METEOROLOGICAL OFFICE

History

National Meteorological Library and Archive
Factsheet 21 — Met Office History and Timeline

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.

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The National Meteorological Library and Archive are open by appointment.

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This shorter history of the Met Office is draws heavily upon the work of the late Malcolm Walker. For more detail on all aspects of the history of the meteorological Office to 2010 we would recommend Walker, M. History of the Meteorological Office, CUP, 2012

1. A new science is born

Setting the Scene

When the Met Office was founded in 1854 it did not spring out of nowhere. It was the product of the pioneering work of innovative minds across three continents. On 17 October 1839 American naval Officer Matthew Fontaine Maury was severely injured in a stagecoach accident. It ended his seagoing career, and he was then put to work as Superintendent of the US Navy Depot of Charts and Instruments at the US Naval Observatory. He realised that he now had at his disposal thousands of observations about wind, weather and currents and that these could be of great use to seafarers if they were collated into a useable and shareable format. Maury also produced special charts and forms for American naval officers and seamen to continue sending in observations and brought all of this together in his Wind and Current Charts, leading to faster and safer voyages. Not content with this Maury felt that he could achieve more if he developed an international system.

In Great Britain the pioneering but largely forgotten aeronaut and meteorologist James Glaisher was responsible for establishing the first UK wide network of reliable meteorological observers in the 1840s. He inspected each station, calibrated instruments and designed the Glaisher Screen for better exposure of thermometers. As the Superintendent of the Magnetic and Meteorological Department of the Royal Observatory in Greenwich, Glaisher was responsible for the administration of the Department and for organising observations and investigations. As such he was Britain's first full time government appointed meteorologist. Glaisher also demonstrated that observations could be gathered and sent into a central point with speed by collaborating with station masters and the Electric Telegraph Company. Indeed, at the Great Exhibition of 1851 meteorological observations sent via telegraph were used to demonstrate the ability and breadth of the new telegraph network. The observations were drawn up onto charts and published by lithography at the Great Exhibition for one penny each.

In the colonies, British Army officer William Reid had also begun work to understand tropical cyclones. He persuaded the British Colonial Office to set up meteorological stations in the colonies and in 1851 he succeeded in persuading his former commanding officer, Sir John Fox Burgoyne, to authorise the establishment of a worldwide network with the Royal Engineers taking on responsibility for making meteorological observations. In one final successful leap Burgoyne, encouraged by Reid, approached the United States to suggest expansion of the network through collaboration with the US. In early 1853, after some discussion resulting in a decision not to include land networks due to difficulties in changing already established practices, the American government issued invitations to 'a conference limited to adopting a universal system for observations at sea'.

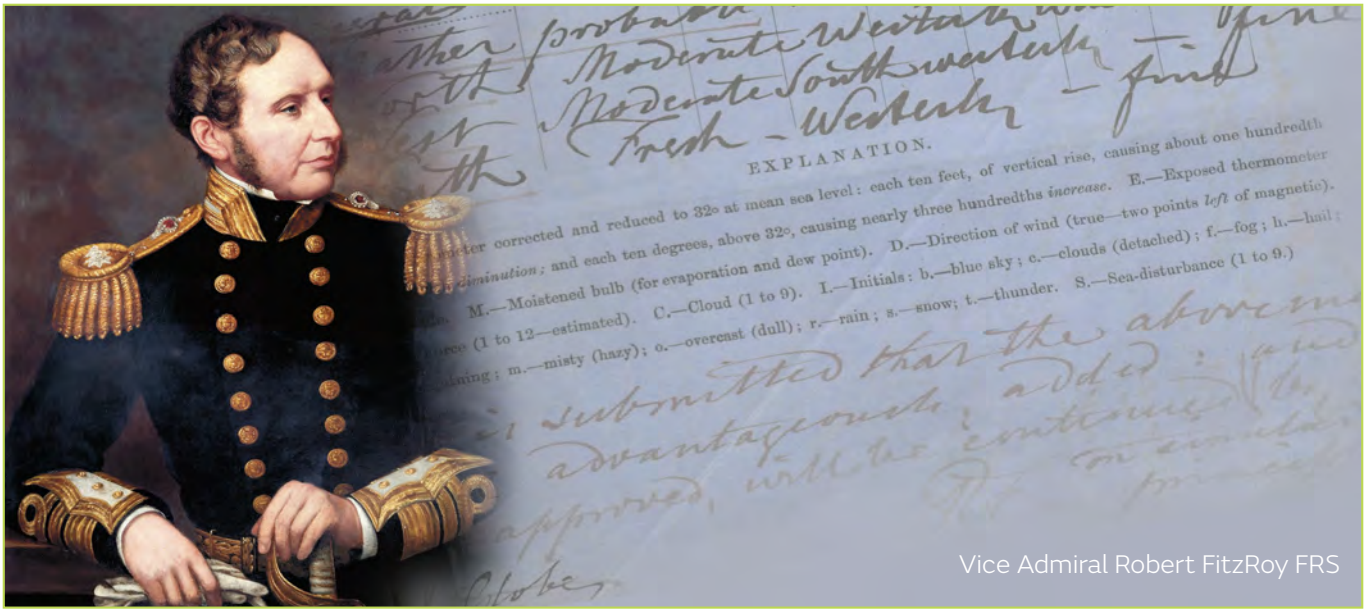
With the development of networks, standardised reporting, proven speed of communication and a desire for national and international collaboration the seeds had been sown for the birth of the Meteorological Office.

Founding the Office

The first International Meteorological Conference went ahead in Brussels from 23 August to 8 September 1853. Twelve delegates represented ten nations: Belgium, Denmark, France, Great Britain, The Netherlands, Norway, Portugal, Russia, Sweden and the United States. The delegates from the UK, were land meteorologist Henry James, and the Arctic explorer Frederick William Beechey. They were forbidden to commit to any expenditure! By the end the delegates had agreed a code for observational practice at sea and the use of a standard meteorological register. Other than a change from two to four hour observing intervals the process agreed by the delegates remains largely unchanged even today.

