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The Marine Observer

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THE MARINE OBSERVER

A QUARTERLY JOURNAL OF MARITIME METEOROLOGY PREPARED BY THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE

VOL. 61 **No. 314** **OCTOBER 1991**

CONTENTS

COVER PHOTOGRAPH: Red tide photographed from m.v. *Mobil Falcon* by Mr C.R. Booker, 2nd Officer, on 26 November 1990 in the Gulf of Oman.

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

LONDON: HMSO

Editorial

One of the consequences of recent alterations of course to the East by ship operators, towards the crew manning offices of the orient, is a corresponding decline in standards in the shipboard departments most affected by these changes in manning practice. This seems inevitable when individuals from countries with little or no executive maritime tradition suddenly find themselves in positions of responsibility on a ship's bridge. Despite the proliferation of new rules and methods aimed at improving standards of safety at sea, the only certain way to ensure a measure of satisfactory implementation of safety procedures is by careful training. In this aspect those that remain of the old guard, the senior members, have a vital role to play. Their expertise as seamen and their willingness to hand down their acquired skills, including those relating to the voluntary weather observing enterprise, must ensure the continuity necessary to sustain this mutually beneficial and important service: good quality observations *from* ship means good quality forecasts *to* ship.

Enough of preaching to the converted, when there is much to talk about regarding recent developments in and around the world of weather. As our two main articles demonstrate, the oceans play a vital part in controlling the Earth's climate and our knowledge of the processes involved is still very limited. Dr Stewart in his article on *Ocean and Climate* points out that modelling of the ocean alone cannot begin to deal with all the problems effectively. There are, therefore, many projects afoot to study the surface and the deep of the oceans and voluntary observers admirably assist in these with their participation in the Tropical Ocean and Global Atmosphere project as well as the World Ocean Circulation Experiment. Clearly much work remains to be done to increase our knowledge by acquiring more and more data. This is particularly important in the southern ocean where data collection is still very sparse and the co-operation of ships trading in the region is most urgent. New instruments for the measurement of ocean data are regularly introduced by oceanographers, to enhance the monitoring capability.

There are many developments of interest occurring in and around the Met. Office. A complete weather radar network for the United Kingdom will become a reality early in 1992 when a new radar station on the Isle of Lewis in the Outer Hebrides comes on line. After more than 20 years research and development, the U.K. now has the most comprehensive weather radar coverage in the world. Detection and measurement of rainfall is vital for many industries and activities but probably the biggest beneficiary of the radar network is flood forecasting. The Met. Office has taken a leading role in setting up a European-wide weather radar network and is charged with receiving data from four European countries, with another five due on line soon.

The Met. Office division whose work is bringing dramatic change to the observation network with automatic equipment for remote parts of the country is headed by Mr Frank Singleton, Divisional Director for Observations, who is charged with policing the quality of observation which lies at the heart of accurate weather prediction. He believes that automatic sensing of wind, temperature and pressure, with the facility of adding observers' manual input, will give us more data and help to reduce costs. It should reduce the need for constant human observations but the current type of synoptic observation will always need expert human observers because we cannot automate everything, particularly the instruments sited on the moving ship platform.

The new forecasting suite at the recently opened Plymouth Weather Centre is a good example of the modern services the Met. Office plans to provide for the General Public and for industry, giving continuous service round the clock. A key service developed by the Plymouth Weather Centre is the daily forecast to hotel companies in the holiday region of Devon and Cornwall.

In the research sector, the Land Transport Consultancy Group of the Met. Office has carried out motorway fog studies around the U.K., including a major study of the M25. As a result, fog sensors were installed at 50 points around the 125 miles of London's orbital motorway. Fog warnings for motorists are activated automatically if visibility drops below 300 metres. Another project involving study for the last five years was the short-range dispersion of pollution from chemical by-products expelled into the atmosphere. When all the information gained is collated it will be published and should prove an important reference document for industry and government.

It may be of interest to report that the Met. Office Mobile Unit was called to duty during the Gulf war, with the establishment of 21 staff becoming active members of the R.A.F. Reserve of officers or Volunteer Reserve, complete with uniform and trappings. The unit was set up 30 years ago after the Suez crisis and its last active service was in the Falklands in 1982. The Met. Office Meteorological Research aircraft continues to play a key role in the environmental battle to save the Gulf, with a team of experts who carried out experiments on the huge plume of smoke blanketing the area. The aircraft made seven flights into the heart of the plume and the team also used an R.A.F. helicopter to fly over Kuwait's blazing oilfields to photograph the smoke plume at source.

Reverting to matters meteorological, the Met. Office Marine Superintendent has been in the forefront of the Global Maritime Distress and Safety System (GMDSS) implementation programme. With the satellite EGC SafetyNet transmissions of Maritime Safety Information due to begin in February 1992, the IMO will be eagerly awaiting the introduction of their much heralded scheme. The GMDSS will be introduced in stages between 1992 and 1999. It will take into account technological advances such as satellite communications, and will result in the gradual phasing out of Morse wireless-telegraphy. Although the carriage of a radio officer may then not be necessary, it will still be essential to carry a specialist to maintain the GMDSS equipment. The Marine Superintendent also visited Tokyo in January 1991 to attend the International Conference on Improvement of Meteorological Information Service for Mariners, hosted by the Japan Meteorological Agency. One of the main topics of the conference concerned the preparations and activities being undertaken by countries geographically adjacent to Japan, with particular emphasis on GMDSS aspects. It emerged that China also has a very strong interest in preparing the meteorological products for a similar area.

As we were going to press we were preparing to provide complementary weather routeing to Mr John Walker on the first North Atlantic crossing of his prototype Wingsail craft *Blue Nova*. This 55-foot trimaran is the first in Walker's *Planesail* range to be introduced since he initiated the concept of his Wingsail in 1965, and Metroute was arranging to closely monitor the computer-controlled craft on its maiden ocean crossing from Plymouth to Newport, RI, via the Azores and Bermuda, leaving the U.K. in mid-July. On its demonstration tour *Blue Nova* was due to follow the U.S. east coast boat show circuit southwards, reaching Fort Lauderdale in about October. Our ship routers will continue to follow her progress from Florida with interest, whether it is Mr Walker's decision to head homewards via Caribbean destinations, or to make for San Diego and the west coast through 1992.

A shortage of suitable items from ships' logs to present in the Marine Observers' Log section of this edition may be a small sign of a drop in observing standards, reinforced by the fact that there was a similar shortage of aurora reports for the period, notably only Ocean Weather Ship *Cumulus* reported aurorae. It therefore remains important for all keen observers to keep up their excellent work and to encourage those following on to do the same. The brief review above of a few of the latest developments may serve to demonstrate the continuing importance of the voluntary observer at sea.

J.F.T.H.

October, November, December

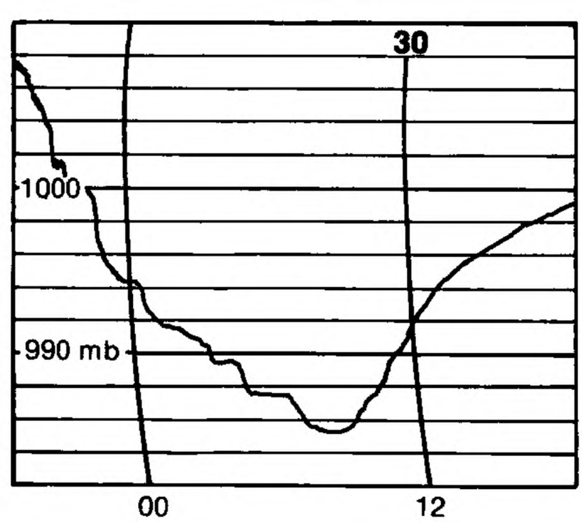
The Marine Observers' Log is a quarterly selection of observations of interest and value. The observations are derived from the logbooks of marine observers and from individual manuscripts. Responsibility for each observation rests with the contributor.

TYPHOON 'PAGE'

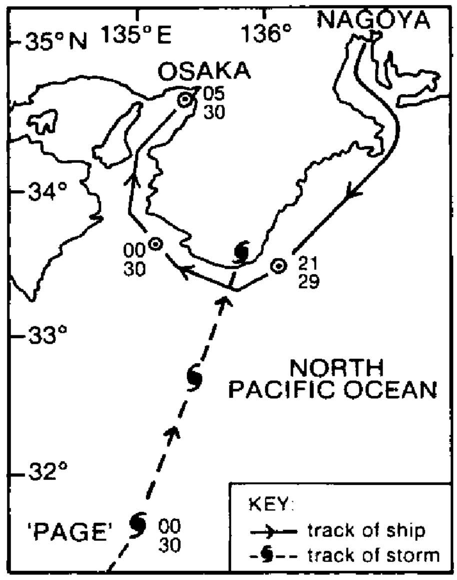
Western North Pacific

m.v. *Arafura*. Captain J.W. Cardelli. Nagoya to Osaka. Observers: the Master, Mr R.G. Macdonald, 1st Officer, Mr R.G. Morris, 2nd Officer, Mr A.J. Gray, 3rd Officer and ship's company.

29–30 November 1990. The ship had arrived in Yokohama on the 25th and the progress of Page was carefully monitored, it became apparent that the *Arafura* would come under the storm's influence while on passage from Nagoya to Osaka. On the 29th at 1330 UTC the ship departed Nagoya and, after clearing Ise Wan, encountered freshening ENE'ly winds up to force 8 and rapidly falling pressure. At 2100 the barograph trace indicated that the ship was entering the sphere of influence of Page, which was thought to be 125–140 n.mile ahead. The ship rounded Shionomisaki Peninsula ahead of the storm track and anchored off Osaka as the port had been closed.



Typhoon Page had developed from a low pressure area south-east of Guam and moved slowly westwards, gaining the status of severe tropical storm by 0600 on the 22nd. By 1800 on the 24th Page had reached typhoon status and was apparently heading for Luzon Strait; a satellite image showed a large, well-developed storm. At 0600 on the 27th the central pressure of the storm had deepened to 910 mb with winds of 105 knots around it, Page had also started to curve northwards. The chart shows the storm's track and that of the ship.



The surface facsimile analysis at 0000 on the 30th indicated that Page had been downgraded to a severe tropical storm and was filling rapidly as it moved over the Japanese coast; satellite imagery showed the eye passing close to Shionomisaki as the storm hit the coast of Honshu. The closest point of approach to the ship was approximately 40 n.mile as Page crossed Japan to eastward of Osaka; weather conditions at 0600 when the ship was anchored off Osaka were: pressure 987.3 mb, wind NNE'ly, force 7, overcast sky with moderate rain and rough seas. These conditions began to moderate rapidly at 0730 on the 30th as the pressure began to rise. It was later learnt that Page was the first tropical storm to hit Japan so late in the year for 28 years.

Position of ship at 0600 UTC on the 30th: 34° 36′N, 135° 18′E.

Note. The *Arafura* is a Selected Ship of the Australian Voluntary Observing Fleet.

TROPICAL STORM 'MIKE'

Western North Pacific

m.v. *Endeavor*. Captain G. Cuthbert. Gladstone to Hirohata. Observers: the Master, Mr P. Thompson, 2nd Officer, Mr N. Sumpton, 3rd Officer and ship's company.

8 November 1990. At 0200 UTC, when passing through the Caroline Islands, the ship began to experience the effects of tropical storm Mike as the wind speed increased from WNW'ly, force 6 to force 8–9, blowing steadily while the pressure began to fall steeply. It had been raining almost continuously since 1400 on the previous day, and the intensity of the rain now increased.

The wind continued to blow approximately NW'ly, force 9 and the pressure maintained its steep fall until 1030 when the wind dropped to no more than force

5 and the pressure levelled at 988 mb. From 1100 to 1200 the wind backed from W'ly to SE'ly and again increased in strength to force 8–9 while the pressure began to rise steeply.

Until 1600 there was almost continuous heavy rain, with visibility down to less than 1 cable at times; thereafter, frequent squally showers occurred until 2200 at which time the cloud base had lifted and the showers became much less frequent. When the ship was in the 'eye' of the storm, the areas of precipitation shown by radar on the 48-n.mile range were (with a little imagination) approximately as depicted in *The Mariners' Handbook* and were detectable out to about 40 n.mile away.

At the time of the ship's passage through these conditions the storm was upgraded from a tropical depression to a tropical storm. The wind speed never exceeded force 9 except perhaps for the occasional gust of 50 knots and the sea conditions did not pose any problems for the ship which is a bulk carrier of 120 000 tonnes.

Position of ship at 0200 UTC: 07° 30′N, 142° 25′E.

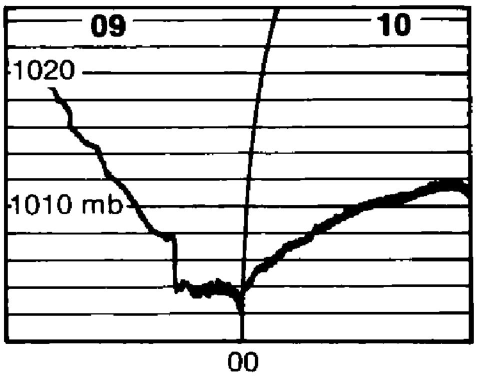
DEPRESSION

Tasman Sea

s.s. *ACT 1*. Captain A.J. Chivers. Port Chalmers to Melbourne. Observers: the Master, Mr L.M. Colam, 1st Officer and members of ship's company.

9–10 October 1990. Whilst the ship was clearing land south of Puysegur Point (South Island, New Zealand) into the Tasman Sea the wind increased from NNE'ly, force 3 to NW×N'ly, force 9 between 2000 UTC and 2030. During this period the pressure dropped suddenly by 4.5 mb (see barograph chart) as the ship began to pass through a low pressure system. The following observations were made between 2000 on the 9th and 0030 on the 10th.

Date and time (UTC)		Wind Dir'n	Wind Force	Pressure (mb)
9th	2000	NNE	3	1006.6
	2030	NW×N	10	1002.6
	2100	N	10	1002.7
	2200	N	11	1002.3
	2300	NNE	10	1002.5
10th	0000	N×E	10	1002.9



Between 2030 on the 9th and 0030 on the 10th the ship rolled and pitched heavily owing to a very rough sea and heavy swell, sustaining damage to some deck fittings and aerials. There was continuous moderate to heavy rain during this time and visibility was never greater than 0.5 n.mile. The wind was estimated to be gusting to 65 knots at times.

At 0030 on the 10th the ship was moving away from the low pressure and the wind eased slightly to NNW'ly, force 8–9; the visibility improved, the rain stopped and by 0400 the wind had eased to SW'ly, force 6.

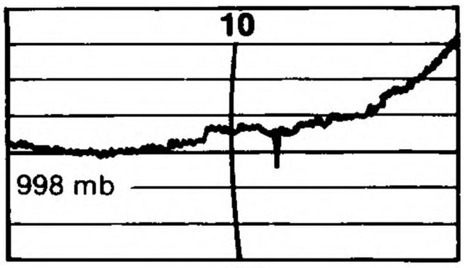
Position of ship at 1800 UTC on the 9th: 46° 30′S, 167° 42′E.

SQUALL

North Atlantic Ocean

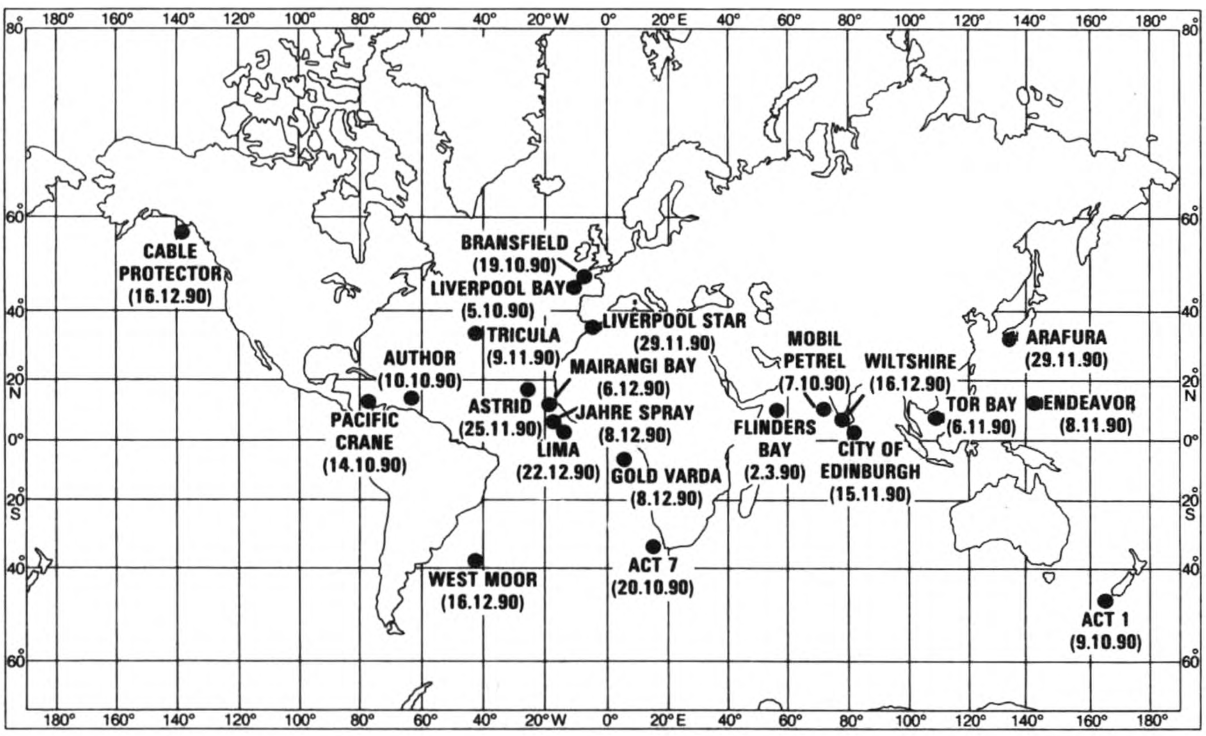
m.v. *Tricula.* Captain A.F. Devanney. Ymuiden to New Orleans. Observers: Mr A. Murray, 2nd Officer, Mr G. Harrison, 3rd Officer, Mr J. Philpott, Radio Officer and ship's company.

