbulent region where there is sufficient vertical motion to form cloud; this cloud is commonly observed to roll over on itself.

In this particular case the roll cloud appears to be associated with a weak cold front in which only the near-surface discontinuity remains.

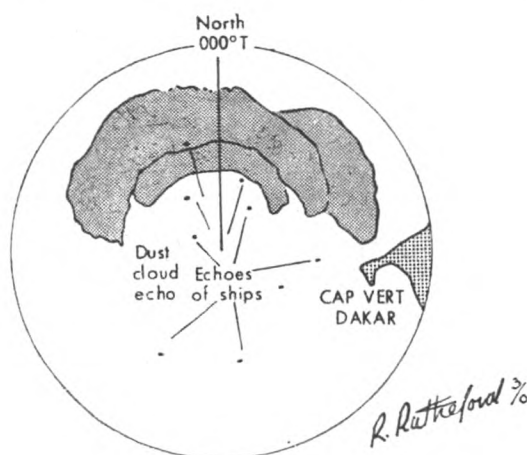
DUST HAZE

North Atlantic Ocean

m.v. *Bamburgh Castle*. Captain D. A. B. Walker. Monrovia to Glasgow. Observer, Mr. R. Rutherford, 3rd Officer.

25th–26th January 1974. During this period repeated echoes of a dust cloud on the radar screen showed up like a coastline, the 'land' appearing to be seven miles deep. Air temp. 23.8°C, wet bulb 24.1°, sea 22.8°. Pressure 1010.6 mb. Wind NNE'ly, force 3 increasing to force 5 on approaching dust.

Position of ship at 1200 on the 25th: 14° 54'N, 18° 00'W.



m.v. *Troll Park*. Captain H. MacDonald. Emden to Jacksonville, Florida. Observers, Mr. E. W. Lauritsen, 2nd Officer and Mr. K. Cassidy, 3rd Officer.

15th February 1974. At 0600 GMT very fine dust particles were observed over a period of about 12 hours, the nearest land mass being 1,700 miles due west. Winds had been predominantly w'ly for 4 days, at the time of this observation the wind was E's, force 2. The type of dust could not be determined.

Position of ship at 0600: 35° 00'N, 47° 30'W.

Note. The observation of sand and dust off the coast of French West Africa is most uncommon during the winter months. Close in to the coast the dust clouds are sufficiently thick to give a 'hard' radar echo, as in the *Bamburgh Castle* report, and they have sometimes been seen on satellite pictures. These dust clouds normally disperse within a few hundred miles of the

coast, but the *Troll Park* report shows that dust may remain in suspension for distances beyond 2,000 miles from the west coast of North Africa. The occurrence of dust in the latter report coincides with a change to E'ly winds on the 14th February. The trajectory of this dust-laden air indicates that it travelled westwards from the Senegal region around the southern side of the subtropical anticyclone, probably having taken about 2 weeks to reach the *Troll Park* position. It is therefore conceivable that the officers of the *Troll Park*, in mid-Atlantic, observed the remnants of the particularly dense cloud of dust reported by the *Bamburgh Castle*.

SEA TEMPERATURES

South Indian Ocean

s.s. *Jervis Bay*. Captain M. R. Ryan, O.B.E. Cape Town to Sydney. Observer, Mr. D. P. Venning, 2nd Officer.

3rd-4th January 1974. Whilst on passage across the Southern Indian Ocean, some interesting sea temperature variations were observed.

	POSITION	TIME (GMT)	SHIP'S COURSE (T)	SEA TEMP. (°C)
3rd January	40° 23'S, 47° 16'E	1700	104	19.5
	40° 42'S, 48° 57'E	2100	103	17.9
4th January	40° 55'S, 50° 38'E	0001	103	12.2
	41° 12'S, 52° 26'E	0400	102	12.2
	41° 21'S, 53° 20'E	0600	102	16.1
	41° 34'S, 54° 13'E	0800	096	16.9
	41° 42'S, 55° 59'E	1200	096	17.6

Note. Large variations in sea surface temperatures of the type described in the *Jervis Bay* report are not uncommon in this part of the South Indian Ocean. They are chiefly attributed to oscillations in the Southern Ocean Current, northward reaching meanders bringing cold water to lower latitudes.

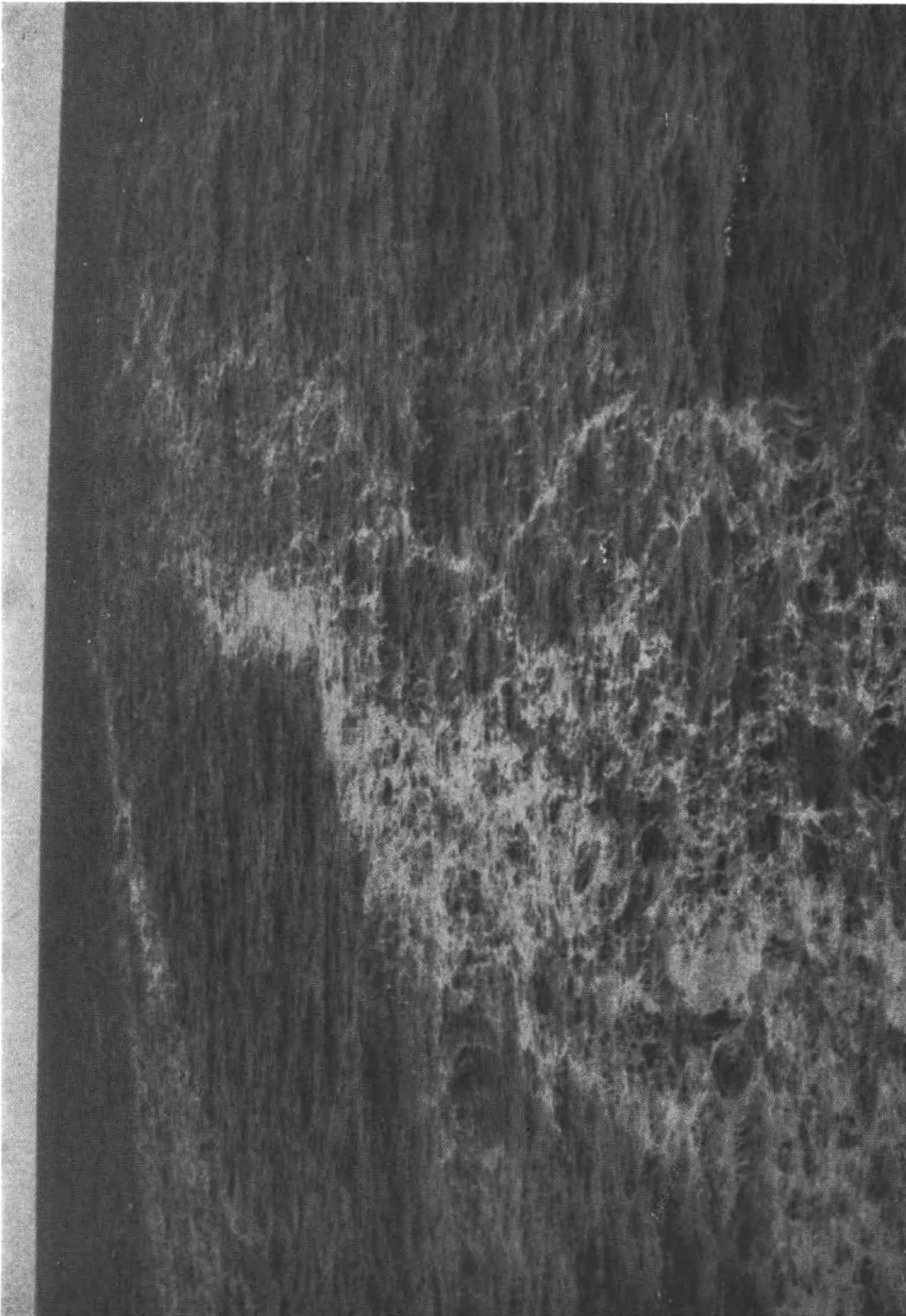
DISCOLOURED WATER

South China Sea

m.v. *Trebartha*. Captain J. W. Cole. Bangkok to Singapore. Observers, the Master and ship's company.

19th March 1974. At 0600 GMT, dense patches of plankton were observed lying along the direction of the wind, the weight of it stopping most waves from breaking. The direction of the main axis of the patch was 115° to 295° and it was approx. 6 miles in length and 3 miles in breadth. To the east of the vessel the patch took on a definite circular form. Also when further denser patches were disturbed by the vessel's passage, a strong smell of rotting fish was detected. The patch had the appearance of very muddy water and could be seen to be several metres deep in places. Samples were taken but as there is no viewing device on board, I am unable to give you a full description. No other marine life was observed in the area. The attached photograph (see opposite page) was taken earlier by the Master while the vessel was on the Indian Coast and shows an almost identical substance to that seen at this observation. Air temp. 28.0°C, wet bulb 25.3°, sea 27.2°. Pressure 1011.3 mb. Wind ESE, force 3. Course 159°T at 13 kt.

Position of ship at 0600: 8° 06'N, 102° 36'E.



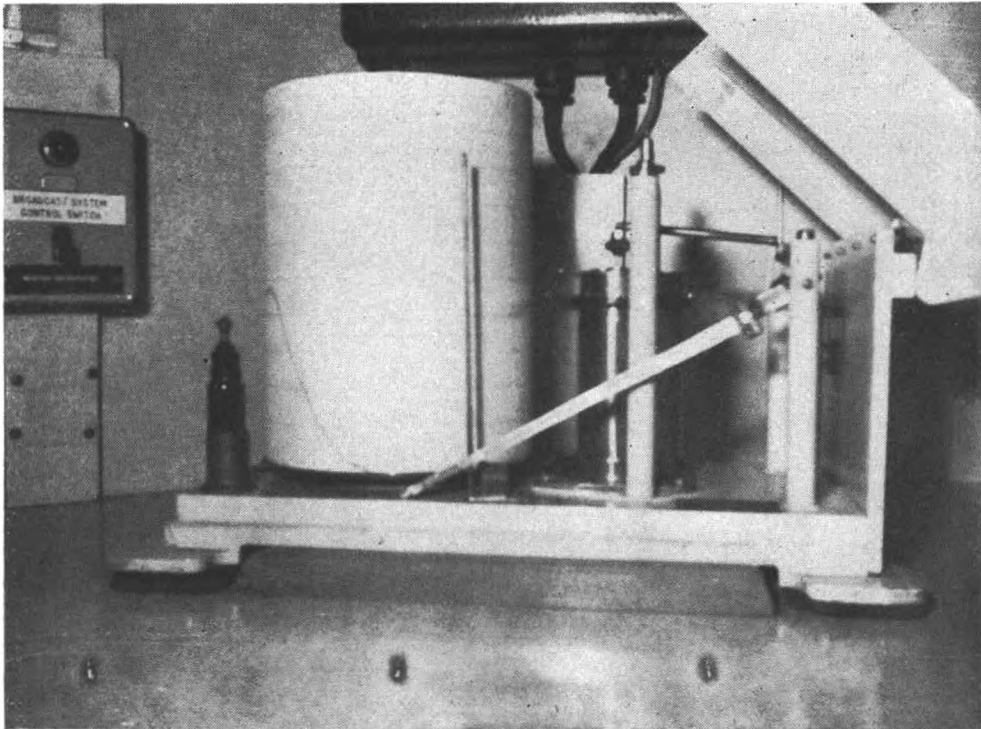
Discoloured water photographed from m.v. *Trebartha* off the Indian Coast (see page 16).



Billow cloud photographed from R.R.S. *John Biscoe* (see page 14).



Billow cloud photographed from R.R.S. *John Biscoe* (see page 14).



The barograph of m.v. *Dunstanburgh Castle* 'in a state of depression' at 1200 GMT on 10th January 1974 (see page 9).



Roll cloud seen from m.v. *Prince Rupert City* on 14th March 1974 (see page 14)

(Opposite page 17)



The presentation of barographs at Bracknell on 16th May 1974; left to right: Dr. B. J. Mason, C.B., F.R.S., Captain and Mrs. J. E. Askew and Captain W. MacVicar, M.B.E. (see page 39).

RADAR ECHO

Indian Ocean

s.s. *Liverpool Bay*. Captain J. Bentley. Port Kelang to Southampton. Observers, the Master, Mr. C. E. Woodward, Chief Officer and Mr. A. Murphy, Cadet.

14th March 1974. At 1500 GMT the vessel passed through a 'hard' line radar echo like approaching cliffs, through which only the wind changed visually. It was first observed at 17 miles range (25-mile range true-motion setting) with the echo roughly NNE/SSW and hardly moving. It was seen about 15 miles in length across the course line. Just before crossing the line 4 whales were observed heading northwards and half a mile west a small school of dolphins appeared. Weather was as follows:

GMT

1330: Air temp. 27.2°C , wet bulb 24.6° , sea 28.5° . Pressure 1009.4 mb. Wind N'E, force 7. Cloud, $\frac{1}{8}$ C_L1, $\frac{3}{8}$ C_H2.

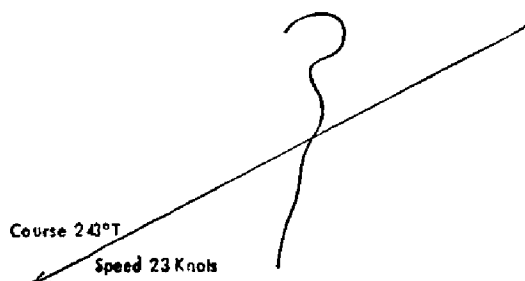
1400: Air temp. 27.2° , wet bulb 24.5° , sea 28.0° . Pressure 1009.5 mb. Wind N'E, force 6. Cloud, $\frac{5}{8}$ C_H8.

1500: Air temp. 26.6° , wet bulb 24.0° , sea 28.0° . Pressure 1009.8 mb. Wind NNE, force 6, variable, decreasing rapidly to force 4. Cloud $\frac{1}{8}$ C_H5, $\frac{5}{8}$ C_H1.

1530: Air temp. 26.1° , wet bulb 23.8° , sea 28.0° . Pressure 1009.9 mb. Wind wsw, force 3. Cloud $\frac{1}{8}$ C_L5, $\frac{5}{8}$ C_H1.

1600: Air temp. 25.9° , wet bulb 23.7° , sea 28.0° . Pressure 1010.0 mb. Wind sw's, force 4. Cloud $\frac{3}{8}$ C_L5, $\frac{3}{8}$ C_M7.

Position of ship at 1500: $33^{\circ} 23'S$, $29^{\circ} 38'E$.



Note. The radar observation is clearly associated with the wind change which occurred at about 1500. The cloud details given suggest that the echo was not cloud. It is more likely that the echo was from the sea surface where the wind discontinuity would show a change in the wave pattern, especially since the sw'ly winds would be opposing the Agulhas Current. The wind change itself may have been due to a slow-moving, weak cold front.

WHALES

Western Mediterranean

s.s. *Botany Bay*. Captain R. A. Wilson. Fremantle to Genoa. Observer, Mr. P. J. Sizer, Cadet.

5th January 1974. At 0615 GMT the vessel shuddered and veered momentarily to starboard. It was observed that the ship's speed dropped slightly, the ship's vibrations increased and the wake widened noticeably. The 1st Officer went forward and subsequently reported that a large whale was caught across the bow, tail on the port side, below the waterline. At 0725 the Master ordered a reduction in speed hoping that it was this preventing the whale's escape. When the vessel had reduced to about 11 kt the helm was put hard over to starboard and then hard over to port in an attempt to shake the whale off. As this was unsuccessful, at 0746 the engines

were stopped and then put astern. The whale came off the bow after about 5 min and drifted away to the south. The lack of movement suggested that the whale was dead or stunned and the oil on the surface of the water and the overpowering smell suggested the former. The whale was estimated to be 10–13 m long and had a white stomach and bluish black back. Course 069°T.

Position of ship at 0600: 37° 52'N, 0° 30'E.