On 6 February 1854 Sir James Graham, First Lord of the Admiralty, announced in the House of Commons that a new department was to be established to analyse pre-existing observations, establish a larger observation network under the newly established principles and share the resulting information with Captain Maury. £3,200 of funding was secured from the Board of Trade vote, the equivalent of over £350,000 today. After the president of the board submitted the vote to the House of Commons on 30 June 1854 there was a short debate during which John Ball, Member for Carlow, suggested that 'in a few years, notwithstanding the variable climate of this country, we might know in this metropolis the condition of the weather 24 hours beforehand'. Hansard reports that the reaction was laughter.

Parliament approached the Royal Society for guidance on whom to appoint to direct the new office and they recommended Captain (later Vice Admiral) Robert FitzRoy. FitzRoy was a skilled surveyor and is often better known as the Captain of HMS Beagle during her circumnavigation of the globe with naturalist Charles Darwin. FitzRoy had a strong understanding of meteorology from his experience at sea and wished to increase meteorological knowledge and awareness among seafarers. He had already made it well known that he was keen to take on the job and was duly appointed 'Meteorological Statist to the Board of Trade' on 1 August 1854.



Vice Admiral Robert FitzRoy FRS

The earliest days of the Meteorological Department 1854 to 1865

The Meteorological Department of the Board of Trade, as it was officially known, was located at numbers 1 and 2 Parliament Street, Westminster. There was a rain gauge and a wind vane on the roof of the building and a staff of four. The first priority of the department was to 'determine the best tracks for ships to follow, in order to make the quickest as well as the safest passages'[1]. FitzRoy set about equipping ships with logbooks and instruments, but in the knowledge that this data would take time to gather he also began re-processing the data from Maury's complex publications to produce a much simpler system of 'wind stars'. These diagrams provided seasonal climatological averages of wind strength and direction and additional rain and current data for each 10-degree square of the oceans.

Meteorological Department building at 1 and 2 Parliament Street, Westminster.

By early 1855 the Royal Society had set a series of eight key aims for the Meteorological Office. These focussed on gathering pressure, sea surface and current data, investigating the trade winds and monsoons, analysis of large scale fluctuations in temperature, charting magnetic variation and finally making observations at British military stations in the Mediterranean , on the coasts of Australia and New Zealand and for at least a year at a station in the West Indies. Although his early work largely followed these lines, FitzRoy appears to have viewed this list rather more as guidelines than a directive.

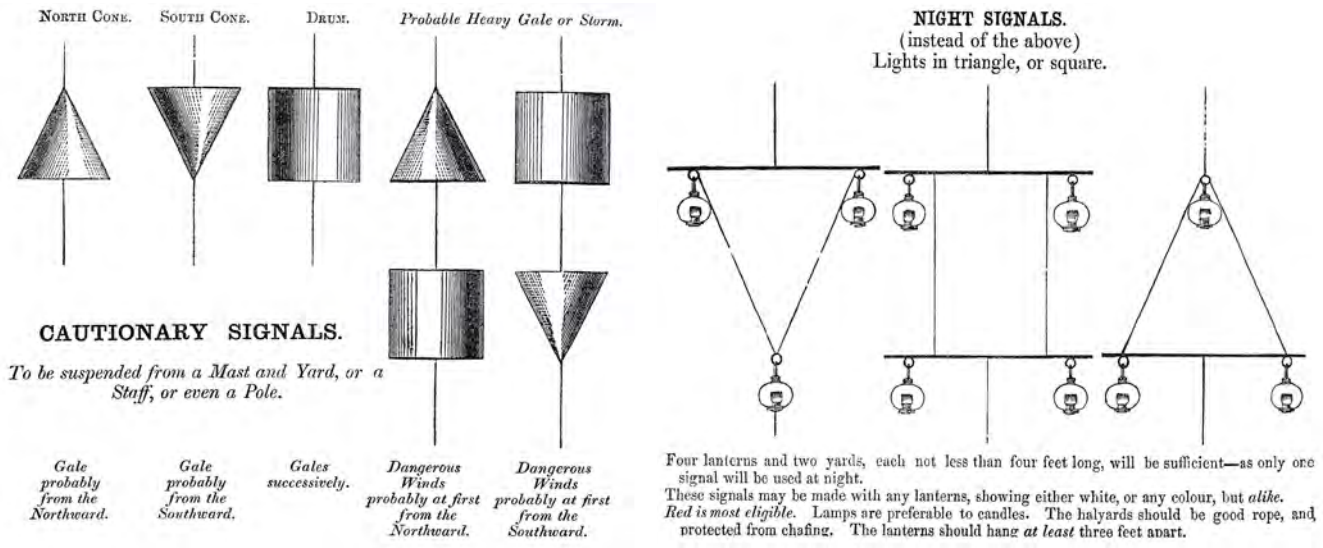
FitzRoy pioneered and developed the science of meteorology. His 'Weather Book' laid out the science, as he perceived it, for the first time and many of his terms remain in use today. He developed the first synoptic charts, developed much of the early science of synoptic forecasting, and even coined the term 'Forecast'. He also believed that meteorology should not be purely theoretical and took the concept forwards into the realm of applied science.

1. *Memorandum Number 1*, FitzRoy, R. 1854

FitzRoy was a firm believer in the use of the barometer as an aid to forecasting and was concerned by the significant loss of life caused by unpredictable weather among the fishing communities of the British coasts. He used his own money, public funds and the generous backing of benefactors such as the Duke of Northumberland to place barometers in a number of fishing villages. He also worked with instrument makers Negretti and Zambra to produce a new design of Barometer which included a simple rhyme to assist with the interpretation of changes in the mercury: 'long foretold, long last; short notice soon past' and 'first rise after low foretells stronger blow'.

