Met.O.990

The Marine Observer

A quarterly journal of Maritime Meteorology

Volume 60 No. 308
April 1990

THE MARINE OBSERVER

A Quarterly Journal of Maritime Meteorology
prepared by the Marine Division of the
Meteorological Office

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VOL. 60 **No. 308** **APRIL 1990**

CONTENTS

COVER PHOTOGRAPH: Electrical storm off Valencia on 18 June 1989, taken with a hand-held camera by Mr K.C. Riddick, Chief Officer m.v. *Encounter Bay*.

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

The Meteorological Office became an Executive Agency on 2 April, this change signifying a turning-point in its evolution. It represents an opportunity to build upon its position as a centre of excellence in the meteorological community and create satisfaction in its customers. The challenge is to do these things by providing value for money for the nation, through quality and professionalism of service.

There has been change and re-organization in the Met. Office ever since its foundation 135 years ago. The changes have come about from developments in science, differing views of the leadership, fresh demands from users of its services and from government insistence on efficient utilization of public resources. Among the options considered for making better use of Met. Office resources were privatisation, contracting out and abolition; but the concept of 'Agency Status' seemed to match the needs of the Met. Office best of all. Thus the Office remains within the Ministry of Defence, but with much greater freedom and accountability than before.

Dr John Houghton, 58, Director-General since 1983, has been appointed as the first Chief Executive, and he sees partnership with business as one of the key features of the new Agency. The change implies a more businesslike approach, but the Met. Office as a huge commercial empire is not what Dr Houghton envisions. He plans to build commercial success on the international reputation of the Met. Office for professionalism and scientific excellence, turning to the business community for other areas of expertise. The Met. Office has already set a target of double its 1989 income from commercial contracts by 1995. Responsibility for handling integral parts of the programme has been moved down to various levels of staff, and new posts of Directors of Operations, Commercial Services and Finance & Administration have been made as part of the re-organization of the senior management of the Office, to achieve clearer lines of responsibility. In this context, the Marine Superintendent, whilst keeping that title, will also head his own branch called Marine Observations. He retains responsibility for the operational administration of marine observing networks, including the Ocean Weather Ship, Voluntary Observing Fleet, Automatic Shipboard Aerological Programme and Ship Routeing operations.

The Met. Office maintains a leading position in world-wide research on the environment, and intends to build on the prime resource of its expertise. This was underlined when the Prime Minister announced in her speech to the United Nations last November the creation of the new U.K. Centre for the Prediction of Climate Change. The objective of the Centre will be to produce the best possible predictions of future climate change as a basis for developing policies to control the greenhouse effect, building on the established base of modelling and scientific excellence in the U.K. An essential part of the Centre's function will be to identify the scientific work which can contribute to the improvement of General Circulation Models (GCMs). These are mathematical simulations of how the global atmosphere, interacting with the oceans, land masses and the biosphere, distributes the incoming energy from the sun and determines the overall heat balance and patterns of climate around the world. Current GCMs have to rely on many approximations and assumptions, and comparison of models using different approaches has led to a degree of concensus about the likely range of average global temperature rise for an effective doubling of greenhouse gas concentration of between 1.5 and 4.5 degrees Celsius. There are many ways in which GCMs can be improved and it is expected the Centre will develop improved models by harnessing available expertise involving liaison and co-operation on a national and international basis and by providing the most advanced computing facilities.

J.F.T.H.

Annual Report of the Marine Division for 1989

1. Voluntary Observing Fleet

On 31 December 1989 the numbers of units recruited into the United Kingdom Voluntary Observing Fleet (VOF) stood as follows:

(a) 431 Selected Ships, equipped with Met. Office supplies consisting of precision aneroid barometer, barograph, thermometers, sea temperature bucket, instruction material and logs. Certain ships are also provided with distant-reading temperature installations, automatic transmission units and radiosonde facilities.

(b) 2 Supplementary Ships, carrying a smaller set of instruments with which to make observations as and when opportunity permits.

(c) 51 'Marid' vessels which use the sea thermometers supplied to take sea temperatures when in coastal waters; these sea temperature data, when transmitted, provide valuable information to assist in the forecasting of fog and are indirectly of considerable help to the mariner. Whilst it is appreciated that 'Marid' ships do not always have the opportunity to take and transmit these sea temperatures, in the North Sea in particular there is an urgent need for additional data of this type.

(d) 2 automatic light vessels and 1 light tower. *Channel* light vessel became the second such station to be fitted with a Marine Automatic Weather Station, following the deployment of *Smith's Knoll* the previous year. Some problems have been experienced with the wind direction sensors on both light vessels.

(e) 2 Auxiliary Ships. Ships on voyages to oceanic areas where weather data are in short supply are requested to make observations with their own instruments, logging them on a special form supplied by Port Met. Officers, and transmitting them by radio whenever practicable.

(f) 30 Oil Rigs and Platforms, which use the full ship code to provide regular observations from the North Sea and adjacent areas.

Owing to the great efforts of Port Meteorological Officers at home and abroad, many new recruits were brought into the VOF, resulting in a modest improvement in the year in the total number of ships observing. These included several foreign flag ships, notably Belgians awaiting the resumption of recruitment by their own country. One recruit of particular interest is the Sail Training Vessel *Francis Drake* of the Ocean Youth Club NW. This 72-foot staysail sailing ketch has been retracing the steps of her famous namesake by making a 12,000-mile, 5-month, round trip from Liverpool to the Canaries, the West Indies, the United States east coast and via the Azores back to Liverpool. In addition to a small permanent crew the *Francis Drake* has been manned by 12 trainees aged 15 to 21, each doing one of the four legs of the voyage, making 48 men and women taking part. Four of these were specially instructed by Met. Office staff in the rudiments of weather observing in order to provide observational data during the trip.

Additional installations of the Meteorological Observing System for Ships (MOSS) have been fitted, particularly to ships having a special need for dedicated data collection and automatic transmission facilities. Twenty-six ships are now fitted with MOSS and the installation programme will continue in 1990. Ocean Weather Ship *Cumulus* was fitted with a MOSS-type trial unit which was modified after test to incorporate the upper-air data. Office transmission costs are minimised using MOSS, and further cost reductions are perceived with the increase in the number of ships fitted with SATCOMS and using INMARSAT rather than HF WT as the means of transmission.

The *OOCL Challenge* continued to operate with the Automated Shipboard Aerological Programme (ASAP) installation belonging to the Canadian Atmospheric Environment Service, but manned by a Met. Office Scientific Officer, who also assisted the ship's observers with surface observations when not occupied with the twice daily radiosonde launches. The Belgian *Canmar Europe* also continued the upper-air programme, with a U.K. owned ASAP container on board on her 5-day North Atlantic crossings, including the use of a modified deck balloon launcher which obviated the need to alter course for each balloon ascent.

The nine U.K. VOF ships assisting with the Voluntary Special Observing Project-North Atlantic (VSOP–NA) were asked to continue their efforts beyond the end of the year, by providing the special groups in their weather messages up to the middle of 1990. A total of 50 ships from six countries, Canada, FRG, France, Netherlands, U.K. and U.S.A., are involved. The first VSOP–NA observations were made in May 1988, and some ships have contributed over 500 of the special observations. Results so far, monitored and archived by the Marine Advisory Service, have been very useful and have required careful analysis in the context of vessels' statistics, to clarify which overall biases and scatters may be ascribed to observing practices, instrument type or exposure. Differences due to alternative national practices and instrument types are to be quantified, e.g. differences between air temperatures measured by thermometers in screens and by psychrometers have been investigated further. Whilst some ships using psychrometers give air temperatures higher than the 'background field' on average, most others as well as those using screens, tend to give lower values. There is a possible indication here that these differences are due to the make of psychrometer used: the analyses continue.

Another ongoing special project is the Operational World Weather Watch System Evaluation-North Atlantic, which continued to enable the extracts from ships' logged data to be used to provide an assessment of their observations on forecasts.

Moored and free-drifting buoys (unmanned) were deployed in accordance with a detailed WMO programme to provide automatically transmitted weather data to various National Meteorological Centres.

2. Ocean Weather Ship Programme

After 30 November the operation of Ocean Weather Ships including *Cumulus*, see photograph opposite page 79, became independent of the North Atlantic Ocean Stations Board, although that constituent body of the World Meteorological Organization will not be finally wound up until late 1990. The *Cumulus*, nominally purchased from the Netherlands Government in 1985 on the understanding of return to them when the U.K. no longer has operational need of the ship, carried out a similar routine to the previous year's. Round voyages of 33 days were made from her home port of Greenock to Station 'Lima' in position 57°N, 20°W, where hourly surface and six-hourly upper-air observations were carried out. As part of the Integrated Global Ocean Services System (IGOSS), Expendable Bathythermograph soundings of temperature and depth in the sea were made twice daily using Nansen Bottles and telexed home on behalf of EUMETSAT and the Hydrographic Department. The Royal Aircraft Establishment and Institute of Oceanographic Sciences were two of the organizations which contracted to use the many spare berths on board, for carrying out their own investigations. Following an open tender exercise earlier in the year it will not be known until later in 1990 whether J. Marr & Son of Hull will continue to manage and operate the weather ship for the Met. Office. Marr's performance has been entirely satisfactory and, in addition to routine operations, they negotiated a new contract with Vaisala of Cambridge for maintenance of the radiosonde upper-air system on board. Marrs also took over from the Met. Office the employment of scientific staff on board. Under the WMO Voluntary Co-operation Programme the Kenya Met. Department, for the second time, sent an official from the Mombasa Port Met. Office to undertake an autumn training voyage aboard *Cumulus*. As a result of this liaison Mombasa's holding of small stocks of stationery has been restored, for issue to visiting ships of the United Kingdom VOF.

The Met. Office is desirous that the ample vacant accommodation on board *Cumulus* will be put to good use on repayment to the Met. Office, by visiting scientific bodies at a time when research into climatic change is of such importance. From December 1989 the weather ship will normally be based at 'Lima' but may be deployed to adjacent areas to the west of northern Europe as deemed most practicable.

3. Ship Routeing

By the year's end increased automation gave METROUTE full capability to handle the increased ship routeing business now enjoyed, providing nearly double the revenue received two years before: the major contracts with Shell and Esso were renewed. The complement of Master Mariners operating the service for shipmasters and operators stands temporarily at six in number, until retirement in mid-1990 of the senior member of the team restores the total to the normal Master Mariner level of five staff members. They kept abreast of developments in the routeing field, including a display of interest by some of the larger shipping companies in computer-to-computer data links, implying a long-term wish to augment the traditional Router/Master dialogue with some decision-making at fleet HQ. Back-up to METROUTE operations is provided by automated support from *inter alia* the adjacent Central Forecasting Office and the Computer Complex at Bracknell Headquarters.

The first edition of a new quarterly magazine for clients, called *Outlook*, was launched by the Marketing Services Branch in the winter months, to promote public awareness of our commercial and public use activities. The importance of specialized marine meteorological services was recognized by WMO's Commission for Marine Meteorology at its tenth session held in Paris in February, when the Commission established a new working group specifically to handle this matter.

Contacts were made with *Lloyd's Register* and the New Zealand Met. Service, among others, with a view to discussions on METROUTE agency representation around the world. Special services provided during the year included tropical cyclone and depression advisories worldwide, weather watch in the China Sea and for three clients on avoidance of hurricane 'Hugo' in September.

Amongst the many routeings provided were several for tows, motor yachts on delivery, dredgers in action, many Maersk Line ships, *Queen Elizabeth 2* and two other Cunard cruise liners, and a new contract with James Fisher for routeing of that company's five nuclear waste carriers from Barrow-in-Furness to Japan. The contract for the North Pacific section of these voyages was won over from well-known competitors.

The Sea Ice Service continued to work closely with METROUTE, providing weekly sea ice situation charts for the relevant portions of the North Atlantic, Baffin Bay and the Baltic Sea. Clients in northern North America, Europe and Asia receive regular updates on the sea ice situations in their areas of operation. Information is also supplied to Lloyd's of London Casualty Department. The P. & O. liner *Canberra* was provided with current ice information on her July cruise to Spitzbergen.

4. Services to Shipping

Gale warnings and weather bulletins for commercial shipping and fishing were regularly broadcast by the BBC, British Telecom International (BTI) and by NAVTEX. In order to centralize and simplify its broadcasts of weather forecasts and gale warnings from Coast Radio Stations, BTI introduced its new Distributed Operational Control System. These broadcasts are now controlled either by Land's End Radio for the southern region, or by Stonehaven Radio for the northern. The former *Leaflet No. 3*, now published as *Weather Services for Shipping*, contains all the information necessary for users of shipping forecasts, and can be obtained from the Met. Office on request.

5. Marine Enquiries and Consultancies

In addition to handling the routine acquisition, quality-control and computer archiving of logbook observations from both the U.K. and foreign VOFs, the data section has made further progress with the special compilation of datasets for the tropics (30° N–30° S). These data are required for the Tropical Ocean Global Atmosphere (TOGA) programme, to document marine weather conditions in as much detail as possible over the 10-year period from 1985. By the end of 1989, well over 2.3 million ships observations had been collected and forwarded to the World Data Centres in the U.S.A. and the Soviet Union, for use by research teams.

The data section is co-ordinating the VSOP–NA, to which about 50 ships from six national VOFs are contributing special observations (see above). During 1989 considerable progress was made in archiving these observations, and techniques for their analysis are now being developed. It is hoped that differences due to differing national observing practices and instrument types can be quantified; although these differences are mostly small, they are important when heat and moisture fluxes between ocean and atmosphere are calculated. These quantities are fundamental to our understanding of the basic processes which determine climate and climate change.

As usual, the majority of enquiries addressed to the advisory services section came from the legal and insurance sectors, and were concerned with the loss of, or damage to, vessels or cargo. The storms over areas Biscay and Finisterre in late February gave rise to a considerable number of requests for information and advice. Other accidents requiring special study were the loss of the drill ship *Seacrest* in the Gulf of Thailand in early November, and the breakaway of the Fulmar floating service unit in the North Sea on 24 December. A study of waves and surges in the Bristol Channel was conducted as part of the exercise to define the design standards for a new sea wall to protect the nuclear installations at

Hinkley Point. Trials of a possible new service to forecast inshore waves, tides and surges for coastal engineering contractors were conducted at sites in the Straits of Dover and in north-west England.

Further progress has been made in the computer support for METROUTE. A further range of charts for use by the shipmasters can now be produced automatically, and various summaries of the routed voyages can be produced on request.

6. Awards and Publications

Inscribed barographs were again presented by the Director-General to the four most deserving shipmasters, whose dedication up to the end of the year to the cause of marine weather observing over a long period merited recognition.

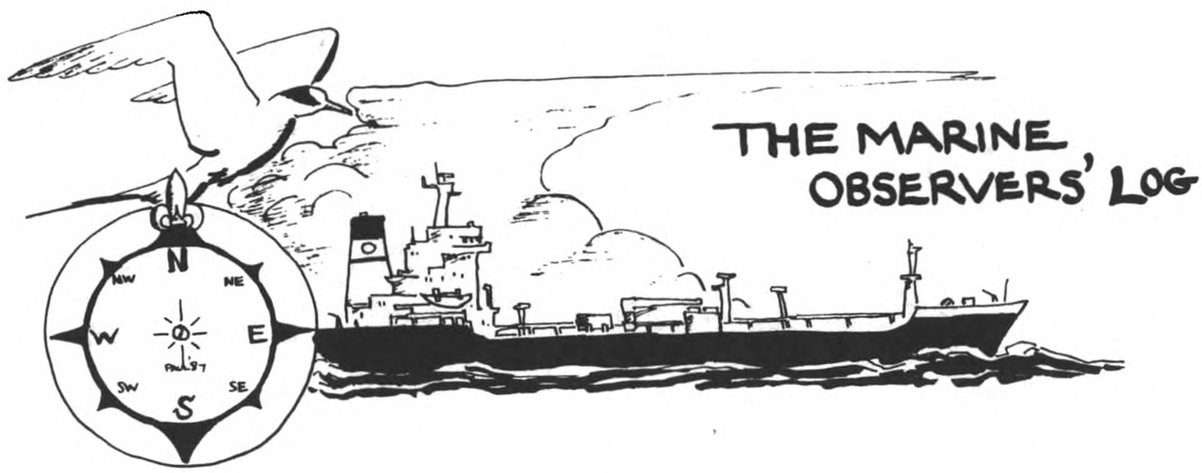
Book awards were made to co-operating Masters, Principal Observers and Radio Officers in recognition of the 100 best logbooks assessed as 'Excellent' during the year. Additional awards were made to those principally engaged in recording the extra groups in the 10 ships participating in the VSOP–NA project. The three books chosen as awards were *Reader's Digest Book of Facts*, *Collins World Atlas* and *Longman's Concise English Dictionary*.