Weddell Sea

R.R.S. *Shackleton*. Captain G. H. Selby-Smith. Port Stanley to South Georgia. Observers, the Master, Mr. R. A. Graham, 2nd Officer, Mr. P. Coombs, 3rd Officer and ship's company.

27th February 1974. As the ship approached the Caird coast from the north-west, the first of many whales was sighted approx. 30 miles from the ice shelf. As we closed the coast the number and frequency of the sightings grew more numerous with anything up to 20 or more whales in sight at any one time. At noon the vessel was manoeuvring through open pack-ice 4 miles from the ice shelf (extended to the westward of chartered position as fixed by satellite navigation) and whales were still being sighted amongst the floes, often at distances as little as 60 m from the ship, although their numbers decreased while the ship was in ice. From noon the ship steamed westward along the 73rd Parallel skirting close pack-ice and the numbers of whales sighted again grew more numerous. Heavy snowfall prevented further sightings in the late afternoon. Of the whales sighted the majority were identified as Fin and Sei with positive identification also being made of two Humpbacks and numerous Killers. Opinion varied over other sightings which must therefore be recorded as unidentified although it is fairly certain that other species were sighted. While in the ice the ship passed close to several large pieces of blubber and meat which scores of birds were feeding upon. Sea temp. – 1.5°C.

Position of ship at 1200 GMT: 73° 02'S, 20° 03'W.

Atlantic Ocean

s.s. *Esso Ulidia*. Captain A. W. Eadie. Fawley to Persian Gulf. Observers, Mr. N. W. Thomas, 1st Officer and Mr. J. H. Roberts, A.B.

14th March 1974. At 0720 GMT a large disturbance was noticed in the water on the starboard bow approx. one mile off. This disturbance was caused by whales, which were thought to be Killer whales, attacking another whale of the same species. As the victim jumped clear of the water in its attempt to escape a tremendous amount of blood issued forth discolouring the surrounding sea.

The aftermath of the incident was an oily residue on the sea surface and about six cruising fins.

Position of ship: 00° 58'N, 10° 25'W.



SHARK

South Pacific Ocean

m.v. *Dilkara*. Captain M. P. Lamble. Brisbane to Honolulu. Observers, Mr. S. Jacklin, Cadet and Mr. A. D. Marsden, Radio Officer.

7th January 1974. At 0030 GMT a disturbance in the water was sighted right ahead. As it came nearer it was identified as a large shoal of tuna fish being attacked

by a number of sharks. Although the vessel passed within approx. 15 m of them they seemed quite unperturbed and carried on with the meal. The sharks were brown-grey with white tips to the dorsal fins and were approx. 3 m in length.

Position of ship at 0030: 25° 15'S, 161° 18'E.

Note 1. After consulting *The Shark, Splendid Savage of the Sea*, by Jacques-Yves Cousteau, we think the sharks you saw could have been *Albimarginatus*, the White-tip shark. Although engaged in a normal meal, they would have no qualms about attacking humans and are recognized as one of the most dangerous species.

Note 2. The *Dilkara* is a Canadian Selected Ship.

FISH

Indian Ocean

m.v. *Hector Heron*. Captain G. E. Trowsdale. Westernport, Victoria to Las Palmas. Observers, Mr. A. J. Blackler, Chief Officer and Mr. S. Chakraborty, A.B./Helmsman.

1st February 1974. At 0200 GMT a large flying-fish was found on deck, port side, aft by the look-out. It was unusually large, sufficient for a breakfast for two. Its statistics were:

Wing span	48½ cm	Length of lower tail fin	9 cm
Length overall	39 cm	Length of upper tail fin	7 cm
Width of body	4½ cm	Length of after set of 'wings'	10 cm
Depth of body	5½ cm	Breadth of main 'wings'	13½ cm
Diameter of eyes	2 cm	Breadth of after 'wings'	7½ cm
Diameter of mouth	1½ cm	Length of dorsal fin	7 cm

The fish weighed .56 kg and was coloured royal blue above and silver below. Wind NE, force 2. Course 270°T at 14.2 kt.

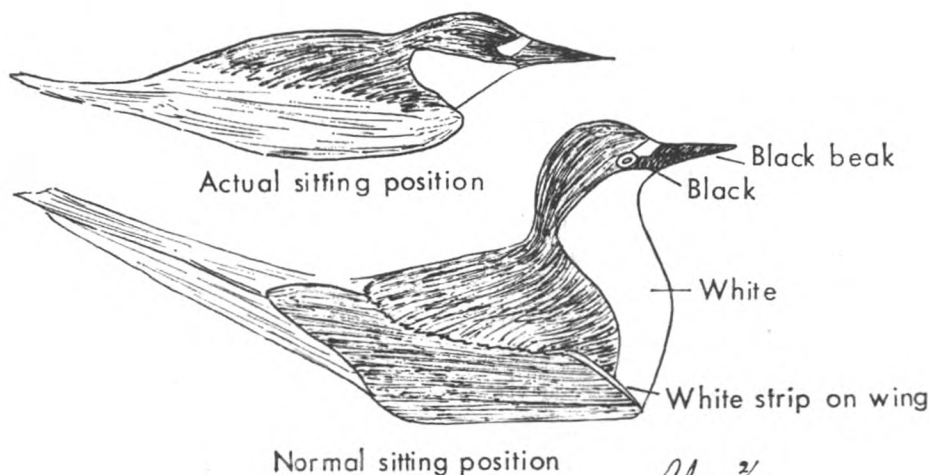
Position of ship: 32° 14'S, 54° 01'E.

BIRDS

Indian Ocean

m.v. *Laomedon*. Captain L. Henshall. Durban to Djakarta. Observers, the Master and all deck officers.

3rd January 1974. Late during the night a bird was heard around the ship which was at that time about a day from the Sunda Strait and the weather was very wet with strong NW'ly winds. In the morning a sea-bird with a dark brown body, white



Normal sitting position

Alger 3/2

neck and half face, white belly, pointed black beak about 5 cm long and with small webbed feet was found exhausted abaft the bridge. The bird was identified as some type of tern (see drawings).

After a few hours it was found staggering around the fiddley and later on the boat deck. During the evening a sailor found it by No. 4 hatch and took it to his cabin where it stayed for about two days.

The ship arrived in Djakarta late on the 3rd and lay at anchor for a week during which time the bird hopped over the side and tried to fly but soon landed on the water and floated away. It would not eat while on board and this included raw fish caught whilst at anchor. It did, however, have a little water.

Position of ship: 8° 12'S, 102° 36'E.

Eastern Pacific

m.v. *Fernie*. Captain D. Penberthy. Balboa to Japan. Observers, the Master, Mr. J. N. Cobban, 2nd Officer, and other officers.

30th January–12th February 1974. At 1200 GMT on 30th January two birds, identified as Red-footed Boobies, arrived to accompany the ship, resting on masts between fishing. There seemed nothing remarkable about this owing to the close proximity of land except that there was only one pair. However, during the following days the numbers increased daily until by 5th February, 40 birds could be counted, and still the numbers increased. During the first few days an occasional frigate-bird was sighted, thought to have been the Magnificent Frigate-bird, but after all appeared to be of the booby family. On the morning of 5th February one was found on deck but would allow no one near it; it was thought to be a young one as the feathers on its face had a downy look. However, it had gone by the afternoon. The birds did not appear disturbed by the numerous visits of people to the fo'c'sle to study them through binoculars. Several small squid and fish were found on the deck beneath the masts, presumably dropped on return from a fishing trip. On 12th February the number of birds started to decrease until eventually all were gone.

Position of ship at 1200 on 30th January: 8° 00'N, 87° 48'W.

Position of ship at 1200 on 12th February: 21° 30'N, 171° 06'W.

North Pacific Ocean

m.v. *Laomedon*. Captain L. Henshall. Nagoya to Balboa. Observers, the Master, Mr. P. L. Gasson, 2nd Officer and all officers.

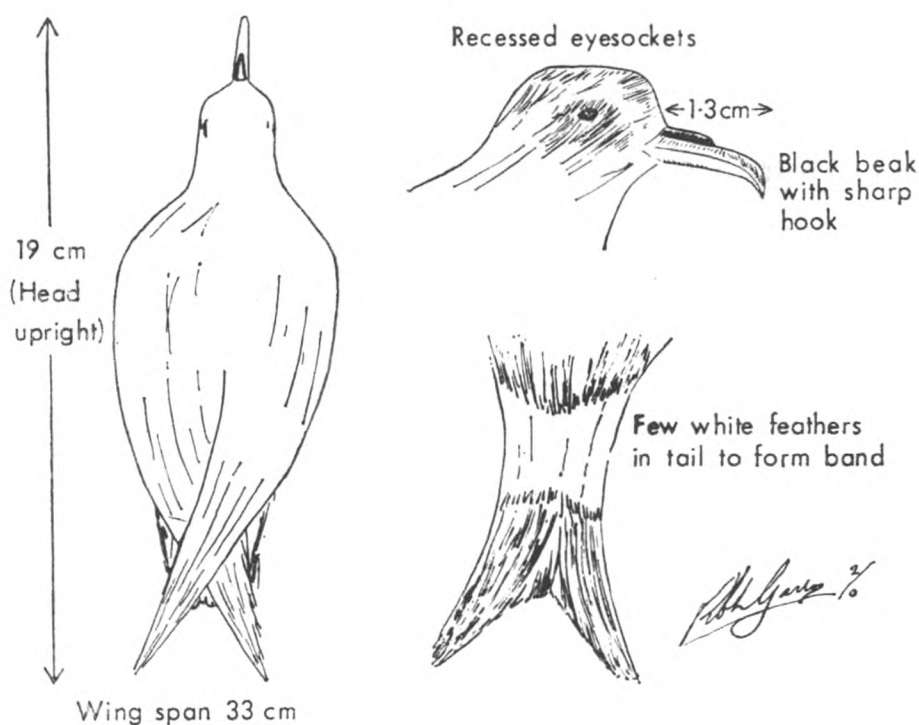
14th March 1974. At 0600 GMT two birds were found, one on deck and the other wandering around inside the accommodation. This one was removed as quickly as possible but with some difficulty as it was a large sea-bird in a bad temper. We could not properly identify this bird but it had a large white/grey body, slightly flattened head with a white face, eyes on the front of an ovoid face with a black 'cap' above the eyes and part way along the back of the neck. The beak was about 9–10 cm long and very pointed but thick. The feet were large, white and webbed. We could not see the wing colours as they were kept folded but they seem to have been predominantly white with a little black. We did not wish to try opening them.

The other bird was fairly small, about 19 cm tail to beak, with about a 33-cm wing span. The colour was chocolate brown with a patch of white around the tail. The beak was very hooked at the end and had a vent along the top for about half length. The feet were small, black and webbed with small sharp claws.

When being drawn, the bird sat very quietly in hand, although it was very tired. It had been wet recently as some of the tail feathers were still crossed and untidy. It would not eat but was left on deck with some water.

Both birds had left the ship in the morning, while the vessel was about 35 miles off the west coast of Mexico near Acapulco.

Position of ship at 0600: 17° 48'N, 103° 50'W.



Western North Atlantic

R.M.S. *Queen Elizabeth 2*. Captain M. Hehir. New York to Nassau. Observer, Mr. N. H. Osborne, 1st Officer.

18th–19th March 1974. At 1630 SMT on the 18th a large white bird was seen close to the vessel when we were some 104 miles N'E of Elbow Cay off Great Abaco Island in the Bahamas. Course 190°T at 14½ kt. For the past 36 hours strong to gale force W–NW winds had been experienced.

The bird circled round, seeming reluctant to land, probably because there were quite a number of passengers on the open decks. However, it eventually settled at 1930 and was brought to the bridge in an obviously exhausted state.

When standing with its neck retracted, as in the sketch, it was about 40 cm in height. Its neck was estimated to be about 30 cm long and its bill 13 cm. The plumage was pure white, the bill yellow and the feet and legs black. There were long, fine feathers on the back and tail. It was suggested by a passenger that the bird was a Snowy Egret.



On the following morning, when the vessel was alongside at Nassau, the bird had apparently regained some of its energy, despite having refused food and water. It was released and, after two attempts, took off from the wing of the bridge and flew away.

Position of ship at 1630 on 18th: $28^{\circ} 14'N$, $76^{\circ} 27'W$.

South Pacific Ocean

m.v. *Phemius*. Captain D. M. Belk. Balboa to Brisbane. Observers, Mr. J. Othman, 3rd Officer and ship's company.

29th March 1974. During the forenoon five birds of the same species were found on deck utterly exhausted. The birds were discovered at different parts of the ship after a heavy downpour of rain, lying soaked and helpless. The Radio Officer and his wife took two of the birds while the Fourth Engineer and his wife looked after the other three. The birds had to be fed and dried before we could study them, since they were in such a weak state being soaked and wet.

After a few hours they were dry and looked more lively, thus giving me an opportunity to study and photograph them. They were sea-birds of some species with the obvious webbed-toes feature. The birds were approximately 23–25 cm long overall and stood at approximately 11 cm high, with a wing span measuring up to 61 cm wide. The breast and collar were white in colour with a white band over the beak and encircling the eyes. When viewed from above it was a distinctive black head shaped like a 'V' with black feathers. The beak was sharp, pointed, about 5 cm long and black in colour, and together with black legs and webbed toes completed their outfit. Another noticeable feature was that the tails were forked like a swallow but not so deeply.

From these observations we came to the conclusion that they belong to the tern family but on the other hand they can be of some other species. Unfortunately, four of these birds died the next day and the only survivor flew away.

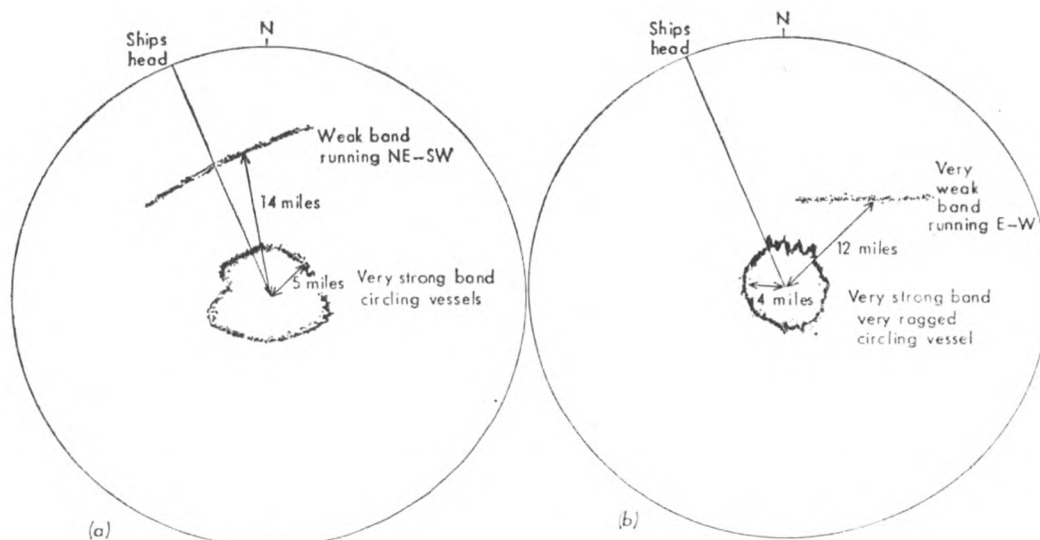
Position of ship: $04^{\circ} 33'S$, $118^{\circ} 49'W$.

ABNORMAL REFRACTION

Eastern North Atlantic

m.v. *California Star*. Captain D. McPhail. Balboa to Los Angeles. Observers, the Master and all deck officers.

