Met. O. 923

The Marine Observer

A quarterly journal of Maritime Meteorology

Volume XLIX No. 266
October 1979

£1·50 net

VOL. XLIX | No. 266 | OCTOBER 1979

CONTENTS

Letters to the Editor, and books for review, should be sent to the Editor 'The Marine Observer', Meteorological Office, Eastern Road, Bracknell, Berkshire RG12 2UR

Published for the Meteorological Office by
HER MAJESTY'S STATIONERY OFFICE

To be purchased direct from HMSO at any of the following addresses: 49 High Holborn, LONDON WC1V 6HB; 13a Castle Street, EDINBURGH EH2 3AR; 41 The Hayes, CARDIFF CF1 1JW; Brazennose Street, MANCHESTER M60 8AS; Southey House, Wine Street, BRISTOL BS1 2BQ; 258 Broad Street, BIRMINGHAM B1 2HE; 80 Chichester Street, BELFAST BT1 4JY, or from booksellers.

PRICE £1·50 NET or £6·48 per annum (including postage)

October, November, December

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 UK will supply bottles, preservative and instructions on request.

TYPHOONS 'NINA' AND 'ORA'

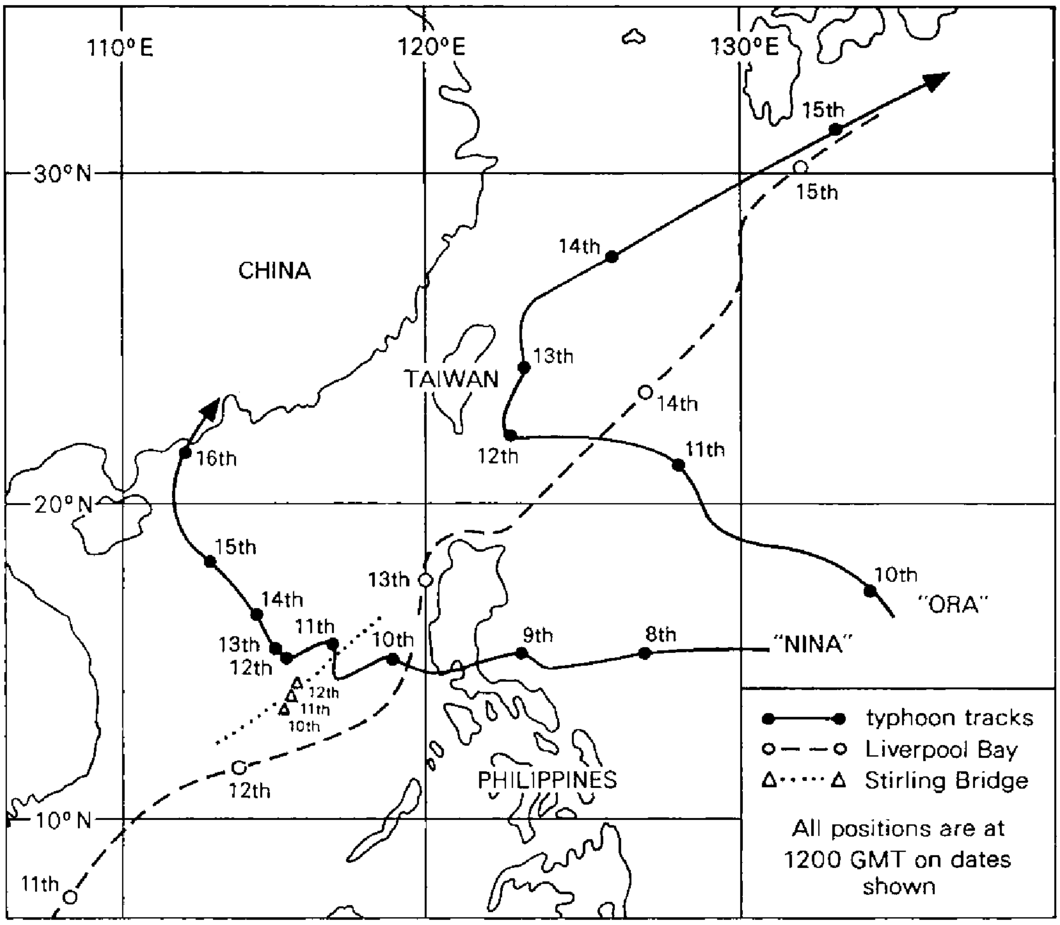
South China Sea

s.s. *Liverpool Bay*. Captain J. Banna. Singapore to Tokyo. Observers, the Master and ship's company.

10–16 October 1978. Whilst on passage from the Malacca Straits the most recent facsimile weather chart revealed a tropical storm and a tropical depression in the western Pacific, to the east of the Philippines, which might hinder the vessel's progress.

The following are extracts from the vessel's logbook:

	GMT	
10th	0630:	The vessel departed from Singapore and proceeded at a reduced speed of 15 knots as Nina was then forecast to move west at 8 knots. The vessel's speed should have let Nina pass clear ahead.
11th	0300:	Long NNE'ly swell observed.
	1200:	Heavy NNE'ly swell, overcast with intermittent light rain, vessel pitching easily.
12th	0001:	Wind SSW, force 5, barometric pressure 1008·9 mb, air temp. 27·3°C, sea temp. 27·0, rain clearing. Three-hourly observations requested by Hong Kong Radio.
	0140:	Vessel altered course to 060°(T) and speed increased to 22 knots. Nina was at this time a severe tropical storm moving very slowly west.
	0800:	Wind veered to become NW, force 5, light rain, heavy northerly swell, pressure 1004·6 mb.
	1200:	Report received from Japan to the effect that both Nina and Ora had been upgraded to typhoon status.



	1800:	Wind SW, force 8, pressure 999·9 mb, rough sea, heavy NW'ly swell, vessel rolling and pitching moderately and shipping water forward.
	2000:	Course altered to 075°(T), speed increased to 23·5 knots.
13th	0130:	Course altered to 020°(T), wind S'ly, force 7, rough sea, heavy confused swell, vessel yawing, rolling and pitching moderately in a following sea. Continuous rain, mainly light but heavy at times.
	0600:	Course altered to 360°(T), wind S'E, force 7, pressure 1001·6 mb, heavy confused swell, rain clearing but visibility still reduced by spray.
	1200:	Wind S'E, force 4, heavy northerly swell.
	1500:	Vessel entered Babyan Strait in order to avoid Ora now reported stationary off the east coast of Taiwan, swell reduced considerably in the lee of the land.
14th	0001:	Vessel now in the Pacific, wind SW, force 3, swell increasing from the north.
	0300:	Message received from Hong Kong—three-hourly observations no longer required.
	1800:	Wind increased to become SSW, force 6, intermittent light drizzle.
	2330:	Course altered to 340°(T) and speed reduced to 15 knots to allow Ora to pass ahead. Wind SW'W, force 8, rough sea, heavy swell, moderate to heavy rain at times.
15th	0415:	Course altered to 020°(T) and speed increased to 22 knots, wind NNW, force 8, rough sea, heavy NW'ly swell, vessel rolling and pitching easily.
	1200:	Ora now 290 n. mile to north-east of vessel, rough sea, heavy N'ly swell, rain giving way to scattered showers.

16th 0001: Wind N'ly, force 9, pressure 1009·1 mb, very rough sea, heavy NW'ly swell, vessel shipping spray overall and rolling and pitching easily.

0400: Wind NNW, force 9, gradually veering and decreasing to become NE'N, force 6 by 0900.

Position of ship at 1200 on the 10th: 2° 18'N, 105° 00'E.
Position of ship at 0001 on the 16th: 32° 36'N, 136° 06'E.

Note. Typhoons Nina and Ora developed over the Philippine Sea. Nina appeared on the 8th and moved westward whilst Ora appeared on the 10th and moved to the west-north-west. The chart accompanying this report shows the tracks of the two typhoons and those of the *Liverpool Bay* and the *Stirling Bridge*. The latter's observation follows below. The photograph opposite page 189, reproduced by kind permission of the Editor of the *Mariners Weather Log*, is a satellite picture of the two typhoons and it is worth noting that the connection between them indicates that the 'Fujiwhara Effect' may have been involved. This is where two cyclone centres also rotate about some point between them.

Nina attained typhoon strength on the 12th over the southern Ryukyu Islands. The fact that the typhoons were close together created very dangerous conditions over the Formosa Strait during the 11th, 12th and 13th.

On the 14th Ora recurved towards the north-east and became a weakening tropical storm, just south of Kyushu, on the 15th. At this time Nina was also recurving and passing to the west of Hainan. It had largely dispersed near Hong Kong on the 17th.

TYPHOON 'NINA'

South China Sea

m.v. *Stirling Bridge*. Captain J. W. Waldie. Tubarão (Brazil) to Kakogawa (Japan). Observers, Mr F. A. Bayliss, Chief Officer, Mr R. W. A. Brough, 2nd Officer and Mr L. Attard-Montalto, 3rd Officer.

10–14 October 1978. During this period the *Stirling Bridge* encountered Nina (see notes and chart accompanying the *Liverpool Bay* observation above) and the following are extracts from the vessel's logbook:

GMT

10th 0400: Wind NW, force 7, overcast with moderate rain, rough sea and moderate swell.

1200: Wind NW'W, force 9, rain, moderate NNE'ly swell, barometric pressure 1000·6 mb (rising).

1600: Barometric pressure 1002·4 mb.

2000: Wind NW'W, force 8–9, pressure 1002·1 mb, overcast, moderate rain, rough seas and heavy swell, vessel altered course from 045 to 042°(T).

11th 0001: Wind NW'W, force 8, pressure 1003·8 (rising unsteadily), overcast with heavy rain, very rough sea and heavy NE'N swell.

0800: Pressure 1000·3 mb (falling).

1200: Wind W, force 9–10, pressure 1000·6 mb (steady then rising), overcast, very rough sea and heavy swell.

1700: Vessel hove to heading on a course of 243°(T).

2000: Wind W'S, force 10, pressure 995·9 mb (falling then steady), heavy rain.

12th 0400: Wind WSW, force 10, pressure 997·8 mb (rising then falling).

0800: Pressure 996·0 mb (falling then rising).

0900: Pressure 997·4 mb (rising), vessel altered course to 046°(T).

1600: Wind SW, force 9, pressure 997·2 mb (rising then falling), occasional breaks in the cloud, rough following sea.

13th	0001:	Wind SSW, force 8, pressure 998·8 mb (rising).
	0800:	Wind S'W, force 8, pressure 998·8 mb (falling then steady), cloudy with showers, rough sea.
	1600:	Wind S, force 7, cloudy, occasional rain, rough following sea, heavy swell.
	2000:	Wind S'E, force 6, cloudy, rough sea and heavy swell.

Position of ship at 0001 on the 10th: 14° 33'N, 116° 04'E.
Position of ship at 2000 on the 13th: 17° 51'N, 119° 56'E.

TROPICAL STORM 'TESS'

Western North Pacific

m.v. *Wild Fulmar*. Captain D. T. Hughes. Osaka to Melbourne. Observers, the Master and ship's company.

2–5 November 1978. The following is the sequence of weather observed and events as the vessel approached tropical storm Tess.

	GMT	
2nd	0040:	The vessel was proceeding to Los Angeles when orders to proceed to Melbourne were received.
3rd	0200:	Tropical storm reported in position 17° 54'N, 145° 18'E, almost stationary.
	0730:	The vessel was pitching heavily in a long southerly swell—this was the first indication of our proximity to the storm. Course altered to 147°(T) in order to pass to the east of it.
	1130:	The storm now reported to be moving in a northerly direction at 6 knots. Course altered to 136°(T).
	1545:	In position 26° 35'N, 145° 37'E, course altered to 090°(T). Storm's position 19° 30'N, 145° 30'E moving N'E at 6 knots.
	2200:	Wind SE'ly, force 2, barometric pressure 1003·0 mb, dry bulb 24·5°C, wet bulb 24·0, light intermittent rain, vessel pitching heavily and taking water overall.
4th	0001:	Course altered to 115°(T).
	0030:	Wind S'W, force 7, very heavy rain.
	0200:	Wind SSE, force 7, a second belt of very heavy rain.
	0230:	Wind SE, force 4, barometric pressure falling quickly.
	0600:	Wind SE, force 8, barometric pressure 1000·4 mb, dry bulb 26·0, wet bulb 24·8, vessel rolling and pitching in heavy southerly swell. All personnel restricted to accommodation block. D.R. position 23° 58'N, 149° 45'E, course 135°(T), engine at 120 r.p.m. During the next four hours maximum rolls of 45° to port and 47° to starboard were recorded. The vessel's course was constantly being altered in order to try to reduce rolling.
	1000:	Wind S'E, force 8–9, barometric pressure 997·7 mb, dry bulb 26·0, wet bulb 24·8, atmosphere oppressive, visibility now being reduced by heavy driving rain, engine at 100 r.p.m. and racing badly, vessel pounding heavily.
	1200:	No observations were transmitted during the next 6 hours as the main transmitter was 'tripping out' due to excessive vibration.
	1400:	Wind SE, force 9, dry and wet bulb both reading 25·7, barometric pressure 1000·7 mb, now steady.

1500: Barometric pressure now rising.
1800: Wind SSW, force 8, dry bulb 26·8, wet bulb 26·3.
2100: Storm now reported in position 24° 42′N, 147° 54′E.
2230: Snap sights of the sun showed vessel's position to be 23° 06′N, 150° 42′E, now ahead of the storm centre, vessel pitching and rolling violently.

5th 0200: Wind SW, force 7–8, barometric pressure 1007·8 mb, dry bulb 27·5, wet bulb 26·1, clouds beginning to disperse from the south-east, vessel's course altered to 170°(T), position of storm now 26° 00′N, 148° 30′E, moving north-east at 16 knots.
0600: Wind S'W, force 5, barometric pressure 1009·4 mb, dry bulb 27·5, wet bulb 26·1.
0800: Increased to full sea speed, 150 r.p.m. course 179°(T).
1400: Wind S'E, force 3, swell moderating and gradually changing to a westerly direction, barometric pressure 1013·1 mb, dry bulb 28·2, wet bulb 27·2.

No structural damage was observed but the stores in the fore and aft peaks were badly damaged and a lashed pile of pallet sideboards had broken loose on the foredeck. Most weather-exposed paint was badly wrinkled and had been stripped off in some places around the air vents, funnel and accommodation. Some furniture in accommodation was broken.

Position of ship at 0200 on the 3rd: 30° 16′N, 142° 51′E.
Position of ship at 0200 on the 5th: 22° 31′N, 150° 29′E.

Note. 'Tess' formed west of Guam on the 1st, moved to the NNE and intensified to become a tropical storm by the 3rd. After crossing the 25th parallel near 149°E on the 5th it turned to the NE and began to turn extratropical.

HEAVY WEATHER

North Atlantic Ocean

s.s. *Atlantic Causeway*. Captain R. A. Holmes. Le Havre to New York. Observer, Mr S. E. W. Sutherland, 2nd Officer.

At 0600 GMT on 7 December the vessel sailed from Le Havre; the intended track was a rhumb line from position 50° 07′N, 02° 06′W to Nantucket Light-vessel.

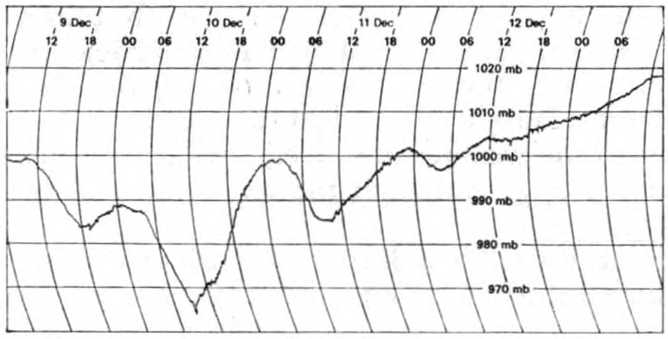
During the morning of the 7th rough seas and a moderate south-easterly swell was recorded, the wind at this time was SE, force 6–7. An intense depression was centred off the west coast of Ireland and at 1230 the Master ordered that the course be changed from 259 to 250°(T).

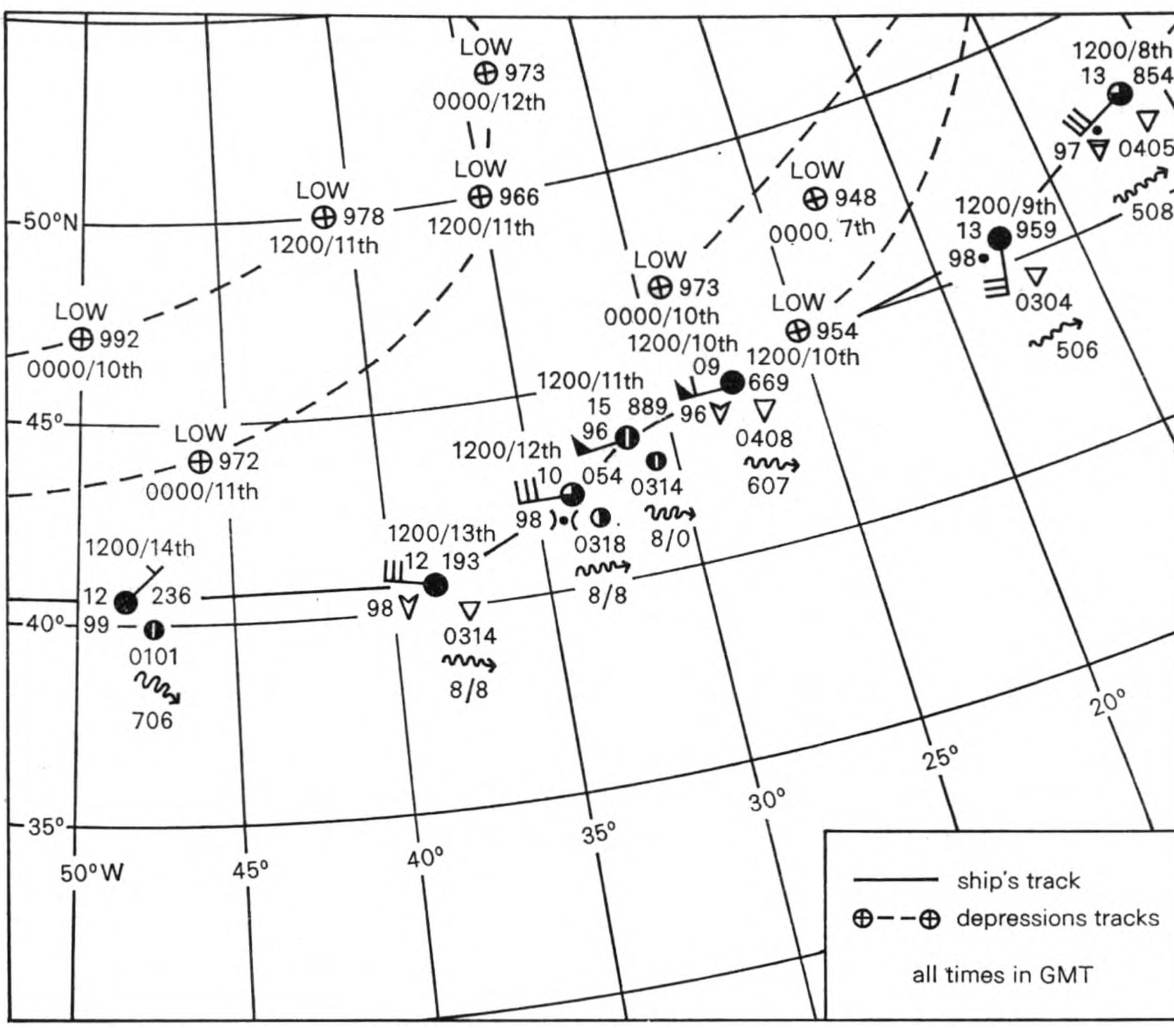
By 1800 the wind had veered to south-westerly and moderated. However, a heavy swell from the south-west was being experienced and at 2118 the engine was slowed from 105 to 90 r.p.m. in order to minimize pounding.

Throughout the 8th the wind remained at SW'ly, force 9, the swell became longer and further speed reductions to 75 r.p.m. were made.

On the 9th the barometric pressure steadied during the morning, the wind moderated and the swell became confused, full sea speed was, therefore, resumed. At 1100, however, the pressure began to fall again, see barogram, and by 2100 the wind had increased to become W'S, force 9. At 1930 the pressure steadied then rose a little, full sea speed was being maintained as the vessel pitched moderately in a westerly swell.

On the morning of the 10th the barometric pressure was falling rapidly and the wind was now S'E, force 7. At 0924 the vessel encountered a heavy rain squall during which the wind freshened and veered to W'N, force 11 and the pressure began





to rise. By 1100 the wind had veered further to become NW'N, force 11 and a heavy swell was running in from the west. Two hours later the vessel was hove to in a very heavy WNW'ly swell, the wind had become WNW, force 12 and very heavy rain and reduced visibility due to driving spray were being experienced. By 2200 the weather improved a little as the wind decreased to NW'W, force 7, the pressure continued to rise and the swell had become long and confused. Engine revolutions were now increased slowly to 65 r.p.m.

At 0300 on the 11th the pressure began to fall again and at 0830 the air temperature rose from 10·5 to 16·6°C as the cloud began to dissolve. By 1100, however, whilst the pressure was rising rapidly, the wind freshened to become W'S, force 10–11, the swell became confused. At 1700 the vessel was hove to again in a very heavy confused swell.

By 0001 on the 12th the wind had decreased slightly but the vessel remained hove to until 1200, by which time the swell had moderated sufficiently to allow an increase in speed to 65 r.p.m. During the remainder of the day the wind remained steady at WNW, force 8 and the pressure continued to rise slowly.

Throughout the 13th the weather improved until by the end of the day the wind had become W'ly, force 2–3. Although the swell was still heavy, full speed was resumed safely at 2230.

By 1200 on the 14th the swell had decreased considerably and comparatively good weather was experienced during the remainder of the voyage to New York.

Position of ship at 1200 on the 7th: 50° 00'N, 2° 42'W.
Position of ship at 1200 on the 14th: 40° 24'N, 48° 24W'.

Note. The chart which accompanies this report shows the vessel's track across the Atlantic together with weather observations at the time indicated. The vessel's proximity to the low pressure systems explains the reason for the heavy weather experienced for such a continuous period.

VIOLENT THUNDERSTORMS AND ST ELMO'S FIRE

Mediterranean Sea

m.v. *British Holly*. Captain J. C. Wilson. Augusta (Sicily) to Lavera (France). Observers, Mr S. Gammage, 2nd Officer, Mr A. A. Kazi and Mr D. Banamal.

27 November 1978. At 1535 GMT a slight hail shower preceded an extensive area of violent thunderstorms. During the two hours that followed, the vessel was surrounded by almost continuous lightning discharges which consisted of brilliant single and forked flashes as well as multiple discharges. As many as a dozen or more single flashes were observed almost simultaneously over one or two points of the compass.