Publication of the annual reprint of the leaflet *Weather Services for Shipping* was delayed whilst extensive revision was made to its content and style, in order to produce a publication for the '90s. It is no longer planned to have an annual reprint of the leaflet as a matter of course. Following the demise of the last manned observing light vessel, the special observers' form was modified for exclusive use by the Royal Sovereign light tower. Reprints were carried out of six other forms, the *Marine Observer's Handbook* and the logbook, Met O 911A.

7. General

In support of the *Cutty Sark* Tall Ships Race from London to Hamburg in July, the Marine Superintendent arranged for London Weather Centre to provide a weather briefing in Guildhall for the Masters and Navigators of the 140 entrants, the day prior to the start of the race.

The Port Met. Officers' Conference, held at Bracknell HQ in July, brought together Management, Marine Superintendent, U.K. Marine Division staff and European Port Met. Officers for the biennial gathering. The standardized conference agenda made for lengthy discussion, but some useful agreements were reached, for instance, on the need to extend the VSOP–NA programme to the end of June 1990, and to gain the support of observers in this project by use of informative newsletters. Representatives of the GCBS would be invited to Bracknell to try and encourage the BBC to maintain user-friendly shipping forecasts. The representative from Belgium brought the heartening news that his Government was considering the reinstatement of its voluntary observing practices, including a resumption of Port Met. Officers based at Antwerp and Zeebrugge. A full report of the conference appeared in the January 1990 edition of this journal.



April, May, June

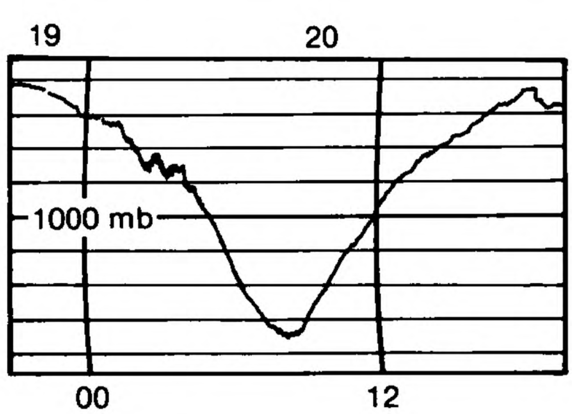
The Marine Observers' Log is a quarterly selection of observations of interest and value. The observations are derived from the logbooks of marine observers and from individual manuscripts. Responsibility for each observation rests with the contributor.

TYPHOON 'BRENDA'

South China Sea

m.v. *Scandutch Hondo*. Captain K.J. Owen. Busan to Singapore via Hong Kong. Observers: the Master and ship's company.

18–20 May 1989. At the beginning of this period, a developing tropical depression east of the Philippines was indicated via facsimile when the vessel was on the Japanese coast; the initial forecast was for it to move approximately north-west at a speed of 10–12 knots. The vessel commenced three-hourly observations at 0000 GMT on the 18th whilst on passage through the Taiwan Strait, and a series of observations made during the period is given below. The depression was upgraded to a typhoon on the 20th when the vessel was on passage to Singapore, and the barograph trace shows the storm's contours.



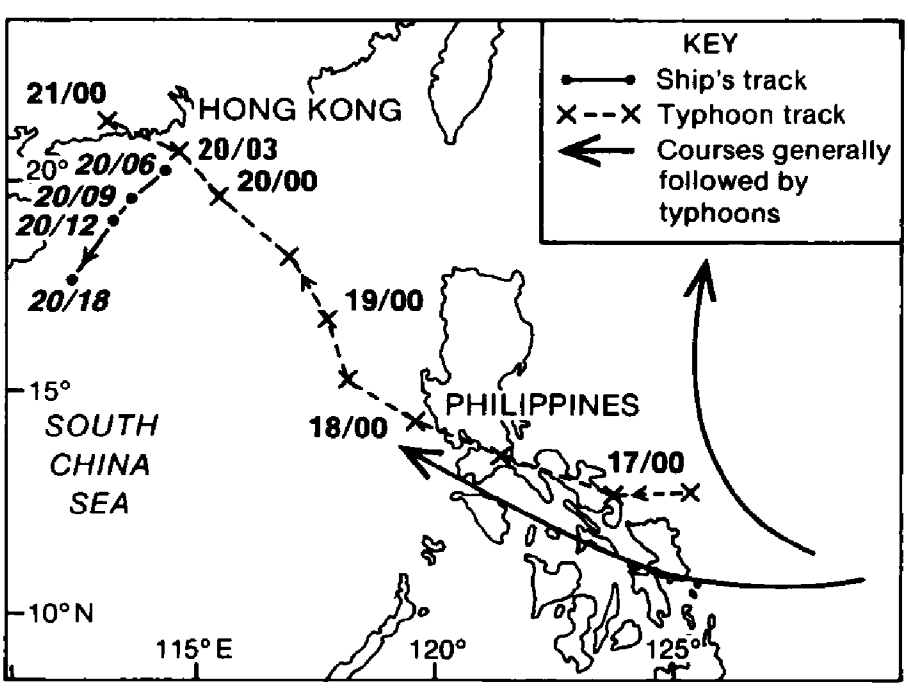
Date and time (GMT)		Wind Dir'n	Wind Force	Temperature (°C) Air	Temperature (°C) Wet	Pressure (mb)	Remarks
18th	1500	NE×N	7	21.5	21.0	1010.6	Moderate following sea and swell.
	1800	NE×N	7	22.0	20.9	1008.5	
	2100	NE	7	22.4	21.4	1007.2	Moderate/rough starboard quarterly seas. Showers. Good visibility.
19th	0000	NE×E	7	20.2	19.0	1007.8	Moderate visibilty. Intermittent light rain.
	0300	ENE	6	23.0	22.2	1007.9	
	1200	NE	3	25.9	23.4	1005.6	Alongside, Hong Kong. Light rain.
	1600	E	3/4	26.0	23.0	1004.7	
20th	0000	NE×N	8	23.0	22.0	999.1	Passage to Singapore. Heavy north-easterly swell. Vessel rolling moderately. Visibility moderate/poor.
	0300	NE	8/9			996.1	Heavy north-easterly swell. Storm upgraded to typhoon status.
	0600	NNW	10	23.2	22.9	987.7	Between 0400 and 0800 rolling and pitching very heavily in high beam seas and short, heavy swell. Continuous heavy rain.
	0900	W×N	8	25.5	23.7	993.6	Rolling gradually easing,
	1200	W	5	25.7	24.0	999.9	visibility increasing to good.

Upon departure from Hong Kong, a course was set to pass closer than normal to the coast of Vietnam as the track of typhoon Brenda was further westward than anticipated. The vessel was estimated to have passed about 40 n.mile west of the eye of the typhoon.

Position of ship on the 20th at 0600 GMT: 21° 06′N, 113° 00′E.

Note. Mr R.D. Whyman, of the Marine Advisory Consultancy and Data Services, Met. Office, comments:

'Typhoon Brenda started life as a tropical depression with wind speeds of 33 knots or less, in the Pacific Ocean to the east of the Philippines on 15 May. By 1200 on the 16th Brenda had been



upgraded to a tropical storm with wind speeds of 34 to 64 knots, and was moving towards Luzon (see map). The tropical storm was upgraded to typhoon with wind speeds of 65 knots or more, by 0000 on the 20th, passing about 240 n.mile to the south of Hong Kong later that day. Landfall was made shortly afterwards and Brenda soon dissipated.

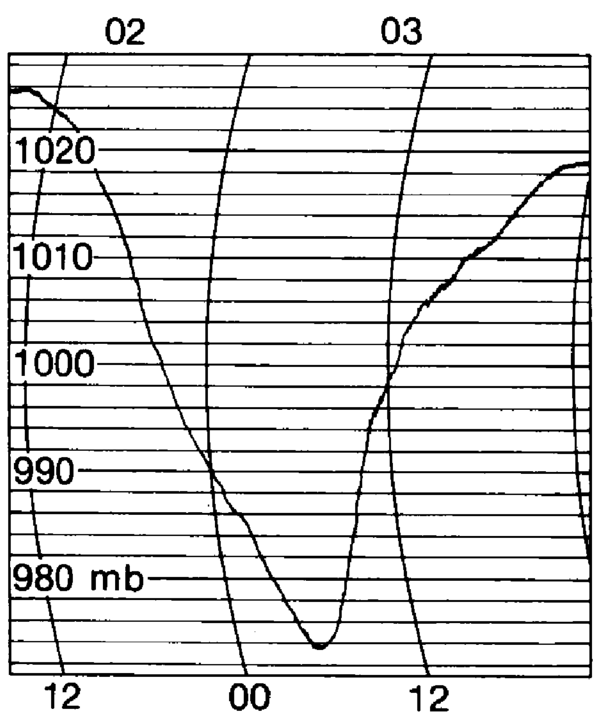
'Reports in *Lloyds List'* stated that on the storm's passage through the Philippines at least 28 people were killed and 58 sailors were reported missing. A number of vessels were lost or damaged; these included the freighter *Zambales*, laden with logs at the time, which sank off Calonite Island 110 n.mile south of Manila with 23 crew reported missing.

'In Hong Kong three people were killed, one was missing and many were injured as gale-force winds and torrential rain lashed the colony. Over 200 mm of rain fell on the 20th and virtually all public transport stopped. In all, about 400 mm of rain fell during the passage of Brenda, compared with the average monthly rainfall for May in Hong Kong of 293 mm.'

DEPRESSION
North Pacific Ocean

m.v. *Valdivia*. Captain N.C. Kerr. Portland, Oregon to Singapore. Observers: the Master, Mr G. Shaw, 2nd Officer and ship's company.

2–3 May 1989. From about 1200 GMT on the 2nd, the pressure fell steadily at the rate of approximately 10 mb every three hours, as shown on the barograph trace, and the ship then encountered a deep depression. The following observations, made during the above two days, have been taken from the ship's log.



Date and time (GMT)		Wind Dir'n	Force	Dry bulb (°C)	Pressure (mb)	Remarks
2nd	1700	W×S	6	12.0	1014.5	
	2100	SE	9	14.5	998.7	

3rd	0100	S	9/10	15.1	988.0	Alter course owing to heavy rolling. hand steering.
	0300	SSW	10		980.5	
	0500	SW	11	12.0	975.6	Visibility reduced by spray. Violent seas, extremely heavy swell.
	0600	SW	12		974.0	Vessel hove to. To Master's orders.
	0700	WSW	12		983.8	Anemometer ceases to register.
	0800	W	12		987.9	
	0900	W	12		990.9	Rolling and pitching heavily. Extremely heavy seas and swell.
	1000	W	12		995.2	
	1100	W	11		999.8	
	1200	WNW	11		1003.8	
	1300	WNW	10	12.0	1006.2	

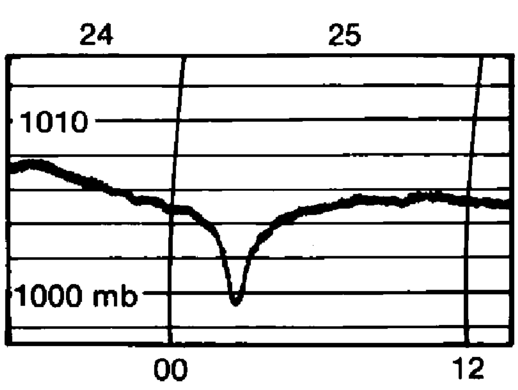
From this point the wind continued to moderate and had decreased to NW'ly, force 9 at 1700, and to NW×W'ly, force 6 at 2100, whilst the pressure maintained a steady rise. Between 0100 and 1500 on the 3rd, the vessel sustained winds of 60 knots, gusting to 80 knots, and the anemometer had ceased to function because the 'propeller' and tail fin section had both been lost in the storm.

Position of ship on the 3rd at 1200 GMT: 36° 48'N, 160° 12'E.

North Atlantic Ocean

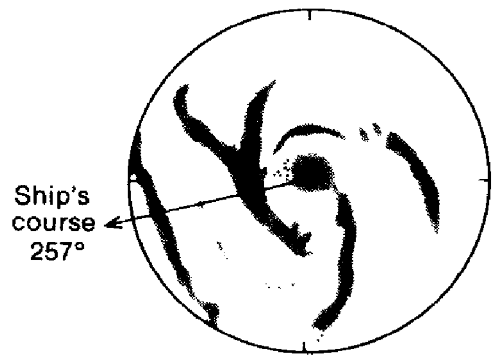
m.v. *Appleby*. Captain S.J. Honey. Redcar to Hampton Roads. Observers: the Master and Mr S.G. Leitch, 3rd Officer.

25 June 1989. Weather observations made at 0000 GMT showed 4 oktas of cumulonimbus which increased quickly to 6 oktas, and moderate/heavy rain commenced at 0025. At 0055 the wind backed fairly rapidly to E×N'ly, force 4–5 whilst the pressure began to fall quickly, see barograph trace. By 0120, the wind



was still backing, though not so fast, and at 0125 after a very sharp fall of 4 mb in the pressure it steadied for a few minutes until 0135 when it began to rise sharply; the wind at this time was NE'ly, force 4. The radar was set to the 48-n.mile range, and gave a picture something like that shown in the sketch.

At 0146 the cloud began to break up revealing some stars overhead, and by 0200, the wind was N'ly, force 4. The clouds remained fairly broken until 0228



48-n.mile range, 0135 GMT

when the vessel again entered a band of rain from cumulonimbus clouds. By 0230 the wind had backed to NW'ly, force 4 and the pressure was still rising; by 0330, the barograph trace had reached approximately the same level as before and then began to level off. A great deal of cloud and rain was still visible on the radar, and intermittent rain and showers continued for several hours after this time.

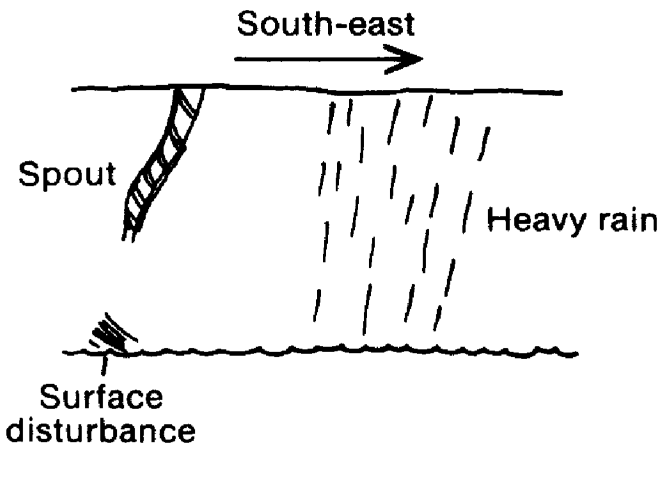
Position of ship: 39° 18'N, 61° 11'W.

WATERSPOUT

Western Pacific Ocean

m.v. *Endeavour*. Captain D.J. Rouse. Dalrymple Bay to Singapore. Observers: Mr G. Cuthbert, 1st Officer and Mr J. MacDonald, 3rd Officer.

8 May 1989. At 2300 GMT a waterspout was observed moving east-south-east at a distance of 0.5–1.0 n.mile from the ship. It was observed for about five minutes and was fairly small, coming from the base of a large cumulonimbus cloud from which rain was also falling. There was heavy rain at the front of the cloud but the waterspout was at the back, see sketch.



The column of the spout was fairly thin with a slight kink in it, and only reached half-way to sea level. At the surface below the waterspout a disturbance could be seen on the water, consisting of a fine spray spinning in an apparently anticlockwise direction. The cloud from which the waterspout originated was a central one in a line of cumulonimbus clouds about 29 n.mile long and 2 n.mile wide.

Weather details were: air temperature 27.4 °C, wet bulb 26.2°, sea 29.4°, pressure 1009.1 mb, wind NW'ly, force 4.

Position of ship: 02° 00'S, 141° 25'E.

Note. Mr M. Rowe, of the Tornado and Storm Research Organisation, comments:

'The most useful feature of this description is the mention of the direction of rotation of the spout, as few reports mention this information. It is clear, from the surface disturbance below the visible spout, that it did extend down to the sea surface, but that the lower part was invisible because the air was not humid enough to allow condensation within the funnel.

'Large shower and thunderstorm clouds contain a complex pattern of air currents. In the present case warm, moist air will have been rising, cooling and condensing its moisture into cumulus cloud. In such a cloud there is usually also a descending current, which reaches the surface as a cool, gusty squall. Many waterspouts probably form where the rising and descending currents interact, or where the air currents of one cloud interact with those of another.'