2nd February 1974. At 1500 GMT a mirage effect was observed. Vessels approaching at long ranges appeared to be approaching on their masts while others at a closer range appeared to have a full ship inverted on them. The horizon at this time was distorted, with a false horizon showing quite clearly. At 1830 the radar screen showed two bands of echoes very similar in appearance to rain. The first was very strong and completed a full circle around the vessel at about 5 miles range; the other was observed to be at about 14 miles, it was less distinct and appeared to run in an almost straight line NE to SW (see sketch a). The first band appeared to be closing on the vessel and the second was becoming gradually closer. The horizon ahead of the vessel was surmounted by a dark smog-like belt. At 1900 the circling band disappeared off the radar, but the second band now appeared much stronger, lying in the same direction as before. At 1945 the second band now encircled the vessel at 4 miles range with a third band lying in an east-west direction being very indistinct and broken (see sketch b). At 2020 the southern peak of San Clemente Island was seen clearly above the layer of smog. From the ship's position at the time of sighting, the island was estimated to be some 48 miles distant. Only Southern Peak with a charted height of 273 m was visible, having a distorted appearance of elongation resembling an anvil, but the lighthouse could be clearly seen. The peak took on a normal appearance approx. 10 min later. The sea horizon



at this time shimmered noticeably and peaks could be seen well inland. Weather at 1830, air temp. 16.5°C , wet bulb 13.8° , sea 15.3° . Pressure 1021.4 mb. Wind N'W, force 2-3. No clouds. Course 339°T at 20 kt.

Position of ship: $30^{\circ} 37'\text{N}$, $116^{\circ} 54'\text{W}$.

Note. All the effects described, both visual and radar, are accounted for by the refraction of light and radar waves at a temperature inversion in the lower layers of the atmosphere due to the anticyclonic conditions which prevailed at the time of this report.

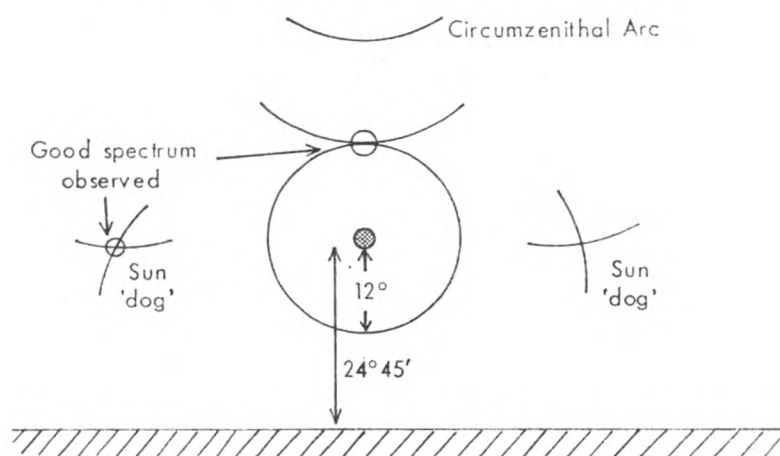
SOLAR HALO

Weddell Sea

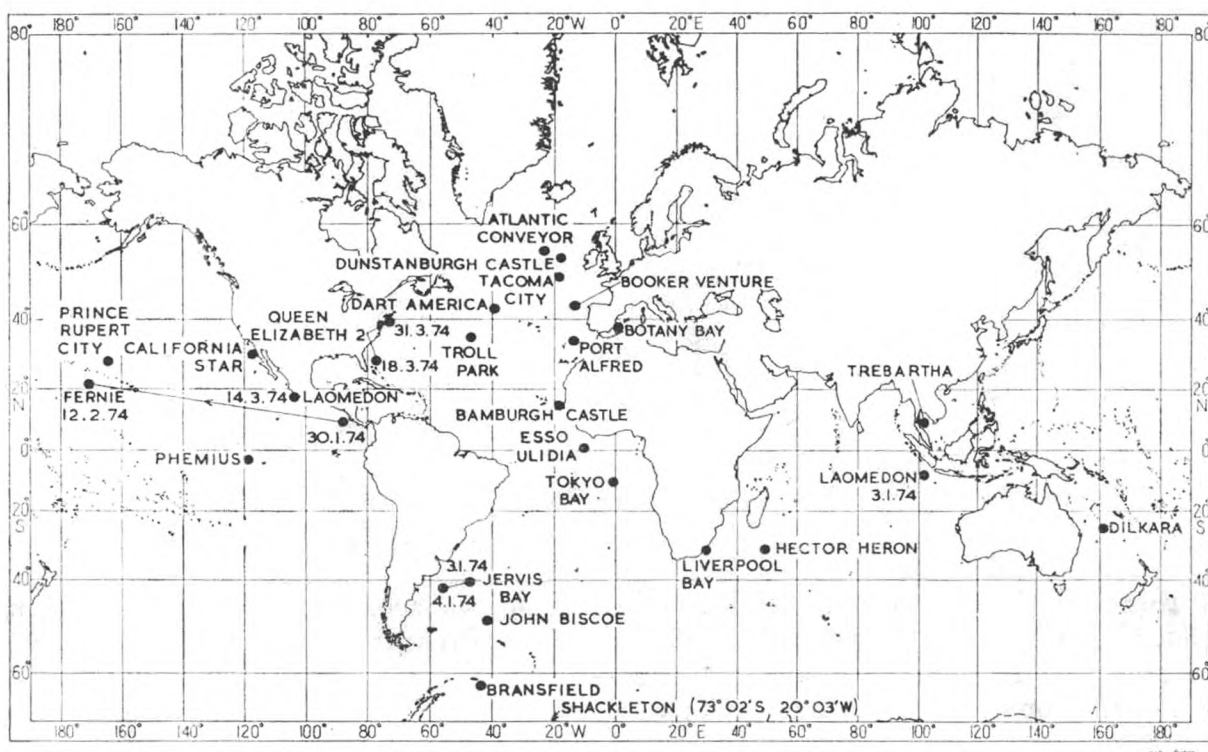
R.R.S. *Bransfield*. Captain T. Woodfield. Falkland Isles to Halley Bay. Observers, the Master and ship's company.

23rd January 1974. At 1955 GMT a solar halo display was observed as described in the accompanying diagram. Cloud C_{H6} and C_{L8} .

Position of ship at 1800: $61^{\circ} 54'\text{S}$, $44^{\circ} 12'\text{W}$.



Note. When the sun's altitude is 25° the mock suns or 'sun dogs' lie at an angular distance of about 24° from the sun, that is just outside the 22° halo. As the diagram is presented, the mock suns lie well beyond the halo displayed, seemingly confirming that the angular radius of 12° for this halo is correct. Haloes are most often observed with radii of 22° and 46° , but haloes with smaller radii have sometimes been reported. However, this is the first report we have had of a halo as small as 12° . It would be interesting to have more reports of these abnormal haloes. These reports should include the angular distance from the centre of the sun or moon and the altitude of the luminary.



Position of ships whose reports appear in "*The Marine Observers' Log*".

SATELLITE RE-ENTRY

South Atlantic Ocean

s.s. *Tokyo Bay*. Captain M. Lees. Port Kelang to Southampton. Observer, Mr. R. A. Gill, 2nd Officer.

24th January 1974. At 2150 GMT a group of five objects, spectacularly incandescent, were observed traversing the sky. The objects were in very close formation and first appeared on a bearing of 215° at an altitude above the horizon of approx. 9° , travelling in a general N'y direction. They finally disappeared on a bearing of 350° , having maintained a constant altitude so far as it could be ascertained. The duration of the observed transit across the sky was 35–40 sec, thus discounting the possibility of the phenomenon being a meteor shower, though not eliminating the possibility of it being a meteor breaking up. On balance, however, the greater likelihood was attributed to it being a satellite disintegrating, having re-entered the earth's atmosphere. Certainly the description given in the *Marine Observer's Handbook* would tend to support this theory. One further impression, rather than an observation, was the size of these objects: something in the order of $\frac{1}{3}$ the sun's diameter, relatively speaking, thus suggesting that they were possibly very close although no sound of their passage was heard.

Position of ship: $11^\circ 20'S$, $00^\circ 08'W$.

Note. The sighting was probably of the re-entry of the launcher rocket of the Soviet communications relay satellite 'MOLNIYA 2H' which decayed at about that time. The object crossed the equator south to north at approx. 4°W at 2144 GMT and decayed in the earth's atmosphere soon afterwards.

AURORA

The following notes have been received from Mrs. Mary Hallissey of the Aurora Survey:

"Auroral reports received at the Balfour Stewart Auroral Laboratory of the University of Edinburgh from British ships for the months January–March 1974 are summarized in the following table. From 'selected' ships we receive positive data extracted from logbooks by the Marine Division of the Meteorological Office. Original reports for all darkness hours are received from Ocean Weather Ships, and curiosity aroused by the brief note on the *Weather Adviser* report sheet 'left station to answer distress call' on 11th January at 0320 was satisfied when we read with interest and admiration the report in the July issue of the *Marine Observer* of the trip to give aid to m.v. *Despina*.

"The year 1974 began quietly, as befitting the year before the expected minimum activity period in the solar cycle. Opinions differ as to what order of minimum this is to be, but we appear to be descending on a somewhat erratic course towards it, enlivened as it is by the occasional unexpectedly large bursts of activity. However, the mean figure of 38.0 for the yearly sunspot number for 1973 compares with 37.5 for the same year of the preceding cycle, 1962. Apart from a markedly higher figure for April 1973, the values for the two years are almost identical.

"The geomagnetic field activity figures for January–March 1974 which, by ignoring many complexities, we expect to be reflected in auroral behaviour, show a 27-day recurrent disturbance on 25th/26th January, 23rd/24th February and 20th–23rd March, with minor storm conditions prevailing at these times. Disturbance of a recurrent nature was also recorded on 11th/12th February, but the activity of 16th March was apparently neither flare-induced nor of a recurrent nature and was followed by flat-calm magnetic conditions until the 20th March outburst.

"Most of the ships in the accompanying list are positioned in high latitudes where aurora is visible at some time on most clear nights, but the pattern of the reports, the varied intensity of the displays, the location and extension of activity all play a part in the statistical build-up. (We would mention here too that we welcome the rare southern hemisphere observation from s.s. *Moreton Bay*.) Some idea of the spread of visible aurora during only minor geomagnetic storm conditions can be assessed for 25th/26th January. Rays reported by observers in *Weather Monitor* at 2345 on 25th January were at a height permitting the assessment that they would be visible at geomagnetic latitude 55–56°—a glow was in fact reported by the coast-guard at Kilnsea (Φ56°); reports from observers in the *Weather Surveyor* confirmed activity in all quadrants in Φ70°, and at 0001 on 26th January the report from observers in m.v. *Hausa* in Φ71° was that the aurora spread to northwards of their position. Only slightly more active conditions on 20th March were sufficiently disrupting as to block out reception of weather maps on the facsimile recorder of s.s. *Manchester Commerce* in mid-Atlantic at Φ57°.

"We are most grateful for all the reports and sketches we receive from you, and look forward to having your continued co-operation."

DATE	SHIP	GEOGRAPHIC POSITION	Λ	Φ	I	TIME (GMT)	FORMS
1973							
26th Sept.	<i>Scottish Wasa</i>	69°00'N 36°00'E	110	67	+78	2246-2250	HB, RB
1974							
13th Jan.	<i>Weather Reporter</i>	58°57'N 19°00'W	070	65	+72	2115-0400	N
14th	<i>Weather Reporter</i>	59°11'N 18°54'W	070	65	+72	2000-0350	N
15th	<i>Weather Reporter</i>	58°59'N 18°37'W	070	65	+72	2000-0210	N
	<i>Jura</i>	59°00'N 02°42'W	080	62	+70	2200	N
17th	<i>Jura</i>	60°51'N 00°53'W	090	63	+72	0145-0400	HA
20th	<i>Weather Reporter</i>	59°00'N 18°44'W	070	65	+72	0330-0440	N
22nd	<i>Weather Surveyor</i>	60°08'N 24°00'W	060	67	+74	2310-2350	N
24th	<i>Weather Surveyor</i>	63°56'N 22°56'W	070	70	+76	2300, 2310	All forms
25th	<i>Hausa</i>	66°48'N 16°30'W	080	71	+77	0600	N
	<i>Weather Surveyor</i>	63°57'N 23°55'W	070	70	+76	2000-0300	All forms
	<i>Weather Monitor</i>	52°28'N 19°31'W	060	59	+69	2045-2345	RR, N
26th	<i>Hausa</i>	66°36'N 17°00'W	080	71	+77	0001, 0600	N
	<i>Silvershore</i>	68°23'N 13°00'E	110	67	+77	2000-0200	HB, N
27th	<i>Hausa</i>	66°18'N 16°30'W	080	71	+77	0600	N
	<i>Weather Monitor</i>	52°18'N 20°36'W	060	59	+69	0245	N
	<i>Hausa</i>	66°30'N 16°48'W	080	71	+77	1800	N
	<i>Weather Surveyor</i>	62°09'N 32°36'W	060	70	+76	2150	HB
						2315-0500	HB, RB
28th	<i>Hausa</i>	66°42'N 16°54'W	080	71	+77	0001, 0600	N
	<i>Weather Surveyor</i>	62°01'N 33°31'W	060	70	+76	2145-2230	RA
						2340-0100	RB, P
29th	<i>Weather Surveyor</i>	62°00'N 33°36'W	060	70	+76	0350	P
30th	<i>Weather Surveyor</i>	62°00'N 32°43'W	060	70	+76	0148, 0240	HB, RA, RB
		62°05'N 32°24'W	060	70	+76	2010	RA
						2315-2400	HB, RB, V, P
31st	<i>Weather Surveyor</i>	62°10'N 32°18'W	060	70	+76	0450	HA
						0700	N
3rd Feb.	<i>Weather Surveyor</i>	61°57'N 33°32'W	060	70	+76	2342	RA
4th	<i>Weather Surveyor</i>	62°01'N 33°26'W	060	70	+76	0350	HA
5th	<i>Weather Surveyor</i>	62°10'N 32°37'W	060	70	+76	2255	HB
6th	<i>Weather Surveyor</i>	62°09'N 32°40'W	060	70	+76	0155	HB, RB
9th	<i>Weather Surveyor</i>	62°12'N 32°54'W	060	70	+76	2300	RB
10th	<i>Weather Surveyor</i>	62°14'N 33°01'W	060	70	+76	2025-0300	HB, RA, RB, V, P
14th	<i>Weather Surveyor</i>	62°11'N 32°57'W	060	70	+76	0345-0600	HB, RB
21st	<i>Moreton Bay</i>	48°24'S 114°51'E	180	-59	-77	1240-1400	HA, N
	<i>Weather Adviser</i>	58°52'N 18°48'W	070	65	+72	2100	N
22nd	<i>Weather Adviser</i>	58°59'N 18°37'W	070	65	+72	0500-0630	N
23rd	<i>Mabel Warwick</i>	67°10'N 12°30'E	110	66	+76	0145	N
	<i>British Trust</i>	61°18'N 18°32'W	110	60	+73	2300-2345	HB, RB
24th	<i>Jura</i>	60°30'N 01°43'W	090	63	+73	1930-1950	RR, N
	<i>Weather Adviser</i>	59°14'N 18°40'W	070	65	+72	2045-2400	RR, N
27th	<i>Weather Adviser</i>	59°01'N 19°05'W	070	65	+72	0300	N
28th	<i>Weather Reporter</i>	52°34'N 19°57'W	060	59	+69	0100	N
	<i>Weather Adviser</i>	58°53'N 19°08'W	070	65	+72	0200-0500	HA, RA, RR, N, V, P
1st Mar.	<i>Weather Adviser</i>	58°59'N 19°06'W	070	65	+72	0400-0600	N
2nd	<i>Weather Adviser</i>	59°03'N 19°09'W	070	65	+72	0600	N
9th	<i>Weather Adviser</i>	59°06'N 19°12'W	070	65	+72	2100	N
10th	<i>Weather Adviser</i>	59°07'N 19°20'W	070	65	+72	0001	N
16th	<i>Weather Monitor</i>	59°10'N 18°03'W	070	65	+72	0145	N
17th	<i>Weather Monitor</i>	58°59'N 18°47'W	070	65	+72	2135	N
20th	<i>Manchester Commerce</i>	48°45'N 33°38'W	050	57	+68	2130-2250	RA, R
21st	<i>Weather Monitor</i>	59°06'N 19°49'W	070	65	+72	0145-0600	N
	<i>St. Loman</i>	68°25'N 11°00'E	100	67	+77	2030-2120	RR
	<i>Weather Monitor</i>	59°03'N 19°27'W	070	65	+72	2145-2210	R, N, P
22nd	<i>Weather Monitor</i>	58°49'N 19°17'W	070	65	+72	2245-0005	HA, RA, N
23rd	<i>Weather Monitor</i>	58°51'N 19°30'W	070	65	+72	0255	N
24th	<i>Weather Monitor</i>	58°52'N 19°44'W	070	65	+72	0150-0510	HB, N

KEY: Λ = geomagnetic longitude; Φ = geomagnetic latitude; I = inclination; HA = homogeneous arc; HB = homogeneous band; RA = rayed arc; RB = rayed band; R(R) = ray(s); P = Patch; V = Veil; S = striated; N = unidentified auroral form.