FitzRoy's barometers saved countless lives but perhaps his biggest single impact on safety at sea followed the disastrous Royal Charter Gale of 25–26 October 1859. Widely believed to be the most significant storm of the 19th Century the Royal Charter Gale caused the loss of 133 ships and 800 lives. At least 459 of the lives lost were onboard the steam Clipper Royal Charter, on the last leg of her two month voyage from Melbourne to Liverpool. The ship was wrecked off Moelfre on the coast of Anglesea and there were just 39 survivors. All the women and children aboard died. FitzRoy already felt that his department should provide an operational storm warning service for shipping by using the telegraph system to gather observations and communicate warnings to ports and harbours. During the public furore following the Royal Charter Gale he approached parliament with a report proving the department's understanding of the storm and a proposal to establish a storm warning service. His ideas and his methods were widely supported and even Prince Albert the Prince Consort took an interest.

Parliament gave FitzRoy permission to proceed and, despite much scepticism among the scientific community over whether accurate forecasting was possible, the first thirteen stations began to send in their observations by telegraph on 3 September 1860. They were Aberdeen, Greenock, Berwick, Hull, Yarmouth, Dover, Portsmouth, Jersey, Plymouth, Penzance, Queenstown (now Cobh), Galway and Portrush. Soon after this observations from France, Copenhagen, Helder, Brest, Bayonne, Lisbon and several other stations in the UK were added to the list. The first storm-warning was issued on 6 February 1861, but on the Tyne it was widely disregarded and followed by significant loss of life after which further warnings were heeded. Warnings were issued to the relevant coastal ports using the telegraph but visible signals were required in order to communicate them to ships. To do this FitzRoy designed a system of cones and drums to be hoisted on a mast or other visible site. The cones and drums, which were replaced with a system of lights at night, indicated the expected wind direction. Spherical shapes were avoided to ensure there would be no confusion with time balls.



FitzRoy's warning system

Forecasts for the General Public followed on 1 August 1861.[2] FitzRoy did not have permission to produce these but felt that they would be useful and could be easily added beneath the observations for the previous day which were already regularly published in the Times newspaper. His forecasts were not always accurate, but they were widely consulted and heeded. Indeed a meeting of the shareholders of the Great Western Docks at Stonehouse, Plymouth noted that the loss of revenue in 1862 was due to the reduction in vessels being repaired in the graving docks following damage caused by being caught out in storms at sea. Even Queen Victoria sent messengers to FitzRoy's house to request a forecast before travelling to her residence at Osborne, on the Isle of Wight.

2. FitzRoy essentially coined the term 'Weather Forecast' stating that these were the result of the application of scientific process and not prophecy. The Weather Book A Manual of Practical Meteorology p. 350.

The office continued to develop despite FitzRoy failing to report on its activities between 1858 and 1862. Much of the work was good but inevitably the forecasts were not always accurate and unfortunately, FitzRoy took the inevitable criticism personally. In addition, as a devout Christian his strongly adverse reaction to the publication of Darwin's On the Origin of Species did not assist his position among the scientific establishment.[3] His ideas on meteorology were widely approved of by many leading scientists but he increasingly felt the need to defend himself, often in letters published in the Times. His health began to suffer with his defacto deputy Babington taking on the running of the department and almost all forecasting work. As a result of the attacks on his forecasts, financial concerns (his entire fortune of £6,000, equivalent to around £400,000 today, had been spent on public service) and concerns over his scientific standing, FitzRoy sank into depression. On the morning of Sunday, 30th April 1865, he went to his dressing room and cut his throat. The wound proved fatal and FitzRoy (given the nature of his death)[4] was buried in the front churchyard of nearby All Saints Church, Upper Norwood.

The Galton Report 1866

Following the death of Robert FitzRoy the President of the Royal Society Sir Edward Sabine advised the Board of Trade that the vacancy should not be filled immediately and that instead an enquiry should be launched. He suggested that this would consider whether it was worth continuing storm warnings and that it may be unnecessary to continue publishing daily forecasts. Meanwhile he felt that the marine statistics work could be transferred to the Hydrographic Office, thus essentially closing the Meteorological Department. There followed a long period of debate between the Board of Trade and the Royal Society on the exact purpose and role of the department with the Board of Trade indicating its interest in maintaining the work started by FitzRoy and the Royal Society keen to focus specifically on the collection of marine observations and side-line or cease forecasting operations. This period of discussion led to the foundation of a committee of enquiry which was presided over by Royal Society representative Francis Galton, a vocal critic of FitzRoy's methods and a great friend of Sabine. The committee had no representatives from the Meteorological Department or the Royal Observatory Magnetic and Meteorological Department at Greenwich although Thomas Babbington, FitzRoy's defacto successor and a very able forecaster in his own right, was consulted periodically.

The findings of the committee, known as the Galton Report, were presented to Parliament on 13 April 1866. The report took a very critical view of the Meteorological Department. Galton considered FitzRoy's methods wholly unscientific and felt that meteorology should be founded on absolute laws of physics. Referring to the eight key aims suggested by the Royal Society in 1855, the report noted that the role of the Meteorological Department was not to publish observations, speculate on theory or in any way prognosticate on the weather. They noted that FitzRoy had made a good start in collecting observations, the only role they saw for the office in 1855 but concluded that he had become distracted with forecasting and had not achieved the desired aim.

The report proposed that the collection of observations be accelerated as much as possible and continued by the Board of Trade but that the analysis of these observations should be given to a new committee of the Royal Society or the British Association and funded by the government. Publications should cease and any relevant information should be published by the Hydrographic Department. Daily weather forecasts were also to cease as they were based on rules or laws that had not been proven or written down although it was accepted that many of them could be. At the time the report noted that Storm Warnings could continue but should be reviewed and monitored by a different department. As for funding, this should continue in order to cover the collection of observations but should cease in 15 years by which time sufficient observations would have been obtained. In later correspondence the Royal Society noted that they would be happy to establish a committee to oversee and control the work of the Meteorological Department with members nominated by them, and the ability to hire and fire Meteorological Department staff.

