



Met Office



Remember

National Meteorological Library and Archive
The Met Office in World War One and World War Two

The National Meteorological Library and Archive

Open to everyone

The library was first mentioned in the 1870 Annual Report of the Meteorological Office.

In 1914 the archive was established as the official custodian of meteorological related records. It holds historic weather records on behalf of the nation and is an approved place of deposit under the Public Records Act.

The National Meteorological Library and Archive is a National Archive (TNA) Accredited Service.

The National Meteorological Library and Archive are open by appointment.

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A blue-tinted historical photograph showing a group of soldiers in World War I uniforms crossing a narrow wooden trestle bridge over a trench. The soldiers are wearing helmets and carrying gear. The background is a desolate, war-torn landscape with many dead, skeletal trees and a hazy sky. The text "The Meteorological Office in World War One" is overlaid in white on the middle of the image.

The Meteorological Office in World War One

The Meteorological Office in World War One

At the start of the war little significance was attached to the importance of meteorology in warfare; a pilot would simply look out of the window to assess whether conditions were suitable for flying and hope that they remained so. Following losses in the air and on the ground, and the deployment of gas as a weapon on the battlefield, attitudes changed rapidly. During the spring of 1915 requests for assistance were received from the General Office Commanding the Royal Flying Corps and from Major C Foulkes at Army General Headquarters (GHQ), the officer responsible for dealing with gas attacks.

Recognising the importance of the meteorological advice his staff could provide, the director of the Meteorological Office, W Napier Shaw, acted quickly. In just over a month he had completed initial negotiations with the war office and arranged for the establishment of the Meteorological Field Service as a section of the Royal Engineers. Napier Shaw also persuaded the Committee of Imperial Defence that they needed a meteorologist on site during autumn preparations for the winter campaign in the Dardanelles. Dr. EM Wedderburn left for the Mediterranean in September 1915 to initiate a meteorological service for the Mediterranean Expeditionary Force.

The Met Office in the field

The Meteorological Field Service was formed in the summer of 1915 and was known as the Meteorological Section Royal Engineers, universally shortened to Meteor R.E., for the rest of the war. Its duty was to support the British Expeditionary Force in France by carrying out local meteorological observations and providing regular reports in addition to daily reports to the Meteorological Office in London.

The service in France was run from the British Expeditionary Force General Headquarters at Montreuil, France and consisted of Major HG Lyons, Royal Engineers, who would act as Napier Shaw's representative and run the organisation and two Meteorological Office staff. Ernest Gold and AEM Geddes were released from their duties at the Meteorological Office and granted temporary commissions in the General List of Captain and Lieutenant respectively. Lyons arrived at St. Omer on the 8 June 1915 with Gold and Geddes following on the 11th.

Before long a reserve of officers had been commissioned at home to replace or supplement those on field service if and when required. General Headquarters also requested an additional meteorologist to advise on probable changes in the force and direction of the surface wind in order to assist with preparation for gas attacks but it was agreed that the Field Service could satisfy both departments.

Meteor staff provided a range of services:

- To act as Meteorological Advisors to the General Staff both at General Headquarters (GHQ) and at Army Headquarters (AHQ).
- To supply all meteorological information required by the Royal Flying Corps (RAF from 1 April 1918). The RFC needed cloud and fog information and rapidly learned the value of accurate weather forecasts, particularly thunderstorms. These brought dangers while flying such as lightning, hail and strong up and down draughts and further dangers while landing from gusts and downbursts near the ground.
- To furnish the regular reports required for the correction of range in artillery operations. Successful deployment of balloons for artillery spotting relied on having a strong understanding of upper winds. The artillery also developed an increasing reliance on accurate meteorology. The accuracy of gunfire depended on the winds and air density in the layer of the atmosphere through which shells travelled. With the high-angle fire that developed during the Great War, knowledge of temperature, humidity, wind speed and wind direction at ever greater heights became essential.
- To provide meteorological reports and forecasts for offensive and defensive gas operations.

With growing understanding of how meteorological advice could assist military operations the section grew rapidly. By October 1915 it consisted of one Commandant, Gold (who was promoted to Major soon afterwards), one Captain, six Subalterns, two Sergeants, sixteen Corporals, one Clerk, six Batmen and one Driver. The Captain and one Subaltern were normally stationed in England. Their transport comprised one motor car, three motor cycles and two bicycles.

Demand for meteorological services continued to increase and in addition to the unit on the Western Front Meteorological Sections were also subsequently formed to assist on other fronts. These included the Gallipoli Front, Macedonia Front, Italian Front, North Russian Front, Independent Force RAF and a Home Unit with its headquarters on Salisbury Plain to meet the requirements of the Army. In 1918 all of these sections were brought under the title of the Army Meteorological Service. At the end of the war the establishment of Meteor consisted of 32 officers and 200 other ranks.

Forecasting

An important role of the Meteorological Section R.E. and, by association, the Meteorological Office during the war was to provide forecasts and meteorological advice to the army and the Royal Flying Corps (RFC), (an army unit) on all fronts. Initially all of the forecasting was done from GHQ but over time all five armies in France gained their own Meteor section. Although the forecasts were the best available they were very basic and of limited use. This was especially the case with forecasts for aviation.

One of the important pieces of work undertaken by the Meteor staff was to research the climatology of the Western Front to gain a better impression of what sort of conditions could be expected and the seasonal variations. They collated a wide ranging body of data from the previous thirty years including prevailing winds, rainfall totals, days of frost, snow and thunderstorms and continued to build on this knowledge throughout the war. All of this information enabled deeper understanding of the meteorology of the area. Greater availability of observational data and understanding of how it might be used by different units of the army, including the RFC, led to marked changes in the style and detail level of forecasts and reports as the war progressed. From its inception Meteor had produced copies of synoptic charts for GHQ and AHQ but these had to be hand drawn thus severely limiting their numbers and distribution.

Meanwhile the earliest surviving operational forecast, produced by Ernest Gold on 24 October 1916, shows that these gave only a very brief indication of wind speed and direction and of the weather to be expected for the day of issue and the following day. By the end of 1917 more comprehensive weather reports for North West Europe were being produced giving a brief 'outlook' and increased information on visibility and upper winds. Recognising the usefulness of such reports Captain Goldie instigated the introduction of 'clay copiers' enabling distribution of the local 'North West Europe' Daily Weather Reports to far more locations.

Forecasting for aviation remained challenging. As an army establishment the RFC received its forecasts through Meteor R.E. but in 1918 when the RFC and the Royal Naval Air Squadron (the latter of which had operated largely independently of Meteorological Office support) merged to become the Royal Air Force the RAF immediately began to develop its own meteorological service. Again this was largely independent of the Meteorological Office and by the end of 1918 the RAF meteorological service had established some 35 offices, mostly in the UK, mainly manned by two forecasters (officers) and six observers (other ranks). Indeed the RAF meteorological service developed to such an extent that after the war they claimed to be better placed to run the UK's peacetime meteorological service than the Meteorological Office.

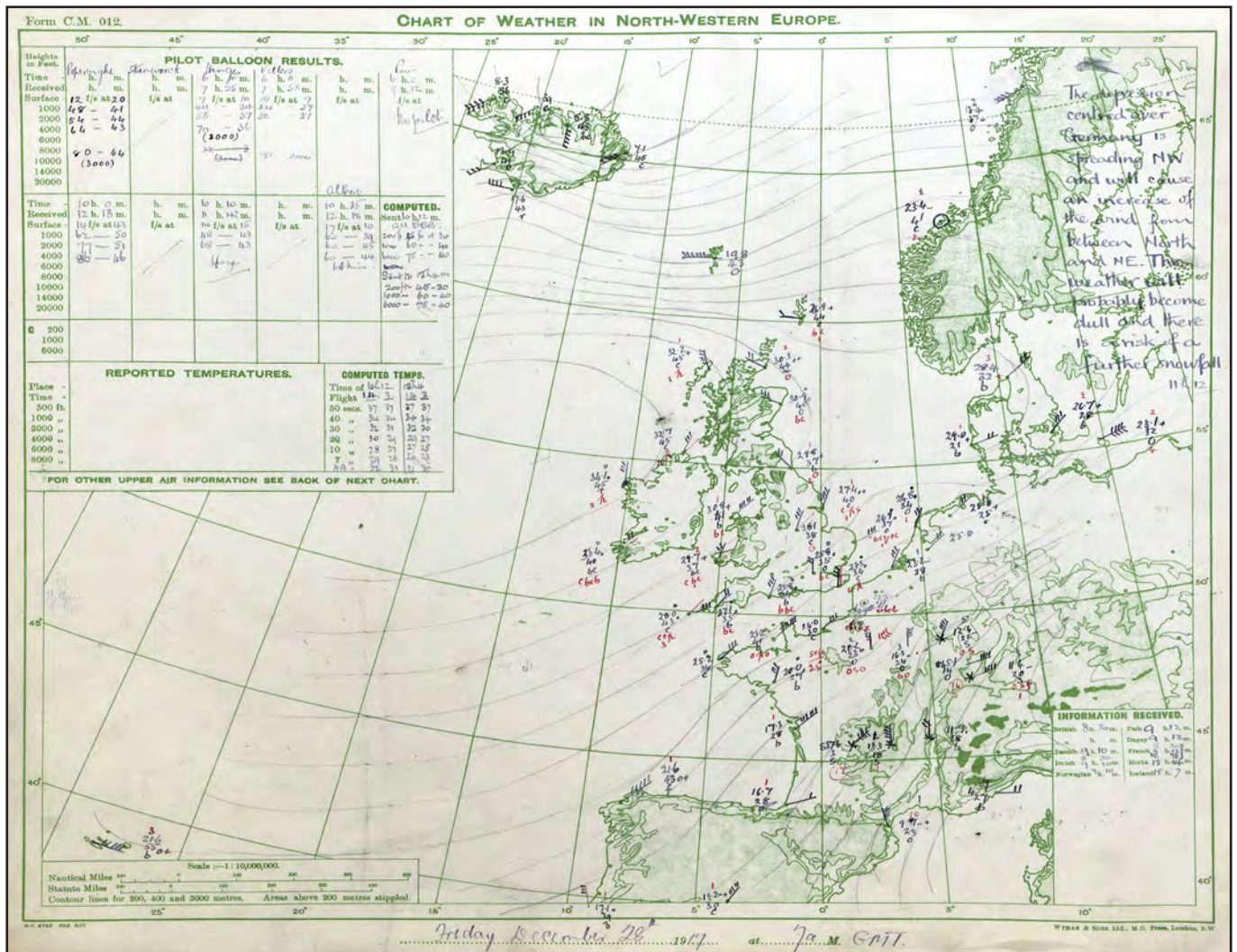


Figure 3. An example of how forecasts changed and became more detailed with time. This is a synoptic chart for 28 December 1917.