SEVERE ELECTRICAL STORM

South China Sea

m.v. *Benalder*. Captain J.L. Walterson. Hong Kong to Singapore. Observers: the Master, Mr J.H. Clark, Chief Officer, Mr P.D. Gould, 2nd Officer, Mr D. Mackay, SG1A, and members of ship's company.

10 May 1989. Between 1900 and 2130 GMT the vessel experienced the effects of an electrical storm; sheet lightning was visible throughout the first hour as the cloud increased, and further details appear in the following observations.

1930: Moderate rain shower with lightning observed at 2 n.mile.

2010: Heavy rain commenced at ship. Severe lightning and loud thunderclaps close to station.

2030: An almost simultaneous flash of lightning and clap of thunder on the starboard side was felt by many of the ship's complement. There were no visible signs of the ship having been struck, although St Elmo's fire was observed around the whip aerial couplings. No other equipment was damaged, but the barograph trace showed a small fall and rise in pressure at this time.

2130: Lightning and rain ceased.

Shortly after 2030, comparison of compasses showed that the magnetic compass heading had changed as follows:

Time	Gyro	Magnetic	Gyro error	Compass error	Variation	Deviation
Before 2030	214°	212°	½° L	2½° E	Nil	2½° E
Shortly after 2030	214°	192°	½° L	23° E	Nil	22½° E
Eight hours later	211°	190°	1° L	22° E	Nil	22° E

During the voyage, the magnetic compass remained very sensitive and unpredictable with its headings, and showed no sign of returning to its original deviation on any course.

Position of ship: 09° 49'N, 109° 54'E.

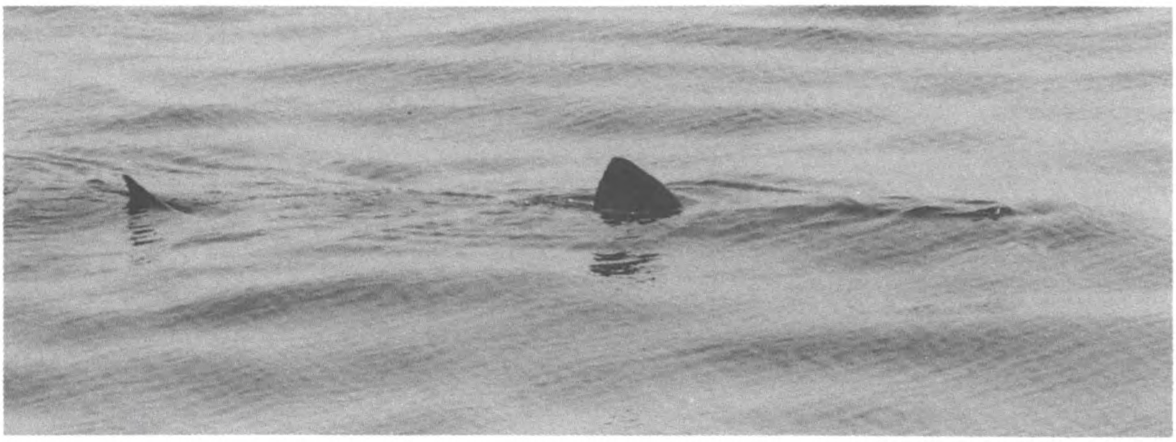


Photo. by Captain N. Maynard

Top: Basking Shark seen from m.v. *Mark-C.* (See page 71.) Centre: Rescued petrel on board m.v. *Atlantic Universal.* (See page 73.) Bottom: Humpback Whale photographed from m.v. *Alliance.* (See page 68.)

Photo. supplied by Mrs E.L. Harris

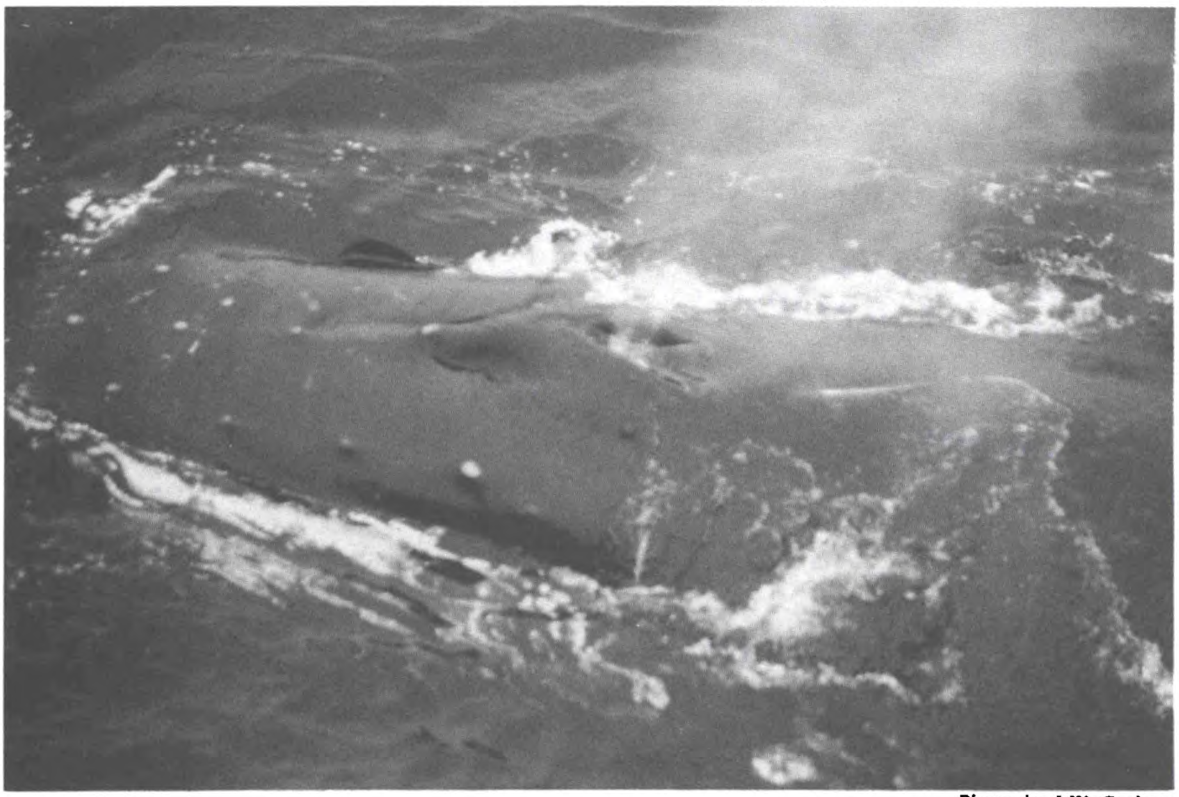


Photo. by J.W. Graham

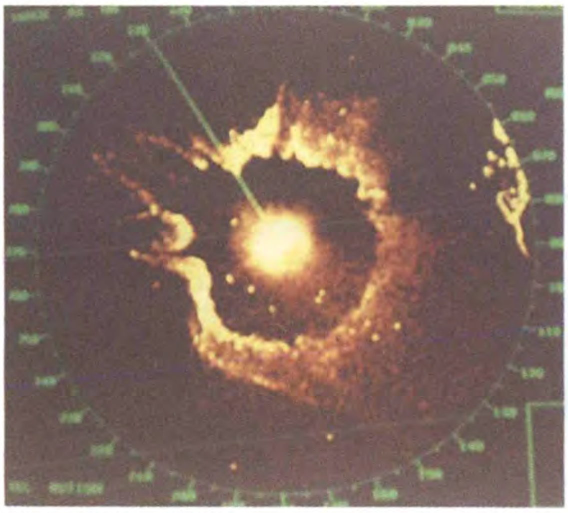


Photo. by E.M. Pallister

Left: Radar screen of m.v. *Forthbank*. (See page 67.) Below: Seal photographed from m.v. *ACT 7*. (See page 71.)

Photo. by I. Cousins

Photo. by J.A. Laws

Left: White-tipped Shark photographed from m.v. *Benavon*. (See page 71.) Below: Gray-capped Cuckoo resting on board m.v. *English Star*. (See page 87.)

Photo. supplied by Captain C.I. MacKillop

DUST

Red Sea

m.v. *Forthbank*. Captain P.J. Elder. Singapore to Suez. Observers: the Master, Mr W. Mather, Chief Officer, Mr A. Haynes, 2nd Officer, Mr E.M. Pallister, 3rd Officer and Mrs Pallister.

30 May 1989. Whilst the vessel was passing Jeddah to starboard at 50 n.mile, a large and unfamiliar echo was found to be tracing on the radar screen, commencing at 1600 GMT.

The first observation consisted of a complete ring, the inner radius being 13 n.mile, and the outer one about 28 n.mile. One hour later, at 1700, the outer radius showed signs of the echo 'printing' outwards towards the edge of the screen, the inner radius now being 18 n.mile and the extreme point reaching 34 n.mile. At 1800 a gap appeared in the formation which was becoming 'horseshoe' shaped with the extreme range at 40 n.mile and the inner range constant at 18 n.mile. A photograph, taken at approximately this time, appears opposite page 67. Thirty minutes later, the shape remained but the outer edges of the trace were very pointed and jagged, while over the next half-hour this formation became less distinct and was slowly dissipating. The horse-shoe shape appeared to stretch out until it seemed steady at the extremes at ranges 48 n.mile and 38 n.mile.

The elongated shape remained for several hours and was detected to move eastwards before eventually fading from the screen at about 65 n.mile. During all this time, the visibility was not seriously affected, remaining fairly constant at 9.5 n.mile. This trace was obviously a heavy attendance of sand particles in the atmosphere. The radar set in use was the Racal Decca ARPA-S-2690 BT.

Weather conditions throughout the observation were: air temperature 30.0 °C, wet bulb 26.5, wind NW'ly, force 4.

Position of ship at 1800 GMT: 21° 18'N, 38° 18'E.

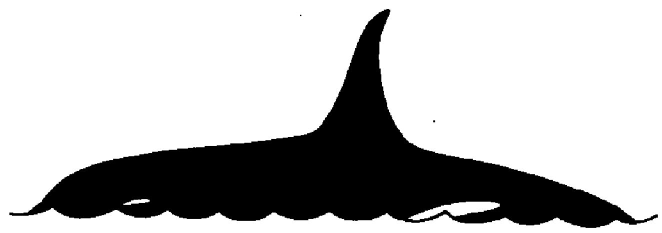
CETACEA

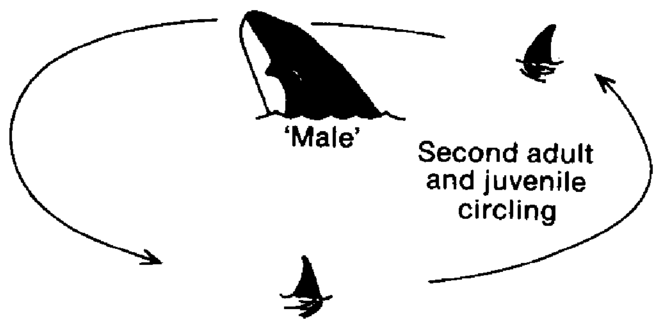
St George's Channel

m.v. *Matco Avon*. Captain J.M. Bell. Falmouth to Stornoway. Observers: Mr I.J. Collins, 3rd Officer and Mr R. Sandford, SG1A.

3 May 1989. At 1945 GMT whilst the vessel was on a course of 020° at a speed of 9.5 knots a group of three Killer Whales was observed passing down the port side. Apparently heading in a south-westerly direction, the group appeared to consist of two adults and one juvenile, the adults being about 7.5 m to 10.5 m long, and the juvenile 4.5 m to 6.0 m. The largest of the adults was believed to be a male as its dorsal fin was higher and more triangular than those of the others. This whale passed closest to the ship at about 0.25 n.mile while the rest of the group were at about 0.5 n.mile. All repeatedly broke the surface, the 'large male' doing so more regularly.

As shown in the sketch, their colour overall was black with a white flash on the head, and white patches on the undersides. On one occasion, the male rose up nose first and was circled by the two others before sinking back down. At this





time, the whales were approximately 1 n.mile off, and a second ship was overtaking the observers at about 1.5–2.0 n.mile on the port quarter; it was wondered whether this behaviour was some reaction to the ship's presence.

Weather conditions were: dry bulb 11.0 °C, sea 10.7°, pressure 1025.8 mb, wind, variable, force 2. Rippled sea and low swell.

Position of ship: 51° 40′N, 05° 51′W.

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

'This behaviour was very likely to have been precipitated by the presence of the vessel and has been observed frequently in Killer Whales and in Pilot Whales too. It is known as 'spyhopping' and probably has more than one function, including visually confirming an accoustic signal.'

Norwegian Sea

m.v. *Alliance*. Captain L. Holtschmidt. On passage for NATO. Observer: Mr J.W. Graham, 2nd Officer.

10–11 June 1989. At 1011 GMT on the 10th, whilst the vessel was stopped, five distinctive 'blows' were noted at approximately 0.5–2.0 n.mile. At first, they were thought to be Sperm Whales, but white markings on the underside of the flukes then identified them as Humpback Whales. Three whales dived soon after being sighted and did not resurface during the observation; the remaining two were watched for an hour until the vessel moved off again. They were swimming very close together, blowing two or three times every 5–8 seconds, then dived together for a couple of minutes before surfacing in the same area. Although observed through a 1000 mm telescope, it was impossible to estimate their size.

The following day at 0750, two whales were observed blowing close ahead. The vessel was stopped about 50 m off and it was expected that they would sound and disappear. Instead, they appeared 5 m off the starboard side and, for the first time, the observer was able to examine at close hand 40 tons of Humpback Whale of estimated length 12 m (see photograph opposite page 66). Both whales circled the vessel, also swimming below it and reappearing on the opposite side. This continued for about 10 minutes after which they sounded, surfacing six or seven minutes later some 300 m away. Unfortunately, mist came down and they were not seen again. The vessel remained stopped for a further hour and then moved off.

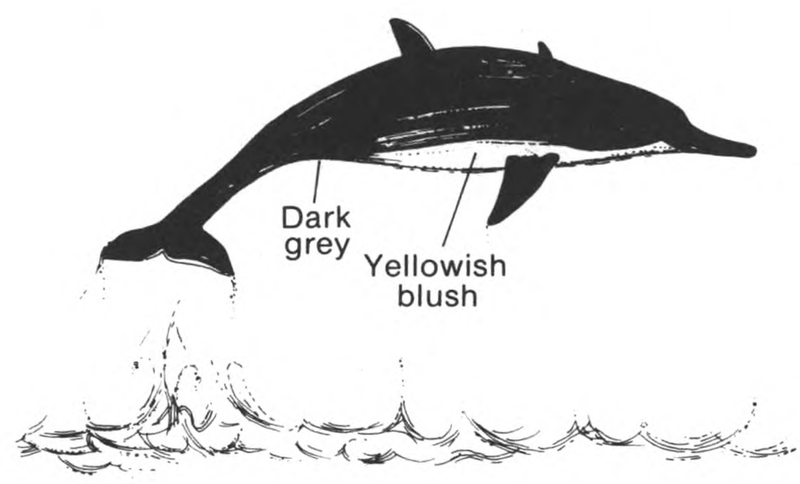
The sea temperature throughout ranged from 3.0 °C to 3.8° and the wind was E'ly, force 3.

Position of ship on 10 June: 67° 59'N, 12° 45'W.

Indian Ocean

m.v. *Cardigan Bay*. Captain P.J. Clark. Jeddah to Busan. Observers: Mr M.R. Greenslade, 3rd Officer, and passengers.

13 April 1989. At 0430 GMT, 20–25 dolphins were observed swimmimg past the ship. They seemed to be in a frenzy on approach of the vessel, and were jumping out of the water, see sketch. Some of them were observed spinning and



turning, reaching quite a height out of the water. On closer inspection, the bellies of the dolphins seemed to have an almost yellowish blush.

From the description and actions of the dolphins, the observers came to the conclusion that they were of the spinner family.

Position of ship: 05° 46'N, 83° 12'E.

Note. Mr D.A. McBrearty comments:

'The dolphins have been provisionally identified as spinner dolphins and may well have been so; the characteristics shown in the sketch do suggest the *Stenella* species.'

Tasman Sea

m.v. *ACT 7*. Captain W.A. Wilson. Botany Bay to Port Chalmers. Observer: Mr P.J. Brown, 2nd Officer.

7 May 1989. At 0255 GMT a single spout was observed fine to starboard at a distance of about 1 n.mile; three other spouts of a similar nature were then noted.