The Galton Report findings were accepted, and the Royal Society was invited to establish a Standing Committee to run the Meteorological Department. Although the Report had indicated that storm warnings could continue it was decided that from 7 December Storm Warnings would cease. It was suggested that this would be on a temporary basis until they could be resumed in an improved form. Daily weather reports would continue to be published. The Meteorological Committee of the Royal Society formally came into being on 1 January 1867 and met for the first time just two days later. It consisted of eight fellows of the Royal Society: Edward Sabine, John Peter Gassiot, William Allen Miller and Warren De La Rue (all members of the British Association Kew Committee), Francis Galton and William Spottiswoode of the British Association, Captain George Henry Richards (Hydrographer of the Admiralty) and William James Smythe (a noted meteorologist).

3. At the 1860 Oxford evolution debate where Darwin's work was discussed FitzRoy denounced the book and was reported to have marched up and down waving the Bible over his head.
4. Individuals who committed suicide were generally buried outside of consecrated ground.

Babbington resigned as temporary head of the office on the day that storm warnings ended and there was widespread negative reaction to the cessation of the service in the middle of winter. Seafarers, harbour authorities and many others complained. Letters were written in national newspapers to the Board of Trade, questions were asked in the House of Commons. Even some of the scientists who had opposed FitzRoy spoke out in defence of his signals and others questioned if they were in fact so unreliable, given that France and other countries had followed FitzRoy's lead and established their own storm-warning services. FitzRoy's entire reputation continued to be questioned by some and strongly defended by others including Babbington and the Hydrographer of the Admiralty. Regardless of the negative opinions of scientific and governmental organisations, FitzRoy remained popular and revered by many for his work to improve safety at sea.

A new beginning 1867–the Meteorological Office

The first step for the new Meteorological Committee of the Royal Society was to appoint Robert Henry Scott as Director of the Meteorological Department of the Board of Trade. Scott was not a meteorologist but had some knowledge of the discipline. He was also a close friend of the committee chair, Sabine. Meanwhile Captain Henry Toynbee was offered the post of Marine Superintendent and Mr Balfour Stewart, Director of Kew Observatory, became the Committee Secretary.

Scott took up his post on 7 February 1867 and the new title of the 'Meteorological Office'[5] was adopted at the meeting of the Meteorological Committee on 25 February 1867. Early meetings concerned finances and expenditure, but swiftly moved on to meteorological matters. Toynbee proposed various improvements in registers and guidance on the mounting of barometers, while the Committee moved to establish observatories at Kew, Glasgow, Aberdeen, Stonyhurst, Armagh, Valentia and Falmouth. By the end of 1867 the observatories at Kew, Glasgow and Stonyhurst had become fully operational and the remaining four followed before the end of 1868. Scott, Toynbee or Stewart visited most of the telegraphic stations and other sites including fishing villages and small ports in the possession of loaned instruments and arranged for defective instruments to be recalibrated or replaced if necessary.

Kew Observatory, the site remained in use from 1867 until its closure in 1980

The return of Forecasts

Pressure to re-establish the storm warning service did not decrease and a campaign to see its restoration was developed by Colonel W. H. Sykes, FRS, MP. He approached the House of Commons on 15 February 1867 asking if Storm Signals would be continued and was told that as soon as control of the department had been handed to the Royal Society they had informed the Government that the Society was not prepared to continue the storm signals as they lacked any scientific base. This engendered a further stream of complaints from all over the UK and overseas, but most were ignored.

5. The name would remain unchanged for well over a century but by the 1980s the Meteorological Office had been unofficially referred to as the Met Office for many years. The abbreviated form became official when it appeared on the cover of the 1987 Annual Report. No reason for the shortening was given, and the full name was used throughout the report, nevertheless the shortened form became the official name from 1988.

In late May 1867 a letter was received noting that the Duke of Richmond, President of the Board of Trade, had been visited by a deputation from both Houses of Parliament requesting the re-establishment of the storm warning service and asking if the Committee would reconsider their position. The response came back that storm warnings would not re-commence but that they would continue to work on collecting information which would enable the establishment of a proper underlying theory. Sykes continued to press his point throughout 1867, supported by 28 petitions, a range of letters from leading institutions, and a campaign in the press highlighting the increased number of shipwrecks that had followed the cessation of the service. Even James Glaisher, the epitome of a man of science, argued against the continuing position of the Meteorological Committee and finally the British Association agreed to approach the Board of Trade in support of the case to restart the warnings service. This placed them in direct opposition to the Royal Society.

As a result of this collective pressure, the Meteorological Committee finally proposed their new storm warning service. This would use the telegraphic network to communicate warnings to locations and a series of semaphore signals to inform shipping. Whilst these were being tested, the warning drum but not the cone to indicate wind direction would be brought back into operation. The new service was announced on 30 November 1867 and the first warning issued on 10 January 1868. This storm warning service, now better known as the Shipping Forecast, has continued without interruption ever since.

Following testing, the new semaphore storm warning system proved ineffective whilst analysis of storms and warnings issued from 1861–1866 indicated that much of FitzRoy's original system, originally so heavily discredited by the Royal Society and the Meteorological Committee, was in fact accurate and reliable. As a result, the storm warning cones and drums were left in operation and continued in use until 1 June 1984 by which time it was considered that all ships would have the means to receive warnings by radio.

The office needed more space and in 1869 it moved to 63 Victoria Street. It occupied the four floors above a piano tuners shop and the basement and was recognisable by the display of noticeboards on the first-floor balcony giving the sea-state at Dover and the weather at Valentia, Scilly, Holyhead, Yarmouth and the Needles.

Meteorological Office building at 63 Victoria Street

As time went on Galton became more convinced of the accuracy of weather forecasts prepared by the Office and their scientific basis. Publication of forecasts in the newspapers resumed on 1 April 1879 and public forecasts continued except during war time when weather data was classified as a state secret to prevent its use in enemy operations.