Gas warfare

Following the first use of chlorine gas the Army's General Headquarters in the Field in France also requested forecasts of probable changes in surface wind direction and force.

German forces had deployed Chlorine Gas for the first time on 22 April 1915 at the opening of the Second Battle of Ypres and on several further occasions during April and May 1915. Lyons told the Gas Advisor in the Field, Lt-Col Charles Foulkes, that he would have to provide full and regular observations of wind direction and strength at points along the front that were of importance and promised that these would be used to try and increase the precision of forecasts.

He also asked Foulkes to take Gold along the portion of the front line concerned in order that he might have a better idea of the relief and features of the country. Meteorology was quite literally on the front line, and now so were Meteorological Office personnel.

Although no members of Meteorological Office staff were killed while engaged on meteorological duties during the war it was while working with gas that this position nearly changed. Lt. CD Stewart of Meteor R.E. was working with the Special Brigade, 3rd Battalion. The Special Brigade was responsible for setting up and releasing gas. In order to successfully launch an attack wind conditions had to be light and Stewart's role as a member of Meteor personnel was to advise on and try to predict suitable wind conditions. On the night of 31 August 1916 Stewart's unit launched an attack near Messines but soon afterwards the wind changed blowing the gas back onto the British trenches.

At the Casualty Clearing Station Stewart's casualty form was notated 'Wounded. Gas poison. Drifting gas'. He never recovered sufficiently to be declared fit for active service and was eventually invalided out in October 1918.

Balloon observation services for the Royal Artillery

Day time observations of wind speeds were taken using pilot balloons and Chinese lanterns were used to take observations by night. From April 1916 Meteor R.E. began sending meteorological information to artillery units by telegram twice per day. These were known as 'Meteor telegrams' and gave basic meteorological data intended to assist artillery units with their calculations of ballistic corrections for their guns. The telegrams gave the wind speed and direction at 2,000 feet (606 metres) and 4,000 feet (1,212 metres) or 3,000 feet (909 metres) in foggy conditions.

During the late summer of 1916 permission was obtained for a meteorological observer to accompany a Balloon Officer in a kite balloon while engaged in spotting for artillery units near Ypres. The aim was to gain a more accurate record of winds and gather temperature measurements up to 4,000 feet (1,212 metres). From August 1916 temperature data was being added to the Meteor telegrams but it soon became clear that the requirements of each were incompatible. As a result a dedicated Meteorological Kite Balloon Section under the command of Meteor R.E. was established at Hazebrouck.

The formation of this dedicated section led to more frequent and detailed meteor telegrams. From March 1917 they gave information based on shell flight times of 7, 10, 20, 30, 40 and 50 seconds and increased to six issued per day. The kite balloon normally only ascended to 4,000 feet and temperatures for 6,400 feet and 10,000 feet would have been calculated rather than directly measured.



Figure 4. Kite balloon of the type used by the Meteor Kite Balloon Section (courtesy of Air Historical Branch, RAF).

Ever increasing importance was attached to gathering data, particularly upper air data, and providing it to customers as quickly as possible. Many practical advances were made during the war to enable meteorologists to meet these demands. With the increase in available data from kite balloon ascents, techniques were also developed to speed up its analysis. When Gold first arrived in France it would take close to an hour to compute upper air winds from the observations made on a half hour flight.

Working with Lieutenant Entwistle and Corporal Durward, Gold was able to simplify the procedure and, after some instruction, observers were able to make the necessary computations while still in the air using the newly introduced slide rule. As a result upper air data could be issued to pilots and the artillery within two minutes of the end of the flight thus transforming the efficiency and effectiveness of meteorological provision.

From January 1918 Meteor telegrams increased to seven per day and additionally included information for shell flight times of 60 seconds requiring calculations of temperatures at 14,400 feet (4,363 metres). This was too high to gain data from kite balloons so it became necessary to find another means of acquiring data at these higher altitudes.

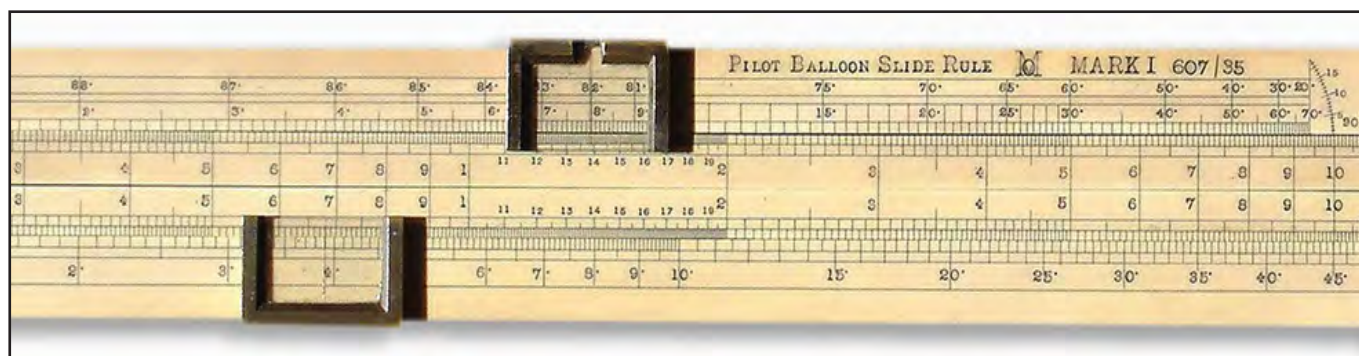


Figure 5. Mark 1 pilot balloon slide rule, introduced in 1915 to determine upper wind velocities from an ascending pilot balloon which was tracked using a theodolite.

Meteorological reconnaissance flights

From spring 1916 semi-regular measurements of upper air temperatures from aircraft were being made by the Experimental Flight of the Central Flying School at Upavon, Wiltshire. Initially temperatures were recorded from a thermometer attached to a wing strut but by late summer Captain GMB Dobson had designed a barothermograph which was able to provide a continuous temperature trace during a flight.

The instrument was manufactured at the Royal Aircraft Factory (RAF) at South Farnborough, Hampshire and became known as the RAF barothermograph. From January 1918 the artillery needed temperature observations at altitudes beyond the reach of kite balloons. There was already evidence that observations could be made from aircraft and so it became the logical next step for Major Gold to seek approval for the formation of a Meteorological Flight, to be formed as a unit of the Royal Flying Corps (RFC).

The flight, known universally as 'Meteor Flight' was established in early February 1918 at Berck aerodrome, near Berck-sur-Mer and about 12 km from GHQ. As it needed just two pilots and four men to maintain the aircraft it was attached to the RFC GHQ Communication Squadron. Gold wanted Lieutenant CK Douglas to command the new unit.

Douglas was not a professional meteorologist but had written significant papers on rates of temperature lapse with altitude and on cloud types while flying as an observer with the RFC in 1916. In fact he could not be released until later and the first pilots to serve with Meteor Flight, the first Meteorological Reconnaissance Flight, were Lieutenants RV Sessions and GE Marden MC.

The unit was equipped with two Armstrong Whitworth FK8 aeroplanes with a distinctive white shooting star representing a meteor on the fuselage. They carried RAF barothermographs and also thermometers graduated in degrees celsius attached to a wing strut. From April, once a suitable method of attachment had been invented, the aircraft carried psychrometers which enabled the provision of humidity data as well as temperature.

In a further development it was recognised that photographs of clouds were more useful than verbal accounts and so cloud photography during ascents was introduced from March 1918.

Flights were made twice daily as early in the morning as possible and just before dusk. Each took between 60 and 90 minutes, aiming to reach 14,000 feet (4,242 metres) and temperatures were recorded at regular intervals during the ascent and descent. In addition the flights recorded vertical and horizontal visibilities, the height of the base and top of any cloud encountered and any change in temperature at the top of the cloud. On landing all the information was passed back to GHQ using a simple code created by Gold.

The planes also had onboard wireless sets and could transmit observations while in flight but it is not clear how much they were used.



Figure 6. Meteor Flight Aircraft showing the shooting star design. Marden in cockpit, Sessions standing (Courtesy of B. Session).

The RFC became the Royal Air Force (RAF) in 1918 and the formal title of the Meteor flight became the RAF Meteorological Flight but it continued to be known by its old name and serve similar functions. Captain CKM Douglas finally joined the flight in May 1918 and became its first Commanding Officer.

Shortly after Douglas joined the section the RAF formed a Bomber Force, known as the Independent Force. This was tasked with the strategic bombing of locations such as railway depots and factories as far east as the Rhine. A dedicated Meteorological Section was formed at the HQ of the Independent Force at Nancy but the pilots soon found that the forecasts it provided were too general for flying operations at night and often above the clouds.

To provide more detailed forecasts the meteorologists needed more upper air data so proposals were made to establish a network of meteorological flights: three in England, one in Ireland and a further two in France. In the end the proposals were not put into practice. Instead, in late summer 1918, the meteorological flight's remit was changed to form an Experimental Meteorological Section.

Daily ascents increased and in addition the section was tasked with investigating the source of the problems that faced Independent Force, in particular the lack of upper wind data during periods of extensive cloud cover.

Although the artillery no longer required information after the signing of the armistice, Meteor Flight continued to operate. Wind and temperature observations were still needed by the Meteor Section at GHQ to provide daily aviation forecasts across north east France and from Belgium to Cologne until their disbandment in April 1919.

After this all RAF units in France were gradually disbanded and Meteor Flight, the last bastion of the Meteorological Field Service was finally ordered to disband on 24 August 1919.

The Met Office at Home



Figure 7. The Meteorological Office at South Kensington in the early 20th century.

Throughout the war the Meteorological Office headquarters at South Kensington, a purpose designed building on the corner of Exhibition Road and Imperial College Road, was the primary support centre for the network of meteorological services and stations supporting all armed forces both in the UK and in the theatres of war. The impact of the war on staff was felt in many different ways. At the outbreak of hostilities some 30 of the 90 full time staff of the Office enlisted. Many of them joined the 1st/13th Battalion of the London Regiment, known as Princess Louise's Kensington Battalion. At least five were killed on active service and many more were injured.

With the founding of the Meteorological Field Service, the effect of an expanding workload with fewer staff became clear. Lyons and Shaw assessed the office and found that only two 19 year olds could be spared at the time. Several staff who had requested leave to join the armed forces were refused permission and still the office struggled to keep up with demand. The shortage of manpower and the need to increase staffing levels to satisfy demand for meteorological data led to a significant increase in the number of female staff. Initially they were employed as clerks but by 1918 women with the necessary qualifications in mathematics and physics were being appointed as professional assistants.

Particular strain was felt by the Forecast Division department which had to respond to ever increasing demands for information. Several staff of the Office suffered nervous breakdowns during the war, most of them in the Forecast Division. Most were able to return to work in due course but sadly one was not.