At about 1750 several points of light were observed on the main transmitting aerial which leads from the mast above the bridge to a mast well forward of the bridge front. Gradually the number of points of light increased until they completely covered the aerial. Each light was about 15 cm apart and was moving closer to the next one quite quickly. The lights took on a bluish cast.

At 1757 as we stood in the rain looking up at the aerial and wondering what we were observing, the penny suddenly dropped, so to speak, for, in the same instant, a flash of lightning occurred together with a tremendous hissing noise. The flash was accompanied by a clap of thunder which sounded like a naval gun in action.

Having picked himself up from behind the dodger and groped blindly back into the wheel-house, Mr Gammage ascertained that the aerial had suffered no ill-effect.

The small blue lights were again observed after the blinding flash, this time some greater distance apart from each other. However, the lights multiplied rapidly until at precisely 1800 they all seemed to merge to the accompaniment of a colossal flash and crack. This particular event was observed from inside the wheel-house—to quote the observer: 'the interests of better observation taking second place to the instinct for survival'.

Position of ship at 1800: 38° 48'N, 9° 18'E.

Note. We feel sure that the observers realized that as well as observing, and indeed experiencing, severe thunderstorms, they also witnessed St Elmo's Fire. This is described in the *Meteorological Glossary* in the following way:

A more or less continuous luminous electrical discharge of weak or moderate intensity in the atmosphere emanating from elevated objects at the earth's surface (lightning conductors, wind vanes, masts of ships) or from aircraft in flight (wing tips, propellors, etc.).

This phenomenon is usually bluish or greenish in colour, sometimes white or violet. It is accompanied by a crackling sound and occurs when an electrical field in the neighbourhood of the object becomes very strong as when a cumulonimbus cloud is overhead. The phenomenon is also termed 'corposant', i.e. ghost-like, because of its once-supposed supernatural nature.

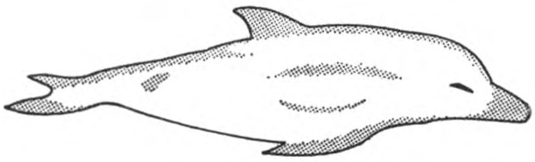
DOLPHINS

Eastern North Pacific

m.v. *Orcoma*. Captain T. J. Sax. Le Havre to Cristobal. Observer, Mr G. M. Baron, 3rd Officer.

8 November 1978. At 1500 GMT whilst the vessel was approaching Cutuco, El Salvador, and steaming at about 9 knots, Mr Baron was on the forecastle head when he observed five dolphins (four adults and one infant) swimming in and around the bow wave, see sketch. The family were obviously enjoying themselves taking full advantage of the free ride. Indeed, adds Mr Baron, one dolphin, about four metres long, was lying on its side motionless being carried along in the bow wave. None of the others attempted this but were content to swim along just forward of the bow. It was also noticed that the infant kept close to its mother, swimming slightly beneath her.

Approximate position of ship: 13° 10'N, 87° 49'W.



Note. Mr D. A. McBrearty of the Department of Anatomy, University of Cambridge, comments:

'The illustration is a very good representation of a Bottlenosed dolphin, *Tursiops truncatus*. This animal has a world-wide distribution in tropical and temperate waters.

'There are three nominal species, *Tursiops nuuana*, *Tursiops aduncus* and *Tursiops gilli*—the last named being the one most probably concerned in this report.

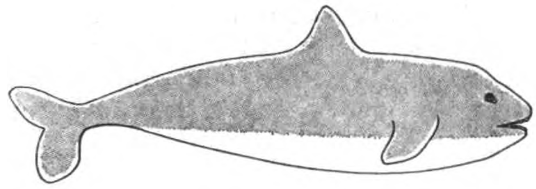
'It has been suggested that there are two forms of *Tursiops*, an inshore and offshore form, which vary in size. Other workers believe that there is only one species of *Tursiops* and that the smaller inshore animals are the young and adolescent members of the offshore species. Some radio-telemetry experiments have been done which support this last view, but more taxonomic work still needs to be done to determine the validity of separate species. Sexual maturity occurs in females at about 228 cm length and in males at about 250 cm length.

'Bow wave-riding is a great pastime with all members of the dolphin and porpoise family—they often use the large whales for this purpose as well as ships. The large bull which was on its side would be watching the observer and generally keeping an eye out for any danger sign to the group. Dolphins have excellent "sonar" but can only utilize it in a forward beam, therefore, if you come up from behind and alongside, they will roll onto their side or even jump clear of the sea in order to keep you in view.'

WHALES

South Atlantic Ocean

m.v. *Benhope*. Captain G. D. Mutch. Port Kembla (Australia) to Enstedvoerket (Denmark). Observers, the Master and ship's company.



30 October 1978. At 1100 GMT a whale, as shown in the sketch, was observed to jump out of the water at a distance of about 100 metres from the vessel; it attained a height of about half its length. It remained with us for 15–20 minutes, blowing every 20–30 seconds, then moved off in a north-easterly direction.

The whale was a purple-blue colour on the topside with a grey-white underside. It had a pronounced dorsal fin and a bump on the head just forward of the blowhole. It was about 10 metres long and had a girth of about 1·5 metres at its thickest.

Position of ship at 1200: 8° 06′S, 3° 30′W.

Note. Mr McBrearty comments:

'I believe this to be a Minke whale, *Balaenoptera acutorostrata.* It is the smallest of the rorquals with adult length of about 7·2 to 8·2 metres in males and 8 to 9·4 metres in females. Most animals found in the southern hemisphere do not have the distinctive white patch on the flippers.

'The name rorqual is taken from a Norwegian word and refers to the pleats or throat grooves of which there are about 50–60 on the underside of the animal.

'Distribution is world-wide but the animals seem to prefer the polar and temperate regions and are seldom seen in the tropics. They are found very close to the ice edge in the Antarctic and are often trapped and drowned when the sea ice freezes over.

'Schools of 100 animals have been recorded, but mostly they are found singly or in pairs. The Minke whale has become increasingly important to the whaling industry with the protection of the larger species. The catch in 1977 was 11 385.'

Eastern North Pacific

m.v. *Columbia Star*. Captain D. Brewster, Balboa to Los Angeles. Observers, Mr J. Clayton, 2nd Officer and Mr W. Copland, 3rd Officer.

15 November 1978. During the morning three whales, approximately six metres long, were observed close to the vessel; judging by their size and the shape of fin they were thought to be Minke whales. The presence of the vessel did not appear to disturb them in any way.

During the afternoon two killer whales, each about seven metres in length, passed within three metres of the vessel.

On the following morning two further Minke whales, about four metres in length were observed near to the vessel. These also were unperturbed by their close proximity to the vessel.

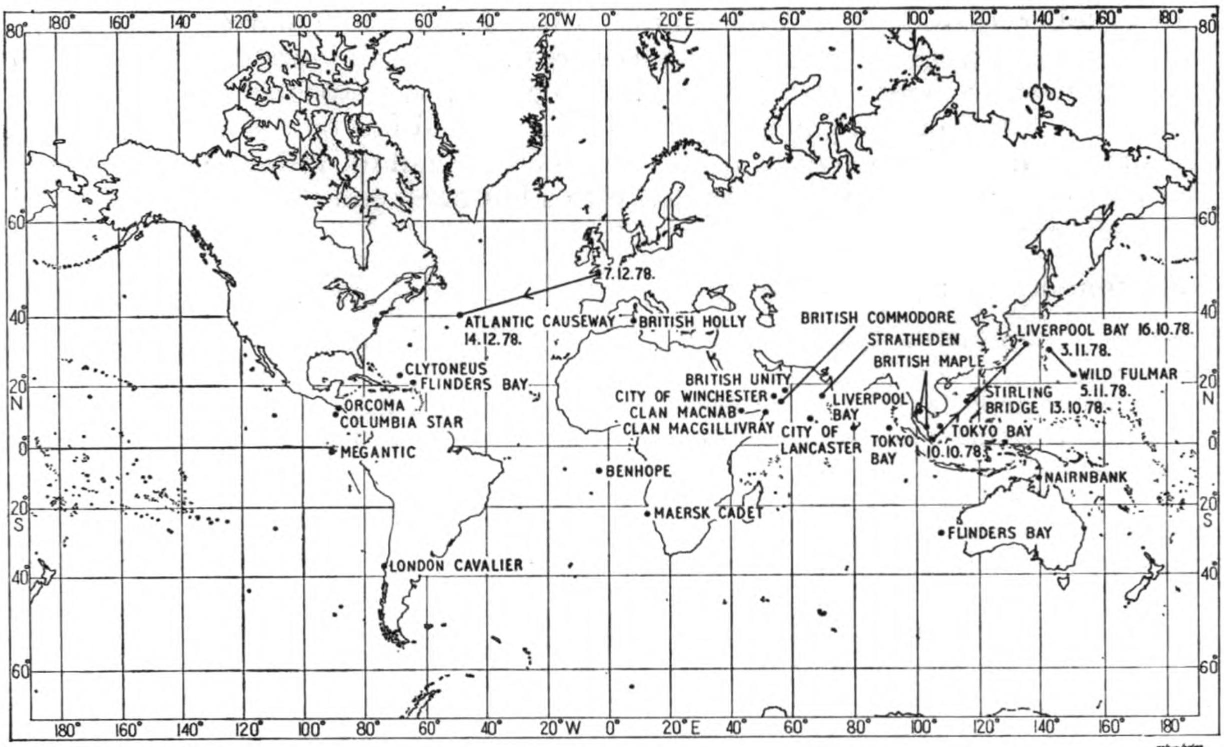
Position of ship at 1200 GMT on the 15th: 11° 03′N, 89° 29′W.

Note. Mr McBrearty comments:

'The Minke whale, *Balaenoptera acutorostrata* is a cosmopolitan species being found in all oceans of the world. One species only is recognized in the North Pacific and all have the distinctive white patch on the flipper. This flipper patch may be seen through the water if the whale is reasonably close. Minke whales have a habit of coming to the side of vessels at sea although it seems that it is mainly the younger animals who practise this behaviour.

'The food of Minke whales in the North Pacific includes krill and copepods as well as small fish such as sand lance (*Ammodytes* spp.) and anchovy (*Engraulis mordax*).

'The size of sexually mature animals is of the order of seven metres which is slightly smaller than the corresponding figure for the southern hemisphere. Calves may be produced at any time of the year but the peak months are June and December. Usually only one calf is born to each female per year after a gestation period of some 10 months.'



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

Eastern South Pacific

m.v. *Megantic*. Captain K. L. Row. Balboa to Lyttelton (New Zealand). Observers, Mr C. J. Dennis, 3rd Officer and Cadets S. J. Chapman and C. D. Quinn.

12 December 1978. At 1500 GMT a killer whale was observed within one cable on the port side of the vessel. It twice jumped clear of the water, each time twisting in mid-air and landing on its back. After this short display it swam away showing its dorsal fin only once. Distinctive black and white markings were observed on the back of the whale.

Position of ship: 2° 03'S, 90° 10'W.

Note. Mr McBrearty comments:

'It is not fully understood why some of these animals seem frequently to leap into the air while others do so less often. It certainly is a spectacular sight and the object does appear to be to make the largest splash and loudest noise possible. This might be the cetacean equivalent of "showing off" or of "drawing oneself up to full height"—it may, however, have a more functional use.

'We do know that the skin of cetaceans is quite different from that of other mammals, for instance, the surface cells are "alive" not keratinized as are those of land mammals. The dermis is also highly innervated with nerve fibres and endings. It may well be that, under certain circumstances, the whales get a build-up of loose cells and other debris on the surface which causes an irritation and that a good leap into the air has a relieving effect. Whales do indeed seem to enjoy being rubbed, scratched and stroked.'

FLYING-FISH

Arabian Sea

m.v. *City of Lancaster*. Captain A. W. Forrest. Vishakhapatnam (India) to Jeddah (Saudi Arabia). Observers, the Master and ship's company.

16 October 1978. Shortly after sunrise a flying-fish was found on deck. It was brought to the bridge where photographs were taken, see opposite page 188, and the following measurements made: overall length 25 cm, wing-span 28 cm, diameter of eyes 1½ cm, lower tail fin 5 cm, upper tail fin 4 cm and fins on the underside 5 cm. The upper part of the body was blue-black in colour and the lower part silver-grey. The state of sea at the time was rippled with a low swell and the height of the deck above sea level was about 5 metres.

Position of ship: 9° 16′N, 65° 18′E.

Note. Dr F. Evans of the Dove Marine Laboratory, the University of Newcastle upon Tyne, comments:

'The photograph is of a cypsilurid ("four-winger") flying-fish, it is not possible to say which one. Generally, four-winged fish are found closer to the coast, the two-wingers being more oceanic.

'There are several fisheries for coastal flying-fish and they are very good to eat. Did the observers notice the copepod parasite, like long pieces of string, stretching backwards from between the pair of ventral fins? These are not uncommon.'

SEALS

Eastern South Atlantic

m.v. *Maersk Cadet*. Captain R. T. Eynon. Lagos to Port Elizabeth. Observers, Mr G. W. Miller, 3rd Officer and Mr T. Enriquez.

13 November 1978. At 0525 GMT two seals were observed. They appeared to be about 1½ metres long and were black in colour. Their direction of travel was not clear as, at the time, they were taking avoiding action from the vessel—eyeing us with some curiosity as they moved by.

Position of ship: 22° 42′S, 12° 52′E.

Note. Dr Evans comments:

'These seals were specimens of the South African fur seal, not a true seal but related to sea lions (amongst other things they have small ear-lugs, not possessed by true seals, and a small distinct tail). They are found on the rocks and islands off the coast from Cape Cross (about 21°S) to Bird Island (Port Elizabeth). This pair, about 80 n. mile off shore, were probably females, judging by their size, the males being about half as large again.'

CRABS

Gulf of Aden

m.v. *Clan Macgillivray*. Captain T. E. Roberts. Suez to Mombasa. Observer, Mr A. J. Blackler, Chief Officer.

1 November 1978. A large number of crabs were observed swimming on the surface; they were red in colour and measured about 10 centimetres across. They were passing the vessel's side about one every ten seconds. Fifteen minutes after sunrise no more were seen.

Position of ship: 12° 15′N, 50° 43′E.

Note. Dr Evans comments:

'An interesting note of portunid crabs. Without a specimen I am unable to name them exactly, but a crab called *Charydis* which is red has been observed to swarm in the Indian Ocean and it may well have been this one.

'Portunids have the last pair of legs flattened into a paddle shape and some of them have been observed to swim at two knots.'

BIRDS

Western North Atlantic

m.v. *Clytoneus*. Captain C. S. Mackinnon. Holyrood (Canada) to Aruba. Observers, the Master and ship's company.

19 October 1978. At 1800 GMT the bird shown in the sketch was observed flying around the vessel. The neck and underparts were creamy white in colour and the head appeared to be light brown with black speckles. It had a hooked beak about 2½ cm long, talons, a wing-span of a little over one metre and was estimated to be 20 cm in height.

The bird made several unsuccessful attempts to fly off in a southerly direction and finally departed on the morning of the 21st. A similar bird was observed later, this was not considered to be the same bird since the first one was unsure of itself and had greater difficulty in landing.

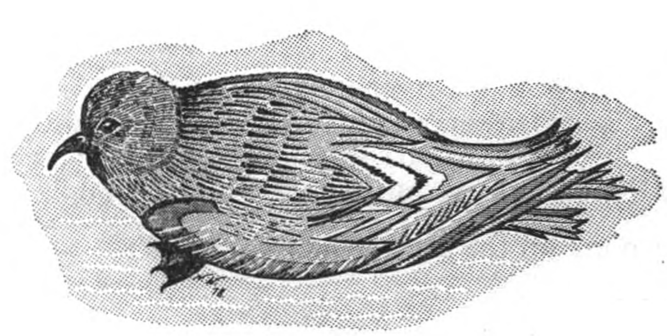
Position of ship: 23° 12′N, 68° 00′W.

Note. Captain Tuck, Chairman of the Royal Naval Birdwatching Society, comments:
'I consider this to be an Osprey, *Pandion haliaetus*. This bird regularly haunts this area.'

Western North Atlantic

s.s. *Flinders Bay*. Captain K. E. Howard. Rotterdam to Cristobal. Observers, the Master and Mr D. Saunders, 3rd Officer.

7 November 1978. At 1500 GMT a small bird, see sketch, was found on the starboard bridge-wing. Upon inspection it was found to have a damaged wing and so was taken into the wheel-house and placed in a box which was suitably cushioned. Attempts were made to feed the bird with sugar and water to help it regain its strength, these were, however, unsuccessful as, after about an hour, the bird died.



Numerous back-issues of *The Marine Observer* were consulted and it was discovered that the bird was a storm petrel. It was 175 mm in length and had a wing-span of 220 mm.

Position of ship: 21° 14′N, 64° 22′W.

Note. Captain Tuck comments:
'This is the Wilson's storm petrel. The bird would have a white rump patch, not shown in the sketch because the wings were closed. It would at this time be on southern migration.'

South China Sea

m.v. *British Maple.* Captain K. J. Mackay. Singapore to Bangkok. Observers, Mr C. J. Davison, 2nd Officer and Mr M. Reed, 3rd Officer.

11 October 1978. At 0300 GMT a small beautifully coloured bird was found sheltering abaft the bridge structure, see photograph opposite page 188.

The bird was about 12 cm long with a beak of about 4 cm. The body was rust coloured and the head blue-black. The feathers were so well knitted together as to give a velvet appearance.

The bird appeared to be very tired and made no attempt to escape when it was approached so that a photograph might be taken. After a two-hour rest it flew off.

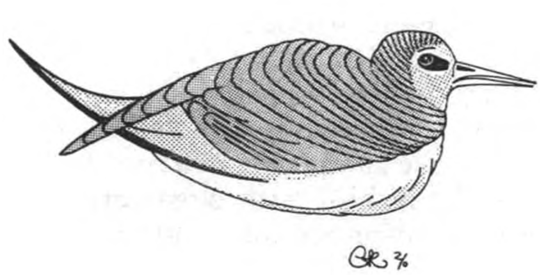
Position of ship: 6° 10′N, 103° 19′E.

Note. Captain Tuck comments:
'This is the Ruddy Kingfisher, *Halycon coromando.*'

Arabian Sea

m.v. *British Commodore.* Captain R. F. Shaw. Khor al Amaya (Iraq) to Abidjan (Ivory Coast). Observers, the Master, Mr C. J. Coxhead, 2nd Officer, Cadet C. D. Whittemore and Mr A. H. Khan.

3 October 1978. At 2200 GMT the noise of a disturbance was heard on the starboard bridge-wing and upon investigation a bird, as shown in the sketch, was found which, it was thought, had collided with the navigating bridge bulkhead.



The bird's beak was long and a distinctive orange-red in colour, a black mark in the shape of a diamond was observed on the beak near to the head. A large black mark extended from the eyes towards the beak. The tail was a fluffy white with black trimmings. The plumage was also white with dark edging.

Position of ship at 0001 on the 4th: 14° 42′N, 56° 36′E.

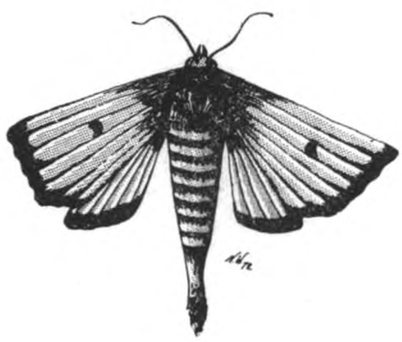
Note. Captain Tuck comments:
'This is the Immature Red-billed Tropic-bird, *Phaethon aethereus.*'

MOTH

Eastern Indian Ocean

s.s. *Flinders Bay*. Captain K. E. Howard. Fremantle to Suez. Observers, the Master and Mr N. Dabin, 4th Officer.

18 December 1978. As members of the ship's company were cleaning up the vessel the day after sailing from Fremantle, several moths were found. One of the largest, with an overall length of 21 mm and a wing-span of 24 mm, was found by the starboard lifeboat. It was taken up to the bridge and the sketch accompanying this observation was made by the 2nd Officer's wife. The wind was from the south-east and it was thought that the moth had come on board after our departure from Fremantle. The vessel was approximately 400 n. mile off the coast when the insect was found.



Position of ship: 28° 21′S, 107° 41′E.

Note 1. Mr T. Willett-Whittaker of the Department of Entomology, British Museum (Natural History), comments:

'We are unable to identify this species, it is probably a notodontid.'

Note 2. A notodontid is a moth of the family Notodontidae. This is an extensive family of moths which resemble the Noctuidae but are distinguishable from them chiefly by the venation (arrangement of veins) of the forewings and whose larvae are usually naked and often of grotesque form with lumps, spines and fleshy processes.

LIZARD

Gulf of Siam

m.v. *British Maple*. Captain K. J. Mackay. Bangkok to Bunya (Borneo). Observers, Mr D. A. Brown and Mr C. J. Davison, 2nd Officers and Mr M. Reed, 3rd Officer.

16 October 1978. At 0200 GMT a small lizard-type creature was observed roaming around the vessel, see photograph opposite page 188.

The creature was about 8 centimetres long, the tail accounting for half of the length. Its colour was like that of mud. It had four feet with five toes on each foot and a small frog-like head.

Position of ship: 10° 48′N, 101° 30′E.

Note. Mr E. N. Arnold of the Department of Zoology, British Museum (Natural History), comments:

'This animal appears to have been a gecko.

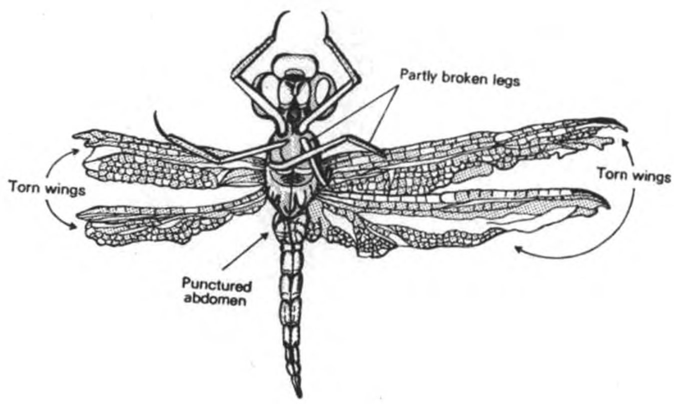
'Geckoes are lizards belonging to the family Gekkonidae. There are about 650 species found in the warmer parts of the world, about half of which have adhesive pads on their toes with which they climb. Most species are largely nocturnal and many of the climbing forms enter houses where they may be seen on walls and ceilings. They often wait by lights for their insect prey. It would be reasonable to expect them to live, at least for a time, on board a ship.'

DRAGON-FLY

Arabian Sea

m.v. *Stratheden.* Captain M. H. Wilson, Keelung to Dubai. Observer, Mr B. N. Odemba, 3rd Officer.

