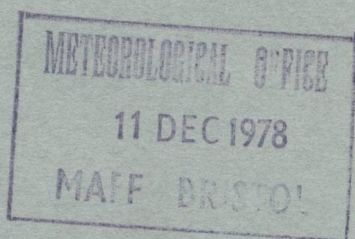


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FORECASTING FOR THE ESCAPE OF SCHARNHORST AND GNEISENAU

By the late DR WALTHER STÖBE

An earlier English version of this article was discovered in 1975 in the Meteorological Office, RAF, Laarbruch, Federal Republic of Germany by the then Senior Meteorological Officer (Mr T. E. Williams) while he was looking through some old files; it was subsequently passed to the Defence Services Branch of the Meteorological Office at Bracknell by the then Chief Meteorological Officer, RAF Germany (Mr W. G. Durbin), and thence to the Editor of the *Meteorological Magazine*. We attempted to get in touch with Dr Stöbe at his retirement address in Munich, but were informed in reply by Frau Marie Stöbe that her husband had died in 1971. However, Frau Stöbe very kindly made available to us the original German text of the article, and also granted us permission to publish an English translation.

The original text makes reference in several places to various illustrations and figures which unfortunately are no longer available; the artwork in this present version has been devised by the Editor.

We think that all meteorologists, especially those with experience of war-time forecasting, will find Dr Stöbe's account of the difficulties faced by German forecasters of great interest and fascination; it seems to us to be a valuable addition to the already extensive literature dealing with the Second World War.

In the present translation the word 'Luftwaffe' has been retained when it stands for the German Air Force, but expressions such as 'die englische Luftwaffe' have been translated as 'the Royal Air Force'; the 'Navy' means the German Navy as distinct from the Royal Navy of Britain. The German typescript contains several underlined passages which have been rendered into italics. 'England' and 'englisch' have been rendered by 'Britain' and 'British' where appropriate.

PREFACE

No other event of the last World War can better bring home the connection between a military action and meteorological support than 'Donnerkeil', the code-name given to the break-through of the German pocket battleships through the English Channel. Firstly, it was a completely self-contained act of war and, secondly, because the Navy and Luftwaffe were working in co-operation, the meteorological setting assumed particular importance.

This paper was made possible because I, as Chief Meteorological Officer of Air Fleet 3, was responsible, with Dr Süssenberger, the Meteorologist of the Naval Group (West), for the meteorological advice and can recount the events from personal experience. In addition I had assembled a large part of the meteorological data, intending to prepare a paper later, and I kept it together during the confusion at the end of the war.

The centre of interest of the paper certainly lies in the weather situation but, despite this, the course of the escape must be described so as to complete the picture. This is an account of almost documentary fidelity, and for this I am indebted to the kindness of various people who took part in the action. Above all I must mention General Max Ibel, who furnished me with an actual account of the Air Force activity and the daily log of Operation 'Donnerkeil' up to its completion, and who was attached as Commander of the Fighter Squadrons to the Naval Commander, Admiral Ciliax. Furthermore General Koller (Rtd), who was then Chief of Staff to Field Marshal Sperrle's Air Fleet helped me considerably by drawing on his exceptional memory.

This paper ought, thus, not only to show the difficulties of the German Weather Service due to the War, but also to demonstrate that careful use of a few observations can produce effective results if ordinary ability is supplemented with a little luck.

PREPARATIONS FOR THE OPERATION

On 4 February 1942 I received an order from the Chief of Staff of Air Fleet 3, which was stationed in Paris, to prepare a most detailed weather forecast for the period 5–14 February 1942 as an operation was being planned to take place during this period in the English Channel. The Navy was also to take part, but I had not yet received more exact information on the type and execution of the operation.

Once again the usual difficult conditions for the advisory meteorologist were apparent. He had to be responsible for preparing a forecast for an important undertaking, but would either be given an incomplete idea of the operation or be informed at the last moment so that secrecy would not be endangered. Only a few discerning military officers realized during the course of the war that the meteorologist, who in all the important decisions in a modern war may be able to turn the scales, can never correctly prepare his forecast if he is not informed of the tactical plan in time. The opinion held by many young officers of the General Staff that the meteorologist should give only a general forecast so that the officer could make the tactical interpretation always led to failure because the officer himself could never find his own way through the vagaries of the weather, particularly under difficult war-time conditions, whereas the tactical matters were always much clearer and simpler, and the meteorologist was capable, with comparative ease, of thinking correctly on tactical matters and acting accordingly.

In addition to this major general difficulty which arose out of the need for security, another unpleasant one came along; the demand was made for a long-range forecast. The situation was that the higher the rank of the staff officer the longer ahead he had to plan, and he thus naturally demanded the same of his meteorologists in connection with the weather. However, apart from their greater experience, for the higher staff always used older meteorologists, the latter had no scientific advantage over the run-of-the-mill meteorologists. The meteorologist in the higher staff thus found it his most difficult problem to convince his military taskmasters of the limits of meteorological knowledge and capability, particularly concerning how soon one reached one's wits' end with regard to long-range forecasting.

With its scientific impossibility in mind, I at first refused to make the required long-range forecast. Only after the Chief of Staff, who always understood the

difficulties facing a meteorologist, had assured me that, far from nailing the Weather Service down over any particular forecast he merely required from us the best outline we were capable of producing, did I, after consultation with my able colleague Dr Nestle, set about the venture—and that with very mixed feelings.

It must be remembered that under war conditions every ordinary forecast was already very difficult. Certainly over the greater part of continental Europe many observations were available for consideration, but for the vast expanse of the Atlantic Ocean we had nothing. Iceland had gone by the middle of June 1940 and decoding of the English or American reports was successful only on isolated occasions, so that for the western region we were dependent almost entirely on the meteorological flights.

There were four regular daily flights:

- (1) From Stavanger due west to about 12°W.
- (2) From Wilhelmshafen almost to the latitude of the Shetlands.
- (3) From Paris into St George's Channel and the Irish Sea.
- (4) From Brest north-westwards to the latitude of central Ireland.

The flights took place only once a day, so that 24 hours elapsed between successive observations, and they merely provided a scanty replacement for the usual extensive observations of normal times. The important gap constituted by Ireland* and the zone some 500 km wide between Ireland and Scotland not reached by the flights was never stopped. Isolated reports from England and Ireland, partly intercepted weather reports from airfields and partly agents' reports, were very important but throughout were quite insufficient. Thus it was quite impossible for the forecasting officer to form even a moderately accurate picture of the situation in the area of main activity over Iceland or in the East Atlantic. In practice this meant that one was never free from surprises. So the daily forecast for the battle area of Great Britain became a nerve-racking affair for every advisory forecaster in western districts. And now, to cap it all, a long-range forecast! Even in normal times this sort of practice was a tricky affair. Genuine aids were slight. The monthly forecasts from the Long Range Research Institute in Homburg were useless for advice purposes as they were too general. Forecasts of the average cloud cover or the average pressure distribution were no use. Just as little use to us was the large-scale Navy publication 'The ten main weather types over central Europe in relation to the weather in the English Channel' which had appeared in 1941. What good was it to know, for instance, that in February the frequency of weather type 7 (north-westerly weather) was 54 per cent, and that for this type Calais would have a mean temperature of 4.2 °C, while visibility would be fair or changeable? The actual weather can never be approached through such statistical means and frequencies as these. The possibility of working with symmetry points and 'mirror' curves failed because pressure data in the areas in question were either not available or were uncertain. A more valuable work, for the practical forecaster, was the article, unfortunately classified as SECRET, by the recently deceased Walter Lay called 'Synoptic pressure singularities' published in 1941 by the Reichsamt für Wetterdienst, Berlin. Here an attempt was made to construct on a seasonal basis a series of charts representing the general weather situations. A definite help in the same direction (i.e. using singularities) was the graphical presentation of the daily

* The German reads 'Island' i.e. Iceland, which must be a typing error.

storm frequencies based on 40 year averages (after an English work covering north-west Ireland and south-east England). Unfortunately, moreover, the need for strict security ruled out any closer co-operation with the Central Weather Group at Luftwaffe HQ in Berlin, who were much concerned with long-range forecasting.

The meteorological office of the Air Fleet in Paris was therefore quite alone in this assignment. In practice the Staff was provided with long-range forecasts as follows. The starting point was the weather situation at 0800 hours on 5 February, from which extrapolation was carried out in accordance with weather developments, which corresponded roughly to Lay's charts for 7 and 12 February. From the 6th a daily correction was made to the forecast by referring to the new weather situation. In this way we groped slowly forward to a forecast for the middle of the month.

The first forecast for 5 February, which was to stretch to 14 February, shows very clearly that we knew little of what we were about, so that it was necessarily confined to generalities. The following, taken from my notes, describes how the forecast was placed before the staff officers (with the accompaniment, naturally, of verbal explanation of the appropriate weather chart).

THE PROBABLE WEATHER SITUATION IN THE BASE AREA,
HOLLAND-FRANCE, 5-14 FEBRUARY 1942

'The development of the weather in the area in question will be determined by the very pronounced high-pressure area over the continent on the one hand, and advancing disturbances from the Atlantic on the other. The anticyclone over central Europe and in the east is very stable, being strengthened by the thick snow cover, and will not be broken down easily. The Atlantic disturbances coming from the north-west and west will hardly be able to reach further than Holland, whilst the cold air from the east will just about reach the Paris area.

In particular one can forecast the changes of the weather in Holland and in the coastal areas of France as follows:

5-7 February. Continuing frosty weather in Holland with occasional light snow-fall and lifted fog at 600-1000 ft at times. In France a disturbance will again move further south-east or east-south-east accompanied by slight precipitation (rain) and more extensive and often complete cloud cover.

8-11 February. Holland will again lie in the frontal zone and decidedly bad weather with rain and also snow can be counted on. Later the front will move eastwards.

Changeable weather is expected in France.'

So much for the forecast, which shows that we are dealing, first and foremost, with the oscillation of a meridionally aligned trough between the continental and Atlantic highs.

As far as the general weather situation is concerned, it may be said that in consequence of the Azores High being displaced far to the north, the tracks of the Atlantic depressions lay very far north, and the continental influence had become very marked in the west, so that, according to a report in *The Times* dated 13 March 1942, February 1942 was the coldest February in England and Wales since 1895, colder in fact than the hard Februaries of 1917 and 1929.

The supplementary information for 6 February now allows a definite outlook

to be given, which to some extent agrees with the actual course of the weather on 12 February.

'Sometime after 10 February the passage of individual depressions from the north-west along the east side of the intensifying anticyclone west of the British Isles is expected, so that in two to three days a pronounced bad-weather zone is expected in the region of the North Sea and the southern part of the east coast of England.'

In addition there was discussion concerning a steering from the north-west which, although not recognizable on the surface chart, had been forecast over the low-pressure areas over Norway and Russia present on Lay's charts. *The discussion of the weather situation from 7-12 February in Lay's work points to a special development of the northern source of depressions in the region of Iceland, caused by the warm air mass from the Atlantic meeting the cold Arctic air mass which was being steered southwards.*

In the meantime I had been able to gain more information about the imminent operation by illicit means. Officially, I knew only that the Luftwaffe was to protect the escape of our warships through the English Channel, and even then they gave me the wrong direction (escape from east to west). Now I was told of the weather requirements.

- (1) The *ideal* weather was considered to be a situation which would prevent the much-feared British torpedo-carrying planes, and, if possible, also the bombers, from being used. This meant that very low unbroken cloud, or, even better, persistent fog, must cover south-east England.
- (2) Otherwise, the Luftwaffe, meaning their fighter planes, which were very sensitive to bad weather (as they could not fly blind), must be able to land and take off unhindered and protect the ships from the British attacking aircraft without encountering weather obstacles. This meant, at best, cloudless weather with good visibility both over the North Sea and in the Channel as well as over the airfields in northern France and Belgium.
- (3) In no case must the weather situation be such that the Royal Air Force could go into action, while the German aircraft could neither take off nor land, thus leaving the German ships unprotected. It was thus imperative that the weather situation should not be composed of perfect flying conditions over south-east England, with perhaps a slight cloud cover in the Channel, while the coast of France and Belgium lay under fog or deep cloud accompanied by bad visibility.

The weather conditions which the Navy demanded for the progress of the action were the following:

- (1) No fog over the whole distance so that maximum speed could be used.
- (2) Sea slight (because the various ships in particular the speed launches—'Schnellboote'—which protected the flanks, would otherwise be unusable).
- (3) A following wind if possible.
- (4) In order to make proper use of darkness the action had been timed for the days around the date of the new moon. About six days were available to choose from, namely 11-17 February, any later month than February being out of the question owing to the shorter length of the night.

It will be seen how many conditions one had to bear in mind and for the meteorologists it was a question of nerve-racking watchfulness in order not to

miss any favourable opportunity and also to appreciate every unfavourable weather situation quickly so that from the beginning the prospect of success was not endangered.