The Office Keeper was admitted to the London County Asylum in the summer of 1917 and pensioned off with effect from 1 January 1918. During 1917 the decision was taken to re-organise the work of the division and introduce continuous attendance. Thus for the first time forecasters were on duty 24 hours a day, 7 days a week. In order to find the staff to make this change possible all the qualified staff were transferred in from outstations and observatories in the hope that this would reduce pressure on the division to a sustainable level.

The Instruments Division also felt the challenge of serving a country at war. Demands for instruments which had totalled a value of just £3,000 a year before the war stood at £12,000 a year by 1917. One example of the increased demand can be seen in the issue of pilot balloons which were used to calculate upper wind speed and direction.¹ Only a handful were used in the whole of 1914 yet by 1918 requirement had risen 13,176 per month. The balloons could not be used in isolation but two new models of theodolite were designed and, after testing, large numbers were constructed and issued along with associated equipment and instruction manuals.

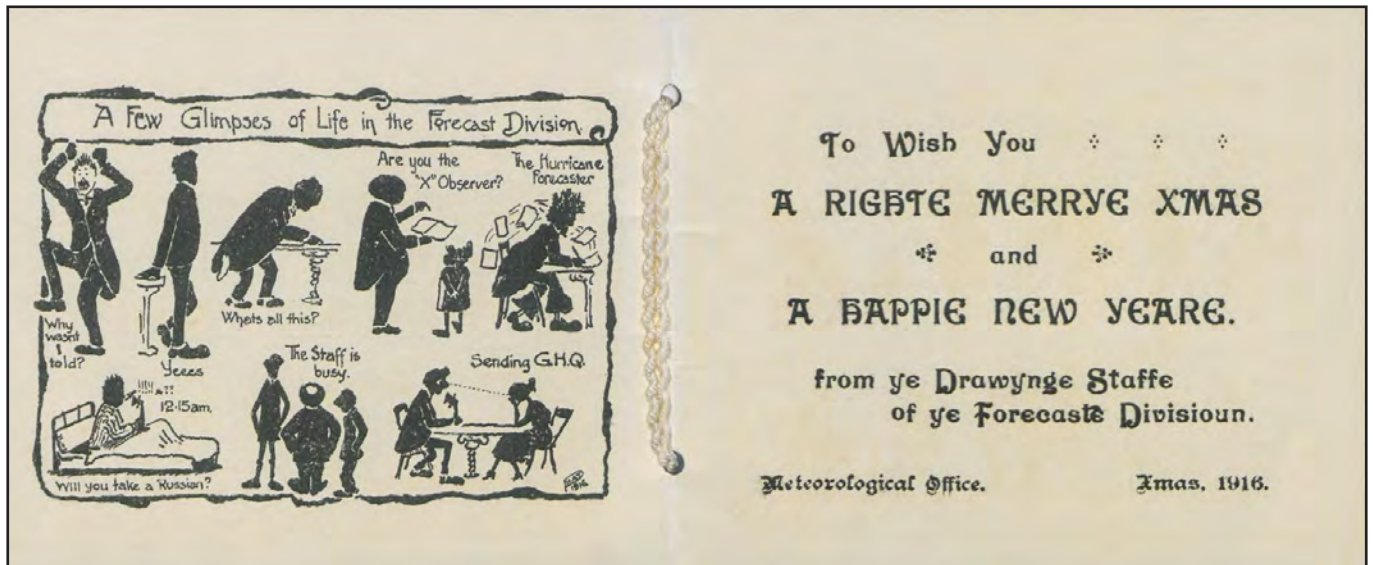


Figure 8. Christmas card designed and sent out by the Forecasting Division 1916.

Shaw wrote in the 1918 Annual Report: "Now that the weather is recognised to be of primary importance in so many of the affairs of life, and the requirements of so many departments of the Navy, the Army and the Air Force include a knowledge of weather conditions, not only at the surface in the various parts of the globe but at elevations which have up to now been of interest to the meteorologist alone, some more comprehensive organisation is necessary."

Following the cessation of hostilities the Government decided that the Meteorological Office was best placed to hold responsibility as the national meteorological service. Its services were considered to be of such significance for the future of aviation that control of the Office was transferred from the Board of Trade to the Air Ministry.

¹Pilot Balloons and theodolites could also be used to calculate the height of the cloud base but it does not appear that this element was recorded during WW1.

Roll of Honour 1914–1918

George Joseph Barker, Private 1/13th London Regiment Service Number 5100.

Born 12 January 1897, Died 10 October 1916 near Gueudecourt, France age 19. No known grave, remembered on Thiepval Memorial.

George joined the Meteorological Office at the age of 17 and worked in the Statistical Division until he was called up in April 1916.

Harold Billett, Private South African Infantry Service Number 8492.

Born 11 April 1890, Died 18 October 1916 aged 27 near Eaucourt l'Abbaye. No known grave, remembered on the Thiepval Memorial.

Harold was engaged by the Meteorological Office to assist JS Dines at Farnborough but the office had not yet been constructed so in the interim Dr. Shaw, Director of the Meteorological Office employed him working on calculus associated with the upper air.

Harold began working at Farnborough in early 1914 but resigned his post on 15 February the following year after a dispute about his salary. He became Scientific Assistant to the Chair Meteorologist of the Irrigation Department of the Union of South Africa.

Norman Charles Bradnock, Private London Regiment 1/13th Service Number 2466.

Born 1895, Died 9 May 1916 aged 20 during the Battle of Aubers Ridge at which 436 of the 1,000 men in his regiment, the Kensingtons, were killed. No known grave, remembered on the Ploegsteert Memorial.

Norman is believed to have joined the Meteorological Office around 1912 and by 1914 was working in the Forecast Division. He enlisted at the outbreak of war.

Walter Benjamin Greening, Able Seaman RNVR Service Number LZ/288.

Born 1896, Died 3 May 1915 aged 19 at Gallipoli. No known grave, remembered on the Helles Memorial.

Walter probably joined the Meteorological Office around 1912 and by the summer of 1914 he was working in the Marine Division. Unlike others from the Meteorological Office he enlisted in the RNVR when war broke out (in keeping with his background in the Marine Division).

Like many others he found that the Admiralty did not have enough ships to employ the number of Navy volunteers. Those unable to be found ships became the Nelson Battalion (the Nelsons) and were in effect soldiers in naval uniform. Greening, with 200 other Nelsons was killed during a dawn attack on a Turkish machine-gun position on a flat plateau with no cover.

Milton Kershaw, 2nd Lieutenant Gloucestershire Regiment.

Died 7 November 1914, during the first battle of Ypres. No known grave, remembered on the Menin Gate.

Milton was a professor at the Royal Agricultural College in Cirencester and worked for the office as an observer. His signature can be found in daily registers up to July 1914.

Milton is noted as having being the Meteorological Office's representative for Gloucestershire and his death is recorded in the Annual Report for 1915. At the outbreak of war Milton joined the Gloucestershire Regiment. He was the first person connected with the office to be killed in action during the war.

Edward Thomas Streets, Rifleman, London Rifle Brigade Service Number 302654.

Born 1897, Died 12 April 1917 near Warncourt during the Battle of Arras. No known grave, remembered on the Arras Memorial.

Edward is thought to have been one of the two boys of the Meteorological Office employed on general office or cleaning duties who were identified as being available for enlistment into the army when they came of age.

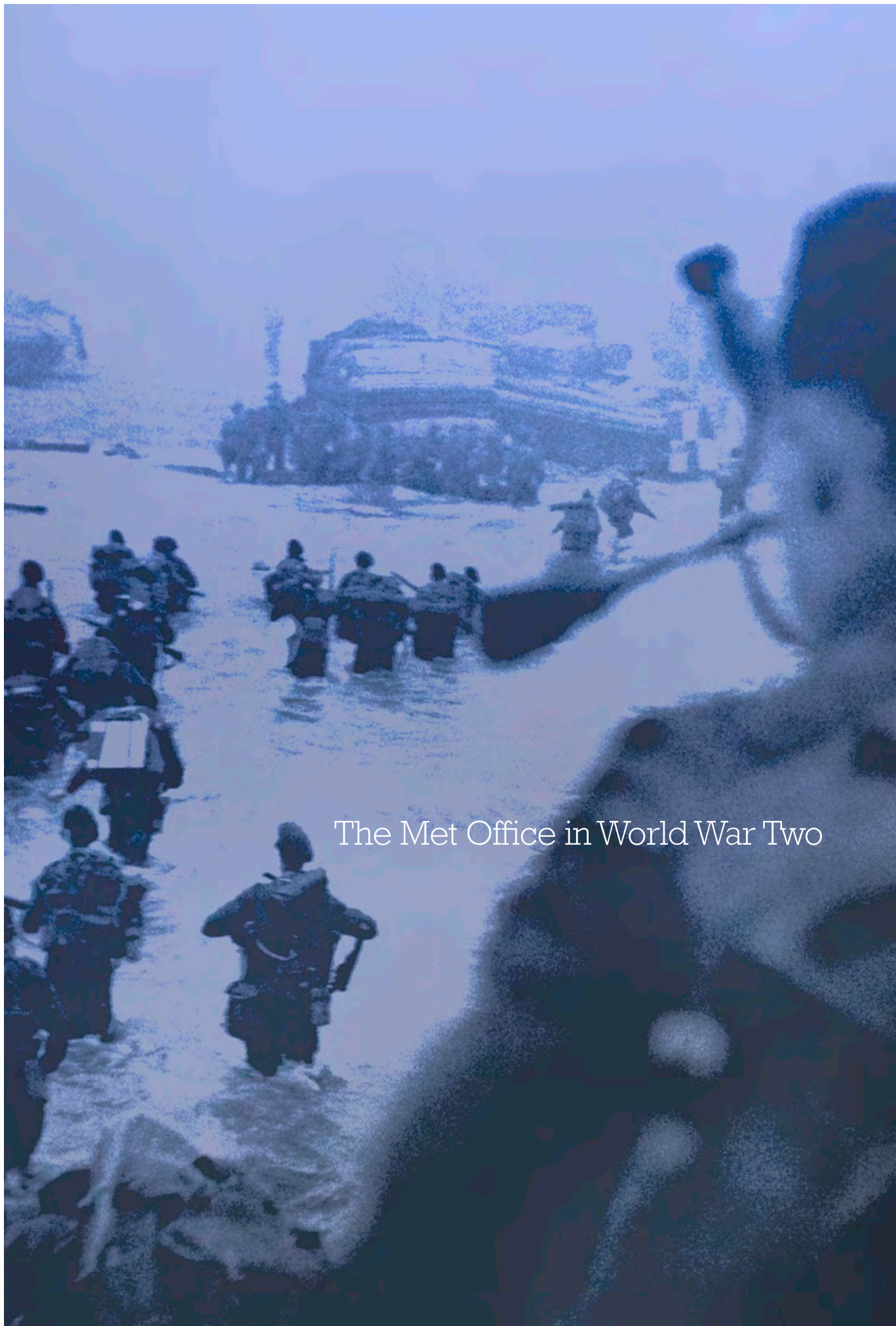
Campaign: - B. E. F. 1914. (A) When decoration was earned
 (B) Present situation

Name	Corps	Rank	Reg. No.	Roll on which included (if any)												
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<i>C. M.</i> Milton	-	lieut*		Off. 21/3.												
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Correspondence:
 f Kershaw Bg. applies for 1914 Star in respect of his late son. 10.12.17.
 O/C No. 1 Inf. Rec. Office. Warwick, forwards roll of officers of Lyncester R. eligible for 1914 Star. 9-11-17.
 Address = - Kershaw Bg. (14) -
 17002 Lond Showl.
 Pleckheaton, Yorks -

Figure 9. Medal index card of Milton Kershaw showing he was part of the British Expeditionary Force (B.E.F.).