26 November 1978. At 0410 GMT a dragon-fly was observed clinging onto the bulkhead near the wheel-house. The insect was easily captured and, upon examination, it was observed that some legs were missing or broken, there was a large hole in the abdomen through which all the abdominal fluid had escaped and the wings were torn at the edges, see sketch. There was some movement in the head, legs and mandibles. It was thought that the insect had either lost a battle with an enemy or had sustained damage during the strong to gale force winds experienced during the past few days.



The insect died soon after capture whilst Cadet S. James was making the sketch.

Position of ship: 16° 00'N, 70° 00'E.

Note. Mr E. A. Jarzenbowski of the Department of Entomology, British Museum (Natural History), comments:

'This could well be *Pantala flavescens*, Fabricius, a circumtropical species of Libellulidae.'

BEETLE

Arabian Sea

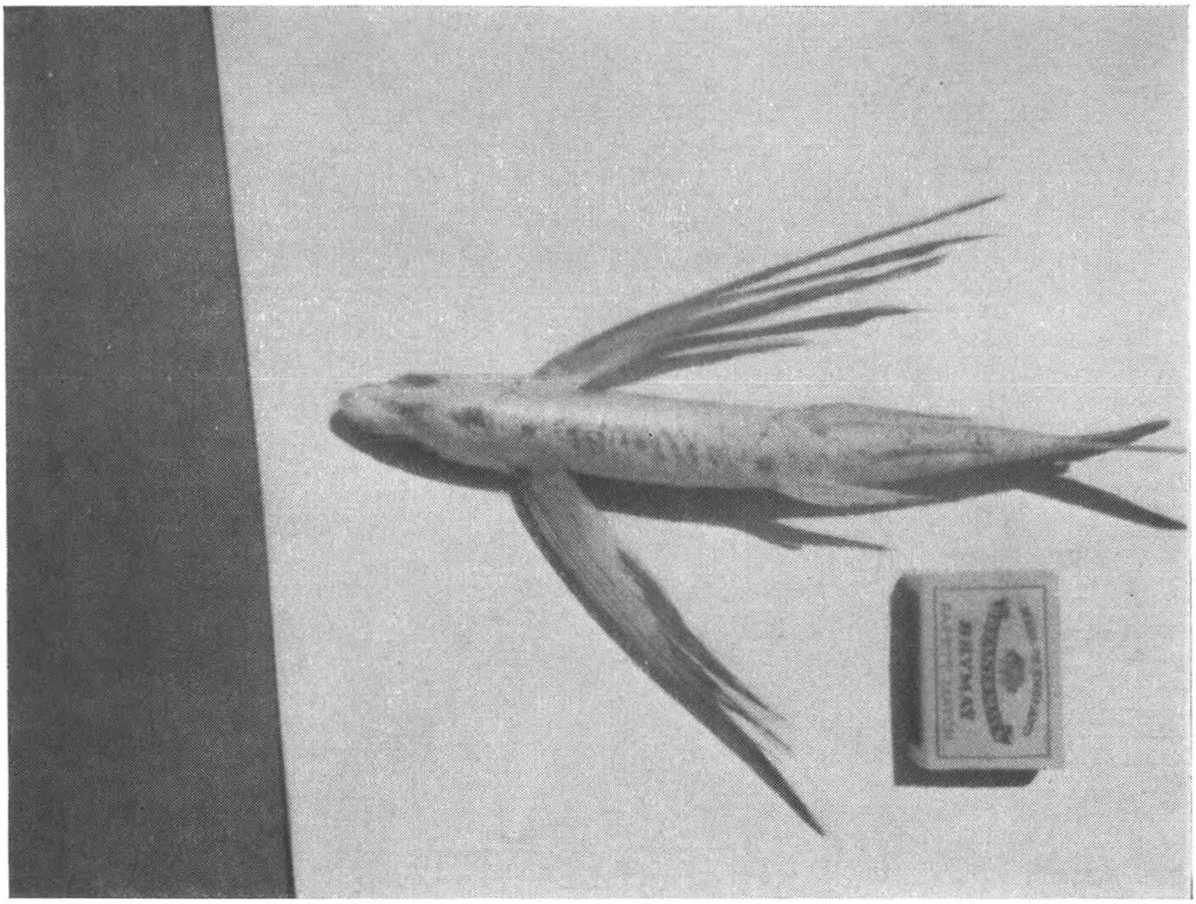
m.v. *City of Winchester.* Captain H. Swinney. At anchor off Salalah. Observers, the Master and ship's company.

17 October 1978. At 1800 GMT a large black beetle flew onto the bridge-wing. It was approximately four centimetres in length, had six legs, retractable wings and a 'rhino-shaped' head, see sketch.

Position of ship: 16° 01'N, 54° 02'E.

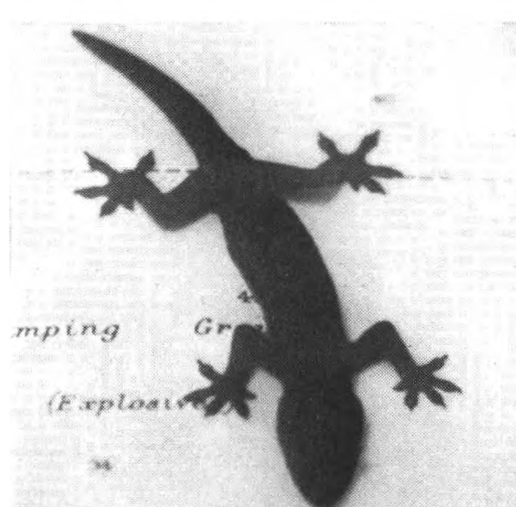
Note. Mr M. J. D. Brendell of the Department of Entomology, British Museum (Natural History), comments:

'I would suggest that the beetle almost certainly belonged to the genus *Heliocopris* and that the species was most probably *gigas* Linnaeus. This is a large beetle capable of strong flight. As with many insects it is attracted by artificial light and will often fly towards such a light



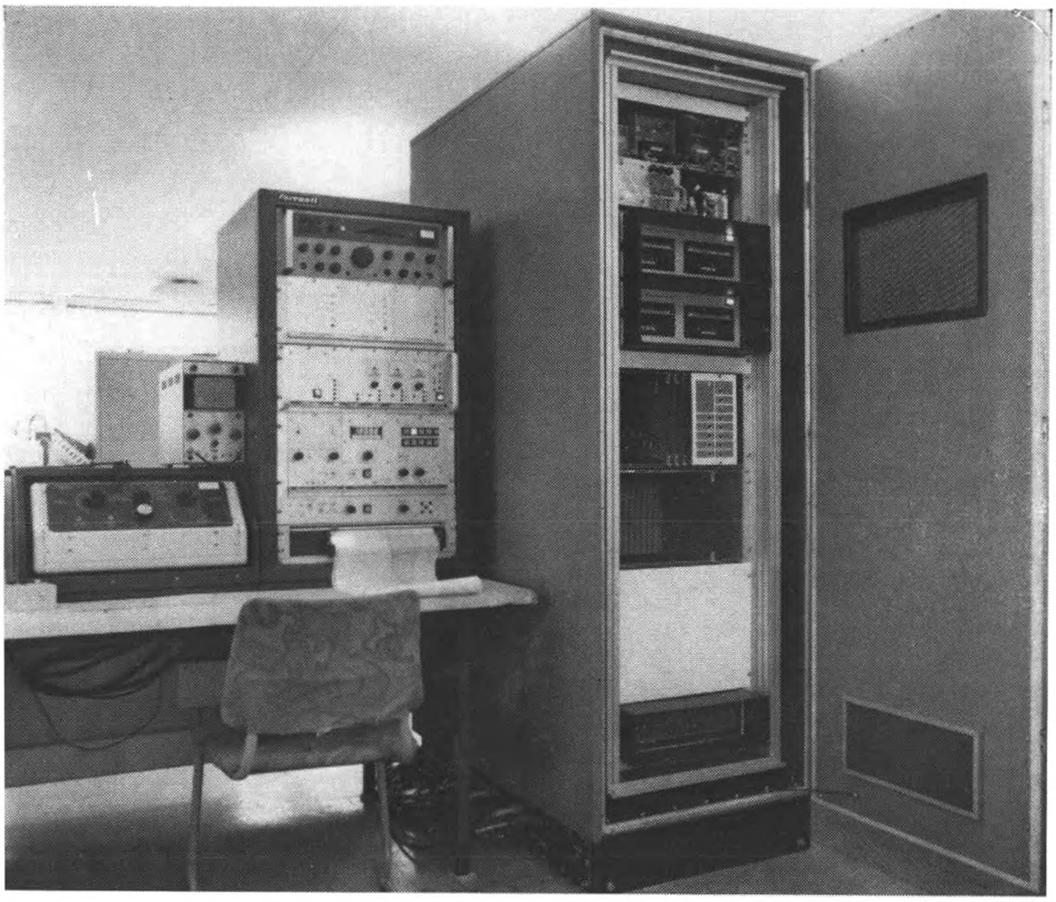
Flying-fish found on board City of Lancaster (*see* page 183)

Ruddy Kingfisher on board British Maple (*see* page 186)

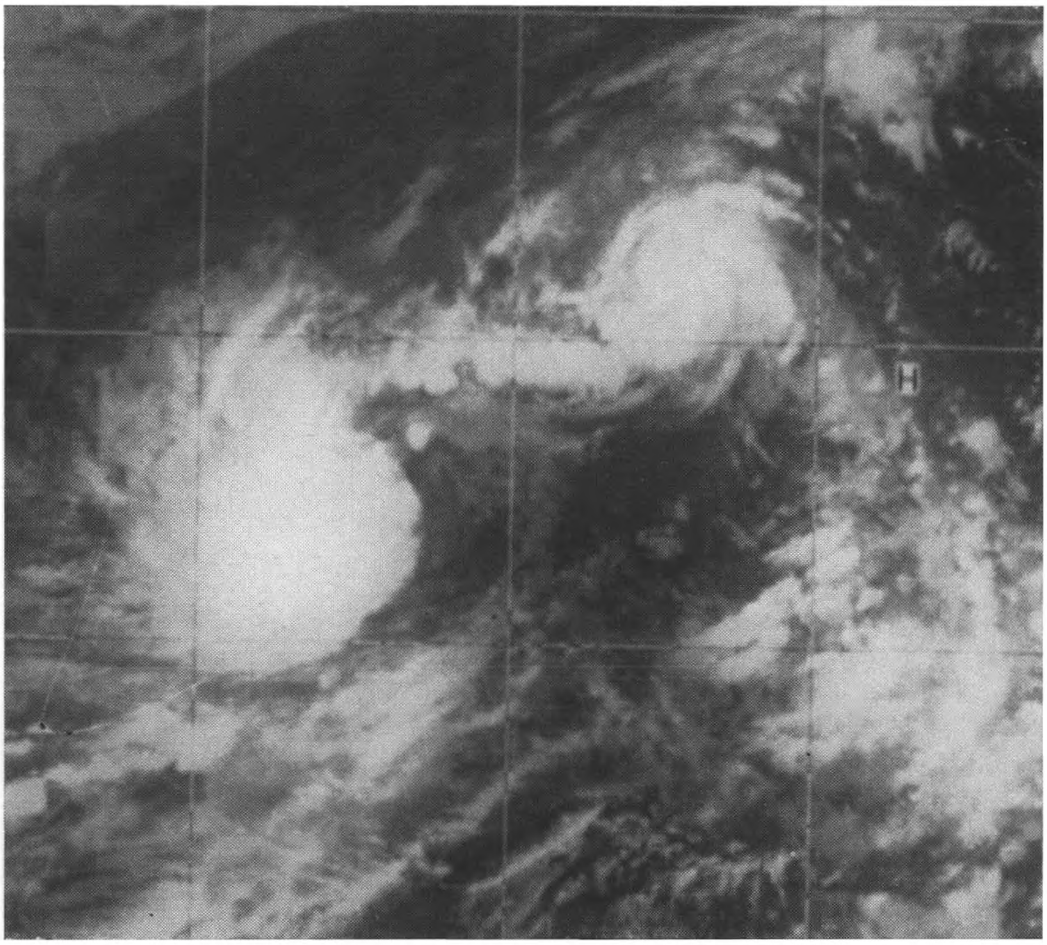


Gecko found on board British Maple (*see* page 187)

opposite page 189

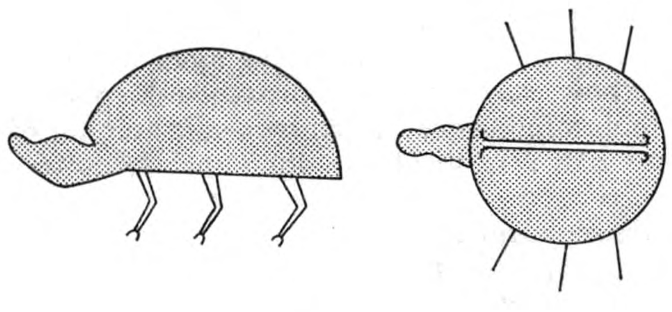


Computer and other ground station equipment for processing signals received from the radiosonde (*see* page 195)



The mercator projection of the tropical ocean shows typhoons Nina and Ora (*see* page 176)

National Oceanic and Atmospheric Administration photograph



source at night crashing to the floor half dazed when it makes contact with a bulb or lamp cover.

'*Heliocopris* belongs to the large world-wide family Copridae "Dung-Beetles". *Heliocopris gigas* and some of the other large species are sometimes called "Elephant dung-beetles" or "Tumblebugs" and are well known for their practice of rolling herbivore dung into large balls, using their back legs to do so. Each dung-ball is trundled into an excavated hole and a single egg deposited in a depression on its surface. This later hatches and the resultant larva burrows into and feeds on the contents of the dung-ball. As it feeds it grows, gradually increasing the size of the hollow within the dung-ball that accommodates it. After pupation the perfect adult beetle emerges from the "shell" of the now hollow dung-ball leaving, as it does so, a large hole in one side. These empty larval cells were long thought to be little earthen pots left by an ancient civilization.

'The adult male beetles usually have large "horns" protruding from the head and are said to use them when fighting one another. "Contending males are sometimes found dead with their horns interlocked" according to Gilbert Arrow in his book *Horned Beetles* (1951).

'The distribution of *Heliocopris gigas* includes Arabia as well as Egypt and India. There are specimens in the British Museum (Natural History) from Muscat (Oman).'

BIOLUMINESCENCE

South China Sea

s.s. *Tokyo Bay*. Captain D. G. Brown. Suez to Hong Kong. Observers, Mr D. J. Brewer, Chief Officer, Mr W. Broadbent, 2nd Officer and Mr G. Greendale.

6 November 1978. At 1750 GMT bioluminescence in the form of a system of rotating bands with no central hub visible was observed. The phenomenon, which was observed on both sides of the vessel, had a milky-white appearance and pulsated at the rate of two to three flashes every second.

On the port bow the bands were observed about 20° off the bow, moving towards the vessel and rotating in a clockwise direction. They disappeared from view then reappeared abaft the beam coming into the vessel amidships. On the starboard bow the bands rotated anti-clockwise and moved in towards the vessel. After moving into the vessel's side the bands sheered off astern then disappeared altogether.

The phenomenon was observed for about 10 minutes.

Weather conditions at the time were: dry bulb 27°C, wet bulb, 24, sea temp. 28, overcast, wind light variable.

Position of ship: 6° 00′N, 107° 30′E.

Note. Dr P. J. Herring of the Institute of Oceanographic Sciences, comments:

'A very interesting account of small phosphorescent wheels. The different directions of rotation and the fact that both wheels veered towards the vessel and then moved away again are particularly intriguing. This is not easily reconciled with their supposed origin as seismic disturbances in shallow water.'

Indian Ocean

s.s. *Liverpool Bay*. Captain J. Banna. Hong Kong to Suez. Observer, Mr I. Cairns, 2nd Officer.

31 October 1978. As the vessel was steaming along the south coast of Sri Lanka, a bright shimmer, having the appearance of the moon's reflection, was observed in the water on the port bow. As the vessel approached the phenomenon it was seen to be a large patch of bioluminescence caused by a vast number of flashing organisms. The patch was about half a nautical mile long and about 100 metres wide; it lay in a north to south direction.

Smaller patches of bioluminenscence had been observed at times during the previous three hours both close to the vessel and in its wake, and patches were observed for about an hour afterwards, however, none of those observed before or afterwards approached the size of this particular patch.

Weather conditions at the time were: air temp. 27·2°C, sea temp. 28, sea calm. The echo sounder showed 100 fathoms.

Position of ship: 5° 51′N, 80° 31′E.

Indian Ocean

s.s. *Tokyo Bay*. Captain D. G. Brown. Suez to Hong Kong. Observer, Mr J. Dixon, 2nd Officer.

4 November 1978. At 1830 GMT bioluminescence in the form of bands was observed for about half an hour. A small number of bands appeared close to the vessel, others were about 2 n. mile distant.

When close, single luminous organisms, about 3 cm wide and 10–20 cm apart, were seen to 'twinkle'. No effect was observed, however, when the Aldis lamp was directed onto the organisms.

The bands were about 1 km long and 5–10 metres wide. They lay in an east to west direction about 15–20 metres apart from each other.

Weather conditions at the time were: overcast with drizzle, sea temp. 29°C, wind W'ly, force 6–7.

Position of ship at 1800: 5° 48′N, 91° 30′E.

Note. Dr Herring comments:

'The accounts by the *Liverpool Bay* and *Tokyo Bay* probably deal with a similar phenomenon. This flashing luminescence, or "twinkling" of individual sources, is not observed very often; it may have been caused by large groups of small shrimps disturbing some other smaller luminous organisms. Shrimp shoals in Indian Ocean coastal waters are sometimes identified by local fishermen on the basis of the luminescence they cause.

'Shoals of small fishes may equally have been responsible. The flashing appearance suggests that the luminescing organisms were not dinoflagellates but something larger, possibly comb-jellies.'

RADIO SIGNAL DISRUPTION

Arabian Sea

m.v. *British Unity*. Captain G. M. Gough. Minā al Ahmadi to Djibouti. Observer, Mr P. J. Whiteley, Radio Officer.

1 October 1978. At 0635 GMT whilst communicating with Karachi Radio (strength 2) on the 8 MHz band, the signal was lost. Mr Whiteley then tried to contact Bahrain on 4 MHz, contact was established at 0652 (strength 2–3) but was subsequently lost whilst awaiting his turn. A brief tune on 4 MHz showed an almost complete lack of signals. At 0710 he tried to contact Portishead Radio on 22 MHz, normally strength 3–4 at this time, but again no signal was heard. Both receivers were working and both showed the same lack of signals. Tests with a signal generator showed gain of main receiver normal, substitution of aerials produced nothing—these were checked and found to be satisfactory. A test with a short-wave

broadcast receiver on the communal aerial showed loss of signals on all bands. There was no static noise normally associated with sunspot activity or electric storms—the weather was fine.

At 0810 signals from Portishead Radio were heard at strength 2–3, these later improved. Tuning through the bands showed that some signals were now being received on the 16 and 22 MHz bands, however, 12 MHz reception was still poor and nothing was heard on the 4, 6 and 8 MHz bands.

By 0900, 8, 12, 16 and 22 MHz reception had improved to normal but 4 and 6 MHz and MF reception was still poor. Bahrain Radio was heard strength 2.

By 0915 all bands were back to normal and Bahrain Radio was heard strength 4 on 4 MHz.

Subsequent communication with Portishead Radio and Bahrain Radio revealed that neither had experienced any fade-out, it seems, therefore, to have been a localized incident.

Position of ship: 18° 19′N, 57° 29′E.

Note. Mr R. G. Flavell, Chairman of the Propagation Studies Committee of the Radio Society of Great Britain, comments:

'I have examined the Meudon Ursigramme messages containing solar/geophysical data for the day in question and find that the Observatory at Toyakawa, Japan, reported solar flare activity in progress at 0734. Although the Radio Officer's observations began at 0635 the first definite signs of a short-wave fade-out seem to have occurred somewhere between 0652 and 0710. This is in close accord with a report from Hiraiso Radio Observatory, Japan (36N, 140E), of a gradual short-wave fade-out beginning at 0718, reaching a maximum at 0738 and ending at 0800 (signals from Portishead were heard again by the *British Unity* at 0810).

'The subsequent comments from Portishead and Bahrain, coupled with the fact that no short-wave fade-outs seem to have been reported from European Observatories, suggests that the *British Unity* was near the western limit of the zone affected.

'The following passage from *Sun, Earth and Radio* by J. A. Ratcliffe is relevant to the circumstances:

"The effect of a SID (sudden ionospheric disturbance) is mainly to increase the electron content of the D region and to increase the absorption, so that often the signal can no longer be received. During a sudden fade-out of this kind the signal becomes weak in a time interval of a few seconds and then returns to normal during the next three-quarters of an hour or so. Fade-outs can interrupt long-distance radio communications so suddenly and so completely that engineers have sometimes thought that the power supply to their receivers had failed. Because SIDs, and with them fade-outs, are caused by intense bursts of X-rays coming from the sun they occur only on the daylight side of the earth, and equally at all latitudes." '

EARTHQUAKES

Chilean Waters

m.v. *London Cavalier*. Captain G. Jacobs. At anchor, Lirquen. Observer, Mr W. Carmody, 3rd Officer.

21 December 1978. At 0416 GMT the vessel shuddered giving the impression that the main engine had started and stopped in a matter of a few seconds. All the lights in the village went out for several minutes and that same evening the fish were not biting although on the previous and following evening the fishing was good. It was also noted that the dogs in the village were restless and making a lot of noise.

Later it was discovered that there had been an earthquake, force 6 on the Richter Scale with the epicentre about 75 n. mile distant from the village. The only damage in the village seemed to have been a collapsed bar and, among the ship's company, the 2nd Cook suffered a broken leg and head injuries.

Position of ship: 36° 43′S, 72° 58′W.

Note. Mr Graham Neilson of the Institute of Geological Sciences at Edinburgh has made the following interesting and informative comments:

'The earthquake which gave rise to this report was centred in latitude 36° 29·5'S, longitude 72° 34·5'W and occurred at a depth of 30 n. mile below the earth's surface. The ship was only 20 n. mile from the epicentre and this probably explains the severe shaking felt by those in the *London Cavalier*. The magnitudes given for the shock are 5·6 body-wave and 5·3 surface-wave indicating that the event radiated more longitudinal wave energy than surface-wave energy. Probably a fair amount of energy was converted to a water-borne shock wave near to the epicentre thus mimicking an underwater explosion. Such reports from seafarers often mention the similarity of submarine earthquakes to depth charge explosions and this mechanism probably explains the similarity of the two phenomena.

'The time of origin of the earthquake was 0413 and 55 seconds GMT indicating that the shock waves took about two minutes to reach the vessel. Allowing for inaccuracies in the location of the focus and time given by Mr Carmody, the velocity of the disturbance was probably of the order of a little over one kilometre per second, close to the velocity of sound in water. This tends to confirm the suggestion that the water-wave was felt.

