

6 June 1944

D-DAY

The role of the Met. Office



How weather played a critical part in the Normandy landings



Front cover. Moderate seas as Allied forces land in France. The RAF provided a constant low level anti-aircraft balloon barrage over landing craft, over the beaches and inland as troops moved forward.

Imperial War Museum

▼ Four Typhoon fighters returning from a sortie beneath 9/10 Altocumulus. © Crown Copyright/MOD

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Imperial War Museum.

FOREWORD

By Professor Julian Hunt, Chief Executive of the Met. Office

"Some are weather-wise, some are otherwise"

Benjamin Franklin

(1706–1790)

The success and failure of invasions and large military expeditions between the British Isles and the continent of Europe have always depended on the weather: Julius Caesar, William of Normandy, Edward III, Henry V ("Fair stood the wind for France"), Henry VII, the Spanish Armada, William of Orange, Marlborough, Napoleon, the British Expeditionary Force at Dunkirk in May 1940, and Hitler in the autumn of 1940 all faced the problem and had varying degrees of success and luck. Modern meteorology aims, of course, to ensure that weather forecasts help a commander make his own good luck.

I am proud to endorse this little history of the role of the weather in the 1944 Normandy landings and the part meteorologists played in this critical event in the history of the twentieth century. On both the German and the Allied side, meteorologists during the Second War were given great resources to meet an evident need and, by and large, served their nations well. The role of Group Captain Stagg of the Met. Office in the dramatic weather-dependent decision to launch the D-Day assault on 6 June 1944 is well known: advice to the weather-wise American Supreme Commander, General Eisenhower, was, however, the tip of the iceberg. All operations received weather advice, which was always most difficult to give and yet most important for the recipient when the weather was close to tolerable limits. None would have been possible without the whole network of observing stations, telecommunications, training, research, administration and international co-operation. In some ways wartime meteorology laid the foundations of modern weather forecasting throughout the world.

I dedicate this booklet to the meteorologists of all nations who took part in the Second World War, but especially to the seventy members of the Meteorological Office who gave their lives.

Julian Hunt



OPERATION NEPTUNE

EARLY in 1944 Britain and the Soviet Union were the only European countries which were neither neutral nor occupied by Nazi forces. But preparations for the Allied recovery of Europe to be spearheaded from the west had been under way for many months: Operation Overlord. The first step, the crossing of the English Channel for a foothold on mainland Europe, was code-named Operation Neptune. Chartered meteorologist and ex-Met. Office forecaster of 46 years' experience, STAN CORNFORD, sets the weather scene for 6 June 1944.

First Met. flight. Spitfire ready for the pre-dawn take-off from a recaptured airfield in France.
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CHURCHILL, Roosevelt and Stalin agreed at the Tehran conference that June would be the month for the Soviet summer offensive in the east. General Dwight "Ike" Eisenhower set 5 June 1944 as the date for the assault in the west, "subject to last-minute revision in the event of unfavourable weather."

The assault on Normandy needed a moonlit night, dawn at low tide, good visibility, light winds and little low cloud throughout the day and for several following days.

For central planning and advice the broadly acceptable minimum weather conditions were:

D-Day should be within one day before, to four days after a full moon

D-Day itself should have quiet weather, followed by a sequence of three quiet days; wind should be less than Beaufort Force 3 (8-12 m.p.h.) onshore and Force 4 (13-18 m.p.h.) offshore.;

D-Day should have cloud cover of less than three-tenths below 8,000 feet and visibility more than three miles; there could be a cloud base generally above 3,000 feet but with morning mist or fog not excluded.

Astronomical and tide tables showed tide and moonlight would combine favourably on 5, 6 and 7 June. The tide, but not the moonlight, was right again two weeks later.

Because of the combination of conditions needed, climate research revealed that the odds from the outset were at least 13-to-1 against the wind and weather being even broadly acceptable.

The need to have a full moon - for low tide beach mines and obstacles identification at sunrise - roughly trebled those odds.

A full moon, to help airborne forces' pre-dawn landings, doubled the odds again.



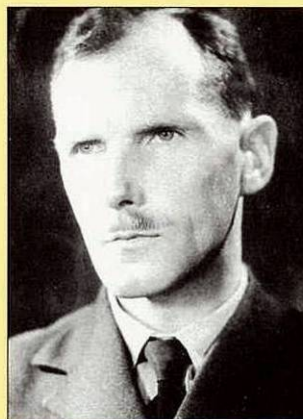
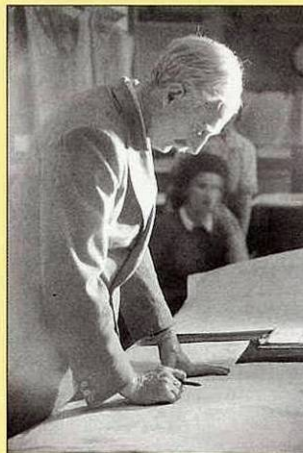
An anti-aircraft balloon leaving a landing craft for the beaches.
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▼ CKM Douglas OBE AFC MA, senior forecaster at Dunstable. His wise assessments, legendary memory and cogent physical argument helped form the forecasts for Neptune.
Imperial War Museum.

▼ Group Captain Stagg CB OBE DSc FRSE (RAF and Met. Office). General Eisenhower's Chief Meteorological Officer. © Crown Copyright/MOD

▲ Supreme Commander Eisenhower.
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During the planning phase, it became clear that General Eisenhower would need forecasts for seven days ahead. In fact, throughout the war, British researchers and forecasters worked hard to produce seven-day forecasts. Such forecasts, however, could not be made with the available knowledge and tools.