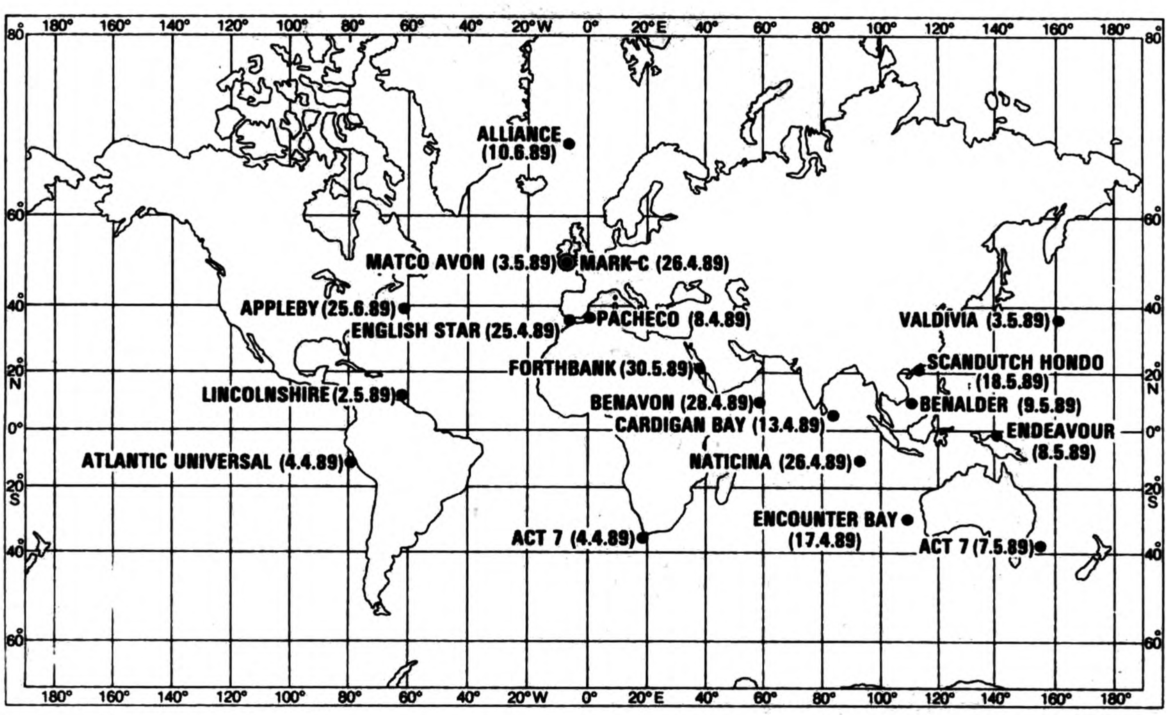
As the vessel drew close only one whale was seen on the surface; this had a dark, brown/grey back, of which approximately 10 m was visible, but no dorsal fin was observed. When the whale dived the tail flukes were not raised, it appeared simply to sink below the waves at a range of approximately 120 m. The spout was vertical, single and fairly narrow; its height being a quarter of the exposed length of body.

After consulting information on board the vessel (*Whales of the World* by Lyall Watson), the whale was identified as a Great Right Whale by its lack of a dorsal fin and by the area in which it was sighted. The sea temperature was 19.8 °C.

Position of ship: 37° 53′S, 155° 47′E.

Note. Mr D.A. McBrearty comments:

'The observers may be right in their identification of a Right Whale, but I am not wholly convinced by the description provided. Right Whales are more generally black than brownish, and when seen resting or moving slowly on the surface it should be possible to see some of the white càllosities on the head and around the high, arched jaw-line. The description of the blow is also uncharacteristic, at best it can be seen to be distinctly V-shaped in a double plume, and in all instances it is certainly short and bushy, never tall or narrow. However, the Right Whale is the only large, southern whale species which completely lacks a dorsal fin of any kind, and this alone should identify it.'



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

SEALS

South Atlantic Ocean

m.v. *ACT 7.* Captain W.A. Wilson. Rotterdam to Adelaide. Observers: Mr M.J. Power, 1st Officer, Mr P.J. Brown, 2nd Officer, Mr I. Cousins, 3rd Officer and members of ship's company.

4 April 1989. At about 1230 GMT whilst the vessel was rounding the Cape of Good Hope an unidentified seal was seen basking on the sea surface. Later that

afternoon, when the vessel was drifting some 40 n.mile south of Cape Agulhas, it was visited by another seal (thought to be a South African fur seal).

The seal came within about 3 m of the ship's side, and proceeded to bask in the afternoon sunlight, paddling water over its body and then using its flippers to scratch different parts of its anatomy. With an estimated length of about 2 m, and being a dark brown colour, the seal stayed for approximately 45 minutes, delighting the onlookers. Numerous photographs were taken, one of which appears opposite page 67.

Position of ship: 35° 23′S, 19° 26′E.

SHARKS

Western Approaches

m.v. *Mark-C.* Captain N. Maynard. U.K. coastal passage. Observer: the Master.

26 April 1989. At 1900, whilst the vessel was on passage for Rochester, a single basking shark was seen. Its length was estimated to be between 6 m and 8 m, and it appeared to be generally circling in the calm conditions at a speed of about 5 knots. The shark was noted to be very manoeuvrable.

An observation card was completed for the Marine Conservation Society's Basking Shark Watch, and a photograph of the shark was also taken (shown opposite page 66).

Position of ship: 51° 20′N, 06° 00′W.

Note. The Marine Conservation Society has launched its Basking Shark Watch with the aim of ascertaining the numbers and distribution of these creatures about which so little is known but which nevertheless are the subject of commercial fishing. Anyone can participate in the survey, and observation forms can be obtained from U.K. Port Met. Officers or from the Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU.

Indian Ocean

m.v. *Benavon.* Captain H.G. Gray. Jeddah to Port Kelang. Observers: the Master, Mr A.V. Plant, 2nd Officer, Mr J.A. Laws, Chief Engineer Officer and ship's company.

28 April 1989. Within several minutes of the ship being stopped, at 0300 GMT, two White-tipped Sharks appeared very close to the ship, swimming along the length of the port and starboard sides. The sharks, differing only in size, continued to swim in a steady search pattern, neither appearing to take any notice of the other. After an hour, the larger of the two, estimated to be about 4.5 m long and 2 m across the back from fin to fin, moved away from the ship. The smaller one maintained its search pattern, concentrating on the hull area housing the O/B discharges. The shark swam mainly with its dorsal fin above the water and appeared not to dive to any great depth during its six-hour stay. At no time did the observers lose sight of the shark which was accompanied by five or six pilot fish; these kept in very close proximity to it and could be seen clearly from the ship.

When the engines were started upon resumption of passage, the shark moved away and made no attempt to follow the ship as it slowly gained speed. The photograph opposite page 67 shows the smaller shark, estimated to be about 3.5 m long and 1.5 m across the back from fin to fin, accompanied by a pilot fish.

Weather conditions were: air temperature 31.4 °C, sea 29.0°, pressure 1013.4 mb, wind, light airs.

Position of ship: 10° 15′N, 59° 13′E.

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

'This is a nice account of what were two very large White-tipped Sharks (*Carcharhinus longimanus*). In Bigelow & Shroeder's *Fishes of the Western North Atlantic* the following appears: "The maximum size (of the white-tips) is said to be 12 to 13 feet, but we think it likely that at least some may grow considerably longer, for larger sharks, apparently of this species because of the rounded shape of the first dorsal fins, have been described recently to us seen at the surface over the continental slope in the offing of Woods Hole from the research vessel *Atlantis*.'

'Pilot fish are commonly associated with white-tips as are remora, a favourite place of attachment for these latter being upside-down on the shark's back behind the large dorsal fin.'

BIRDS

Mediterranean Sea

m.v. *English Star*. Captain C.I. Mackillop. Naples to Lisbon. Observers: the Master and ship's company.

25–26 April 1989. Whilst the vessel was approaching the Straits of Gibraltar a small, colourful bird was observed flying around the decks. Once outside the straits, strong winds and heavy seas from the north were experienced for about 12 hours; the vessel was practically hove to in winds gusting to force 9/10. Thus, not much thought was given to the bird, which was thought to have flown ashore looking for shelter.

On arrival at Lisbon, and while on stations for berthing, a small, what appeared to be a rag, was seen lying on the deck. On closer inspection, it was found to be our colourful, feathery friend. The bird, which was yellow, blue and green, was a budgerigar, and close to death.

The Steward took the budgie into his care and nursed it back to health on a steady diet of Weetabix and Grape Nuts; the budgie, who was christened 'Bud' (short for 'Budweiser') regained his beautiful colours.

Bud has now become a part of life on the ship; he or she has a cage which he has learnt to escape from, and has a diet of proper bird seed. He has become very tame, flying around freely in the crew's bar and enjoying a drop of bitter every now and then.

Position of ship on the 25th at 1200 GMT: 36° 06′N, 04° 42′W.

Note. In case Bud still has not been fully identified, 'he' would have blue/grey skin around the base of the bill whereas 'she' would have pink/brown skin.

Eastern South Pacific

m.v. *Atlantic Universal*. Captain C. Ramsden. Valparaiso to Panama. Observers: Mr P.J. Taylor, Chief Officer, Mr J.G. Harris, 2nd Officer, Mrs E.L. Harris and ship's company.

4 April 1989. When the ship was nearing the Equator, and as the weather was getting warmer, it was decided to clean out the swimming pool. At 1430 GMT, whilst waiting for the engineers to turn on the G.S. pump, and with scrubbing

brush and Teepol at the ready, the Second Officer's wife looked into the pool and noticed a small bird sitting in the bottom (the pool was empty at the time). After phoning to stop the pump being switched on, it was decided to take the bird to the bridge wing where it was quiet.

It made little effort to move when approached and was easily picked up. On the bridge wing it was placed in some water which it did not seem to appreciate. Bread and biscuits were offered and refused, it seemed uninterested in anything except the shady corner it had been placed in. The Mate came on watch as usual at 1600 and, owning a parrot at home, knew more about the feathered visitor, so he took over the care of what was identified as a storm petrel of some sort, possibly the White-faced Storm Petrel, see photograph opposite page 66. Some shredded cod was offered in a small amount, and the petrel, by this time looking more at ease, actually accepted some.

An old budgie cage became the temporary home for 'Lucky', and during the evening he spent his time eating a little and hopping around the bridge wing in the last of the sun. Meanwhile, the crew had found another bird with slightly different markings, but in the same confused state, and the two were put together and 'put to bed' when it went dark.

In the morning, Lucky seemed suitably rested and after a wander around while performing 'test flaps' he took off successfully into the bright blue yonder. Similarly, the second petrel, after one unsuccessful attempt, also took to the air and flew out of sight just after midday. The observers hoped that their hospitality was beneficial and that the birds recovered from the sudden attention on board the *Atlantic Universal*. Weather conditions were: air temperature 24.0 °C, pressure 1010.6 mb, wind SE'ly, force 5.

Position of ship: 11° 29'S, 79° 30'W.

Indian Ocean

m.v. *Naticina*. Captain A.T. Willy. Ras Tannurah to Whangarei. Observers: the Master, Mr A.F. DeVanney, Chief Officer, Mr M. Silloriquez, GIS and members of ship's company.

26–29 April 1989. As daylight developed on the 26th, the observers' attention was drawn to a bird on the starboard side of the forward maindeck by 1 starboard wing cargo tank. The bird appeared to be having difficulty standing and it was staggering about also unable to fly. At this time, the ship was spraying and the bird was being buffeted about as it tried to shelter behind the tank cleaning lines on the deck, then it disappeared. Due to the prevailing conditions nobody was allowed on deck.

Conditions remained much the same for the following twenty-four hours, but when the Chief Officer went to check the forward spaces, the 'passenger' was found huddled at the base of the inert gas riser, just to starboard of the centre line, and protected from the worst of the weather by the fo'c'sle head. The bird looked somewhat forlorn and windswept, still appearing unable to fly and barely able to hold itself up. It was possible for the Chief Officer, making what were hoped to be 'bird type noises', to get within about 1 m of it, and a photograph [not shown] was taken. It seemed to view the officer with little trepidation as if it would accept whatever fate would deal it, making no attempt to get away; even to hold its head up seemed to take a great effort. Some raw fish and bread soaked in milk was laid out, but this had not been touched when the bird was next visited.

On the 28th, 'Abby' as the bird became known, was still trying to shelter in the lee of the inert gas riser but was sunk right down so that just the webs of the feet were visible and the head was turned back between the wing tops. The way in which the wind was catching the body made it look as if nothing further could be done for the bird, but it responded to a handclap by lifting its head to look before returning to the previous position for more sleep. More raw fish was placed quite close in the hope that this would be more appetizing than the earlier offering.

During the morning of the 29th it was found that some of the fish had been eaten, and Abby was gaining more rest with the head protected by the wings. When aroused he seemed to be much more alert and was more aware of the surroundings; the eyes were also much more lively than on any previous visit. As the Chief Officer made the final rounds of the ship before dark, it was found that Abby had moved from his usual position, and as he could not be located anywhere else it was assumed that after a long rest, he had regained some strength and decided to leave.

One possible point of interest was that during the first day or two on board, the bird made no droppings at all, but in the second half of its stay everything was back to normal and the evidence was clearly visible in large amounts.

Position of ship on the 29th: 22° 40′S, 103° 52′E.

Note. Captain P.W.G. Chilman, of the Royal Naval Birdwatching Society, comments:

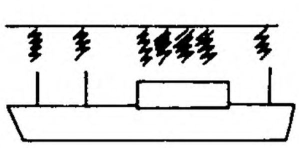
'The only booby that has bright-red feet is the Red-footed Booby (*Sula sula*). It is just as well that this is so as this bird has a great variety of different plumages, including a brown morph, which looks very like a juvenile. Your specimen was an adult bird, juveniles have yellow to grey feet, and look like the brown morph but with a rather paler head and neck than usual. The bill is not typical, it should be all blue-grey.'

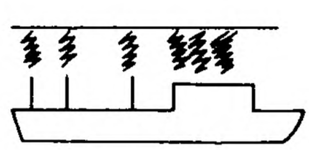
ABNORMAL REFRACTION

Mediterranean Sea

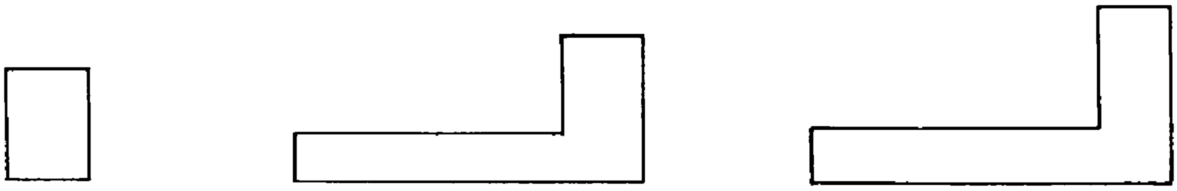
m.v. *Pacheco*. Captain D.A. Saunders. Gibraltar to Valletta. Observers: the Master, Mr P.G.H. Stapleton, Chief Officer, Mr D.J. Sweet, 2nd Officer, Mr M. Horswill, Chief Engineer Officer and Mr E. Lamb, 2nd Engineer Officer.

8 April 1989. At 1300 GMT whilst off the Algerian coast, it was noted that refraction was distorting the appearance of ships at a distance of 12 n.mile away. The effects seen are shown in the first sketch. At the time of this observation there was clear sky, the visibility was 16 n.mile and the dry-bulb temperature was 17.5 °C.





Later in the day, at 1730, refraction was again noted, but this time ships seemed to have elongated accommodation and one appeared as a cylinder, as shown. The sea horizon was also affected, producing a 'wave' effect.



Prominent tide rips were also seen by radar 4 n.mile ahead of the *Pacheco*, but when passing through the position, nothing was visible; there was no evidence of tide rips or pollution. However, a heat haze was observed all around the horizon. The dry-bulb temperature read 20.0° and the sea temperature throughout was about 16.0°.

Position of ship at 1300 GMT: 36° 40′N, 00° 23′E.

Note. Dr R. White, of the Institute for Research in Meteorological Optics, comments:

'The absence of any clear third (uppermost, erect) image in these observations suggests that the thermocline was fairly sharp here.

'Were the wave-like structures along the horizon manifest as differences of (1) sky colour or brightness, or (2) haze, mist or cloud? In case (1), it may be that refraction at an undulatory boundary between air masses of different densities is involved. Many meteorological conditions give rise to wave-like structures.