The foundation of the International Meteorological Organization

Since the Brussels Conference in 1853 there had been wide acknowledgement of the need to develop international networks of meteorological stations and to standardise techniques. After many proposed conferences failed to come to fruition a conference finally took place at Leipzig from 14–16 August 1872. Among the 52 delegates the Meteorological Office was represented by Scott and the Scottish Meteorological Society by Alexander Buchan. The delegates, who comprised most of the world's leading meteorologists, broadly agreed on a set of standardized methods and paved the way for the establishment of an international body to deal with meteorology.

Subsequently, 32 representatives from 20 governments attended the Vienna Congress from 2 to 16 September 1873. Scott and Buchan again represented the UK and, as was the case in Brussels, were given strict instructions not to make any commitments involving expenditure. The Congress agreed a significant number of practicalities including the classification of weather stations, definitions of meteorological phenomena, a list of symbols to indicate precipitation types on charts and in climatological tables and the continued use of Luke Howard's cloud classifications. Use of the metric system remained a matter of contention. The Vienna Congress also agreed to establish the Permanent Meteorological Committee to deal with meteorological problems common to the international community. The committee met in 1873, 1874, 1876 and 1878. At the 1878 meeting the committee drafted the rules and statues of the International Meteorological Organisation and this formally came into being at the Rome Congress of 1879, at which the International Meteorological Committee also replaced the Permanent Meteorological Committee. Scott served as secretary in both and remained Secretary of the IMC until 1900.

Climatological Networks and Wireless Telegraphy

At their 1874 meeting the committee agreed upon the designation of weather stations whereby a first order station produced hourly readings and a second order station produced at least two observations per day. They requested observations from fifteen second order stations from Great Britain. This proved difficult as most Meteorological Office stations did not meet the required specifications and it did not have a network of Climatological Stations. In England and Wales the operation of the climate network was left to the Meteorological Society (Royal Meteorological Society from 1883) and in Scotland it was left to the Scottish Meteorological Society, both of them being independent organisations not funded by the UK government. Following a series of negotiations, it was agreed that observations from both societies would be used and in recognition of their co-operation both were invited to send representatives to the Rome Congress of 1879. The Meteorological Office then began to establish its own network of climatological stations in the UK and the colonies, but this created its own challenges, with three different organisations collecting and publishing data independently in addition to the rainfall network established by George Symons in 1860.

By the early 20th century the Meteorological Office was keen to create a joint publication of all the observations, but the societies were not happy to lose their independent publications. Financing the operation of these networks proved costly and eventually forced a decision which resulted in the transfer of all the Royal Meteorological Society stations to the Meteorological Office by 1911. In Scotland the Scottish Meteorological Society continued to operate their stations, but from January 1914, in return for funding from the Meteorological Office their observations were published in the Monthly Weather Report[6]. This marked the first time that all climatological data from the British Isles was available in one publication since the active establishment of climatological networks. The British Rainfall Organisation, the successor to Symons rainfall network, continued to operate and publish independently until 1919 when it too became part of the Met Office.

Achieving consistency was not without its challenges, as demonstrated by the introduction of absolute measurements where inches were replaced by millimetres for and millibars for pressure. The new units were used in the British Meteorological and Magnetic Year Book from January 1912 and the Daily Weather Report from 1 May 1914. The British Rainfall Organisation adopted millimetres in 1915. Instruments were re-calibrated but strangely barometers were marked up in centibars rather than millibars. From 1 January 1912 the Year Book also gave air temperatures in Absolute degrees to assist with calculating barometer corrections as the equation required absolute units. Further confusion was caused in 1916 when British Summer Time was introduced. The Office made the decision to keep all timings in GMT, but observers became confused and it was far from clear what precise times the observations were being made. With time however everyone adjusted.

In December 1901 Marconi successfully transmitted a message using wireless telegraphy. The potential for using this system to widen the network still further and obtain observations from ships crossing the Atlantic was quickly recognised but it took a little longer to put into action. The first report, giving the weather at 51 degrees North 15 degrees West, was received at 2.15 pm on 10 January 1909 from the SS Corsican of the Allan Line. 1219 messages were received by the end of March, but only a few hundred arrived fast enough to be of use in forecasting. Nevertheless, the practice continued and by 1913 the office was receiving between 400 and 600 reports from ships per month. These were of great value to forecasters and following the publication of the first Marine Observers Handbook in 1915 the Office was able to supply a wide range of guidance and instruction to further improve accuracy and consistency.

6. Control of the network and the office in Edinburgh passed fully to the Meteorological Office in 1921

Scientific investigation

The Meteorological Office became involved in scientific research from the mid-1880s through collaboration with the Royal Meteorological Society and the Meteorological Council. Following the publication of the enquiry into the Tay Bridge rail disaster the Royal Meteorological Society established the 'Wind-Force Committee' in 1885. The Meteorological Office became involved in collecting and analysing observations from self-recording instruments and tested various types of anemometer at exposed locations around the coasts. The analysis showed that the existing anemometers were unable to record accurate gust data, and this resulted in the invention of a new 'pressure-tube anemometer' by British meteorologist William Henry Dines.

In 1883 the Ben Nevis Observatory was established with funding from private subscriptions. The Meteorological Council (successor to the Meteorological Committee[7]), agreed to contribute to the maintenance of the observatory in return for the supply of observations to the Meteorological Office. Meanwhile Scott and others from the UK became involved in various international projects including the International Meteorological Commission for the Polar Year. Although Britain did not send observers to take part in the polar year, which ran from 1882–1883, it did provide a number of instruments and the Meteorological Office produced a series of daily synoptic charts of the North Atlantic Ocean from all of the data that was collected. These charts were drawn up to aid investigation into whether meteorology in higher latitudes affected events in middle and lower latitudes. German meteorologists produced a similar series for the South Atlantic.