'On shore the event was felt at Concepcion (Intensity 6), Chillan (Intensity 5), Los Angeles (Intensity 5) and Talca (Intensity 4)—all these figures relate to the Modified Mercalli Intensity Scale (see below) which is a subjective estimate of the degree of shaking at a particular place.

'Intensity should not be confused with magnitude. Magnitude is the quantity determined from seismograms and is related to the energy released by the earthquake, thus all seismographs, irrespective of their focal distance should give about the same value for the magnitude of a particular earthquake. As stated above, intensity is a number assigned to the effects of a shock at a particular point and decreases with distance from the epicentre. Points of equal intensity can be corrected by a curve called an isoseismal and it is generally found that the epicentre lies within the highest isoseismal.'

Modified Mercalli Intensity Scale (1956 *version*)

Because the performance of masonry is such an important criterion for evaluating intensity, this version specified four qualities of masonry, brick or otherwise, as follows:

Masonry A Good workmanship, mortar and design. Reinforced, especially laterally, and bound together using steel, concrete, etc. Designed to resist lateral forces.

Masonry B Good workmanship and mortar. Reinforced, but not designed in detail to resist lateral forces.

Masonry C Ordinary workmanship and mortar. No extreme weaknesses like failing to tie in at corners but neither reinforced nor designed against horizontal forces.

Masonry D Weak materials such as adobe, poor mortar. Low standards of workmanship. Weak horizontally.

Intensity

I Not felt. Marginal and long-period effects of large earthquakes.

II Felt by persons at rest on upper floors or favourable places.

III Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt like heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.

V Felt outdoors, direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI Felt by all. Many frightened and run outdoors. People walk unsteadily. Windows, dishes, glassware broken. Knick-knacks, books, etc. off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken visibly or heard to rustle.

VII Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and architectural ornaments. Some cracks in masonry C. Waves on ponds, water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII Steering of motor cars affected. Damage to masonry C, partial collapse. Some damage to masonry B, none to masonry A. Fall of stucco and some masonry walls. Twisting fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down, loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX General panic. Masonry D destroyed, masonry C heavily damaged sometimes with complete collapse, masonry B seriously damaged. General damage to foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.

X Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.

XI Rails bent greatly. Underground pipelines completely out of service.

XII Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

Gulf of Aden

m.v. *Clan MacNab*. Captain W. J. Howson. At anchor, Djibouti. Observers, the Master and ship's company.

21 December 1978. At approximately 0410 GMT an earthquake took place. The vessel, which was lying alongside the berth, shook violently for about ten seconds, the shocks being transmitted through the water. The phenomenon awoke the entire vessel's company, but before most people realized what was happening, it was over.

Apparently Djibouti is subject to earth tremors and there are no buildings over three stories high in the city.

Position of ship: 11° 30′N, 43° 05′E.

Note 1. Mr Neilson comments:

'At present no data is available on the earthquake which gave rise to the report from the *Clan MacNab*.

'The observer is quite correct in his statement that Djibouti is subject to earth tremors and in 1973 a swarm of earthquakes caused much alarm there; the seismological observatory in Addis Ababa recorded about 60 events between 0800 and 1900 on 28 March. These shocks had their origin under the Gulf of Tadjoura but caused little damage on shore.'

Note 2. As a general comment on this observation and that received from the *London Cavalier*, Mr Neilson adds:

'Such data is always valuable as nothing has been done on the macroseismics of submarine earthquakes since Rudolph's work in the late 19th century. Thanks mainly to such reports as those received from these two ships we are starting to build up a file on recent events and in a few years it may be possible to classify the effects of submarine disturbance. This will be useful for such things as assessing possible damage to submarine cables.'

RESCUE AT SEA

Arafura Sea

m.v. *Nairnbank*. Captain B. J. Masey. Torres Strait to Penang. Observers, the Master and ship's company.

10 October 1978. At 1045 GMT when the vessel was 86 n. mile west of Carpentaria Light-vessel and steering a course of 270°(T), a distress signal—SOS—on a lamp was observed two points forward of beam. The Master was informed immediately, engines put on standby, a radar fix obtained of the vessel in distress and course altered to this position.

Upon reaching the vessel, which was 4 n. mile to the south of the *Nairnbank*, it was seen to be a ketch riding to a sea anchor with navigation lights on and main sail hoisted and sheeted. At 1143 the vessel was manoeuvred to within hailing distance and the ketch identified as the *Scorpius* from San Francisco. Communication was initially established by loudhailer and it was learned that the ketch had lost both rudder and propeller and required a tow to the nearest port—this message was relayed by our radio officer to Thursday Island Coast Radio Station. A message was relayed to us on VHF by the Australian ship *Darwin Trader* who was standing by to the effect that the Australian Coastal Surveillance Centre (ACSC), Canberra required further information and so at 1215 a lifeboat was lowered and despatched to the ketch.

It was found that the *Scorpius* had a Citizen's Band radio on board and communication was established by using the vessel's walkie-talkie. At 1230 the following information was relayed to ACSC: length overall—46 feet, displacement—44 000 lbs, rig-ketch, owner—Leroy F. Wood, port of registry—San Francisco, occupants—the owner, wife and baby daughter, colour—hull black, decks white, masts black, constructed of ferro-cement, destination—Indonesia, nature of distress—loss of rudder and propeller, no immediate danger to life, enough water and food for several days, morale good, vessel lying quietly.

At 1327 the following was received from Canberra via the *Darwin Trader*: 'Thank you for information, you are both relieved of standing by, a towing vessel will be arranged as soon as possible.' This information was passed on to the *Scorpius* and the *Nairnbank* then got under way and set course for Cape Wessel.

Position of ship: 10° 48′S, 139° 33′E.

Note. On 17 November when the *Nairnbank* had returned to the Australian coast, Thursday Island harbour was called on VHF to request further information about the *Scorpius* and it was learned that she was eventually towed into Thursday Island and was still there undergoing repairs. Between the *Nairnbank's* meeting with her and her arrival at Thursday Island, she had also lost one of her masts.

On 20 November upon the *Nairnbank's* arrival at Mackay, the Master received a letter from ACSC advising that the *Scorpius* was towed to Possession Island by the barge *Forbes Wilson* and then on to Thursday Island by the *Tenu* and arrived on or about 15 October.

Wan Bollins

EA

381

GRO

3 x

charts

841285

Cotidal &

Corange

cdr glem line

B.J &

adj waters

5058

All correspondence concerning this distribution to:-

The Marine Superintendent
Marine Division (Met O 1a)
Eastern Road
Bracknell
Berkshire
RG12 2UR

Telephone 0344 (Bracknell) 20242 Ext 2738

551.508.822

A Brief Introduction to the United Kingdom Mark 3 Radiosonde System

By R. E. W. Pettifer

Meteorological Office, Bracknell

(This article is reproduced from *Weather* March 1979, by kind permission of the Editor.)

For nearly 40 years one of the principal sources of information upon which the analysis of weather and weather forecasts has been based has been the results of a large number of simultaneous measurements of the temperature, humidity and wind at a series of heights within the atmosphere made at various world-wide locations. Such measurements are made regularly at fixed intervals of time and this knowledge of the state of the atmosphere in the vertical dimension is of central importance to the comprehension of the state of the atmosphere at some fixed time in the recent past and to the prediction of the state at some future time. At each place where the measurements are made the information is obtained by means of a small package of instruments, called a radiosonde, which is suspended beneath a large balloon. The balloon is filled with either hydrogen or helium gas so that it will carry the radiosonde aloft in free flight until eventually the balloon bursts and the radiosonde is returned to the ground by parachute. Many such instruments land in the sea and are lost but some are found on land and these are recovered for re-use and a small reward is paid to the finder.

There are three methods currently used to measure the winds in the atmosphere through which the balloon ascends. All of them rely on the fact that a freely ascending balloon will travel horizontally with the speed and direction of the wind that it encounters. In the radio-theodolite method the position of the balloon is determined by a measurement of the direction from which radio waves, transmitted by the radiosonde, reach a receiver on the ground. In the radar method a highly reflective target made of metallized mesh is attached beneath the balloon and the position of the target is followed with a radar set. The third method makes use of the LORAN or OMEGA radio navigation signals to locate the position of the radiosonde. A small receiver in the radiosonde picks up signals from three land-based LORAN or OMEGA transmitters and the changes in the phase differences between these signals can be used to follow changes in the geographical location of the radiosonde. This information, from which the winds are deduced, is transmitted by the radiosonde to the radiosonde receiver station on the ground.

Of these three methods of measuring the changes in the position of the balloon the radar method is the most accurate and is generally used in the United Kingdom, although the LORAN system is used for radiosonde flights carried out from British weather ships at sea.

The United Kingdom Radiosonde Mk 3

In late 1977 the Meteorological Office introduced into routine operational service at one upper-air station a new type of radiosonde designated Mk 3. During 1978 this radiosonde was introduced at all the United Kingdom upper-air stations and has thus completely replaced the now obsolete Mk 2b instrument. The new radiosonde is shown in Figure 1 and the photograph opposite page 196. It consists of three meteorological sensors, a thermometer, a hygrometer and a barometer, together with a package of electronics that serves to convert the measurements of temperature, humidity and pressure into radio signals and to transmit these signals

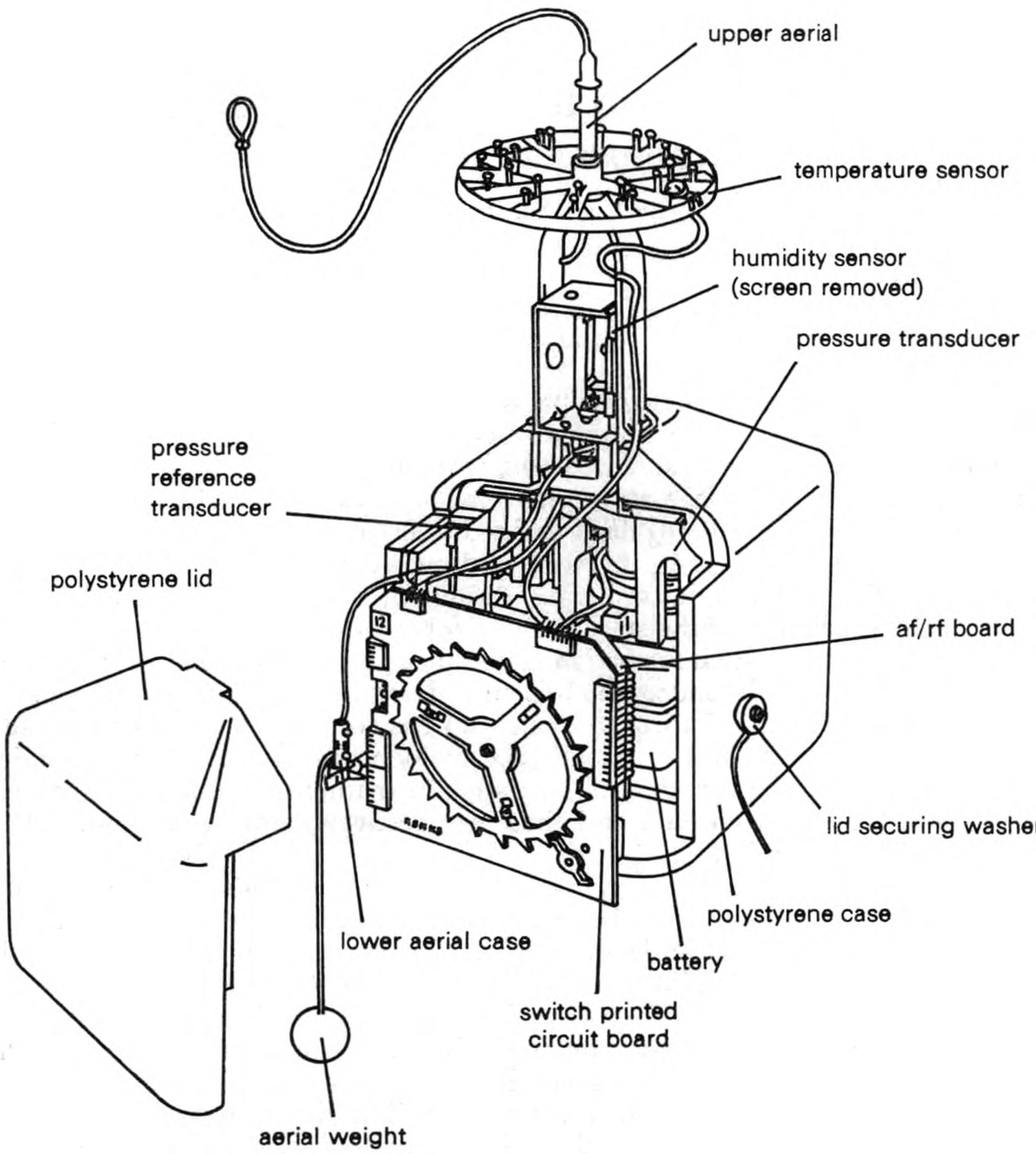
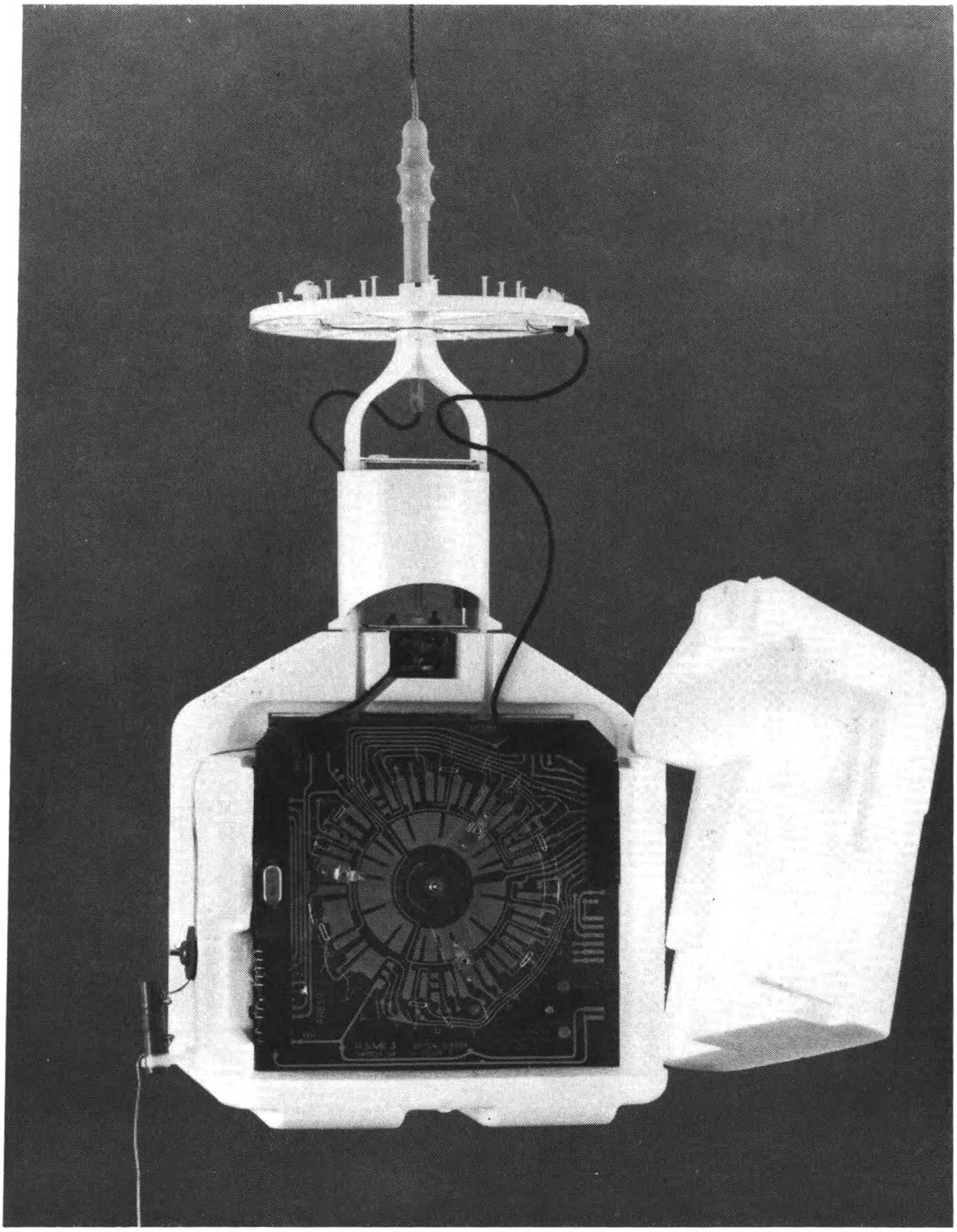


Figure 1. Schematic diagram of the Mark 3 radiosonde

to a receiving station on the ground. Once received, the signals are measured and decoded in a computer-controlled processor so that the meteorological information may be extracted from them.

The radiosonde thermometer consists of two rings of very fine tungsten wire, the electrical resistance of which varies substantially and rapidly when the wire is subjected to changes of temperature. The wires are wound into two helical coils and mounted on a white, plastic, ring-shaped former that is itself mounted symmetrically on top of the radiosonde assembly. Although this exposed position puts the fragile wires at risk of breakage, so that they rarely survive a descent and landing, it is needed so that the thermometer is immediately affected by any variation of air temperature encountered by the radiosonde. The changes in the electrical resistances of the wires are used to vary directly the oscillation frequency of a simple resonance circuit formed of resistances and capacitances. The oscillations that are produced are amplified and used to amplitude-modulate a radio wave with a frequency in the range 27·5 MHz to 28·0 MHz which is produced by a miniature transmitter in the

opposite page 196



The Mark 3 radiosonde. The instrument measures 20·5 cm along its base (*see* page 195)

opposite page 197

Presentation of Barograph on 24 April 1979 at Newcastle Weather Centre; left to right: Captain J. D. Hellings, Mrs Hellings and Mr F. H. Bushby (*see* page 205)

Photo: Searl & O'Rorke (Industrial) Ltd radiosonde. The resultant signal is transmitted through the radiosonde aerial and is received on a radio set at the upper-air station from which the radiosonde was released.

The hygrometer is a piece of Goldbeater's skin which is stretched between a fixed brass mount and a small parallelogram spring. As the device encounters changes in atmospheric humidity the length of the skin changes; it increases as the air becomes more moist and shrinks as the air becomes drier. To the free end of the skin there is attached a short ferrite rod which is free to penetrate the hollow centre of a small wire coil wound upon a cylindrical ferrite former. As the position of the ferrite rod within the coil core changes, so does the electrical inductance of the coil. These changes of inductance are used in a manner similar to the resistance changes of the thermometer to vary directly the oscillation frequency of an inductance-capacitance resonance circuit and, as before, these oscillatory signals are radioed to the ground. The hygrometer is mounted below the thermometer on the top of the radiosonde, see Figure 1.

The barometer is used primarily to ascertain the height of the radiosonde in terms of atmospheric pressure which decreases smoothly with height. It is housed completely within the moulded polystyrene body of the instrument and is further protected by a separate polystyrene container. It is a very high quality aneroid capsule made of a nickel alloy, and it is mounted in a specially designed frame which, by differential expansion, partially compensates for the effects of changes of temperature on the accuracy of the pressure measurement. One side of the aneroid capsule is fixed to the frame but the other side is free to move in response to changes in pressure; it moves outwards as pressure decreases and inwards as pressure increases. These changes in shape are turned into electrical oscillations in exactly the same way as are those of the hygrometer skin. A ferrite rod attached to the free face of the aneroid capsule moves up and down within the core of a coil; the movements change the inductance of the coil and thus the frequency of the oscillator circuit.

The Mk 3 radiosonde is capable of making very accurate measurements of pressure, temperature and humidity and to ensure that the accuracy is maintained throughout the course of an ascent, a check must be kept on the way in which the decrease of temperature to which the radiosonde is subjected affects the performance of the electronics. For this purpose there are three 'reference' elements included in the instrument. The most obvious of these is the pressure reference element which is housed in a small polystyrene box alongside the pressure aneroid in the body of the radiosonde. This element has a ferrite rod which will move within its coil only in response to changes in temperature. The temperature response of the device is arranged to match closely that of the pressure aneroid so that by monitoring small changes in the frequency of the oscillatory signal produced by the pressure reference element we may calculate corrections to be applied to the pressure measurements that will complete the compensation for temperature effects. The other two 'reference elements' are electrical resistances specially chosen so that they have only a very small response to changes in temperature. They are permanently soldered onto the electrical circuit board and by monitoring changes in the frequency of the signals produced by these resistances when they are connected in place of the thermometer, we can eliminate from the temperature measurements errors that arise because changes in temperature have affected electrical components other than the thermometer.

The radiosonde may thus, at any time, transmit any one of six different signals: pressure, temperature, humidity, pressure reference, temperature reference (1) and temperature reference (2). It is obviously necessary to arrange in some way that these signals are transmitted in a regularly recurring sequence. This is achieved by means of a three-pole commutator switch which has 39 electrical 'ways' or independent circuit connections. The switch consists of a five-inch diameter acrylic gear wheel which is centre mounted on the face of a specially designed printed circuit board. The inner face of the gear wheel carries three wiper contacts which in each allowed position of the wheel make one of the required electrical connections. Each time the position of the wheel changes the signal being transmitted also changes. The transition time between signals is 0·3 seconds and the time between successive movements of the gear wheel, i.e. the signal duration is 0·7 seconds. The switch is driven by a small two-arm rotor which engages in the teeth of the gear-wheel and pulls it round. The rotor is turned by a miniature electric motor which drives through a reduction gear chain made of plastic gears housed in a plastic gear box. The motor and gear box assembly are mounted on the rear of the switch-board.

The meteorological variable of greatest interest is the temperature, followed, in the lower atmosphere at least, by the humidity. Pressure, because of the regular way in which it decreases with height, is readily deduced from a smaller number of measurements than are necessary for the other two. In view of this, the order of the signals transmitted from the radiosonde is: *P*ressure, *T*emperature, h*U*midity, *T*emperature, *R*eference, *T*emperature, h*U*midity, *T*emperature or, in abbreviated form, PTUTRTUT.

The reference signal progresses cyclically from the pressure reference through the two temperature references and back to the pressure reference. From the signal times given above it is easy to deduce that we measure pressure once every 8 seconds, humidity once every 4 seconds, temperature once every 2 seconds and a particular reference value once every 24 seconds of the flight. A balloon will typically ascend at a rate of 5 or 6 metres per second to a height of about 30 kilometres so that through the 30 kilometres we may expect a pressure measurement roughly every 35 metres, a humidity measurement roughly every 25 metres and a temperature measurement roughly every 10 metres.

The electrical power for the radiosonde is provided by a small battery carried in the lower section of the main body of the instrument behind the switch and circuit boards. The battery is a lead-acid-zinc accumulator and the cells are filled with semi-concentrated sulphuric acid. The case of the accumulator is made of rigid polythene and the whole device is carefully wrapped in a polythene bag. An amount of absorbent wadding sufficient to soak up all the acid is included in the packaging so that when the radiosonde returns to earth there should be no danger from acid spills, although it is of course advisable to handle the battery pack with caution. By the time the radiosonde reaches the ground, the battery will normally be exhausted and the instrument will no longer be functioning. Occasionally, however, the switch may still be turning if an instrument is found very soon after it lands.