Forecasting 'Negative' Storm Surges in the Southern North Sea

BY INSTR. LT. CDR. J. TOWNSEND, M.A., R.N.(RTD.)
(Storm Tide Warning Service, Bracknell)

The need for a 'negative surge-warning service'

The meteorological effects on tidal levels are well known; low pressures, or winds which result in onshore currents, cause levels to be higher than predicted. The disastrous tidal flooding on the east coast of England during the night of 31st January 1953 which resulted from such effects led to the establishment of the Storm Tide Warning Service (STWS), as described by Cdr. Synnott in the April 1964 edition of *The Marine Observer*.¹

More recently, the growing traffic of deep-draught ships in the shallow waters of the southern North Sea has underlined the converse danger—the navigational hazard resulting from tide levels *below* predictions. A change in tidal level from meteorological causes is a storm surge and it is convenient to refer to this second type as a 'negative' surge. On 27th February 1967, tides fell 7 feet below predictions at Southend and in December 1936 they fell 7.9 feet below predictions. Records kept by the Port of London Authority (PLA) of negative surges at Southend since 1969 have shown that tides fell 2 feet below predictions there 25–30 times a year, and that a level of 4 feet or more below predictions can be expected 5 times a year. Levels more than 5 feet below predictions are rare, but occurred twice in 1972. Evidently 'cuts' in the tide comparable with the minimum permitted under-keel clearance (3 feet) of the deep-draught ships are far from rare.

Since January 1972 the Thames Navigation Service of the PLA has broadcast warnings over both Gravesend and North Foreland radio whenever levels at Southend are observed to be 3 feet (1 metre) or more below predictions. However, the Hydrographic Department of the Navy has, for some considerable time, envisaged a service to give several hours' warning before the onset of the situation and, further, to include in the warnings not only the Thames Estuary but also the southern North Sea and the Strait of Dover. In September 1973 the Hydrographer, after discussion with the Ministry of Agriculture, Fisheries and Food, and the Department of Trade and Industry, instructed the STWS to introduce such a 'negative surge-warning service' on an experimental basis. Warnings were therefore issued throughout the remainder of the 1973–74 operational season and will be continued throughout the 1974–75 season. (The STWS operational season covers the winter months from the first large equinoctial spring tide of August or September to 30th April each year.) This, then, seems a convenient time to review the methods used and the difficulties and problems still to be solved.

The behaviour of North Sea storm surges

A paper on North Sea storm surges was written by R. D. Hunt of the Meteorological Office two years ago.² As an example of a typical surge, the paper cited the surge of 28th/29th September 1969 which resulted from a common surge-producing situation—a depression moving from west to east in a latitude of around 60°N. In the circulation ahead of the depression south-westerlies covered the British Isles. Since wind-driven currents set somewhat to the right of the wind direction (in the northern hemisphere), the resulting currents were to the east, causing a drop in tide levels (negative surge) on the east coast of England, but a rise (positive surge) on the west coast of Scotland. Positive surges (and most negative surges) move in the same way as the astronomical tide, so the positive surge moved from the west coast of Scotland into the North Sea (as an 'external surge') and then

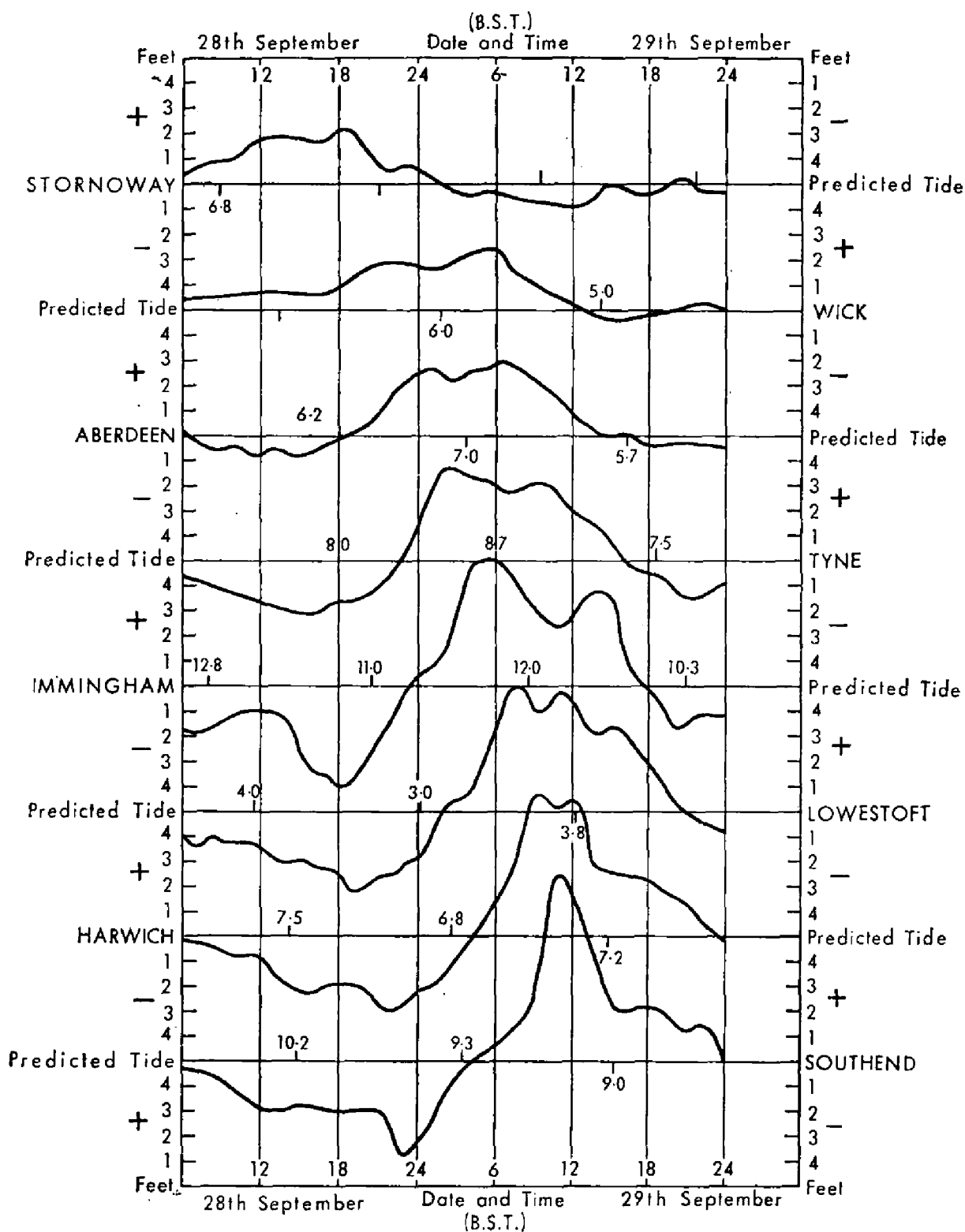


Fig. 1. Surge-residual diagram, 28th-29th September 1969.

southwards down the east coast. By this time the depression had moved on to the Norwegian coast and the circulation behind the depression gave north-westerly winds in the North Sea.

The resulting currents enhanced the size of the positive surge as it moved down the coast. These characteristics are clear in Fig. 1, a graph of the difference between actual and predicted tidal levels for Stornoway in the Hebrides and seven east-coast ports from Wick to Southend. The southward progression of both the negative and positive surges is seen. The short vertical lines show times of high water and

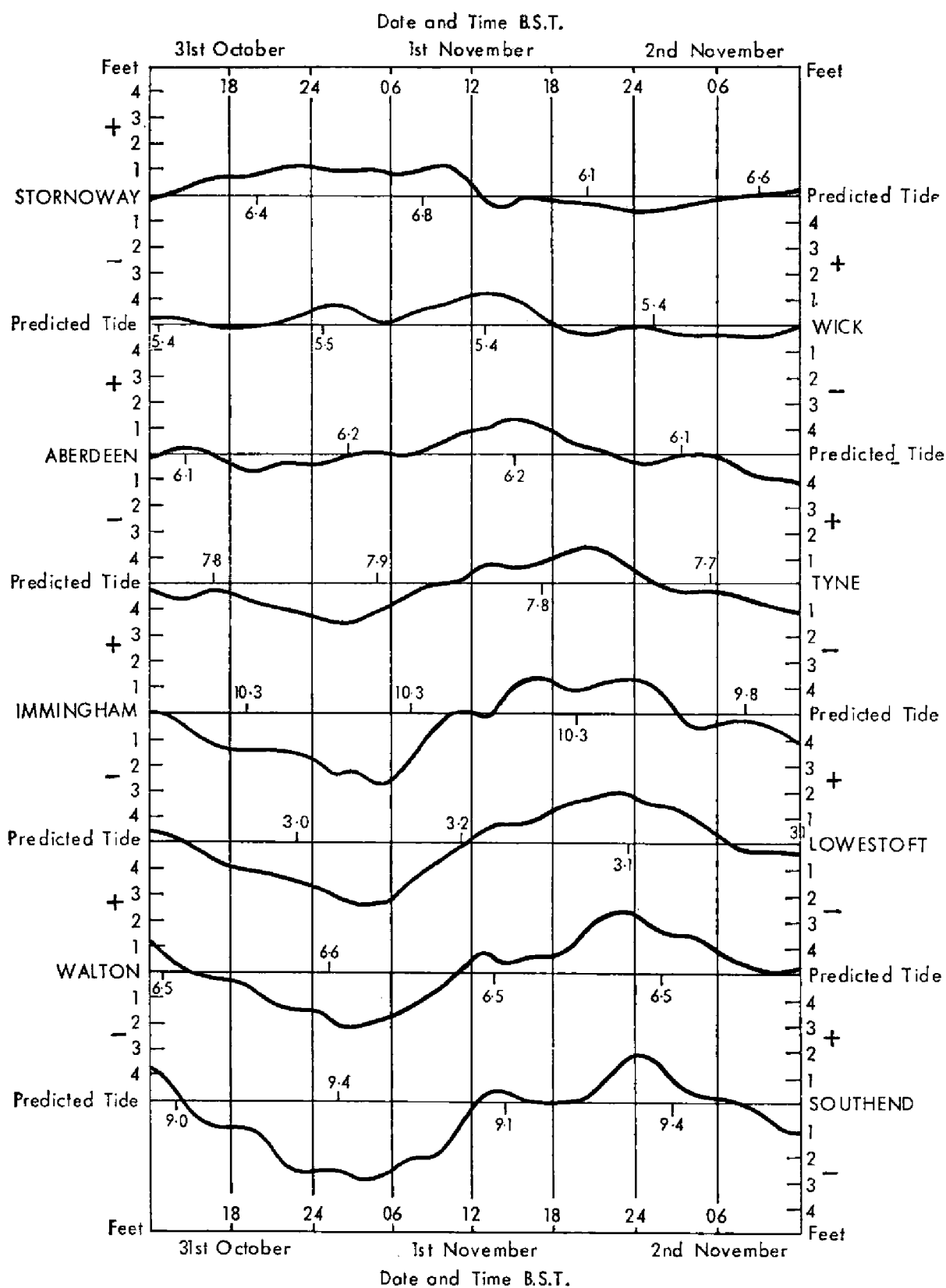


Fig. 2. Surge-residual diagram, 31st October–2nd November 1970.

permit a comparison of the speed of the surges with that of the astronomical tide; for example, the peak of the negative surge occurs 3–5 hours before high water at each port.

Positive surges in general behave in this way, but the southwards progression is not observed with all negative surges. Fig. 2 shows this. The negative surge of 31st October/1st November 1970 occurs approximately simultaneously for all the

southern ports (certainly from Immingham southwards) so that, while it occurs near low water at Immingham and Lowestoft, it occurs near high water at Walton and Southend. An examination of records of negative surges suggests that about 75 per cent move progressively down the coast, while 25 per cent are of the non-progressive type giving more or less simultaneous falls in tidal level at all the southern ports. (The distinction is not always clear-cut, with some 'progressive' surges moving appreciably more slowly than the astronomical tide, and some 'non-progressive' occurring somewhat earlier in the north than in the south.) It has been suggested that uniform southerly winds over the whole North Sea result in non-progressive surges, while the progressive kind occur when the southerlies set in only sooner, or more strongly, in the northern part of the North Sea; evidence for this is, however, inconclusive.

Forecasting positive surges

The technique of forecasting positive surges is described in the paper by Hunt² referred to earlier. The residual (difference between actual and predicted tide) at the time of high water is forecast, high water being the only time in the tidal cycle when flooding is likely. The forecast is made by empirical equations, derived from the statistical examination of tidal and meteorological data for a large number of surges, correlations being sought between the required high-water residual and winds in various parts of the North Sea at various times. Because of the progression of the surge down the coast, it is possible to use as one of the parameters the residual observed at a more northerly port where the surge arrives earlier. This is undoubtedly a powerful technique, since the earlier residual will include many factors which are not expressed explicitly in the meteorological parameters. For example, it is found unnecessary to include pressure, since abnormal pressures will already have influenced the residual at the more northerly port. Attempts to find equations based on meteorological factors alone have been much less successful. Wind areas, w, x, y, a and z, each 120 nautical miles in diameter, and ports used in the forecasts, are shown in Fig. 3.