10 November 1990. At 1310 UTC a heavy rain shower was seen and as the ship neared it the wind veered to 320° and increased. Ten minutes later the ship entered the shower and the visibility was immediately reduced to less than 50 m by rain as the wind increased to force 12. The poor visibility was further reduced by driving spray (the anemometer showed 95 knots) and the barograph trace showed a sudden drop in pressure of 2.2 mb.



By 1335 the rain had decreased to become light while the wind moderated to force 9 and backed to 300° and the pressure returned to its previous reading.

Position of ship: 36° 47′N, 40° 57′W.



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

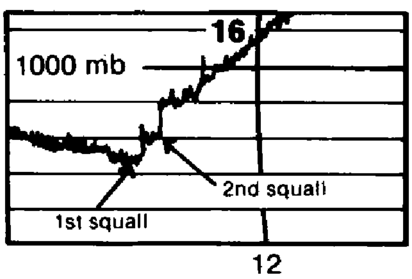
PAMPERO

South Atlantic Ocean

m.v. *West Moor*. Captain D.J. Lloyd. East Cove, Falkland Islands to Ascension Island. Observers: the Master, Mr N.C. Horner, 1st Officer, Mr E. Antolino, 2nd Officer, Mr G. Hoeppner, Chief Engineer Officer and Mr K. Parker, 2nd Engineer Officer.

16 December 1990. Whilst on a temporary course of 090° to ease heavy rolling caused by a steep west-north-westerly swell, a pampero was encountered and the following observations were made (the barograph trace shows the associated pressure changes).

Time (UTC)	Remarks
0500:	Extensive line of squalls sighted on radar at 30 n.mile to the south-west, aligned north-west to south-east. Pressure 997.5 mb, falling slowly; wind increased rapidly to NW'ly, force 7–8.
0600:	Squall line 12 n.mile to south-west with lightning visible. Air temperature 17.6°C, wet bulb 16.2°; pressure 996.5 mb, falling slowly; wind NW'ly, force 8.
0640:	Squall line reached ship. Torrential rain with thunder and lightning overhead, visibility reduced to approximately 100 m. Pressure fall ceased at 996.0 mb and then suddenly rose 2.7 mb in 1 minute; wind W'ly with gusts to 45 knots. The swell was noticeably decreased in heavy rain.



Time (UTC)	Remarks
0705:	Rain ceased as squall line passed to north-east. Another (parallel) line of squalls was visible on radar, 6 n.mile to rear of leading line. Pressure dropped rapidly by 1 mb, wind backed to W'ly and decreased to force 6. Visibility improved to 5–6 n.mile and swell remained much reduced.
0730:	Secondary line squall reached ship. Moderate to heavy rain with lightning sighted but no thunder heard. Air temperature 13.8°, wet bulb 13.2°; pressure rose very rapidly by 2.0 mb and wind remained W'ly, force 6.
0740:	Rain ceased as squall passed. Wind W'ly, force 7–8.

By 0900 the pressure was 1000.3 mb and rising and the wind veered to WSW'ly, force 8, the heavy west-north-westerly swell was again present. The cloud base began to lift and patches of blue sky became visible as conditions improved.

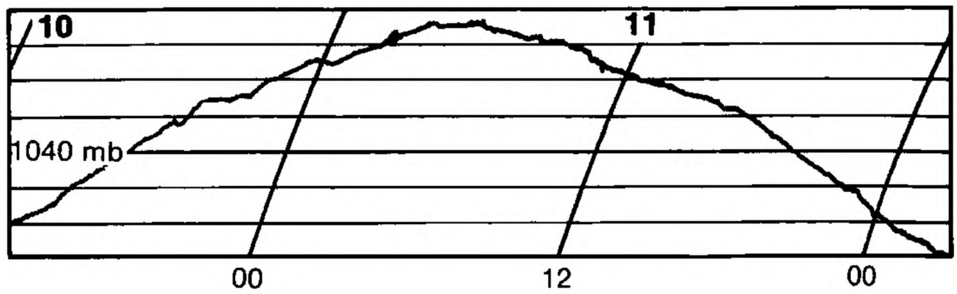
Position of ship: 39° 06'S, 40° 33'W.

ANTICYCLONE

Gulf of Alaska

m.v. *Cable Protector*. Captain F.J. Hill. Seward to Cape Spencer. Observers: the Master, Mr D.A. Wilson, Meteorological Officer and ship's company.

16–17 December 1990. Whilst on passage the ship encountered a phenomenal area of high pressure (see barograph trace). During the evening of the 16th a low



pressure system, previously stationary, passed the vessel to the north. The wind became predominantly NW'ly, reaching gale force by midnight when the sky had become overcast and the dry-bulb temperature had dropped to 0.1°C having been 1.5° at 1600.

At approximately 1100 on the 17th the wind suddenly veered from NW'ly to NE×E'ly and the low pressure system sped off in roughly a south-easterly direction. The following anticyclone moved south and ensured the ship's safe passage through the inland waterways to Vancouver. As the center came closer the barograph pen almost went off the top of the scale as the precision aneroid showed a maximum pressure of 1047.9 mb.

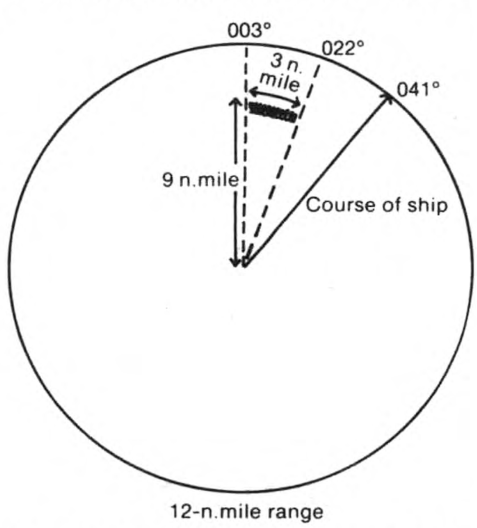
Position of ship at 2100 UTC on the 17th: approximately 58° 42'N, 139° 36'W.

CURRENTS

Caribbean Sea

m.v. *Author*. Captain E.J. Maxwell. Port of Spain to Bridgetown. Observers: the Master and Mr G. Ritchie, 3rd Officer.

10 October 1990. At 0140 UTC an unusual echo was observed on the radar; it formed a continuous line from a bearing of 003° to 022° at a range of 9 n.mile. The echo was approximately 3 n.mile long and had no discernible width, see sketch. On consulting the relevant chart it was concluded that the echo was, in fact, the equatorial current boundary, as charted. The target was clearly visible up to a range of 2 n.mile but was then lost and not observed again.



The only change noted in the following meteorological conditions as the vessel passed the target was a slight rise in the sea temperature from 26.0°C to 28.0° between 0140 and 0200: air temperature 28.0°, wet bulb 27.5°, pressure 1009.4 mb, wind E×N'ly, force 2–3; confused swell.

Position of ship: 11° 12'N, 61° 20'W.

Indian Ocean

m.v. *Flinders Bay*. Captain D.A. Dornom. Suez to Fremantle. Observers: the Master, Mr D.K. MacCorquodale, 1st Officer, Mr N. James, 2nd Officer and Mr F.N. Cambra, 3rd Officer.

2–3 October 1990. At 1126 UTC on the 2nd a satnav fix gave the ship's position as 10° 54.9′N, 52° 51.6′E. The weather at the time was fine, the wind was SSW'ly, force 5 and the ship's speed was logging 20 knots while the rpm indicator was normal at 121 rpm. At 1316 another satnav fix gave a position of 10° 36.5′N, 53° 29.4′E; when the speed was worked out between this fix and the previous one, a speed of 22.75 knots was obtained. This naturally raised doubts about the accuracy of the later fix and questioned whether the satnav had 'thrown a wobbler'.

However, the next fix gave rise to the possibility that there was a strong current because the position given by a fix at 1436 revealed a speed made good of 23.21 knots from 1126 and 23.92 knots from 1316. The routeing chart for October was referred to and it indicated a current of 1½ knots for the area in which the fixes had come. The currents experienced at this time were double that indicated on the chart. A further fix gave a speed made good of 24 knots which was the maximum experienced; this was worked out between a fix at 1706 in position 09° 47.8′N, 54° 48.0′E and one at 2034 in position 08° 57.9′N, 55° 55.6′E.

On the 3rd a fix gave a speed made good of of 22.04 knots while a further fix at 0718 gave a speed of 20.6 knots. The observers proved that the satnav had not thrown 'wobblers' because solar observations taken during the morning were in agreement with it. By this time, the wind had decreased to S'ly or S×W'ly, force 3–4 while the rpm had been constant throughout.

From the satnav fix at 1126 on the 2nd to a fix at 0112 on the 3rd, a distance of approximately 240 n.mile was measured out forming a radius with the centre in DR position 06° 55′N, 53° 20′E.

Position of ship at 1436 UTC on the 2nd: 10° 20.5′N, 53° 57.3′E.

CETACEA

Western Mediterranean

m.v. *Liverpool Star*. Captain S.H. Duckworth. Falmouth to Limassol. Observers: the Master, Mr P.W. Jackson, 1st Officer and Mr J.C. Hague, 2nd Officer.

29 November 1990. At 1158 UTC the ship was eastbound through the Strait of Gibraltar and was starting to experience the effects of an eastgoing tide. Two pilot whales were sighted close to the starboard bow, travelling together in a westerly direction. As they passed alongside to starboard the whales veered away momentarily before resuming their travels. Moments later, three more groups of pilot whales were sighted amongst the tide rips; they were close together and travelling westwards sporadically, no doubt feeding in the upwelling waters from sub-surface currents. In all, an additional 15 whales were seen.

As the ship neared these groups a disturbance in the water by one of them was noticed and inspection through binoculars provided a most unusual sight, as shown in the sketch. Two dolphins were in close attention to one of the whales and one of them was 'riding up' on the whale's back just forward of its dorsal fin. The dolphin's jaws were seen to be repeatedly opening fully then closing rapidly and as the ship neared this group, a staccato domino-clicking sound was clearly

heard by observers on the bridge wing. Meanwhile, the second dolphin kept station alongside the whale's port quarter and this action was continued by both individuals until all were lost to sight astern.

The pilot whales were 4–5 m long with dark-brown/black upper bodies and a heavy, rearward curving dorsal fin whereas the dolphins were about 2 m long with dark-grey upper bodies, pale-grey jaws and sharply pointed dorsal fins.

Position of ship: 35° 55′N, 05° 40′W.

Note. Mr D.A. McBrearty, of the Dolphin Survey Project, comments:

'This is an interesting account of interaction between pilot whales (*G. malaena*) and dolphins, probably Bottlenose dolphins (*T. truncatus*). Whales and dolphins produce a variety of sounds both under and above the water. The underwater sounds are extremely complex involving clicks and whistles in the low- and high-frequency range and of both long and short duration. The above water sounds are usually sharp rasps and squawks similar to those described by the observers. Any visitor to a captive dolphin display will hear these sounds at some time during the performance. Whale and dolphin sounds have been investigated and analysed for years, ever since the end of World War II; some repetitive calls have been identified as signature whistles, distress calls, etc., while others are believed to be associated with feeding and navigation. The meaning of most of the sounds produced is still very much a matter of opinion.'

Indian Ocean

m.v. *City of Edinburgh*. Captain F.G. Anderson. Singapore to Suez. Observers: Mr J.M. Groat, Chief Officer and Ms Michelle Pearl, Radio Officer.

15 November 1990. At 1100 UTC when the ship was off the south coast of Sri Lanka on a course of 269° at 22.5 knots, in excess of 50 whales were sighted; they were of different types and sizes but two species were identified. The first was a pair of Sperm whales which surfaced close to the ship blowing approximately every 15–20 seconds. There had been no plumes seen in their direction for some time, and it was assumed that they had just surfaced after a deep dive. The blunt head, rounded fin and angled blow were clearly seen.

Another whale passed close down the starboard side of the vessel, turning away at the last minute; this one had a white underside extending from the snout to about half the body length, small flippers and a sharply curved dorsal fin. With an estimated length of 15 m this individual was thought to be a Fin whale.

The whales followed no general direction of travel and no young were sighted. The estimate of their number was conservative as, during the 90 minutes of the observation, there were never less than four or five blows visible at one time.

Position of ship: 05° 49′N, 80° 32′E.

Dr P. Ryder (Director of Operations, Met. Office) presents Captain A.J. Chivers with a long-service award. (See page 194.)

Dr P. Ryder presents a long-service award to Captain H.K. Dyer. (See page 194.)

Dr P. Ryder presents a long-service award to Captain D.C. Blackman. (See page 194.)

Dr P. Ryder presents a long-service award to Captain D.N. Boon. (See page 194.)

Opposite page 173

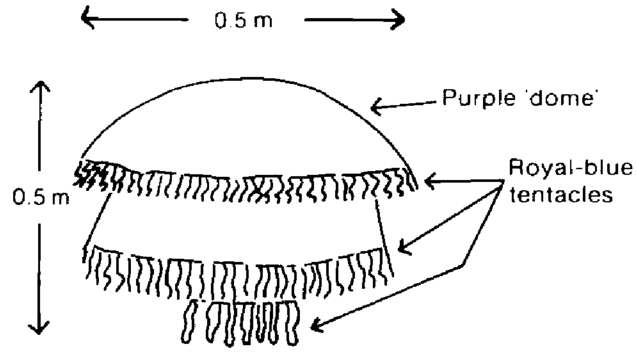
Presentation of barographs at Bracknell Headquarters on 24 April 1991. Standing, left to right: Captain G.V. Mackie (Marine Superintendent, Met. Office); Captain R. Symonds (Personnel Manager, Geest Line Ltd); Captain A.J. Chivers (Blue Star Ship Management Ltd); Captain H.K. Dyer (Blue Star Ship Management Ltd); Captain D.C. Blackman (P. & O. Containers Ltd); Captain W.R. Houghton Boreham (Operations Manager, Blue Star Ship Management Ltd); Captain D.N. Boon (Geest Line Ltd); Dr P. Ryder (Director of Operations, Met. Office); Captain J. Cox (Marine Services Manager, P. & O. Containers Ltd). Seated, left to right: Mrs Chivers, Mrs Dyer, Mrs Blackman. (See page 194.)

JELLYFISH

Indian Ocean

m.v. *Mobil Petrel.* Captain P.D. Kelly. Juaymah to Singapore. Observers: the Master and Mr C.W. Blacker, 2nd Officer.

7 October 1990. At 0800 UTC while the ship was about 20 n.mile off the Indian coast numerous jellyfish were observed close by, particularly a group of 15–20 creatures which were seen close to each other, one of which is shown in the sketch.



They were purple/royal-blue in colour (in some cases, seemingly ultraviolet) and had a diameter of about 0.5 m. The 'dome' of some was coloured a distinct purple whilst others were more a milky-blue. There was an apparent double 'skirt' of small tentacles with a few short, main tentacles appearing below, all were coloured a dark royal-blue. Nothing unusual was noted about the jellyfish except their vivid colouring, particularly of those that exceeded the estimated average size.

Position of ship: 08° 55′N, 76° 11′E.

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

'These very large jellyfish were a species of *Rhopilema* and closely related to, if not the same as the edible jellyfish of Japan. The colour is usually blue, but is sometimes dark-red. According to Mayer's *Medusae of the World*, (Volume 3 (1910)), "It is the custom in Japan to preserve it with a mixture of alum and salt or between the steamed leaves of a kind of oak. It is then soaked in water, flavoured with condiments, and when so prepared constitutes an agreeable food". It seems that it is eaten as an accompaniment to saki.'