The radiosonde in use

Once the radiosonde is airborne, the signals are transmitted continuously to the ground where they are received at the station from which the instrument was released. Since the radio transmitter in the radiosonde is crystal controlled, each station can operate radiosondes on its own allocated frequency and the instrument flown by one station will not interfere with those flown from other stations.

A typical arrangement of ground station equipment for use with the Mk 3 radiosonde is shown in the photograph opposite page 189. There are eight upper-air stations in the United Kingdom from which radiosondes are launched twice each day, at midnight and midday GMT. At the ground station the frequency of the received signal is measured and is fed automatically to a mini-computer. Within the computer are stored all the calibration data that describe the variations of the radiosonde signal frequencies with changes in temperature, pressure and humidity, together with a complex set of instructions that allows a very large number of measurements made by the radiosonde to be evaluated, sorted out, examined for quality and finally selected for retention if they are meteorologically important. The calibration data have to be fed into the computer afresh for each new radiosonde sensor that is used since each one is individually calibrated before use, but the instruction set for processing the measurements forms a permanent computer program. Because the evaluation and selection of the data must be carried out at the same time as the information is received from the radiosonde, the computer must deal with tasks in 'real-time'. This results in a large and complex program which requires a computer core store capacity in excess of 40 000 'words'. However, by splitting the computation of the data into three independent tasks that can be performed in turn, one before the balloon is launched, the second whilst the balloon is ascending and the third after the balloon has burst, the actual size of the core store required can be kept down to about 32 000 'words'.

The results of the computer evaluation of the data are twofold. A detailed list is provided of all the 'significant', i.e. meteorologically important, measurements of temperature, humidity and wind, together with the pressure (height) in the atmosphere at which they occurred. This list is eventually filed in a permanent computer archive held at the headquarters of the Meteorological Office at Bracknell. The station mini-computer also compiles a much smaller list of the most important of the significant measurements and then assembles this information into an internationally understood code. This coded message is produced by the computer in two stages; the first part is provided when the radiosonde reaches a height of about 18 kilometres and the rest a few minutes after the balloon bursts. These messages are sent directly from the upper-air station to the international communications centre at Bracknell by means of a land-line connected to a teleprinter and from there, within a few minutes, they will have been dispatched to any country that wishes to receive and use them for weather analysis and forecasting.

The United Kingdom Mk 3 Radiosonde System is the first fully automatic upper-air measurement equipment to be introduced on a routine operational basis anywhere in the world. It is now providing regular measurements of upper-air temperatures, humidity and wind of a quality well in excess of any hitherto available and is likely to form the principal means of acquiring these data in the United Kingdom for at least the next 20 years.

551.515.13:629.12

Anatomy of a Storm

By Richard W. James

(US Naval Oceanographic Office, Suitland, Md, USA)

Reproduced by kind permission of the Editor, *Mariners Weather Log*.

A major storm developed in the North Atlantic during 9–12 September 1978. One of the ships that felt the force and fury of this storm was the *Queen Elizabeth 2*, bound for New York from Europe. Early on 11 September the *Queen Elizabeth 2* encountered a 'very heavy south-west sea and swell with the wind gusting to force 12', see Figure 1. Heavy seas caused damage to forecastle rails and bow plates, a deck platform was torn loose and innumerable glasses, crockery and dinnerware were broken. About a score of passengers and two crew members were injured, although none seriously.

What are the characteristics of such a storm? High winds and high seas, obviously, but more significant is the rapidity with which the waves grow from merely bothersome to dangerous. Figures 2 to 6 illustrate this for the storm.

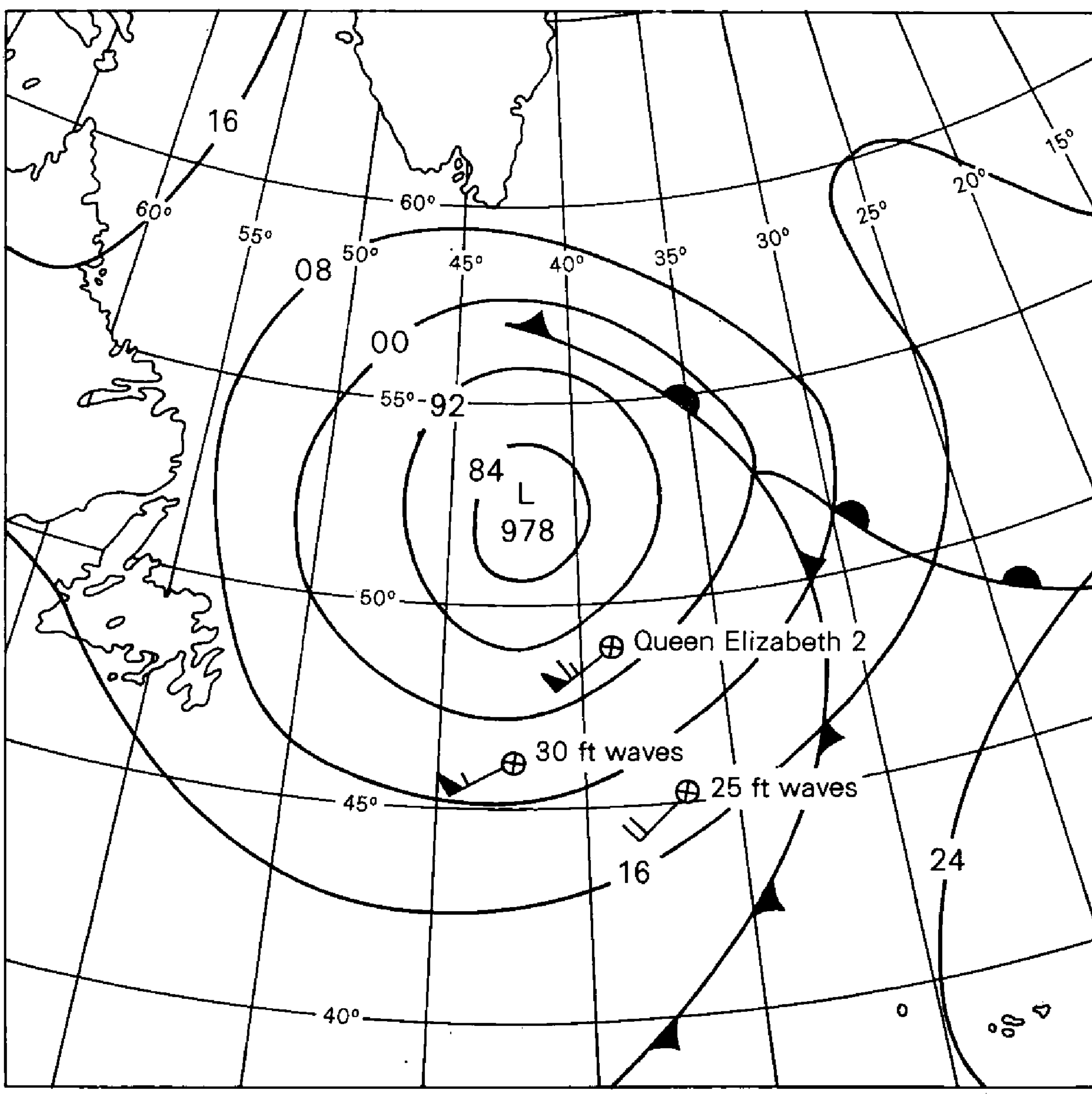


Figure 1. The 1200 GMT surface analysis for 11 September 1978 showing the position of the Queen Elizabeth 2

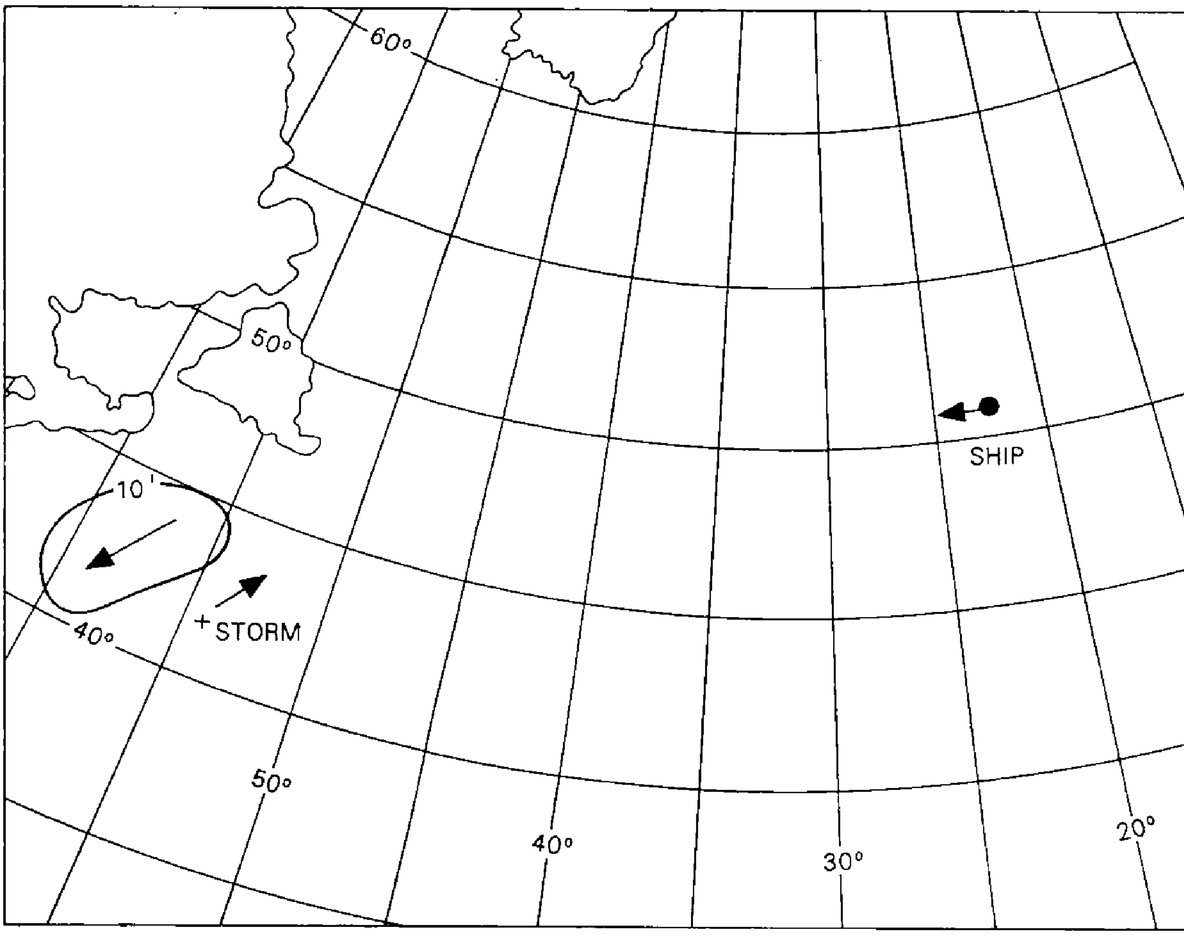


Figure 2. The 0600 GMT significant wave height analysis for 10 September 1978 showing the positions of the storm centre and the Queen Elizabeth 2

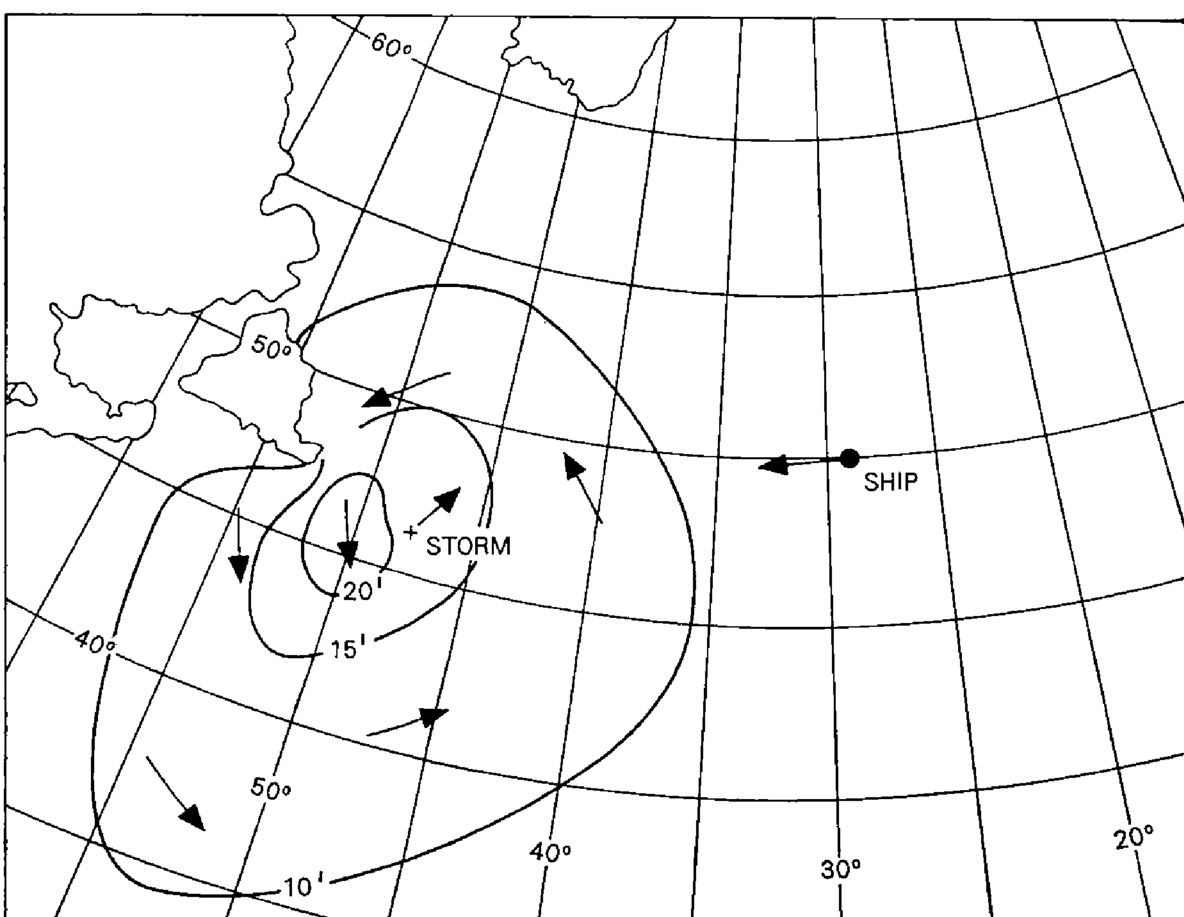


Figure 3. The 1800 GMT significant wave height analysis for 10 September 1978

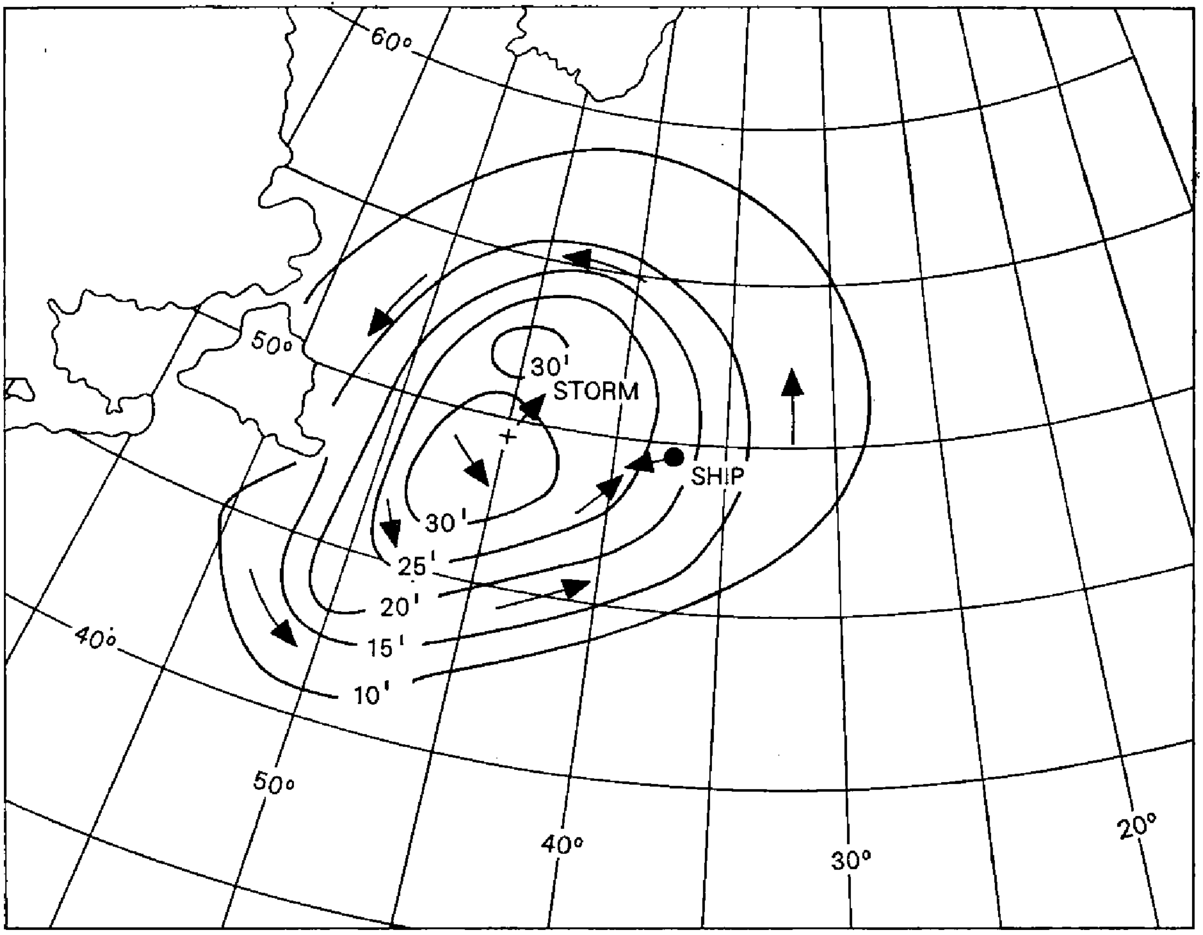


Figure 4. The 0600 GMT significant wave height analysis for 11 September 1978

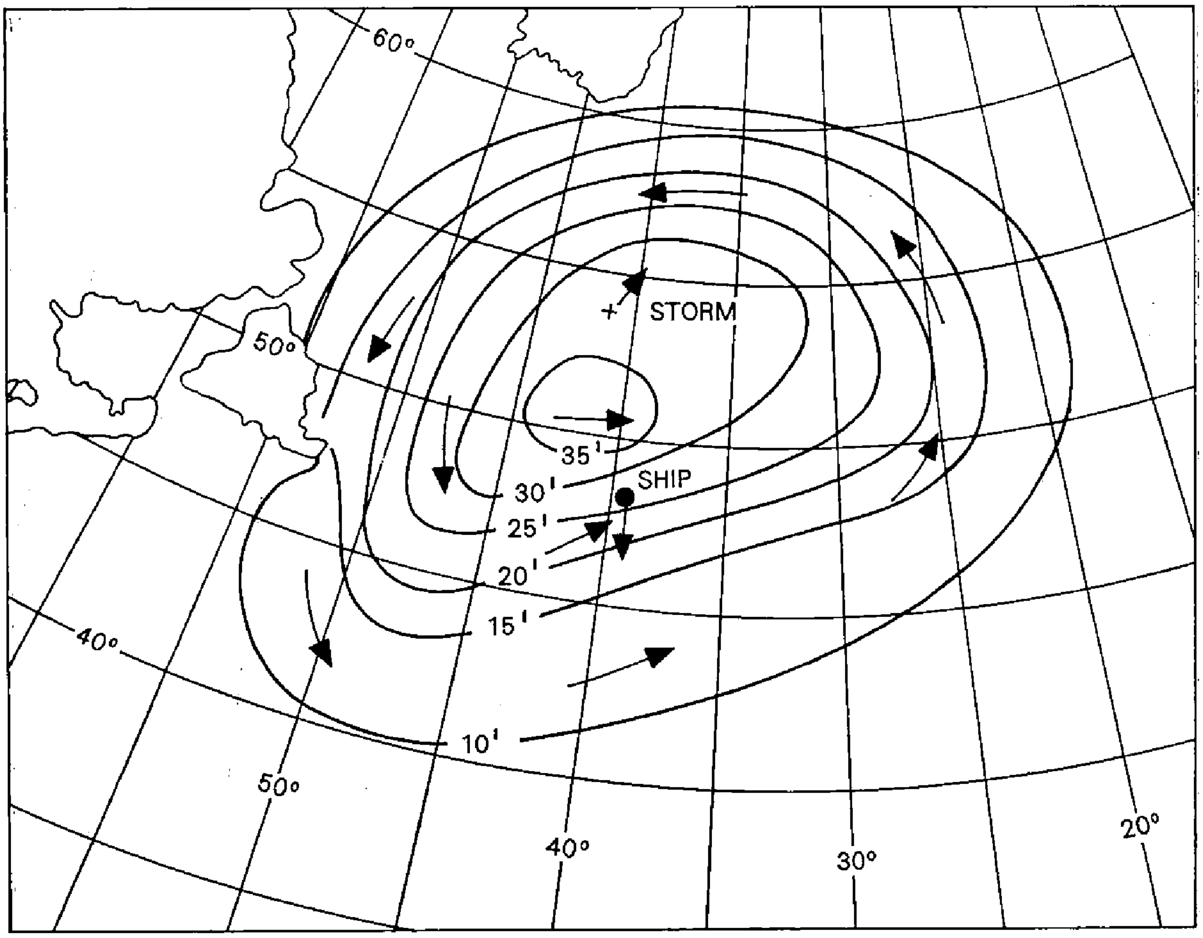


Figure 5. The 1800 GMT significant wave height analysis for 11 September 1978

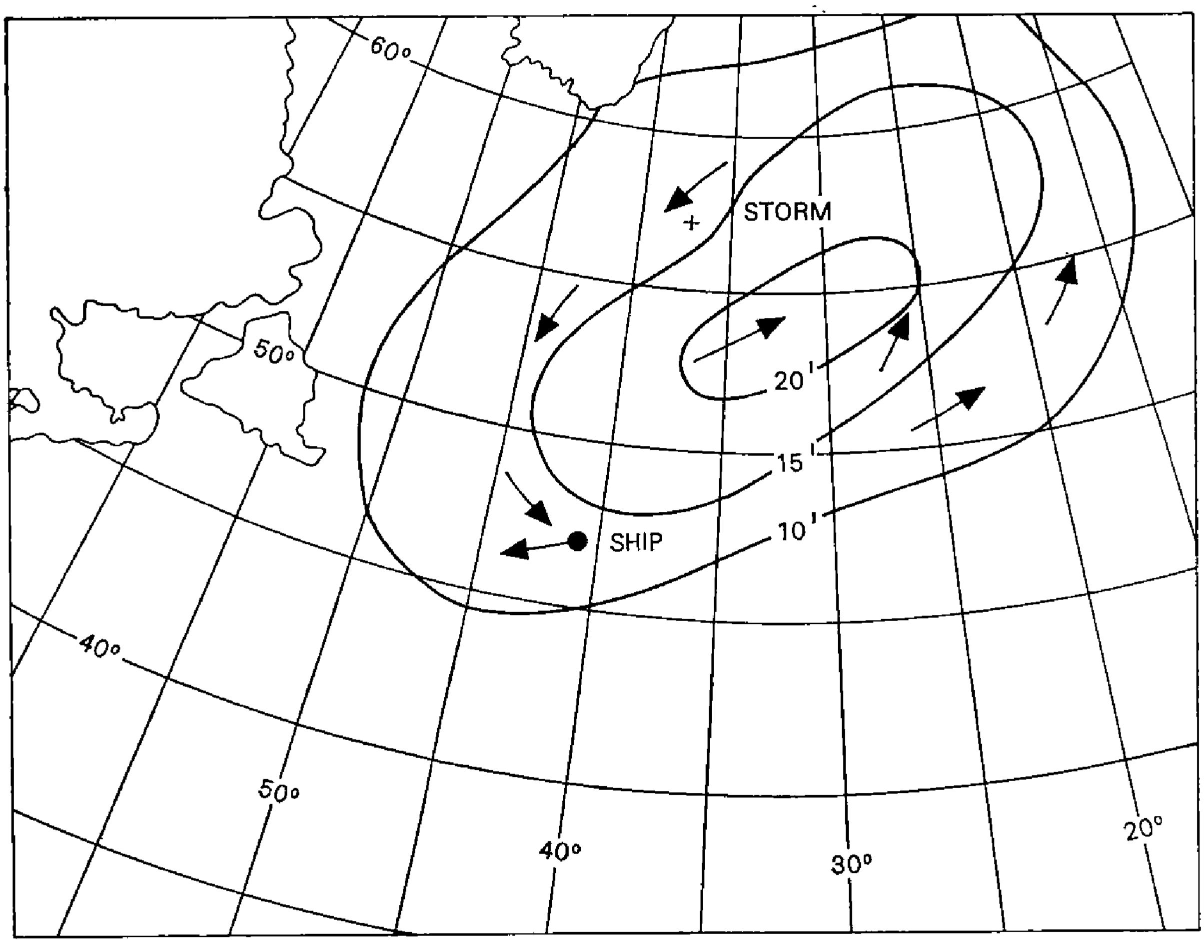


Figure 6. The 0600 GMT significant wave height analysis for 12 September 1978

Early on 10 September the storm was approximately 350 nautical miles south of Newfoundland, having moved south-eastwards from the coast of Maine during the previous 18 hours. Some deepening had occurred, but the only area in which waves of over 10 feet had been generated was to the north-west of the depression centre. This was the result of a strong pressure gradient created by the movement of a high pressure area in New England. At this time the *Queen Elizabeth 2* was some 1400 nautical miles to the east and experiencing only light winds.