Typical of the forecasting equations is that for Tyne (North Shields):

$$\begin{aligned} \text{High-water residual (R) at Tyne} = & 0.75 \times \text{high-water residual at Wick} \\ & + 0.003 \times (320^\circ \text{ component of surface wind} \\ & \quad \text{at Fair Isle 11 hours earlier}) \\ & + 0.02 \times (030^\circ \text{ component of geostrophic} \\ & \quad \text{wind for area 'w' 6 hours} \\ & \quad \text{earlier}) \\ & + 0.09 \text{ metres} \end{aligned}$$

$$\text{or, } R_T = 0.75R_W + 0.003sV_{FI(t-11)}^{320} + 0.02gV_{w,(t-6)}^{030} + 0.09.$$

Originally, the parameters were chosen largely subjectively. The more northerly residual was chosen to give a suitable warning period. Wind areas were selected, to some extent, by common-sense considerations. Also, attempts were made to include some dynamic effects. Thus, the motion of the meteorological system is important (in particular, a trough which moves at the natural speed of free waves for the depth of water concerned can give a very large surge because of resonance effects), and it is observed that a newly established wind field is much more effective in causing surges than a long-established one. This last fact is recognized in, for example, the equation used for surges produced in the Thames Estuary by east to north-east gales in the southern North Sea:

$$R_S = R_L + 0.01V_t \cos 5/4(\theta - 70^\circ) - 0.07V_{(t-10)} \cos 5/4(\theta - 70^\circ),$$

where R_S and R_L are the high-water residuals at Southend and Lowestoft and V , θ the wind speed and direction over area 'z'; t and $(t-10)$ are the time of high water

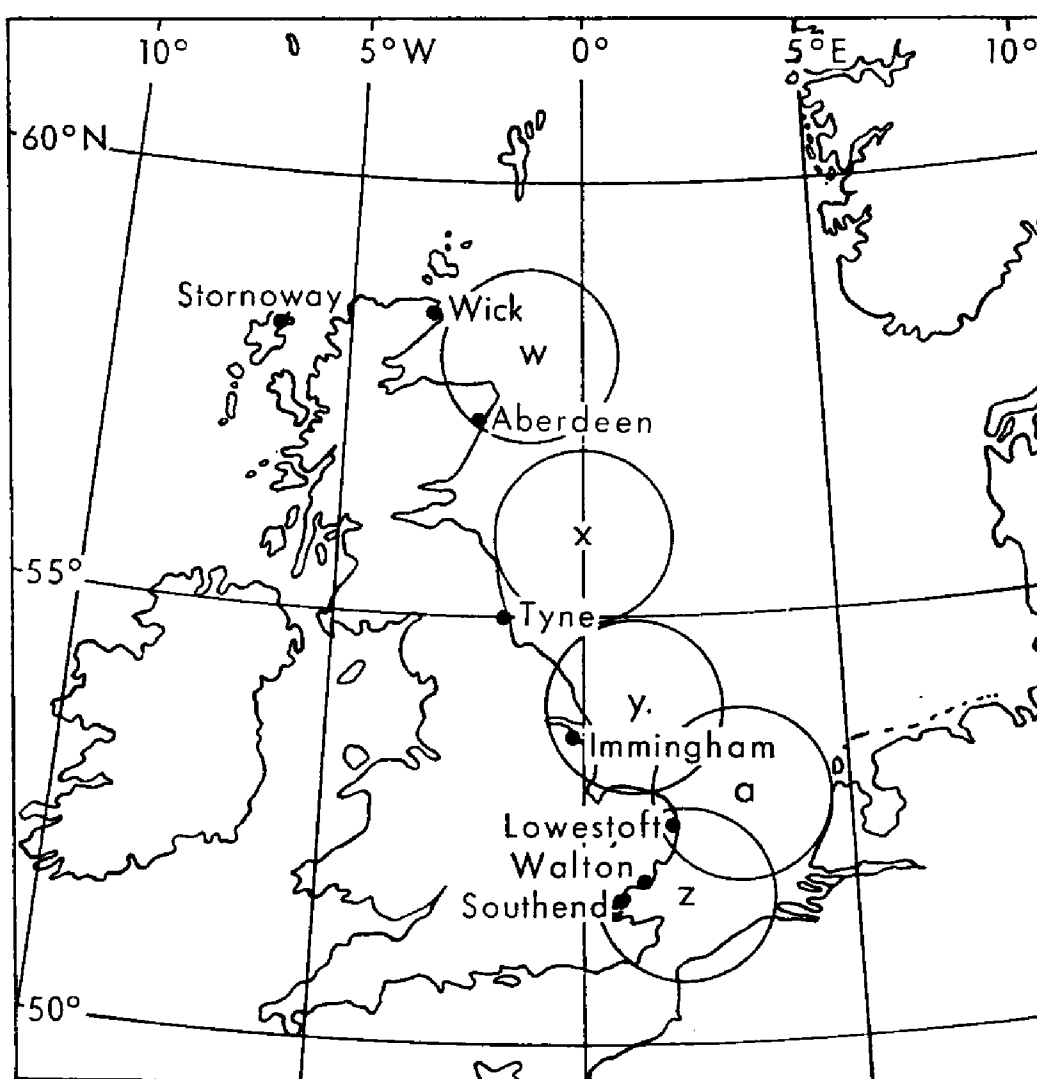


Fig. 3. Reference ports and wind areas.

and 10 hours previously so the second (negative) term represents a reduction in the surge if the wind has been established for more than 10 hours.

At the beginning of 1970 Dr. P. E. Francis of the Meteorological Office introduced a Stepwise Multi-Regression computer program, to reject successively the least significant of a large number of possible parameters and derive the corresponding equation. A feature of this program was that, because of the marked interdependence of meteorological parameters, it was necessary to reconsider after each rejection certain of the parameters previously rejected as insignificant.

Forecasting negative surges

When the Storm Tide Warning Service was faced with the problem of forecasting negative surges, it was natural that it should be guided by past experience in forecasting positive surges, as outlined in the last paragraph. While mathematical models such as those being derived at the Institute of Oceanographic Sciences, Bidston^{3,4} might provide the best long-term solution to the problem, empirical equations seemed to offer the best immediate answer, and the 75 per cent of negative surges which progress down the coast seemed amenable to the same techniques as the positive surges. With the 25 per cent of 'non-progressive' surges, it clearly would not be possible to use a more northerly residual in the first term of the equation and it

was foreseen that much greater difficulty would be met in finding an accurate forecasting equation. It was therefore decided to treat the 'progressive' and 'non-progressive' surges as two separate problems and to concentrate first on the 'progressive' type.

In fact, the first equation derived was for the high-water residual at Southend, based on the residual at Immingham or Lowestoft and the most significant wind—which was found to be the 200° component of the geostrophic wind over area 'y', 6 hours before Southend high water. But it was early realized that although high water was the most important time for issuing flood warnings during positive surges, this was not true of negative surges; a 'cut' in the tide could be of navigational significance at any time during the tidal cycle. It would be of more value to forecast the maximum depression of the tidal levels and the time at which it would occur.

Data available when this investigation was made consisted of tidal and meteorological information for 33 negative surges occurring between the end of 1969 and mid 1972. Of these, 24 had progressed down the east coast in a manner similar to the astronomical tide or to positive surges, and 9 were of the 'non-progressive' type.

Progressive surges

Using the 24 'progressive' cases, correlations were sought between the maximum residuals at Southend and Lowestoft and winds over the southern areas 'y', 'z' and 'a', at various times between that of the peak residual and 12 hours previously. For Southend, the best correlation was with the 200° component of the wind over 'a' 4 hours before the negative peak; for Lowestoft with the 200° component 6 hours earlier. But the correlation coefficients were only around 0.5. However, if differences between the maximum residuals at Southend and Tyne (North Shields) and between Lowestoft and Tyne were used, correlations were improved. The first gave a correlation coefficient of 0.68 with the 200° component of the 'a' wind 6 hours before the time of the Southend peak; the second gave 0.64 with the 180° component 4 hours before the Lowestoft peak. The corresponding regression equations were:

$$R_S - R_T = 0.03 V_{a, (t-6)}^{200} + 0.6 \text{ feet,}$$

$$R_L - R_T = 0.03 V_{a, (t-4)}^{180} + 0.2 \text{ feet,}$$

where R_S , R_L and R_T are the maximum negative residuals at Southend, Lowestoft and Tyne, $V_{a, (t-6)}^{200} = 200^\circ$ component of geostrophic wind over area 'a', 6 hours earlier.

When applied to the 24 cases considered, the equations gave root-mean-square errors of 0.5 feet, the Southend equation having worst errors of +1.4 feet and -1.0 feet, the Lowestoft worst errors of +0.3 feet and -1.3 feet. Thus they seemed to offer promise of reasonable forecasting equations. In metric units they became:

$$R_S = R_T + 0.009 V_{a, (t-6)}^{200} + 0.18,$$

$$R_L = R_T + 0.009 V_{a, (t-4)}^{180} + 0.06.$$

Speed of surge and warnings

For the 24 'progressive' cases, the mean time of travel of the surge peak from Tyne to Lowestoft was 5 hours (shortest 3 hours, longest 8 hours), and from Tyne to Southend 8 hours (range 5 to 11 hours). (This compares with $5\frac{3}{4}$ hours and $8\frac{3}{4}$ hours for the astronomical tide.)

Hence a reasonable forecasting technique would be to observe the negative surge peak at Tyne (the STWS has repeaters from seven east-coast tide-gauges) and to assume that it would reach Lowestoft 5 hours later and Southend 8 hours later. This would allow a satisfactory warning period. From the maximum residual at Tyne, and from forecasts of the 'a' wind for 1 hour ahead and 2 hours ahead, the

surge size could be calculated from the above equations. A warning could then be issued if it were estimated that the tide would be more than, say, $\frac{1}{2}$ metre below predictions.

Extension to other parts of the southern North Sea

The above technique would give forecasts for Southend and Lowestoft only, but warnings are required for all the shallow waters of the southern North Sea and Thames Estuary. In fact, the problem of forecasting for off-shore areas is yet insoluble, since regular tidal observations are made only on the coasts. (Some off-shore tidal measurements have been made but these are for short periods only, in association with particular projects.) Neither the conventional float-and-well tide-gauge with its need for constant attention and checking nor the pressure-operated tide-gauge with its need for frequent calibration is suitable for unattended operation in an off-shore position. So there are no data available to examine the behaviour of surges anywhere but on the coasts.

However, Dr. K. R. Postma of the Royal Netherlands Meteorological Institute kindly provided high-water and low-water records for Flushing, Hook of Holland and Den Helder, for about 30 periods between mid 1970 and mid 1973 affected by negative surges. The estimated maximum residuals were compared with the maximum residuals for the corresponding surges at Lowestoft, Walton and Southend. The average heights, in feet, of this set of surges were:

Lowestoft 2.4, Walton 2.6, Southend 3.2, Flushing 1.6, Hook of Holland 1.1 and Den Helder 1.1.

Secondly, the Senior Hydrographic Surveyor of the Port of London Authority provided plots of the negative surges of 1972 from the PLA tide-gauge repeaters, which gave the following means for maximum residuals:

Walton 3.1, Margate 2.8, Shivering Sands 3.3, Southend 4.0 feet.

Dover records were available for two surges only; in both these cases, the Dover surge was the same size as the Margate one.

Finally, a paper by a sub-group of the Netherlands Consultative Council for Physical-Oceanographic Research of the North Sea, examining the frequency and size of negative surges at high water and low water for Flushing, Hook of Holland, Dover and Dunkirk, found a similar pattern for all four ports.⁵

All this suggests that negative surges are biggest in the Thames Estuary, that East Anglia and Kent have negative surges about three-quarters as big as Southend and that those of the Dutch coast are perhaps somewhat smaller. This indicated a rough working rule that warnings should be issued for the Thames Estuary only if Southend's calculation gave a residual of $\frac{1}{2}$ metre, and for both the Thames Estuary and the North Sea if Lowestoft's gave $\frac{1}{2}$ metre or Southend's $\frac{3}{4}$ metre.

Surge profile

It should be emphasized that the forecasting equations above are designed to give only the maximum value of the negative surge; they cannot give any estimate of the size during the rise to the maximum or the falling-away after. Nor is the profile of the surge at a more northerly port any guide; surge-tide interaction at shallow-water ports causes marked changes in the profile.

The practical significance of this is that, with a very large negative surge, warning limits may be reached well in advance of the surge maximum, so that to wait for the Tyne residual to reach its peak would result in too short a warning. To cover this possibility the following technique is used. As soon as a negative surge situation is suspected, calculations are made each hour, treating the current Tyne residual as if it were the maximum. If one of these calculations gives a Lowestoft or Southend

residual over $\frac{1}{2}$ metre a warning is issued because, if the Tyne residuals used were actually the maximum, the calculation will be valid; if the Tyne residuals were not the maximum, the calculation will not be valid but it may reasonably be assumed that later calculations will give even larger residuals.

Other equations

On one occasion the technique described broke down because of a failure of the repeater from the Tyne tide-gauge. Alternative equations (in metric units) based on the Immingham residual were therefore devised. They were just as accurate but, of course, provided a shorter warning period since the surge took only $5\frac{1}{2}$ hours to travel from Immingham to Southend and 3 hours to travel from Immingham to Lowestoft.

$$R_S = R_I + 0.008V_{a,(t-6)}^{200} - 0.04 \text{ metres,}$$

$$R_L = R_I + 0.009V_{a,(t-4)}^{180} - 0.22 \text{ metres.}$$

Non-progressive surges

If one of the unsolved problems in negative-surge forecasting is the lack of off-shore data, the other is the failure, so far, to find a satisfactory equation for the surges which do not progress southwards down the east coast.

(a) The maximum negative residual at Southend in these cases was found to correlate best with the southerly component of the geostrophic wind over area 'a' six hours earlier. But the correlation coefficient was too small for a forecasting equation based on this parameter alone (0.26 or, if one bad case were omitted, 0.52).*

(b) The residuals at Southend were therefore corrected for atmospheric pressure, using the static law that 1 mb of pressure produces 1 cm change in sea level, and assessing a mean pressure of 1016 mb at Southend. This greatly improved the correlation (0.64, or 0.80 if the one bad case were omitted), but the constant in the resulting regression equation was unacceptably large:

$$R_S = 0.033 (P - 1016) + 0.03V_{a,(t-6)}^{180} + 2.4 \text{ feet.}$$

(It would give a 2.4-foot surge with no wind and normal pressure.)

(c) A general equation of the form

$$R_S = a(P - 1016) + bV_{a,(t-6)}^{180} + c \text{ feet}$$

was investigated by the Least Squares Method and gave $a = 0.024$, $b = 0.026$, $c = 2.6$ feet—again unacceptable.

(d) Bearing in mind the positive-surge equation for Southend in easterly gale conditions, mentioned above, a solution of the form

$$R_S = aV_{a,(t-6)}^{180} + bV_{a,(t-12)}^{180}$$

was sought, but this also proved unfruitful.

(e) On theoretical grounds, equations involving the square of the wind speeds should be better than those with linear winds (since the wind stress causing the currents should be proportional to the square of the wind). No such improvement had been found with positive surge equations, nor could a suitable negative surge equation be found using non-linear winds.

* Subsequent calculations, based on a wider set of data, gave poorer correlations than those quoted in this and the next sub-paragraph.

It is possible that the difficulties were due in part to the rather small sample of data used—12 surges, all with maximum residuals between 2 and 4 feet. Or the winds in the southerly areas 'a', 'z', and 'y' investigated may not be the most relevant ones, however likely this may seem at first sight. Alternatively, some so-far-unconsidered factor such as topography, or tidal oscillations in the southern North Sea, may be relevant—certainly the rather similar residuals in the sample occurred with a wide range of wind components, between 0 and 50 knots.

Attempts to make even a subjective or qualitative estimate for such situations have been difficult. The south to south-westerly winds which gave negative surges in the North Sea are almost always associated with south to south-westerly winds off Scotland which cause a positive surge on the west coast of Scotland. This positive surge subsequently enters the North Sea and, without guidance from more northerly ports, it is not easy to guess which of the two contrary effects will triumph.

Results of the 1973–74 experiment

The experimental warning service was operated from 11th September 1973 to 30th April 1974 and 'radio navigational warnings' were issued by the North Foreland and Humber coastal radio stations when STWS estimated that there would be tidal depressions of 2 feet (0.6 metres) or more. This level was reached at Southend on 27 occasions. Of these 27, 18 were successfully forecast; 3 warnings were issued, but the time of the surge was incorrectly forecast; 3 were marginal, with 0.6 metres barely exceeded, and at no port other than Southend; one of the 3 remaining cases was caused by the breakdown of the Tyne repeater. In addition, 5 false alarms were given, when the tide failed to drop 0.6 metres below predictions.

Conclusions

Results using the techniques described were sufficiently encouraging to justify a repeat of the experiment during the 1974–75 Storm Tide Warning Service operational season, from 18th August 1974 to 30th April 1975. However, two problems are yet to be solved for a complete warning service: the theoretical one of the 'non-progressive' surges and the practical one of obtaining off-shore data. (More data for English Channel ports west of Dover–Dunkirk would also be of interest.) The Hydrographer of the Navy, the Department of Trade and other shipping interests are working together to solve these problems.

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The Barometer off Cape Horn

The following paper contains a report made in 1881 by the Master of the U.S. Ship *Falmouth* on the anomalies of barometric pressure recorded in the seas off Cape Horn. Opinions are expressed by other navigators of the period and by Lieut. M. F. Maury,* U.S.N., who later arranged for the production of tables (not included in this reproduced paper) indicating the average heights of the barometer off Cape Horn, then comments:

In 1831, I doubled Cape Horn in the U.S. ship *Falmouth*. I was master of the ship, and it did not escape my attention that there were certain anomalies of the barometer in those regions. I found the barometric pressure off and about Cape Horn, not only much less than it is at the sea-level generally, but I observed that certain fluctuations of the barometric column off the Horn, did not, as in other parts of the sea, always indicate certain changes in the weather.