MARINE LIFE

Eastern North Atlantic

t.s. *Astrid.* Captain D.R. Norman. Canary Islands to Cape Verde Islands. Observer: the Master, Dr E. Green, Science Officer and members of ship's company.

25 October 1990. Whilst on passage a floating buoy was recovered, attached to which was a large tangle of rope about 2 m wide. The float and rope supported a large collection of animals including many hundreds of mature goose barnacles and swimming crabs. Entwined within the rope were masses of fish eggs and, at the very centre, so trapped that they had to be cut out, two flying-fish of the species *Exocoetus volitans* of length 22 cm and 25 cm, they were rigid but showed no sign of decomposition. The egg-laying habit of *E. volitans* was not known but

the mass of eggs was so large it suggested that the two trapped specimens were not the only layers. A single, golden-coloured fish 10 cm long and bearing two prominent ventral spines was also found along with several unidentified polychaete worms ranging from 5 cm to 30 cm in length. A photograph of some of the collection appears opposite page 189.

Position of ship: 18° 12'N, 23° 45'W.

Note. The following are extracts from an analysis made by Dr F. Evans:

'The goose barnacle (not shown) was most likely *Lepas hilli*, while the crabs were most likely Sargassum crabs (*Planes minutus*). The flying fish appear not to be two-wingers but four-wingers (pelvic fins and pectorals enlarged for flight) and hence were not *Exocoetus*. The eggs around the head of the small yellow fish are flying fish eggs. Some flying fish have eggs with fine tendrils designed to tangle with floating objects on being laid. There was, and perhaps still is a flying fish fishery in the West Indies for the four-winger *Hirundichthys affinis*; it depends upon the fish's instinctive behaviour of swimming up to drift nets in order to spawn on them; they then become enmeshed in the net. It seems very likely that both fish and eggs are of the species *Hirundichthys speculiger*.

'The yellow fish is a species of carangid, a group of fish with many names, jack, kingfish, pompanos and horse mackerel being a few. The two prominent detached spines are diagnostic, but to be more precise is difficult. All the creatures are associated with drifting debris of the tropical Atlantic; however, I have never before seen the large blue-black worms among such a collection of surface organisms. They are ragworms of the family Eunicidae related to the Palolo worm of the West Indies.'

BIRDS

Caribbean Sea

m.v. *Pacific Crane*. Captain D. Marr. Cristobal to Cherbourg. Observers: Mr W.R. Durrans, 3rd Officer, Mr P. Cutler, Cadet, Mr S. Jones, 4th Engineer Officer and members of ship's company.

14–16 October 1990. Approximately 12 hours after leaving the Panama Canal the small bird shown in the photograph opposite page 189 was observed resting on one of the vessel's aft decks. After several minutes of careful coaxing it plucked up enough courage to venture within a few centimetres of the Third Officer. The bird was obviously very tired and was given pieces of bread soaked in milk and butter, a saucer of water and some cornflakes; although it tried all of these offerings, the cornflakes seemed to be to its particular liking and it actually took these directly from the Fourth Engineer's hand.

It was roughly 10 cm tall and was coloured a well co-ordinated mixture of brown and white with red tips on its throat and the fore part of the wings. One suggestion was that it was a Hawfinch or perhaps a Java sparrow, although Java was a long stretch away from the Caribbean.

By the following afternoon the visitor was even venturing so far as to be hopping upon peoples' knees. On the morning of the 16th while the vessel was in the vicinity of Haiti, the bird was found to have gone.

Position of ship: approximately 11° 48'N, 77° 42'W.

Note. Commander M.B. Casement, of the Royal Naval Birdwatching Society, comments:

'The bird is a male Rose-breasted Grosbeak (*Pheucticus ludovicianus*) in first-winter plumage. This species breeds in the eastern U.S.A., and winters in central and South America.'

Eastern North Atlantic

R.R.S. *Bransfield.* Captain S.J. Lawrence. Grimsby to Rio de Janeiro. Observers: the Master, Mr G. Chapman, 3rd Officer and ship's company.

19 October–7 November 1990. Two starlings were first observed on board the vessel in the English Channel; several days later they appeared on the bridge wings and were very forward in their search for food, hopping through the bridge and rummaging in bins and ashtrays. One had hopped through wet paint and spread it all over the bridge controls and telephone handsets. They were given watered milk and breadcrumbs but over the next few days they found they could do better outside the gash room on the poop deck. Their 'nest' appeared to be in a coil of mooring rope on the poop and were seen most days flying around the decks; despite passing a couple of miles off the Canary Islands they did not depart the vessel.

Surprisingly, the starlings were still alive when the ship arrived in Rio de Janeiro and it was thought they went ashore and settled there, but the observers wondered if they would survive.

Position of ship at 1200 UTC on the 19th: 48° 54′N, 05° 12′W.

Note. Commander M.B. Casement comments:

'This is a very interesting report; I suspect the birds probably survived. The starling's remarkable spread from Europe to North America is probably due to its exceptional survivability and opportunism. Hitch-hiking aboard ships is an important factor.'

Gulf of Manaar

m.v. *Wiltshire.* Captain C.H. Marsh. At Tuticorin. Observers: Mr G.D. Dockerty, 2nd Officer, Mr I.D. Howard, 2nd Officer, Mr A.P. Henry, Cadet and Mrs Howard.

16–18 December 1990. The vessel arrived at Tuticorin in the early hours of the 16th; daylight revealed two birds of prey on board, believed to be ospreys. Both birds were of similar colouring, as shown in the photograph opposite page 189, and one appeared to be slightly slimmer; it was assumed they were a pair. Overall, the birds were tan in colour with off-white chests and heads. When gliding with the wing-tips raised, the tips seemed to be darker or perhaps black. Both birds stood about 45 cm high (when compared with deck floodlights) and one was rarely seen without the other; usually, both occupied the same derrick post.

At one stage, one bird was seen holding a small fish in its talons, it landed on a derrick post with the fish but dropped it after 10–15 minutes making no attempt to recover or share it with the other bird. Upon later inspection the fish appeared almost intact apart from its missing head. Neither bird seemed at all interested in the numerous small birds flying around the ship but did chase a large, black rook or crow. The 'black bird' was more agile than the two 'ospreys' and, after being chased for about 10 minutes, flew off towards the shore without being followed by them.

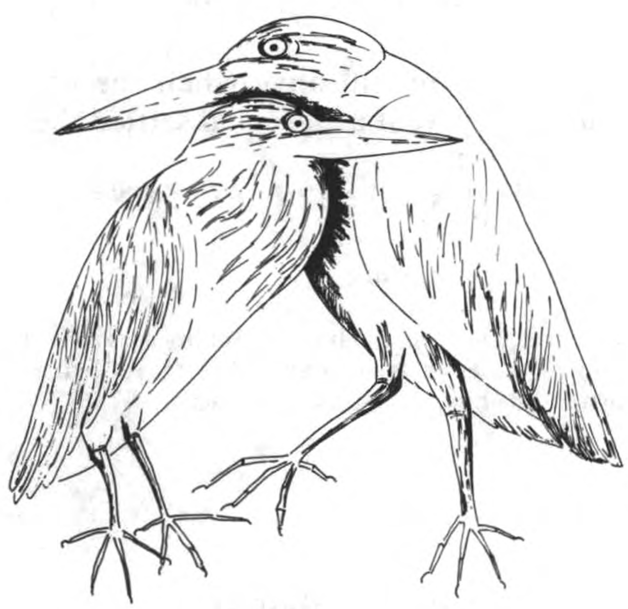
The two birds were with the vessel throughout the stay in port and left upon its departure on the 18th.

Position of ship: approximately 08° 48′N, 78° 10′E.

South China Sea

m.v. *Tor Bay*. Captain P.A.E. Sambrook. Singapore to Kobe. Observers: the Master, Mr A.P. Talbot, 1st Officer, Mr N.R. Hart, 2nd Officer, Mr I.D. Hebborn, 3rd Officer and ship's company.

6 November 1990. At 0140 UTC when the ship was about 120 n.mile south-east of Vietnam two birds, as shown in the sketch, landed on top of a container about 30 m in front of the bridge. At the time, the vessel was making 8 knots for water-washing purposes and there was very little wind over it.



The birds were similar in size and markings, standing about 35 cm tall. They were coloured as follows: upper side of wings dark-brown, undersides white; head greenish with brown flecks, breast light-brown with dark-brown flecks; eye yellowish with black pupil, bill brownish-green with a black tip; legs greenish-brown. In one bird the eyes had brighter markings and the legs were brighter also.

At 0200 the ship was up to full speed again so both birds were having to crouch low and tread carefully to keep their balance. Apart from the occasional inquisitive sorties along the length of the container they remained still at the after end where the wind seemed less strong, although their feathers were continually being ruffled. The birds remained with the ship until 0930 when a shift of wind to ahead saw them off.

Position of ship: 09° 10′N, 109° 50′E.

Note. Commander M.B. Casement comments:

'From the useful sketch and description, these were probably Little Green Herons (*Butorides striatus*) which are widely distributed throughout south-east Asia, and often hitch-hike aboard ships during migration.'

BAT

Eastern North Atlantic

s.s. *Lima*. Captain D.J. Conway. Yanbu to Europoort. Observers: the Master, Mr D. Freeman, 1st Officer, Mr R.D.S. Arthur, 2nd Officer and members of ship's company.

22 December 1990. Whilst the ship was drifting and awaiting orders a bat, which was later discovered to be a fruit bat, was found lying on deck after a crash-landing. It was approximately 15 cm in length with light-brown skin and its head had fox-like features with large ears. The bat did not seem to be injured but was merely confused and tired. After a short time, it took off and was last seen heading in a south-easterly direction. During the previous 12 hours the weather had been unsettled with rain and lightning which must have upset the bat's senses.

Weather conditions at the time of the observation were: dry bulb 28.4°C, pressure 1008.8 mb, wind N'ly, force 3, overcast and hazy.

Position of ship: 06° 30'N, 16° 15'W.

Note. Mr J.E. Hill (Retired), of the British Museum (Natural History), comments:

'This bat may have been a Straw-coloured fruit bat (*Eidolon helvum*), relatively widespread in west Africa. Among fruit bats this is a medium-sized light-coloured species that might easily be blown or stray out to sea while flying from the roost to a feeding site or from one feeding site to another.

'The report is yet another of an ocean-going bat off the west African coast, although earlier records have been of insect-eating species. Possibly, strong offshore winds occur in this area that might account for these records, although obviously it is feasible that bats can board a vessel while in port, and subsequently sail with it.'

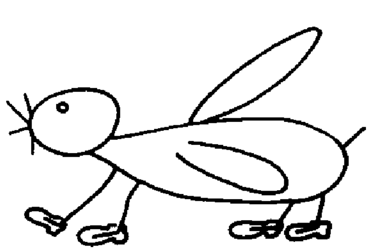
LOCUST

Eastern North Atlantic

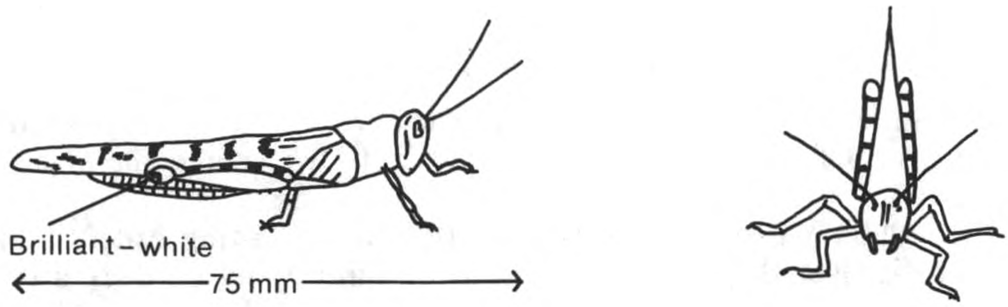
m.v. *Mairangi Bay*. Captain B. Graham. Rotterdam to Capetown. Observers: the Master, Mr K. Ireland, 2nd Officer, Mr D.L. Dodsworth, 3rd Officer and Mr D. Warburton, Chief Engineer Officer.

6 December 1990. At 1230 UTC the vessel was 22 n.mile west of Dakar when the Chief Engineer reported a large locust on the ship's stairway. After some gentle persuasion the 3rd Officer managed to capture the beast in an ice bucket and transport it to the bridge where, with much trepidation, the lid of the bucket was removed.

The locust seemed very uneasy at first, so a quick sketch was made in case it flew away (see first sketch), but after a few minutes it appeared to be fairly



contented so more detailed sketches were made. Measuring 75 mm from head to tail, it was a light sandy-brown colour overall with dark-brown 'striped' areas as shown and its rear leg joint was brilliant white. No attempt was made to feed it in case it was a carnivorous variety.



While this locust was being portrayed, a second slightly smaller and more yellowy one was observed on the bridge wing but flew away when approached. The captured locust was eventually released at 1345 and no further sightings were made. At the time the wind was N×W'ly, force 4.

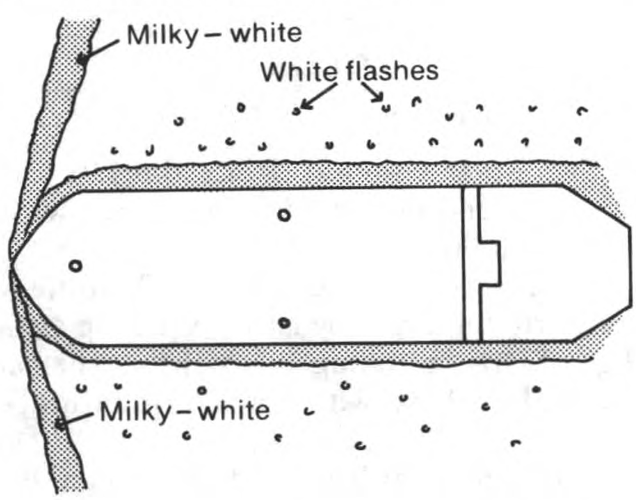
Position of ship: 14° 46′N, 17° 49′W.

BIOLUMINESCENCE

Eastern North Atlantic

m.v. *Jahre Spray*. Captain G.S. Oakley. Kwa Ibo to Delaware Bay. Observers: the Master, Mr W.T. Dela Cruz, 3rd Officer and Mrs Oakley.

8 December 1990. At about 2200 UTC bioluminescence became visible from both the port and starboard bridge wings. As shown in the sketch there was a milky-white bow wave and also a milky-white band along the full length of the vessel, extending outwards to about a metre from the sides. Numerous rapid white flashes were seen on the sea surface away from the milky areas and this was also noted in the wake for about 50 m astern.



The ship was on a course of 310° at 13.3 knots and was loaded to a draft of 55 feet. Weather conditions were: air temperature 27.1°C, wet bulb 26.1°, sea 29.0° and it was a moonless night with traces of cloud on the horizon.

Position of ship: 10° 48′N, 18° 24′W.

ABNORMAL REFRACTION

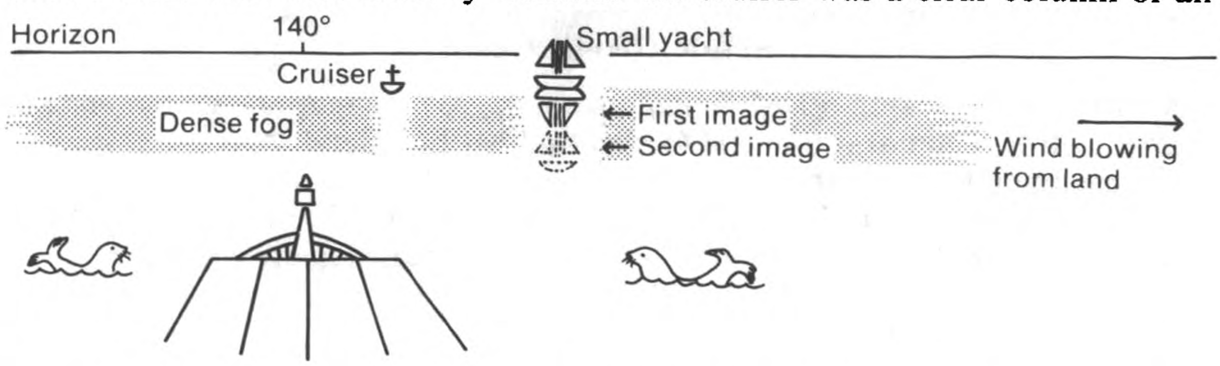
South Atlantic Ocean

m.v. *ACT 7*. Captain A.J. Cheshire. Rotterdam to Adelaide. Observers: the Master, Mr D.P. Andrew, 3rd Officer and ship's company.

20 October 1990. At about 0930 UTC as the vessel approached the Cape of Good Hope from the north-west, Table Mountain became clearly visible by the

naked eye at 75 n.mile (height of eye 31 m). Cape fur seals, too numerous to count were basking on the surface apparently 'sunbathing' and many were observed inverted in the water, leaving their flippers swaying above the surface.