Some 12 hours later, at 1800 GMT on 10 September, the storm had moved to the north-east and had intensified considerably. The region of waves of 10 feet or higher had expanded tremendously, see Figure 3, and waves of 20 feet in height were present in the western portion of the storm. The *Queen Elizabeth 2* was still proceeding westwards in light westerly winds with only a moderate swell.

Over the next 12 hours the storm became extremely dangerous as gale force winds developed to a distance of 500 nautical miles out from the centre. Waves in excess of 30 feet had been generated near the centre and the area covered by waves of 10 feet or higher had grown from the 180 by 300 nautical mile box 24 hours earlier to a circular region roughly 500 nautical miles in diameter straddling the northern shipping lanes. In other words, the storm area had not just doubled or tripled, but it had expanded by 1600 per cent in just 24 hours.

Figure 4 shows the wave conditions and the position of the *Queen Elizabeth 2* at 0600 GMT on 11 September. The ship was now well into the storm and, although not in the most dangerous quadrant, reported 'rough beam seas and heavy swell'. Speed had been reduced to ease the pitching. Two hours later the *Queen Elizabeth 2* changed to a southerly course and reduced speed even further. She reported 'pitching and pounding heavily, at times shipping water forward and heavy spray overall. Wind gusting to force 12. Very heavy south-west swell and very rough seas'.

During this period the ship's barometer bottomed at 991 mb—it had fallen 27 mb in 12 hours.

Her change in course was a good manoeuvre as the storm continued to intensify, see Figure 5. On her original westward course the *Queen Elizabeth 2* would have encountered increasingly rough seas of 30 to 35 feet. Instead, as shown by Figure 5, the ship and storm were now moving in opposite directions. Although the situation was still dangerous, at 1800 GMT on 11 September the *Queen Elizabeth 2* was headed for more moderate conditions.

The final wave analysis, see Figure 6, shows that by 0600 GMT on 12 September the ship was back on course with moderating conditions. The height of the waves was still over 10 feet and the north-westerly wind now force 7 but the worst was over. Although still dangerous, the storm was weakening.

How high were the maximum waves encountered by the *Queen Elizabeth 2*? As shown by the analyses, Figures 4 and 5, the 'significant' wave heights were of the order of 25 feet; this figure is consistent with the ship's reports. The 'significant' height of a wave, however, is defined as the average of the highest one-third of the waves. This is necessary since in a storm there is a large variation in individual heights—a fact reflected in the common adage 'every third wave is the highest'—or every fifth, seventh and so on.

Studies show that in a seaway where the significant wave height is 25 feet, a number of waves will reach heights of 30 to 35 feet and, at least once every 3 hours, an exceptional wave of double the height of the significant waves can occur. Thus, a single wave of 50 feet in height was possible during the time the *Queen Elizabeth 2* was closest to the storm centre. Closer to the centre of the storm, where the significant heights were 30 to 35 feet, the maximum wave could have been as high as 70 feet.

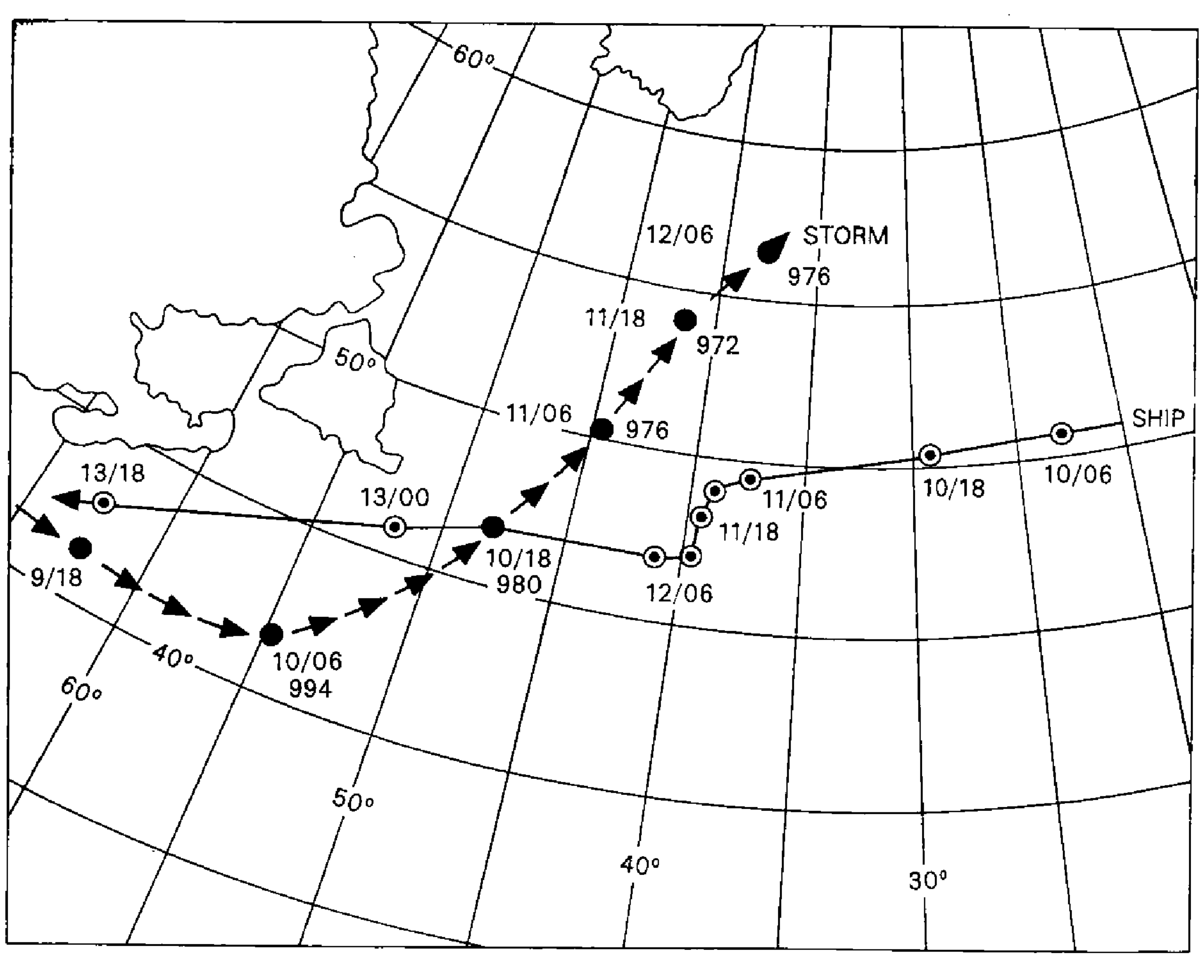


Figure 7. Tracks of the severe September storm and the Queen Elizabeth 2

Figure 7 shows the overall tracks of the storm and the *Queen Elizabeth 2*. The diversion to the south, which resulted in a late arrival in New York, was, nevertheless worth while, considering the potential risk had she adhered to the original track.

PRESENTATION OF BAROGRAPH

Barographs have been presented as Long-Service Awards to shipmasters since 1947 and although most of the presentations have been made at the Meteorological Office Headquarters at Bracknell, during more-recent years the pleasant and somewhat informal ceremony has also been conducted at the Meteorological Office College at Shinfield Park and occasionally on ships.

Earlier this year when three Masters received barographs, Captain J. D. Hellings was at sea; it was, therefore, arranged that a separate presentation should be made soon after his return to the United Kingdom. As Mr F. H. Bushby, Director of Services, Meteorological Office, and Captain G. A. White, Marine Superintendent, both had engagements in Newcastle upon Tyne towards the end of April, it was agreed that Captain Hellings, who lives in the north-east of England, should receive his barograph at the Newcastle Weather Centre in Newgate House on 24 April. This also provided an opportunity for Captain and Mrs Hellings to see the services produced for the public at the Weather Centre.

Mr Bushby, in presenting an inscribed barograph to Captain Hellings, explained the continuing need for meteorological observations from ocean areas and emphasized the value of the contribution made by approximately 600 British Voluntary Observing Ships. The fact that the UK maintained an Ocean Weather Station in the North Atlantic, together with three other European-operated Ocean Weather Stations, demonstrated our need for the type of high-quality data which was only obtainable from ships. Mr Bushby then thanked Captain Hellings for his valuable contribution made over 23 years.

In accepting the barograph and thanking Mr Bushby, Captain Hellings paid tribute to the efforts and good services of the officers who had sailed with him during his years at sea.

Captain and Mrs Hellings were later entertained to lunch by Mr Bushby and Captain White.

A photograph of the presentation appears opposite page 197.

G. A. W.

INDIAN EXCELLENT AWARDS

(From the Deputy Director-General of Meteorology (Weather Forecasting), India)

During the year 1977–78 there has been active and continuous co-operation between the India Meteorological Department and the ships of the Indian Voluntary Observing Fleet (IVOF) in the collection of meteorological information from the high seas and this is very much appreciated; we look forward to even more co-operation in the future. It is becoming increasingly realized that the ocean and the atmosphere should be observed and studied together because they continually affect each other in a number of ways.

During the year ending 31 March 1978 18 new ships were added to the strength of the IVOF and 5 ships were decommissioned. At the end of the year there were 280 on the Fleet List which included 45 Selected, 203 Supplementary and 32 Auxiliary ships. Eighty ships sent in less than 5 logbooks and 135 ships sent in less than 10 logbooks. However, 16 216 observations—about 2000 more than the previous year—were received from 1364 logbooks sent in by these ships.

It is essential that observations made by ships are transmitted as expeditiously as possible to the nearest coastal radio stations to facilitate their reception on a real-time basis at the forecasting offices. Special encouragement is given to the ships which send crucial observations when a depression or tropical storm is in its formative stage or when it is intensifying into a severe tropical storm. Due recognition is also given to ships which transmit important and very urgent observations even though they do not belong to the IVOF.

The meteorological work of the ships of the IVOF during 1977–78 has been assessed taking into account the quality and quantity of observations and also the percentage of recorded observations which have actually been transmitted to coastal radio stations. Allowance has also been made to individual ships for the actual number of days spent at sea. As usual the number of ships selected to receive Excellent Awards in the form of books is 15 and the number of Certificates of Merit awarded is 10. The Masters and other officers who were on board the ships for at least six months during the year are awarded books or certificates.

The names of the ships which received Excellent Awards are as follows:

Name of Ship	Owner
Kanishka	Shipping Corporation of India Ltd.
Harshvardhan	Shipping Corporation of India Ltd.
Zakir Hussain	Shipping Corporation of India Ltd.
Andamans	Shipping Corporation of India Ltd.
Mizoram	Shipping Corporation of India Ltd.
Vishva Vikram	Shipping Corporation of India Ltd.
Chhatrapati Shivaji	Shipping Corporation of India Ltd.
Jaladurga	Scindia Steam Navigation Co. Ltd.
Jalamangala	Scindia Steam Navigation Co. Ltd.
Jalagopal	Scindia Steam Navigation Co. Ltd.
Jalagirija	Scindia Steam Navigation Co. Ltd.
Akbar	Mogul Line Ltd.
Daman	Damodar Bulk Carriers
Chennai Perumai	South India Shipping Corporation
Chennai Selvem	South India Shipping Corporation

Certificates of Merit have been awarded to the following ships:

Vishva Anurag
Vishva Prayas
Vishva Kanti
Devaraya
Vishva Siddhi
Vishva Mangal
Vishva Dharma
Nan Cowrey
Lok Palak
Nand Kala

The Excellent Awards were distributed at the National Maritime Day function held on 5 April 1979 at Bombay. Certificates of Merit were handed over to the Shipping Companies concerned for onward transmission to the officers who qualified for them.

AURORA NOTES OCTOBER–DECEMBER 1978

By R. J. Livesey

(Co-ordinator of Auroral Observing, the Solar Section of the British Astronomical Association)

In the attached table are listed the observations received for the period October to December 1978. Should any observation come to hand after the closing date for the printer's program, its observer may rest assured that the data will be used in our statistical analysis of auroral activity.

During the period, auroral storms were widely reported on the nights of 26–27 October, 10–11, 20–21, 24–25 and 25–26 November while further activity was observed in the period 26–31 December. Radio echoes from aurora-generated ionospheric disturbances were detected by amateur radio operators in the latter half of October, mid to end of November and towards the end of December.

The most important storm nights were those of 24–25 and 25–26 November when auroral arcs penetrated south to be seen in Cambridgeshire with all-sky activity in central Scotland and coronae in the Border area. Radio operators reported corresponding strong echoes.

A number of quiet glows were reported in the period. However, unless a glow is reported by several observers or appears on the same night as more active aurora which can be linked to it, isolated glows are treated as unconfirmed events in view of the fact that other atmospheric effects can lead to false glows on the horizon. At certain observatories interference filters are used to scan the sky. These devices cut out the general range of visible light wave-lengths and permit only a small part of the spectrum to pass to the observer's eye, which is tuned to the auroral green light emitted by excited oxygen atoms in the high atmosphere. In conditions of very faint light the method is not foolproof but is generally very useful in detecting auroral light in cloudy or moonlit conditions. When an amorphous moonlit cloudy horizon is seen in a filter the clouds look black and backlit by the auroral light passing through gaps in the cloud.

The marine observations are a valuable contribution in helping to check doubtful contacts with the aurora in very cloudy conditions when few land observers can keep a good lookout, as has happened in the winter of 1978–79 bridging the gap in the northern hemisphere between Europe and North America, where some of our correspondents observe. In taking an observation into account the position of the observer relative to the earth's magnetic pole is of importance, as has been explained in a previous report.

Looking over the past three years, it has been of interest to follow the voyages of the vessels *Miranda*, *St Jasper* and *Summity* in the regions of Lofoten, North Cape and the Barents Sea and to plot the positions at which observations of the aurora were made relative to the geomagnetic latitude. The accompanying map shows that more auroral activity and more-active aurorae tend to be seen in geomagnetic latitudes 67 and 68 which is in the region of maximum probability that aurora will be encountered.

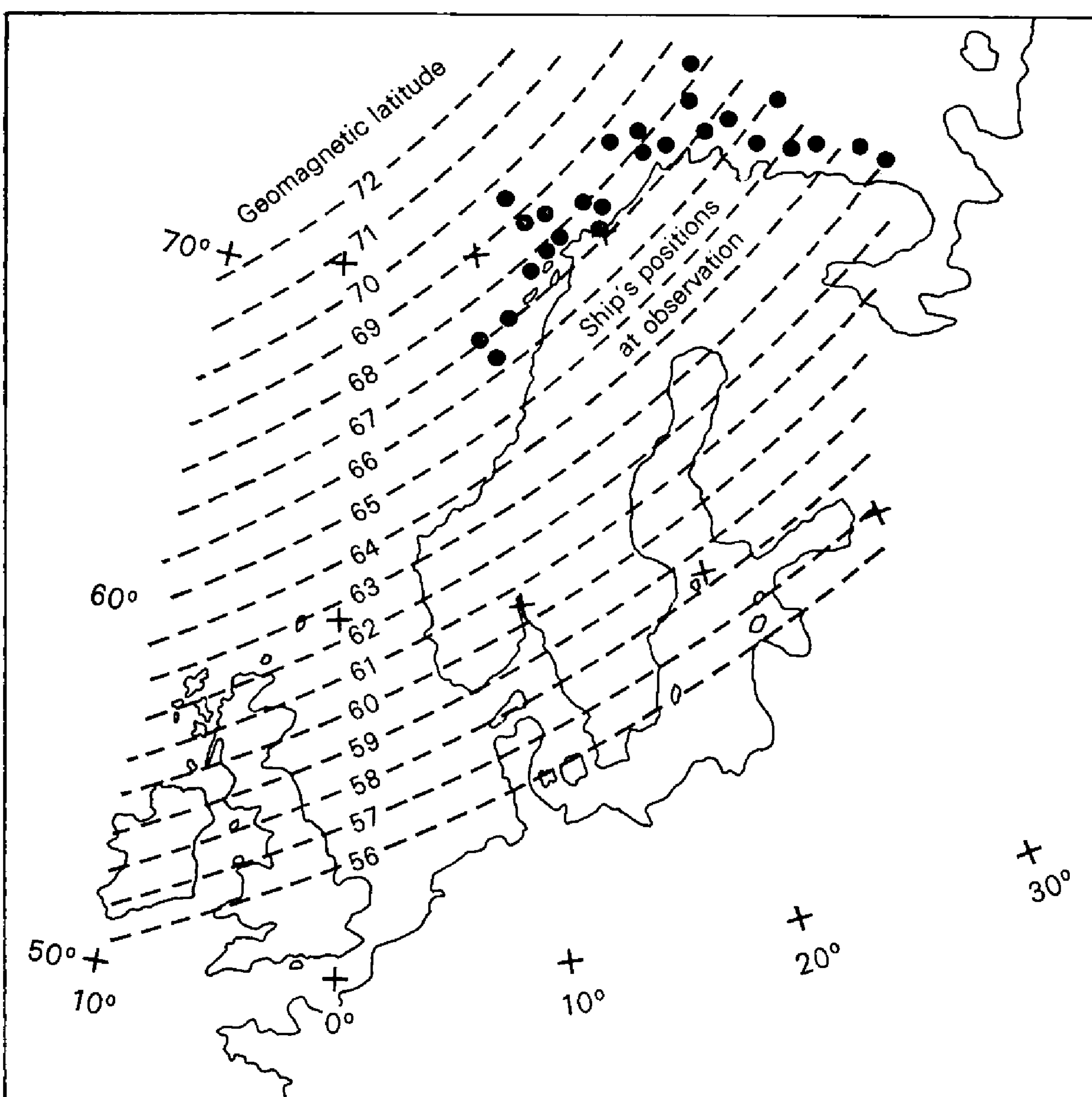
It should also be noted, however, that the configuration of the Norwegian coast tends to make ships run for some distance along the geomagnetic latitude of maximum probability. Thus, the frequency of auroral occurrence cannot necessarily on its own be taken as confirmation of aurora observed, say, in southern Scotland.

The following table analysis furthers the details of the voyages presently under review.