The Met Office in World War Two

The Met Office in World War 2

During World War 2, both military commanders and civilian authorities recognised the importance of including meteorological advice in the planning stages of any operation. Most military organisations, civil aviation and a range of government departments all looked to the Meteorological Office for advice and as the war progressed the Office expanded dramatically to meet these needs.

Military requirements

All RAF and Army operations relied entirely on advice from the Met Office. For the Royal Navy the involvement of the Office was limited to supply of basic reports and technical analysis to the Naval Meteorological Service. RAF commands and especially the RAF Bomber and Coastal Commands were particularly dependent on meteorological advice at all times.

Bombers needed to take off and land again safely eight to ten hours later and their crews had to be able to get to and from target areas and locate targets without getting lost or straying over heavily defended areas. Coastal Command aircraft carried out anti-submarine patrols and convoy protection duties, meaning flights could last for twelve hours or more.

In both cases the RAF needed to know as much as possible about cloud cover, visibility and upper air winds at the home station, en-route, and, at the target destination. Unfortunately lack of available data, especially detailed Upper Air data, meant that the Meteorological Office could provide only limited information and forecasts were often imprecise at best.

Additional routine services provided to the RAF and the Army included meteorological support for training of airborne troops and the provision of advice for parachute and glider operations. Meanwhile a great range of special operations also required meteorological advice, one of the more well known of these being the Yalta Conference between Churchill, Roosevelt and Stalin in February 1945 which necessitated the establishment of a meteorological observation office at Yalta to provide data to assist in the creation of forecasts for their various flights.

With the war involving operations and travel, particularly air travel, across large parts of the globe, staff of the Meteorological Office were posted to RAF units and theatres of war in many parts of the world to carry out observations and provide forecasts and advice to commanders and other military personnel. They were joined by many RAFVR (Royal Air Force Volunteer Reserve) (Met Branch) personnel who had joined up to serve as meteorologists for the duration of the war.

Meteorological Office staff often worked alongside staff of other allied meteorological services and, in some locations, helped to train locally recruited staff in meteorology. This in turn assisted them in the post war development of their own national weather services.



Figure 10. Reading a thermometer in the Western Desert (left) and an aerial view of the Met Station at Spitzbergen, Svalbard, Norway (right).



Figure 11. An RAF Met. Section at work on a forward air strip on the Mandaly front. The radio has been concealed between two banana trees (right).



Figure 12. Meteorologists briefing air crew in Burma (left) and at RAF Coastal Command (right).

Civilian requirements

Meteorological advice for military purposes made up only a part of the work of the Office during the war. The issue of standard weather forecasts to the civilian population ceased with the outbreak of war because such information would be used by the Axis powers. However some organisations and individuals still required meteorological information. A range of government departments also required forecasts and meteorological advice for a wide variety of purposes.

Agriculture:

- There was a slowly increasing recognition of the impact of an attack on food supplies and in the summer of 1941 it was feared that incendiary bombs might be used to set light to standing crops and stack yards. The Met Office became involved with the Ministry of Home Security and developed a system of warnings based on the state of ripeness of the crops in relation of the weather expected. The system was operational from summer to harvest in 1941 and 1942 but was discontinued in 1943 on the grounds that its usefulness was not sufficient to justify the work involved in its preparation and distribution.
- By 1942 the government accepted that despite the potential security risks some kind of forecast needed to be provided to farmers to ensure they were able to safely harvest the grain crops. A code system was introduced to give a broad indication of the expected conditions the next day and the further outlook. For example 'dog' meant no rain before sunset the next day with reasonably dry air and some sunshine and 'buy' meant the weather would probably continue fair or good for some time. These harvest forecasts were issued from 10 August to 30 September 1942 and in 1943 and 1944 they ran from 1 June to 30 September each year. Forecasts for Scotland began on 16 August 1943 and continued during the harvest season of 1944.
- Eventually restrictions were eased to assist other farmers although rather too late for the fruit growers for whom frost warnings, issued by the BBC, commenced on 1 April 1945. The frost warning was the first broadcast forecast referring to the UK to be issued since the outbreak of war in September 1939

Industry:

- Forecasts were required to enable gas and electricity suppliers to gauge the expected loads on their supplies and make appropriate arrangements. Electricity companies also needed warnings of thunderstorms. In May 1940 it was agreed that the Central Electricity Board could receive a duplicated weather chart of the British Isles chart and a general forecast. Until January 1945 this was telephoned each morning to the control centre in a confidential code. Subsequently the National Control Engineer was given a forecast each evening at 8pm to enable him to predict the peak of demand each morning. He was then able to issue a warning of dangerously high demand if needed without any reference to the weather.
- There were additional arrangements with the gas suppliers connected with a ban on the use of central heating in certain classes of premises. In order to enable the ban to function the Met Office supplied climatological information to the Ministry of Fuel and Power which then set the annual dates for enforcing the ban. The Office supplied additional forecasts which enabled flexibility so that the Ministry could temporarily lift the ban during cold spells.
- A Met Office unit headed by PA Sheppard also looked into the possible use of smokescreens to hide factories and other facilities from attack.

Transport:

- In 1938 The Ministry of Transport informed the Air Ministry (of which the Met Office was a part) that they could dispense with weather forecasts in war time! The winters of 1939–1940 and 1940–1941 proved particularly severe in many parts of the British Isles and transport services were regularly disrupted. As early as November 1939 the Southern Railway sought the help of the Met Office and it soon became clear that other railway and bus services and local authorities needed help.

As a result arrangements were made for a general weather inference to be telephoned from the Office to the Ministry of War Transport at about 09.30 and also for weather reports and district weather forecasts to be sent to the Ministry and the Rail Executive Committee. The code system for passing this information on was:

- Steel – snow expected, becoming icy with traffic.
 - Copper – night frost following thaw or rain, producing patches of ice.
 - Gold – thaw expected, probably only temporary.
- Snow warnings were also gradually passed onto other organisations in need of the information.
 - During 1942 the Met Office provided meteorological support to a serious investigation which looked into the possibility of using heat to disperse fog on airfields. This followed cancellations of operations because aircraft were grounded on fog bound airfields and increasing losses of bomber aircraft crashing in fog when returning from missions. A petrol burning device named FIDO was developed, but it used a great deal of fuel and petroleum was expensive. FIDO had been installed on seven airfields by December 1943 and 15 by May 1945. However it was accepted that, in general, diversion to another airfield was by far the cheaper option. The Petroleum Warfare Department (PWD) was disbanded in 1945.
 - Although internal civil aviation ceased with the exception of flights between Liverpool and the Isle of Man and the mainland and Scottish islands, international civil aviation was an essential service throughout the conflict. Meteorologists were therefore needed to support the continuation of the few remaining internal flights, routes to neutral countries and further routes in many other parts of the world.

Civil defence:

- With the ever present fear that gas could be used against the civilian population, the Office, in conjunction with the Home Office, developed a system of warnings of weather conditions suitable for the deployment of a poison gas attack.
- From 15 January 1941 onwards brief indications of the weather which might be expected during the hours of darkness were issued to the Ministry of Home Security. The warnings were then distributed to the various civil defence regions via the Ministry's communication network including, at the end of the message, a plain-language statement of the weather to be expected.



Figure 13. An aircraft using an airfield that has been cleared of fog using Fog Investigation and Dispersal Operation (FIDO). The ring of flames around the airfield is formed of burning petroleum, the heat from which was used to disperse the fog.

Meeting demand – growth and development across the Office during WW2

Preparations for dispersal of the Met Office at the outbreak of war were made in 1938. Initially it was planned that the HQ and administrative division would move to Southport in Lancashire, then the location changed to Tetbury in Gloucestershire but in the end a small HQ branch remained in London throughout the war.

The Forecasting Division was to move to Dunstable in Bedfordshire, conveniently located for communications but war broke out before the new buildings were completed and the Division was temporarily evacuated to Birmingham on 27 August 1939 switching to Dunstable in February 1940. The Marine and Climatology Divisions, and the Instruments and Army Division, moved in November 1939 to Wycliffe College at Stonehouse, Gloucestershire.



Figure 14. The Met Office buildings at Dunstable, home of the Forecasting Division during WW2.

Supporting the routine and special civilian and military requirements of wartime required not only the continuation of much of the regular meteorological work of the Office but also the development of new areas. As a result the Office expanded greatly during the war and staff numbers increased from about 700 to over 6,000.

The Office was fully integrated with the RAF throughout the war and irrespective of rank, and even as civilians, forecasters were accepted by the RAF as a crucial part of their operational organisation. Even at outstations with no trained forecasters the assistants and WAAFs were often treated with equal respect. This inclusive approach is credited with much of the success of operational meteorology during the war.

At the start of the war there were no effective upper air charts and only a limited understanding of the upper atmosphere. The office had no internal expertise or even a network of upper air stations and there were just two meteorological flights making twice daily soundings to 24,000ft at Mildenhall and Aldergrove.

Radiosonde stations were located at Penzance and Lerwick using Finnish and French equipment until these countries were invaded, at which point the Met Office was forced into developing and operating its own version. In addition upper air analyses and forecasts were conducted by the surface bench. During 1942 it was decided to create an upper air bench at Dunstable and this came into being in January 1943 under the supervision of Petterssen. Knowledge was still very limited and although irregular met reconnaissance sorties over the Atlantic started in the late spring of 1941 it was not until 1944 that more tracks and twice daily sorties were introduced.