I communicated a paper upon this subject to the *American Journal of Arts and Sciences*, which was published in that Journal in 1834, and from which the following extract is taken:—

“The barometer has not been found to be of much practical utility off Cape Horn; how useful soever it may be in middle latitudes, by indicating the approach of hurricanes, it is no index to the wind in the high latitudes to the south of Cape Horn. He who, in the Chinese seas, is warned by the barometer of the approaching typhoon, and can foretell the coming of a gale by the height of the mercury in it, finds that off Cape Horn the same indications are frequently followed by moderate breezes, and even by calms. Here the mercury below the mean height of lower latitudes becomes very unsteady, falling and rising several inches in a few hours. During the strength of a gale, sometimes it is observed to rise; at other times, it falls or remains in *statu quo*. Its mean height, south of the latitude of Cape Horn, is 29.03 in.

“As the Pacific coast of Terra del Fuego and Patagonia is approached with the wind from the westward, the mercury in the barometer ascends. When the wind is strong, it rises above thirty inches, and close under the land, with fresh westerly gales, it frequently stands above 30.50 in.

“From lat. 45°, embracing a region towards the south of twelve or thirteen degrees in breadth, the most prevalent winds are from the westward. Vessels entering this region from the south have a rise in the barometer, when the wind is on the land. The rise is generally observed to commence about the latitude of the cape, continuing to increase as the land is neared; and, when the winds are fresh, a greater accumulation of atmosphere is shown by a higher range of the mercury.

“The result of my own barometrical observations, compared with others to which I have had access, shows that within this region the barometer stands higher, when the winds are from the westward, than it does, *coeteris paribus*, between the same parallels in the Atlantic. The difference is nearly as 29 to 30, and increases as the land is approached. This accumulation of atmosphere is caused from the obstruction which the mountains of Patagonia, and the highlands of Terra del Fuego afford to the winds in their passage across the continent towards the Atlantic.”

According to Erman, there is a low barometer also in the sea of Ochotsk. This observant traveller mentions also a district—the basin of Lake Baikal—remarkable for its barometric anomalies, in Asia; where, in winter, there is a cloudless sky with a high barometer. This region of permanently dry and *heavy* air, is antipodal to the region of light and damp air off Cape Horn. But it is probably due to the influence

* MAURY, M. F. Sailing directions. Philadelphia, E. C. and J. Biddle, 1855.

of the desert and mountain ranges of Asia, which, after having extracted the moisture from it, and then withholding supplies of more, combines to disturb the general system of atmospherical circulation.

Several years (1839) after I had called attention, in *Silliman's Journal*, to the low barometer off Cape Horn, the Royal Society of England alluded to the phenomenon in their report on the Instructions for Ross' Expedition to the Antarctic Regions. They point to a remark by Captain Foster, as the first suggestions of this anomaly. The Prussians claim it for their Admiral Lütke, who observed it when he doubled the cape in 1827. I am unable to decide as to priority. I lay no claim to it; for the phenomenon was traditional among Cape Horn navigators, when I first doubled that cape. This was in the U.S. ship *Brandywine*, 1826; and no observant navigator can perform that voyage, without noting the low range of his barometer in those stormy regions.

My own opportunities, however, for investigating this subject in 1832, were not as good as they now are. I determined, therefore, with sea journals in abundance before me, to review the question of mean height, as well as to re-examine the opinions of navigators concerning the barometric indications as to the weather off the cape. I thereupon requested Mr. O. C. Badger, P.M.U.S. Navy, to extract, from the first Cape Horn abstracts that he should take up, the opinions therein expressed with regard to the barometer. In a little while he brought me in a number, among which but three, viz: Capt. Hull, of the *Charles Mallory*, Capt. Littlefield, of the *Alboni*, and Capt. Scott, of the *Adelaide Metcalf*, spoke in favor of it. Capt. Hull says: "My barometer tells the weather here to a charm." Capt. Littlefield says: "Never in one instance, has my barometer deceived me;" and Capt. Scott remarks: "Thus far, I think, the barometer has been an infallible guide as to the weather."

I have also, since, received the following log of the ship *Queen of Clippers* (John Zerega), from New York to San Francisco.

"Sept. 2. Lat. 56° 08's; long. 65° 27'W. Barometer at noon 28.70; temperature of air, 36°; of water, 40°. Winds: first part, WNW; middle part, SSW; latter part, W by S. Commences light winds and beautiful weather; at 2 P.M. heavy tide rips, nearly turn the ship round with the wheel hard up. At 9 P.M. light wind from SW, wore ship. At 10 P.M., calm, squall gathering from SSW; in royals, and clewed up everything except topsail and foresail; but before we got through, it struck us, and I was glad that I was so well prepared for it. It blew very hard for three hours; close reefed fore and mizzen topsails, and doubled reefed main topsail and mainsail. Latter part, heavy gales and hail; ship under the same sail. We seemed to be pursued by contrary winds. (I see in your book of *Directions*, that some of the captains state that they do not consider the barometer as a guide in high southern latitudes; but I differ from them, although I may not have had as much experience as some of them, having been 13 years at sea, of which time I have been captain six years). I think, if the glass falls three or four tenths in a few hours, it is almost positive that it will be succeeded by a gale or very heavy gust, which will last several hours, although the simple fact that the barometer falls does not, as a natural consequence, predict wind; it only shows that there is a commotion in the atmosphere in your vicinity, which may be succeeded by wind or rain, but I think more likely by the former. If you would be so kind as to write me, on my next voyage, a particular track which I should follow, you would oblige me very much; also the mistake which I made on this voyage; and, if you please, I should like to hear your opinions concerning the barometer".

All the other opinions are adverse; I quote a few of them:—

"The barometer remains low all the time; it appears to be of no use here."—*D. C. Landis, ship F. W. Brune.*

"Barometer useless".—*W. L. Phinney, ship Kentucky.*

"The mercury here appears to be very lively—will rise and fall from 30.10 to 29.16 rapidly; but it is to be observed that this variation is not attended with the

same degree of increase and decrease of wind that we experience elsewhere. Consider the barometer here of very little use.”—*T. Dahlgren, barque Byron.*

“Barometer rising; but find it no guide whatever.”—*S. M. Hudgins, barque Hugh Birkhead.*

“Barometer, unsteady; squalls the same, without any apparent effect on the barometer. I do not trust to it.”—*Charles A. Ranlett, ship Surprise.*

“The mercury fell this day 1·42 in, and no wind to speak of.”—*W. E. Putnam, ship Empress of the Seas.*

“I watch the barometer closely; but do not think it is to be depended on here as in the North Atlantic Ocean.”—*Samuel Harding, ship Robert Harding.*

“My barometer has been almost useless since I was in the latitude of the Rio de la Plata. The heaviest gales I had, it ranged from 29·15 to 29·40, and it has been as low as 28·35 with a whole sail breeze. It has, however, invariably fallen for a northerly wind, and risen for a southerly one. It has ranged during the last six weeks from 28·35 to 30.”—*Oliver H. Saunders, ship B. Howard.*

“I have never known the barometer to range so low, and know not what to make of it.”—*B. Buxton, ship Union.*

“A most extraordinary fluctuation in the barometer, from 30·03 in. to 29·3 in., the weather and appearance giving no indication of storm or rain.”—*Robert McCarran, ship Defiance.*

“The barometer continues to fall, although the wind is southwest. I have always seen it rise with the wind from that quarter.”—*W. B. Daniels, ship Seaman.*

“The barometer ranges the highest with the wind wsw, and lowest from the northward. It either accompanied or followed the change, never preceded it.”—*John Gillan, barque Delegate.*

“I do not see that it (the barometer) is a guide to be depended upon. Certainly, my experience, this passage, would show its fall followed by delightful weather.”—*R. F. Coffin, ship Senator.*

These opinions fully sustain the opinion which my own observations and experience induced me to express twenty years ago.

The anomalies, however, of a mean low pressure were well deserving of a close investigation. I therefore requested Mr. A. A. Semmes, Passed Midshipman of U.S. Navy, to arrange from the log-books of the office the following tables, to show the average height of the barometer off Cape Horn, and in the trade-wind region north and south, both in the Atlantic and Pacific Oceans.

With regard to these tables, I should remark that the barometer has been entered in the tables without any correction whatever; and that the barometer to which the tables refer, is the common mercurial marine barometer.

Though this instrument, as at present used and constructed for the sea, abounds with sources of error, there is but one of the errors arising from the many sources, for which the correction may be applied on board ships, and that is for temperature.

Every navigator knows that mercury is one of the most expansible of metals, and that a column of this fluid, for instance, that is exactly thirty inches long at the temperature of 80° will not be exactly thirty inches long at any other temperature, say that of zero. Its absolute weight will be just as much at the one temperature as at the other; and, therefore, the atmospheric pressure remaining the same, it is easily understood how the height of the barometer will change with every change of temperature.

Since, then, the temperature of the trade-winds is higher than that of the gales off Cape Horn, the barometer in the *open air* ought to show a greater apparent pressure—*i.e.*, a higher column—in the former than in the latter region. This difference would amount, on the average, only to the expansion of the mercurial column due the change of temperature. This difference of column would probably not amount to as much as 0·2 inch (two-tenths of an inch), if the Cape Horn barometer were kept in the open air; but generally it is not so kept. It probably does not amount, in

reality, to more than 0.05 inch, if so much; for the usual place for the barometer is the captain's cabin, and there the temperature to which it is subjected is probably not more than a few degrees, at most, below that of the trade-winds. The stove in the cabin, the heat of the crew below, all tend to lessen, in the cabin, the difference of temperature between winter and summer.

Nevertheless, if navigators would always require a thermometer to be attached to the barometer (or would not purchase a barometer without an attached thermometer), and would note it also whenever the barometer is recorded, the correction for temperature, be it much or little, might be applied. This correction cannot be applied here, because navigators are not in the habit of observing the attached thermometer.

Now, here is a most important and interesting physical phenomenon, which cannot be properly or thoroughly investigated for the want of a marine barometer capable of giving correct absolute determinations. Nay, we are embarrassed and crippled in the investigation for the want of the readings of the attached thermometer. If we had these, we could show, from the observations we have, very nearly the exact difference between the mean height of the barometer in the trade-winds and off Cape Horn.

I mention this to illustrate the importance of a nicer and more accurate system of observations, as recommended by the Brussels Conference.

Let us return to the tables.

Now, as the barometers in these tables, which show the pressure in the trade-winds, are the identical barometers which show the pressure off Cape Horn also—they require no correction, save that of temperature, to show the difference between the absolute barometric pressure in the trade-winds, and off Cape Horn. If the barometer have an error of 0.2 in., or an error of any other value too much or too little in the trade-winds, it carries precisely the same error off Cape Horn. These tables, therefore, though they do not show truly—because of the undetected errors of the common marine barometer—the real pressure of the atmosphere, either in the trade-winds or off Cape Horn, yet they do show correctly, or very nearly so, the *difference* of pressure in those regions.

The difference is truly remarkable, and is well worthy of farther investigation.

PRESENTATION OF BAROGRAPHS

In the July 1974 number of *The Marine Observer* a short account was given of the presentation of the first of the year's barographs to Captain W. F. Joyce of the Head Line, up till then the only recipient of that year's barographs available.

On 16th May 1974 we were lucky to be able to present two further awards for the year, to Captain J. E. Askew of Manchester Liners and Captain W. MacVicar, M.B.E. of the Runciman Line. Captain Askew was accompanied by Mrs. Askew and the presentations were made by the Director-General of the Meteorological Office, Dr. B. J. Mason.

After the presentations, luncheon was taken with the Director-General and senior officers of the Meteorological Office and the party was later shown round the office, special attention being paid to the use which is made of ships' observations. A photograph taken at the presentations is reproduced opposite page 17 and we now await an opportunity of presenting the remaining barograph to Captain J. A. North who has unfortunately been unable to attend either of the previous two ceremonies.

L.B.P.

ICE CONDITIONS IN AREAS ADJACENT TO THE NORTH ATLANTIC OCEAN FROM JULY TO SEPTEMBER 1974

The charts on pages 41 to 43 display the actual and normal ice edges (4/10 cover), sea-surface and air temperatures and surface-pressure anomalies (departures from the mean) so that the abnormality of any month may be readily observed. (The wind anomaly bears the same relationship to lines of equal pressure anomaly as wind does to isobars. Buys-Ballot's law can therefore be applied to determine the direction of the wind anomaly.) Southern and eastern iceberg limits will be displayed during the iceberg season (roughly February to July). In any month when sightings have been abnormally frequent (or infrequent) this will be discussed briefly in the text.

The periods used for the normals are as follows. Ice: 1966-73.¹ Surface pressure: 1951-66.² Air temperature: 1951-60.³ Sea-surface temperature: area north of 68°N, 1854-1914 and 1920-50,⁴ area south of 68°N, 1854-1958.⁵

JULY

In Hudson Bay and Davis Strait, above-normal temperatures helped in the rapid break up of the ice. By the end of the month the ice remaining in Hudson Bay was about normal. Over Baffin Bay and south-east Greenland there were deficits of ice although there had been no marked anomalies. To the north of Spitsbergen, the strong south-easterly wind anomaly resulted in a marked deficit. There was an excess to the south of Zemlya Frantsa Iosifa. In Belle Isle Strait, numerous icebergs, sometimes near 200, constituted a severe hazard to shipping throughout the month.

AUGUST

In Hudson Bay and Baffin Bay, normal seasonal melting soon cleared remaining ice. Off the east Greenland coast slightly higher than normal temperatures caused a deficit of ice while in the northern Barents Sea and Kara Sea below normal temperatures and a slight northerly wind anomaly delayed the melting process and a large excess of ice persisted. Over 100 icebergs were reported in Belle Isle Strait during the first part of the month but this number was later considerably reduced.