'Anomalous radar echoes are sometimes associated with refractive-index variation which also produces optical anomalies, and it seems possible that such, rather than tide rips, were involved here.

'Under mirage conditions, there is often a fairly sharp boundary between rays of light that have come direct to the observer from the upper, cleaner atmosphere and those from nearer the horizon that have been "diluted" a very long way through the dirtier atmosphere layers nearer the surface. This may have contributed to the observed heat haze here.'

INSECTS

Caribbean Sea

m.v. *Lincolnshire*. Captain R.A.F. Edwards. Loading, Point Lisas. Observers: the Master, Mr I.D. Howard, 3rd Officer and ship's company.

2 May 1989. At 1400 GMT while the vessel was loading a cargo of anhydrous ammonia, a swarm of bees descended on the ship. When first discovered, the swarm was about 7 cm in diameter and there were approximately 30 more individual bees lying on the deck about 10 m from the swarm, in an area of roughly 61 cm square. These remained on deck showing no activity until the vessel sailed later that day, but they were most definitely alive! During the course of the afternoon, the main swarm was growing, reaching 18–24 cm in diameter.

Shore personnel were informed, and the vessel was advised to leave the bees alone while someone was contacted to remove them. Attempts to obtain a sample were abandoned when a Trinidadian crew member mentioned that they might be African 'killer bees'! The bees were about 1 cm long and were similar to the honey bee found in the U.K.

In the event nobody arrived from ashore and the vessel sailed with the swarm on board. The swarm moved several times during unmooring, and in the night it must have left the ship.

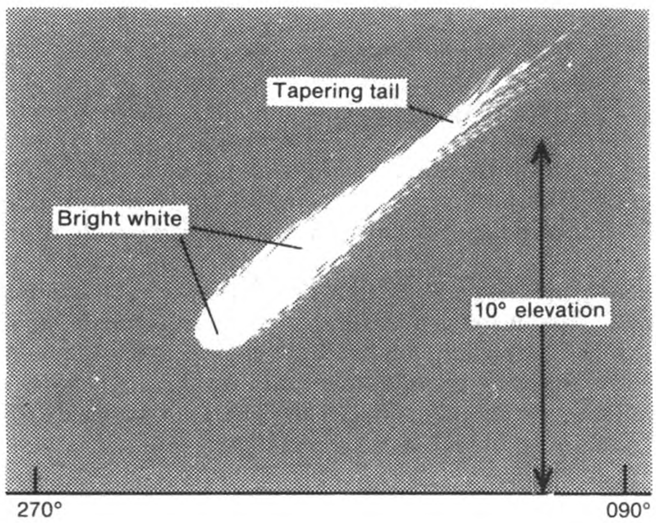
Position of ship: 10° 23′N, 61° 30′W.

METEORITE

Southern Indian Ocean

m.v. *Encounter Bay*. Captain B.V. Chipperfield. Suez to Fremantle. Observers: Mr G.R. Smith, 2nd Officer, Mr D.C. Collins-Williams, 3rd Officer, Mr D. Parnaby, 3rd Engineer Officer, and Messrs D. McLellan, D. Ewing and D. Walkling, ABs.

17 April 1989. At 0040 GMT a very bright, white light like a flare or firework was observed on the starboard quarter; it was at an altitude of about 10° and was visible for less than 1 second, see sketch. The object had a long, white tail which gradually tapered off into a 'shower of sparks', and was observed from both the bridge and the officers' bar, so it may have started at a higher altitude and been obscured by the accommodation structures.



At the time of the observation the wind was SE×S'ly, force 5 and the cloud cover was 1 okta of small cumulus.

Position of ship: 29° 48'S, 110° 40'E.

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

'The short duration of flight indicates that the object was a natural fireball. The sparks and tail were due to the material being very friable, or that the whole body consisted of a loose agglomeration of particles and could have been cometary in nature.'

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Noctilucent clouds*

By M. Gadsden
(Physics Unit, Aberdeen University)

Noctilucent clouds ('those silver-blue cloudlets') are the subject of a special long-term study of the Aurora Section. Regular visual observations, principally by members of the Section, have been made systematically over a period of at least 25 years. The data assembled by the Section are specially useful in current research. What noctilucent clouds are, how they are thought to occur, and what future research lines seem likely, are reviewed in this contribution.

NLCs

In what follows, it would be easy to alter the abbreviation 'NLC' to 'noctilucent clouds' wherever it occurred. However, the abbreviation is so commonly used in speech and writing throughout the research area that it would be needlessly pedantic[2] to insist on this.

What NLCs look like

Summer twilights in Scotland are long: for several weeks around the solstice, nautical twilight lasts all night. At Aberdeen, for example, astronomical twilight does not occur from the last week in May until the middle of July, bright twilight occurs with a centre of symmetry that moves during the night around the northern horizon from the northwest after sunset to the northeast just before sunrise. When the sun is θ degrees below the horizon, the upper atmosphere above the observer is sunlit above a height of H km; the value of H is given by the equation.

$$H = 6370\ (\sec\theta - 1)$$

The radius of the Earth is taken to be 6370 km; approximation of $\cos\theta$ for small angles will yield the even simpler approximation that the numerical value of H in kilometres is the square of the solar depression angle, θ, expressed in degrees. These simple relations take account neither of the refraction and absorption of sunlight as it passes obliquely through the lower atmosphere nor of the half-degree angular diameter of the Sun's disc but are, nevertheless, handy in estimating the heights at which the upper atmosphere is still in sunlight. With slant viewing towards the twilight arch, the bottom height is less than H; away from the twilight arch, it is greater. When θ is 6 (the end of Civil Twilight), H is 35 km; for $\theta = 12$ (the end of Nautical Twilight), H is 142 km.

The atmosphere above the tropopause (which is at a height varying from 8 km in polar regions to 18 km in the tropics, and generally higher in the summer than in the winter) is *dry* and clouds could be expected to be rare or nonexistent in the stratosphere and higher regions. In fact, there are nacreous (mother-of-pearl, iridescent) clouds seen typically during wintertime and occurring at heights[3] close to 25 km. In the summer, pale blue clouds that shine in the twilight sky occur and they have been shown to be at heights close to 82 km, where the pressure of the atmosphere is approximately 1 microbar (one one-hundred-thousandth of the pressure at sea level).

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The clouds are quite obvious to an observer; Figure 1 shows a print of a colour slide taken at Aberdeen University. In the foreground, there is a street light and there are two university buildings in the middle distance. Tropospheric clouds are backlit by the twilight and appear in silhouette. In the sky above them, there are luminous clouds clearly quite different from the lower, silhouetted, clouds; these are the NLCs.

This particular picture shows some structure in the NLCs and this is a common occurrence; indeed, it would be difficult to distinguish the clouds were they featureless. The second picture, Figure 2, shows clouds filling the twilight arch, again with some wave-like structure showing. On this particular occasion, the clouds showed a red upper edge. This indicates that the upper border is the edge of the illumination on the NLC layer and not necessarily the edge of the cloud sheet. Calculations[4] have shown that on this night the atmosphere to the north of Aberdeen was especially transparent and sunlight suffered remarkably little absorption low in the atmosphere before going on up to the upper atmosphere to light up the NLCs.

On occasions, the wave-like structure in NLCs is very noticeable and Figure 3 shows ripples breaking up the edge of the NLCs. Photographs such as this are valuable evidence for small-scale structure occurring in the upper atmosphere.

Geographical zones for observation

Experience shows that an observer has to be in the 'right place' to be able to observe NLCs. The scattering power of an NLC is rarely more than 10^5 to 10^4; that is to say, only 10 to 100 parts in a million of the incident sunlight is scattered. NLCs are optically thin. They cannot be seen from the ground in daytime and in the early stages of twilight. They are almost invariably a summertime phenomenon (in the Southern Hemisphere, the observing season is December to February) and the observer must be at a sufficiently *low* latitude for the summer twilight sky to become dark enough so that the NLCs have enough contrast to become visible. Experience and calculation show that, in practice, this means that observations should be made after the end of Civil Twilight. At the solstice, then, an observer at a latitude higher than 61 degrees is too close to the pole to see NLCs (although at the beginning and end of the observing season, the sky becomes dark enough).

Secondly, observations have shown that NLCs are a high-latitude phenomenon, rarely visible from equatorwards of 50°. It follows, therefore, that there is a range of latitudes, approximately 50–65°, in which an observer could see NLCs. This is shown (the cross-hatched bands) on the outline map in Figure 4, which also has an indication (the stippled areas) of the two auroral zones. Note what little land area there is for an observer in the Southern Hemisphere and that northwest Europe and the Soviet Union are the heavily populated areas for NLC observation.

History of the observation of NLCs

Although NLCs are very obvious to an observer at high mid-latitudes, there is no identified written record of their observation before 1884.[5] Probably the first published report of observations of NLCs is the letter from Leslie,[6] who wrote in 1884:

> ... in the early part of July this year... . The sky around and above where the sun had set, looking almost ceiling-like in its opacity, upon which soon appeared numbers of weird small cloud forms,

Figure 1. Noctilucent cloud display photographed from Aberdeen University, July 11/12 1974 at 00.21 UT.

Figure 2. Noctilucent cloud display photographed from Aberdeen University, July 23/24 1986 at 00.31 UT.

Figure 3. Noctilucent cloud display photographed from Aberdeen University, July 23/24 1986 at 02.16 UT.

Photographs by M. Gadsden

Photo. by Captain G.V. Mackie

O.W.S. *Cumulus* after dry-docking at Milford Haven, July 1989. (See page 57.)

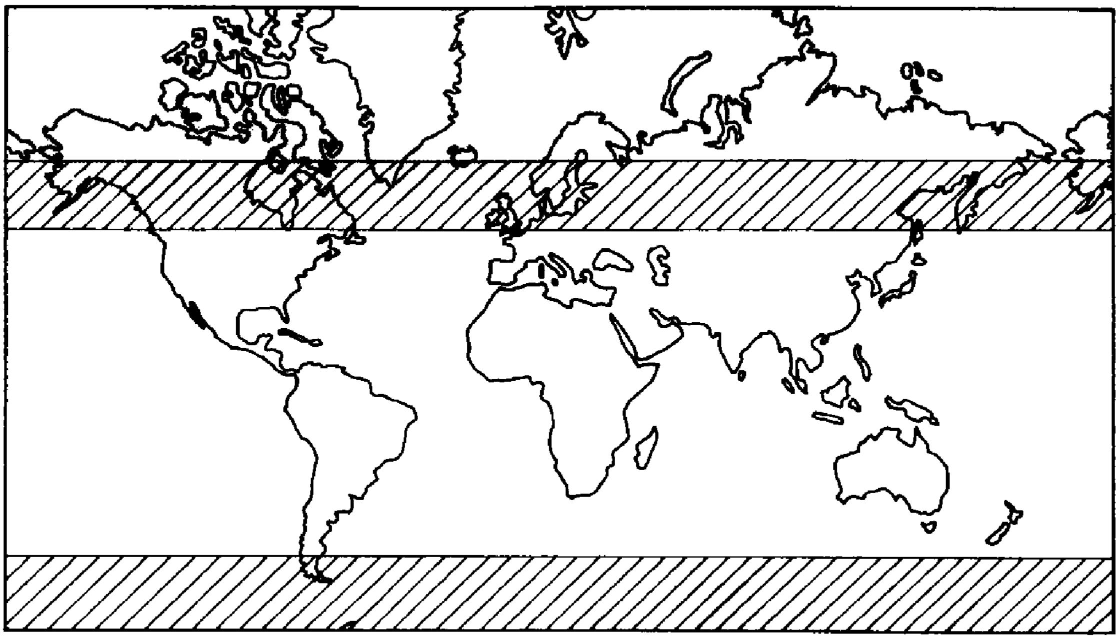

Figure 4. Outline map of the world to indicate the regions from which NLCs are easily observed (the cross-hatched area in the sketch). The stippled bands overlying the map indicate the two auroral zones.

at times very regular like ripple-marks in sand, or the bones of some great fish or saurian embedded on a slab of stone. Against these pale sunsets all buildings and trees told like black velvet, while the clouds would rest almost stationary for a long time ...

The eruption and explosion of Krakatoa on August 27 1883 had caused spectacular colours to be seen in twilight around the world and interest in twilight studies rose sharply. It is clear[7] that the spectacular twilights during the latter half of 1883 and which continued well into 1884 were the result of a heavy burden of dust in the stratosphere.

Otto Jesse, the great German astronomer, took the first photographs of NLCs in 1887 and in 1889–1896, a special photographic station was operated at Berlin-Grunewald under the direction of Friedrich Simon Archenhold.[8]

Photographic triangulation of NLCs was carried out in Germany from 1887 onwards and the results[9] showed that NLCs typically lay in a more-or-less horizontal layer close to a height of 82 km. Repeats of the triangulation over the last century, coupled with direct determinations using rocket-borne photometers penetrating a cloud layer, have not altered this general conclusion.

The first half of the twentieth century showed an increasing interest in NLCs, particularly by Soviet physicists (which continues to the present day). The International Geophysical Year, 1957–1958, emphasized polar studies and these involved auroral studies. James Paton, then Director of the Association's Aurora and Zodiacal Light Section, organized a very effective network of visual observers. By 1964 it was clear that these observers, particularly in Scotland where the bright nights ruled out auroral observation at the height of summer, were reporting NLCs in some numbers. Paton[10] arranged for the observations to be collected and published in a systematic manner and this collection and publication continues. After Paton's untimely death in 1973, the work was carried on by D.H. MacIntosh and M. Hallissey for several years and it is now ably carried forward by David Gavine.

At first, the clouds were assumed to be simply a layer of dust from Krakatoa that had penetrated to 82 km, but the persistence of NLCs throughout the century that has elapsed since the Krakatoa eruption has led to the current thinking that the clouds consist of *ice crystals*. They can be thought of as being rather similar to cirrostratus which owe their existence in the very low pressure, extremely dry, upper atmosphere to anomalously low temperatures occurring during the summertime at great altitudes.

The environment of NLCs

The physical quantities describing the atmosphere at 80 km are quickly summarized:

Pressure	1.4 Pa (14 microbar)
Temperature	165 K (−108 °C)
Mean Free Path	3.5mm
Water vapour mixing ratio	1.5×10^6

These quantities apply for a 'model' atmosphere at 60° N in July[11] but evidence from recent rocket measurements shows that, when NLCs are present, the temperature is much lower than that given. Some flights[12] have shown temperatures as low as 111 K (−162 °C).

The clouds form at heights where the atmosphere can be described as a dry partial vacuum. This means that the temperature for nucleation of water vapour to form ice crystals *has* to be exceedingly low. The frost-point for a water vapour pressure of a few tens of picobars is calculated to be approximately 120 K (−150 °C) and the very low temperatures measured under NLC conditions come as no surprise. It might be thought to be paradoxical that these low temperatures should occur during the summer: the explanation is that the atmosphere around 80–90 km absorbs little solar radiation and its temperature is set by dynamical changes in the atmosphere rather than by insolation. During the summer, there is a general pole-to-pole flow of air at these heights, with air rising over the summer pole and descending over the winter pole. Air, as it rises, cools and this leads to the summer coldness of this part of the atmosphere (and, vice versa, warmth in winter).

Clouds need something to condense on and it is an open question at the present time whether the condensation nuclei of NLCs are ions, formed through photoionization by solar ultraviolet radiation, or meteor 'smoke', the submicroscopic solid particles formed by condensation of meteoric material boiled off during ablation of meteors. In either case, there are plenty of potential nuclei and the sole prerequisite for cloud formation appears to be an atmospheric temperature below the frost-point.

Another consequence of the low partial pressure of water vapour is that the growth of a cloud particle is very slow; there are simply not enough water molecules available to allow quick growth. Calculation of the flux of water molecules striking an embryonic cloud particle show that the particle will take hours or a day to grow to an observable size. At these heights, measurement of the drift speeds of meteoric trains by radar show that there are strong winds blowing. The NLCs that are seen at latitudes of 55–60° almost certainly began to develop after nucleation at latitudes 75–85°. Satellite observations[13] have shown that there is an almost permanent layer of cloud near the pole during the summer. The clouds are known as PMCs (polar mesospheric clouds) and seem to consist of rather smaller particles than those present in NLCs.

The increase in numbers of NLCs

Analysis of the data gathered by the Association's Aurora Section has shown[14] that the frequency of occurrence of NLCs appears to be increasing over the last quarter-century. The data, brought up to date, are shown plotted in Figure 5, where the number of nights each year on which NLCs were reported to be present are plotted for the twenty-five years 1964 to 1988. Note that it is the number of *nights* that is plotted not the number of *reports*, which would reflect the number taking part year by year in the network of observers. Indeed, if the number of *regular* observers is considered (and by this is meant those who report throughout the season rather than just when there happens to be a spectacular display), the size of the network has remained remarkably steady over the period.