Naturally the meteorologists were concerned to find all aids which were in any way available, in order to fulfil this difficult task. For the Luftwaffe there was no other possibility than to strengthen the weather reconnaissance flights. The Navy had, however, on the suggestion of Dr Süssenger, who had been let fully into the secret earlier than I, set aside three U-boats exclusively as weather observers. They were to be placed so that not only could they watch the region of the east Atlantic High, which was the key point of our long-range forecast, but also the crucial region around Iceland. *From 8 February these reports were to be given three times daily and they meant not only an easing of the problem of the briefings, but, as further events showed, were the key to success.*

Naturally, steps were also taken to augment the few reports from our agents in Britain and Ireland, and above all to pay greater attention to the openly radioed weather messages of the Royal Air Force. The latter were certainly a welcome supplement, but were meagre both in number and value.

The supplementary forecast for 7 February showed considerable uncertainty. Over the southern North Sea a weak ridge of high pressure had built up from the west; it extended almost to the continental anticyclone over Russia. The uncertainty arose from the fact that no reports from the eastern Atlantic were to hand, and it could be assumed that, because of the south-easterly thrust, the whole Atlantic anticyclone had moved southwards, thus bringing about a simple west-east arrangement of isobars over Great Britain and the North Sea that would create a westerly weather situation which would quite upset our view of the future general situation. Besides, it could perhaps happen that because of the approaching anticyclone, widespread fog and lifted fog would occur over the Channel. A further uncertainty arose out of the impending change in the general situation in the north, as the continental anticyclone in the east appeared to be declining, and the low over Norway which was expected from Lay's analysis appeared to be forming.

So the forecast for 7 February closed with these words: 'Consequent upon the beginning of a transformation of the general weather situation (break-up of the continental anticyclone and the south-westerly movement of the Atlantic anticyclone) the further development of the general situation can be seen only with great uncertainty'.

On 8 February it was, however, already clearly seen that the ridge of high pressure which had pushed forward on the previous day would be broken down again. The reports from U-boats in the Atlantic, which were now coming in, also showed that the Atlantic anticyclone had not altered its position. Unfortunately the reports from the region of Iceland were still uncertain, but the activity of the developing low over northern Norway, which was already noticeable at high levels, had already been allowed for in the forecasts.

'The ridge of high pressure will be gradually broken down, so that the disturbances coming from the north and north-west are expected to reach the area of Holland around 9-10 February and later on 10 and 11 February the French areas . . . As the general situation is still in a state of flux, the further development can only be foreseen with difficulty, especially as no worth-while data from the region of Iceland are to hand.'

It is seen that the Atlantic anticyclone was still to be accounted the major

steering centre as the depth and effect of the Norwegian low was not yet quite clear.

On 9 February it was clearly recognized that the Russian high had broken down and that *the high-pressure area to the west with its centre west of Ireland still remained important. The Iceland reports from the U-boats made it possible to recognize, though not unambiguously, that new disturbances would develop there.*

On 9 February the forecast up to the 14th ran in essence as follows: 'At present Holland and France lie under the influence of a mixing zone of air masses producing fog, some of it shallow. In the south of the battle area there is also a tendency to fog and lifted fog.

However, in the region of Iceland the approach of new disturbances is expected soon, whereby the development of the weather over the North Sea and over the battle area (south-east England) and above all over the Dutch base will take place more quickly'.

On 10 February it was realized that the general weather situation was controlled by the deep depression over North Scandinavia which extended to high levels. The new development west of Iceland suggested by the weather reconnaissance of 9 February, and steered south-eastwards by the large new stationary depression over Norway, had already reached Jutland. *The route for the passage of further such frontal zones was indicated.* Owing to the strong, unhindered influx of cold northerly air masses round the back of the Norwegian depression the build-up of further areas of convergence near Iceland had to be taken into account.

The forecast for 11–12 February therefore ran as follows: 'The general situation shows no change. The passage from the north and north-west of individual small disturbances embedded in the cold air stream is possible. These will make themselves felt through the dying-out of shower activity and then through temporary deteriorations in weather.

Definite timings are not possible without observations'.

Thus a weather situation was reached which for some days was expected to show certain constant elements of development and sequence. Fog and lifted fog, and slow changes in the synoptic situation which were considered unsuitable for the operation were not expected (as on 9 February), but instead more rapid changes in the region of the North Sea, with less pronounced developments in the English Channel, would certainly make sorties by the Luftwaffe possible.

With this, the alert signal was given by the meteorologists, and on the evening of 10 February Admiral of the Fleet Saalwächter, who was in charge of the operation from the naval side, together with his Chief of Staff and Admiral Ciliax, who was to take command of the ships, appeared at Field Marshal Sperrle's HQ in the Palais du Luxembourg for a conference on the start of operation 'Donnerkeil'. I personally merely presented the weather in the above terms, otherwise taking no part in the discussions, but I was present at the supper which followed. It was laid down at the meeting that on the following day, Wednesday 11 February, a decisive session, in which the Chief of Staff of the Air Fleet, Colonel Koller and I were to participate, would be held between 1200 and 1300 if all the meteorological reports had been received and processed. There was also a noteworthy discussion which gave an interesting insight into the mentality of the Navy. When Saalwächter was asked why he was determined upon the next day, he admitted with embarrassment that in any case, Friday, which also happened to be the 13th, was out of the question. No man of the Navy would

give the operation a chance if it took place on such a doubly ominous day. We enlightened people of the Luftwaffe felt this very strange, especially in a war when one could certainly not be very choosy about ways and means. But because the declaration came from so authoritative a person it had to be heeded, no matter how much matters were thereby complicated.

It was thus possible on 11 February to make all the preparations necessary to ensure that all the reports would be received in good time for processing by noon on the Wednesday of the decisive briefing. The weather reconnaissance squadrons were operated so that all their reports were received by us by the latest at 1100 hours. Also for 11–12 February a reserve squadron had been detailed to fly from Brussels over the North Sea in order that the weather in the region of exit from the English Channel could be correctly appreciated. It was agreed with the Navy that all incoming reports (the U-boats were picked up from here directly) would be passed to us immediately and we would pass any to them.

It may be mentioned here that co-operation with the Naval Weather Service and their chief, Dr Süssenberger, was exemplary in every way, which, from the military viewpoint could not always be said of the Air Force and the Navy. The little jealousies which otherwise occurred between the two parts of the defence service were completely absent in the weather service. It was unfortunately a widespread phenomenon for the different offices, often including those within the Luftwaffe, to seek to play the meteorologists off one against the other. In the sphere of Air Fleet 3 this was prevented by a telephonic conference which took place daily, generally at 1600 hours, and at which the most important staff meteorologists decided on the forecasts. In our cases, naturally, a common opinion had first been agreed on between the naval meteorologist and myself, without, of course, putting anything over on our commanders. Ambitious or mutually jealous forecasters could cause great damage and they did not last long.

A sudden meteorological sensation occurred in the early morning of 11 February. The observation from the U-boat which was immediately south of Iceland reported westerly gales and low and continuously falling pressure. This was apparently a new formation, probably a so-called fast-moving wave depression. One could be fairly certain of its direction and speed because the stationary upper low over the North Cape would steer it southwards and south-eastwards, as had happened with its predecessor of the day before.

At the decisive briefing held, as arranged the day before, at 1245 (German Summer Time) I gave a verbal forecast roughly as follows (the record being made immediately after briefing), using the weather maps for clarification.

‘On the basis of the 8 o’clock European Chart, in which the results of the meteorological reconnaissance squadron at Stavanger and U-boat reports south of Iceland have been incorporated, the following judgement of the weather for 12 February has been formed.

A low-pressure disturbance has formed in the region south of Iceland. Strong winds and falling pressure in the area north of Scotland suggest that in all probability this depression will move south with a speed of about 50 km/h and on 12 February between 0800 and 1000 hours will lie in the region of the eastern exit from the English Channel and will then move further south.

In the first hours of the forenoon the weather would deteriorate quickly in the Channel area and, after the passage of the front, which might take 2–4 hours, a clearance would follow quickly, while the battle area would again clear up. Conditions over the bases would deteriorate as they improved over the battle

area.* In the afternoon the bases would again have favourable weather.* It is emphasized that this is the most extreme view of what may happen.'

The last sentence meant to imply that we had not wanted to set down an exact timing, but rather to sketch out clearly the extreme position in order to have a margin of safety. The naval meteorologist was concerned in his forecasts more with the western Channel region and could promise favourable weather for departure and for the night on account of the high pressure in that region.

As it had to be assumed that the ships, on keeping to plan, would have passed the 'Narrows' between 1000 and 1100 and would be able to continue sailing during the night without hindrance and that the fighter protection could be sent in, the forecast as given satisfied Admiral of the Fleet Saalwächter. He tensed, straightened himself—he was of small stature—and gave his Chief of Staff the following command:

'My decision is that you should send the code-word'.

It was exactly 1345 hours.

As will be seen from the following reports of the escape, the high over the west of the English Channel had done its bit. In consequence of the approaching low-pressure disturbance the wind had increased in the eastern Channel exit, preventing fog formation in the eastern coastal area and allowing covering fighter planes to take off as planned. Despite the fact that the deterioration took place in the east rather later than forecast, the fighters were also able to take off from the Dutch and Belgian bases in the afternoon, even if they had to contend with the same visibility difficulties as had the British attacking forces.

Perhaps it is still of interest to mention that February 1942 was exceptionally bad for all flying operations, in the main precisely because of the fog in the eastern Channel area and in Holland. The exception was a few days from 11 February onwards, when these areas were most free from fog. The good use made of the first favourable weather situation in February for the escape must be counted as a great feather in the cap of the weather service.

THE PROGRESS OF THE OPERATION

The two battleships *Scharnhorst* and *Gneisenau* and the large cruiser *Prinz Eugen* had lain since 1941 in Brest and La Palice respectively. *Prinz Eugen* had put to sea for a time with the battleship *Bismarck* on an Atlantic mission and had come, if alone, safely back to Brest. The two other ships had already come to the French Atlantic coast earlier. In consequence of the continuous air attacks by the British, carried out since 23 November 1941 (according to my record there were, up to the time of the escape of the ships, 25 more or less heavy twilight and night attacks, by which the ships were repeatedly damaged), it became impossible to allow the ships to remain at their position in Brest and a return to a home base was necessary. Since sailing from Brest to Germany lay entirely through the Channel, the idea of returning the ships to Germany this way was by no means out of consideration, although such a journey would be attended by very difficult circumstances. The voyage did, however, obviously require thorough preparation and special protection. It was the Luftwaffe which had to provide such protection.

* Translation uncertain; the original reads as follows: Die Basis würde in gleichem Maße schlechter, als der Kampfraum wieder aufklart. Nachmittags dürfte auch die Basis wieder einwandfreies Wetter zeigen.

Thus after 1345 on Wednesday 11 February when the code-word 'Hagel' ('hail') had been given to start the action, the ships were ordered, as planned, to sail at 2000 hours (beginning of darkness).

The ships had already cast off and were setting out when the air raid warning sounded at 2040 hours. The ships hove-to again and laid down a smoke screen. About 30 British planes attacked Brest. It was naturally very important that the position of the ships should appear unchanged to the British. When the aircraft had flown away again—the ships remaining undamaged—the riddle arose 'had the British seen anything of our intention to leave, or not?'

At 2200 hours the air raid ended. We waited to see if, after the British planes had landed, any increased activity became evident at their airstrips, but everything remained quiet.

So two precious hours were lost, for the sailing could not now start before 2245 hours. The night lasted at this season of the year about 12 hours (because the ships were travelling east) so that only by the maximum speed of over 30 knots could the 360 nautical miles (approximately) to the narrowest place in the Channel be reached during night-time. But the loss of time did not prove so great, as the surprisingly favourable tides increased the speed. Thus, in the almost calm and cloudless weather resulting from the high-pressure area, and also under relatively good visibility conditions, the bold operation began at 2245 hours German Summer Time (2045 GMT).

The Commander, Admiral Ciliax was on board *Scharnhorst*. The Luftwaffe had provided him with Colonel Ibel as Fighter Commander.

After the great tension at the beginning of the operation, during the rest of the night all went quietly and according to plan. The three big ships accompanied by several destroyers and modern torpedo-boats reached the light buoy on the line Deauville-Le Havre at 0832 on 12 February 1942.

The wind freshened slowly from the south-west (almost a following wind) but the state of the sea was still slight.

At 0842 hours the first German covering aircraft took off from the airfield at Abbeville. The convoy of ships was arranged so that the great ships followed the innermost course closest to the French coast, the torpedo-boats and destroyers were deployed to the north and the E-boats, which had joined them under way, formed the extreme edge of the protection. At first the covering fighter planes flew in low in strong formations on the side which faced the enemy.

Protected in this way the convoy now approached the most dangerous place, the narrows where the Straits of Dover are only 32 km wide.

The tension in the ships and in the Operations Rooms of the Naval Group and Air Fleet in Paris grew continuously. When would the British discover the convoy?