By the last week of May, the Supreme Commander and his staff at his Southwick Park, near Portsmouth, headquarters knew that the weather was going to be the most important remaining unknown factor for the operation's success.

With increasing frequency the three armed Services' met. representatives tried to bring together the views of the forecasting centres' using "scrambled" telephone conferences, trying to foresee each critical weather element.

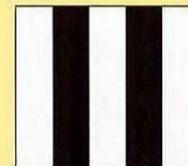
They were Dr J M Stagg (RAF and Met. Office), Col Donald N. Yates, US Army Air Forces, his deputy, and Royal Navy Instructor Commander John Fleming, meteorologist to the Naval C-in-C Allied Expeditionary Force.

This team presented its assessments to Eisenhower, his Cs-in-C and their Chiefs of Staff. Comparing each of these "agreed forecasts", the commanders learned how to assess them.

DAY-TO-DAY DELAY

The weather was fairly settled for most of May. Early June brought unseasonably unsettled westerly winds, with moving low pressure areas and weather fronts. Agreement became rare among the meteorological experts.

At 2130 hours Double British Summer Time (1930 hours GMT) on Saturday, 3 June it was still daylight. Forecasting centres had for once reached reasonable agreement at their usual scrambler telephone conferences. Group Captain Stagg told General Eisenhower he expected that the weather would be too bad for



landings on the other side of the Channel on the first choice for D-Day, Monday 5 June.

High pressure over France and low pressure further north would maintain strong south-westerly winds in the Channel. There would be rough seas and too much cloud for successful bombing operations.

Eisenhower had to take into account that ships had begun loading two days earlier. Putting back into harbour and unloading would give rise to mishaps. And to start so great an operation and then stop it could not be kept secret.

Bombardment of southern England by pilotless aircraft - V1s - was imminent; the next favourable tides in mid-June might produce even less satisfactory weather.

That Saturday evening, Eisenhower decided to "hold up Operation Neptune on a day-to-day basis". Following an early briefing the next morning, he confirmed this decision. Convoys at sea were ordered to put about.

TEMPORARY WEATHER WINDOW

At 2130 hours DBST the next evening, as Eisenhower and his battlefield commanders assembled in Southwick House, Allied troops had been entering Rome.

Each C-in-C had, as usual, already been briefed by his own met. adviser.

Outside, there was driving rain.



► The crew of a Whitley Bomber, tasked to search and destroy U-Boats, being briefed by a civilian forecaster. Note the censor has blocked out the date and many of the weather details. © Crown Copyright/MOD

▲ Met. WAAFs on the control tower roof at a busy airfield about to measure upper winds using pilot balloon, theodolite and slide rule. Imperial War Museum.

◀ WAAF measuring the wind at cloud level using the Besson Comb Nephoscope. Imperial War Museum.



▲ Field Met. Unit, taking temperature reading and drawing chart. © Crown Copyright/MOD

◀ Meteorological flights were made routinely by RAF Coastal Command. The observer checks his wet- and dry-bulb thermometers before take-off. © Crown Copyright/MOD



The cold front giving the rain had been unexpected earlier. It was now moving south-eastwards and would clear the assault area within two or three hours. This would have precluded airborne operations had the meeting 24 hours earlier chosen 5 June as D-Day.

However, a ridge developing behind the front could provide a temporary window in the unsettled weather over the Channel and assault area just for the critical hours of Tuesday, 6 June.


The strong winds would moderate during Monday and that night and at H-hour on Tuesday morning, the weather would be suitable for heavy bomber operations.

Operations later on Tuesday could be curtailed by large areas of cloud, but the cloud was likely to be high enough to enable the fall-of-shot to be spotted for the naval heavy guns.

Stagg was confident a fair interval would follow the front but, beyond that, he was not so confident in the generally stormy weather patterns over the Atlantic quietening down after Tuesday. But there was a reasonable chance that the Azores anticyclone might extend northwards again.

Eisenhower asked how many hours he could count on for the attack. Stagg replied that the morning would be fair and good weather might last throughout the afternoon. Asked for his opinion by Eisenhower, Field Marshal Montgomery said: "I would say 'Go!'" The order was given.

For a second time, a decision had been made on the basis of a weather forecast which was very different from that the commanders could see and hear for themselves.



Nevertheless, the forecast was maintained and the order confirmed after a briefing early the next morning.

As he had in North Africa and Sicily, Eisenhower, having taken the best available meteorological advice very carefully, was again knowingly launching an invasion in weather which many thought unsuitable.

THANK THE GODS OF WAR

Less than five hours later, at 0900 on 5 June, the first convoy left Spithead. The west wind blew at Force 5. This tested landing craft crews and was unexpected by many in the Army, who thought that an invasion needed fine weather and a calm sea.

On 6 June, wind and weather permitted night-time airborne operations and during the hour before the landings large areas of clear sky allowed visual bombing of the shore defences.

The sea was still rough and many men were sick during their 17-hour crossing. Waves caused some of the landing craft to lag and there were some losses, especially of tanks fitted with special flotation skirts. A hazy fog over Normandy cleared around midday.

German meteorologists, too, had been preoccupied with tides, wind and weather. A special group made forecasts in anticipation of the invasion. The military had set down tide, light, wind and weather limits which they judged were the minimum needed by the Allies.

If conditions looked likely to favour an early hours assault at any particular point along the Atlantic Wall, troops there were alerted.



▲ Met. WAAF makes the hourly readings of wet- and dry-bulb temperatures in the Stevenson screen. © Crown Copyright/MOD

◀ RAF Stirling aircraft in their D-Day livery line up in preparation for dropping paratroops over France. © Crown Copyright/MOD

▶ Flying Control at RAF Hendon with met. information displayed. QFE, QFF and wind direction and speed. © Crown Copyright/MOD

Main picture. Troop-carrying gliders and their tugs approach the French coast in a fair weather cloudscape of cumulus and stratocumulus. Imperial War Museum.