Ben Nevis Observatory 1890

All this meant that by the turn of the century the Meteorological Office was well respected around the world, but it had not yet been directly involved in any theoretical improvements in the field of meteorology. This changed in 1900 with the appointment of Dr William Napier Shaw to direct the Meteorological Office following the retirement of Robert Scott. Napier Shaw had a strong background in meteorology, and he was surprised to find that the Meteorological Council had little interest in forecasting or in the fact that its scientific basis of weather had advanced very little since the time of FitzRoy. Meanwhile most of the office staff were ageing and their chief interest was now in whether they would be entitled to pensions. Most had worked for FitzRoy and at that time had ranked as civil servants but whilst they remained staff of the Board of Trade their status, which carried with it a pension entitlement, had changed when the Royal Society took over control of the Meteorological Department in 1867. In the end pensions were funded by the closure of some telegraphic reporting stations and the cessation of Scottish Meteorological Society funding for the maintenance of observatories. This included funding for the observatory on Ben Nevis, which closed in 1904.

The office was certainly in need of some progressive thinking. There were no telephones and only one typewriter.[8] Messages outside of the office were sent by telegram or messenger and inside the building by means of a speaking tube with a whistle at each end to attract attention. Letters including copies were all produced in longhand.

7. Following a further enquiry into the work of the Office in 1877, in which evidence from meteorological office staff was again lacking, the Committee was reformed into the Meteorological Council. It's activities remained largely unchanged, but its membership was now paid.
8. When the first telephone was installed in 1903 there was so much excitement that discipline was temporarily relaxed to allow a crowd of seniors and juniors to watch the Post Office engineer fit it to the wall of the Office Keepers room. The first call was to the Royal Meteorological Society and staff then rushed to experience the novelty of calling friends. Some expressed surprise and indignation when asked to pay for private calls!

There were no upper air observations, and the lack of typewriters meant that the Daily Weather Report had to be written and drawn in lithographic ink. This meant that staff had to become expert draughtsmen and calligraphists and in addition, the forecasters had to operate the telegraphic equipment and be proficient in sending and receiving Morse code. It was also standard practice for the two senior forecasts to visit the nearest pub before dictating the forecast!

All operations of the office were carried out within the building at Victoria Street which included a forecasting office, a marine instrument store and a statistics division which had as one of its most important tasks, responsibility for publishing the Meteorological Observations at Stations of the Second Order and the Weekly and Monthly Weather Reports. Female and male staff worked separately, and the female staff arrived 10 minutes later and left 10 minutes earlier than the men to avoid any interaction. No talking was permitted unless on an official matter and anyone arriving after 09:15 was marked in as late with two infractions in a week resulting in an appearance before the director. The best room on the top floor was occupied by Mr and Mrs Drane, the resident caretaker and his wife. For any staff who required it Mrs Drane also provided a substantial lunch, served on trays and eaten at desks, for 1s 2d per day.

Saturday afternoon tea in the Forecast Room, Victoria Street 25 March 1911

Shaw argued that the Meteorological Office should become more deeply involved in scientific research and as a result Rudolf Gustav Lempfert joined the office in 1902. Shaw also published several papers each year. The office investigated fog and a dust-fall traced to the northwest of North Africa. From the latter, Lempfert and Shaw went on to develop a model for the movement of air in a cyclonic depression which looked at the air mass itself and not the isobars. The office also supported investigations of the upper atmosphere by president of the Royal Meteorological Society W.H. Dines, and George Simpson, then assistant to Napier Shaw.

Whilst investigating the upper air in the North Sea in 1905 Simpson also took the opportunity to investigate the effects of wind on sea state and produced an alternative scale of wind based on the appearance of the sea. It was published in 1906 and adopted by the International Meteorological Organisation in 1939. In 1906 Simpson also devised a scale for use on land. He then moved on to become the first lecturer in meteorology in a British university, acted as the meteorologist for the 1910–1913 Terra Nova expedition, and served as Director of the Meteorological Office from 1920–1930.

Significant investment in further research led to the establishment of Lerwick Observatory in 1921. Its initial purpose was to assist with a request from the Norwegian Government for cooperation in a special study of meteorological, magnetic and auroral conditions at high latitudes, but it soon became an important meteorological and geophysical station in its own right. Lerwick Observatory continues to be a multi-purpose research station recording meteorological, seismological and geomagnetic observations and also carries out important Ozone monitoring work.

Dines Kite being let out during upper air investigations

Back into government hands

In 1905 the Meteorological Office transferred back into Government control. It was controlled by a Meteorological Committee appointed by the Treasury but was not part of any specific Government Board. The change greatly simplified the management of the office and saved a substantial sum of money. By the turn of the Century the Office was also in need of new accommodation. A site was identified on the corner of Exhibition road and Imperial Institute Road where it could be co-located with a Post Office thus removing the need for special wires connecting to the Meteorological Office.

The new building opened in 1910 and was a significant improvement on Victoria Street. Printing machinery was installed in the basement enabling the in-house printing of the Daily Weather Report and monthly weather charts, essentially becoming the first Reprographics department. A significant area in the main hall was devoted to a library and museum space and the recording parts of operational instruments located on the roof were also placed in publicly accessible areas. Although the office would undergo further changes of location and status it would remain a part of government from this point on.

Met Office building, Exhibition Road, South Kensington

2. The early 20th Century

World War 1

Despite the Meteorological Office offering to support the army at the start of the war, the response was that the army did not go to war with umbrellas. This did not mean, however, that it was entirely disconnected from the war.

The Office had already been involved in early developments in aeronautics and indeed the first Met Office outstation was established at Benson in 1914 to support the Royal Aircraft Factory. At the same time the War Office proposed that a meteorologist should be attached to the staff of the Central Flying School of the Royal Flying Corps (RFC) at Upavon where they would provide instruction on meteorology and carry out additional experimental work.

Despite Meteorological Office involvement during pilot training the RFC initially operated in France without any meteorological support. The decision proved costly and it was the need to support aviation which would eventually bring the Meteorological Office into the war.