In the meantime the British had flown their dawn reconnaissance patrol, but the routes of the reconnaissance machines were so laid out, that one machine reconnoitred the Channel Islands, which the ships had already long passed, and another Abbeville, which, at this time, the ships had not reached. Both reconnaissance planes had seen nothing, and the monitoring service reported complete quiet on the English side. On the German side during the morning extensive interference with the whole British radar service on the Channel coast had been initiated, by sending out a specially equipped plane. This would simulate the radio sound of countless German bombers; it had the fine code-name 'Garmisch-Partenkirchen' apparatus. It was sent out to the south of the Isle of Wight and

was intended to draw the English fighters away from the Dover area. The British planes did take off, but only from out of the middle Channel coast and not from the London area. In fact the British had soon noticed the deception and had landed again.

The ships and aircraft naturally maintained complete radio silence. The tension grew; the narrowest place by Cap Gris Nez was passed at 1250 hours and the unbelievable happened—on the British side nothing stirred. The weather had indeed become somewhat worse and there were occasional slight rain showers and occasional lower clouds, but the English coast was visible, even if poorly so. The E-boats protecting the English coast had laid a smoke-screen, and at 1319 for the first time the British E-boats came within fighting distance. At the same time, just half an hour after the narrowest point had been passed, the first shots from the batteries at Dover fell in the neighbourhood of the ships.

In the meantime it had been realized from a radio message picked up from a British patrol boat that the convoy had been recognized as such.

By 1333 hours the convoy was already out of range of the guns of the three batteries, for the shots were falling 4 km short. From the radio reports the preparations of the Royal Air Force had been diagnosed and on the German side complete fighter protection had been commanded. Led by the best-known German fighter pilot, Galland, the fighter squadrons were deployed to a rigid plan, so that sometimes more than 30 fighters were on station above the convoy. The German planes, ME 109s (Messerschmidt) and FW 190s (Fokke-Wolf) were equipped with long-range fuel tanks and could stay in the air for 75 minutes and reach a speed of 500 km/h. Above all else it was necessary to prevent the much-feared British torpedo-carrying aircraft from reaching their goal. At 1334 *Prinz Eugen* sighted the first Swordfish torpedo-carrier. By 1350 some nine torpedo-carriers had been shot down or driven off. No damage was caused to the ships.

At 1350 hours radio silence was lifted in order to put in the full fighter support.

Just one hour later at 1455 hours, the first enemy bombers, mostly two-engined machines, were sighted. From then up to the onset of darkness the convoy was *continuously* attacked by single planes and squadrons of bombers.

Now, however, yet more shelter, of decisive importance, arrived: the weather became noticeably worse. The sky became completely overcast and rain fell. Underneath the 300 ft cloud base the visibility towards the French coast was still just good enough for the German fighters to fly. They continually attacked the British bombers as they appeared suddenly through the cloud, shooting them down or driving them off. Despite the obstinate sorties of the British planes, made doubly difficult by the bad weather, the whole force of 200–300 planes sent in caused no damage.

It is true, however, that *Scharnhorst* ran into a surface mine at 1530 hours. Luckily at this time the weather was so bad that the visibility was only 1–2 km, with cloud at 300 ft and continuous rain. Air attacks were hardly to be expected in such weather. What was worse was that the convoy must now disperse. The Admiral and his staff transferred into a destroyer and in poor visibility the ships were lost to view for long periods.

The weather had improved again locally, the visibility was now 3–4 km and at 1600 hours the British bombers began their attacks again. But the German fighters were also able to operate again and, with assistance from the ships' A.A. guns, the hostile attackers were prevented from achieving any success. Because of the more frequent bad weather areas in the north-east, with their very low

cloud banks and the variable but mainly poor visibility, a united attack by bigger units on single ships was impossible. Also ineffective was the attack of the light naval forces (one light cruiser and five destroyers were reported) which took place from 1643 to 1655 hours, as the ships soon lost contact with each other.

The following incidents show how difficult it was for both sides to survey the situation in these conditions of poor visibility and with the convoy dispersed. It had been recognized from radio interceptions that British warships were approaching. A bomber squadron of the IX Fliegerkorps was sent out against the British units. At 1700 hours a German plane dropped bombs on one of its own destroyers. Also a radio message from the leader of the British naval forces was intercepted, requesting fighter protection as he was being attacked by bombers. It is, however, certain that at this time no German aircraft was over the British convoy, so that here also it could only have been one of their own aircraft which had dropped the bombs.

At 1843 hours Admiral Ciliax and his staff transferred to yet another destroyer, a difficult manoeuvre in the heavy seas. And there to their joy they saw *Scharnhorst* steaming by. But at 2250 hours she again ran into a mine. At 2055 hours *Gneisenau* too had run into a mine, but despite this she was able to continue the journey at 15 knots.

The attacks of the British ended at 1910 hours and nothing more followed on the next day. At twilight there were still single German machines over the ships, and on the morning of 13 February 1942, the German fighters were able to take over the protection in quiet weather without being disturbed. In the course of the day all the ships were able to reach their allocated home bases.

Certainly things looked bad for the fighter squadrons on the evening of 12 February; of the 250 (approximately) sent in, 70 were missing according to the evening check-up. It turned out later, however, that the missing aircraft had landed at all sorts of places in Holland, as the weather had been so bad over land that only very occasionally had a return to home base been possible. The damage due to landing was, in any case, greater than that due to enemy action. The German Navy and Air Force completed a brilliant achievement, and it was not their fault that it had little effect.

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1975 Escape of the *Scharnhorst* and *Gneisenau* (Ian Allan Ltd).

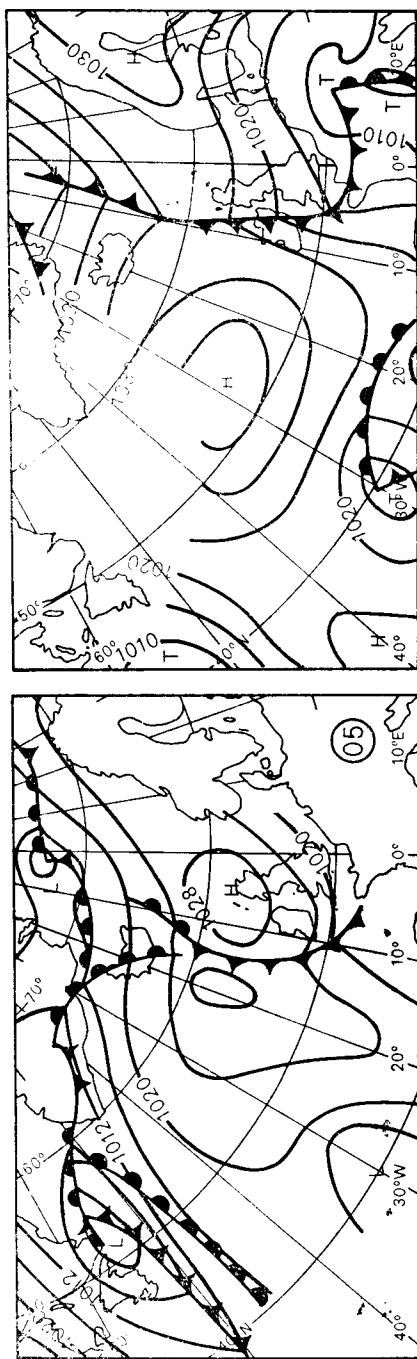


FIGURE 1—BRITISH AND GERMAN SURFACE WEATHER CHARTS FOR 5-13 FEBRUARY 1942

These charts have been copied from contemporary issues of the *Daily Weather Report* and the *Täglicher Wetterbericht*, both secret at the time but long since declassified. The British charts, with isobars at 4 mb intervals, are on the left with the day of the month in the bottom right-hand corner; the German charts, with isobars at 5 mb intervals, are on the right. The time of observation of the British charts is 00 GMT for ships and Greenland; and 01 GMT for all other areas; the time of observation for the German charts is '02 DSZ' i.e. 00 GMT. Note that on the German charts 'T' stands for 'Tiefe' i.e. a 'Low' or depression centre.