On the horizon some miles distant dense fog was sighted; on closer inspection it turned out to be a large patch of sea fog drifting with the wind which was blowing off the land. By 0945 the fog had passed the ship's course line and its bearing was opening up on the starboard side. The radar had detected two targets and through binoculars they were found to be a cruiser and a yacht; the sketch shows what was seen. Directly 'beneath' the cruiser was a clear column of air



emanating from its hull, across the surface towards the observers. The yacht, which was of higher vertical stature, showed two mirages; one was inverted hull-to-hull with the yacht, this image being almost as clear as the object itself, while the second mirage was sail-to-sail with the one 'above' it. This one was not so clear and showed a shimmering effect.

Weather conditions were: dry bulb 17.5°C, sea 15.1°, pressure 1013.5 mb.

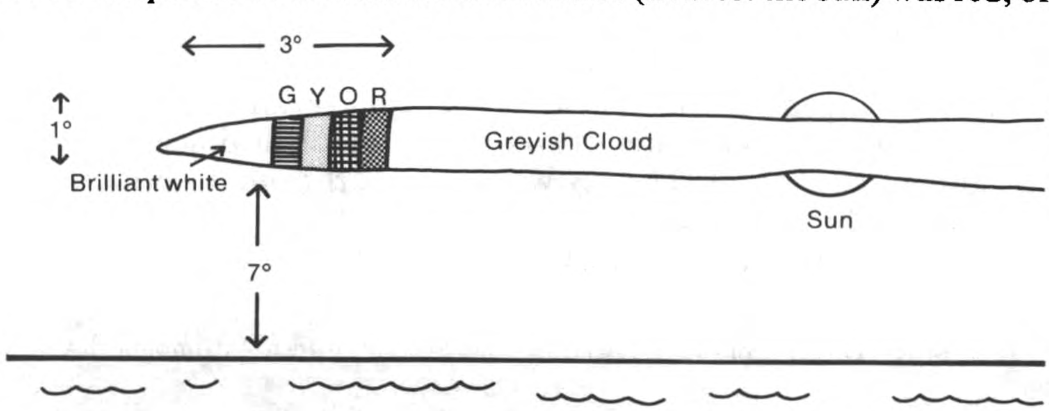
Position of ship: 33° 28′S, 17° 35′E.

MOCK SUN

Eastern North Atlantic

m.v. *Liverpool Bay*. Captain A.J. Palmer. Southampton to Port Said. Observers: Mr J. Dixon, 1st Officer, Mr P. Murphy, Radio Officer and Mr N. Harrison, A.B.

5 October 1990. At 1705 UTC there were 3 oktas of cloud which included 2 oktas of cirrus in bands invading the sky, and it was noted that the end of one of the bands was taking on the colours found in the red end of the spectrum, see sketch. The sequence of colours from the inside (nearest the sun) was red, orange,



yellow and green with the extreme tip of the cloud being brilliant white. This effect lasted for roughly 10 minutes after which the colours faded but the tip still remained brighter than the rest, with a reddish band dividing the 'normal' from the bright parts. As the sun lost altitude the reddish band moved along the cloud towards it and the phenomenon lasted until 1750 when the sun's altitude was approximately 1°. A very clear green flash was observed when the sun set at 1804.

Weather conditions were: air temperature 16.8°C, wet bulb 13.3°, pressure 1027.0 mb, wind WSW'ly, force 2–3.

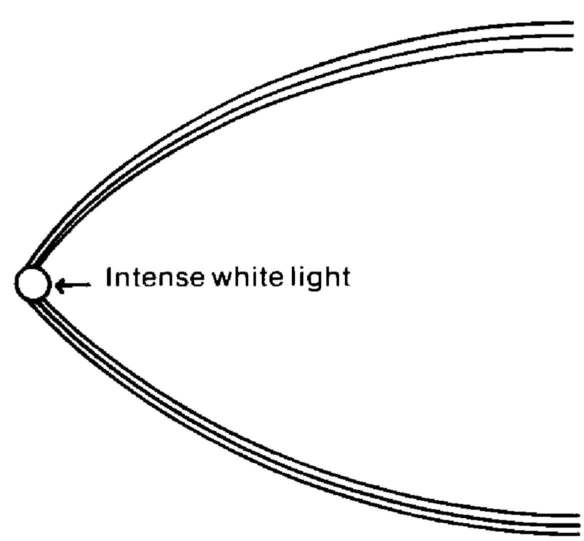
Position of ship: 46° 24'N, 07° 18'E.

SATELLITE

South Atlantic Ocean

m.v. *Gold Varda.* Captain J.M.C. Robinson. Lagos to Singapore. Observers: the Master, Mr R. Chandraratne, 1st Officer and Mr E. Tulang, A.B.

8 December 1990. At 0400 UTC on a bearing of 170° and altitude of 20° a bright, white object trailing streamers of light as shown in the sketch, was observed fine on the starboard bow. The streamers of light were convex in shape and the aspect was remarkably like the side view of an angel fish; the distance of the object from the streamers was about 10° of arc.



In three minutes, the satellite (if such it was) travelled from the starboard bow to slightly abaft the port beam, attaining a maximum intensity when bearing 120° before it disappeared behind low cumulus cloud at an altitude of 15° above the horizon. At its maximum intensity the brightness of the object resembled the landing lights of an aircraft. The sky was clear apart from the aforementioned cumulus and the ship's course was 162°.

Position of ship: 04° 18'S, 06° 51'E.

Note. Mr H. Miles, Director of the Artificial Satellite Section, British Astronomical Association, comments:

'The object seen was the decay of a satellite; it was most likely 1990–59A, Badr–1, a Pakistan satellite launched from a new pad at Xichang, China, on 16 July 1990.

551.46:551.588

The ocean and climate*

By Dr R.W. Stewart
(Centre for Earth and Ocean Research, University of Victoria, British Columbia)

The ocean plays a role in the climate system that is complementary and of comparable importance to that of the atmosphere. It stores heat and releases it later, often in a different place, and both absorbs and releases CO_2. Understanding and predicting the behaviour of the climate thus require understanding and predicting the behaviour of the ocean, which in turn require both modelling and monitoring the ocean.

How the ocean affects climate

The ocean is sometimes referred to as 'the flywheel of the climate system', although this inadequately describes its contribution. Like a flywheel, the ocean stores energy, in this case thermal energy, when it is in large supply during the day or summer, and releases it when the energy supply is reduced or reversed during night or winter.

When heated, the ocean responds by storing some of the heat and by increased evaporation. Because the heat is mixed down for some metres by the wind, temperature rises much less than it does on dry land under the same heating conditions. The evaporation, however, has profound effects on the atmosphere and on climate. Water vapour released into the atmosphere greatly increases the greenhouse effect in the atmosphere. When it condenses (sometimes far from where it evaporated) the resulting heating of the air is a major source of energy for atmospheric motion.

When the ocean is cooled, it responds by generating vertical convective motions, which bring heat to the surface, so that the cooling is spread over considerable depth — sometimes to the bottom. Thus the temperature fall is much less than over land under the same cooling conditions.

The overall result is that for the two-thirds of the Earth's surface covered by ice-free ocean, the temperature over the whole ocean ranges only from −2 °C (the freezing point of salt water) to 30 °C, and at any one place by hardly more than 1 °C during the course of a day and 10 °C during the course of a year. Over dry mid-continental areas, the variation from place to place can be about 100 °C, and during the course of the year in particular places about 80 °C. Further, the relatively slow response of the ocean to heating and cooling results in the oceanic annual cycle being retarded relative to that in continental regions. Temperature contrasts between the land and adjacent sea surfaces gives rise to a variety of atmospheric responses, from the daily generation of coastal land and sea breezes to the great seasonal monsoonal circulations.

Such effects would be experienced even if the ocean were little more than a deep swamp — as indeed it is assumed to be in many numerical models of the climate system. However, the ocean is much more complex. It môves, both horizontally and vertically, under the influence of wind forcing and density differences generated by heating and cooling, evaporation, precipitation and runoff. In moving, it redistributes heat (and salt) in ways that are of central importance in determining the details of the Earth's climate. The North Atlantic provides a particularly notable example. In the tropical Atlantic, solar heating

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and excess evaporation over precipitation and runoff create an upper layer of relatively warm, saline water. Some of this water flows north, through the passages between Iceland and Britain. On the way it gives up heat to the atmosphere, particularly in the winter. Since winds at these latitudes are generally eastward, the heat is carried over Europe, producing its mild winters relative to others at similar latitudes.

So much heat is withdrawn that the temperature drops close to the freezing point. Unlike fresh water, sea water has no temperature of maximum density higher than the freezing point, so cooling always increases density. This water, now in the Greenland Sea, remains relatively saline, and the combination of low temperature and high salinity makes the water more dense than deeper water below it. Convection sets in and the water sinks — occasionally and locally right to the bottom. There it slides under, and mixes with, other water already close to the bottom. It spreads out and flows southward, deep and cold.

This thermohaline circulation, surface warm water flowing north, cooling, sinking and then flowing south, provides an enormous northward heat flux. It amounts to about 1 PW [1 petawatt (10^{15} watts)], fully comparable with that transported poleward by the atmosphere.

This is part of the climate system that has been most clearly identified as one which might be dramatically modified by quite small changes. Thus if the surface salinity in the northern parts of the North Atlantic should be reduced for some reason, then cooling might not be able to produce water dense enough to sink to great depths, let alone the bottom. This is now the case in the Arctic Ocean and in the North Pacific, so it is clearly physically possible. Should that occur, the winter North Atlantic would be covered by a layer of water that would quickly cool, freeze in some areas and would be unable to provide the heat source that now warms Europe.

Lowered surface salinity could be brought about by increased precipitation, melting of the Greenland ice-cap and/or changes in the way relatively low salinity water of the Arctic Ocean passes into the Atlantic. Any or all of these changes are possible, and modelling studies indicate that the resulting climate change could be quite persistent. There is evidence that such a change in conditions occurred toward the end of the most recent ice age, some 12 000 years ago, perhaps because of the rapid unleashing into the North Atlantic of fresh water derived from melting the Laurentian ice sheet.

Even larger quantities of deep water are generated near the Antarctic continent. If for some reason, like increased precipitation or increased melting of Antarctic ice, the surface salinity in this region were substantially lowered, this source could also be cut off.

Deep water from these two sources spreads throughout the ocean. There it is slowly warmed by mixing with slightly warmer water above, and new supplies of cold water push under it. Over the course of centuries the water gradually rises, warmed by mixing from above and pushed up by newly produced cold water below. Eventually it rises enough to participate in the wind-driven circulations of the upper parts of the ocean and then to become part of the thin upper layer that is directly heated by the sun. From there it can move into higher latitudes and again be cooled to the point of convection. Water that moved into the most distant parts of the ocean, in the North Pacific, can take about 1000 years to complete this cycle.

Other surface water, which does not reach very high latitudes, also experiences cooling and convection, in this case only to some intermediate depth. It also spreads out, mixing laterally with water of about its own density, pushes up water above it and is in turn pushed up by other water sliding in below it. This shallower circulation can be completed in a few years or decades.

During the highly turbulent convective process, water is in repeated contact with the surface and comes into approximate equilibrium with atmospheric concentrations of gases, including notably O_2, CO_2 and freons. The freons are inert, and provide a valuable passive tracer for ocean movement. On the other hand, O_2 and CO_2 are strongly affected by biological activity. The surface layers of the ocean contain phytoplankton which, in the presence of sunlight, convert dissolved CO_2 into organic carbon. These are eaten by animals, which are in turn consumed by other organisms. Debris from these organisms falls out of the surface layers into the deeper water. On the way down, bacteria decompose some of the material, releasing CO_2 and nutrients in dissolved form in the process and absorbing O_2. As a result, the deeper water is enriched in CO_2 and nutrients and depleted in O_2.

Deep ocean mixing is inefficient and slow, so although the deep water is warmed somewhat as it rises, the great majority of ocean water is much closer in temperature to bottom water than to surface water. (At a depth of 1 km the temperature of most of the ocean is about 5 °C.) The depth of the warm surface layer varies considerably, depending upon ocean circulation, but typically the main thermocline, in which winter temperature decreases from values close to those of the surface to values close to those of the deep water, lies between about 100 m and 1000 m. (In summer a temporary upper layer develops, which may be up to about 100 m deep and up to 10 °C warmer.) The main thermocline is particularly shallow in tropical areas.

In certain areas, notably on some coastlines and near the equator, wind-driven currents drive surface water away, so that it is replaced by the upwelling of deeper water from within the main thermocline. The upwelled water is rich in both nutrients and CO_2. If other conditions are suitable, the nutrient supply greatly enhances biological activity and most of the richest fisheries in the world are located in these upwelling areas. Some of the excess CO_2 is absorbed by the marine plants, and the rest is exuded to the atmosphere. It should be noted that part of the CO_2 released was absorbed from the atmosphere in convective regions, perhaps thousands of kilometres away and hundreds of years earlier. The atmospheric CO_2 was then in lower concentration than today, so the concentration of CO_2 in the water is correspondingly lower and so is the amount of the gas exuded to the atmosphere. This is one of the ways in which the ocean can absorb CO_2: enhanced absorption in high latitude convective regions and reduced transfer to the atmosphere in upwelling regions.

The eastern equatorial Pacific provides an outstanding example. The most frequent wind pattern in the Pacific leads to upwelling off the coast of South America and cool thermocline water coming to the surface there and in an equatorial tongue which extends far into the Pacific. The western equatorial Pacific, on the other hand contains a deep pool of the warmest water in the world, usually above 29 °C. From time to time the eastern region becomes flooded with this warm water. This is the El Niño phenomenon, which has profound effects upon the climate and upon marine life of all kinds.

This phenomenon has been the subject of intense study, particularly during the 1980s, within the Tropical Oceans and the Global Atmosphere TOGA programme, and substantial progress has been made in understanding and attempting to predict it. Behaviour of the equatorial Atlantic and Indian Oceans is also quite variable, with climatological consequences on regions that contain a large fraction of the world's population but remains less thoroughly studied and less well understood than is the Pacific.

Limits of our present understanding

The behaviour of the ocean will only be understood through an interplay between modelling and observation. Understanding of the nature of important phenomena is far too incomplete to enable modelling alone to deal with the problems effectively. Models must be constrained and modellers must be guided by comprehensive data sets. With respect to the deep ocean, it is not even clear what a model should be expected to reproduce. For example, it may well be that the deep water in the North Pacific is a relic of a previous climate and should not be reproduced by a steady-state ocean model based on today's climate.

The upper layers are better observed and it is much clearer what the models should be designed to reproduce. However, it is known that the most energetic motions in the ocean are only about 100 km in size, and it is also known that unless a model is able to deal with these small scales it cannot closely reproduce the larger-scale motions. Comprehensive ocean models are therefore very demanding of computer capability. Indeed even the largest available computer is unable to handle an appropriate ocean model for even a steady-state solution, let alone for the transient behaviour one would like to study in order to understand the effects of greenhouse-gas induced warming. Suitable computers are expected to be available within about a decade. In the meantime it is necessary to refine techniques for handling many important phenomena, including heat transport by ocean currents, deep convection and other aspects of the annual cycle, and various mixing phenomena. This work must be supported by appropriate data, since for a very long time to come modelling will require the inclusion of a great many factors that can be obtained only from observation.

On the other hand, observations alone will remain insufficient. They will continue to be too sparse in both space and time to provide an adequate description. Models can tie the observations together and put them in appropriate context. They can also help identify the nature and location of the most crucial observations. Only through modelling is it possible to make quantitative statements about the way the system may evolve in the future.

The ultimate objective is, of course, prediction. This is of two kinds: (1) detailed prediction of the weather forecast type and (2) sensitivity to external changes, in particular those associated with global warming. The only kind of detailed prediction which seems possible in the relatively short term is that associated with the tropical ocean. There, the progress made with attempting to predict El Niño shows great promise. To some extent it is limited by the inaccuracy of long-range atmospheric forecasts, but predictions of the evolution of ocean behaviour are an essential input to predicting that of the atmosphere. The ocean and the atmosphere are particularly tightly coupled in this part of the world. Oceanography and meteorology must be equally tightly coupled to deal with it. Predictions will depend crucially upon the timely acquisition and distribution of ocean data, of the kind now being undertaken within TOGA.

The behaviour of the ocean depends on driving forces through the surface: wind stress, precipitation, heat flux and evaporation. None of these is now adequately determined. This weakness arises partly because these quantities cannot be routinely measured, and their relationship to other measurable quantities has not been established with sufficient accuracy. It is also partly because there are inadequate atmospheric data on surface wind, temperature and humidity. In principle the surface fluxes should be obtainable from weather forecasting models provided sea-surface temperature is known. However, much work remains to be done before this becomes routinely possible.