As well as the general increase in numbers of NLCs shown in Figure 5, there is a periodic rise and fall in the numbers. This seems to be associated[14] with sunspot numbers.

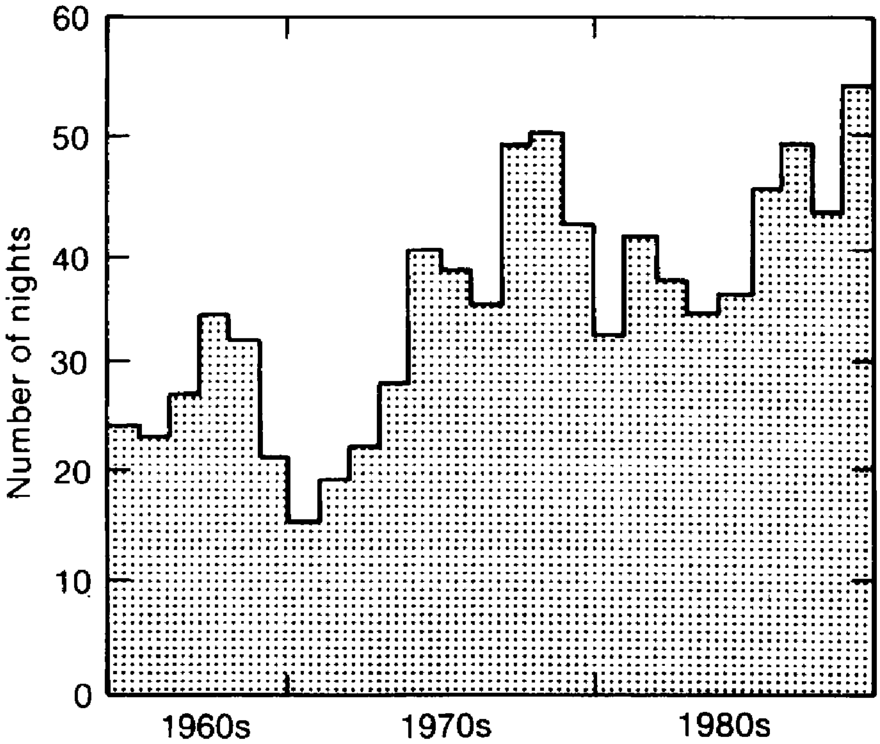

Figure 5. Plot of the number of nights on which NLCs have been reported by observers in northwestern Europe in each year from 1964 to 1988.

A recent paper[15] suggests that the increase in the amount of methane in the Earth's atmosphere by a factor of approximately two in the last century or so has caused an increase in the amount of water vapour in the upper atmosphere, which will lead to an increase in the brightness of NLCs. Because detection of NLCs from ground level is critically dependent on sufficient contrast of the NLCs in the twilight sky, it is argued that there will be a consequent increase in the frequency of observation of the NLCs.

It is not clear what will be the relative importance of changes in water vapour concentration in the upper atmosphere and changes in average temperature (with a drop in average temperature giving more frequent extremely low temperatures).

The rise and fall in frequency of occurrence with solar activity seems likely to be the result of corresponding changes in average temperature of the upper atmosphere. Furthermore, there is good evidence[14] for lunar tides having an effect on the frequency of occurrence of NLCs and this is very probably caused by small changes in temperature related to a small tidal oscillation.

Whatever the answer is, it seems possible that the upper atmosphere is responding to changes in the lower atmosphere, which may well be caused by human activities. It is likely that NLCs provide a sensitive indicator of changes in the upper atmosphere from whatever causes these occur.

The way ahead

In this brief review it will have become clear that the Association's work on NLCs has been of great value in studies of NLCs. With the current concern with environmental changes, the dedicated work of the observers has borne fruit and long may this continue.

Wave motions in the upper atmosphere show up through using NLCs as markers and therefore timed series of photographs of individual wave structures can give much information. The interval between successive pictures need be no less than 5 to 10 minutes. Time-lapse cine photography with one frame every few seconds gives very satisfying results; video recording does just as well.

With 200 ASA film, or a CCD camera, an exposure of four seconds at f/2 will usually give a satisfactory exposure. This has to be decreased, though, as the NLCs disappear into the brightening dawn twilight. Photographs taken of NLCs on the infrequent occasions when they are seen overhead are of special interest because they will show the pattern of waves in the cloud sheet without any ambiguities caused by slant viewing of an optically-thin sheet.

If pairs of photographs are taken at pre-arranged times from two well-separated places, they can be used to measure the height of NLCs using either the standard methods of auroral triangulation[16] or the consistency method of Hapgood, Taylor and Simmons.[17] These measurements can be specially useful because, in fact, there have been few height determinations made over the years, far too few to allow a study of systematic changes in height.

Finally, a co-operative venture between Aberdeen University and the Institute of Astrophysics and Atmospheric Physics in Tartu (Estonian SSR) has just been founded. This project is to place a photometer on board the Soviet Mir space station to measure the scattering of sunlight from NLCs in the forward direction. If all goes to plan, the photometer should be in orbit in three to four years.

Because of the need for a dark twilight sky, it is difficult at ground level to get measurements of the intensity of sunlight scattered through angles of less than 30°. From a spacecraft, NLCs are seen edge on above the limb of the Earth (on the horizon) and the clouds show an obvious brightening as the Sun approaches the limb from below the horizon. The brightening is rather more marked than would be expected if the cloud particles were only submicroscopic in size. If the photometer measurements confirm the presence of strong forward scatter, then NLCs must include some proportion of quite large particles and it is difficult to understand why this should be so with our current understanding of the formation and nature of NLCs.

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The Global Telecommunication System of the World Weather Watch

The fundamental purpose of the GTS is to provide the necessary telecommunication infrastructure for collecting, exchanging and distributing observational data and the processed products of Global Data-processing System centres with the required speed and reliability. The last update in *The Marine Observer* on this facility appeared in the October 1975 edition soon after a second revision of the original plan which was established in Geneva in 1967. The other two elements of the programme are the Global Observing System and the Global Data-processing System. The purpose of this article is to provide a technical update on the various aspects of the GTS.

The GTS has a three-tier structure: (a) the Main Telecommunication Network linking the World Met. Centres and certain Regional Telecommunication Hubs, (b) the Regional Met. Telecommunication Networks and (c) the National Met. Telecommunication Networks that are the responsibility of individual members.

NMTNs permit National Met. Centres to collect observations from fixed or mobile stations either directly or through, say, coastal stations or INMARSAT coast-Earth stations (for ship observations) or International Civil Aviation Organization collection centres for aircraft observations. Some 20,000 surface observations and 2,000 upper-air observations from fixed stations as well as 4,000 ship observations and the same number of aircraft reports are collected daily by NMCs and are retransmitted to the RTH with which they are associated via the RMTN. Additional observational information (such as satellite or radar data) is likewise inserted on the RMTN by certain centres. Finally, the RMTN carries selected regional broadcasts of observational data and processed products in order to meet Members'needs to the degree possible.

Plans for the RMTN provide for 259 circuits which should link 15 RTHs, five Regional Specialized Met. Centres not associated with RTHs, and 150 NMCs; 222 of these circuits have already been established. Twenty-one radio-teleprinter and 26 radio-facsimile broadcasts on the HF band are provided by RTHs; certain geostationary met. satellites relay transmissions of facsimile charts as well as satellite imagery.

Whereas all these means are used to exchange observational data and processed products at the regional level, it should be remembered that the capacity of NMCs to receive information available on the GTS varies greatly from one country to another. For example, 67 of the 259 circuits are of the telephone type, permitting the exchange of bulletins at speeds of over 1200 bit/s, and/or facsimile charts; most of these circuits are found in Europe and North and Central America. In other Regions data are mostly exchanged at slow speeds (generally 50 or 75 baud) and NMCs generally rely on HF broadcasts to receive GDPS centre products.

The MTN links together the RMTNs, thus ensuring a world-wide exchange of observational data and processed products. It is made up of 22 circuits linking the three WMCs and 15 RTHs and transmission speeds on 12 of these circuits are equal to or higher than 9,600 bit/s. Automation of the GTS centres is essential for the rapid exchange of traffic. Currently the WMCs, 29 RTHs or RSMCs and 35 NMCs are automated.

The features of the GTS are such that it is used to meet the data-exchange requirements of other programmes of WMO and of other international organizations. For example, agrometeorological, climatological, seismological data as well as data on trans-boundary fluxes of hazardous substances are, or can be exchanged over the GTS.

GTS operational techniques have evolved rapidly to meet the growing needs of the World Weather Watch. Starting with the telegraph speed of 50 baud (standard in the early days of WMO and still used on many regional circuits), many of the MTN circuits now permit transmission speeds of 9,600 or 19,200 bit/s. A rate of 64,000 bit/s is even envisaged for several sections of the MTN in the near future.

Back in the 1960s WMO had to develop its own communication procedures for medium-speed (1,200–2,400 bit/s) data transmission. The surge of new telecommunication and data-processing techniques now make it possible to use

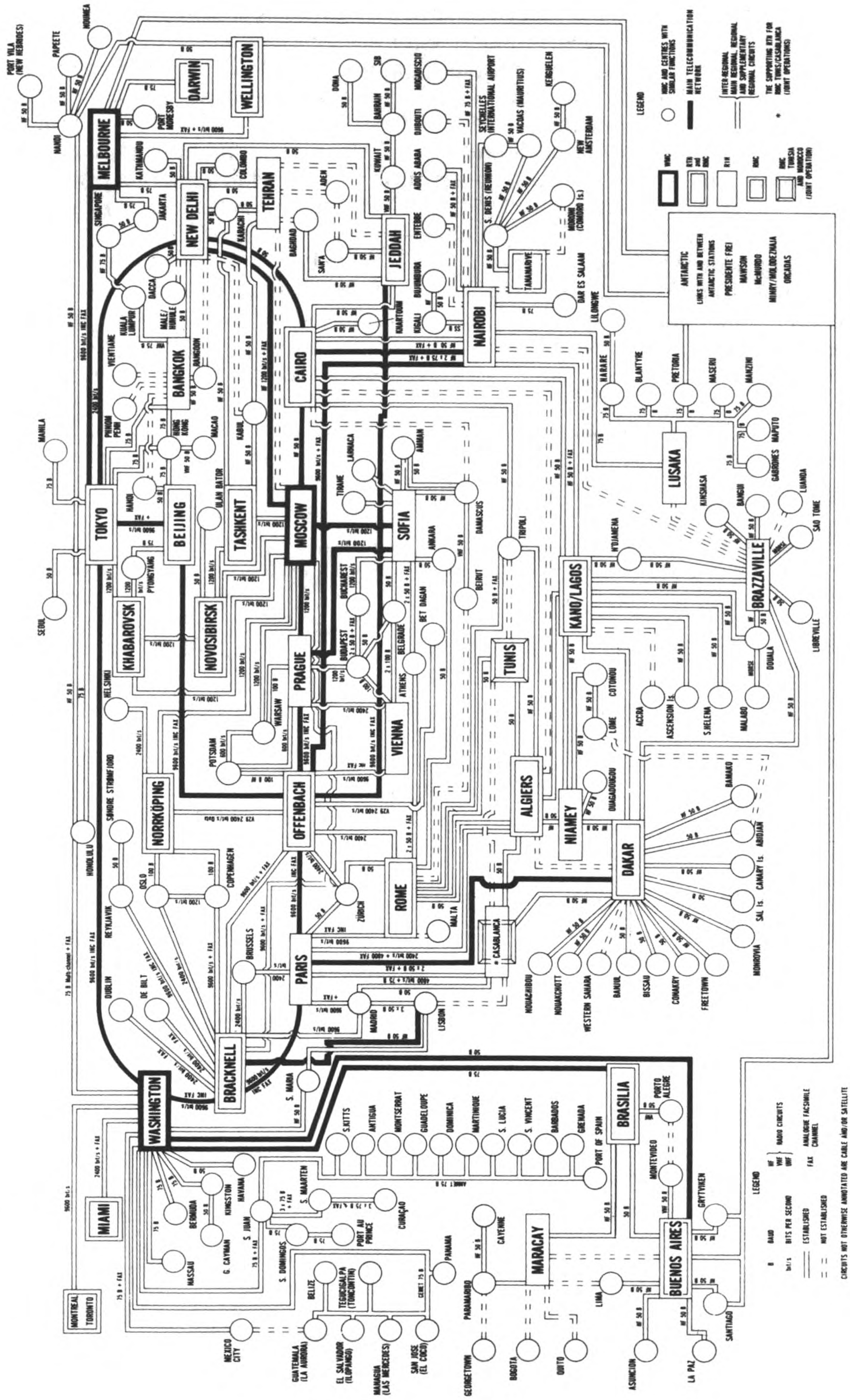

Figure 1. Plan of the Global Telecommunication System.

internationally standardized procedures and standardized, hence less expensive, hardware and software. The Commission for Basic Systems has already set about drawing maximum advantage from international standards in the field of data communication that have been developed for the Open Systems Interconnection architecture for upgrading the GTS and indeed the entire WWW. These methods and techniques used on the GTS and WWW will make it possible to handle an increased volume and diversity of observational data and products (especially in binary form), whilst guaranteeing WMO Members access to information according to their needs and possibilities.

Satellite telecommunication circuits have already had a big influence on the GTS since they permit links between countries at a cost that is almost independent of distance. Satellite data-collection and/or dissemination systems, either through met. or telecommunications spacecraft, already play an important role on the GTS, of which they constitute an essential component at the global, regional and national levels.

The Met. Office provides at its Bracknell Headquarters a RTH and other facilities which maintains it in the forefront of international co-operation in coping with the rapid growth of data-exchange requirements. A glance at Figure 1 will show the Bracknell RTH connected to one world centre, three other regional hubs and six national centres. Thanks to the efforts of all WMO Members, this reinforcement of the GTS gives every reason to believe that it will be able to meet the demand.

ABBREVIATIONS USED IN THIS PAPER

GDPS	Global Data Processing System
GTS	Global Telecommunication System
MTN	Main Telecommunication Network
NMC	National Meteorological Centre
NMTN	National Meteorological Telecommunication Network
RMTN	Regional Meteorological Telecommunication Network
RSMC	Regional Specialized Meteorological Centre
RTH	Regional Telecommunication Hub
WMC	World Meteorological Centre
WMO	World Meteorological Organization
WWW	World Weather Watch

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The *English Star* 'goes cuckoo'

The reefer *English Star* (9,900 grt) was *en route* to Bahia Moin from Savona on 4 March 1989 when it was visited by the bird shown opposite page 67 at 1800 GMT. The ship was in the Caribbean Sea at the time, about 100 n.mile north of the Colombian coast.

It flew around the ship, eventually coming to rest on the step outside the crew accommodation, and seemed to be enjoying the cool, air-conditioned draught blowing out of the small gap under the door. The unidentified bird was light brown in colour, with a dark-grey head, long tail feathers and very large, clawed feet (in relation to its body). For about an hour it sat quietly, but then began flying around the main deck once again, swooping low on several occasions seemingly to attack the crew. After 45 minutes it flew away.

The observers, who included Mr F.K. Robertson, 2nd Officer and Mr J.R. Benson, 3rd Officer, forwarded their report of the bird to the Met. Office at Bracknell, and the details were duly passed on to the Royal Naval Birdwatching Society so that an identification could be made. However, despite the excellent photograph, the RNBWS was unable to identify the bird with certainty, and so the report was sent off once again, this time to the British Museum (Natural History); after all, if the identity of the bird could not be found there, where could it?

At the museum, Peter Colston became very enthusiastic about the sighting and identified the *English Star*'s visitor as a Gray-capped Cuckoo (*Coccyzus landsbergi*). He said that the cuckoo normally occurred in northern South America and was obviously well off course to have over-flown the Colombian coastline by such a distance, making this an extraordinary sighting. The museum, he added, had only three skins of this comparatively scarce cuckoo in its collection.

The *English Star*'s observers are to be congratulated for their star 'tick', and we look forward to receiving more of the VOF's bird observations, uncommon or not, in the future.

SPECIAL LONG-SERVICE AWARDS

Last autumn the Chief Executive selected four shipmasters whose persistent dedication to the cause of shipboard weather observing up to the end of December 1988, made them worthy of special reward. Accordingly, the following will be presented with barographs inscribed with their names and observing period:

CAPTAIN P.J. CLARK, P. & O. Containers Ltd
CAPTAIN S.J. LAWRENCE, British Antarctic Survey
CAPTAIN P.J.R. MANSON, P. & O. Containers Ltd
CAPTAIN C.O. THOMAS, Bibby Bros Management Ltd

To be nominated for a barograph award, meteorological records must have been received by the Met. Office in at least 18 separate years, including the year in question, in this case 1988. These special awards have been made annually since their introduction by the Director of the Met. Office in 1948.