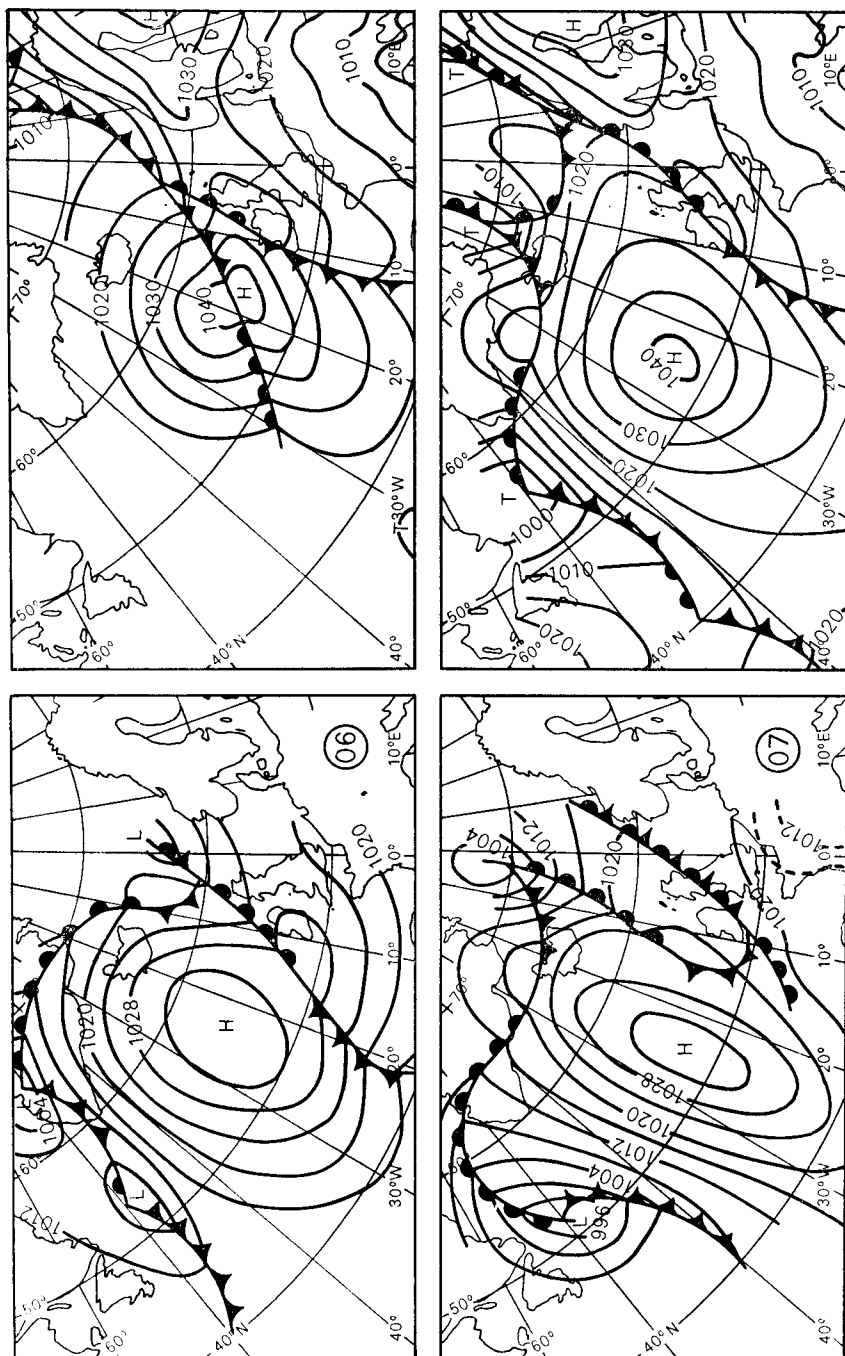


FIGURE 1—continued

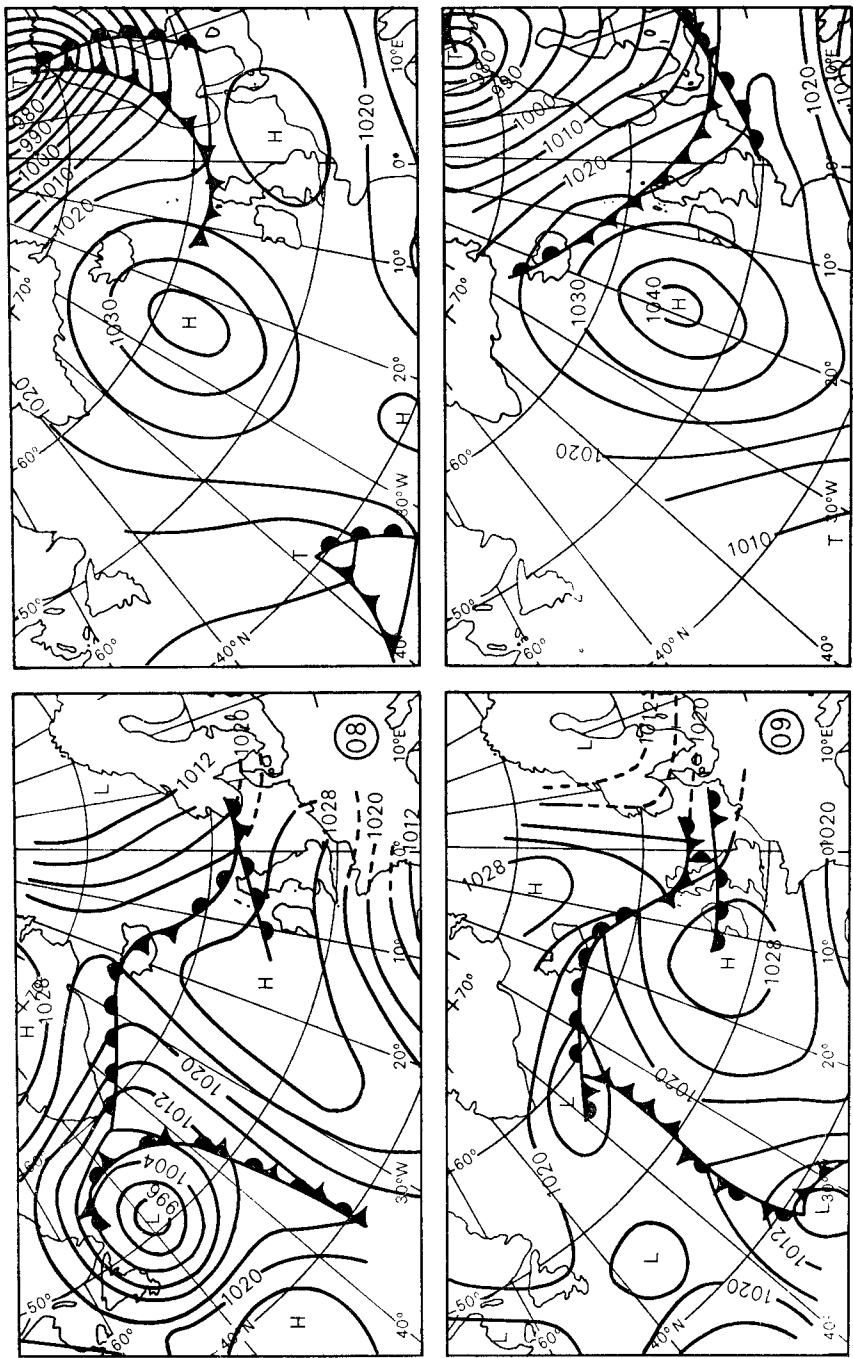


FIGURE 1—continued

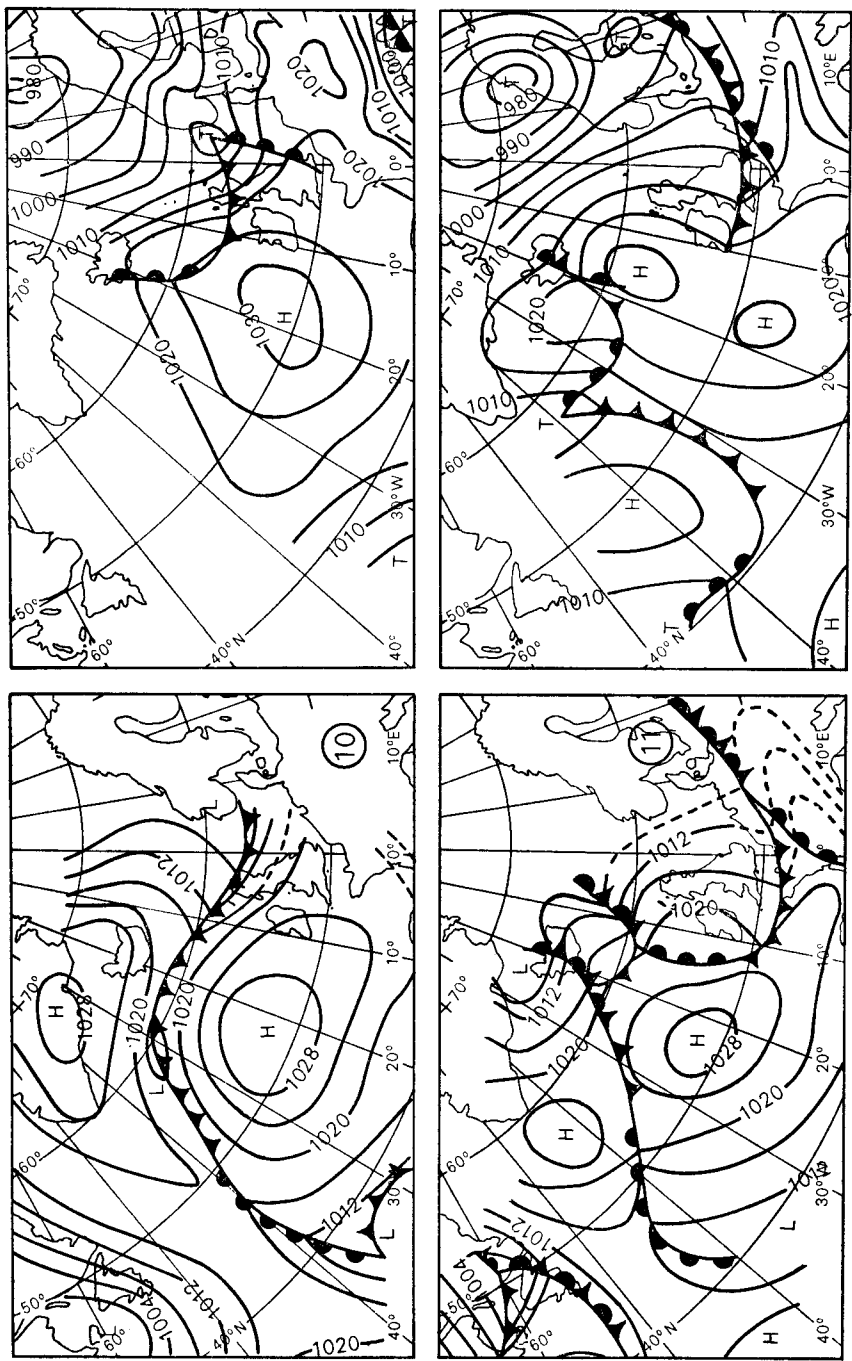


FIGURE 1—continued

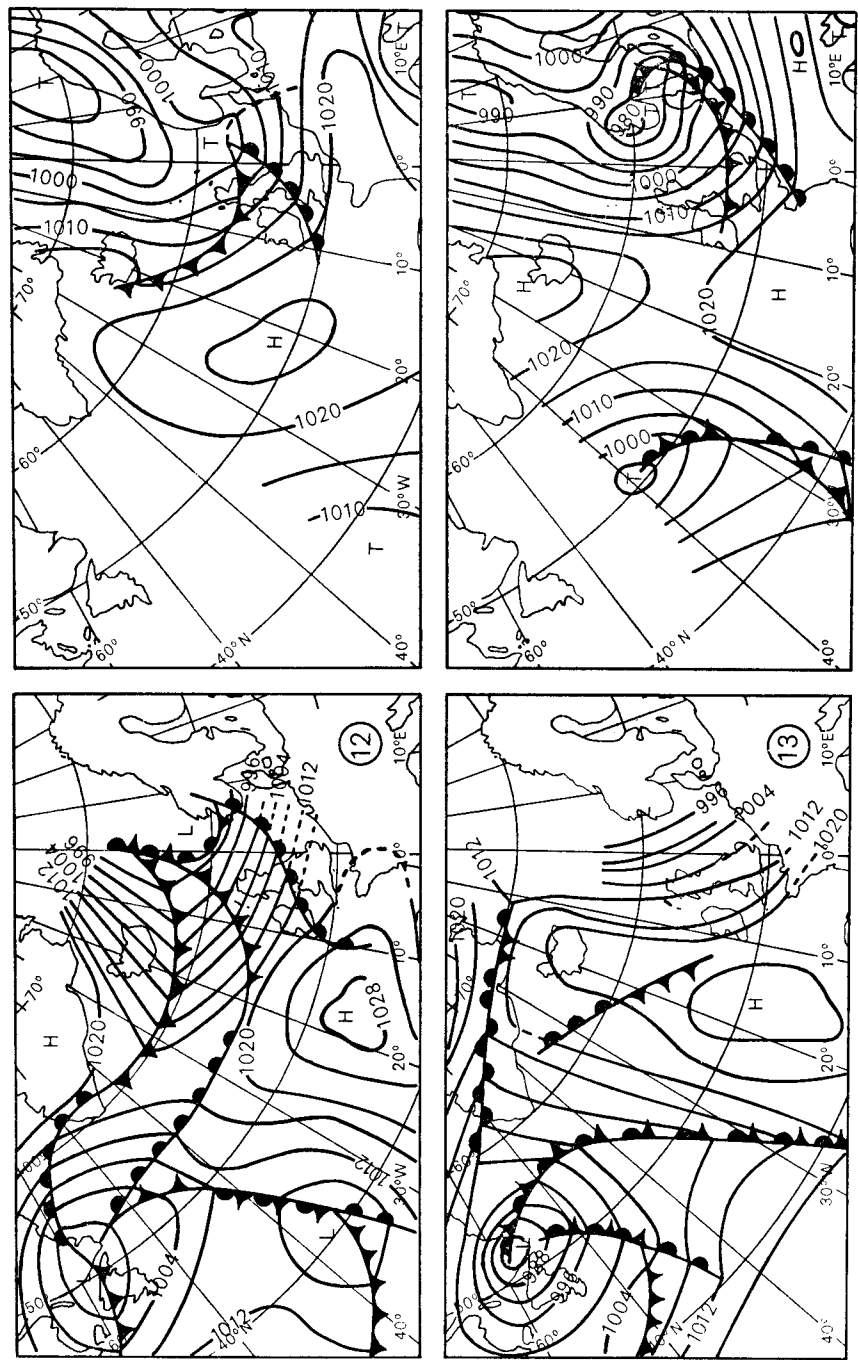


FIGURE 1—continued

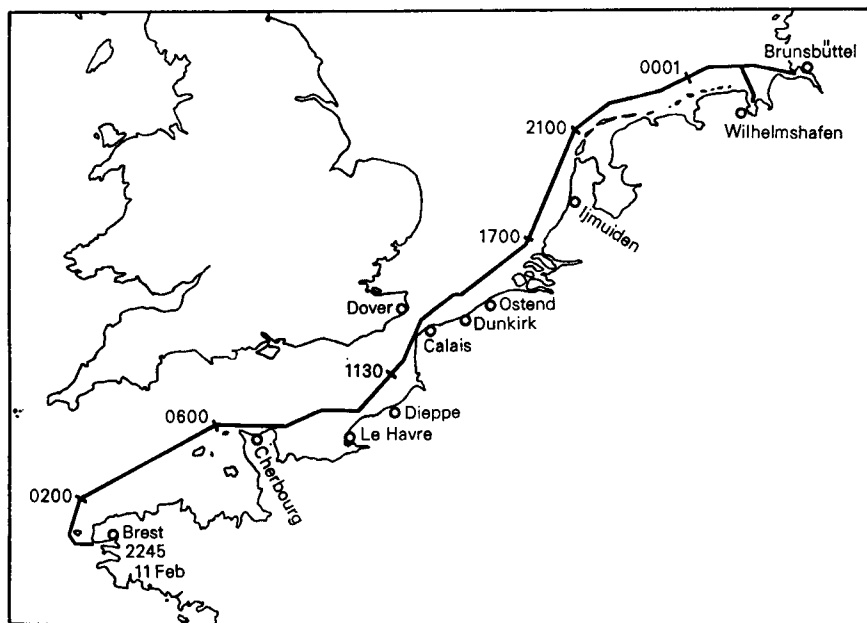


FIGURE 2—ESCAPE ROUTE OF GERMAN WARSHIPS, 11–13 FEBRUARY 1942

Times are as in text, viz. German Summer Time, two hours in advance of GMT.

551.5:06:929.6

THE METEOROLOGICAL OFFICE BADGE

By R. P. W. LEWIS

A new design for the official badge of the Meteorological Office was brought into use early in 1978 and we thought it would be of interest to our readers if we gave a short account of how this and earlier designs arose.

In 1910 the Office moved into its new premises in Exhibition Road, South Kensington. The Director at the time was Dr W. N. (later Sir Napier) Shaw. We have received a letter from Mr H. L. B. Tarrant, who served from 1902 to 1948 and became Chief Clerk, and in it he says that after the move '... we had on the staff a Miss Humphries* (a draughtswoman)* and I think that when Dr Shaw (as he was then) decided that the Office should have a crest†, Miss Humphries produced some designs under his directions. However, I think the final design, and the plaques, were produced by the Bromsgrove Guild to whom Dr Shaw referred the matter for professional advice'.

* Listed in the *Annual Report* as 'Miss E. C. Humphreys, Photographic Assistant'.