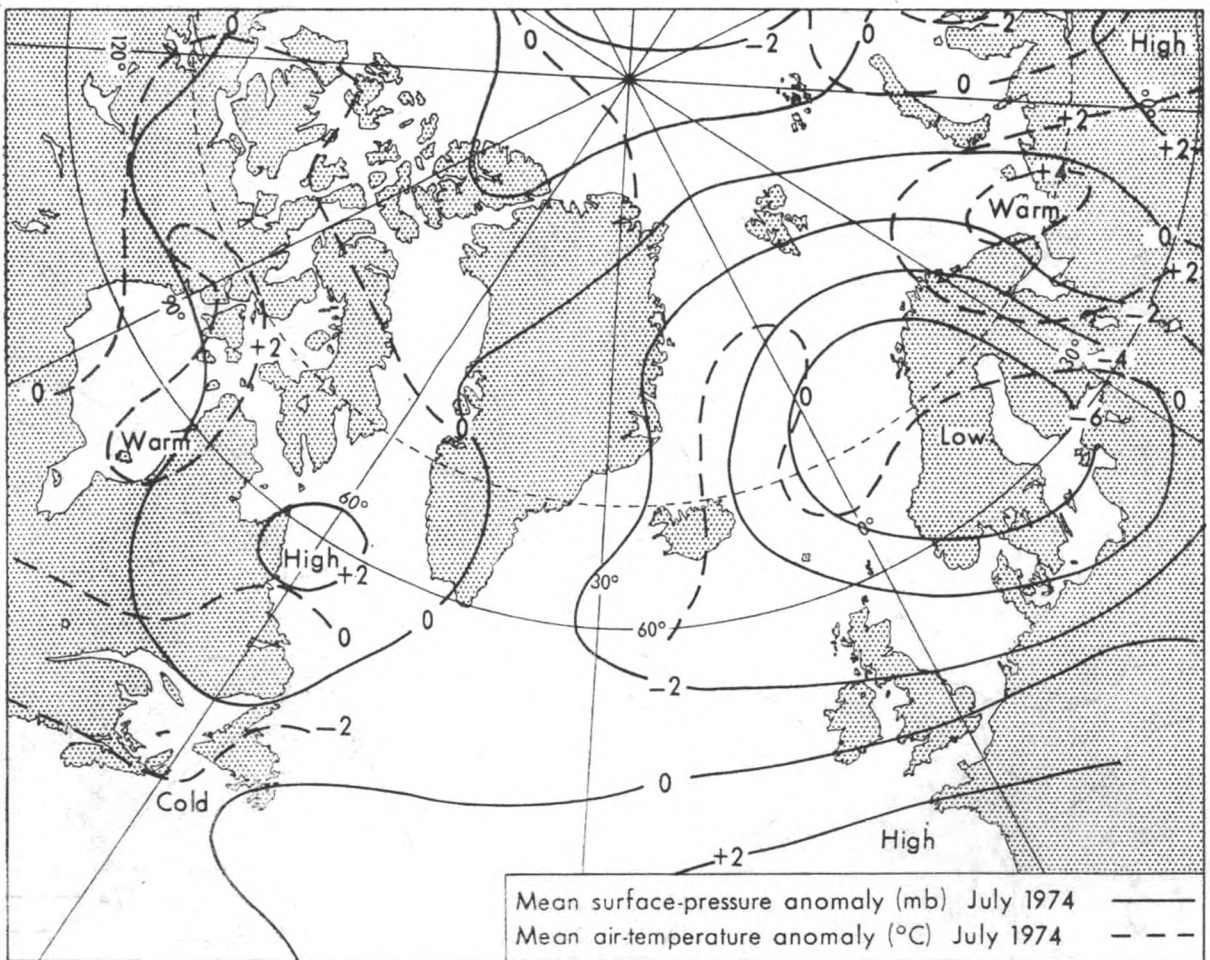
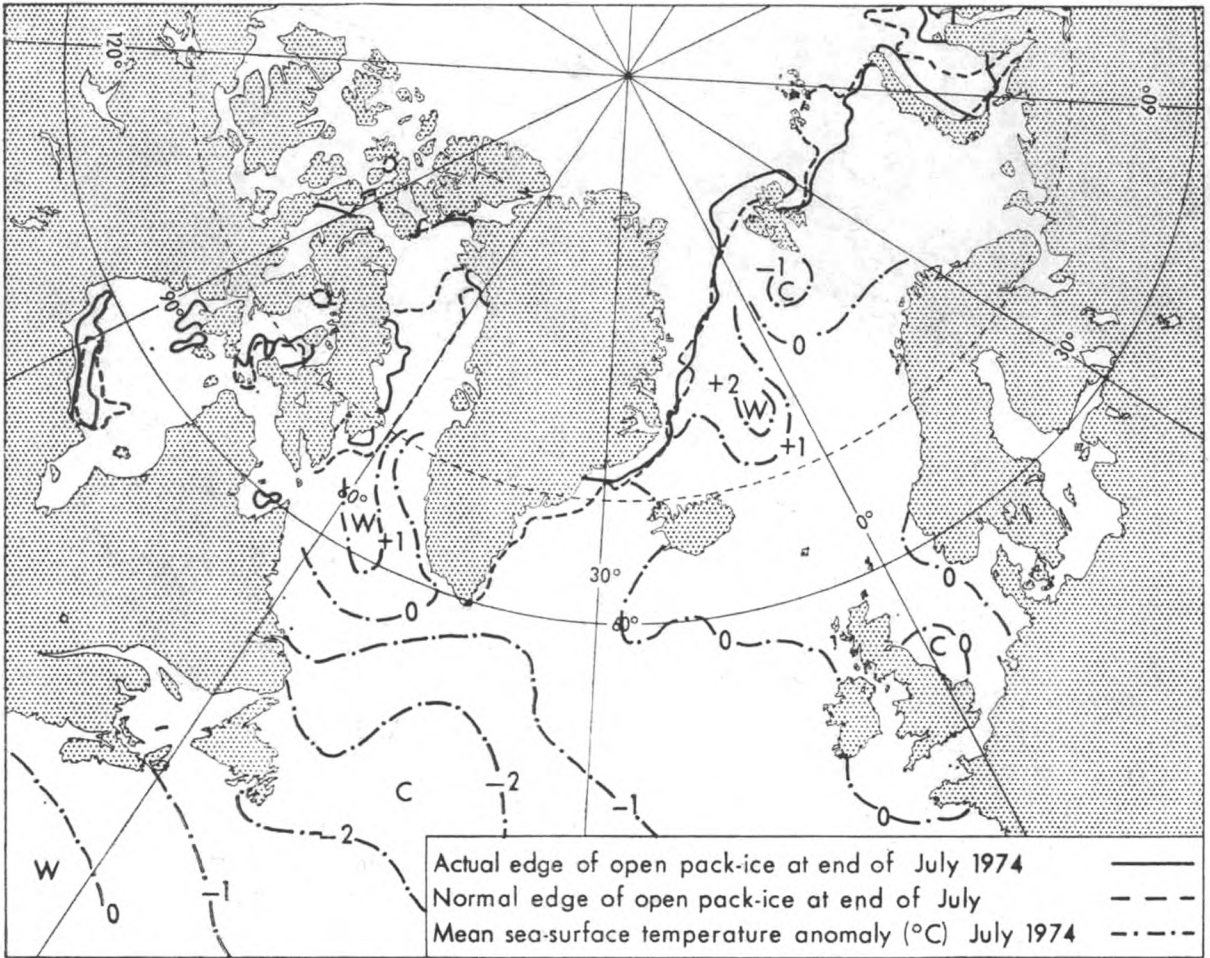
SEPTEMBER

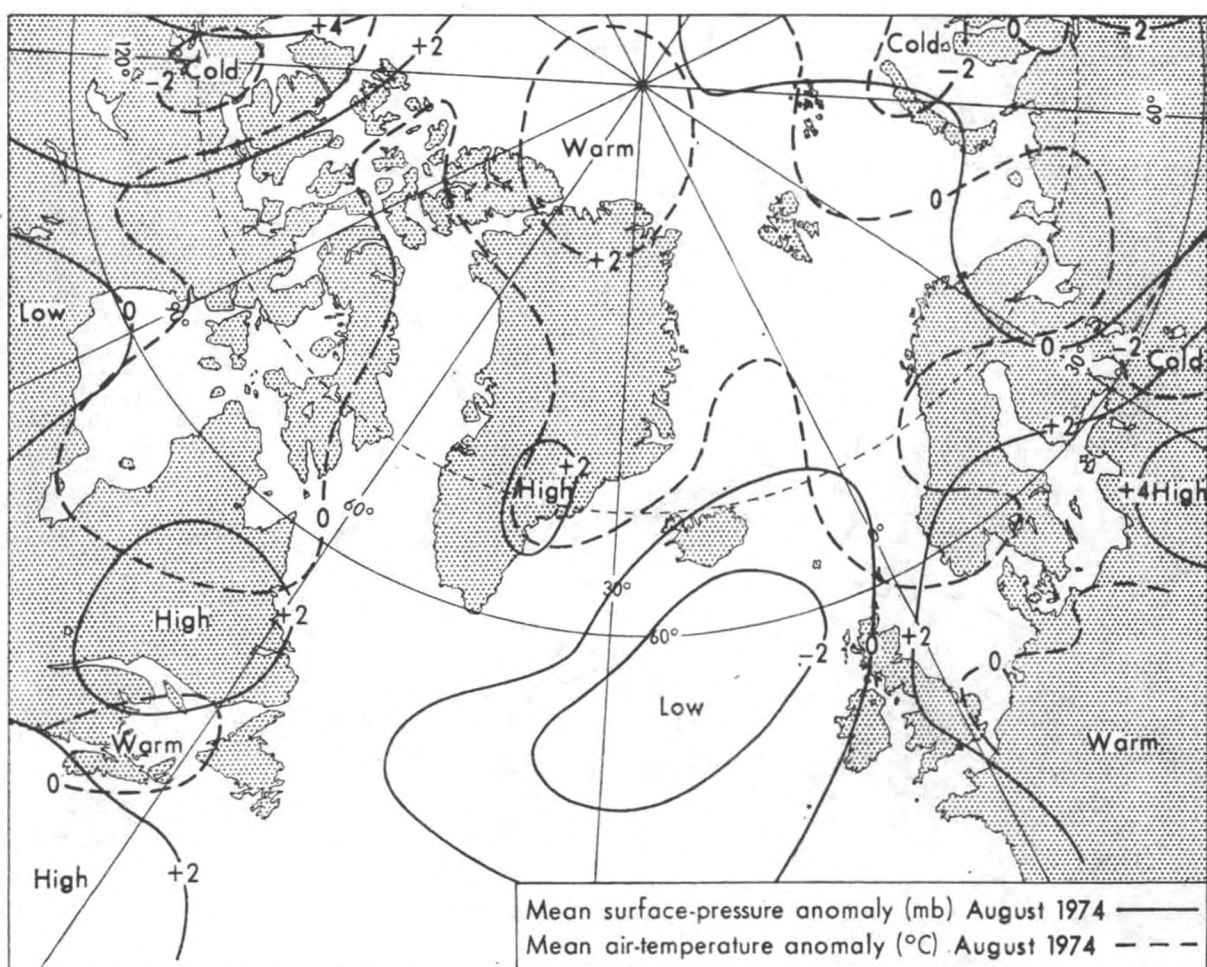
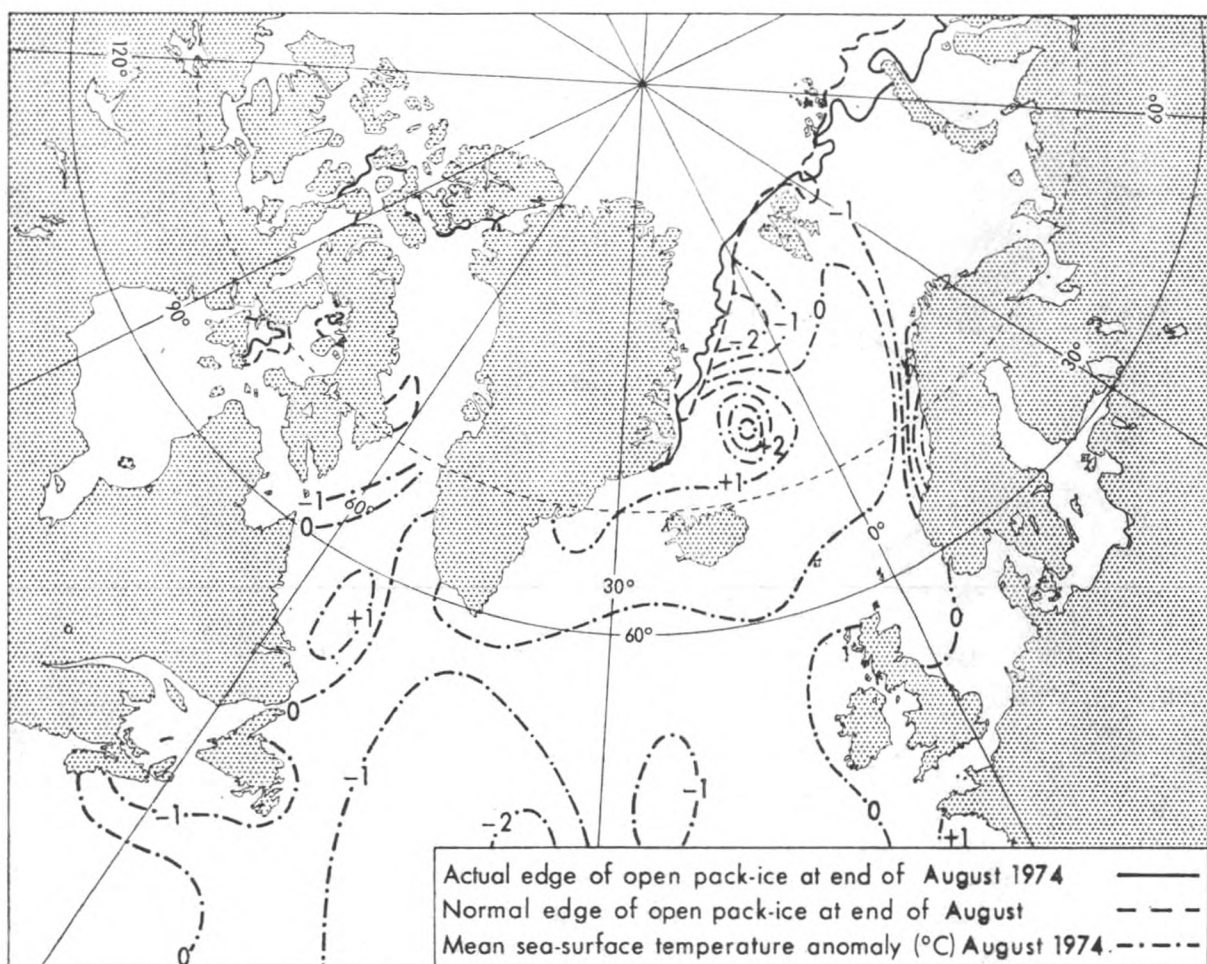
In the Greenland Sea the deficit of the previous month persisted. In the northern Barents Sea and Kara Sea the colder-than-normal temperatures still delayed the melting process although a south to south-east wind anomaly accounted for a smaller excess than in the previous month.