All four Masters continue to contribute to our knowledge of climate around the world by their co-operative meteorological efforts, but up to 31 December 1988 their respective contributions were as follows.

Captain Clark has served the whole of his sea time in the P. & O. Group and sent us his first meteorological logbook from the P. & O. S.N. Company liner *Strathaird* in 1954. In 22 observing years since then he has provided a total of 52 logs with an Excellent marking assigned to 30 of these, and he has received Excellent Awards on eight occasions. He transferred to Container Fleets (Overseas Containers Ltd) in 1970 and has served as Master of *Cardigan Bay* since 1984.

Captain Lawrence's first met. log came from the *Beaverpine* of Canadian Pacific in 1964 and this was followed by a further 37 logs spread over 20 observing years. Since the receipt of his first log after joining BAS in 1971, all but six of the remainder have been marked Excellent, making 29 in this category in all, mainly from his command *Bransfield* since 1972. Excellent Awards have been sent to Captain Lawrence on 14 occasions.

Captain Manson started the sea life in the Union Castle Company, sending us his first met. log in 1963 from *Transvaal Castle*. In 23 years of supplying weather data he has provided a total of 47 logs, of which 24 were classed as Excellent. Awards for this excellence have been made for five of the years in question. Captain Manson's first log from Overseas Containers reached this office from *Botany Bay* in 1971 and his most recent command from which logs have been received is *Strathbrora*.

Captain Thomas first provided a met. log from Bristol City Lines' *Gloucester City*, this log being received in 1965. A further 55 logs followed during 23 years when associated observing took place, and 'Excellent' was the verdict on assessment in 31 cases. The *Dart Atlantic* was the first Bibby-owned ship from which Captain Thomas sent a log, in 1972, and his most recent contribution came from *Staffordshire*. He also received seven Excellent Awards.

The award ceremony is expected to take place this spring, on a date mutually suitable to as many of the participants as can be arranged.

AURORA NOTES APRIL TO JUNE 1989

By R.J. Livesey

(Director of the Aurora Section, British Astronomical Association)

Table 1 lists the observations received to date from mariners. Table 2 lists the principal periods of auroral activity as determined from land and marine observations. All work of the auroral observers is voluntary, including the contributions from ships' officers and meteorologists who, like everybody else, undertake the observing and recording as an addition to their normal professional or daily routines. To all, many thanks.

The sun continues to be very active and there is evidence to suggest that this sunspot cycle could be the most active of all since regular records were begun in

Table 1 — Marine Aurora Observations April to June 1989

Date	Ship	Geographic Position	Time (GMT)	Forms in Sequence
1/2 Apr. ..	*Cumulus*	56° 50′N, 19° 46′W	0230	N
1/2 ..	*Bransfield*	67° 40′S, 68° 10′W	0240–0340	G
2/3 ..	*Cumulus*	56° 51′N, 19° 46′W	0030	N
2/3 ..	*Bransfield*	67° 40′S, 68° 10′W	0030–0300	G
2/3 ..	*Ironbridge*	49° 23′N, 64° 50′W	0100	RR
3/4 ..	*Bransfield*	67° 40′S, 68° 10′W	0000–0400	HA.G.mP.RR. RV.RR
5/6 ..	*Bransfield*	67° 40′S, 68° 10′W	0130–0320	G.RR.qA.G
7/8 ..	*Cumulus*	57° 07′N, 19° 41′N	2300	N
9/10 ..	*Bransfield*	67° 40′S, 69° 10′W	0230–0445	G
11/12 ..	*ACT 7*	45° 00′S, 91° 31′E	1530–1700	G
13/14 ..	*ACT 7*	43° 04′S, 114° 14′E	1730–2030	G.RR.pRR
22/23 ..	*Alliance*	64° 00′N, 01° 20′W	0008–0035	$aR_1R.aR_2R.aRR$
25/26 ..	*Alliance*	60° 08′N, 06° 30′W	2306–0145	$qHCRR.pHCR_2R.$ $qHRB.pCRR.$ $R_3R.p_2RB$
25/26 ..	*Cumulus*	56° 57′N, 20° 10′W	0030–0330	RR.qN
25/26 ..	*Corystes*	52° 38′N, 02° 16′E	0010	RV
26/27 ..	*Cumulus*	56° 54′N, 20° 09′W	2340–0330	maRR.P.qN
26/27 ..	*Alliance*	60° 48′N, 06° 30′W	2308–0238	$qRR.aRB.$ $apCRR.aRB.$ $p_2CRB.$ $p_2CR_2R.p_2G.$ HG
26/27 ..	*Baltic Link*	54° 31′N, 00° 30′W	2335–2345	RA.G.Short duration. Half-sky.
27/28 ..	*Cumulus*	56° 46′N, 20° 11′W	2320	qN
27/28 ..	*Alliance*	62° 00′N, 08° 00′W	0000–0149	$ap_2RB.p_2BG.$ $HG.qHB.p_2B.$ Half-sky
28/29 ..	*Cumulus*	56° 50′N, 20° 00′W	0040	qN
4/5 May ..	*Cumulus*	56° 14′N, 13° 08′W	2340–0115	qN
5/6 ..	*Cumulus*	56° 55′N, 19° 41′W	0000–0045	qN

KEY: a = active, m = multiple, p = pulsating, p_2 = flaming upwards, q = quiet, A = arc, B = band, C = coronal, G = glow, H = homogeneous, N = unspecified form, P = patch, RA = rayed arc, RB = rayed band, RR = ray structure, R_1R = short rays, R_2R = medium rays, R_3R = long rays, RV = rayed veil.

the early nineteenth century. Table 2 shows that magnetic and auroral storms were experienced at the beginning and end of April, at the beginning of May and in June. As the summer twilight blotted out the visibility of the aurora in north-west Europe in June, it was visible only to our correspondents in Canada and the U.S.A.

The bright aurora of 25/26 April was seen as far south as Cardiff and was overhead with coronal structures over the Forth Estuary and also at Winnipeg in Canada. Dr Gavine assessed it as the brightest aurora that he had seen for some twenty years.

A feature of the aurorae since the great aurora of 13/14 March has been the sharpness of form and brightness at the peaks of the storms. Many photographs have captured red glows, veils and strong individual rays. Michael Murphy in

Table 2 — Auroral reports received April to June 1989

Date	Time (GMT)	Number of Observers	Magnetic Index	Location and Activity of Aurorae*
1/2 Apr.	2121–0340	7	120	Scotland (5), Finland (6)
2/3	2100–0300	6	89	Scotland (1), Finland (6)
3/4	2100–0400	14	93	Winnipeg (6), Dakota (4), Scotland (2) Finland (6)
4/5	2130–1041	10	109	Winnipeg (6), Dakota (3), Scotland (3), Finland (6)
5/6	Unconfirmed	3	102	Finland (5)
6/7	2211–2214	3	83	Scotland (1), Finland(4)
7/8	2220–0310	4	61	Dakota (3), Scotland (5)
8/9	0100–0120	1	62	North Scotland (2)
10/11	2149–2347	1	37	Orkney (1)
12/13	Unconfirmed	1	37	Dakota (1)
14/15	2115–0542	5	68	Winnipeg (6), Dakota (5), Scotland (5)
16/17	2155–0003	2	57	Scotland (3), Finland (6)
17/18	Unconfirmed	1	40	Finland (4)
22/23	0008–0035	1	26	Shetland (5)
23/24	2140–0050	2	27	Scotland (2)
24/25	2155–0145	5	54	Scotland (4)
25/26	2110–0443	25	118	Winnipeg (6), United Kingdom (6), Finland (6)
26/27	2320–0340	7	159	Winnipeg (1), Shetland (6), Scotland (5), Eire (4)
27/28	2330–0432	9	164	Winnipeg (6), Eire (5), Scotland (5), Shetland (6)
28/29	0040	2	116	Dakota (5), Scotland (1)
29/30	0049–0147	2	84	Dakota (1), Orkney (1)
1/2 May	0310	1	45	Winnipeg (5)
2/3	0030	1	40	North Scotland (1)
3/4	2340	1	50	North Scotland (1)
4/5	2340–0140	5	76	Dakota (5), Scotland (5)
5/6	0000–0304	4	78	Winnipeg (5), Dakota (4) Scotland (1)
6/7	Unconfirmed	1	104	North Dakota-Glen Ullin (5)
22/23	Unconfirmed	1	67	North Dakota-Glen Ullin (4)
24/25	Unconfirmed	1	139	North Dakota-Glen Ullin (5)
26/27	0626	2	57	Winnipeg (5), Dakota (5)
31 May/ 1 June	Unconfirmed	1	33	North Dakota-Glen Ullin (1)
1/2	0818–0849	1	43	North Dakota-Glen Ullin (5)
2/3	Unconfirmed	1	44	Winnipeg (6)
6/7	Unconfirmed	1	52	North Dakota-Glen Ullin (5)
7/8	Unconfirmed	2	68	Winnipeg (5), Dakota (3)
9/10	0357–0806	2	135	Winnipeg (5), Dakota (5)
13/14	0357–0806	2	78	Winnipeg (6), Dakota (4)
14/15	Unconfirmed	1	103	North Dakota (5)
21/22	Unconfirmed	1	37	Nova Scotia (2)
28/29	Unconfirmed	1	26	North Dakota (4)
29/30	Unconfirmed	1	30	North Dakota (4)

* Storm activity code: 1 = glow or patch, 2 = homogeneous arc or band, 3 = rayed arc or band, 4 = ray bundles, 5 = active moving or flaming storm, 6 = coronal or half-sky, 7 = all-sky storm.

Note. The magnetic index is the sum of the index A_p for the day before, the day of the start and the day of the finish of the aurora.

County Clare, Republic of Ireland, managed to photograph a bright-white veil of rays resembling a silver curtain in the heavens. No such similar photograph has been seen in recent years although observers have reported seeing white rays from time to time.

Summer in the Northern Hemisphere is the time to observe noctilucent clouds (NLC) from May until August. Dr Gavine reports an active summer with many apparitions of these clouds. After due allowance for the sunspot cycle, Dr Gadsden, of Aberdeen University reports that they are still on the increase. One wonders if these clouds are in any way related to the greenhouse effect. Be that as it may, the observation of NLC is currently of more scientific importance than observing aurora, and it is very fortunate that an aurora observing network is ideal for looking for NLC. There is a demand for observations from our records by research groups in the U.K., Estonia, the U.S.S.R., U.S.A. and South America.

One of the factors related to the state of the upper atmosphere has been the question as to whether or not the aurora and NLC can co-exist in the same sky in view of the fact that auroral activity heats up the atmosphere and might prevent the cold conditions necessary for NLC to form. From time to time we have received photographs showing NLC in the Canadian skies with small, and inconsequential auroral activity in the background. This summer we have received from Mark Zalcik, of Edmonton, Alberta, a magnificent photograph showing both NLC and a strong, rayed arc.

The Geomagnetism Unit of the British Geological Survey, Edinburgh, forecast a magnetic and auroral storm for 17 June and this was repeated on BBC Television CEEFAX. Auroral observers were alerted and magnetometers watched in anticipation. Precisely nothing happened. In fact, following upon a magnetic storm on June 14th and 15th, the field activity fell to zero at 0000 GMT on the 17th, and after some sporadic low-level field activity, slowly rose through the 19th to stormy conditions on the 20th.

The forecasting of auroral storms can be attempted in several ways. One method is to track undisturbed regions on the sun that could lead to outpourings of particles and associated magnetic fields, whose trajectories could meet up with the Earth. If the trajectory is wrong, then the activity can bypass the Earth and nothing happens. Another method is to examine the auroral and magnetic records and look for potentially recurrent activity one solar rotation, that is to say, 27 days, further on. NOAA, at Boulder, Colorado, issue on a weekly basis, forecasts for the following 28 days relating to expected solar activity and the consequential disturbances to the Earth's magnetic field and from which radio, prospectors using magnetic equipment, electrical transmission systems, pipeline operators and other technological systems may deduce if their equipment is likely to be disturbed by solar activity. Forecasts are issued by mail, teleprinter and other communications systems. On radio station WWV on 2.5, 5, 10, 15 and 20 megahertz a 40-second message is broadcast at 18 minutes past each hour, giving solar and geophysical activity for the most recent twenty-four hours and for the next 24, updated every three hours. A typical Bartels Diagram is given in Figure 1.

Land-based auroral observers construct simple magnetometers or listen in for radio aurora effects as early warning systems of impending auroral activity. Magnetic effects can be detected to the equatorward side and beyond the horizon of the visible aurora. Furthermore, radio aurora effects can be strongly detected with no visible aurora present, which appears as the radio aurora ceases, and disappears as radio aurora effects are again heard.

Advance forecasting of an impending aurora, like forecasting good weather for a local cricket match, can be fraught with uncertainty. However, if there is an important storm that extends equatorwards, for example, to be visible overhead

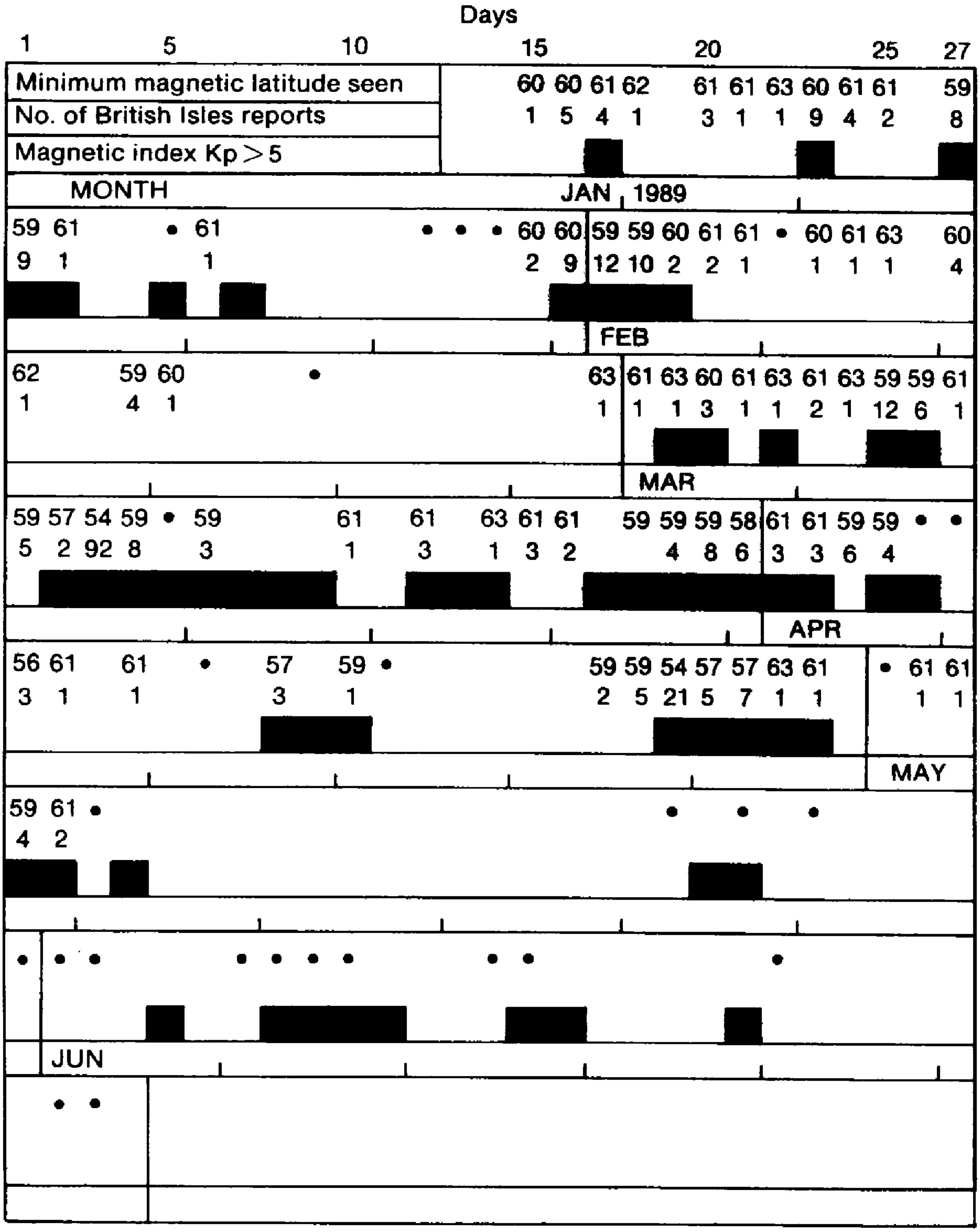

Figure 1. Bartels Diagram showing the relationship between minimum geomagnetic latitude at which aurora was seen in the British Isles sector only, the number of observers and magnetic activity. January to June 1989. (The symbol * denotes that aurora was active somewhere in the sub-auroral zone.)

in the English Channel, or seen in the Bahamas or Caribbean or in Australia, then there is a good chance that there will be auroral activity for the following night or so but at progressively higher latitudes as the energy stored in the Earth's magnetic field by the causative solar event is gradually dissipated.