† Mr Tarrant uses the term 'crest' incorrectly for 'badge'. A crest, though it may be displayed separately, exists not in its own right but only as part of a complete achievement of arms containing at the very least a shield or 'coat of arms'. See e.g. MacKinnon (1966).



PLATE I—ORIGINAL METEOROLOGICAL OFFICE EMBLEM

**This wooden plaque is one of two made in 1911 for the new office in South Kensington and is now housed in the Cartographic Drawing Office at Meteorological Office Headquarters.
(See page 339.)**

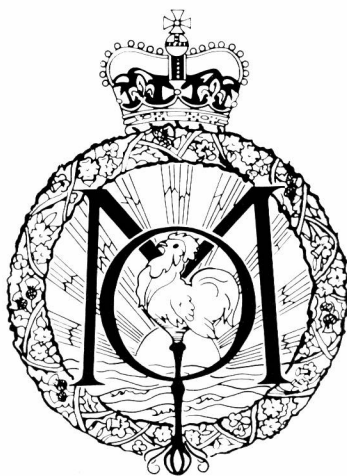


PLATE II—OLD METEOROLOGICAL OFFICE BADGE

A recent version of a design based on the wooden plaque of 1911.
(See page 339.)



PLATE III—NEW METEOROLOGICAL OFFICE BADGE

This design was introduced in 1978. It was produced by the Graphic Design Division of Her Majesty's Stationery Office. (See page 339.)



PLATE IV—HANDOVER OF THE Mk 3 RADIOSONDE SYSTEM

Mr P. Dorey, Managing Director, Ferranti Computer Systems Ltd, signs the formal hand-over document for Mk 3 radiosonde watched by, on his right, Mr F. H. Bushby, Director of Services of the Meteorological Office, on his left, Mr B. O. Penny, AD/SLR 3, and standing, Dr D. N. Axford, AD Met O (OI). (See page 355.)



PLATE V—HANDOVER OF THE Mk 3 RADIOSONDE SYSTEM

Dr R. E. W. Pettifer (Mk 3 radiosonde Project Manager) launches the demonstration sonde watched by Mr P. Dorey, Managing Director, Ferranti Computer Systems Ltd, and Mr I. Ball, General Manager, Ferranti Computer Systems Ltd. (See page 355.)

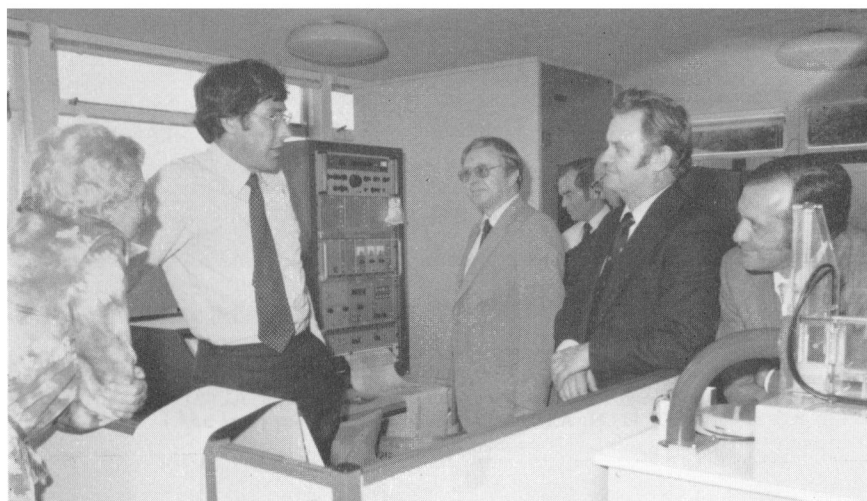


PLATE VI—HANDOVER OF THE Mk 3 RADIOSONDE SYSTEM

Dr R. E. W. Pettifer (Mk 3 radiosonde Project Manager) describes the progress of the demonstration flight to, from left to right, Miss L. M. Abrey (S9 (Air)), Mr P. Dorey, Managing Director, Ferranti Computer Systems Ltd, Mr I. Ball, General Manager, Ferranti Computer Systems Ltd, and Mr B. O. Penny, AD/SLR 3. (See page 355.)

The *Annual Report of the Meteorological Committee* for 1911–12 and the Minutes of the Committee confirm that the work was executed by the Bromsgrove Guild and add that it was paid for by private subscription and administered on behalf of the Meteorological Office by the architects' department of the Office of Works. The plaques to which Mr Tarrant refers were two in number and made of wood; they were displayed in the Library, one over each door. One plaque is still in existence and is housed in the Cartographic Section (Met O 18d); it is shown in Plate I.

(The Bromsgrove Guild, who used to do a great deal of work of this kind, arose from William Morris's group of craftsmen in Victorian days; some years ago it was absorbed into the Bromsgrove Casting and Machinery Company and no relevant records survive.)

During the next few years the plaque design was used as the basis for various small logotypes which were printed on publications. A version was used, for example, on the *Meteorological Office Circular* issued from 1917 to 1919, and then on the title page of the *Meteorological Magazine* when this became the official journal of the Office in 1920 following the take-over of Symons's 'British Rainfall Organization'; it was used on the *Daily Weather Report* from April 1919.

A larger and more elaborate version was first used on the cover of the *Meteorological Magazine* in February 1939. Other versions with minor variations occur here and there: stamped on official bindings, as a blazer badge, and so on. A recent version is shown in Plate II.

A few years ago demand began to grow for the Meteorological Office to display its own official badge on RAF premises and on the aircraft of the Meteorological Research Flight. The apparently obvious answer, namely to use a version of the old design for the plaque, turned out to be impossible because the design had never received the official recognition of the College of Arms and it is not permissible for unofficial designs to be used on aircraft or other RAF property.

The advice was sought of the Graphic Design Division at Her Majesty's Stationery Office (HMSO) who recommended that a new design should be produced, based on important elements in the old one, but clean, simple, and modern in appearance, and able to function as a logotype for official stationery as well as on a flag or on an aircraft. After one or two false starts a suitable design was produced by Mr Peter Branfield of HMSO in consultation with Met O 18, and this is illustrated in Plate III.

In December 1977 we were informed that the Property Services Agency and Garter King of Arms had approved the design for all official purposes and in consequence of this decision the RAF later agreed that it might be displayed on MRF aircraft.

REFERENCE

- | | | |
|---------------|------|---|
| MACKINNON, C. | 1966 | The Observer's Book of Heraldry. London, Frederick Warne and Co. Ltd. |
|---------------|------|---|

WEATHER CONDITIONS FOR LONG GLIDING FLIGHTS OVER ENGLAND

By T. A. M. BRADBURY
(Meteorological Office, Bracknell)

SUMMARY

An analysis was made of weather conditions suitable for closed-circuit gliding flights of more than 200 km over England. The best conditions were found when vigorous convection developed in a relatively shallow layer extending from the surface to about 2 km provided that the wind speed in this layer did not exceed 10 m s^{-1} , the cloud base was more than 1 km above the general ground level, and more than 50 per cent of the possible sunshine was recorded. The synoptic situations most likely to provide these conditions occurred after the passage of a cold front where a ridge or small anticyclone developed.

INTRODUCTION

In recent years there has been a steady increase in the number of cross-country flights attempted by glider pilots. Before 1960 nearly all long flights were made downwind but recently the majority of flights have been planned as closed circuits round one or more previously declared turning points. In 1976 there were 493 cross-country flights from one gliding site alone. The average distance covered was 230 km but a number of flights exceeded 500 km and one covered 801 km.

On a fine summer weekend there may be over one hundred gliders making cross-country flights over England. Many pilots rely on forecasts issued to their club by a meteorological office or simply listen to bulletins issued by the BBC but some pilots regularly consult a forecast office before planning a long flight. Forecasters may find it useful to know the conditions found most favourable for long closed-circuit flights and the synoptic situations most likely to provide these conditions.

DATA

The dates of all cross-country flights of more than 200 km were taken from the Lasham Gliding Society log for the years 1975 to 1977. Flights which exceeded 399 km were listed separately; since these were much less frequent the period was extended back to 1968 in order to collect a large enough sample. In the tables which follow these are referred to as ' ≥ 400 km days'. It is justifiable to assume that conditions were particularly good when the longer flights were made but the converse is not necessarily true. Equally good conditions may have occurred on other days which might have been included in the ' ≥ 400 km list had there been sufficiently experienced pilots free to fly them. Meteorological data were taken from the *Daily Weather Report* and the *Daily Aerological Record*, supplemented by specially plotted charts and tephigrams on a few outstanding days. Low-level soundings made by balloon at Cardington were found useful for studying the changes in stability of the air between early morning and late afternoon but these soundings never reached the top of the convective layer on good soaring days.

CONDITIONS NEEDED FOR LONG CROSS-COUNTRY FLIGHTS

All the flights made use of the convective upcurrents known as 'thermals'. In the USA and New Zealand very long gliding flights have been made in lee waves or

along the slopes of extensive mountain ranges but the vast majority of cross-country flights over England relied on 'thermals' exclusively. On some days a few pilots were able to climb from thermals into waves which extended far above the convective layer but these flights represented only a tiny fraction of the total. These exceptions are not thought to invalidate the list of essential conditions which follows.

(a) Convective currents rising from the surface must be strong enough to lift a glider at 2 m s^{-1} (4 knots) or more. These currents must be distributed fairly regularly over a wide area and convective activity must continue for most of the day.

(b) Wind speeds in the convective layer must be low compared to the cruising speed of the glider. If the wind speed exceeds 10 m s^{-1} (about 20 knots) most pilots find it difficult to complete long closed-circuit flights.

(c) The cloud base must be high enough for glider pilots to continue their undulating progress of climbs and descents without the need to enter cloud or risk a premature landing. Almost all long cross-country flights oblige pilots to pass under or through airways radiating out from London and other major cities. Since gliders cannot be flown in accordance with Instrument Flight Regulations the pilots must remain well clear of cloud when crossing airways. In many cases this requires a pilot to stay 1000 ft below cloud.

Unless the cloud base rises to at least 1 km (approximately 3300 ft) by early afternoon it is difficult to complete a long cross-country flight and most good soaring days were distinguished by cloud bases of 1.5 km (5000 ft) or more.

FACTORS FAVOURABLE FOR CROSS-COUNTRY GLIDING

Previous trajectory of air mass

On most days the air over England had come from a colder region. The approximate direction from which the air had come was estimated from six-hourly charts and tabulated under eight directions. If the air appeared to have spent more than 24 hours over the country it was classified under 'local'. The results are shown in the following table.

TABLE I—FREQUENCY OF AIR TRAJECTORIES FROM DIFFERENT POINTS

	N	NE	E	SE	S	SW	W	NW	Local	Total
	<i>Number of days</i>									
Flights of										
200–399 km	16	3	15	2	0	1	16	18	17	88
≥ 400 km	29	14	5	0	0	1	15	16	7	87
All	45	17	20	2	0	2	31	34	24	175

The table shows that relatively warm winds from a southerly point very rarely provided good soaring conditions. Air from the north-east gave several outstandingly good days in spring or early summer when the freezing level was very low but subsidence and relatively dry air prevented shower development.

Wind speeds

If the wind in the convective layer exceeded 10 m s^{-1} (approximately 20 knots) the chance of a glider successfully completing a long closed-circuit flight appeared to be much reduced. Since wind speeds are given in knots for aviation purposes these units have been used in the following table.

TABLE II—FREQUENCY OF 850 mb WIND SPEED ON GOOD SOARING DAYS
(AT MIDDAY)

Flights of	Speed range (knots)								Total
	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	
	<i>Number of days</i>								
200-399 km	17	25	22	14	8	1	0	1*	88
≥ 400 km	11	33	25	12	5	1	0	0	87
All	28	58	47	26	13	2	0	1	175

The figure marked with an asterisk in the right-hand speed column of Table II represents an occasion when a pilot was able to make exceptionally good progress into wind by following a long line of active cumulus clouds (base 6000 ft). The line of rising air associated with such cumulus 'streets' often makes it unnecessary to circle to gain height.

It will be seen that more than 90 per cent of all flights took place when the 850 mb wind was not more than 20 knots. Closer examination of the strong-wind days showed that either winds were decreasing markedly between 12 and 18 GMT or there was a significant decrease in the wind just below the 850 mb level.

TABLE III—FREQUENCY OF 850 mb WIND DIRECTIONS AT MIDDAY
(FOR SPEEDS OF 10 KNOTS OR MORE)

Flights of	Wind directions								under 10 knots	Total
	N	NE	E	SE	S	SW	W	NW		
	<i>Number of days</i>									
200-399 km	10	12	4	2	2	8	6	9	35	88
≥ 400 km	12	13	7	1	2	0	8	9	35	87
All	22	25	11	3	4	8	14	18	70	175

It may be seen that the longer flights were very rare if the 850 mb wind was between south-east and south-west.