The fact that the Office still had only a very limited understanding of upper air winds, in particular how narrow the bands of strong winds could be, was brought into tragically sharp focus on the night of 24–25 March 1944. An allied bomber stream destined for Berlin which had been forecast to meet winds no stronger than 45mph was torn apart when it encountered winds in excess of 120mph resulting in the loss of 72 bombers.²

The ongoing work of many divisions of the Office was also critical to many aspects of wartime meteorology:

- The Climatology and Library Division continued to collect and tabulate UK climatological data throughout the war and provide advice to various specialist bodies. Demand on library resources actually increased dramatically with loans increasing from 3,515 in the year ending 31 March 1940 to more than 37,000 in each of the last three years of the war. One key role of the division was the ongoing production of a series of handbooks on the weather over the oceans. Work on this series had started before 1939 but after this priority was given to handbooks relating to the main theatres of war.
- During the war the Marine Division concentrated on the preparation of climatological, ocean current and sea-ice atlases. These were needed by the Admiralty for many operational purposes and sea ice atlases were particularly important in assisting with the planning and routing of Atlantic and Arctic convoys.
- The division also sought to maintain the Voluntary Observing Fleet (VOF) which consisted of Royal Naval and Merchant vessels which had volunteered to provide detailed meteorological logs during their voyages. This required finding a constant supply of new vessels to replace those lost to enemy action. In 1939 there were 390 regular observing ships and 600 supplementary ships sending abridged data. Despite heavy losses of British shipping throughout the war from attacks on convoys and raids on ports, by May 1945 the number of regular observing ships stood at 272 and the number of supplementary ships at 208. This was quite an achievement in a war which cost the lives of over 30,000 seamen of the British Merchant Navy and 2,426 ships covering a total tonnage of 11,331,933.

²This became known as the Night of the Big Winds.

- The Instruments Division saw a dramatic increase in the demand on its resources during the war. Not only was it required to supply certified instruments to Meteorological Office stations across the world, it was also tasked with supplying the Naval Meteorological Service, the Voluntary Observing Fleet and, in the later stages of the war, the Dominions and some allied Services. The Division also developed new equipment and instruments as required.

The scale of the increase in demand on the division can be seen in expenditure on meteorological equipment and numbers of instruments supplied. Total annual expenditure on meteorological equipment increased from an average of £7,800 pa in 1929–1933 (equivalent to £472,000 today), to £37,000 in 1939–1940 (£1,751,000) and £225,000 (£8,442,000) in 1944–1945 falling slightly to £212,000 (£7,512,000) in 1945–1946. During the war the division supplied 30,000 radiosondes, 2,000,000 pilot and radiosonde balloons, 30,000 thermometers and 18,000 aneroid barometers and all of the instruments had to be calibrated and certified. Indeed after the war the division, which had been evacuated from London to Stonehouse Gloucestershire, was too large to fit back into its original premises in South Kensington and so a new building was found adjoining HMSO in Harrow.



Figure 15. A Met WAAF reads wet and dry thermometers housed in a Stevenson Screen – some of the thousands of instruments produced at Stonehouse.

Observations – the challenge, the solutions and remote sensing, the dawn of a new era

In order to create the multitude of forecasts required by military and civilian authorities, obtaining observations became an absolute priority. Before the outbreak of war there were 43 stations passing their observations to the Central Forecasting Office at Dunstable. As airfields and other sites opened across the country the number of meteorological offices increased greatly, reaching 552 by the end of the war.



Figure 16. Two WAAF personnel taking upper air observations with a balloon, theodolite and slide rule.

Obtaining observations from outside the British Isles was considerably harder. Throughout the war observations reached Dunstable from Spain, Portugal, the Azores, Iceland, Canada and the US and observations were also received from the neutral Republic of Ireland. Just as in the UK and allied countries, meteorological reports were classified in all Axis countries.

This meant that with the outbreak of war the supply of observations from parts of Europe controlled by Germany reduced to almost nothing and observations from the rest of Europe decreased rapidly as one by one countries fell into the control of the Axis powers.

Axis sources

Despite what should have been a total lack of information, Meteorological charts plotted at Dunstable during the war show that observations from Germany, the Atlantic Ocean and countries occupied by the Axis forces were reaching forecasters in Britain.

Some observations were received from clandestine sources, particularly in Poland, but the key sources of information were German coded transmissions made using Enigma codes all of which were broken by the British. There were three versions of Enigma, those used by the German Army and RAF being far simpler than that used by the German Navy which was not broken consistently until late in 1941.

The first chart to include German observations is dated 5 April 1940 but it is almost certain that the code was broken much earlier. German weather data was sourced from the Government Code and Cypher School and Bletchley Park where the task of decoding a vast number and variety of axis radio communications had become routine. Transmissions identified as weather observations were passed by the Bletchley cryptographers to a special unit called IDA at Dunstable where they were decoded and used to inform British charts and forecasting.



Figure 17. Wireless transmission reception room, Dunstable.



Figure 18. A never ending yet critical task – plotting and drawing charts.

Some charts from Dunstable show detailed analyses of isobars with no observations shown and others give a few observations but certainly not sufficient to justify the isobaric detail given on the chart. It was important not to give cause for suspicion that the German codes had been broken and therefore great caution was used when plotting these observations involving the use of transparent overlays enabling observations to be kept separated from analyses and vice versa.

The result was that German meteorological observations being provided for their own military operations were available to British meteorologists only a short time later. RPW Lewis commented that ‘British Intelligence was able to supply the Central Forecasting Office at Dunstable with information of such good quality, so fast, that surface and upper-air charts could be plotted, covering the whole of Axis-occupied Europe’.

British sources

Manual observation

The imposition of radio silence on merchant ships of the British and allied forces in order to give some protection from the U-Boat menace meant that there was an almost total loss of weather reports from all of the oceans. Particularly crucial amongst these was the eastern Atlantic area from which observations were vital for those who were forecasting for the British Isles.

Acquiring data from the Axis powers and allied assistance was a good step towards plugging the hole in Atlantic observations but more needed to be done. Responses to initial requests for increased data met with refusal, there were not enough aircraft for reconnaissance flights, no flexibility would be granted in lifting radio silence, and permission was not granted to use fast, armed trawlers to bring back information. Eventually in July 1940 the Admiralty agreed to charter two steamers, which would be defensively armed, to be deployed in a weather reporting role with three meteorologists.

The ships completed five and six voyages before being sunk by U-Boats with the loss of 83 lives - 40 men aboard the Arakaka including meteorologist Sidney Portass and 43 men on the Toronto City including meteorologist Stanley Proud.³

³Meteorological staff killed on the weather ships. SS Toronto City: EJ Hedley Smith, S Proud, FV Thom. SS Arakaka: SL Portass, PWH Short, RHR Wroughton.

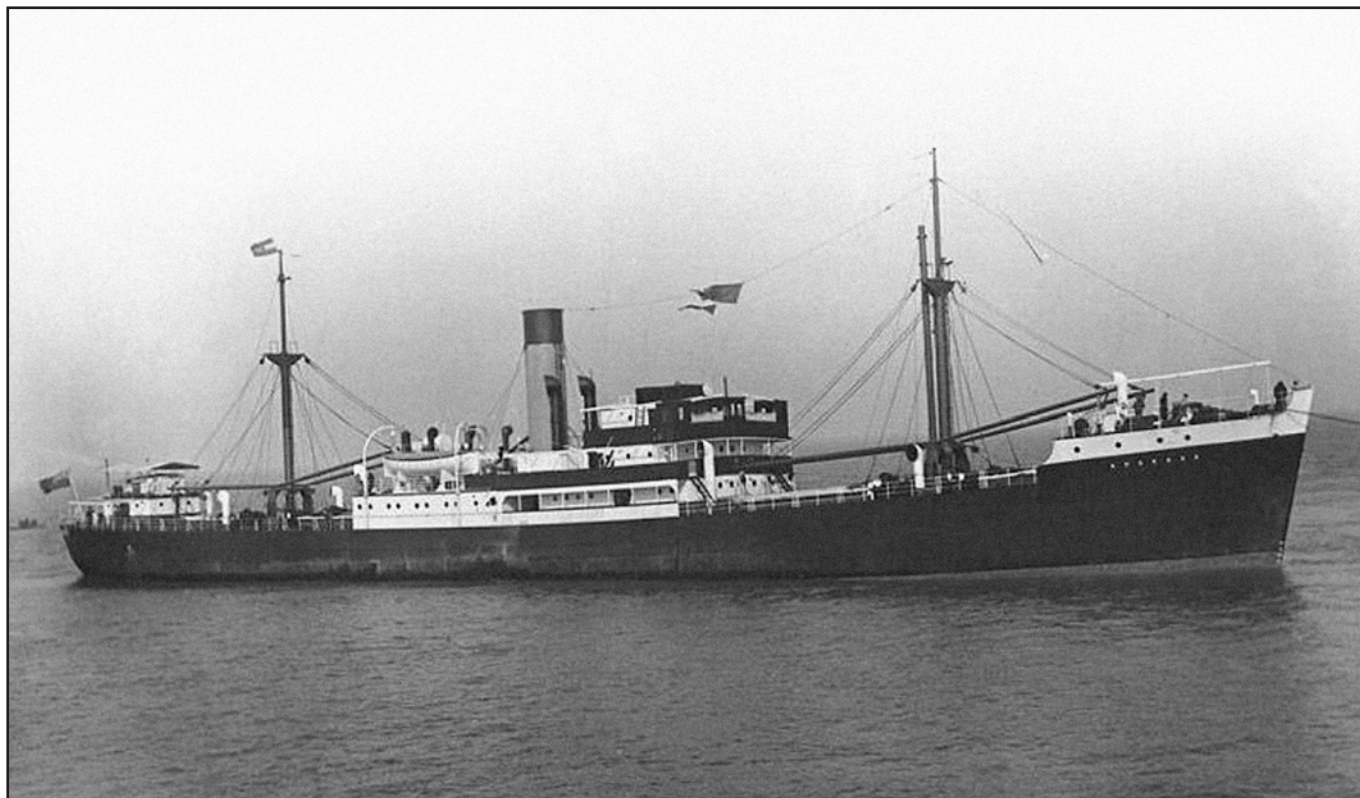


Figure 19. The steamer SS Arakaka, torpedoed on 22 June 1941 with the loss of all hands.⁴

The number of ocean weather stations maintained by the US and the UK did increase but only very slowly. By the end of May 1945 there were 16 ocean weather stations north of latitude 15 degrees North which provided weather observations and air sea rescue services however many of them only became operational towards the end of the war and for the majority of the period there was only very limited data on the Northern Atlantic Area.

There were just too few weather observations of the eastern North Atlantic to be of sufficient use to forecasters and the Office pressed hard for additional special reconnaissance flights to supplement the RAF Meteorological Flights which had been based at Mildenhall and Aldergrove since 1936 but nothing came of their representations because of a shortage of aircraft and aircrew. Then, in the summer of 1940, RAF Bomber Command voiced concerns about the accuracy of weather forecasts for flights over the North Sea and northern Germany while greater knowledge of Atlantic weather was also required.