The Meteorological Field Service was established within the Royal Engineers in summer 1915 in order to provide forecasts for the RFC including warnings on thunderstorm location and fog. Three staff were posted to France to support the British Expeditionary Forces under command of Major Henry Lyons RE. Their role swiftly grew to include assistance with deployment of observation balloons, using atmospheric data to advise the artillery on high angle fire, assisting with warning for enemy gas attacks and forecasting appropriate conditions for allied gas operations.[9]

Meteor RE, as the Meteorological Office in the field was known, grew rapidly in response to the demand for its services. The first operational forecast for military operations was issued on 24 October 1916 and soon after its establishment the Office despatched a meteorologist to support the Mediterranean Expeditionary Force during the Dardanelles campaign and on the Western Front observers operated on the front lines in support of the Gas units. None lost their lives, but several were affected by exposure to poison gas.

Meteor Flight aircraft c. 1918

As the war progressed the artillery units required observations from ever higher levels in the atmosphere and with time these reached beyond the limits of the observation balloons. To meet this demand the Office and the Royal Engineers established Meteor Flight. The Meteor Flight pilots operated at high altitude in early aircraft with open cockpits. They had to fly their planes whilst also making observations from a range of instruments attached to the wing struts and the central fuselage of the aircraft. These were perhaps among the most remarkable observations made by the Meteorological Office and in addition to supporting the Royal Artillery they also added greatly to understanding of the Upper Atmosphere. Meteor RE became the first Meteorological Research Flight and continued to operate until August 1919.

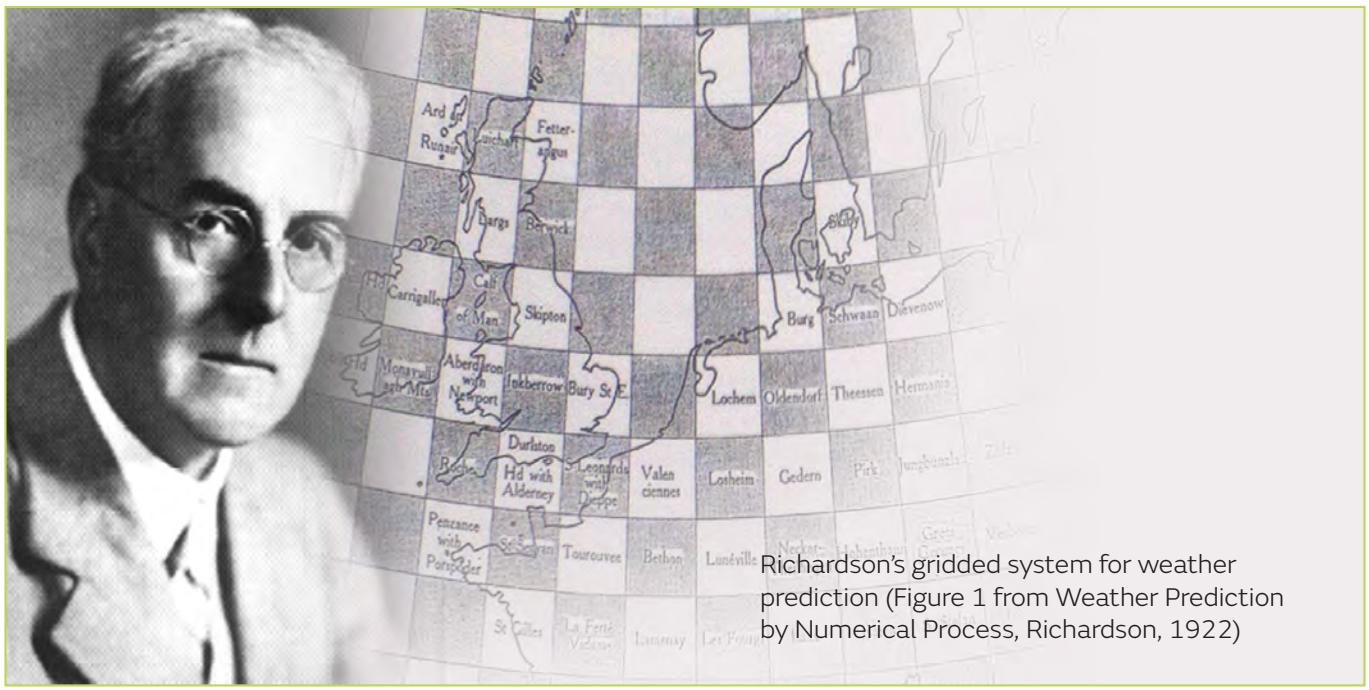
9. Following the widespread use of poison gas as a weapon during the First World War several Met Office meteorologists were seconded to Porton Down to assist with work on chemical defence. For further information see Carter, G. B. ***Chemical and biological defence at Porton Down 1916–2000***, HMSO, 2000.

At home the work of the Office changed significantly. It became operational 24/7 for the first time in support of colleagues in the field and many more women joined the staff to replace those called up or volunteering to fight. The staff felt the great pressure of supporting their colleagues in the field and several suffered nervous breakdowns – mainly in the Forecast Division. Thankfully most were able to return to work in time.

Following the Armistice on 11 November 1918 weather forecasts to the public resumed on 15 November. Although most meteorological activities began to return to peacetime requirements, international co-operation did not restart for some time and mobilized members of staff were not demobilized until late in 1919.

Lewis Fry Richardson

The First World War also plays a part in the story of early supercomputing. In 1913 Lewis Fry Richardson had been appointed Superintendent of Eskdalemuir Observatory. His main role was to investigate the application of mathematical equations to modelling the atmosphere with the aim of developing new methods of forecasting. His aim was to help the office move away from synoptic forecasting by developing the concept of numerical weather prediction where forecasting was based entirely on the laws of physics. Richardson was a Quaker and felt he could no longer work for the Office when it moved to a war footing. Following the failure of his requests to leave and join a Red Cross unit or the Ambulance Corps, he resigned and joined a Friends' Ambulance Unit as a driver. Whilst serving in France he also continued to work on his research and even worked through a complete example with data obtained from colleagues in Norway.



Richardson's gridded system for weather prediction (Figure 1 from Weather Prediction by Numerical Process, Richardson, 1922)

The draft of his seminal work 'Weather Prediction by Numerical Process' laid out numerical modelling, the use of gridded data, and even described the working of a modern computer albeit using human beings. It was lost for some months after being sent behind the lines to safety before the Battle of Champagne but eventually turned up under a heap of coal. The book was published in 1921, forty years before the existence of the first computers capable of turning his dreams into reality.