Accurate determination of sensitivity demands accurate models. These can only be developed and checked by accurate and comprehensive data. The goal must be to develop models able to predict the evolution of ocean properties subject to changing driving forces. The way in which the ocean responds to changes in driving forces as they are observed, will be an essential input into the development of such models. Thus there is a requirement for ongoing time-series of ocean data to determine the way in which the ocean is changing.

An essential requirement for improved models of the ocean is much better and more complete knowledge of what the ocean is actually like now. This information is also needed in order to determine how it is changing. One of the major objectives of the World Ocean Circulation Experiment (WOCE) is to satisfy this need. The data obtained in WOCE will enable use of basic conservation laws and the powerful mathematical tools of inverse modelling in order to obtain crucial knowledge on the way our contemporary ocean is transporting heat and salt about the Earth. They will also provide a firm base upon which to build time series of the evolution of ocean behaviour in a changing world. Even before these data are collected, the data from WOCE will be closely compared with data gathered in past, piecemeal efforts in order to detect and try to understand changes now taking place.

WOCE will also include a comprehensive study of the Southern Ocean, to improve understanding of that important area where most of the deep water of the ocean is formed, and where the different oceans are linked and thus able to influence one another.

An ocean monitoring system

The detailed nature of a future ocean monitoring system will only be known after WOCE has been completed. However, enough can be seen already to permit planning and initial implementation to go ahead, with a view to refining the system as more information becomes available. The system will have several components.

Satellites provide the only feasible way of giving truly global coverage. Measurement can and should be taken of sea-surface temperature, ocean colour which can be related to plankton activity, wave characteristics which can be related through scatterometer measurements to wind stress, surface elevation which can be related to surface currents, sea-ice cover and sea-ice character.

Ships of opportunity permit relatively inexpensive measurement of near surface wind speed, air temperature and humidity, salinity of water near the surface and temperature structure of the upper layers of the ocean. Efforts are being made to perfect an expendable instrument capable of measuring upper-layer salinity with sufficient precision.

Tide gauges provide an inexpensive way of determining changes in sea-level; which can be interpreted in terms of ocean heat content and currents, as well as long-term trends in sea-level — an important parameter in itself.

Buoys can provide information from areas rarely travelled by ships of opportunity. They give very accurate sea-surface temperatures which can be used to calibrate satellite data. They can also provide information on upper ocean temperature structure and ocean currents. It would be desirable to develop buoy instrumentation capable of measuring upper-ocean salinity reliably, although there are severe technical difficulties in achieving such a capability.

Specialized vessels are very expensive. However, they remain the only vehicles suited for obtaining accurate information on deep temperature, salinity, geochemical constituents of sea-water and tracers such as freons. For most parameters, deep water varies so little that great accuracy is required. It would be desirable to have instruments suitable for deep ocean measurements that would be less demanding on the capabilities of both vessels and personnel in order to make acceptable measurements.

Oceanographers have always been very inventive of new instruments for measuring ocean parameters and there is now a large array of new and proposed instruments. Some have been deployed in small numbers, others have been built as prototypes and still others are being designed. These include a variety of acoustic instruments and arrays, 'pop-up' buoys and unmanned powered vehicles. There will be more as human ingenuity comes to grips with the difficult problems of long-term monitoring of the ocean. Institutional structures put in place to deal with monitoring must be responsive to such new ideas as they become cost effective.

Time and space scales

The time and space scales required for monitoring a system are usually different from those needed to describe and explain it. In this section the former is dealt with, leaving the latter to specialized research programmes, in particular WOCE.

Surface temperature data are used in routine weather forecasting and need to be available within a few hours globally. A combination of satellite data and data received from buoys by satellite can meet this need. For meteorological use a spatial scale of a few hundred kilometres is sufficient, but oceanographers can make use of data down to a scale of about 10 km.

The upper-layer data must be monitored through the annual cycle in order to identify interannual anomalies. Thus a time interval of about 2 months is appropriate. More frequent sampling will be required in some specific areas, e.g. the tropical Pacific, for operational purposes, in order to provide data for assimilation into the upper ocean component of models.

The space scales need to be site-specific and can range from tens of kilometres to several hundred kilometres depending on the location relative to coastlines and the equator.

Deep ocean measurements are more difficult and expensive. Fortunately, changes are slower. Provided the area is repeatedly sampled on those occasions when it is examined, in order to reduce data distortion through short-term, small-scale phenomena such as internal waves, a time interval of about 5 years is suitable. Spatial scales are again site-specific. The requirements for deep ocean measurements, in particular, will be much refined in the light of WOCE.

Oceanography as an operational science

The ocean lays a key, but frequently understated, role in determining the climate. Indeed, any possibility of predicting the evolution of climate beyond a few weeks demands that ocean behaviour also be taken into account. There is great promise that it may become possible to describe and predict many aspects of upper-ocean behaviour with enough accuracy to improve long-range weather and fisheries forecasts. This promise can only be realized if appropriate data are collected regularly and disseminated promptly.

To determine how the ocean is changing now, we must have systematic and repeated measurements at all depths throughout the ocean. To predict its future evolution will require superior models supported by a regular influx of new data.

These needs will require new structures, both internationally and in many countries nationally, as oceanography is rapidly becoming an operational science like meteorology, not just a research science. Experience has shown that structures designed to manage research are not usually well suited to manage operations.

With respect to sensitivity and contribution to long-term climate change, there is every reason to believe that the ocean is now changing in response to climate changes over the past few hundred years (the Little Ice Age). It can be expected to change further as anthropogenic influences increase. The effect of the ocean on the atmosphere could be either to moderate or to intensify these changes. It will certainly modify them.

For more information, readers may contact the World Climate Research Programme, c/o World Meteorological Organization, Case Postale No.5, CH-1211 Geneva 20, Switzerland, which has published the following:

Tropical Ocean and Global Atmosphere (TOGA) International Implementation Plan. Third Edition, 1 February 1990. (Series: ITPO-No.1)

World Ocean Circulation Experiment Implementation Plan. Vol. II: Scientific Background. (Series: WCRP-12, July 1988 (WMO/TD No. 243))

Report of the International WOCE Scientific Conference. Unesco, Paris (28 November to 2 December, 1988). (Series: WCRP-21, April 1989 (WMO/TD No. 295))

Sea-surface temperature studies from the R.R.S. *Bransfield*

By J. Turner and J.P. Thomas
(British Antarctic Survey, Cambridge)

Over the last few years there has been growing concern over the possibility of global climate change caused by man's emission of radiatively active 'greenhouse' gases into the atmosphere. Gases such as carbon dioxide and methane are known to be increasing at greater rates and understanding their impact on the delicate heat balance of the Earth is one of the most important scientific questions to be answered today. This concern has lead to intense activity to develop realistic computer models of the atmosphere which can give reliable guidance on how climate will change under various possible scenarios of limited 'greenhouse' gas emission or a continuation of our present activity over the coming decades. Although it is the change in atmospheric temperature and precipitation that must be predicted, it is now known that any model must take into account the important heat transport and storage role of the oceans if reliable results are to be obtained. This involves being able to determine the world-wide temperature of the oceans and understand the complex processes taking place at the ocean-atmosphere interface.

Sea-surface temperature (SST) data have traditionally been obtained via bucket or hull sensor measurements made from voluntary observing vessels. These ships give reliable data, but with a very uneven distribution over the world's oceans. The main sea lanes are well represented. However, many areas in the Southern Hemisphere have only sparse coverage. For this reason polar orbiting satellites have come to play an important role in the production of routine global SST fields. The satellites make observations of the upwelling infra-red radiation emitted by the sea, from which estimates of the SST can be obtained. As the satellites orbit the Earth at a height of approximately 850 km it is not a trivial task to obtain SST measurements with the accuracy of 0.5 °C required for climate studies. There are also problems in relating the temperatures obtained from the satellites, which see the top few micrometres of the sea (the ocean 'skin'), and the bucket measurements made by ships, which are more representative of the uppermost few centimetres.

However, to try to gain further insight into the relationship between the ocean skin temperature and the bulk SST and to validate the satellite-derived ocean skin temperatures a series of experiments was conducted into the relationship between these quantities using accurate instruments on one of the ships operated by the British Antarctic Survey. This paper gives a description of the goals of this work, the instrumentation installed on the ship and a brief overview of the first season's work.

Satellite measurement of SST

Imagery from the TIROS–N/NOAA series of polar-orbiting spacecraft is received on many ships and is an important tool in monitoring the location of weather systems and the distribution of sea ice. The satellites broadcast VHF signals containing images made in the visible and infra-red parts of the spectrum. The infra-red images are produced using the naturally emitted infra-red radiation at wavelengths around 11 micrometres, in a region of the electromagnetic spectrum where there is little absorption by the atmosphere. Cold objects emit only a small amount of radiation at this wavelength while warm surfaces give a relatively large signal, so allowing an image to be created of the temperatures of the cloud tops and sea under the satellite. To convert the measurements of radiation into estimates of the actual temperature of the cloud tops or sea surface, reference objects of known temperature on the satellite are periodically viewed to give calibration data. This allows the temperature of objects below the satellite to be estimated to within several degrees. This is adequate for many purposes, but is too crude for climate studies. The main error in the single wavelength SST estimates is caused by the atmospheric water vapour which absorbs a significant amount of the upwelling radiation as it passes through the lowest few kilometres of the atmosphere. As there is most water vapour in the tropics the SST errors are greatest here and can be as large as 10 °C. In order to produce more accurate temperatures additional satellite data must be used.

While the visible and 11-micrometre infra-red images are well known because of easily received VHF broadcasts, the satellites also observe the Earth in other parts of the spectrum. Most of the TIROS–N/NOAA series satellites have two infra-red channels which observe the Earth at both 11 and 12 micrometres. At

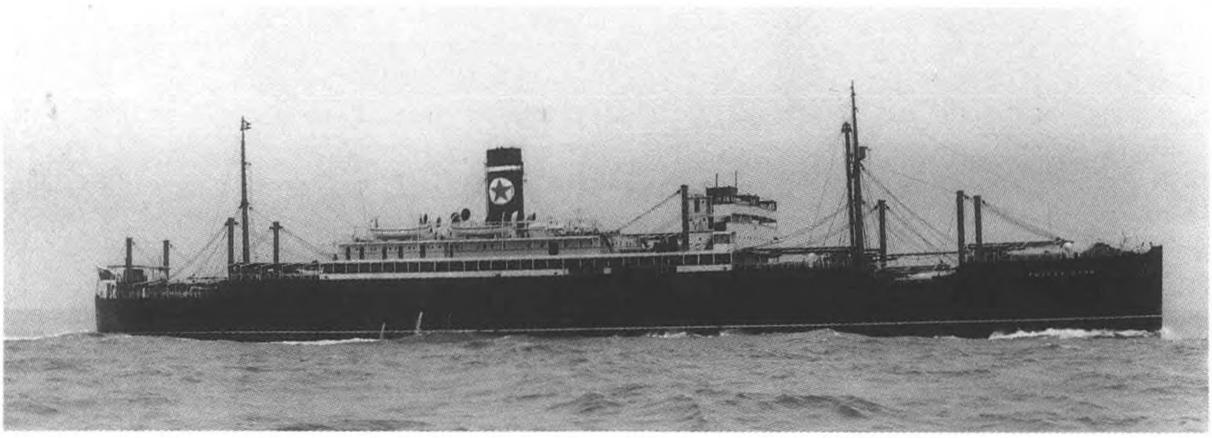


Photo. by W. Parry & Son Ltd

Tuscan Star, 1930, 11 449 grt

Photo. by W. Ralston Ltd

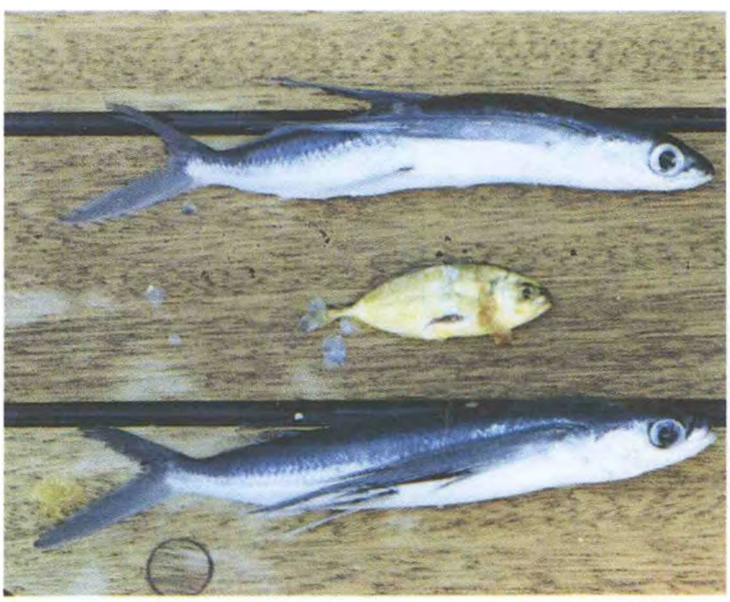
Scottish Star, 1950, 9996 grt

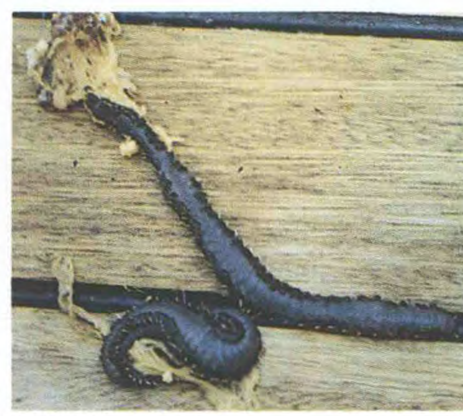
Photo. by FotoFlite

Scottish Star, 1985, 10 291 grt

THE BLUE STAR LINE AND THE MET. OFFICE. (See page 192.)

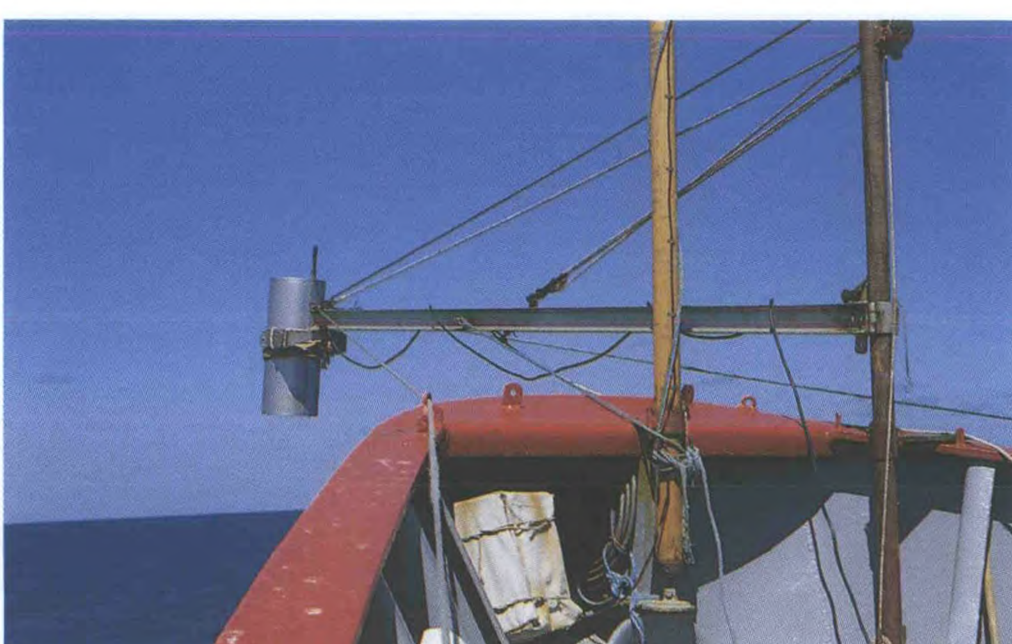
Above, left: Rose-breasted Grosbeak on board m.v. *Pacific Crane*, (see page 174): Above, right: Birds, thought to be ospreys aboard m.v. *Wiltshire*, (see page 175).





Photos. by E. Green

Above: Marine life brought aboard t.s. *Astrid*, (see page 173): Below: Figure 1. The infra-red radiometer mounted on its bow boom, R.R.S. *Bransfield*. (See opposite page.)



Photograph by courtesy of British Antarctic Survey the longer wavelength the atmosphere absorbs slightly more radiation and so gives colder temperatures than at 11 micrometres. Using the observations at both wavelengths it is possible to develop corrections for the basic satellite measurements so that SSTs can be obtained with an accuracy of close to 0.5 °C. This is the basic method by which current satellite SST observations are produced. Although in ideal conditions the accuracy of these SSTs can be high, a number of problems usually have to be overcome in routine processing. Since clouds are opaque to infra-red radiation great care must be taken to ensure that only cloud-free parts of satellite images are used, if the cold clouds are not to induce negative biases in the SSTs. Another problem, occasionally encountered, is contamination of the satellite data by cold atmospheric dust, blown either over the oceans by offshore winds from desert areas or injected into the upper atmosphere by volcanic eruptions. This can also give a negative bias to the satellite-derived SSTs if it is not detected before processing.