During 4 and 5 June, the tides favoured landings on the Normandy coasts and German meteorologists correctly judged that wind and weather would be worse than their instructions told them that the Allies could tolerate.

The first observation from the Normandy beach-head was from Sword Beach, north of Caen, for 1500 Double British Summer Time, some 7.5 hours after the first landings. It was mainly sunny, with a north-westerly wind at Force 4, small amounts of broken cumulus cloud above 4,000 feet, good visibility and a temperature of 59 degrees Fahrenheit (15°C).

Later, in a memorandum accompanying an official report to Eisenhower on the meteorological implications of 6 June as the day chosen for the invasion, Stagg commented that had Neptune been delayed until the next suitable tides the troops would have run into the worst Channel weather for 20 years.

"Eisenhower wrote across the bottom of the memo: 'Thanks, and thank the Gods of War we went when we did.'"

On 6 June 1944, sound, well-judged, weather advice, well-assessed by a well-led team of experienced decision-makers, had worked for the Allies in the west and given them the element of surprise.

On D-Day, Churchill told the House of Commons that Operation Neptune was "the most complicated and most difficult that has ever taken place. It involved tides, winds, waves, visibility, both from the air and the sea standpoint, and the combined employment of land, air and sea forces in the highest degree of intimacy and in contact with conditions which could not and cannot be fully foreseen."

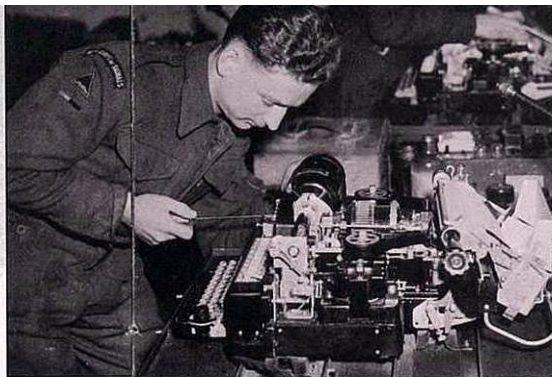
Three days later, in the east, Stalin synergetically launched the first large Soviet offensive of 1944.

The crossing to Normandy was the first step in the long march of Hitler's last summer.

'WHENEVER WEATHER PERMITTED...'

WHEN war broke out, weather forecasts for the public (and the free and open international exchange of weather information) were suppressed. But meteorological advice was made available to all levels of government and command. As in peacetime, it was the large extent of weather events which made them a formidable enemy. "Whenever the weather permitted" recurs in many commanders' reports.

Most commanders had met. advisers, sometimes down to individual airfield and ship level. Each arm of the Forces had its own detailed requirements for combinations of elements such as tide, wind, sea states, moonlight, daylight, visibility, cloud and icing. Often, because of the war and especially over the North Atlantic, essential data were missing. Also, technology had only recently allowed proper three-dimensional measurements of the atmosphere



and then, only where there was air supremacy. Nevertheless, each commander received the best and most detailed weather advice possible for planning and for immediate operations.

Meteorologists organised observing systems and telecommunications networks, arranged weather intelligence and, as staff officers, used their scientific understanding not only to make forecasts as accurate as possible but also to get them properly understood and evaluated. They improved the effective use of people and weapons systems.

Seventy members of the Met. Office gave their lives and are commemorated in the present headquarters at Bracknell in Berkshire.