Eventually in late 1940 agreement was reached to establish three flights, two over the North Atlantic and the third over the North Sea. Observations were initially made by navigators because trained meteorologists were not available but these operations proved to be of limited use due to a lack of trained crew and aircraft. In September 1942 the Meteorological Air Observation Section of RAFVR was formed and existing staff and new personnel were recruited and given the relevant air observation training. The first officers were posted to meteorological squadrons and flights in June 1943.

As the war progressed the effort devoted to meteorological reconnaissance increased with flights being added from 1942. By the end of 1944 there were nine flights, two of which were flown by the expanding American Met Squadron, with one headed south-west out of Iceland, one westwards out of Gibraltar and the rest over the waters around the British Isles. The flights all followed fixed courses which could be altered to suit operational requirements.

⁴www.uboot.net/allies/merchants/999.html



Figure 20. Met Spitfire 1941. The pilot makes observations of cloud types and heights and wet and dry bulb temperatures on a knee pad.



Figure 21. De Havilland Mosquito Aircraft 1943.



Figure 22. High level ascents were required for meteorological reconnaissance – this image from 1942 shows a Gloster Gladiator and the many layers pilots had to don in order to stay warm at 25,000 feet.

Although all of these flights added much useful information there was still a large gap in the observational coverage over mainland Europe. During 1941 a new type of high level, deep penetration Meteorological Flight, code named PAMPA, was developed for this purpose. The flight was initially made using Spitfires but during 1942 these were phased out in favour of the Mosquito which was faster, could fly higher and further (anywhere within 1,000 miles of base in any direction) and required only two crew.

The PAMPA flights were not used for synoptic observations and therefore did not fly fixed routes or times. Instead the aircraft stood ready to take off at any time and in any direction ahead of a major Bomber Command force, to obtain actual weather information over the target (observed by the observer/navigator). Most PAMPA operations were pre-attack sorties but on occasion the planes flew just 30 minutes ahead of the Pathfinder Force target markers and fed up-to-date weather information directly to the Master Bomber or his deputy by radio.

On 1 April 1943 the PAMPA flights were absorbed into the Bomber Command Pathfinder Force as it was Bomber Command who most urgently needed the information it supplied.

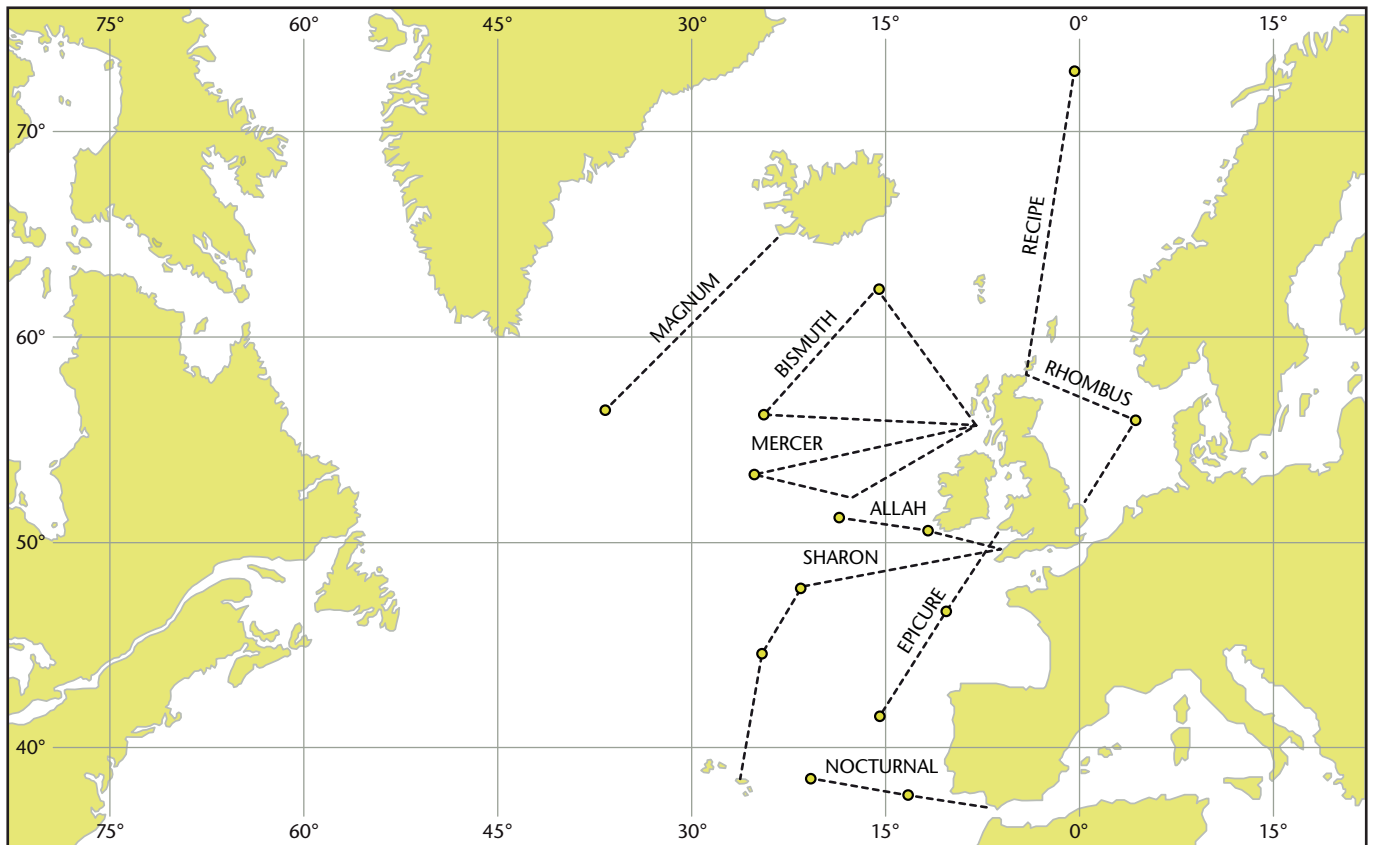


Figure 23. Routes taken by the various meteorological reconnaissance flights operating in 1944.

Remote observation methods

In addition to manually collected observations several remote methods of obtaining meteorological information were also devised during the war:

- Locations of lightning flashes were ascertained by means of the direction finding methods which were pioneered by Watson-Watt and Cave during WW1 and later taken up by the Radio Research Board. Stations were set up at Dunstable, Leuchars and later at St Eval with the ability to observe individual atmospheric simultaneously via direct telephone line. The data provided by this apparatus proved extremely valuable to Bomber Command, in particular for the location of thunderstorms and associated cumulonimbus cloud (which is always associated with severe icing and turbulence) over oceans and enemy territory.
- Radar Operators also found another means of remote sensing almost by accident. They noticed that noise in returning echoes was associated with weather elements such as rain, sleet and snow. A shower was tracked by 10 cm radar at a range of 7 km off the English coast on 20 February 1941 and soon after this, meteorologists learned to recognise the differences between showers, thunderstorms and continuous precipitation on radar displays. They also learned to identify fronts and tropical storms.

- Trials at Larkhill also enabled the development of radar use for wind finding. At the beginning of the war it was impossible to measure upper winds in cloudy conditions since the pilot balloons used to determine upper winds were soon lost in the cloud. Shortly before war was declared a technique was developed at Larkhill which involved attaching a small radio transmitter to a balloon and tracking it using direction finders.⁵ The technique was only used at four upper air stations but enabled meteorologists to determine upper winds for the remainder of the war.

In 1943 further research at Larkhill showed that weather balloons with attached metal-coated radar reflectors hanging from them could be also used to measure the speed and direction of upper winds. The routine use of radar for this purpose started at Shoeburyness in Essex and Fazakerley near Liverpool in 1944 and by the end of the war the Office had its own radar research station with a 10 cm radar at East Hill near Dunstable.

– Developments in radar brought about by the war led to the creation of an entirely new method of meteorological observation which remains a key source of data into the 21st century.



Figure 24. Radar station on the UK coast. WW2 saw the first use of radar in meteorology.

⁵The changes in azimuth and elevation allowed winds to be calculated.

The Met Office and the D-Day forecast

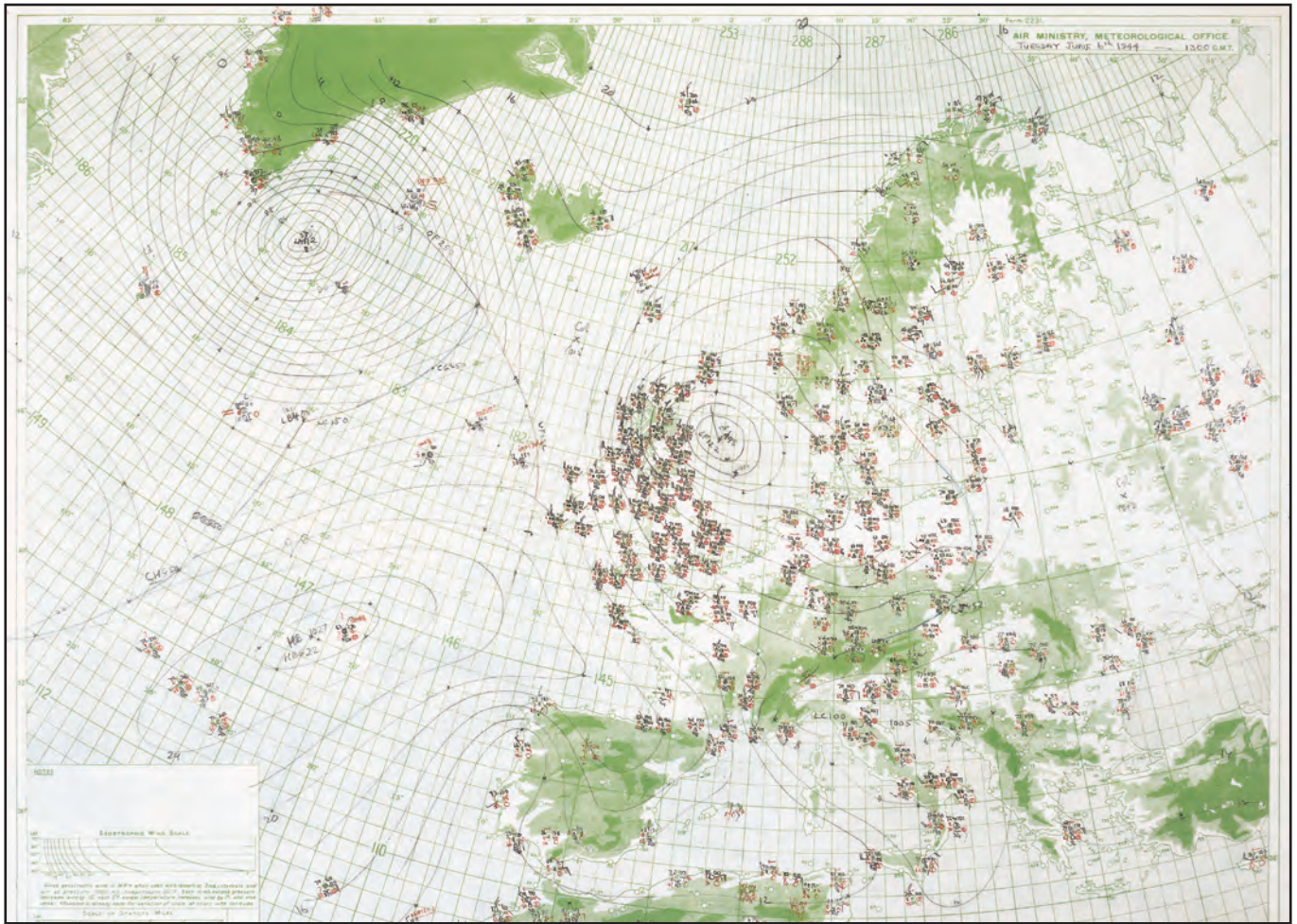


Figure 25. Synoptic chart for 1300z on 6 June 1944.