Instrumentation on the R.R.S. *Bransfield*

To investigate the skin effect and satellite SST measurements an instrument was installed on the R.R.S. *Bransfield* which made observations similar to those of the instruments on the polar orbiting satellites, but from a height of only a few metres above the sea surface. An infra-red radiometer was therefore fitted on a bow boom (Figure 1) to observe the sea surface undisturbed by the passage of the ship. This instrument measured radiation at both 11 and 12 micrometres and had internal calibration targets so that accurate estimates of the skin temperature could be obtained. During operation it was possible to obtain SSTs at approximately one-minute intervals, the data being logged on an IBM Personal Computer.

In addition to the routine surface SHIP meteorological observations frequent bucket and hull sensor temperature measurements were made, along with extra air temperature observations and estimates of cloud cover.

At the time of selected overpasses of the NOAA spacecraft, radiosonde ascents were also made in order to obtain atmospheric profiles of temperature and humidity, which provided important data for relating the differences between the satellite and shipborne radiometer measurements.

The temperature structure of the upper layer of the ocean

The ocean skin is at the interface between the sea and air — two fluids of vastly different properties — and it is across this boundary that heat is transferred. The near-surface air temperature and ocean skin temperature are two important quantities in determining the magnitude of heat transport, which is why radiometers are so important for studies of the oceans as they give direct measurements of the ocean temperature.

Typical temperature profiles of the upper few metres of the ocean are shown in Figure 2 for day and night-time conditions. During the day significant amounts of heat are received in the upper layers through short-wave radiation from the Sun. This produces a warm layer known as a diurnal thermocline, which usually extends to a depth of a couple of metres. At the surface there is usually evaporation which cools the skin and this is supplemented by further cooling when the air is colder than the sea and heat is conducted out of the ocean. Experiments have shown that the skin is often around 0.2 to 0.7 °C colder than the water a few centimetres deeper. Overnight, when there is no input of solar

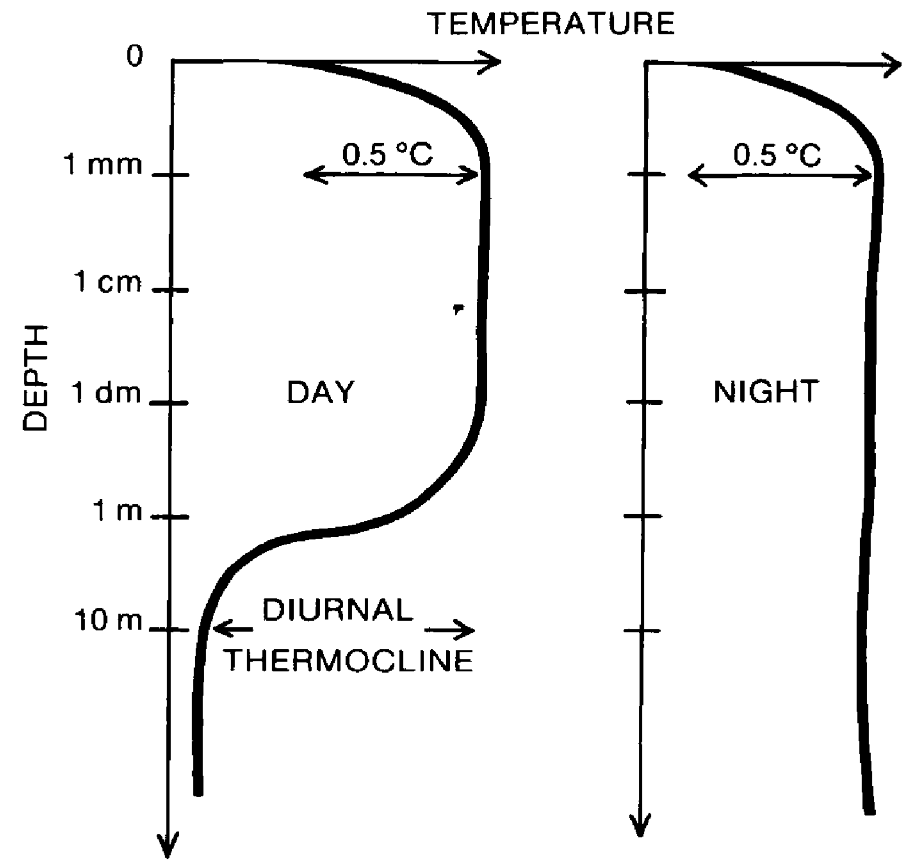


Figure 2. Typical day and night-time profiles of temperature for the top few metres of the ocean.

radiation, the mixing destroys the thermocline and the temperature is similar over the top few metres. The skin temperature, however, is usually still colder than the bulk value because of continued evaporation from the surface. Occasionally, when the atmosphere is warmer than the sea, there will be a flux of heat into the top layer of the ocean which will produce a positive skin effect. This tends, however, only to occur at night.

Radiometer measurements of skin temperature from the R.R.S. *Bransfield*

The equipment described above was first operated on the R.R.S. *Bransfield* during its passage from the Falkland Islands to the U.K. during March and April 1991. This allowed data to be collected over a wide range of climatic and oceanographic situations from cloud-covered, mid-latitude cyclonic to clear tropical conditions. The radiometer was used whenever weather conditions permitted and a large amount of data were collected in computer compatible form. The full analysis of these data, including the correction for the many small atmospheric effects and the comparison with the satellite observations will take some time; however, a preliminary analysis of one case is presented below to indicate the value of these observations.

A typical sequence of radiometer skin temperature measurements is shown in Figure 3. These were made off the coast of Argentina during a two-hour period over which the ship was crossing a complex frontal boundary between the Brazil and Falklands Currents. The radiometer temperatures varied over approximately 1.5 °C as the instrument observed the small-scale variability at the frontal

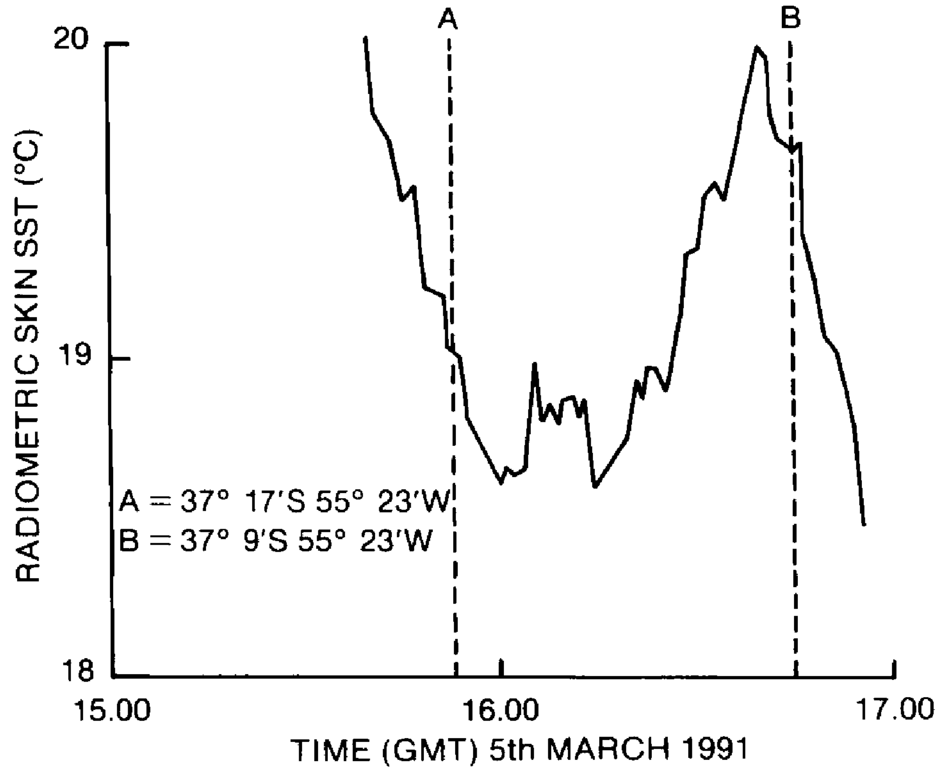


Figure 3. Ocean skin temperatures as measured by the radiometer during a passage across a complex ocean front.

boundary. On this day the wind was NE'ly, force 3, with bands of cumulus and stratocumulus crossing the area. During the day the reduction in solar radiation caused by the clouds crossing the Sun could be detected in the radiometer skin temperatures as short cooler intervals. At the time of Figure 3, however, the cloud was one okta and the skin temperature variations are caused by actual changes in the temperature of the ocean. The temperature trace was produced using the one-minute readings from the radiometer and the instrument was calibrated at fifteen-minute intervals. This case shows the value of the instrument for studying the rapid variations in skin temperature, undisturbed by the passage of the ship, which cannot be observed by any conventional instrumentation.

Developments

At the time of writing (Spring 1991), the European Space Agency was due to launch the ESA Remote Sensing (ERS–1) satellite, a research satellite carrying a range of instruments designed to study the oceans and ice-covered areas of the Earth, in late July. (See *The Marine Observer*, Volume 60, No. 307, January 1990, page 33.) One of the new instruments is the Along Track Scanning Radiometer (ATSR) which is able to determine the ocean skin temperature to better than 0.5 °C. In order to achieve this accuracy high quality validation data is required and the R.R.S. *Bransfield* is one of the research vessels involved in the validation exercise. The annual voyage of the ship to re-supply the British Antarctic research stations offers a unique opportunity to assess the performance over a very wide range of latitudes and a full programme of data collection, including the use of a second generation radiometer, is being undertaken. This should add to our knowledge of the performance of satellite SST instruments and allow the tuning of the processing schemes to produce the most accurate SST data yet obtained.

Acknowledgements

The authors would like to thank the Admiralty Research Establishment, Portland, for lending the infra-red radiometer and the Meteorological Office for providing the radiosondes for use during this first data collection experiment. The Officers of R.R.S. *Bransfield* and the ships section of the British Antarctic Survey also provided much valuable advice on the logistical implementation of the project and the siting of the radiometer. The encouragement and help provided by the ship's company during the voyage is also gratefully acknowledged.

The Blue Star Line and the Met. Office

Long-service barograph presentations to two Captains from Blue Star Ship Management, plus retirements from the company, all in the one year, provide a reason for publishing a short history of the Blue Star Line. We are indebted to Captain W.R. Houghton Boreham, Operations Manager of the company, who suggested this article when attending the barograph ceremony last April, for the loan of reference material and photographs.

William and Edmund Vestey started in meat trading and the operation of cold stores in Liverpool in 1879 and the Union Cold Storage and Ice Company Limited was registered in August 1897 to provide insulated storage for frozen produce. Chartering of vessels for the carriage of frozen meat commenced in the early years of the twentieth century; the brothers had built up extensive meat interests worldwide, especially in the Argentine Republic, and transport was required to move the frozen meat to Britain. In 1909 they acquired their first two ships, *Pakeha* and *Rangatira*, subsequently renamed *Broderick* and *Brodmore*; these two ships were built on the Tees in 1890, being of 4000 gross tons.

Blue Star Line Ltd was registered in 1911 at Holland House, Bury Street, London, with a share capital of £100 000 and commenced trading in January 1912. In the same year the company acquired the retail butchery business of J.H. Dewhurst together with small freezing works in Australia and New Zealand. William Vestey was created a baronet in 1913 and in the following year the first ship to be launched for a Vestey company, *Brodhurst*, 3071 grt, joined six others in the company's fleet. Four ships were lost in World War I.

The first Blue Star ship to become a voluntary observer was *Tuscanstar*, in 1921. Commanded by Captain R.J. Thomas, the *Tuscanstar* meteorological logbook received at the Met. Office in August 1921 still reposes in the archives, together with almost all the other ships' weather logs received since 1855. From the first fleet list to be published in the initial edition of *The Marine Observer* in 1924, *Tuscanstar* would appear to be the only Blue Star ship co-operating with weather observing at that time. The first narrative entry in *The Marine Observer* from a company ship was published in the May 1924 issue concerning an extract from the log of the *Brodholme*, built 1915, 5713 grt, dated 20 November 1920 when she was in the Arabian Sea bound to Sabang from Suez, in an article about the detection of Tropical Revolving Storms.

The *Tuscanstar*, 5893 grt, was built by Hawthorn Leslie, Newcastle, in 1898 as the *Morayshire* for Elderslie S.S. Co. Ltd, managed by Turnbull Martin & Co., and was acquired for Blue Star in 1915, when she was renamed *Brodliffe*. She became *Tuscanstar* in 1920 and was sold by Blue Star in 1929 to Italian owners. She was finally broken up in 1952 after 54 years afloat.

In 1925 orders were placed for nine new ships at U.K. shipyards; the order included five luxury liners for the South American passenger trade, the *Alameda*, built 1919, 6817 grt, being the first of these liners to sail from London in February 1927. In 1929 the suffix 'Star' was added to all the liner names, apparently to avoid confusion with the 'A' class ships of the Royal Mail Line that ran on the same route. The two names were also separated in the case of the ships previously given one name incorporating 'star'. In 1930 the company moved to larger offices at 40 St Mary Axe, London, and in the same year their first motorship, *Tuscan Star* of 11 449 grt, was delivered. (See photograph opposite page 188). She was specially designed for the carriage of chilled and frozen beef. In 1931 the *Arandora Star*, built 1927, 12 847 grt, sailed on a one-day cruise in the English Channel with 350 passengers, going from Bournemouth to Southampton at the cost of 35/- (£1.75) per person.

During the next few years Blue Star built up liner services for the carriage of refrigerated cargoes from New Zealand and Australia. At the outbreak of World War II the fleet numbered 39, totalling 380 000 tons. William Vestey died in 1940 and Edmund in 1953, leaving their company thriving and having to move yet again to larger offices at Albion House, 34 Leadenhall Street in 1955. In the interim, the company had purchased Lamport and Holt Ltd and Booth Steamship Co. Ltd, both of Liverpool. One of the handsome company ships of the day was the second *Scottish Star* built by Fairfield Engineering, Glasgow in 1950, 9996 grt. (See photograph opposite page 188). She was one of the ships unfortunate enough to be trapped in the Suez Canal as a result of the Arab-Israeli war in 1967. After being declared a constructive total loss in 1969, she was towed to Port Said in 1975, being finally sold to Spanish shipbreakers in 1979. In 1957 Crusader Shipping Co. Ltd was registered by Blue Star in partnership with New Zealand Shipping Co. Ltd, Port Line Ltd and Shaw Savill and Albion Co. Ltd in order to develop services to Japan, South East Asia and the west coast of North America from New Zealand. It was only in 1958 that the company obtained rights to load outwards from the United Kingdom to New Zealand.

In 1966 Associated Container Transportation Ltd was formed by Blue Star, Ben Line, Cunard, Ellerman and T & J Harrison, Blue Star having a 42.5 per cent interest in the company. Development of services and joint management arrangements continued throughout the 1970s and 1980s, embracing new operations from Australia to Japan, Australia to South Africa, Europe to west coast North America and Australia/New Zealand to Arabian Gulf ports. New refrigerated cargo liners were built or chartered to maintain this near-global coverage of services. The *Scottish Star*, built 1985, 10 291 grt, is one such example (see photograph opposite page 188), and has continued the excellent liaison with the Met. Office that has been a constant feature in the voluntary observing field. Container ship *ACT 7*, built 1977, 43 992 grt, has a particularly enviable record, having been nominated one of the best three observing ships in ten consecutive years, mainly thanks to the encouragement and expertise of Captain Angus McPhail when in command of the ship, culminating in his receipt of a long-service award barograph in 1986.

In 1985 Blue Star returned to passenger carrying when the *New Zealand Star*, built in 1978, 17 083 grt, was refitted and lengthened, effectively increasing her container capacity by 84 per cent and to take 12 passengers on the South American run, at the same time being renamed *Churchill*. To harmonise with recently introduced minor changes to the service, she has now been renamed *Argentina Star*. She is one of the eleven ships of the Blue Star company still undertaking voluntary weather observing and the Met. Office anticipates with pleasure a continuation of this beneficial co-operation well into the future.

REFERENCE

1. Atkinson, A. and O'Donoghue, K. (1985) *Blue Star*, published by the World Ship Society.

CORRECTION

On page 98 of the July edition, the *Liverpool Star* was stated as being under the control of Blue Star Ship Management Ltd and not Cunard Ellerman Shipping Services Department. Our apologies are offered for this oversight.