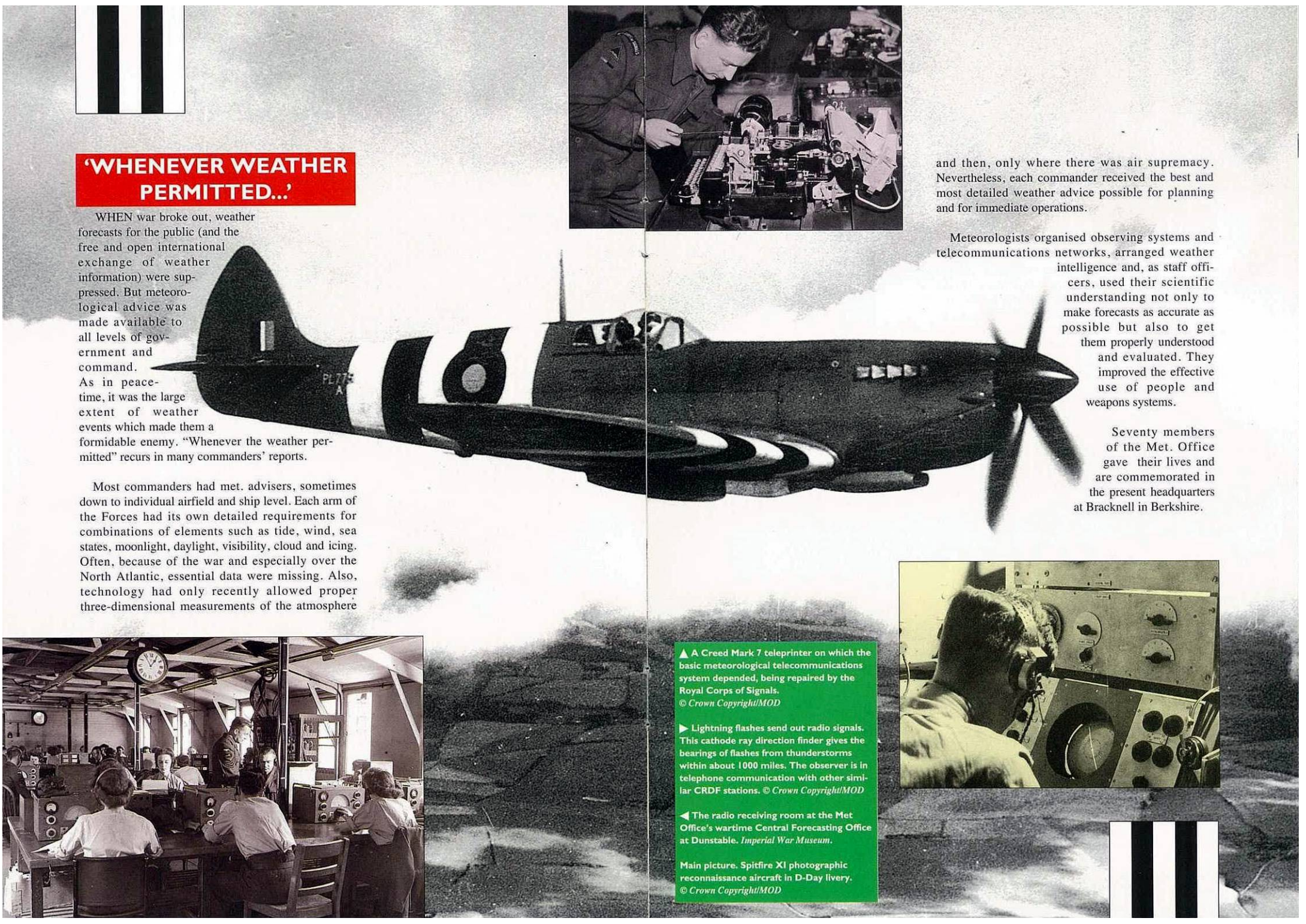
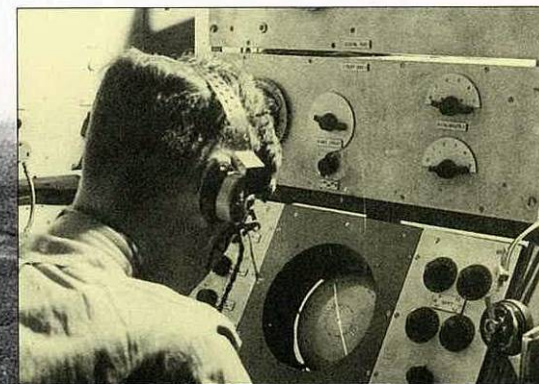


▲ A Creed Mark 7 teleprinter on which the basic meteorological telecommunications system depended, being repaired by the Royal Corps of Signals.
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► Lightning flashes send out radio signals. This cathode ray direction finder gives the bearings of flashes from thunderstorms within about 1000 miles. The observer is in telephone communication with other similar CRDF stations. © Crown Copyright/MOD

◀ The radio receiving room at the Met Office's wartime Central Forecasting Office at Dunstable. Imperial War Museum.

Main picture. Spitfire XI photographic reconnaissance aircraft in D-Day livery.
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BOMBERS AND BOMBARDIERS NEEDED THE WEATHERMAN

THE RAF maintained flights especially to provide observations needed for weather forecasts. Some made climbs over one place to get vertical profiles of pressure, temperature and humidity. Others made long flights over the Atlantic and into hostile airspace.



▲ Mosquito aircraft in clear air above scattered small cumulus. These unarmed aircraft made meteorological and photographic reconnaissance flights deep in hostile airspace. © Crown Copyright/MOD

▼ Civilian Met. forecaster briefing a crew before a flight out over the Atlantic. © Crown Copyright/MOD

Main picture: Wellingtons of a Polish Squadron of the RAF. A number of Polish forecasters stayed on in the Met. Office after the war, mostly serving in Flying Training Command. © Crown Copyright/MOD



The meteorologists' customers were many and varied. Bomber aircraft navigators needed to know what winds and temperatures to expect on their routes and air pressures aloft over their targets.

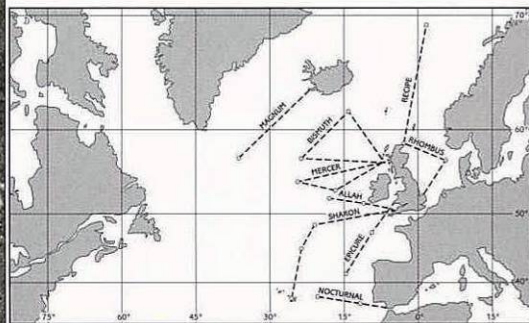
In choosing targets, commanders needed to know if bombing would be visual or through cloud using radar. They also needed to assess how weather was likely to affect the enemy's activities. On the ground, artillery needed to know the winds and temperatures which would effect the flight of shells.

Commanders of fighter-bombers needed to know if it would be worth sending out aircraft over hostile territory to carry out attacks against ground targets, such as flying bomb launch sites and supply-carrying trains.

To meet such needs, in 1944, there were three meteorological services operating in the UK. The Met. Office, the Royal Navy's Naval Weather Service and the weather service of the United States Army Air Forces (USAAF).



1944 METEOROLOGICAL RECONNAISSANCE FLIGHTS



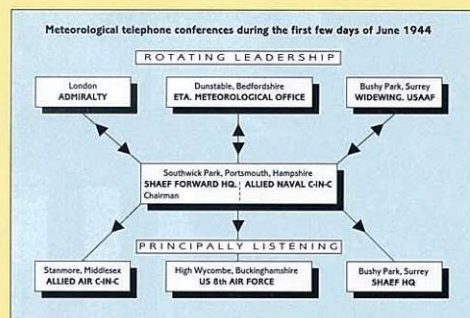
MANY of the Met. Office's wartime forecasters were schoolteachers, mainly of mathematics and physics. Throughout, the Met. Office remained a civilian establishment of the Air Ministry, although most operational staff were in RAF uniform by April 1943.