Dawn on 6 June 1944. The guns of HMS Belfast open fire on the Normandy Coast and under their barrage the first landing craft of the largest seaborne invasion in history approach the beaches. Operation Neptune (the largest Armada in history) and the seaborne element of Operation Overlord is well under way.⁶ Throughout the night, paratroopers have dropped into landing zones across the Normandy area and soon after dawn well over 100,000 Allied forces made up largely British, American and Canadian troops are fighting their way ashore along a 50 mile stretch of beaches complete with all the equipment required for carving their way through the heavily fortified and extremely well designed German coastal defences known as the Atlantic Wall.⁷

Throughout the day they were followed by re-enforcements and thousands of tonnes of supplies needed to keep that vast army operating through the first days of Operation Overlord and the slow advance through northern France. Everything required to keep the invasion force fighting for days and weeks had to arrive by sea including the huge floating Mulberry harbours themselves, towed across the channel in pieces then assembled off the beach heads.⁸

⁶Operation Overlord was the blanket name given to the invasion of France. It consisted of a number of separated operations. Neptune was the seaborne component. In addition Operations Albany and Boston consisted of American airborne troops landing on the Cotentin Peninsula to secure the western flank of the invasion zone while Operation Tonga was the British equivalent landing in the Caen area to secure the eastern flank.

⁷Once ashore British and Canadian troops were supported by specialist modified tanks known as 'Hobart's Funnies' that were used for mine clearance, as bridge-layers and as fascine carriers (fascines were bundles of brushwood used to fill in craters allowing vehicles to pass). The American's opted not to use them and ran into significant difficulties as a result.

⁸The western (American) Mulberry Harbour was all but destroyed by an unexpected gale on 19 June and was never repaired as Cherbourg and its harbour were liberated about a week later. The eastern harbour exceeded its planned life of 90 days and was used until November 1944.

But Operation Neptune, the seaborne part of Operation Overlord, had been planned for 5 June — so why the change? The entire invasion depended on a forecast of acceptable weather. The allied commanders basic wish list of conditions for the invasion was:

- Quiet weather for 48hrs before D-Day to allow the assault convoys to sail from their base harbours and form up and three subsequent days of weather of Beaufort Force less than force 4.
- Less than 30% cloud cover below 8,000 feet (2,400 metres) with a minimum cloud base no lower than 2,500 feet to enable aircraft carrying parachutists and tugging gliders to deploy and visibility more than three miles (5km).
- Low tide at dawn on D-Day itself.
- It should be between one day before and four days after a full moon.

The timing was crucial – the invasion had to coincide with the Soviet summer offensive in the east thus ensuring maximum pressure on German resources. Having realised that it was not logistically possible to invade in May, the month originally preferred, Eisenhower and the allied commanders looked to June. Moon and tide conditions were favourable on just three days; 5, 6 and 7 June with tide conditions, but not the moon, suitable only once more, two weeks later. From the outset the odds of even broadly acceptable weather were at least 13 to 1 and these roughly trebled as soon as the requirement for a full moon was added to the equation.

General Eisenhower, Supreme Allied Commander of the Allied Expeditionary Force set the invasion date for 5 June but added the caveat that this would be subject to last minute revision in the event of unfavourable weather. The man tasked with briefing him on that weather was 43 year old Dr. James Stagg a member of senior staff in the Meteorological Office and Group Captain in the RAF who was based at SHAEF (Supreme Headquarters Allied Expeditionary Forces). SHAEF was located at Bushy Park, Teddington and it was from here that Stagg carried out most of his work, moving to Advanced SHAEF at Southwick House, Hampshire at the beginning of June.

Stagg's key strength was his ability as an administrator and organiser who could produce an acceptable statement on likely weather conditions based on the often differing opinions of the British and American meteorologists tasked with producing the D-Day forecast. That statement was based on advice given via regular telephone conferences using a scrambled telephone circuit, from three teams: US Air Force meteorologists Irving Krick and Benjamin Holzman based at WideWing (the code name for Bushy Park), UK Meteorological Office staff Sverre Petterssen and CKM Douglas based at the Central Forecasting Office in Dunstable (codename ETA) and Admiralty Meteorologists Lawrence Hogben and Geoffrey Wolfe based at the Admiralty in London.

In addition Col. CN Spencer and Dr. RC Sutcliffe, Allied Expeditionary Air Force and Inst/Cdr Fleming Naval Staff Weather Officer listened in to ensure that the advice they gave to their own commanders was in line with that being given to Eisenhower. They would not directly contribute to the D-Day forecast but were invited to contribute to the general discussions.

Eisenhower needed a five day forecast - difficult enough to provide with certainty in 2014 and near impossible in 1944 when forecasts beyond 24 hours were considered impractical except in very settled conditions and even then would only very rarely be extended beyond 48 hours. Stagg knew that whatever the weather his advice would have a momentous impact on the invasion and its accuracy would be vital. After a relatively settled May the weather turned in early June bringing unseasonable conditions with unsettled westerly winds and complex patterns of low pressure areas and weather fronts.

The British and American teams, who had worked independently to produce their forecasts then collaborated to reach a final decision, had often struggled to reach agreement on the forecast but now looked unlikely to reach any accord at all. Initially the American team strongly supported a favourable forecast for the 5th but Petterssen and Douglas disagreed and the Admiralty team was inclined to agree with Petterssen and Douglas although their forecast was rather less gloomy.

Although facing much disagreement Stagg decided to follow the forecast of Pettersen and Douglas backed up by Wolfe and Hogben. Following Stagg's briefing on the expected poor conditions on the French channel coast, Eisenhower took the decision at the 21.30 DBST Supreme Commanders conference on 3 June to provisionally postpone the invasion on a day-by-day basis - a decision that was confirmed following Stagg's next weather briefing at 04.15 DBST on 4 June.⁹ At this point there was no agreement on whether the weather on the 6th would be any better.

During the 4th it began to emerge that a temporary period of fair weather might ensue starting on the night of the 5th and the meteorological teams agreed that a short lived high pressure would build from the south-west with acceptable winds and cloud conditions, although there was more disagreement on the latter. If the forecast was right, it would bring a brief break in the weather on the morning of 6 June.

Far from the conditions desired for a successful invasion but, hopefully, just good enough it might even catch the German defenders off guard since they were equally aware of the limited days when the moon and tide would be right. To this day there is debate about who had exactly the right forecast for D-Day. Central Forecasting Office at Dunstable, the Admiralty and the American USAAF Widewing forecasters all produced forecasts containing both correct and incorrect guidance. Late on 4 June, Stagg was able to advise Eisenhower that, despite the driving rain and gusty winds outside, he predicted fair weather on the morning of the 6th which might last into the afternoon.

Initially Stagg advised that, after this, conditions would become more unsettled but under pressure from Naval Forces Commander Admiral Sir Bertram Ramsay he indicated that the Azores anticyclone might extend north again giving good enough conditions for the days following the invasion. It was a huge decision and risked the lives of thousands of troops packed into small landing craft which would capsize in rough seas. In the early hours of the 5th, relying entirely on Stagg's weather briefing, Eisenhower made the final decision-the invasion would go ahead on the 6th. Less than three hours later the first convoy left Weymouth, Portland and Wareham Harbours bound for Utah Beach. In his diary entry for the 5 June Stagg noted:

Admiral Creasy said "You should be proud of yourself and your forecast" – I wonder. He should wait till he sees how things go.

In the early hours of 6 June, wind and weather permitted some night-time airborne operations but cloud cover severely hampered bombing operations. A higher than forecast wind also meant that many parachutists missed their drop zones with many being blown east into waterlogged terrain. Over the beaches, American Bomber crews, tasked with visual bombing of shore defences just minutes before the first American troops were due to land, were so concerned about the risk of hitting their own troops because they could not see their targets that they delayed releasing their bombs, consequently bombing open countryside. Strong onshore winds also created challenging conditions for the initial assault on almost all of the beaches.

Conditions did improve during the day and the 1300GMT German observation from Caen Airfield reported that 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 15 °C.

⁹DBST (Double British Summer Time). In October 1940 the clocks in Britain were not put back by an hour at the end of Summer Time and in subsequent years the clocks continued to be advanced by one hour each spring and put back by one hour each autumn until July 1945. Consequently Britain was operating two hours ahead of GMT during the summers from 1941–1945.

As a somewhat unexpected bonus the chief meteorologist of the German 3 Air Fleet had advised of poor weather conditions on the 6th and the German Army Commanders had decided not to trigger their warning system, which had been designed to alert troops defending Field Marshal Erwin Rommel's Atlantic Wall, to a likely invasion in the early hours and to funnel additional troops into the area.

Even after airborne operations began and the defending troops alerted their commanding officers their warnings were ignored because, thanks to the great success of British deception plans and the bombing of German radar stations rendering the German Army effectively blind to the approaching transport aircraft, the German High Command was convinced that anything taking place on the Normandy Beaches must be a diversionary tactic and the real invasion would occur in the area around the Pas-de-Calais.

All of these elements combined to give the allies an element of surprise and saved countless lives. Despite working with limited data, in a period of very unsettled weather and without the sophisticated models we have today, Stagg and the D-Day meteorologists calculated, debated and finally agreed on a forecast that proved good enough. Working under intense pressures they had made perhaps the most important forecast in history.



Figure 26. Group Captain JM Stagg.

Later, in a memorandum accompanying an official report to Eisenhower Stagg noted that had Operation Neptune been delayed until the next suitable tides two weeks later (these did not coincide with the right moon phase but would have been the only option had the decision not been made to go ahead on the 6th) the troops would have run into the worst Channel weather for 20 years.