Curvature of isobars

The best soaring conditions were usually associated with ridges or small anti-cyclones. The curvature of isobars appeared to be one of the best single indicators of good soaring weather. It was found impracticable to set a strict numerical value to the curvature over a small area such as England because the majority of charts used were on a scale of 1 : 20 or 1 : 30 million with isobars at 4 mb intervals. In the following table the amount of curvature has been classed as either marked or slight. The six columns range from marked anticyclonic through straight isobars to marked cyclonic curvature. Areas with a very flat distribution of pressure were listed under 'no gradient'. These were often cols.

TABLE IV—FREQUENCY OF ISOBARIC CURVATURES ON GOOD SOARING DAYS

	Anticyclonic		Straight		Cyclonic	
	marked	slight	No gradient		slight	marked
	<i>Number of days</i>					
Flights of						
200-399 km	17	30	18	18	5	0
≥ 400 km	56	20	3	4	4	0
All	73	50	21	22	9	0

This shows that there was anticyclonic curvature on most of the cross-country days and the curvature was marked on most days when flights reached or exceeded 400 km. A survey of every day from March to mid-September 1976 showed that the days of most sunshine were associated with anticyclonic curvature. In most other less sunny years it was common to find that even a small and transient ridge prevented showers from developing in an apparently very unstable air mass.

Surface pressure

Above average values of surface pressure were often associated with anticyclonic curvature of the isobars. On good soaring days the mean sea-level pressure had an average value about ten millibars above the normal. On a few days a lower than normal surface pressure combined with an isobaric ridge allowed good soaring conditions to develop.

TABLE V—FREQUENCY OF MEAN-SEA-LEVEL PRESSURES ON GOOD SOARING DAYS

Flights of	Pressure range (millibars)						
	1001-05	1006-10	1011-15	1016-20	1021-25	1026-30	1031-35
	Number of days						
200-399 km	0	12	20	29	18	6	3
≥ 400 km	1	3	9	19	36	14	5
All	1	15	29	48	54	20	8

Nearly 80 per cent of the ≥ 400 km flights took place when pressure was in the range 1016-1030 mb. The peak in the range 1021-25 mb is more pronounced for the longer flights. All flights showed a sharp cut-off just above 1033 mb; this was probably due to anticyclonic subsidence bringing the inversion down well below 850 mb.

Pressure tendency

Pressure changes were small on the majority of good soaring days. If the passage of a cold front was followed by a large rise of pressure the arrival of good soaring conditions was often delayed until the approach of an anticyclone or its associated ridge. Several outstandingly good days occurred about 24 hours before the arrival of a warm front when the pressure was just about to fall.

TABLE VI—FREQUENCY OF PRESSURE CHANGES 09-12 GMT ON GOOD SOARING DAYS

Flights of	3-hour tendency (millibars)										
	+2.2 to +1.8	+1.7 to +1.3	+1.2 to +0.8	+0.7 to +0.3	+0.2 to -0.2	-0.3 to -0.7	-0.8 to -1.2	-1.3 to -1.7	-1.8 to -2.2	-2.3 to -2.7	-2.8 to -3.2
	Number of days										
200-399 km	1	3	9	6	17	31	15	3	0	3	0
≥ 400 km	0	1	3	11	22	32	11	6	0	0	1
All	1	4	12	17	39	63	26	9	0	3	1
											88
											87
											175

Nearly 90 per cent of all flights occurred on days when the midday pressure tendency lay within the range +1.2 to -1.2 mb.

Stability of the air mass

On most afternoons the air was unstable from the surface to above the 850 mb level but the depth of convection was restricted by a stable layer below the 700 mb level. The decrease of potential temperature between the surface and 850 mb has been found a useful indicator of the strength of thermals (Higgins 1963, Booth 1978). The average decrease of θ between the surface and 850 mb was 2.8 °C (standard deviation 1.88 °C) on ≥ 400 km days and 2.2 °C (standard deviation 1.60 °C) on 200–399 km days. These values are close to the figure of 2.54 °C quoted by Booth for the surface to 1500 m layer on days of good thermals. During the summer the height of the 850 mb surface is usually close to 1500 m. The superadiabatic lapse rate did not usually extend far above the surface and for most of its depth the convective layer had a near adiabatic lapse rate.

Humidity

On most good soaring days the air was relatively dry. Low humidity is normally associated with small amounts of cloud and a high cloud base during the afternoon. The most useful measure of humidity for gliding forecasts was found to be the difference between the dry-bulb temperature and the dew-point at the surface. When the surface temperature is rising this difference can be used to obtain the approximate condensation level (and hence the base of convective cloud) from a simple formula:

$$H = 400(T - T_d)$$

where H is the height in feet, T is the dry-bulb temperature in degrees Celsius and T_d is the dew-point in degrees Celsius. Although the values obtained from this formula are not exact they have been found to be fairly close to those reported by glider pilots for the general level of cumulus bases.

TABLE VII—FREQUENCY OF DIFFERENCES BETWEEN SURFACE DRY BULB AND DEW-POINT AT TIME OF MAXIMUM TEMPERATURE

	Temperature difference (°C)								Total
	7–8	9–10	11–12	13–14	15–16	17–18	19–20	21–22	
	<i>Number of days</i>								
Flights of									
200–399 km	5	8	21	25	9	12	4	4	88
≥ 400 km	1	7	29	19	21	6	3	1	87
All	6	15	50	44	30	18	7	5	175

From this one may infer that the general level of the cloud base rose to above 4000 ft (above 1200 m) by mid-afternoon on all but 12 per cent of days. Some forecasters may be surprised by the very high condensation levels implied by this table. On a number of days the air was too dry for any convective cloud to form, but there were numerous reports of cloud bases at or above 6000 ft (approximately 1800 m). During the remarkable drought in summer 1976 several glider pilots observed that the base of cumulus cloud was above 10 000 ft (approximately 3 km) on very hot days.

Lack of surface moisture

A large proportion of the net radiation received at ground level is absorbed as latent heat used for evapotranspiration when the surface is moist and covered

with growing vegetation. Less energy is converted into latent heat when the ground is dry; this leaves more sensible heat available for producing thermals. The effect of the long drought in summer 1976 was most marked. Large areas of country turned brown, showing that there was insufficient soil moisture for many plants to continue growing. Pilots found that thermals extended higher than usual and cross-country flights were possible on almost twice as many days as usual.

In contrast when the surface is covered by well-irrigated crops almost all the net radiation received during the afternoon may be converted into latent heat used for evapotranspiration (Brooks and Goddard, 1966). American glider pilots have reported that thermals are never found over or just to the lee of such irrigated areas in the middle west of the USA (Moffat, 1974).

When flights of 200–399 km were made the state of ground was reported as dry on 72 per cent of the days and there was no measurable rain on 92 per cent of the days. For flights equalling or exceeding 400 km the figures for dry ground were 76 per cent and for no measurable rain 97 per cent. These figures are similar to those reported for central France (Malpas, 1977).

Sunshine

It appears that a regular supply of thermals is unlikely unless there is bright sunshine for more than half the daylight hours. Some long flights have been carried out under an almost overcast sky but the distribution of thermals is seldom adequate and pilots usually have to fly slowly and waste time searching for upcurrents.

TABLE VIII—FREQUENCY OF HOURS OF SUNSHINE RECORDED ON GOOD SOARING DAYS

	Sunshine duration (hours)								Total
	0–1·9	2–3·9	4–5·9	6–7·9	8–9·9	10–11·9	12–13·9	14–15·9	
Flights of									
200–399 km	1	3	3	19	20	20	13	9	88
≥ 400 km	0	0	3	6	11	21	37	9	87
All	1	3	6	25	31	41	50	18	175

Seventy-seven per cent of the occasions when flights equalled or exceeded 400 km had 10 or more hours of sunshine.

Visibility

Good visibility is important to glider pilots both for keeping on track and for recognizing the areas of good and poor convective activity from the appearance of cumulus clouds ahead. Poor visibility not only hinders navigation and cloud recognition but often marks regions of reduced thermal strength. It is common to find that a decrease in visibility also coincides with weakening thermals and many pilots have remarked on the decrease in thermal strength in the areas of industrial haze downwind of large cities such as Birmingham.

It is probable that haze not only reduces insolation at ground level but also absorbs heat near the top of the haze layer. This reduces the lapse rate between the surface and the haze top and weakens convective mixing (Venkatram and Viskanta 1977, Glazier *et alii* 1976).

TABLE IX—FREQUENCY OF VISIBILITIES AT 12 GMT ON GOOD SOARING DAYS

	Visibility range (kilometres)								Total
	< 10	10-14	15-19	20-29	30-39	40-49	50-59	≥ 60	
	<i>Number of days</i>								
Flights of									
200-399 km	2	9	11	23	14	12	15	2	88
≥ 400 km	0	2	13	15	15	25	11	6	87
All	2	11	24	38	29	37	26	8	175

This table shows that only a small percentage of flights took place when the visibility was less than 15 km. The majority of long flights occurred on days when the visibility was better than 30 km.

SIMILARITIES BETWEEN SYNOPTIC SITUATIONS IN ENGLAND AND CONTINENTAL AREAS ON GOOD SOARING DAYS

Many of the synoptic features which were observed to produce good soaring conditions over England appeared to be equally effective over continental regions. Lindsay (1969) described weather types favourable for cross-country soaring over the eastern part of the USA but did not consider wind speed since practically all the flights were made downwind. Kreipl (1976) gave a number of synoptic charts showing the situation over Germany on record-breaking days. Malpas (1977) produced a statistical summary of days when pilots completed closed-circuit flights of 300 km or more over central France. He noted that the 850 mb wind was less than 21 knots on 90 per cent of days, southerly winds were the least favourable and the most commonly observed mean-sea-level pressures were in the range 1022 to 1025 mb.

DIAGRAMS FOR THE PREDICTION OF CROSS-COUNTRY CONDITIONS

The data from which the preceding tables were compiled have been combined to produce three prediction diagrams. These diagrams are divided into sectors marked GOOD, FAIR, POOR, BAD and NIL to indicate the prospects of a successful flight. The shape of the sectors depends on the position of the original plots; the size of the sectors depends on the number of days counted within the various boundaries. Sixty-five per cent of all days fell in the 'GOOD' sector, 15 per cent in the 'FAIR' sector and a further 15 per cent in the 'POOR' sector making a total of 95 per cent. The remaining 5 per cent were scattered in the sector marked 'BAD'.

Figure 1 is intended to show the cross-country prospects based on a combination of the past trajectory of the air and the future isobaric curvature. It requires a series of analysed charts together with the latest forecast chart. The previous trajectory of the air approaching the country is shown along the y-axis under eight main compass points. The expected isobaric curvature (obtained from a forecast chart) is marked on the x-axis. This curvature is divided into six classes indicated by symbols and letters. The classes range from markedly anticyclonic (A) through straight isobars (str) to markedly cyclonic (C). During the summer cols were sometimes associated with thunderstorms and for this reason a col was ranked between straight isobars and cyclonically curved isobars. Large thunderstorms may ruin the prospects for cross-country flights because a number of cumulonimbus cells can form a barrier which is both dangerous to cross and difficult to avoid.

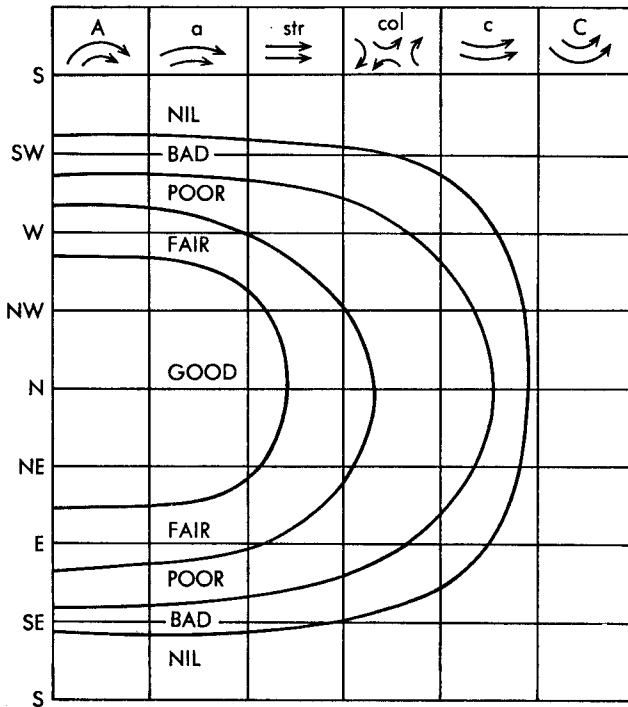


FIGURE 1—PROSPECTS FOR LONG CROSS-COUNTRY FLIGHTS BASED ON PREVIOUS AIR TRAJECTORY AND EXPECTED ISOBARIC CURVATURE

Figure 2 shows the effect of the 850 mb wind on the prospects for closed-circuit flights. The wind speed is shown along the x-axis and the wind direction along the y-axis. The adverse effect of a headwind varies in proportion to the cruising speed of the glider. The optimum cruising speed of a glider is calculated from its performance curves and the rate of climb, modified by any vertical motion of the air through which the glider is flying (Welch, Welch and Irving, 1977). The best speed at which to fly is usually displayed instrumentally and may vary between about 55 and 100 knots depending on the rate of climb. The greater the rate of climb the faster will be the optimum speed.