The Royal Navy separated out its own weather service from the Met. Office's naval division when the Admiralty created the Fleet Air Arm in the years immediately before the Second World War. The Naval weather service shared much of the same telecommunications infrastructure and rested on the same science base as the Met. Office. Its forecasting centre was at the Admiralty. Ashore and afloat, forecasters in the Navy held commissions in the instructor branch, as they still do.

The USAAF weather service had its UK headquarters and forecasting centre at Bushy Park, Teddington, known as Widewing.

The meteorological organisation for Overlord is shown below.

The wise commander learned how to make the forecasts work for him. The most senior knew that intelligence sources often provided weather observations for German-occupied and neutral territory. They were distributed to larger forecast offices by teleprinter on a strict “need-to-know” basis.



▲▲ Met. Students under training. Learning to identify the various types of cloud. © Crown Copyright/MOD

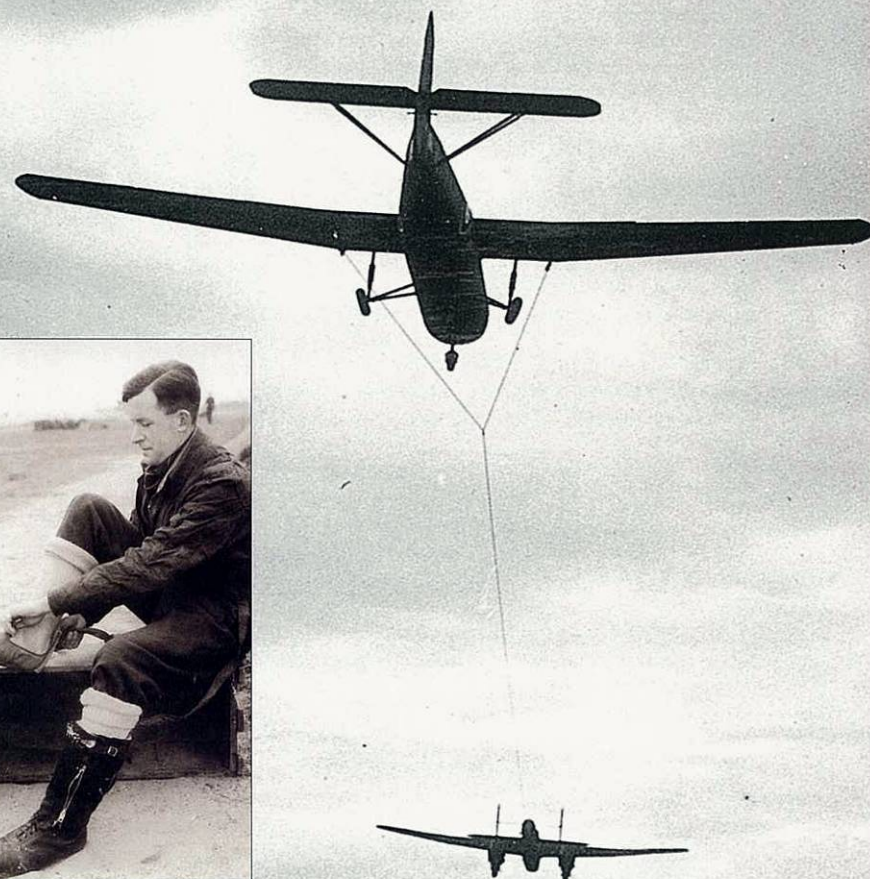
▲ Punched paper tape enabled teleprinters to transmit weather messages quickly and accurately.
Imperial War Museum

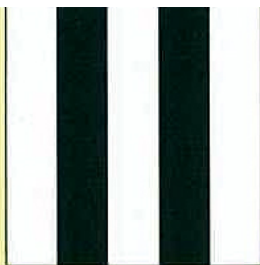
▼ Met. WAAF records signals from a sounding balloon to give measurements of temperature, pressure and humidity in the upper air. © Crown Copyright/MOD



▲ W/O P.J. Griffiths pilot of a met. high altitude flight, putting on his electrically heated gloves and socks which are then connected to his electrically heated jacket. © Crown Copyright/MOD

Main picture. A Whitley towing a troop-carrying Horsa glider beneath a layer of stratocumulus cloud formed by the spreading out of cumulus.
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CALM PERIODS WERE RARE