PRESENTATION OF BAROGRAPHS

The Reading Room of the National Meteorological Archive was again the venue for the annual long-service award ceremony, where the four shipmasters whose names were announced in an earlier edition assembled on 24 April 1991. On the last occasion when the event could be held there before the archives moved in late summer to new premises a mere ship's length westwards in Eastern Road, Dr Peter Ryder, the Met. Office's Director of Operations, made the presentations of inscribed barographs to the following: Captain D.C. Blackman, P. & O. Containers Ltd, Captain D.N. Boon, Geest Line Ltd, Captain A.J. Chivers, MNI, Blue Star Ship Management Ltd and Captain H.K. Dyer, also of Blue Star, see photographs opposite pages 172 and 173. In his introduction to the presentations, Dr Ryder stressed the importance of the continuing help given by voluntary marine observers, asking for their continuing co-operation because surface observations were needed for authentication, even in this day of satellites and radar. The numerical information derived from ships' data was of much importance to forecasters, although a bad observation could be worse than none at all. The importance placed on excellence in the reports from ships was very high, and it was in recognition of such excellence and long observing service that the four assembled shipmasters were being rightly rewarded.

The period considered was the twelve months of 1989 and the qualification for the long-service awards is a minimum of 18 years, 'no time off for good behaviour', and the completion of at least one meteorological log in the year in question. These awards have been made annually since being introduced by the Director in 1948. When making the presentations before an audience of the wives of the shipmasters and shipping company representatives, in addition to members of the directorate and staff of the Met. Office, Dr Ryder observed that it was unusual to be able to bring all four recipients together at one ceremony; on this occasion it happened that all of them had retired from the sea since nomination. It was also a long time since two Blue Star Masters had been in attendance at the same ceremony, and to mark this event it was agreed we should include a short history of the company in this edition of the journal.

AURORA NOTES OCTOBER TO DECEMBER 1990

By R.J. Livesey
(Director of the Aurora Section of the British Astronomical Association)

In Table 1 are listed the observations made at sea for the period which, in this instance, have been provided solely by Ocean Weather Ship *Cumulus*. No doubt other observations may come to hand and these will also be used when the data are entered into the national records at Aberdeen University; better that an observation takes time to reach the BAA than to have no observations at all. Some of the most interesting and useful observations we have seen reported in amateur astronomy are those that observers almost thought not worth recording.

After the active period of geomagnetic and auroral activity associated with the sunspot maximum in 1989 the frequency of events declined in 1990. This is not unusual, for there is a quiet period between two peaks of activity, the one at sunspot maximum and the other in the declining years of the sunspot cycle. Most of the aurorae noted in the present period under discussion were seen from the Moray Firth northwards in the British Isles. The aurorally active nights of 9/10 and 20/21 October, 27/28 November and 12/13 and 18/19 December provided more southerly activity that could be seen in southern Scotland and northern England. The storm of 27/28 November was most widely observed and was overhead above northern Scotland, where coronal structures were reported by several stations.

Table 1 — Marine Aurora Observations October to December 1990

Date	Ship	Geographic Position	Time (UTC)	Forms in Sequence
10/11 Oct. ..	*Cumulus*	56° 55'N, 20° 09'W	0020–0205	QHA. QN. Max. alt. 25°
12/13 ..	*Cumulus*	56° 42'N, 20° 32'W	2115–2345	QN. Max. alt. 10°
14/15 ..	*Cumulus*	56° 57'N, 20° 09'W	0340–0400	QN
20/21 ..	*Cumulus*	56° 31'N, 17° 14'W	2045–2340	QN.aR_2R_2.QN. Max. alt. 18°

KEY: a = active, H = homogeneous, N = unspecified form, Q = quiet, R_2R_2 = medium rays.

In Figure 1 are plotted the calculated frequencies with which the auroral light could have been seen in 1990 from British waters. One curve gives the figures for all auroral forms while the other gives the distribution for quiet aurorae comprising only glows or homogeneous arcs; for comparison, the curve of total aurorae is given for 1990. These curves are prepared on the assumption that if aurora is seen at a particular latitude then, at some time during the night, it would have been visible at all other latitudes polewards towards the auroral zone. Comparing the curves for quiet and total aurorae one can infer that the more active the aurora the further equatorwards it will extend.

In Figure 2 are plotted the six-monthly totals of aurora and geomagnetic activity for the period 1976–1990. The higher the value of the magnetic index K_p the more disturbed is the Earth's magnetic field at sea level and it is interesting to

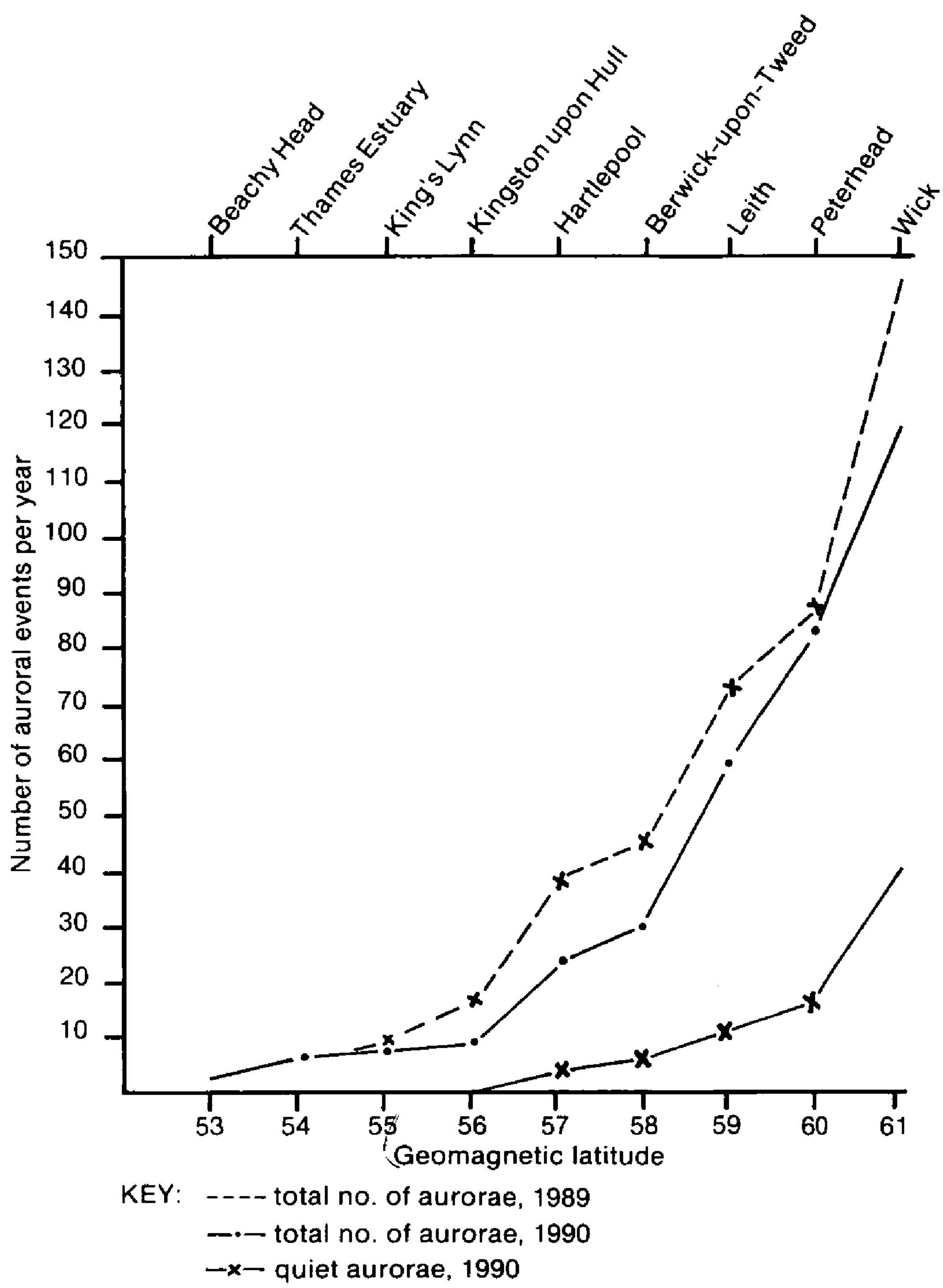


Figure 1. Variation of visibility of the aurora with geomagnetic latitude in United Kingdom waters.

note the activity periods around the sunspot maximum and particularly around 1982 in the period between sunspot maximum and minimum. We are about to enter the declining period of the present sunspot cycle so that an increase in magnetic activity is expected.

Auroral activity in Figure 2 shows the number of occasions when at least two observers reported the event from geomagnetic latitude 62 degrees southward from the Orkney Islands; also shown are all aurorae seen from geomagnetic latitude 59 degrees at the Firth of Forth southwards. This method of presentation tends to show no major secondary peak of auroral activity in the declining years of the solar cycle although there is an upsurge compatible with the upsurge in geomagnetic activity.

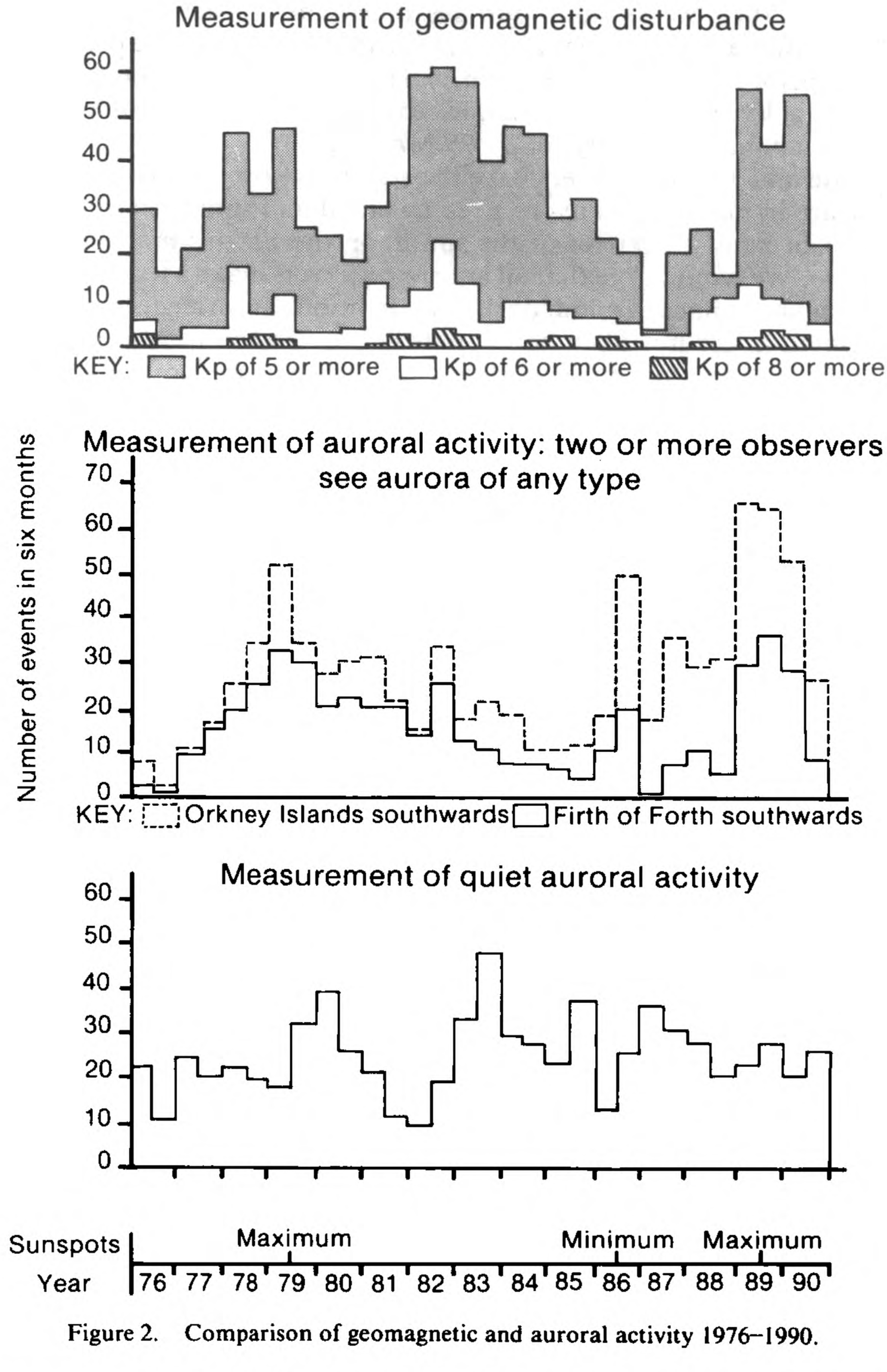


Figure 2. Comparison of geomagnetic and auroral activity 1976–1990.

Measurements of the frequency of the quiet aurorae observed anywhere in British waters by one or more observers is also shown in Figure 2. As Figure 1 shows, these aurorae tend to be found in higher latitudes and Figure 2 indicates periods of stronger, quiet auroral activity in the declining years of the solar cycle. The recent publication by the Radio Society of Great Britain, of Charles Newton's investigations of radio aurora statistics amply confirms that the maximum frequency of those events takes place in the sunspot declining years. If the pattern of sunspot cycles repeats itself in accordance with current theories of solar activity then we should soon see more auroral activity in the higher latitudes. However, big transient auroral storms, although more probable in the period just prior to sunspot maximum, can take place at any time even when the rest of solar activity is at a minimum, for example, on the night of 8/9 February 1986 and much more recently on 24/25 March 1991.

Magnetic and radio observers have the advantage over the visual observer in that they are in no way inconvenienced by cloud and summer twilight, but see different aspects of the effect of the sun upon the Earth's magnetic field and atmosphere. We would urge that all aurora observers make a record of anything they see, for sometimes in good, dark sky conditions auroral glows are observed but not noted in the mistaken belief that the glow is unimportant. Care has to be taken to ensure that auroral glows and twilight are not confused at the appropriate periods of the year. There have also been occasions when noctilucent clouds and aurorae have been confused, but we do have records where both have appeared simultaneously and been so photographed.

Currently under investigation are apparitions of the flash or short-lived aurora that may last from seconds to a minute or so, at most. These appear out of nowhere in relatively confined regions where the magnetic field in that region appears to be generally undisturbed; there are now some well documented examples from skilled and experienced observers. Several possible reasons for the existence of flash aurorae are being considered, one of them being a short-circuit in the Earth's electrical system in the magnetic field downwind of the sun driving electrified particles into the atmosphere to form a short-lived aurora. This is a particular case of skilled observers seeing something, wondering if the apparition was real or imaginary, almost not reporting it but deciding to do so, thereby revealing something of interest worth investigating. The trouble with flash aurorae is, that being short-lived, an observer may only see them by chance and there will be no corroborative evidence from anyone else. Ships at sea have the advantage because there should be more than one person keeping a lookout at the same time. Good sailing.

LETTERS TO THE EDITOR

Super swells

For four years in World War II, H.M.S. *Scott*, a survey vessel, was employed marking the minelay for a squadron of P. & O. liners converted as minelayers, between Scotland and Iceland, against the U-boats.

The ship was small at 1000 tons, 250 ft long, too much top weight and too shallow a draught at 8 ft, so she rolled like a pig in the following seas of a storm; occasionally she yawed 60° and rolled 60° to each side in a near broach-to situation. Pounding head to sea over those years, we popped rivets in the fore peak, corrugated the ship's bottom between ribs back to the boiler room, and twice sheared the ASDIC dome clean off.

My First Lieutenant was quite worried, as he had been OOW in a destroyer that, failing to outpace storm waves at 18 knots, she had broached-to, rolled to 85° (vanishing angle 95°, for no righting moment) and lost 11 men overboard.

On one of several occasions, 100 n.mile north-east of the Butt of Lewis, in the *Scott* we had hoved-to at slow speed, head to sea — turning 180° is always a dangerous moment and probably accounts for the loss of some trawlers without trace or a MAYDAY call — and a half-hour later met a train of three waves estimated from our 35 ft bridge Height of Eye as up to 65 ft from trough to crest, and 500 ft from crest to crest, with our bow in the trough as the stern 250 ft away came over the last crest — quite terrifying. I then spent 3 hours in up to 40 ft waves, never quite head to sea or the ship would stop dead as she pounded, with the danger of being thrown broadside on by the next wave: yet slicing the waves at 15–20° the same danger occurs, needing a quick push from the outer of the twin screws.

Naturally we reported the train of three waves to the Admiralty, who eventually replied that the Meteorological Office and 'Manuals' only permitted such 60 ft wave heights in the Antarctic and then they had to be 8000 ft from crest to crest. Not until the advent of the Weather Ships after the war did the authorities realize that such storm waves existed. Later, the oil rigs north-east of the Shetlands with quadripods to the sea bed, reported waves of 90 ft from trough to crest.

Such large and dangerous storm waves are far from being smooth trochoids. The impression is that the advancing front of the wave is much steeper than the back, and includes smaller subsidiary waves, with hollows followed by almost vertical parts, with the top 10–20 ft actually breaking. Perhaps one day the oceanographers could take cine photos from high up on a far northern oil rig, and any other instruments to determine such profiles.