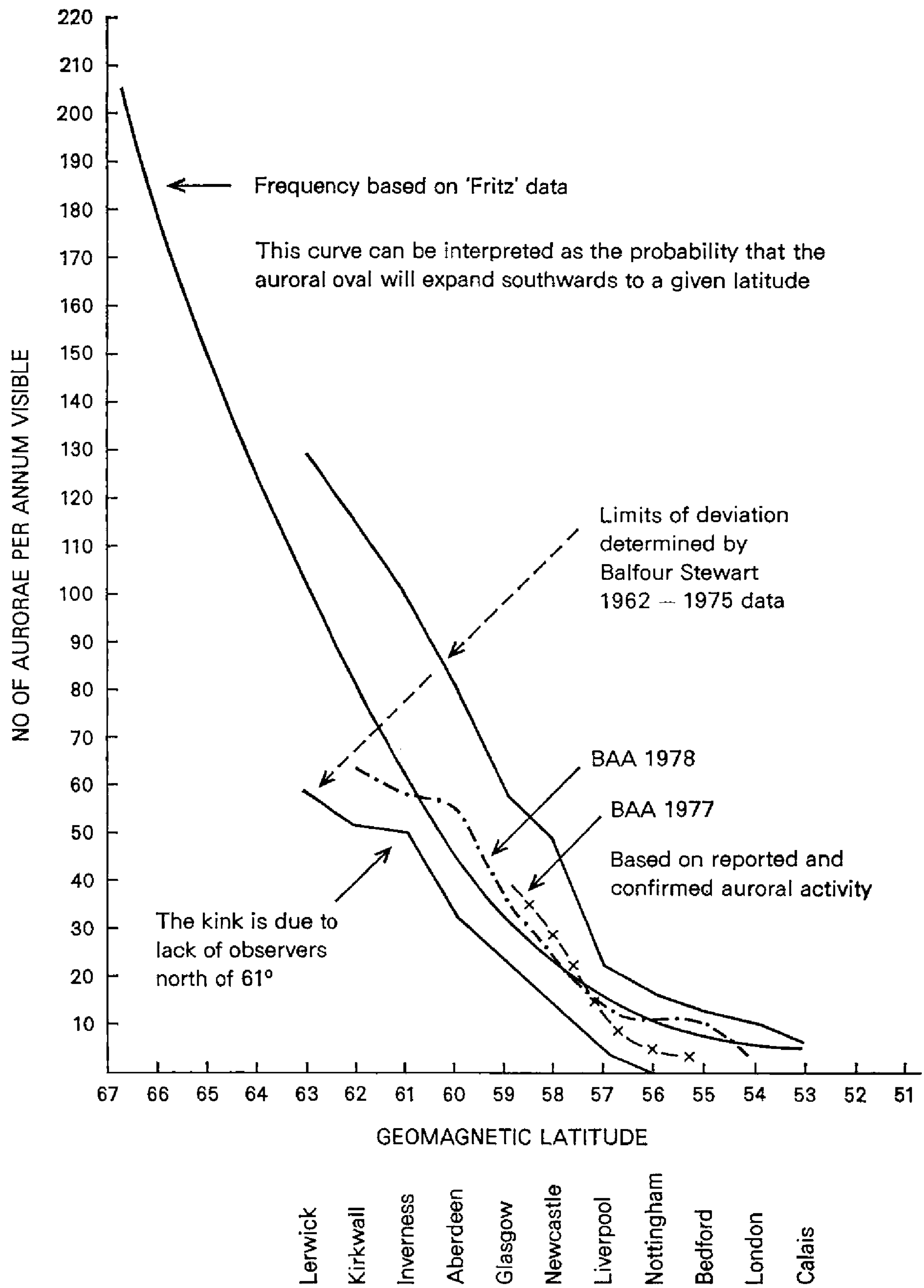
Period	Ship	Days Between First and Last Observation	Range in Geomagnetic Latitude	No. of Aurorae Observed	Mean No. of Days Between Aurorae
Aug.–Sep. 1976	m.v. *Summity*	57	63–68	9	6·3
Aug.–Oct. 1977	m.v. *St Jasper*	38	64–68	7	5·4
Mar.–Apr. 1978	m.v. *Miranda*	29	67–68	6	4·0
Nov.–Dec. 1978	m.v. *Miranda*	13	67–69	4	3·0

The actual frequency of occurrence of auroral activity in one year is obtained by adding together for each geomagnetic latitude the number of nights on which any activity reported reached its most southerly extent on that latitude. Thereafter the

Geomagnetic Latitude ..	63	64	65	66	67	68	69
Glow						2	
Homogeneous Arc	1			1	2		
Rayed Arc			2		3	1	
Ray Structures					1		1
Active Structures ..	1	1	1	1	4	2	1
Overhead Corona ..					1		
All-Sky Aurora							



Maximum intensity of aurora and number of nights on which it was reported



Visibility of the aurora

totals are cumulatively added from south to north on the assumption that the normal position of the auroral arc is in the north and on expanding southwards it could be seen at each successive latitude on that night until it reaches its most southerly visible extent. The graph of the accumulated totals at each latitude forms the probability of seeing the aurora at a given geomagnetic latitude on the assumption that there was no interfering cloud. At Glasgow for instance only about one night in five is, on the average, sufficiently free of cloud for astronomical observing, which accounts for the fact that the probability of the presence of aurora is very much higher than the frequency with which it is seen.

As an example, the writer, at Glasgow, saw 22 aurorae in 1959 when the actual frequency, based on the Balfour Stewart Auroral Laboratory data, amounted to 124. The corresponding figures for 1978 were respectively 8 and 48, thus indicating the degree of interference by cloud cover.

Sunspot activity continued to rise during the period and the frequency of reported auroral activity appeared to keep with it, in spite of much cloud cover. It has been predicted that the current solar cycle will reach a maximum at the end of 1979. It should be remembered that the aurora tends to have a secondary peak in frequency rather later than that of the solar cycle so that it is to be hoped that we shall have plenty to look forward to in the way of observations within the next two or three years. Please keep observing and sending in the details and it will be a pleasure to analyse the data to build up the pattern of auroral activity.

REFERENCE

LIVESEY, R. J. 1979 Aurora Notes January–March. *Mar Obsr*, London, **49**, No. 263, pp. 39–41.

DATE 1978	SHIP	GEOGRAPHIC POSITION		TIME	FORMS
20–21 Nov.	*Manchester Concorde*	51° 45′N	55° 50′W	2300–0030	qRdA
30	*Miranda*	69° 00′N	17° 15′W	1750–2359	N, qA, RdB, V, mB, pV
14 Dec.	*Miranda*	70° 41′N	17° 09′E	1910–2000	R, qARdB, V, A, qB, RdB, V
19	*Miranda*	69° 43′N	19° 03′E	2020–2100	RdB, aRdB, pR
23	*Miranda*	70° 41′N	17° 16′E	1610	qA, mR
28	*Serenia*	59° 15′N	4° 18′E	1800–1950	qN, qRdA, qhA, hP
30	*Admiral Beaufort*	57° 06′N	20° 36′E	0335–0350	qN
30–31	*Admiral Beaufort*	57° 06′N	20° 12′W	1940–0252	pRdB, qRdB

KEY: A = arc, a = active, B = band, h = homogeneous, m = multiple, N = Unspecified auroral light form, P = patch, p = pulsating, q = quiet, R = ray, Rd = rayed, V = veil.

Marine Aurora Observations October–December 1978

ICE CONDITIONS IN AREAS ADJACENT TO THE NORTH ATLANTIC OCEAN FROM APRIL TO JUNE 1979

The charts on pages 212 to 214 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: 1966–75 (Meteorological Office). Surface pressure: 1951–70 (Meteorological Office). Air temperature: 1951–60 (US Department of Commerce, 1965). Sea-surface temperature: area north of 68°N, 1854–1914 and 1020–50 (Meteorological Office, 1966), area south of 68°N, 1854–1958 (US Navy, 1967).

APRIL

The most significant anomaly during April was for low air temperature over the Barents Sea in association with frequent easterly winds. Between Greenland and Canada there was an anomaly for southerly winds accompanied by temperatures higher than normal.

Abnormally cold weather over the Barents Sea had, in fact, persisted for most of the winter with a considerable excess of ice resulting there; the edge at the end of April lay some 200 n. mile west of the position normal for this time of year.

Off Newfoundland and Labrador and in Baffin Bay there were general deficits by the end of the month—even in sectors where there had been some excess at the beginning.

The excessive ice that had lain close to the north coast of Iceland cleared during April and a general deficit was apparent east of Greenland by the end of the month though some patches persisted well out into the Greenland Sea.

MAY

There was a persistence of the major features of April, in particular the excesses of ice in the Barents Sea and deficits east of Greenland, off Labrador and in Baffin Bay.

In the southern part of the Barents Sea the excesses of the previous month were reduced, temperatures being higher than normal near the north-west coast of the USSR

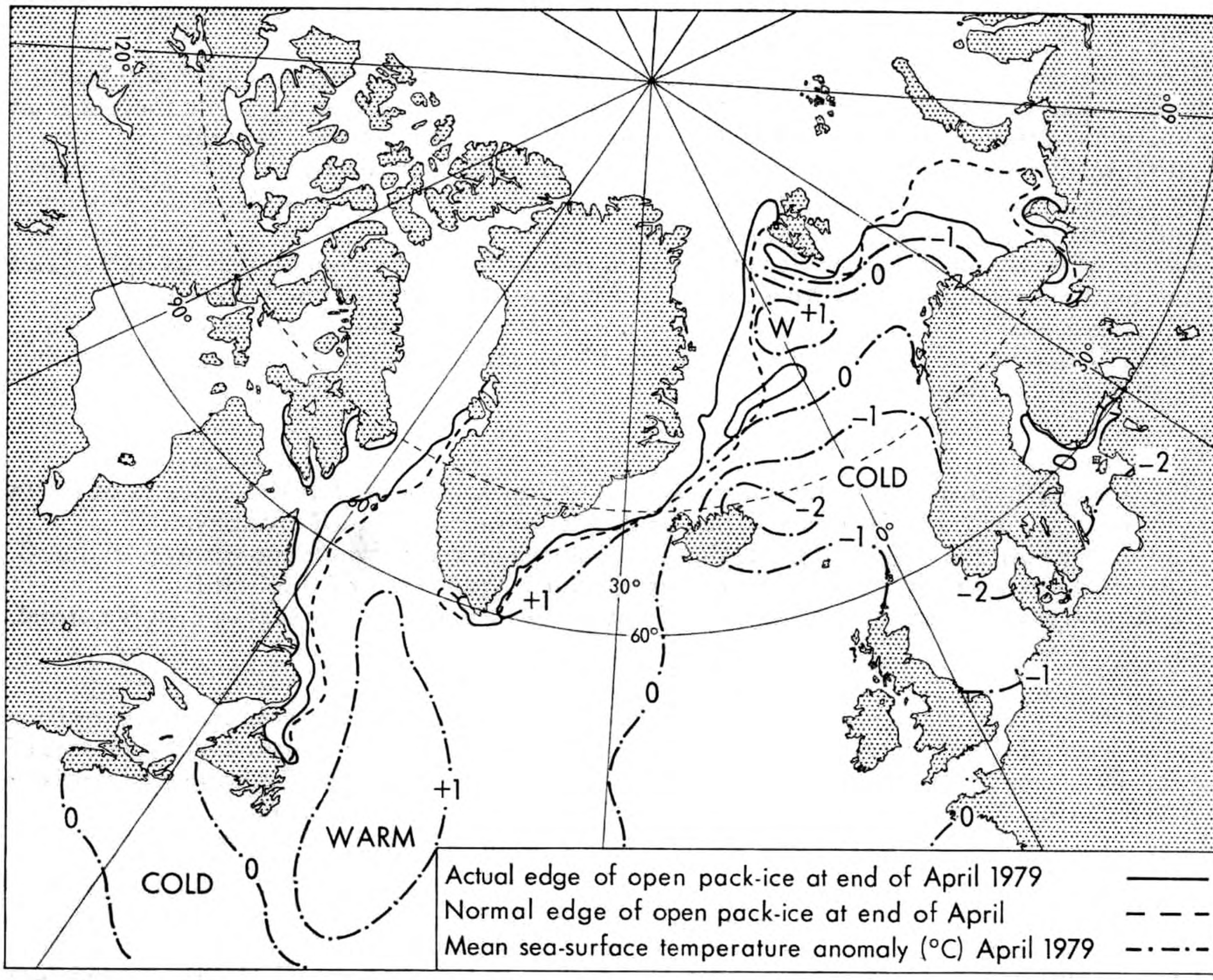
Melting around the coast of Hudson Bay started a little earlier in the season than is normal.

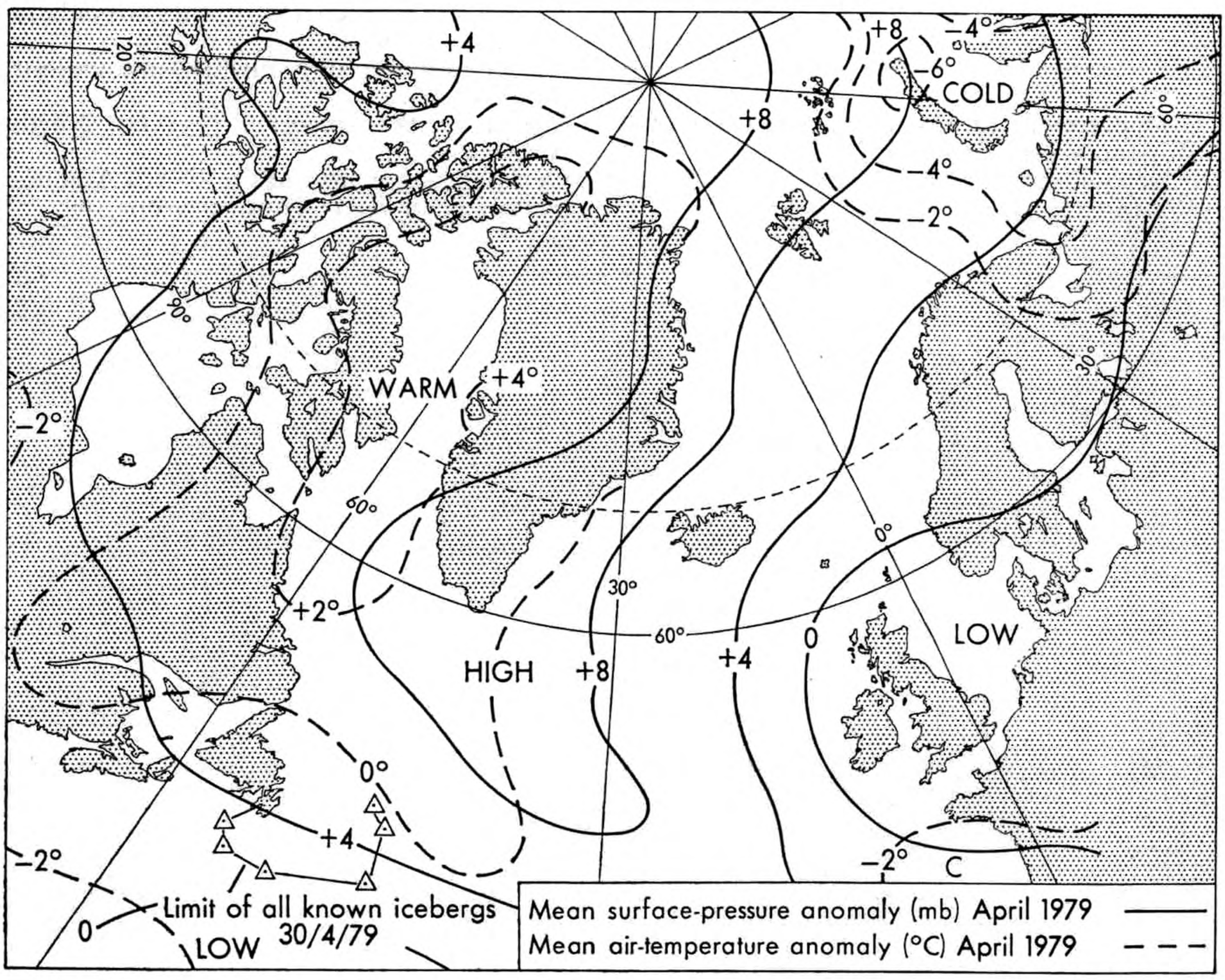
JUNE

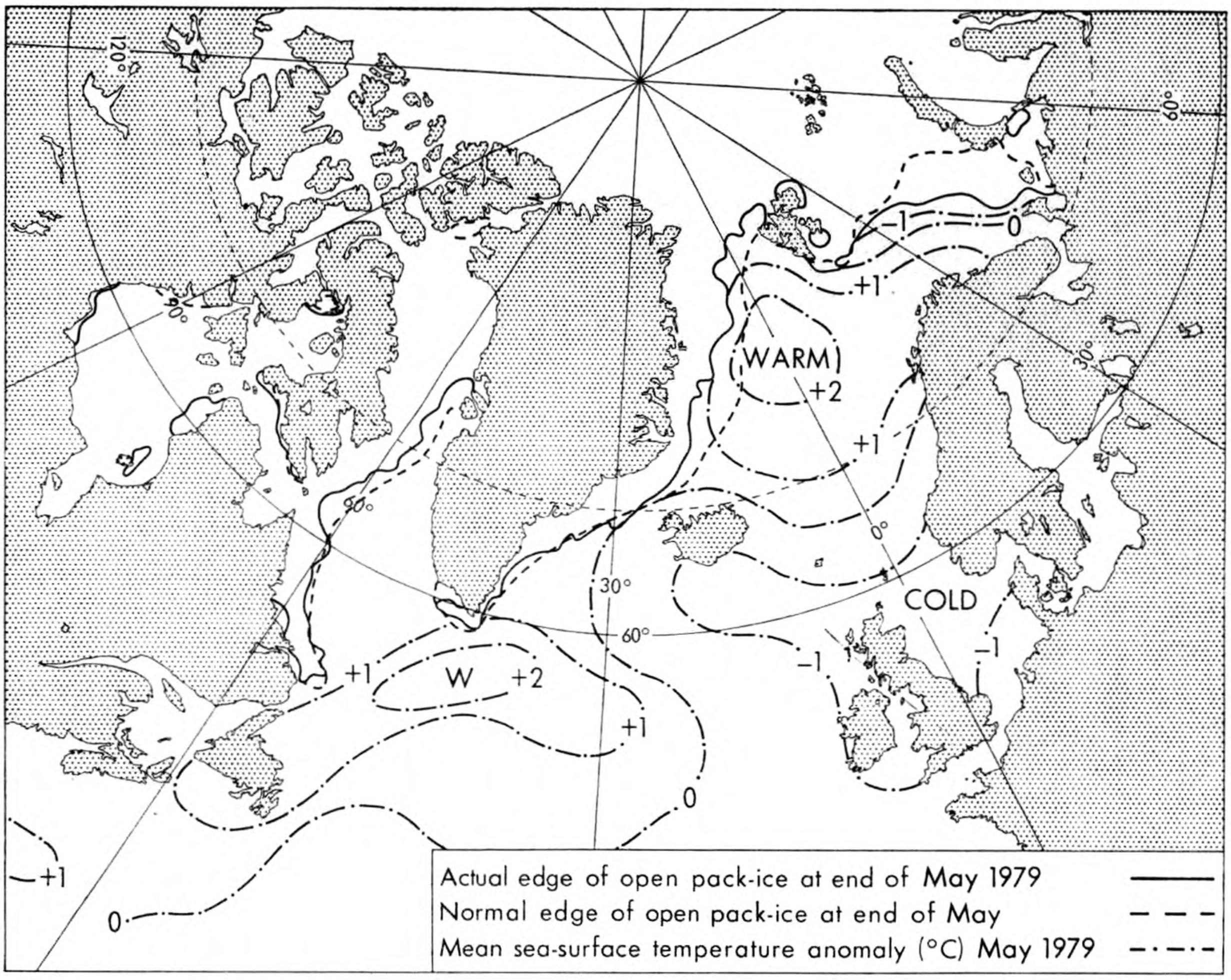
With lower-than-normal temperatures rather general over the ice fields the retreat of ice was less marked than is normal during June. In Baffin Bay the month finished with excesses of ice in places where it had started with deficits. East of Greenland deficits were substantially reduced during the month. Over the Barents Sea excesses of ice persisted.