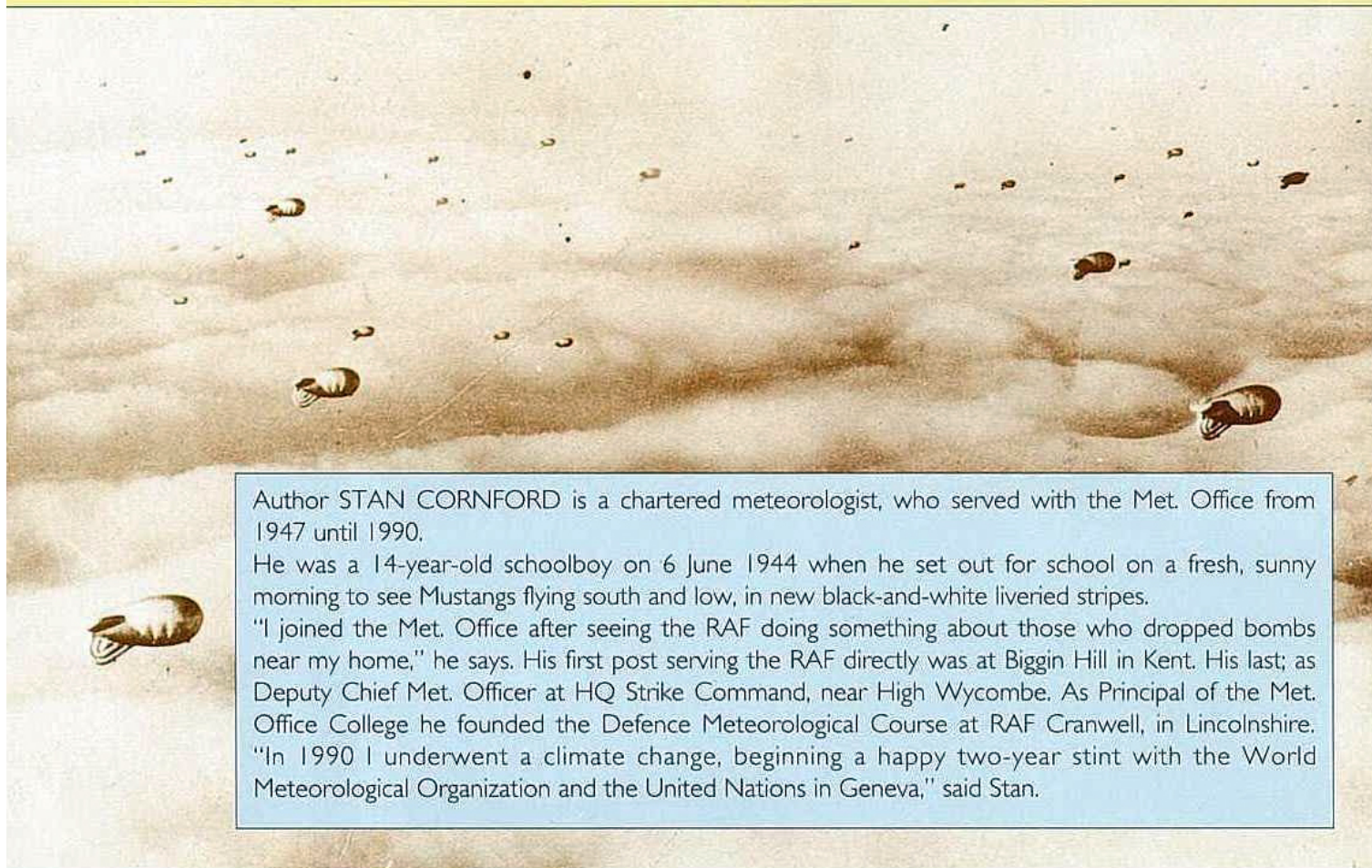
IN practice, in 1944 in Europe, even given a good coverage of the latest pressure, temperature, wind, sea state, visibility and cloud observations, forecasts could be made, with some uncertainty, only out to 24 hours ahead and even greater uncertainty to 48 hours.. Indeed, half a century later, forecasting for the period five to ten days ahead is still a topic of active research.

Military planners in those early war years were aware that in the autumn of 1940, a succession of postponements of the German invasion of Britain, Operation Sea Lion, had achieved nothing. The Germans thought they needed a relatively long period of almost flat calm - similar to the one which blessed the British evacuation from Dunkirk in May 1940. Such periods were rare; when forecasters could predict the beginning of one they were unable to say how long it would last.



▲ Met. Assistant helps the forecaster prepare a synoptic chart. *Imperial War Museum*

▼ Balloon barrage mounted against the flying bombs. Balloons were prone to be struck by lightning and to break their moorings in strong winds.
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Author STAN CORNFORD is a chartered meteorologist, who served with the Met. Office from 1947 until 1990.

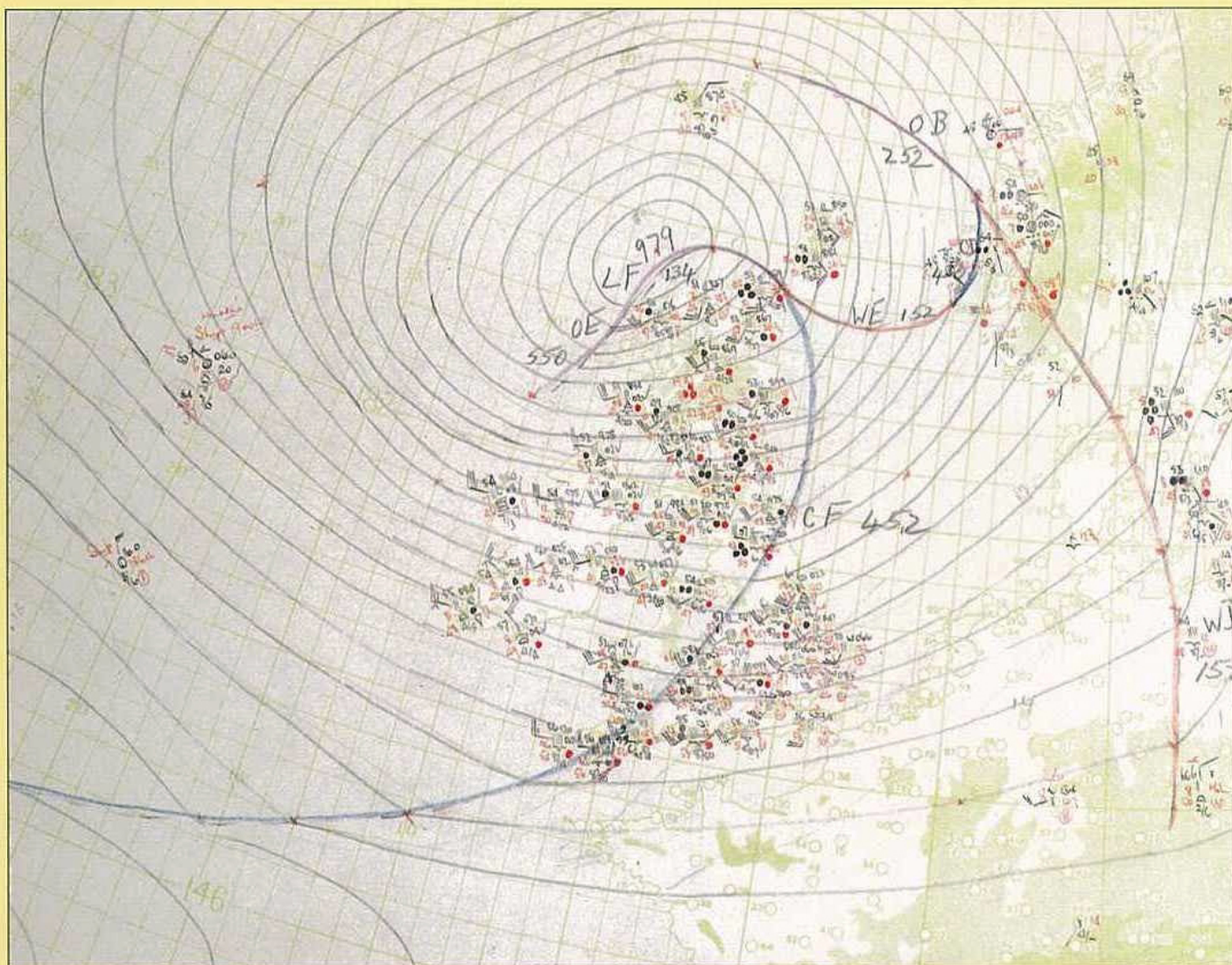
He was a 14-year-old schoolboy on 6 June 1944 when he set out for school on a fresh, sunny morning to see Mustangs flying south and low, in new black-and-white liveried stripes.