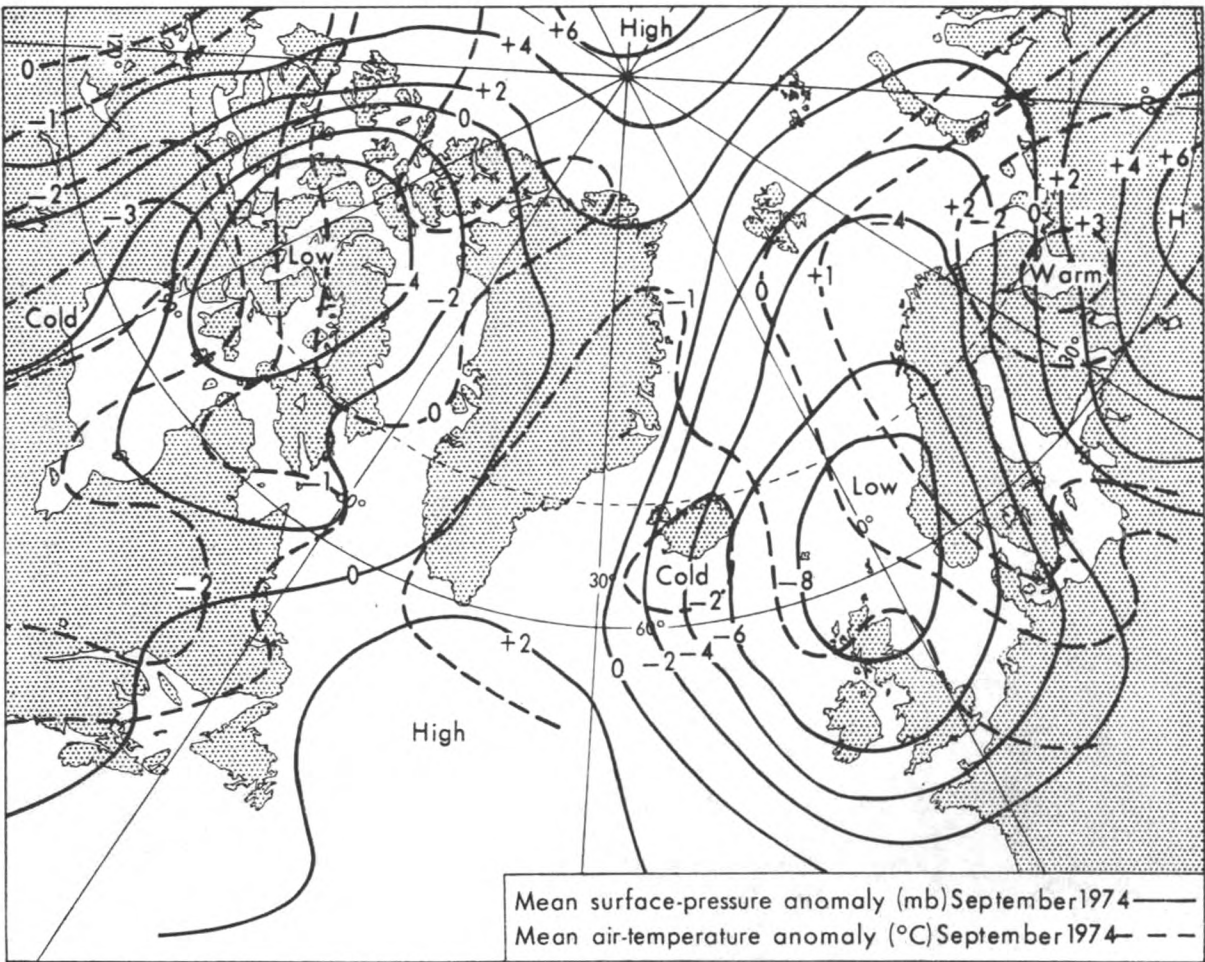
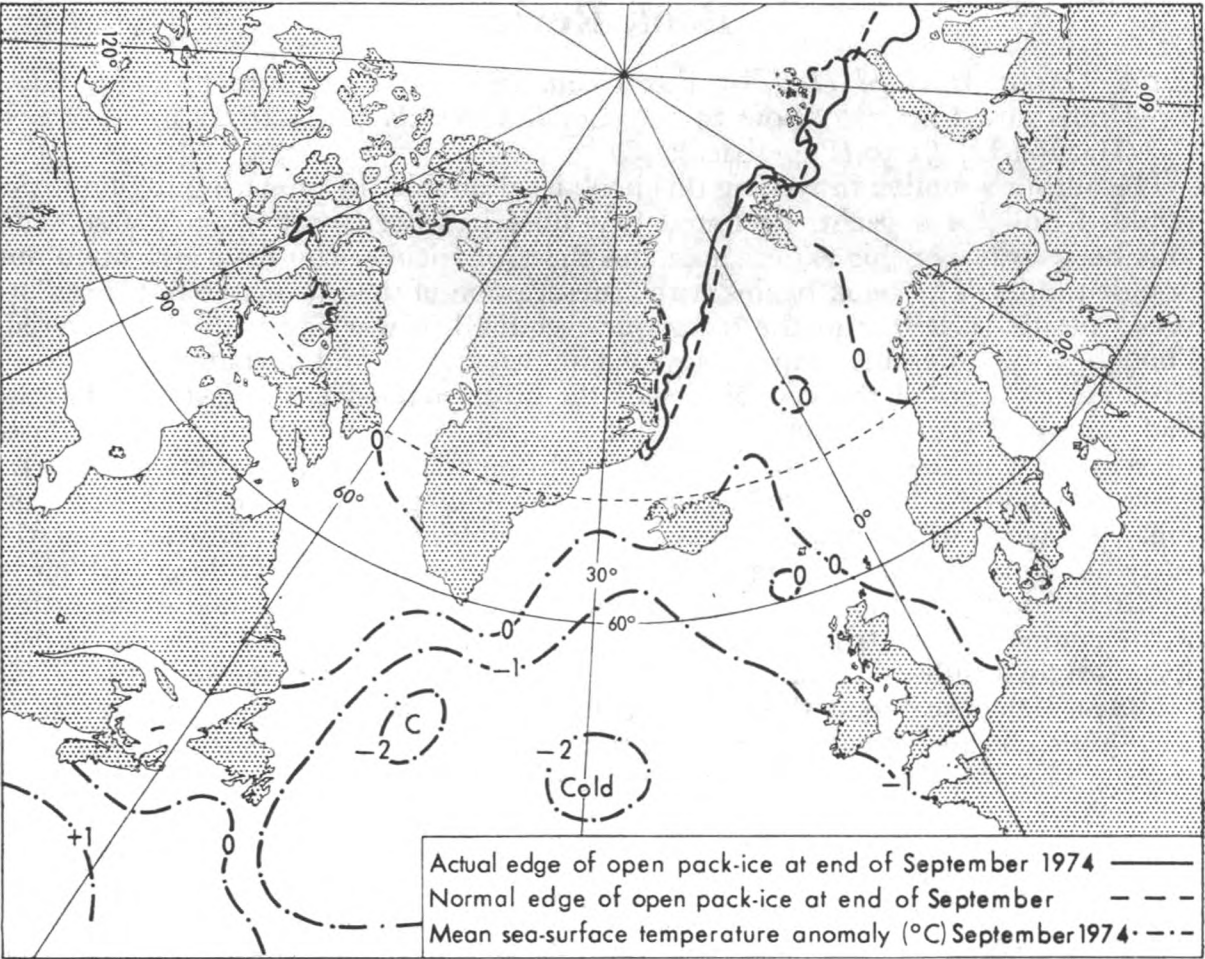
P.A.

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3. Washington, D.C., U.S. Department of Commerce Weather Bureau. World weather records, 1951-60. Vol. 1: North America, 1965.
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Book Review

Fitting Out a Moulded Hull, by Fox Geen. 198 mm × 125 mm, pp. 173, *illus.*, Hollis and Carter, 9 Bow Street, London WC2E 7AL, 1974. Price: £2.50 (Hardback), £1.50 (Paperback).

The author's motive in writing this book is admirable. In preparing to fit out the moulded hull for a yacht, he found that little had been written on the subject. This book draws on his experiences and those of friends who have also fitted out moulded hulls. The book begins with a description of the raw material, glass-reinforced plastic (GRP), and the techniques required in working with this material. Though very different from those used in woodwork and metalwork, they are certainly not beyond the capabilities of the do-it-yourself enthusiast who has already acquired a certain amount of skill in working with wood and metal. After dealing with buying the materials, planning and preparation of the work and the site, we are introduced to the production of sub-mouldings, such as hatch-covers and tanks; a stage at which mistakes may be made and learnt from since these items will be moulded in later on. Fitting out both on and below deck is next described, fairly rigidly within the framework of the original plan. A chapter is devoted to the fitting of the engine with instructions for moulding a stern tube, should that not be part of the original hull moulding. After describing the fitting of items such as cockpit drains and electrical gear there follows a chapter on the protection and repair of GRP hulls. A short chapter is devoted to raising the finances for such an expensive project. The availability of suitable hulls and some technical data on the properties of GRP are given in appendices.

In these times of rising costs, more and more potential owners will be looking into do-it-yourself fitting out rather than buying a completed boat. For these people it would be prudent to draw on the experiences of Fox Geen, himself a practical yachtsman. However, this book will not only appeal to such people. It should be read by everyone who sails in a GRP yacht; they should have a thorough knowledge of the material which keeps them afloat.

R.M.S.

Personalities

RETIREMENT.—CAPTAIN THOMAS RIGG retired from the sea, and from command of the *City of Auckland*, in June 1974 after serving the whole of his long career with Ellerman Lines.

Thomas Rigg was born in Lochgelly, Fife; he signed indentures with Ellerman City Liners in 1928 and commenced his career on the *City of Kimberly*. After obtaining his 2nd Mate's Certificate in 1933 he was appointed to the *City of Hong Kong*. He obtained his Master's Certificate in 1940 and was subsequently promoted to Master of the *City of Newport* in 1957.

Captain Rigg's record with the Meteorological Office goes back to 1947 when he was serving as Chief Officer on the *City of Windsor*; since that period he has served in a number of vessels of the Voluntary Observing Fleet and has altogether sent us 24 meteorological logbooks, a number of which were classed as Excellent. He gained Excellent Awards in 1972 and 1973 whilst in command of the *City of Auckland*.

We wish him a healthy and happy retirement.

J.D.B.

FLEET LISTS

Corrections to the list published in the July 1974 number of *The Marine Observer*.

Information regarding these corrections is requested by 20th October each year. Information for the July lists is required by 20th April each year.

GREAT BRITAIN (Information dated 1.10.74)

The following coasting vessels ('Marid' ships) have been recruited:

NAME OF VESSEL	MASTER	OWNER/MANAGER
<i>Clansman</i>	D. M. Martin	David MacBrayne Ltd.
<i>Esso Mersey</i>	P. Mattocks	Esso Petroleum Co. Ltd.
<i>Frendo Star</i>	G. Eager	Frendo (London) Ltd.
<i>Inganess Bay</i>	W. G. Dennison	Elwick Shipping Co.

The following vessels have been deleted:

Caernarvonbrook, Eileen M, Kyndill, Stormont

The following skippers and radio operators have been added to the Trawler Fleet List:

SKIPPER	RADIO OPERATOR	TRAWLER OWNER/MANAGER
J. W. E. Boyle	C. Bird	Boyd Line Ltd.
D. Platten	M. W. Stather	T. Hamling & Co. Ltd.

GREAT BRITAIN (contd.)

The following ships have been recruited as Selected Ships:

NAME OF VESSEL	DATE OF RECRUITMENT	MASTER	OBSERVING OFFICERS	SENIOR RADIO OFFICER	OWNER/MANAGER
<i>Baron Incheape</i>	28.6.74	M. Dalby	J. Melville, R. Abercrombie, J. Fowler	A. Honan	Scottish Ship Management Ltd.
<i>Brethbank</i>	6.6.74	A. K. H. McBain	J. B. Dawson	..	Bank Line Ltd.
<i>Bristol Clipper</i>	19.7.74	H. Messenger	D. M. Sisson, J. Hopkin, R. Hughes	I. Harpham	Whitco Marine Services Ltd.
<i>British Spey</i>	23.5.74	M. V. McCarthy	J. B. Hood, D. J. Ackroyd, F. W. Lamb	C. M. Taylor	B.P. Tanker Co. Ltd.
<i>City of Canberra</i>	3.9.74	E. G. George	M. Fagen, P. Askew	J. W. Fields	Ellerman Lines Ltd.
<i>City of Newcastle</i>	13.5.74	I. G. Lumley	S. W. Ponter, N. Kerr, C. W. Rapley	..	Ellerman Lines Ltd.
<i>Yedforest</i>	17.7.74	..	P. V. Hunter	..	P. & O. S.N. Co.
<i>Limpfield</i>	2.8.74	J. G. Street	I. R. Lewis, C. R. Heard, J. Cooper	..	Shaw Savill & Albion Co. Ltd.
<i>Mahrad</i>	19.6.74	D. S. Symonds	R. Reid, A. Lacey, T. Mather	J. Coombe	Cunard-Brocklebank Ltd.
<i>Manchester Renown</i>	22.8.74	L. Taylor	N. C. D. Hope, J. Glover	F. D. Farthing	Manchester Liners Ltd.
<i>Mayfield</i>	20.6.74	K. Row	E. Smith, F. D. Harrow, M. Heron	..	Shaw Savill & Albion Co. Ltd.
<i>Nairnbank</i>	28.8.74	J. W. Grestorex	..	A. N. Gray	Bank Line Ltd.
<i>Post Charger</i>	21.8.74	B. Hatton	Panoean Shipping & Terminals Ltd.
<i>Sherbo</i>	9.9.74	J. M. Johnston	D. Small, J. French, D. Waring	J. Crotty	Ocean Transport & Trading Ltd.
<i>Supremity</i>	9.8.74	P. L. Whitehouse	B. Hollywood	..	F. T. Everard & Sons Ltd.
<i>Viking Vigilant</i>	16.7.74	P. H. King	K. D. Ricketts	..	Vigilant Marine Ltd.
<i>Westbury</i>	3.6.74	J. C. Woodbridge	D. P. Hicks, D. Bowman, P. Kenyon	G. Fisher	Houlder Bros. & Co. Ltd.
<i>Wild Curlew</i>	8.4.74	I. Y. Batley	D. Vickers, J. W. Gill, W. Phumister	G. C. England	P. & O. S.N. Co.
<i>Wild Fulmar</i>	15.8.74	M. J. Stubbington	I. Barnett, S. Lintott, N. W. Stephenson	..	P. & O. S.N. Co.
<i>Wimpey Sealab</i>	15.7.74	A. J. Stewart	M. G. E. Robinson, L. Clark	E. McCarter	Wimpey Marine Ltd.

The following Selected and Supplementary Ships have been deleted:

Baltic Venture, Baron Canador, Barrister, Concordia Gulf, Duhalloin, Edelstein, Gallic Bridge, Garrybank, Himalaya, Langstone, Nardana, Santona, Tenbury.

BRITISH COMMONWEALTH

AUSTRALIA (Information dated 30.9.74)

The following have been recruited as Selected Ships:

Cape Moreton (Dept. of Shipping & Transport, Australia)
Forthbank (Bank Line Ltd.)
Harry Messell (University of New South Wales)
Recorder (Cable & Wireless Ltd.)
Sureness (Jebson Line)

The following ships have been deleted:

Al-Mahrosa, *Cable Enterprise*, *Salamaua*, *Tri-Ellis*.

CANADA (Information dated 1.10.74)

The following ship has been upgraded to Selected Ships:

Cygnus (Government of Canada)

The following ships have been recruited as Selected Ships:

Bernes (Kristian-Jebson (U.K.) Ltd.)
Nahidik (Government of Canada)
T. Akasaka (Canadian Pacific S.S. Ltd.)
Ungava Transport (Hall Corporation Shipping Co. Ltd.)

The following ships have been deleted:

Montcalm, *Nego Anne*, *Ontario*, *Simon Fraser*, *Thor I*.

HONG KONG (Information dated 11.9.74)

The following ships have been deleted:

Hai Hing, *Eredine*.

INDIA (Information dated 4.9.74)

The following ships have been upgraded to Selected Ships:

Jalagirija (Scindia S.N. Co. Ltd.)
State of Punjab (Shipping Corporation of India Ltd.)

The following ship has been upgraded to a Supplementary Ship:

Jalajaya (Scindia S.N. Co. Ltd.)

The following ships have been recruited as Supplementary Ships:

Chatrapati Shivaji (Shipping Corporation of India Ltd.)
Himachal Pradesh (Shipping Corporation of India Ltd.)
Jag Shakti (Great Eastern Shipping Co. Ltd.)
Lok Adhar (Mogul Line Ltd.)
Lok Nayak (Mogul Line Ltd.)
Samudra Gupta (Shipping Corporation of India Ltd.)
Satya Sohan (Seven Seas Transportation Ltd.)
Tasneem (Indo Oceanic Shipping Co. Ltd.)
Vishva Abha (Shipping Corporation of India Ltd.)
Vishva Asha (Shipping Corporation of India Ltd.)
Vishva Madhuri (Shipping Corporation of India Ltd.)
Vishva Tarang (Shipping Corporation of India Ltd.)

The following have been recruited as Auxiliary Ships:

Samudra Raksha (Pent-Ocean Shipping Co. Ltd.)
Vishva Bandhan (Shipping Corporation of India Ltd.)

The following ships have been deleted:

Akash Maru, *Damodar Zuari*, *Jag³Arti*, *Jag Vijay*, *Rangat*.

NEW ZEALAND (Information dated 6.9.74)

The following have been recruited as Selected Ships:

Dido (Northern S.S. Co. Ltd.)
N.Z. Aorangi (Shipping Corporation of New Zealand)
N.Z. Waitangi (Shipping Corporation of New Zealand)
Storm (Union S.S. Co. N.Z. Ltd.)
Toa Moana (Shipping Corporation of New Zealand)
Union Sydney (Union S.S. Co. N.Z. Ltd.)
Union Wellington (Union S.S. Co. N.Z. Ltd.)
Woosung (China Navigation Co. Ltd.)

The following have been recruited as Supplementary Ships:

Aratika (N.Z. Railways Department)
Teesta (P. & O. (N.Z.) Ltd.)

The following ships have been deleted:

Holmlea, Moana Roa, Tarawera, Golden Bay, Puriri.