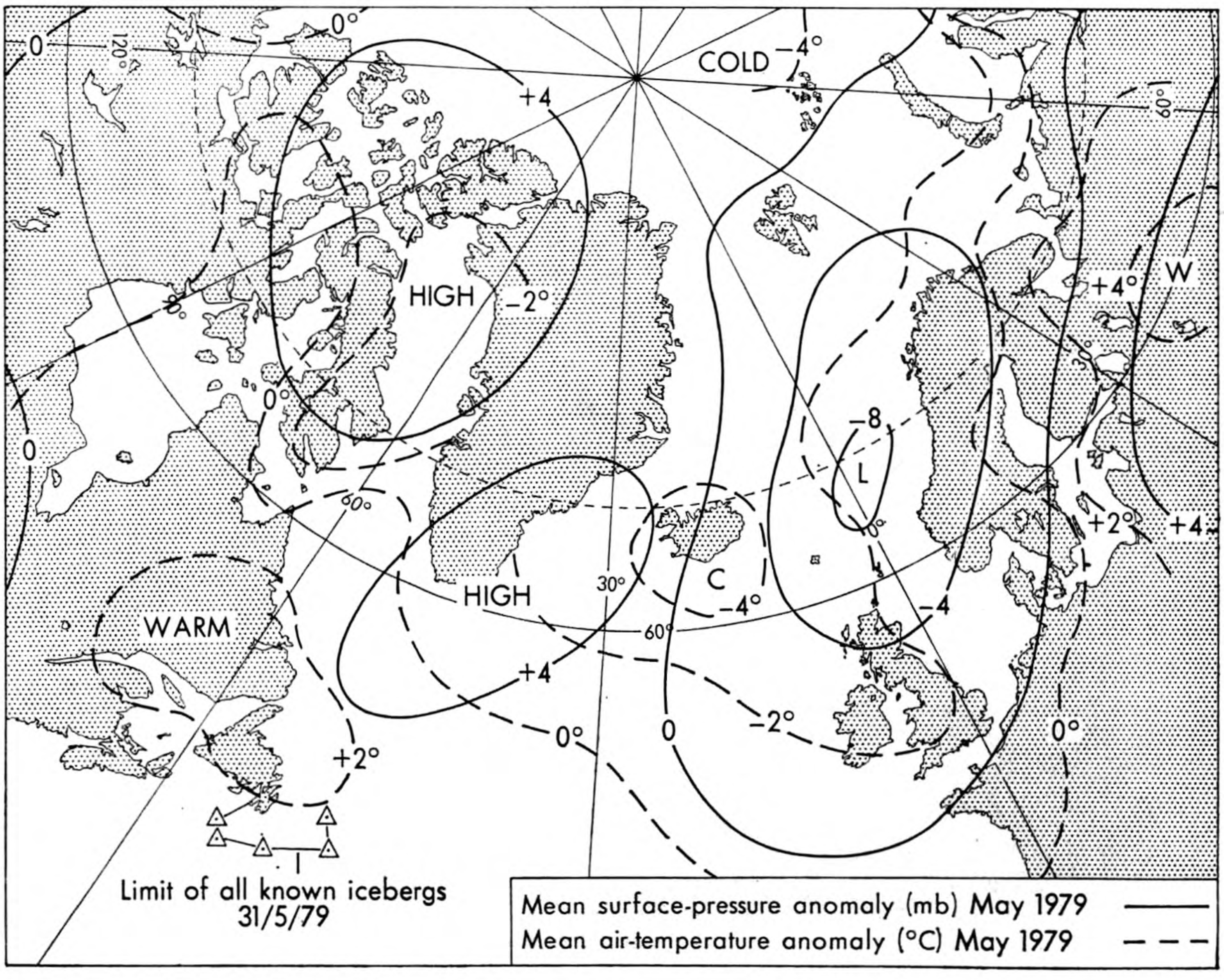
REFERENCES

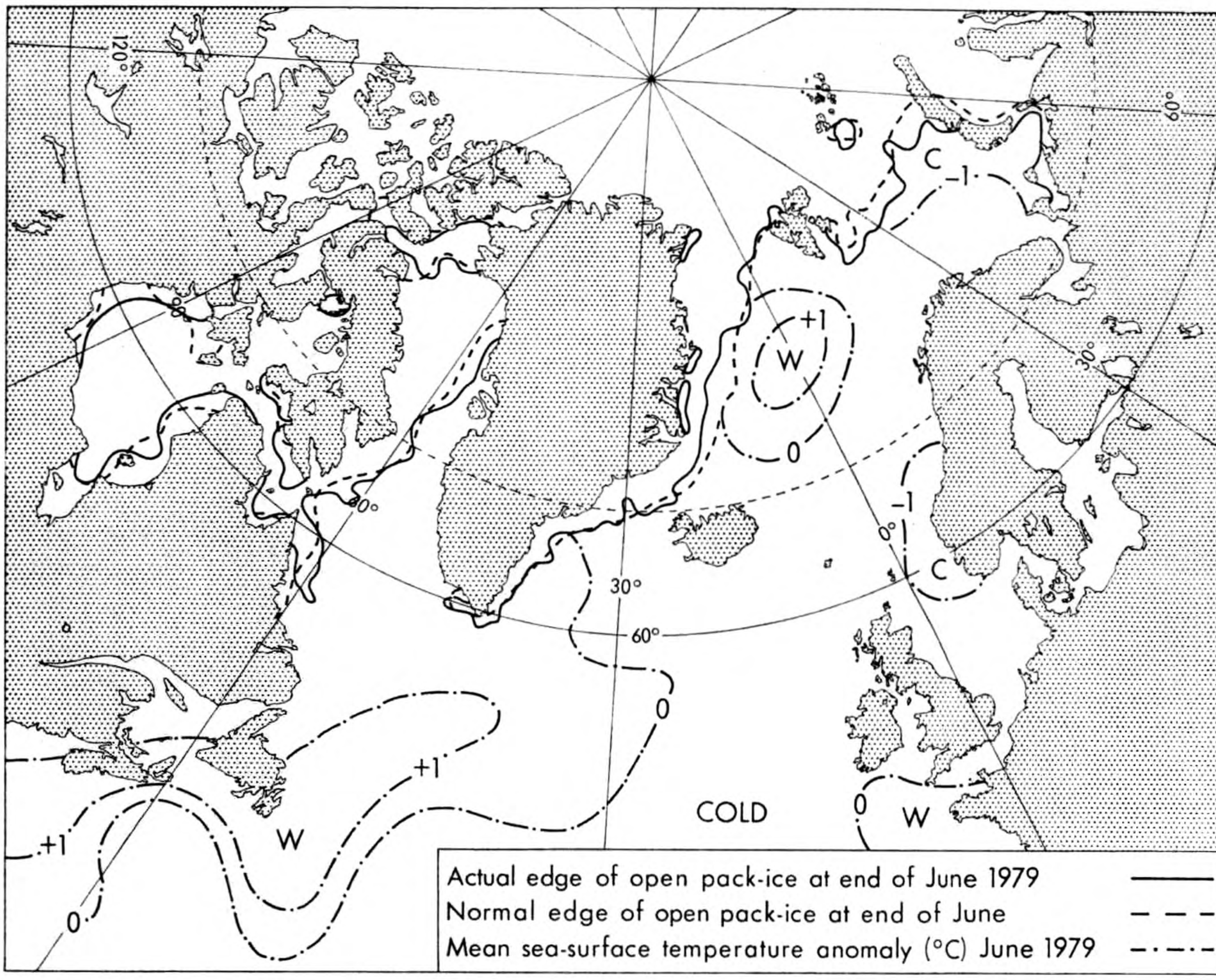
Meteorological Office, London	1966	Monthly meteorological charts and sea surface current charts of the Greenland and Barents Seas.
	—	Sea ice normals (unpublished) and various publications.
US Department of Commerce Weather Bureau, Washington, D.C.	1965	World weather records, 1951–60. North America.
US Naval Oceanographic Office, Washington, D.C.	1967	Oceanographic atlas of the North Atlantic Ocean, Section II: Physical properties.

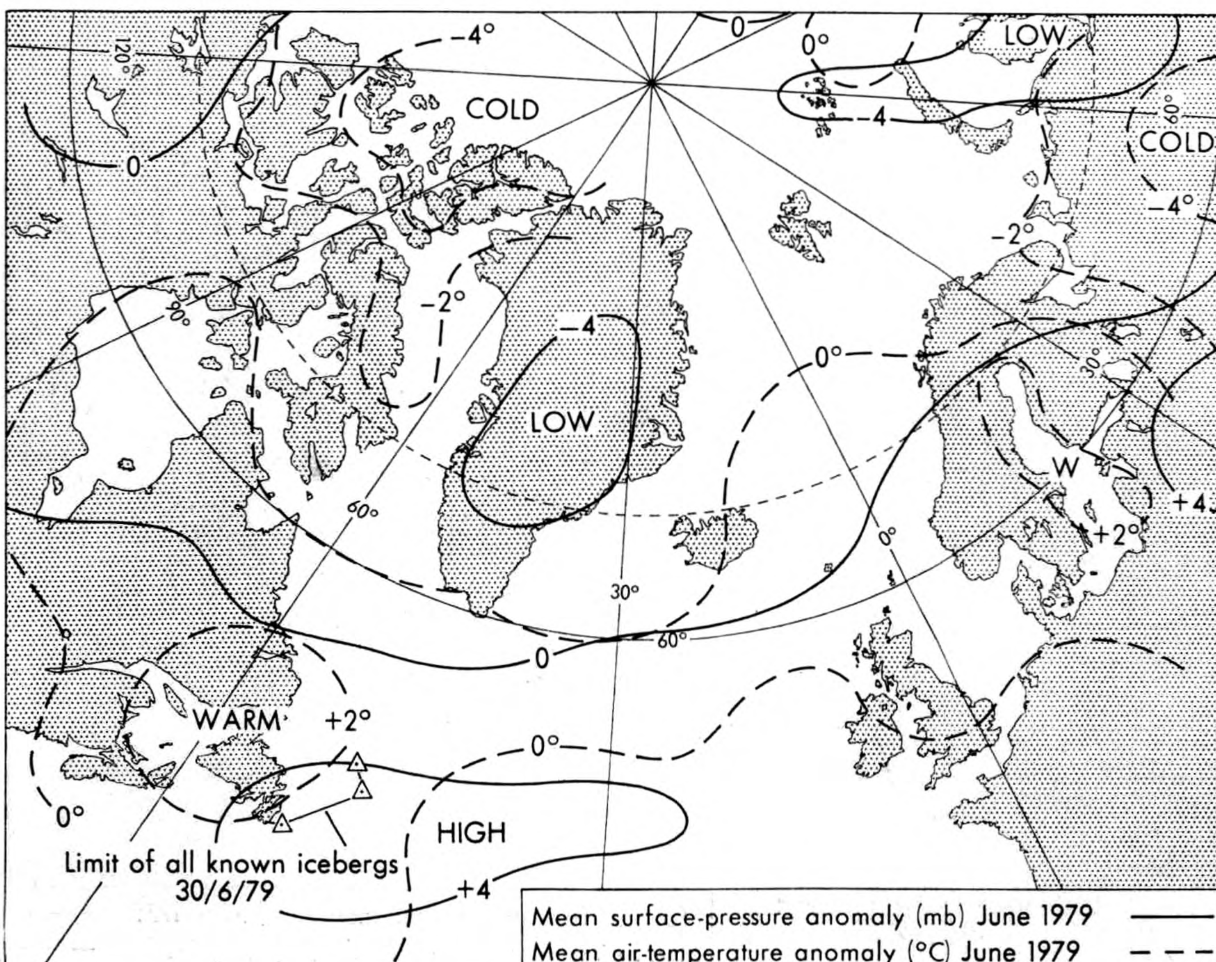

COLD
WARM
W
COLD
Actual edge of open pack-ice at end of April 1979
Normal edge of open pack-ice at end of April
Mean sea-surface temperature anomaly (°C) April 1979


COLD
WARM
HIGH
LOW
LOW
Limit of all known icebergs 30/4/79
Mean surface-pressure anomaly (mb) April 1979
Mean air-temperature anomaly (°C) April 1979


WARM
+2
+1
0
-1
COLD
W
+2
+1
0
+1
0
Actual edge of open pack-ice at end of May 1979
Normal edge of open pack-ice at end of May
Mean sea-surface temperature anomaly (°C) May 1979


0
0°
COLD
-4°
+4
HIGH
-2°
0°
0
-8
L
W
+4°
+2°
+4
WARM
HIGH
C
-4°
-4
+4
+2°
0°
0
-2°
0°
Limit of all known icebergs
31/5/79
Mean surface-pressure anomaly (mb) May 1979
Mean air-temperature anomaly (°C) May 1979


120°
60°
30°
0°
C
-1
+1
W
0
COLD
Actual edge of open pack-ice at end of June 1979
Normal edge of open pack-ice at end of June
Mean sea-surface temperature anomaly (°C) June 1979


120°
-4°
COLD
0
0°
LOW
-4
60°
-2°
-4
LOW
0°
30°
W
+2°
+4
0
WARM
+2°
0°
HIGH
Limit of all known icebergs 30/6/79
+4
Mean surface-pressure anomaly (mb) June 1979
Mean air-temperature anomaly (°C) June 1979

Baltic Ice Summary: April–June 1979

No ice was reported at the following stations during the period: Oxelsud, Visby, Göteburg, Mantylouto, Emden, Bremerhaven, Hamburg, Flensburg, Kiel, Lübeck, Stettin, Gdansk Copenhagen, Aarhus, Oslo, Kristiansandfjord.

April

Station	Length of Season A	Length of Season B	Ice Days C	Ice Days D	Ice Days E	Navigation Conditions F	Navigation Conditions G	Navigation Conditions H	Accumulated Degree Days I
Lulea ..	1	30	30	30	0	0	30	0	1625
Skelleftea ..	1	30	30	30	0	0	30	0	—
Bredskar ..	1	30	20	15	2	20	0	0	—
Sundsvall ..	1	30	30	29	1	17	13	0	—
Sandarne ..	1	30	30	0	30	30	0	0	—
Kalmar ..	1	15	11	0	11	11	0	0	—
Stockholm ..	1	30	30	2	28	30	0	0	499
Helsinki ..	1	30	30	19	11	13	16	0	947
Turku ..	1	30	30	19	11	30	0	0	868
Mariehamn	1	19	19	19	0	19	0	0	—
Vaasa ..	1	30	30	30	0	0	30	0	1113
Norskar ..	1	30	30	0	11	0	30	0	—
Oulu ..	1	30	30	30	0	0	30	0	—
Royttaa ..	1	30	30	30	0	0	30	0	—
Leningrad ..	1	27	25	12	13	14	10	0	1049
Viborg ..	1	30	30	28	2	4	26	0	—
Tallin ..	1	30	30	0	30	7	3	0	—
Riga ..	1	8	8	1	7	1	0	1	672
Pyarnu ..	1	24	24	14	10	0	3	14	—
Ventspils ..	4	7	4	0	4	1	0	0	—
Klaipeda ..	2	11	8	0	8	1	0	0	—

May

Station	Length of Season A	Length of Season B	Ice Days C	Ice Days D	Ice Days E	Navigation Conditions F	Navigation Conditions G	Navigation Conditions H	Accumulated Degree Days I
Lulea	1	19	19	11	8	8	11	0	1448
Skelleftea	1	14	14	14	0	0	14	0	—
Bredskar	1	12	12	0	12	7	0	0	—
Sundsvall	1	14	12	3	9	9	2	0	—
Sandarne	1	2	2	0	2	2	0	0	—
Kalmar	0	0	0	0	0	0	0	0	—
Stockholm	1	1	1	0	1	1	0	0	19
Helsinki	1	2	2	0	2	0	0	0	561
Turku	0	0	0	0	0	0	0	0	502
Mariehamn	0	0	0	0	0	0	0	0	—
Vaasa	1	8	8	2	6	1	7	0	778
Norskar	1	22	22	0	22	14	8	0	—
Oulu	1	13	13	12	1	0	13	0	—
Royttaa	1	29	29	10	19	12	17	0	—
Leningrad	0	0	0	0	0	0	0	0	623
Viborg	1	6	6	2	4	4	0	0	—
Tallin	1	1	1	0	1	0	0	0	—
Riga	0	0	0	0	0	0	0	0	167
Pyarnu	0	0	0	0	0	0	0	0	—
Ventspils	0	0	0	0	0	0	0	0	—
Klaipeda	0	0	0	0	0	0	0	0	—

June

Station	Length of Season A	Length of Season B	Ice Days C	Ice Days D	Ice Days E	Navigation Conditions F	Navigation Conditions G	Navigation Conditions H	Accumulated Degree Days I
Lulea	0	0	0	0	0	0	0	0	—
Skelleftea	0	0	0	0	0	0	0	0	—
Bredskar	0	0	0	0	0	0	0	0	—
Sundsvall	0	0	0	0	0	0	0	0	—
Sandarne	0	0	0	0	0	0	0	0	—
Kalmar	0	0	0	0	0	0	0	0	—
Stockholm	0	0	0	0	0	0	0	0	—
Helsinki	0	0	0	0	0	0	0	0	—
Turku	0	0	0	0	0	0	0	0	—
Mariehamn	0	0	0	0	0	0	0	0	—
Vaasa	0	0	0	0	0	0	0	0	—
Norskar	0	0	0	0	0	0	0	0	—
Oulu	0	0	0	0	0	0	0	0	—
Royttaa	0	0	0	0	0	0	0	0	—
Leningrad	0	0	0	0	0	0	0	0	—
Viborg	0	0	0	0	0	0	0	0	—
Tallin	0	0	0	0	0	0	0	0	—
Riga	0	0	0	0	0	0	0	0	—
Pyarnu	0	0	0	0	0	0	0	0	—
Ventspils	0	0	0	0	0	0	0	0	—
Klaipeda	0	0	0	0	0	0	0	0	—

CODE

A First day ice reported.
B Last day ice reported.
C No. of days when ice was reported.
D No. of days continuous land-fast ice.
E No. of days of pack ice.
F No. of days dangerous to navigation, but assistance not required.
G No. of days assistance required.
H No. of days closed to navigation.
I Accumulated degree-days of air temperature (°C) where known.*

* These figures give a rough measure of the first probability of the formation of sea ice, and later the progress of the growth and its thickness. They are derived from daily averages of temperature (00+06+12+18 GMT) and are the sum of the number of the degrees Celsius below zero experienced each day during the period of sustained frost.

Book Review

Typhoon Havens Handbook for the Western Pacific and Indian Oceans, by Samson Brand and Jack W. Blelloch. 295 mm×270 mm, pp. 178. Naval Environmental Prediction Research Facility, Monterey, California 93940, USA. Price US $13.00.

This handbook was developed by the Environmental Prediction Research Facility of the US Navy in response to a request by the Commander of the US Pacific Fleet that certain Pacific and Indian Ocean ports be evaluated as typhoon havens.

The book is orientated towards commanding officers and masters who are required to make decisions regarding storm evasion and the purpose is to present a single volume reference book which will help them in their decision making.

The first part of the book contains a general discussion on tropical storms describing their development and movement and also commenting on the state of sea likely to be found in their vicinity. Some information is given about the effect of various sea-states and wind forces on a vessel's speed and the section concludes with a method of calculating the danger areas around forecast tropical storm centres.

The remainder of the book presents information about particular geographical areas and includes details of individual ports and harbours, local topographical influences on tropical storms and helpful guidelines for the decision-making process on whether to remain in port or to put to sea. There is also a useful table rating the various ports and harbours on their suitability as typhoon havens.

As received, the geographical areas contained in the book are Guam, Taiwan, Hong Kong, Japan, the Philippine Islands, Korea, Sri Lanka, Pakistan, New Zealand and Australia but, with the exception of Japan, only a limited number of ports and harbours in each area are included, for example, Fremantle is the only port included in Australia. However, as stated in the Foreword, the development of the handbook is a long-term and continuing project; evaluations of other ports will be published for future inclusion. The book is constructed with a loose-leaf binding to allow this.

Whilst much of the information contained in this handbook can be found in the Admiralty Sailing Directions, there is some value in having specific information on the safety of individual ports during a tropical storm available in a quick reference volume such as this. A vessel trading regularly to the areas included would, without doubt, find it useful and the price does not appear to be unduly expensive. We are advised that the handbook is available from the National Technical Information Service, Springfield, Virginia 22151, USA and should be requested by title quoting reference number ADA 058147.

C. R. D.

Personalities

RETIREMENT.—CAPTAIN J. C. SALVIDGE retired on 31 December 1978 after serving 43 years at sea.

John Christopher Salvidge was educated in Hull and Cork before receiving his pre-sea training at the Boulevard Nautical College in Hull between 1933 and 1935. On leaving the College he elected not to sign indentures with a shipping company but to take a job in the deep-sea trawlers sailing out of Hull. His first trawler was the *Lord Nelchett* and thereafter he served in Icelandic and Arctic waters where working in intense freezing conditions became a way of life and he became very familiar with the problems of ice-accretion.

After three years in trawlers he found jobs in the fishing industry were becoming scarce so decided to change over to the Merchant Navy and sailed as an Ordinary Seaman in the *Jedmoor* belonging to the Runciman Steamship Company. At the outbreak of war he was an A.B. in the *British Resource* and was serving in that vessel when she was in collision with the *Celtic Star* and had to put into Dakar for repairs.

Later, in January 1940, he sailed as A.B. in the *Royal Crown* and, whilst in convoy in the North Sea, the ship was attacked by German aircraft and so severely damaged that she had to be abandoned. The life-boats were blown to pieces and there remained only two jolly boats in which the survivors embarked. Although delegated at first to go with the Master in one of these boats, he was fortunate to change over to the boat commanded by the Chief Officer as the Master's was not seen again. After a very weary row in bad weather conditions, the Chief Officer's boat reached the UK shore in the vicinity of Southwold.

In June 1941 Captain Salvidge was serving in the *Elmdene* when she was torpedoed 200 nautical miles off Freetown. Although the ship sank rapidly, the survivors managed to take to the life-boats. Almost immediately, the German submarine surfaced and German seamen searched the life-boats, presumably looking for a radio-transmitter. Captain Salvidge was sitting with his feet on the emergency transmitter which had been sewn up in canvas; on being asked 'Was ist?' he replied that it was condensed milk and was very fortunate in that the German accepted his reply. Later the survivors were picked up by an American ship and were landed at Freetown.

On arrival home he was pressurized by his fiancé to take his 2nd Mate's Certificate and thereafter sailed as 3rd and 2nd Officer in various ships—in the meantime he endeavoured to enter the R.A.F. as a fighter pilot but was turned down as he was in the Merchant Navy.

In 1943 Captain Salvidge joined the *Empire Morn* which landed supplies at Casablanca shortly after the Americans had captured the port. Soon after sailing from that port the ship was either torpedoed or hit a mine with the result that the stern was blown off and there was a heavy loss of life. Fortunately, the ship remained afloat and was towed back to Casablanca and subsequently to Gibraltar for repairs.

In 1944 Captain Salvidge joined the Ellerman Wilson Line but transferred to Palm Line in 1947 and remained with them for the remainder of his career. He obtained his Master's Certificate in 1948.

Captain Salvidge sent us his first meteorological logbook from the *Consuelo* in 1946. Since then we have received a further 10 logbooks bearing his name of which 7 were classed as excellent. He received an Excellent Award in 1947.

We wish him a long, healthy and happy retirement to enjoy his hobbies of flying and shooting.

Notices to Marine Observers

LOCUST REPORTS BY RADIO

Following the establishment of a centralized reporting and forecasting service at the Food and Agriculture Organization (FAO) in Rome, all locust reports by radio should now be sent to FOODAGRI ROME (telex 610181 FOODAGRI) and not to Antilocust London. The cost of all such radio messages will be borne by the FAO.

APPOINTMENT OF NEW PORT METEOROLOGICAL OFFICER

Captain Jack Bentley has been appointed Port Meteorological Officer in Hull to succeed Captain D. H. Rutherford who has been transferred to the Newcastle Port Meteorological Office.

Captain Bentley received his pre-sea training at the Boulevard Nautical School and, in June 1940, was apprenticed to Evans and Reid Management Company of Cardiff.

He obtained his Master's Certificate in November 1949 and, in January 1950, joined Elder Dempster Lines as 2nd Officer. He remained with the Company when they amalgamated with the Blue Funnel Line to form Ocean Fleets Limited.

Captain Bentley was promoted to Master in July 1958 and, prior to his retirement in April 1979, commanded the container ships of Overseas Containers Limited managed by Ocean Fleets on the Far East trade.

NAUTICAL OFFICERS OF THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE, GREAT BRITAIN

Headquarters.—Captain G. A. White, Marine Superintendent, Meteorological Office (Marine Division) Headquarters Annexe, Eastern Road, Bracknell, Berks. RG12 2UR (Telephone: 0344 20242, Ext. 2456)
Captain G. V. Mackie, Deputy Marine Superintendent. (Telephone: 0344 20242, Ext. 2543)
Mr J. D. Brown, Nautical Officer. (Telephone: 0344 20242, Ext. 2461)
Captain C. R. Downes, Nautical Officer. (Telephone: 0344 20242, Ext. 2738)

Mersey.—Mr W. G. Cullen, Master Mariner, Port Meteorological Officer, Room 218, Royal Liver Building, Liverpool L3 1HU. (Telephone: 051–236 6565)

Thames.—Captain R. C. Cameron, Port Meteorological Officer, Movement Control Building, South Side, Victoria Dock, London E16 1AS. (Telephone: 01–476 3931)

Bristol Channel.—Captain J. H. Jones, Port Meteorological Officer, 33, The Hayes, Cardiff CF1 6NU (Telephone: 0222 21423)

Humber.—Captain J. Bentley, Port Meteorological Officer, c/o Dept. of Trade, Posterngate, Hull HU1 2JN. (Telephone: 0482 223066, Ext. 26)

Clyde.—Captain S. M. Norwell, Port Meteorological Officer, 118, Waterloo Street, Glasgow G2 7DN (Telephone: 041–248 4379)

Forth.—All enquiries to Glasgow above.

Southampton.—Captain D. R. McWhan, Port Meteorological Officer, Southampton Weather Centre, 160 High Street below Bar, Southampton SO1 0BT. (Telephone: 0703 20632)

Tyne.—Captain D. H. Rutherford, Port Meteorological Officer, 1–2 Osborne Road, Newcastle upon Tyne NE2 2AA. (Telephone: 0632 811616)

Ship Routeing Service. (Telephone: 0344 20242 Ext. 2577)
Captain A. Phillips, Nautical Officer.
Captain P. B. Hall, Nautical Officer.
Captain C. A. S. Borthwick, Nautical Officer.

LIVERPOOL PORT METEOROLOGICAL OFFICE

The attention of marine observers is drawn to the change of address of the Port Meteorological Office in Liverpool and is now as shown above. The telephone number remains unchanged.

INDEX TO VOLUME XLIX, 1979

Subjects of *Books Reviews, Editorial, Notices to Marine Observers, Notices to Mariners*, Photographs and persons named in *Retirement* and *Obituary notices* are indexed under these general headings.

Printed in Scotland by Her Majesty's Stationery Office at HMSO Press, Edinburgh
Dd 586889 K19 10/79 (16647)

ISBN 0 11 725376 6
ISSN 0025-3251