"I joined the Met. Office after seeing the RAF doing something about those who dropped bombs near my home," he says. His first post serving the RAF directly was at Biggin Hill in Kent. His last; as Deputy Chief Met. Officer at HQ Strike Command, near High Wycombe. As Principal of the Met. Office College he founded the Defence Meteorological Course at RAF Cranwell, in Lincolnshire. "In 1990 I underwent a climate change, beginning a happy two-year stint with the World Meteorological Organization and the United Nations in Geneva," said Stan.

D-DAY

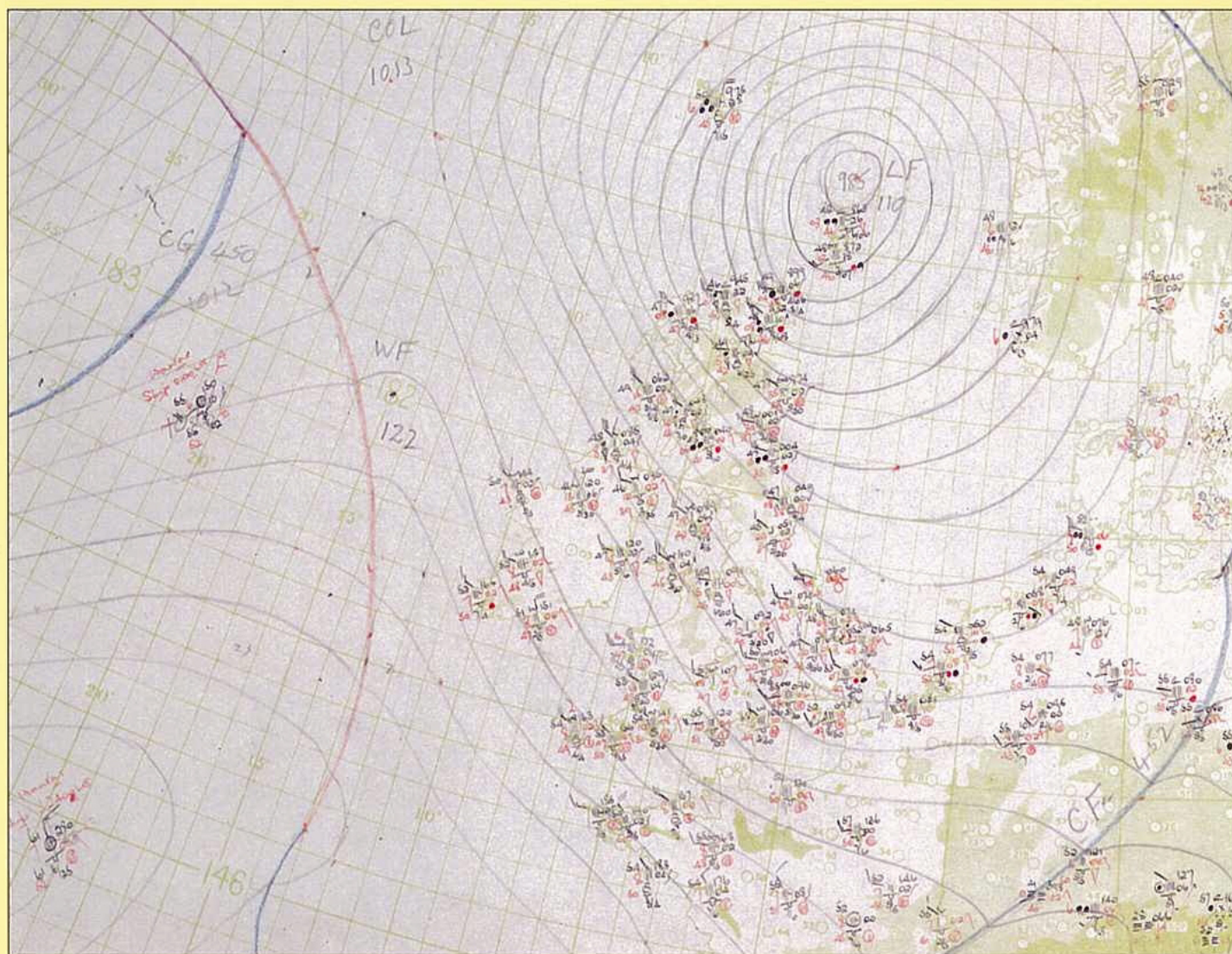
Weather Charts

4 JUNE 1800 GMT



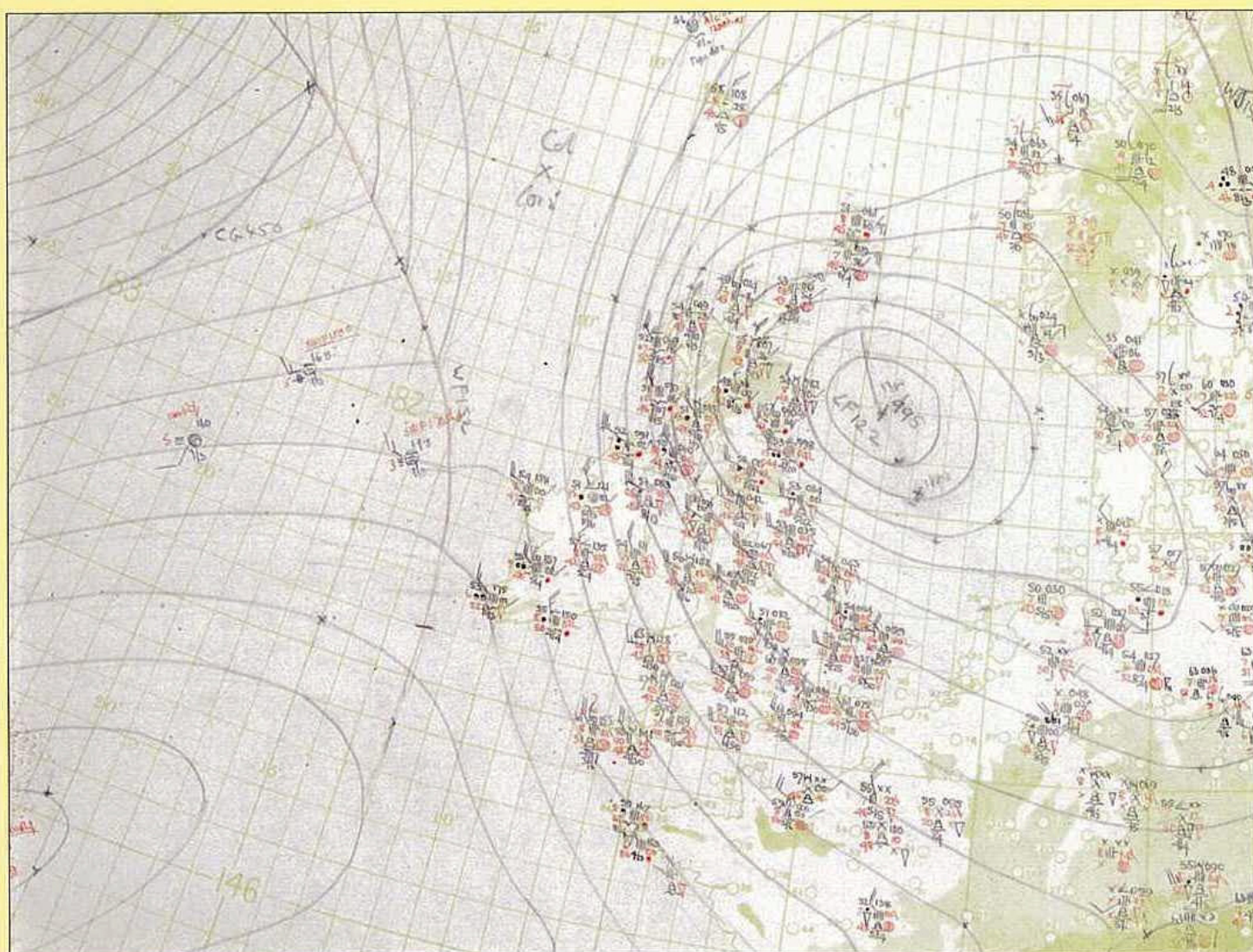
Forecaster's working surface chart for 1800 GMT (2000 DBST) on Sunday 4 June 1944. From the Archive at Bracknell, it was being plotted at Dunstable in the hour before Group Captain Stagg briefed General Eisenhower that an interlude in the stormy period was expected on Tuesday 6 June. At this critical hour no reports were plotted from stations in France. This happened from time to time when the Germans changed their ciphers. The new ciphers were usually broken fairly quickly.

6 JUNE 0100 GMT



Forecaster's working surface chart for 0100 GMT (0300 DBST) on 6 June 1944, plotted in the Central Forecasting Office at Dunstable. At this time airborne troops were landing in Normandy with no weather problems. Deciphered observations from France are available again. The cold front which gave driving rain during the briefing at Portsmouth on the evening of the 4 June, and would have prevented effective air support of a seaborne landing in Normandy on 5 June, has moved well away to the south-east.

6 JUNE 1300 GMT



Forecaster's working surface chart for 1300 GMT (1500 DBST) on 6 June 1944 when seaborne troops had been landing for 7 to 8 hours. Plotted around a hand-drawn station circle near Caen, is the first met. observation from the beachhead still extant in the Archive at Bracknell. It shows broken cloud, good visibility and a Beaufort Force 4 onshore breeze.