Forecast or not, the aurora is full of surprises to the sky watcher who can be caught unexpectedly with a magnificent show. It is also advisable to look towards the equator as well as the pole, as do the observers in the higher latitudes because the storm aurora may have swept over the observer and extended towards the equator from his position. This has been a feature of the recent aurorae reported from north Scotland. The aurora will remain active throughout 1989 and into 1990 so that we should see a number of good displays in the months to come.

LETTERS TO THE EDITOR

Current by Computer

Some time ago I mentioned to a Port Met. Officer that the Met. Office might receive a few more current observations if only set and drift were a little more quickly and easily calculated. I suggested a simple computer program but, it was pointed out, that such items are costly to produce commercially.

I enclose a disk containing the BASIC file for such a program,for your inspection. I hasten to add that this program is free for use or conversion/copying by anyone to whom it may prove useful, and I attach no copyright. Also that I have tested the program and found it accurate so far but please perform your own checks.

I agree to the listing being published in *The Marine Observer* for copying by readers if they wish, and I have also forwarded a copy to Captain Cole, Chairman of the Nautical Institute Information Technology Working Group.

Mr R.O. Jolliffe, Third Officer, *Direct Kookaburra*, P. & O. Containers Ltd.

Miss Margaret Finch, Scientific Officer in our Marine Enquiries section responsible for updating ocean current data from ship's met. log records, ran through the program initially. We explained to her the normal calculation methods used on board ship to obtain set and drift using times, positions, courses and distances run by log. She suggested a few small changes to the program which would make it easier for users to run it on their PCs without having to re-run the program from the beginning in cases where invalid data were keyed. After we sent a listing of the proposed amended version to Mr Jolliffe he kindly suggested one or two further amendments which were duly added.

Space limitations deter us from printing the program listing but interested PC users are invited to send to the Editor their own 3″ or 5¼″ disks and we will arrange for the current program to be copied to their disks.

Our grateful thanks to Mr Jolliffe for his initiative in supplying a copy of his excellent current program, and of course for giving us the benefit of his experience in all aspects of marine observing.

Leeway Allowances

In making ocean current observations I often have difficulty deciding what speed is to be used for DR run between *from* and *to* positions. As expected, it is not always calm and there is usually some slight weather in force.

From page 63 of the *Marine Observer's Handbook*, lines 27 to 29, I gather it is suggested to make allowance for slip under prevailing conditions, but I find it vague. Without a set code allowance of frictional resistance made for engine speed it is certain that variable results will be achieved. For DR plot, if the observer makes use of engine speed derived in direct relation to RPM and course steered without allowing for leeway, it would be useful if there was an additional column in the log for average wind force experienced in relation to ship's head, (ahead, on the bow, abeam, on the quarter or astern). These could be logged using a conventional ship's plan profile with an arrow and figure to indicate wind direction and Beaufort force.

I think the above method would be more useful for experts to arrive at concrete results, bearing in mind the limitations in experimental endeavour. As there is already a column for ship's draught it can also be accounted for. If the above is not suitable, then for the observer to make allowance for frictional resistance for various tangibles, there may be a table from which the observer could make due allowance for ship speed over engine speed against slip.

From reading the sections on ocean currents in the *Marine Observer's Guide* [7th edition, pages 2–14], and the *Marine Observer's Handbook* [pages 62 to 64], I got a feeling that they hinder rather than encourage the observer to keep records, because more rhetoric is placed on leaving the spaces blank than to make an observation.

As the met. log acknowledgement letter always seems to contain a remark about the need for ocean current reports, I was at first inspired then stumbled; engine speed from RPM is used in obs. in this ship's log without allowing for leeway etc. Looking forward for your good advice and trust this is in order.

Salem Sekandar, Principal Observing Officer, *Humanist*, Ocean Tramping Company.

To reply fully to Mr Sekandar's interesting proposition, it might be helpful to review briefly the history of ocean current observations on voluntary observing ships.

The earliest document on the subject found in the Met. Office Archives is official Meteorological Committee Form No. 12, price 2s. 6d. Published in 1872 under the title *Currents and Surface Temperatures of the North Atlantic Ocean, with a General Current Chart*; the materials were collected and discussed under the direction of Admiral FitzRoy, the first head of the Meteorological Department of the Board of Trade. Current records collected on board observing ships were recorded in the general section of their registers from 1854 onwards. They were entered for their True (not Magnetic) directions with the rate of current per day given in nautical miles. It was not until 1921 that a separate column for current entries was provided in the ship's met. log; the present comprehensive format was introduced on the resumption of observing practices after the Second World War, in 1946.

An experiment was made in the 1960s when columns for course steered, leeway and course through the water were added to the current records section. This experiment was short-lived because most observers declined to make use of these special columns, preferring to make their own estimates of leeway based on the many variables which make up this element. The extra data also caused difficulties with keying into the Met. Office data base.

The majority of ships' observers include the leeway allowance as a matter of course before entry into the log, taking into account the ship's loaded condition and the prevailing weather. It would not be practicable to make up a table embracing all the elements which affect each individual ship's behaviour under the wide range of potential weather conditions.

Thus the present format has stood the test of time although under scrutiny by the International Hydrographic Bureau with a view to international standardisation. We ask Mr Sekandar to continue his valuable assistance with the ocean current records whenever practicable and away from coastal and tidal effects.

Phosphorescence Fallacies

Reference *The Marine Observer*, Vol. 59, No. 305, July 1989, Bioluminescence, Arabian Sea [pages 121–122].

Those spoked wheels are circular vessels from the city below the Pacific and in Arabian Seas. This city lies below the Pacific, 4000 km from Peru's coastline. This is printed in a map and manuscript, proved genuine by the expert in Atlantis, dr.Brulet of the International Council for the Exploration of the Sea, Paris and Monte Carlo.

The king and queen left the sinking ark of Atlantis for their new home below three bubbles on the bottom of the sea. Those vehicles proved circular, and are the source of those lights in Pacific, Atlantic and Arabian Seas.

The term *bioluminescence* is false and only to stop publicity, even if hundreds of ships have reported those in the sea, and in 68 years low flying over those ships, circular, and in a flood of lights [sic].

Those submarines can fly in space, and were extra-terrestrial originally, but now cleaning the seas of pollution. The other submarines, seen rarely, have been sighted in Karlskrona bases in Sweden, deeply in harbours, testing the marine defences, and not Russian submarines as reported by those journalists who always tell the public what they like.

Now the wheels have been seen again, and a new observer logged the incident, viz. *Fort Assiniboine*, Captain P.H. Hill etc.

Peer Olaf Hedbak, Gentofte, Denmark

The fact that this letter (original available for inspection on request) is published at the beginning of April is purely coincidental. No comment from Dr Peter Herring of I.O.S.D.L.

Personalities

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

RETIREMENT — CAPTAIN J.M. JOHNSTON advised us recently of his retirement to his home on the Gold Coast, Queensland, Australia, on 1 June 1988.

'Ian' Johnston started his 44 years at sea with Paddy Henderson's of Glasgow in 1944, later joining Elder Dempster and Ocean of Liverpool. He later joined Overseas Containers, in 1979, and spent his last nine sea years in command of *Tokyo Bay*. He was in command for a total of 30 years, serving on 39 British ships as Master. He provided the first of 38 met. logs from *Salween* in January 1959, 11 of these logs being classed as Excellent. He gained Excellent Awards in 1981, 1984 and 1988.

Captain Johnston says that after chasing up his officers to keep the met. work going over many years, old habits die hard and he now maintains his own small station. He had experienced 52 mm of rain in 12 hours at the time of writing, but he missed the constant variability of British weather as he had recently had two months of continuous sunshine.

We wish him happiness and good fortune in retirement and in his stated aim of obtaining his Commercial Pilot's Licence, to add to his Flight Crew Pilot's Licence, this being his method of retaining an active interest in life although he does not expect to do much command-time flying.

Our thanks to Captain Johnston for his kind words about all the help received from the Met. Office during an interesting part of his life filling in meteorological logbooks.

Book Reviews

Oceans of Birds by Tony Soper. 200 mm × 250 mm, 208 pp., *illus.* David & Charles, Brunel House, Newton Abbot, Devon TQ12 4PU. Price: £12.95.

In this charming and original book, Tony Soper seeks to provide a simple introduction to some of the possibilities of seabird-watching on the oceans. It is not intended to be an identification manual but in it the well-known author, naturalist and broadcaster has tried to instill an interest in seabird observation in passengers and crew of cruising ships.

Mr Soper acted as a sort of 'birdwatchers' nanny', as he describes his involvement, often on P. & O.'s cruise liner *Canberra*, but also nearer home on the Tamar estuary on Plymouth Sound, and in the smaller cruise ventures, such as *Lindblad Explorer* with a mere one hundred enthusiastic American birders, cruising the Indian Ocean for instance. His infectious enthusiasm for his subject stands out on every page, and it is hard to imagine any one with the slightest interest not being caught up in his aims to spot as many birds as possible on the voyage, be it a two-week Mediterranean trip or a round-the-world cruise of several months.

The book contains a surprisingly large number of original photographs of both sea- and land-birds, many by Tony Soper himself, in both colour and black-and-white, many of them in his company and that of other humans whose delight at such close contact is obvious. Added to these are the sympathetic illustrations by Michael Loates on almost every page, and it is no wonder that this artist is numbered amongst the world's top-flight wildlife illustrators.

For every port or sanctuary visited there is a short list of the birds seen, as well as a full listing of the different species of pelagic birds spotted, from the magnificent albatrosses to the little auks. Sightings of dolphins and land-birds are occasionally included, and the Panama Canal passage is particularly well documented. The only small error occurs in this chapter where the caption to a fine photograph of the *Canberra* entering one of the Canal locks, the ship seemingly much too broad to enter the cut below, states it is the Gatun lock whereas it is in fact the Pedro Miguel locks, proceeding south, as can be confirmed on inspection of the canal profile shown on the next page.

The voyages undertaken were from Southampton to the Panama Canal via the Canaries and Caribbean islands; across the North Pacific to Hawaii then calling at tropical Pacific islands, Australasia, the China Sea and Singapore; thence via Colombo across the Indian Ocean and through the Red Sea and Mediterranean to return home. Another cruise included passages from Rio via Montevideo to the Falklands and Graham Land in the Antarctic, returning via the west coast of Chile to Santiago (or perhaps Valparaiso intended?). A voyage across the North Sea to the Norwegian and Barents Seas is documented, and finally a cruise from Vancouver to the lengthy Alaskan coastline is covered. All these routes are depicted on a world map, and there are also plans showing bird migration routes.

In all there are twelve chapters and eight appendices, including an index, in this comprehensive guide. Included are a short bird First-Aid section and contact details of a dozen wildlife cruise operators. Some field guides and seabird books are also recommended, helpfully catalogued geographically in the sense of location of the wildlife. Assistance and simple guidance are Tony Soper's watchwords in this encouraging work which cannot help but become popular with all who go down to the sea in ships and watch birds.

J.F.T.H.

How to Write and Publish a Scientific Paper, by Robert A. Day. 149 mm × 228 mm, xi + 211 pp. Cambridge University Press, Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU. Price: £7.95.

This book was first published in America in 1979, and now, in its third edition, is longer by four chapters and a glossary of technical terms. It provides useful guidelines for scientific writers, whether they are 'old hands' or new to the task, but anyone needing to write something longer than a letter would find it a great help.

The author has based his text on the product of thirty years of experience in publishing and as a teacher, and has produced straightforward advice on 'how to' present a scientific paper, breaking it down into component parts and taking each in turn; from preparing a title to citing references, designing tables to writing introductions. There is also information on submitting manuscripts, dealing with editors and an insight into the publishing procedures involved in getting work into print.

The text gives no actual rules to follow, so the prospective author can choose how far he wishes to be guided, but it should perhaps be mentioned that the book was originally written for the American market and it could be that methods employed there are not universal outside the country. For example, in chapter 18, on the subject of The Publishing Process, authors in the United Kingdom could find themselves mislead by the information given on marking proofs for correction. The system illustrated was largely superseded in the United Kingdom in 1976 by new marks introduced by the British Standards Institution.

This apart, the advice given is extremely valuable to prospective authors, and is presented in a light-hearted style punctuated with cartoon illustrations and (deliberate) grammatical and printing 'howlers' which ensure the user's attention and prevents entanglement in technicalities. The book's 'how to' chapter on reviews was borne in mind during the writing of these lines, and it is hoped that the advice given has proved effective!

J.M.

Shiphandling for the Mariner by Daniel H. MacElrevey. 160 mm × 235 mm, 301 pp., *illus.* Cornell Maritime Press, P.O. Box 456, Centreville, MD 21617, U.S.A. Price: $20.00.

Following the success enjoyed by the author's first edition of this book, published in 1983, this second edition incorporates several changes in response to comments from pilots and practising Masters. In fact, the author is at great pains to acknowledge the considerable contributions from professionals in the marine industry, much of it handed down through time. However, Daniel MacElrevey must take credit for a very lucid presentation, amply supported by first class photographs, diagrams and some very amusing cartoons by Earl McMillin.

The text is divided into twelve chapters, starting with arrival and ranging through channel work, use of tugs, berthing, departure, anchoring, special manoeuvres and training in all its aspects. There is a new section containing practice maneuvers (to use the American spelling) and review questions which will help Mates and Masters gain 'hands-on' experience in handling ships.The practical exercises can be used with the book as a shipboard course in shiphandling, self-taught, or, better still, they can be part of a formal maritime school or simulator program.

Although the author modestly states that no single volume can cover all conditions that will be encountered by the mariner when handling a ship, nor can any single technique be agreed upon by all professionals as the 'best way' to do a job, shiphandling is a learned art and it is only possible to give a background upon which to build the necessary skills. Captain MacElrevey must be considered very well qualified to produce such a technical work, having alternated between Panama Canal pilotage and consulting, training and providing shiphandling services to the marine industry, since moving from his home on the Delaware River to Panama in 1970. He covers all the relevant aspects of the skills involved in handling ships quite clearly and simply, and no fault can be found with his theories. The book is long and comprehensive enough to be used as a permanent reference and teaching aid before and during practical work.

The tug work is, naturally, based on the North American practice of having the tug lashed up close under bow or stern, using its head and stern lines, but the author stresses the importance of using the tug only when the ship's own shiphandling tools will not by themselves accomplish the task in hand.It has always seemed a much more practical method than the long tow lines favoured in most European ports, except when narrow locks make the latter the only possible method open to a pilot.

This work certainly covers a very wide range of shiphandling problems, but conning a ship in heavy seas in mid ocean is not included. Apart from this omission there is no hesitation in recommending this book to practising seamen and students aspiring to this satisfying but sometimes difficult art.

J.F.T.H.

Notices to Marine Observers

RETIREMENT OF CANADIAN PORT MET. OFFICER

We have heard from Mr G.E. Payment, Marine Meteorological Officer of the Canadian Weather Services Directorate, Downsview, Ontario, of the retirement of Mr G.T. Meek, Port Met. Officer Toronto for 21 years.

Geoffrey Meek began his career with the British Royal Naval Reserve in 1947 and later served as an officer on merchant ships sailing to Far East and Middle East ports. He moved to Canada in 1955 and joined the Atmospheric Environment Service in 1958 as an Ice Observer on ships operating in the Arctic. He was appointed Port Met. Officer Toronto in 1968 and since then has regularly corresponded with Bracknell, servicing visiting U.K. VOF ships and providing us with inventories. Our grateful thanks to Geoffrey Meek for his vital and willing co-operation over many years, and we send him sincere wishes for good health and happiness in retirement.

Printed in the United Kingdom for Her Majesty's Stationery Office
Dd 290062 C18 3/90 3936 12521

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First published 1990

Annual subscription
£13.50 including postage

£3.50 net

ISBN 0 11 728687 7
ISSN 0025–3251