Strong thermals enable a pilot to climb rapidly and cruise fast between thermals. If thermals are weak the rate of climb will be slow and the optimum cruising speed correspondingly reduced. The pilot thus suffers a double handicap in weak thermals because the longer he spends circling in a thermal the further downwind he drifts and the slower is his optimum speed after leaving the thermal.

Figure 2 shows that when the wind direction lay in the sector from 290° through 360° to 070° the strength of thermals was often adequate for flights into wind. In contrast when the wind direction was southerly thermals were seldom adequate and the prospects of completing a closed-circuit flight were reduced.

Figure 3 shows the effects of the variation in stability and low-level moisture. The change in potential temperature between the surface and the 850 mb level at the time of maximum temperature is shown along the x-axis. Positive values

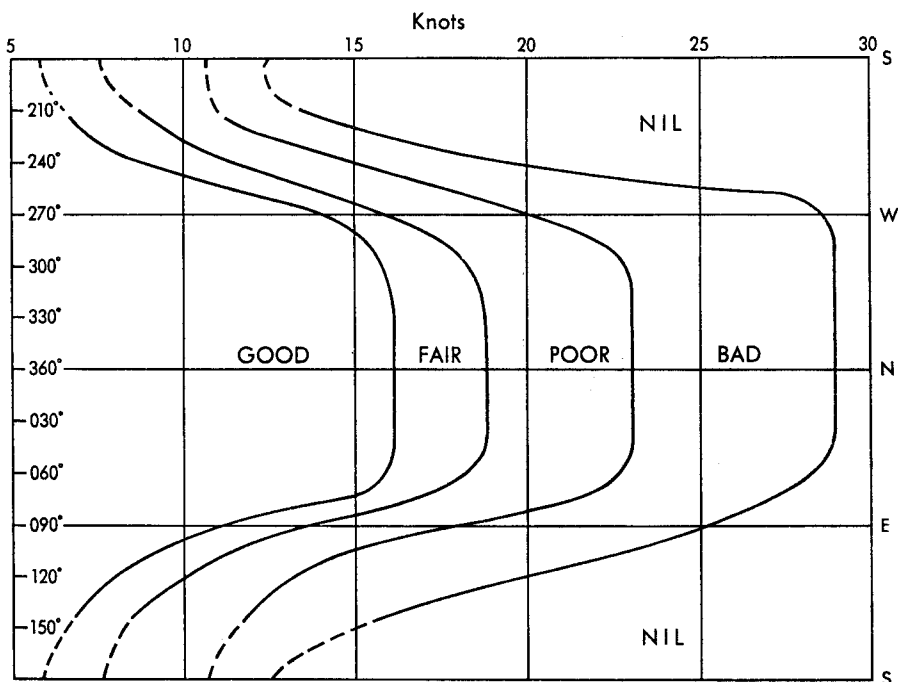


FIGURE 2—PROSPECTS FOR LONG CLOSED-CIRCUIT FLIGHTS BASED ON 850 mb WIND SPEED AND DIRECTION

indicate a superadiabatic lapse rate. The dew-point depression at the surface is shown along the y-axis. These two parameters were combined because it is important that the air should be both unstable and relatively dry for good soaring conditions. If the air is moist and unstable the condensation level will be low and the cloud amount is likely to become excessive.

There were a few days when the value $\theta_{\text{surface}} - \theta_{850}$ was negative, showing that a stable layer existed below the 850 mb level. On such days pilots often noticed that the base of the stable layer rose during the afternoon so that the midday sounding was not truly representative of conditions later in the afternoon. This effect has long been known (Ball 1960, Rayment and Readings 1974); it may have caused the degree of low-level instability to be underestimated on some occasions.

A METHOD OF COMBINING THE PREDICTION DIAGRAMS

The three prediction diagrams may be used in combination to derive a total mark for the day. The system proposed is rudimentary but it is hard to justify attempts at precise figures when assessing the chances of a project as uncertain as a gliding flight. Marks are allotted as 3 for a 'GOOD', 2 for a 'FAIR', 1 for a 'POOR' and 0 for a 'BAD'. If at any stage NIL is encountered the total mark is reduced to zero. After summing the marks for each diagram an extra mark is

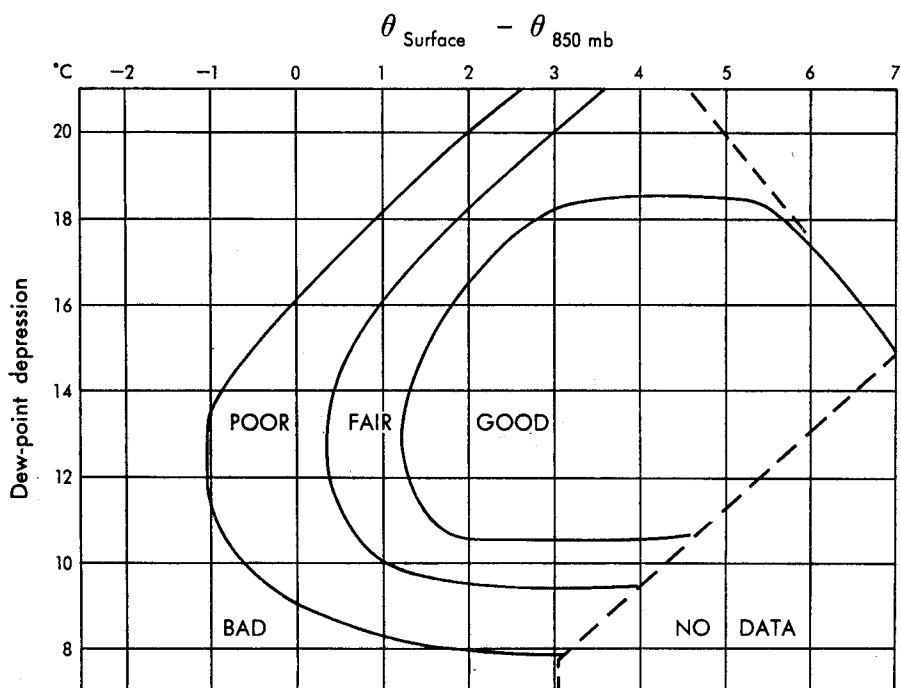


FIGURE 3—PROSPECTS FOR LONG CROSS-COUNTRY FLIGHTS BASED ON THE POTENTIAL TEMPERATURE DIFFERENCE BETWEEN THE SURFACE AND 850 mb AND THE DEW-POINT DEPRESSION AT THE SURFACE AT THE TIME OF MAXIMUM TEMPERATURE

allotted if the pressure lies in the favourable range 1016 to 1030 mb. This brings the total to 10 if every indication is favourable. When applied to ≥ 400 km days the marks fell as follows:

Marks	0	1	2	3	4	5	6	7	8	9	10
No. of days	0	0	0	0	2	4	9	10	15	21	26

It may be seen that more than 80 per cent of occasions scored 7 marks or more.

USE OF UPPER-AIR CHARTS

The 850 mb isotherms were found useful for estimating the advective changes to be expected in the convective layer. A cold tongue in the pattern of isotherms usually marked a region of vigorous convective activity. When this cold tongue lay beneath an advancing upper ridge the convection was usually confined to a relatively shallow layer because middle-level subsidence provided a 'lid'. Figure 4 shows an example of this type of situation. The 300 mb contours have been superimposed on the pattern of 850 mb isotherms. Particularly good soaring conditions were observed near the axis of the cold tongue at 850 mb.

It might be thought that lower than normal temperatures at the 850 mb level would be a useful indication of good soaring weather. This was nearly always

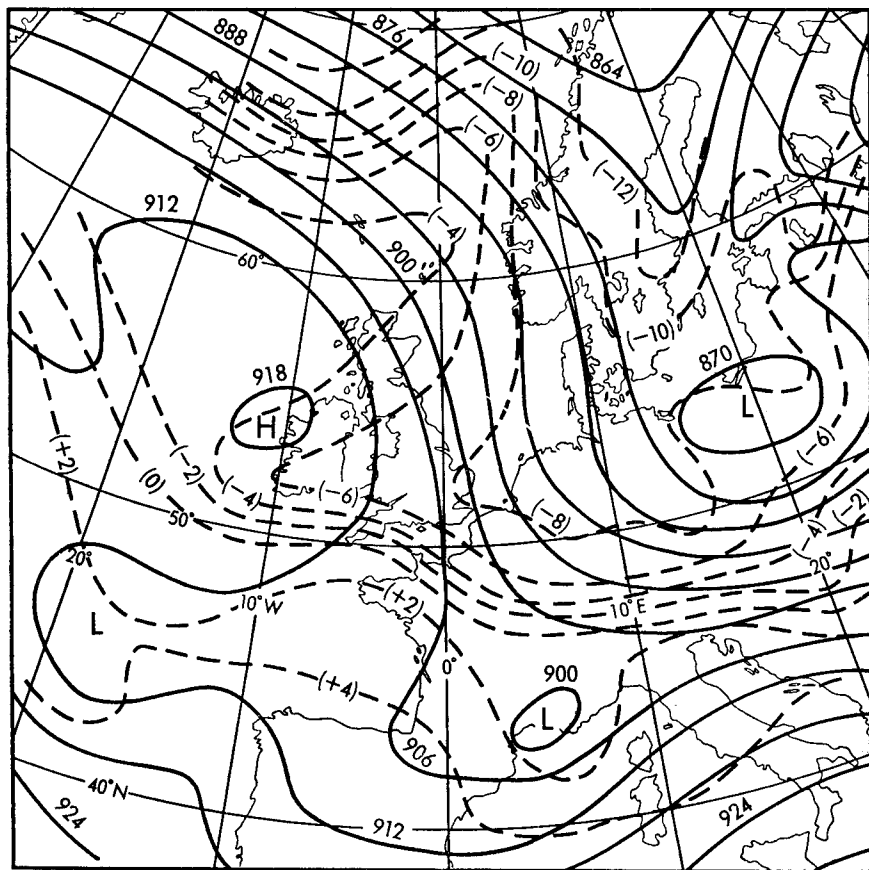


FIGURE 4—850 mb ISOTHERMS (DEGREES CELSIUS, PECKED LINES) AND 300 mb CONTOURS (DECAGEOPOTENTIAL METRES, FULL LINES) ON 28 APRIL 1976

Particularly good soaring conditions were observed where the cold tongue at 850 mb extended across East Anglia and the Midlands of England.

true for days when the longer flights occurred but not for shorter flights. Figure 5 shows the average 850 mb temperatures month by month for days on which cross-country flights took place compared with a 22 year average over the period 1956 to 1977.

During March, April and a number of days in May the temperatures on good soaring days were usually well below normal. In June, July and August, however, the temperatures were often above normal on days when shorter flights took place. These figures may have been biased by the unusually warm dry summer of 1976.

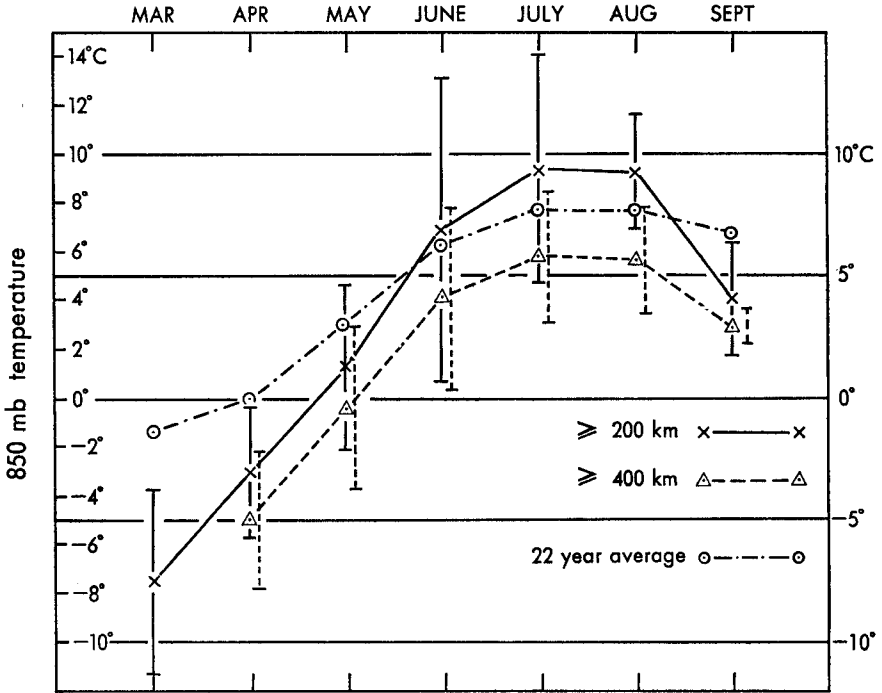


FIGURE 5—850 mb TEMPERATURES ON GOOD SOARING DAYS COMPARED WITH MONTHLY MEAN VALUES

The spread of values covered by one standard deviation is shown by bars. Those for the ≥ 400 km days are slightly offset.