Commander J.M. Sharpey-Schafer, RN, Haywards Heath.

Personalities

(Readers are invited to notify the Editor of observing officers retiring from the Navigating and Radio Departments.)

RETIREMENT — CAPTAIN A.J. CHESHIRE retired from the sea on 12 June last after serving all 41 years of his seagoing life with Blue Star.

Anthony John Cheshire was born in June 1931, educated at St Albans County School for Boys and experienced two years pre-sea training at the Thames Nautical Training College H.M.S. *Worcester* from 1947 to 1949. He joined Blue Star Line Ltd as Cadet in May 1949, his first ship being *Trojan Star*. He obtained his Master's Certificate in 1958. Met. Office records appear to indicate that his first meteorological log was received in July of the same year, compiled aboard the *Brisbane Star*, although it may be that he was observing in earlier years but no U.K. record of this period remains.

Captain Cheshire's first command was *Barcelona Star* in 1965 and five years later he stood by and took out on her maiden voyage from the Bremer Vulcan yard Blue Star's first container ship *California Star*, from which ship he sent in several logs. Out of a total of 48 log books provided in 21 observing years, 21 were assessed as Excellent. He received Excellent Award books on eight occasions between 1974 and 1991.

Over the last few years Captain Cheshire has maintained the highest standard of observing from Blue Star's *ACT 7*, and we send our sincere thanks for his keen co-operation over the years and offer our good wishes for a happy and successful retirement.

RETIREMENT — CAPTAIN E.M.S. PHELPS retired on 1 May 1991 and was awarded the O.B.E. in the Queen's Birthday Honours announced the following month.

Edmund Malcolm Stuart Phelps was born in February 1928 and educated at Prior Park College, Bath. He attended one year's pre-sea training at the School of Navigation, South Stoneham House, Southampton. The term after he left, they moved to Warsash. He served his apprenticeship with the P. & O. S.N. Co., joining his first ship, m.v. *Palana*, in November 1946. He sent us the first of 52 meteorological logbooks from P. & O. s.s. *Mooltan* in August 1949.

Captain Phelps served as a Junior Officer in a number of shipping companies, including Clan Line, All America Cable and Wireless, Newsprint Supply Ltd, Atlantic Steamship and Jamaica Banana Steamship up to 1965 when he was promoted to Chief Officer, having obtained his Master's Certificate in January 1959. In 1965 he joined British Antarctic Survey and remained with one ship, R.R.S. *John Biscoe*, from Second Officer to Master, until he retired. He was promoted to command of the ship in 1972.

His distinguished 27-year weather observing record included 39 logs marked 'Excellent', and for his co-operation in the specialised field of Antarctic survey he has received 15 Excellent Awards and in 1985 he was presented with a long-service barograph by the Director General.

Captain Phelps says,'The award of the O.B.E. came as a very great surprise, but I have been fortunate in spending the majority of my seagoing career with such an interesting organisation as British Antarctic Survey. I have been very happy to have helped the Met. Office and to have had the assistance of very keen and efficient Officers in the process.' The Met. Office also has reason to be thankful for his experienced co-operation over many years, and hopes that Captain Phelps will enjoy a rewarding and happy retirement.

Book Reviews

Guide to Port Entry, 1991/92 Edition. Produced by Colin Pielow, Editorial Director Robert Pedlow. Shipping Guides Ltd, Shipping Guides House, 75 Bell Street, Reigate, Surrey RH2 7AN. Two parts, each 295 mm × 210 mm × 50 mm; about 3,600 pp. Price: £170.00 in the U.K., £180.00 overseas.

This eleventh edition marks the twentieth year of publication of the most complete guide to the world's ports and includes 58 new ports, of which no less than 18 are in China, the others in 20 different countries. The arrangement is unchanged, alphabetical by country and then by port name, and each volume contains a plan section at the end.

The Baltic Deep-Sea Pilotage is included for the first time together with details of associated IMO recommendations on the Baltic and this will be useful to ships transitting the area. All the ports of Germany are now included in one section, as are those of the Yemen.

The details of facilities, berths, services and equipment available are fully comprehensive but users are rightly reminded that the Guide is not a substitute for the correct charts and pilot books, which should always be consulted. Users from all sections of the marine industry are requested to assist the editors in updating the Guide, and a catalogue of the type of information required is helpfully provided. This does not preclude correspondents from suggesting new types of information they would like to see included, but they will doubtless find it very difficult to find any fault or omission in this most professional of port directories published.

J.F.T.H.

Camera at Sea – A Professional Approach to Marine Photography by Jonathan Eastland. 205 mm × 267 mm, vii+150 pp., *illus.* Ashford, Buchan & Enright, 31 Bridge Street, Leatherhead, Surrey KT22 8BN. Price: £19.95.

With a marine career that began in the merchant navy, the author now speaks from his experiences during the past twenty years of his second career as a professional marine photographer and journalist. Unlike the opportunist photographer, he enjoys the enviable position of being able to mentally compose a shot and then make arrangements to bring the ideas to fruition, whether it entails hiring a helicopter, or a launch, or travelling to distant destinations to reach the most advantageous locations in which to capture the subject. Such ploys must normally be out of reach of the merchant seafarer who, although he may travel to spectacular locations and be handy with a camera, seldom has the time needed to produce imaginative and artistic creations.

The book contains many fine examples both in colour and monochrome of the author's craft, supported by the stories behind their making, so there ought to be plenty of inspiration here for the seafarer even if he does not possess or aspire to the numerous combinations of camera bodies, films, lenses and filters used. The subjects are mainly sea-going vessels of all types, with the emphasis on ocean yacht racing.

The index reads like the contents of a photographic shop's window, famous names abound, and throughout the text the author gives an assessment of their performance in his sphere of operations and the uses to which lenses and filters are best suited. Advice is also offered regarding film processing, carriage of accessories, storing of photographic material and the benefits of a little 'inside knowledge' about weather conditions and ship design which can help in the planning and execution of a shot. However, very little help is offered about capturing wildlife at sea on film, this presumably has not been a feature of the author's photographic career.

Camera at Sea will undoubtedly be of most use to the professional or dedicated amateur, lesser mortals will simply enjoy the pictures.

J.M.

Notices to Marine Observers

APPOINTMENT OF NEW PORT METEOROLOGICAL OFFICER, EAST ENGLAND

Captain E.J. O'Sullivan has been appointed as Port Met. Officer for East England, based at Hull, in succession to Captain R.B. Jones who has had to resign for personal reasons.

Edward O'Sullivan returns to the Met. Office after a break of 18 months, having been a ship routeing officer attached to the Metroute team for two years up to January 1990. He served at sea with Elders and Fyffes and other companies including command of coastal vessels.

VSOP–NA NEARS COMPLETION

The Management Board of the Voluntary Special Observing Project – North Atlantic met in late June at the Met. Office College near Reading to review the project and to make a preliminary assessment of the scientific conclusions to emerge from the study of the data collected. Forty-five vessels from six national observing fleets (Canada, France, Germany, Netherlands, United Kingdom and United States) participated over the period Autumn 1988 to Summer 1990, and the board expressed its gratitude to those Masters, Principal Observers and Port Met. Officers who had provided the additional effort to gather detailed ship information and augmented observations. Limited space in this edition prevents further detail being provided here, but WMO will be publishing full reports on the results and recommendations arising from the project. We also hope to give a fuller account of the conclusions from VSOP in the January 1992 edition of this journal.

NEW METROUTE BROCHURE PUBLISHED

A new Met. Office publication, *Metroute – Worldwide Ship Routeing Service*, was launched in the spring. Published internally by the Met. Office, the many different services of Metroute for the Master and for the shipowner and charterer are given the latest corporate glossy brochure treatment. The team of Master Mariners who operate the service, working within the Central Forecasting Office at Bracknell, now have over two decades of experience of ship routeing behind them. They provide voyage planning, bad weather and damage avoidance and round-the-clock monitoring of vessels' progress. Sea-ice monitoring is an integral part of the routeing work to ensure vessel safety. Modest charges for the Metroute service are readily recovered by reductions in fuel consumption, shortening of passage times and comfort and care of cargoes. Additional services include worldwide weather forecasting and routeing for yachts, special forecasts for offshore and other marine interests and monitoring and warning of tropical storms worldwide. The allied Marine Advisory Service of the Met. Office can supply data analyses and advice on any problem involving marine climate or past weather, worldwide.

Copies of the brochure and further information can be obtained from Metroute, The Met. Office, London Road, Bracknell, Berks RG12 2SZ, telephone 0344 854904 or 0344 855654.

THE NAUTICAL INSTITUTE — NEW PUBLICATION

The Management of Safety in Shipping is a major reference work and professional guide for all managers and personnel concerned with ship operations. This is the fifth publication in a series of authoritative guides to be produced by the Nautical Institute on professional subjects for qualified mariners. Linked to the newest work is an open learning certificate and diploma scheme relating to Personal Management Effectiveness. The modules are designed to be studied at a place of work or at home, with the aim of providing a practical programme of management development.

The Management of Safety in Shipping will be sold for £50 to Nautical Institute members and £71.43 for non-members, plus £8 extra per volume by Air Mail. The other books and study schemes relate to *Command*, *Nautical Surveying*, *The Work of the Harbour Master* and *Pilotage*.

Further details of the above and for membership of the Nautical Institute, can be obtained from the Nautical Institute, 202 Lambeth Road, London SE1 7LQ, telephone 071-928 1351.

ROYAL INSTITUTE OF NAVIGATION HALF-DAY MEETING:

METEOROLOGY — CURRENT AND FUTURE STATE OF THE ART AND SCIENCE AT SEA AND IN THE AIR

Three papers by senior personnel of the Met. Office will be presented at this meeting sponsored by the Royal Institute of Navigation, held jointly with the Honourable Company of Master Mariners and the Nautical Institute, London Branch: *Marine Meteorological Services to shipping, past, present and future* by Captain Gordon V. Mackie, Marine Superintendent; *Recent Progress in Weather Routeing for Merchant Vessels* by Mr Jack S. Hopkins, Head of Marine Products in the Commercial Services Directorate; and *Aviation Meteorology* by Mr Frank Dalton, Manager of Aviation Services in the Forecast Division.

The meeting is to be held on Wednesday 20 November 1991 at 1430 hours, on board H.Q.S. *Wellington*, the Headquarters ship of the Honourable Company of Master Mariners, at Temple Stairs, Victoria Embankment, London WC2, opposite Temple Underground station.

Non-members of any of the organising bodies are welcome to attend. Further information can be obtained from the Director of the RIN on 071-589 5021, the Clerk to the Honourable Company on 071-836 8179 or the Honorary Secretary of the Nautical Institute, London Branch on 071-722 7806.

STAFF OF THE OBSERVATIONS (MARINE) BRANCH OF THE METEOROLOGICAL OFFICE

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Captain John F.T. Houghton, Nautical Officer. (0344 855916)
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North-west England: Captain Albert Britain, Port Met. Officer, Royal Liver Building, Liverpool L3 1HU. (Tel: 051-236 6565. Fax: 051-227 4762) (Captain Britain is also Ocean Weather Ship Officer, with an office at Greenock.)

South-west England: Captain Douglas R. McWhan, Port Met. Officer, Southampton Weather Centre, 160 High Street, Southampton, SO1 0BT. (Tel: 0703 220632. Fax: 0703 228846)

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North-east England: Captain Derek H. Rutherford, Port Met. Officer, Room D418, Corporation House, 73–75 Albert Road, Middlesbrough, Cleveland, TS1 2RZ. (Tel: 0642 231622. Fax: 0642 242676)

Bristol Channel: Captain Archie F. Ashton, Port Met. Officer, Cardiff Weather Centre, Southgate House, Wood Street, Cardiff CF1 1EW. (Tel: 0222 221423. Fax: 0222 390435)

East England: Captain Edward J. O'Sullivan, Port Met. Officer, c/o Department of Transport, Posterngate, Hull HU1 2JN. (Tel: 0482 20158. Fax: 0482 28957)

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[1] Addresses and telephone numbers for Marine Branch and Marine Enquiries at Headquarters are liable to change in the latter part of 1991. Until these can be confirmed, telephone the Met. Office switchboard on 0344 420242.

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Mr Robert D. Whyman, Marine Enquiries. (0344 855937)

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Captain Austin P. Maytham, Ship Routeing and Sea Ice Officer. (0344 854945)
Captain Donald J. Hewitt, Ship Routeing Officer. (0344 854904)
Mr Stephen J. Johnson, Ship Routeing Officer. (0344 854905)
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OFFSHORE ADVISERS

Offshore Network Adviser: , Meteorological Office, Observation Provision, Eastern Road Annexe, Bracknell, Berks RG12 2UR. (Tel: 0344 855905)

Offshore Observing Adviser: Mr Iain J. Hendry, Aberdeen Weather Centre, Seaforth Centre, Lime Street, Aberdeen AB2 1BJ. (Tel: 0224 210573. Telex: 73446/7. Fax: 0224 210575)

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Fremantle: Captain Alan H. Pickles, Port Met. Agent, Stirling Marine, 17 Mews Road, Fremantle, WA 6160. (Tel: (09) 335 8444. After hours: (09) 6670. Fax: (09) 335 3286. Telex: 92821)

Melbourne: Mr M. Hills, Port Met. Agent, Pier 14, Victoria Dock, Melbourne, Vic. (Tel: (03) 629 1810)

Sydney: Mr E.E. Rowlands, Port Met. Agent, NSW Regional Office, Bureau of Meteorology, 13th Floor, 162–166 Goulburn Street, Darlinghurst, NSW 2010. (Tel: (02) 269 8555)

CANADA — Headquarters: Mr George Payment, Marine Meteorological Officer (AWDH), Atmospheric Environment Service, 4905 Dufferin Service, Downsview, Ontario, M3H 5T4. (Tel: 416-739-4942)

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Montreal: Mr Denis Blanchard, AES, 100 Alexis Nihon Boulevard, Ville St. Laurent, Quebec H4M 2N6. (Tel: 514-283-6325)

Vancouver: Mr Bob McArter, PMO, AES, Suite 700–1200, W. 73rd Avenue, Vancouver, British Columbia V6P 6H9. (Tel: 604-666-0360)

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Marseille (also Fos): Mr A. Rouzier, Station Météorologique de Marseille-Port, 12 rue Saint Cassien, 13002 Marseille. (Tel: 91.91.46.51, poste 336)

GERMANY — Bremerhaven: Mr Henning Hesse, Wetterwarte, An der neuen Schleuse, Bremerhaven. (Tel: (0471) 72220)

Hamburg: Mr Jurgen Guehne, Seewetteramt, Bernhard Nocht-Strasse 76, Hamburg. (Tel: 040-319 0826)

GREECE — Piraeus: Mr George E. Kassimidis, Port Meteorological Office, Port Office, Piraeus. (Tel: (01) 89-32914)

HONG KONG: Mr S.F. Ip, PMO, Royal Observatory, Nathan Road, Kowloon, Hong Kong. (Tel: 3-7329200)

JAPAN — Tokyo: Mr M. Miyauchi, Japan Meteorological Agency, Otemachi, Chiyoda-ku, Tokyo 100. (Tel: (03)-212-8341)

Yokohama: Mr I. Kawatsu, PMO, Yokohama Local Met. Observatory, 99 Yamate-cho, Naka-ku, Yokohama. (Tel: (045)-621-1991)

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NETHERLANDS — Rotterdam (also Amsterdam): Mr Peter Schnitker, PMO, Aeronautical Meteorological Division of KNMI, Rotterdam Airport. (Tel: (010) 437 0766)

NEW ZEALAND — Wellington: (For all NZ ports). Miss Julie Fletcher, Marine Met. Officer, Tahi Road Ext., PO 1515, Paraparaumu Beach 6153. (Tel: (058) 73-237)

SAUDI ARABIA — Jeddah: Mr M. Murwani, Port Met. Officer, National Meteorological Environment Centre, Jeddah. (Tel: (02) 683-4444 ext. 325)

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Durban: Mr Peter Rae, Port Met. Officer, Meteorological Office, Loius Botha Airport, Durban 4029.

U.S.A. — Headquarters: Mr Vincent Zegowitz, Marine Obs. Program Leader, National Weather Service, NOAA, 1325 East West Highway, Silver Spring, MD 20910. (Tel: 301-427-7724)

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Newark: Mr John Warrelman, PMO, NWS, NOAA, Building 51, Newark International Airport, Newark, NJ 07114. (Tel: 201-850-0529)

Norfolk: Mr Earle Ray Brown, Jr., PMO, NWS, NOAA, Norfolk International Airport, Norfolk, VA 23518. (Tel: 804-441-6326)

Texas: Mr James Nelson, NWS, NOAA, Route 6, Box 1048, Alvin, TX 77511. (Tel: 713-331-0450)

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(2) A limited selection of PMOs holding small stocks of instruments and/or stationery for issue to the U.K. Voluntary Observing Fleet. For complete details, see the *Marine Observer's Guide*.

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