In fact on 17 June, when the decision to invade would have been taken, all of the forecasters predicted an extended fine spell. The change to force six to seven winds with occasional gusts to force eight took place very quickly and caught everyone by surprise. The invasion would have been a total disaster resulting in the loss of most of the allied troops and quite possibly changing the outcome of the war.

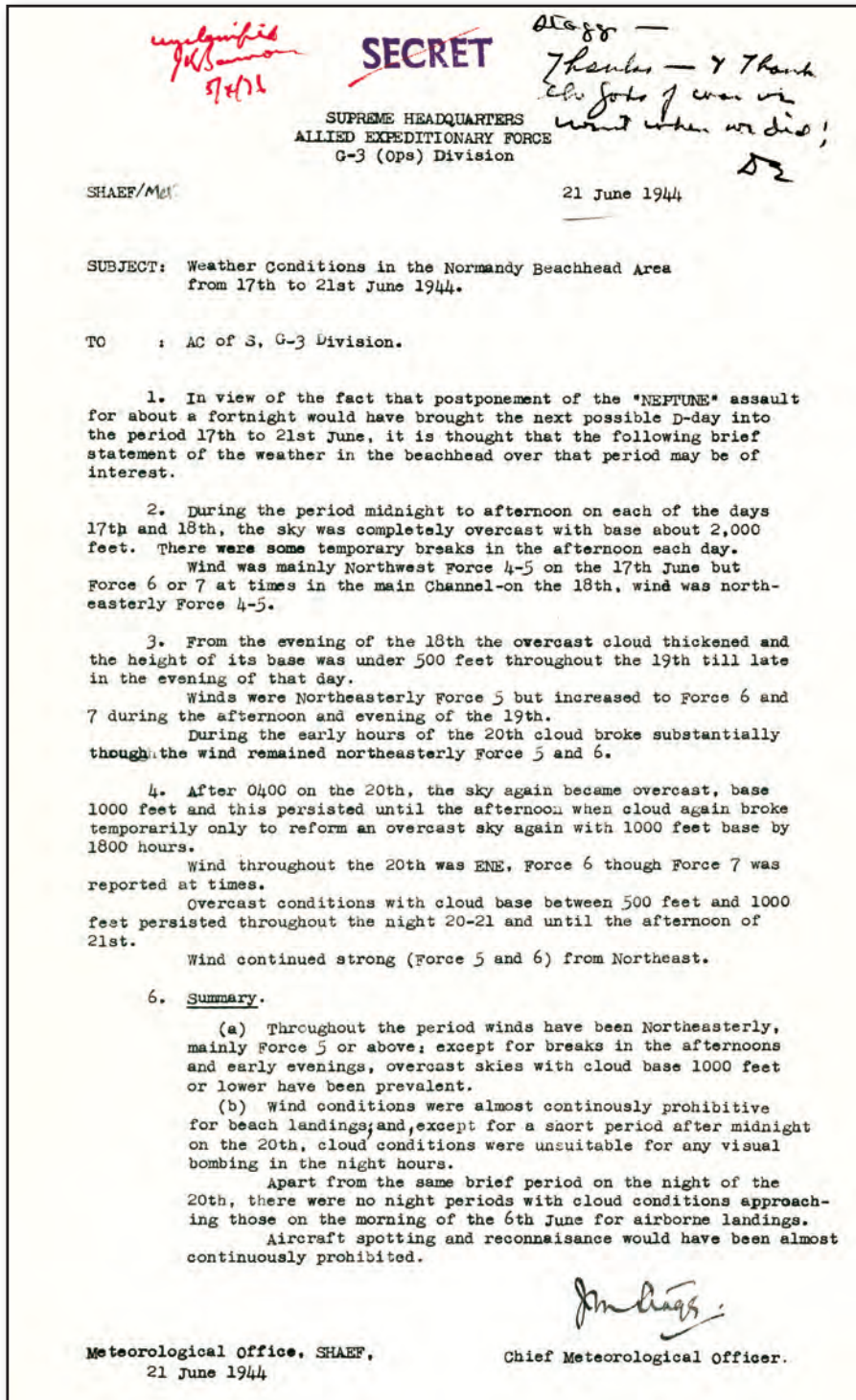


Figure 27. Stagg's memorandum concerning weather conditions for 17–21 June 1944.

Eisenhower wrote across the top of the memorandum:
'Thanks, and thank the Gods of War we went when we did'.

Roll of honour 1939–1945:

Bankier, L. S.	Montgomery, R. E.
Beuttell, R. G.	Moore, E.
Blackburn, E.	Morse, O. M.
Blagrove, S.	Mulligan, D. T.
Brown, D. T.	Murphy, J.
Brown, R.	Nash, R. J.
Brunning, T. C. J.	Patterson, H.
Buttfield, E. H. F.	Portass, S. L.
Campbell, A. W.	Pressley, D. A.
Cartwright, G.	Proud, S.
Clark, S. J.	Pye, J. E. B.
Clifford, N. J.	Read, H.
Clifford, R. G.	Rees, M. T.
Crichton-Miller, C.	Reeve, G. F.
Curd, C. D.	Rivers, F. A.
Davidson, J.	Roberts, N. A.
Edington, W. M.	Rutherford, R.
Fielding, R. A.	Sharp, D. M.
Gange, F. C.	Short, P. W. H.
Goatly, P. B.	Simmonds, A. R.
Gordon, J. M. B.	Smith, P. G.
Groves, L. G.	Stevenson, E. G. H.
Halfrod, G.	Stevenson, R.
Hedley-Smith, E. J.	Tagg, K. T.
Henderson, W. M.	Taylor, J. R.
Hewitson, D. P.	Thom, F. V.
Hill, J. E.	Thomas, G. N.
Hodgson, J. A.	Thompson, A. A.
Holmes, C. D.	Thomson K. K.
Joseph. P. B.	Thorpe, F. H.
Legg, D. C.	Trevitt, K.
Leigh-Clare, H. H. J.	Vann, A. H.
Martin, R. T.	Watson, C. G.
Matthews, H. A.	Willis, A. J.
McCulloch, J. G.	Wrighton, R. H. R.
Merridale, R. G.	

Roll of honour 1939–1945

Seventy one members of Met Office staff died or were killed on active service during World War 2 including four women; Lili Stefania Bankier, Joan Ellen Hill, Olive Mary Morse and Hannah Patterson. The stories of six are told here to illustrate the great range of tasks Met Office staff undertook and the variety of places in which they worked and, tragically, lost their lives.

Lili Stefania Bankier, Leading Aircraftwoman WAAF (Womens Auxiliary Air Force)

Born 1922 in Lodz, Poland died 28 July at Deversoir, Egypt. Lili and her mother escaped from Poland following the German invasion in 1939 and eventually reached Palestine. Her father remained in Poland and eventually died in the Lodz ghetto in August 1942. Lili was one of 616 women resident in Palestine who joined the WAAF between May 1943 and May 1945. After being placed in the 'Meteorologist' trade group and in the absence of a Meteorological Office training school Lili would have received her training 'on the job' at an RAF airfield.

By the summer of 1945 Lili was working with No 23 Forecast Unit at RAF Lydda in Palestine where her duties would have included plotting charts, observing and duplicating forecasts. On 28 July 1945 Lili boarded an aircraft to fly to Shallufa near Suez for a week's leave. The aircraft encountered difficulties with an engine and amid some confusion the wireless operator thought the pilot had ordered the aircraft to be abandoned. Lili jumped from the aircraft at about 500 feet. Sadly her parachute failed to open.

Edwin Henry Frederick Butfield, Leading Aircraftman RAFVR (Royal Air Force Reserve)

Born 1914, died 20 August 1940. Edwin appears to have responded to appeals to join the Meteorological Branch RAFVR in the spring of 1939. In the summer of 1940 he was stationed at RAF Biggin Hill working as an observer in the meteorological office. On the evening of his death Edwin was leaving the Airmen's Mess after his evening meal when nine German Junkers 88s attacked and bombed the airfield without warning.

He managed to reach a bomb shelter but in what proved to be the most severe raid on the airfield of the war a bomb fell through the shelter's entrance killing all 39 men inside. Another observer, Norman Arthur Roberts was killed during the same raid.

Alastair William Campbell, Flying Officer RAFVR

Born 9 February 1919 died 28 October 1944. Alastair was accepted for training as Meteorological Aircraft Observer (MAO) in late 1943. On 8 October 1944 521 Squadron was tasked with flying a special meteorological reconnaissance sortie to a position near Stavanger in southern Norway. The weather near Norway was known to be poor and the flight was to confirm whether conditions would be suitable for a Beaufighter strike against a convoy expected in the area at dawn.

The crew chosen was one of the most experienced in the Squadron and included Campbell, who was, by this time, the squadron's MAO leader. The aircraft took off at 0100 and was never heard from again, nor was any wreckage found.

Campbell Crichton-Miller, Squadron Leader RAFVR

Born 6 August 1915 died 19 February 1943. Campbell was commissioned as a Pilot Officer into the RAFVR (Meteorological Branch) during August 1939. Having completed the first training course at the Meteorological Office Training School in Berkeley Square, London he served at a number of air fields in the UK and France.

In May 1941 Campbell was posted to the Central Landing School at RAF Ringway where he studied the meteorological problems of Army airborne operations and after acting as the RAF's liaison meteorologist for Operation BITING (the raid to acquire key items from a German radar installation at Bruneval on the French coast) he took post as the Senior Meteorological Officer of HQ Wing at RAF Netheravon.

He continued researching into the meteorological aspects of airborne operations and particularly the effect of visibility and it was to further this research that he was included in the crew of a Halifax bomber of 295 Squadron taking part in a raid against an electricity transformer at Distre in northwest France which had been incorrectly labelled as lightly defended. Two of the twelve aircraft failed to return including Campbell's.

John Godbolt McCulloch, Pilot Officer RAFO (Reserve of Air Force Officers)

Born 1 July 1917 died 27 May 1943. John joined the Meteorological office in late 1939 and was a civilian forecaster in 1941. On 11 June 1942 he was commissioned as a Pilot Officer into the Reserve of Air Force Officers proceeded overseas.

The whole of his military service is believed to have been in Kenya and it was while serving with HQ No 246 Wing at Port Reitz that he was admitted to hospital in Mombassa suffering from cerebral malaria, from which he did not recover.

Sidney Leslie Portass, Squadron Leader RAFVR

Born 2 November 1915, died 22 June 1941. Sidney was a forecaster posted to RAF Aldergrove in 1939 and, having been commissioned into the RAFO in 1938 he was one of the first to be mobilised and went to France with the RAF contingent of the BEF before being evacuated during the retreat of 1940.

Portass was one of three meteorological staff posted to the weather ship SS Arakaka. After safely completing five voyages the Arakaka was preparing to return from its sixth when it was hit by a torpedo fired by U-77 with the loss of all hands.



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