EXAMPLE OF CONDITIONS ON AN OUTSTANDINGLY GOOD SOARING DAY

Figure 6 shows the surface chart for 12 GMT on 28 April 1976 when conditions were unusually good; one pilot completed a 760 km triangle and three other pilots exceeded 500 km. The various features of the situation were classified as follows:

Previous trajectory of the air:	From the NE
Isobaric curvature over England:	Marked anticyclonic
850 mb wind at midday:	065° 14 knots
θ_{surface} minus θ_{850} :	4.5 °C
Dew-point depression at surface:	17 °C
850 mb temperature:	-7 °C (7 °C below normal)
Sunshine:	13.8 hours
Mean-sea-level pressure:	1027 mb
State of ground: Dry. Overnight rainfall: Nil.	
Total marks (combined assessment):	10

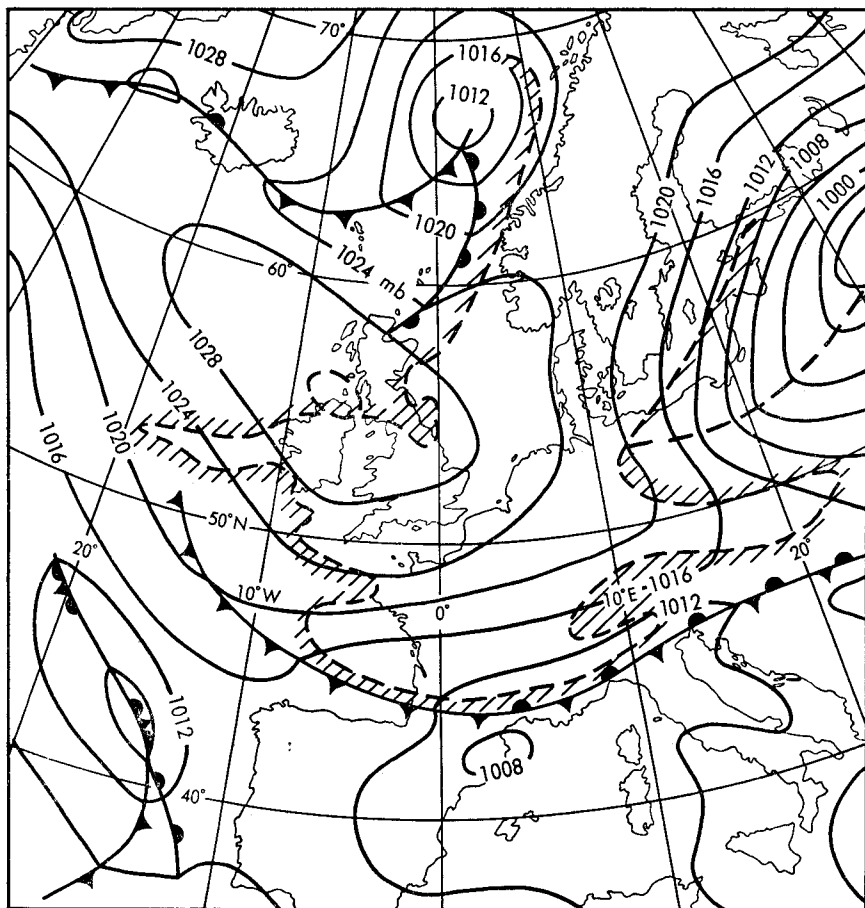


FIGURE 6—SURFACE CHART FOR 12 GMT ON 28 APRIL 1976

The pecked line with cross-hatching marks the boundary of major cloud masses seen on satellite pictures. Soaring conditions were outstandingly good over central and southern England.

SUMMARY OF CONDITIONS FAVOURABLE TO LONG CROSS-COUNTRY FLIGHTS OVER CLOSED-CIRCUIT ROUTES

Previous trajectory of air:	From NW, N or NE (never from the S).
Curvature of isobars:	Anticyclonic.
Mean-sea-level pressure:	1023 mb (plus or minus 7 mb).
850 mb wind:	Speed not more than 16 knots, direction between WNW and ENE through N.
Stability:	Potential temperature decreasing about 3 °C between the surface and 850 mb at time of maximum temperature. Depth of instability restricted by a stable layer below 700 mb sufficient to prevent any shower activity.
Surface dew-point depression:	11 to 18 °C by mid-afternoon.

Surface moisture and rainfall: State of ground dry at 06 GMT, no overnight rainfall.
 Sunshine: At least 8 hours bright sunshine.
 Visibility: More than 20 km.

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REVIEWS

The versatile satellite, by Richard W. Porter. 245 mm × 145 mm, pp. viii + 173, illus. London, Oxford University Press, 1977. Price: £4.95.

In the eleven chapters of this book Richard W. Porter, an American aerospace expert describes a range of 'earth centred' satellite applications. He begins with two short chapters on the history and principles of satellite flight which are followed by a chapter describing the constraints imposed on designs by the environment in which the satellite must function.

The main part of the book (Chapters 4 to 10) describes the use of earth-orbiting satellites for communication, navigation, remote sensing of the atmosphere, the earth and its inhabitants, and astronomy. He concludes with two short chapters on manned flight and 'thoughts for the future'.

It is obvious from the wide scope covered in only 173 pages that the treatment cannot be detailed in any specific area. The author intends the book to be descriptive rather than mathematical and unlike the authors of some attempts at 'popular' treatments he succeeds in conveying information in a way that is readable and comprehensible without doing violence to basic physical concepts. In

particular Chapter 2 entitled 'Overcoming gravity' gives a very simple yet accurate account of the way in which a satellite can be injected into orbit.

The part of the book of most direct interest to Meteorological Office readers should be Chapter 5 entitled 'Watching the weather'. Here a serious drawback of the book, also obvious in other chapters, becomes apparent: the discussion of current satellites is considerably out of date, extending only to about 1974. Despite this failing, this chapter contains useful descriptions of both imaging and temperature and humidity sounding techniques using visible, infra-red and microwave radiation.

Chapter 7 entitled 'Surveying the oceans and the land' contains a useful description of the capabilities of the first 'Landsat' Earth Resources Satellite. It includes some interesting images of south-east England on a remarkably cloud-free day in March 1973, illustrating the way in which information can be extracted from the various wavebands used.

In these cost-conscious times it is surprising, especially from an author who was the manager of the (American) General Electric Company's Aerospace Group, that no attempt is made in the book to evaluate the economic benefits of satellites. Perhaps this proved too difficult, or the book was written in more affluent times!

To summarize, this book is readable, informative and well presented both in text and photographs. It covers a wide area for such a short book and should be considered as general background reading about earth satellites. Used as an introduction to the subject it has a major drawback in having no references to more detailed texts. It also has a rather rudimentary index.

J. L. BROWNSCOMBE

Waves in fluids, by James Lighthill. 230 mm × 150 mm, pp. xv + 504, *illus.* Cambridge University Press, London, 1978. Price: £17.50.

In view of Professor Sir James Lighthill's reputation it is predictable that this review should be most favourable. Apart from personal satisfaction my efforts in reading have done little more than verify that the prologue by the author is accurate in terms of describing the contents and objectives of the book. It is intended for research workers concerned with wave motions in fluids as well as providing a text for courses at graduate and final year undergraduate level. The most striking aspect of the book is not the extent to which it reaches or explores research frontiers but the depth and thoroughness of the basic material. These fundamental ideas which are often assumed in texts with more specific applications are essential to a real understanding of waves in fluids.

The chapter headings 'Sound waves', 'One-dimensional waves in fluids' and 'Water waves and internal waves' should *not* be taken as implying a detailed discussion of these phenomena. Practical applications are fully indicated but within the chapters the main theme is of progressively developing fundamental ideas. These begin with non-dispersive waves for which the ideas of linearity and energy transport are introduced. Consideration is then given to the two limits of wavelength, that is to say sources small compared with wavelength and systems large compared with wavelength. Attenuation effects are also considered. The second chapter considers flows in ducts and then proceeds to non-linear effects in non-dispersive systems. Non-linear effects in dispersive systems are not considered in any detail although the prologue contains a brief introduction to this

difficult field. The section on water waves enables dispersive systems and the idea of group velocity to be considered. The section on internal waves concentrates on internal gravity waves so as to enable a non-isotropic system in which group and phase velocities are in different directions to be considered. This is the extent of the basic material. The epilogue contains a brief but useful introduction to more advanced ideas including the combined effects of non-linearity and dispersion.

The book is thus not really for people wanting a brief outline of current ideas but is intended for those wishing to pursue matters in depth. The exercises given at the end of each chapter present some challenges and serve to illustrate the utility of the material presented. Owing to the clear physical interpretation much will be gained from the book by non-mathematicians but some sections will be opaque without experience with functions of complex variables and Fourier integrals.

In summary Professor Lighthill's book should become one of the standard works in fluid dynamics. It will be of value to all concerned with wave motion and meteorologists will form only a small part of the readership. The greatest benefit will go to students inasmuch as those already engaged in some research seldom find the time to give such a thorough but basic book the time it deserves.

P. J. MASON

NOTES AND NEWS

The Mk 3 radiosonde system is handed over

Friday 30 June 1978 marked the formal end of a long and often difficult road that started in 1958 with the decision to develop a new radiosonde system to replace the Kew Mk IIb. The Mk 3 radiosonde development ground station and the full, operational computer program for routine network stations was offered by Ferranti Computer Systems Ltd (FCSL) and accepted on behalf of the Meteorological Office by the Director of Services, Mr F. H. Bushby.

The Ministry of Defence Project Authority was the Directorate of Strategic Electronic Radar (DSLRL), which was represented at the handover ceremony by Mr B. O. Penny, AD/SLR 3. Following the handover, a demonstration of the system was witnessed by the Ferranti and MOD personnel.

Operational stations have been converting to the new system at the rate of about one a month since February 1978 and the final station was converted in September 1978. The system is fully automatic and the standard TEMP messages are produced in near real time, fully coded and ready for dispatch from the radiosonde station to the telecommunication centre at Bracknell. (See Plates IV-VI.)

R. E. W. PETTIFER

Meteorological Magazine: price increase and change in page size

As from January 1979 the price of an issue of the *Meteorological Magazine* will be £1.30 and the annual subscription £16.74 including postage. The page size will be increased from Royal Octavo (246 × 156 mm) to Crown Quarto (246 × 189 mm).

OBITUARY

Mr J. C. Gordon

With the death on 19 August 1978 of Mr J. C. Gordon, Chief Meteorological Officer, Headquarters, Strike Command, the Meteorological Office has lost an outstanding military meteorologist and the Royal Air Force an able staff officer and a staunch friend. He had become widely known and respected by operational meteorologists in this country and overseas who will long remember him for his wisdom, tact, good judgement and humanity.

John Calder Gordon graduated at Edinburgh University, gaining an M.A. with honours in mathematics and physics in 1951. Earlier however, during 1946–48, his studies at the University had been interrupted by service in the Royal Air Force as a meteorologist. After forecasting training early in 1946 he received several postings as Pilot Officer and later Flying Officer, to airfields in eastern England. Subsequently he spent nine months at Air Headquarters in India, returning home in June 1948 for release from military service and the resumption of his studies. He rejoined the Office in 1951 as Scientific Officer and from the outset he made it known that he was interested in making his career in forecasting services and was not attracted by the opportunities in research that were then expanding. For a number of years he filled senior forecasting posts at major forecasting offices, notably at Prestwick Airport, London/Heathrow Airport, Malta and Nicosia (Cyprus). His ability as a forecaster was recognized in 1964 by his posting as Senior Forecaster in the Central Forecasting Office at Bracknell with promotion to Principal Scientific Officer.

In 1967 he resumed his association with the Royal Air Force on appointment as Chief Meteorological Officer at the Headquarters of the Far East Air Force in Singapore, where he quickly established the excellent working rapport with colleagues, meteorological and military alike, that was a hallmark of the staff and administrative work which he undertook in the remainder of his career. After a brief spell at Headquarters, Air Support Command, Upavon on his return to this country in 1971, he was selected to attend a course at the National Defence College. This led to further spells of Headquarters administration in the Defence Services and Central Forecasting branches at Bracknell. He reached the culmination of his career on appointment as Chief Meteorological Officer at Headquarters Strike Command in June 1976 with promotion to Senior Principal Scientific Officer. Rarely has a man been better suited by his talents, experience and personal qualities for his post.

Johnny Gordon had a huge capacity for making the most of life. A major pastime was golf and it was on the golf course whilst playing with friends and colleagues that he died. His great good humour was tempered with unselfishness and concern for others. As was said in a tribute by a U.S. Navy meteorologist at NATO, those of us who had the good fortune of serving and working with Johnny are richer by far for the experience. Our heartfelt sympathy is extended to his wife, Morag, herself a one-time member of the Office, and to his three children.

D. H. JOHNSON

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NOTICES

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