Richardson returned to the office for a brief time after the end of the war, working on concepts including turbulence and fractals, but after the office transferred to the Air Ministry, which had connections to military activity, he resigned once again and ceased all involvement with mainstream research. Although he did not live quite long enough to see the first practical testing of Numerical Weather Prediction, Richardson was excited to see the potential demonstrated by early experiments in 1950 and wrote that they represented an 'enormous scientific advance'.[10]

10. Lynch, P. 'The Origins of computer weather prediction and climate modelling' in Journal of Computational Physics, University of Miami, 2008.

3. The Inter War Period – the rise of aviation and mass communication

By the end of the war, the importance of meteorology to military operations and most especially to aviation, had been proven beyond doubt. As a result, the decision was taken to transfer ownership of the Meteorological Office to the Air Ministry. The move was against the desires of its director, the Board of Trade, the Board of Agriculture and the heads of the other fighting services who all felt that the office served many interests and wished it to be transferred to the more neutral Department of Scientific and Industrial Research. In spite of much opposition the Meteorological Office transferred from the Treasury to the Air Ministry on 1 July 1919, but it was still managed by a Meteorological Committee which provided at least some opportunity to appoint representatives from the various other stake holders.

Space was now at a premium and the office once again needed room to expand. Although preferable to bring the whole Office (excluding the British Rainfall Organisation) into the same building, calculations revealed that this would require nearly 40,000 square feet. Such a space was not available and so the forecasting and Marine divisions moved to Kingsway (Canada House) and the Library and Statistics Division remained on Exhibition Road where it was joined by the Instruments Division.

Aviation and Upper Air Developments

In June 1919 Alcock and Brown made the first non-stop transatlantic flight and in July 1919 His Majesty's Airship R.34 made the first round-trip crossing of the Atlantic by air. Both ventures were supported by the Meteorological Office. For the Alcock and Brown flight meteorologists and instruments were sent to New Zealand, the Azores and Lisbon along with equipment for observing the upper air. For R.34 not only were additional observations collected to make up North Atlantic charts but also meteorologist Guy Harris flew with the airship. This was the first occasion on which a meteorologist was an operational member of an air crew.

After early scepticism the government launched the Imperial Airship Scheme to establish an airship route from Britain to Egypt and India in 1924. The Meteorological Office soon became involved and formed an Airship Division at Cardington under the direction of Superintendent Maurice Giblett. The division produced a range of climatological charts and collaborated with Robert Watson Watt on the transmission of weather charts by wireless telegraphy.[11] By 1930 two huge airships were ready to begin trials. R.100 successfully travelled from Cardington to Canada and back but despite a poor forecast R.101 took off for Karachi on 4 October 1930. After encountering strong winds, low cloud and heavy rain R.101 crashed and burst into flames near Beauvais in northern France killing 48 of the 54 on board including Lord Thomson, Secretary of State for Air, Sir Sefton Branker, Director of Civil Aviation and Maurice Giblett. The disaster spelled the end for British airships and the Meteorological Office Airship Division although research into the upper air using kite balloons did continue at Cardington and the site went on to develop barrage balloon technology.

Airship R101 photographed on 14 October 1929

11. An operational teleprinter network connecting the office with twelve RAF Stations was established in 1937. It had increased to twenty by October 1938 and forty-eight by the outbreak of war in September 1939.

The airship sheds remain at Cardington Airfield and the site is now the base for the Met Office Meteorological Research Unit which carries out research into boundary layer meteorology, flow over hills, urban meteorology and development of new instruments.[12]

Civil aviation continued to expand rapidly and with it came associated requirements for forecasts and climatological information. The work of the Meteorological Office was critical to the development of commercial air services from the UK. Outstations known as 'distributive stations' were established at a range of commercial aerodromes. Initially priority was given to routes between London, Paris and Brussels but soon meteorological staff were based around Britain and abroad. The first overseas bases were at Malta and Heliopolis in Egypt but as air travel became global so too did the associated meteorological services. In addition to providing pre-flight forecasting, aircraft carried radio telephones and the crew frequently called for meteorological information during flights. Responding to these calls swiftly and accurately required significant co-operation between meteorological staff and radio staff at aerodromes. Support was provided for special events such as the Hendon and Biggin Hill air displays, the Kings cup and the Schneider Trophy. In 1931 the 'Airmet' service was added to the aviation offering to provide information for private pilots. Initially Airmet was a collaborative venture between the Office and the AA but in 1935 it was taken over fully by the Meteorological Office and provided full information for both RAF and Civil aviation. The broadcasts could be picked up by anyone with a suitable radio receiver and became very popular with the general public.

The 1920s and 30s also saw increased recognition of the value of meteorological observations from aircraft, which could reach higher altitudes than balloons and provide observations far faster. The RAF Meteorological Flight was established on 1 November 1924 and operated for 12 years and during the second world war at least 19 meteorological flights flew set routes collecting upper air observations to assist RAF crews, this included high level runs by mosquito aircraft which provided observations to bombing crews operating across Europe. These flights all laid the foundations for the foundation for the establishment of the Meteorological Reconnaissance Flight (MRF), initially founded to carry out High Altitude work in 1942 the flight developed many new instruments and significantly advanced all aspects of upper air research.[13] By the 1960s the Flight, which operated three aircraft for different types of work, was contributing valuable research into Cloud Physics to enable the further development of NWP modelling and in 2010 it carried out critical flights researching the volcanic ash cloud of the Eyjafjallajökull volcano and its impacts on aviation. The MRF is now a collaborative mission with NERC and the Environment Agency.

Meteorological flights have always been expensive to operate and so the Office also began to develop radiosonde technology to make atmospheric observations at height.[14] Sondes could communicate observations in real time via radio telegraphy and could travel higher than aircraft but development was slow and there was still no operational network by the outbreak of the Second World War.

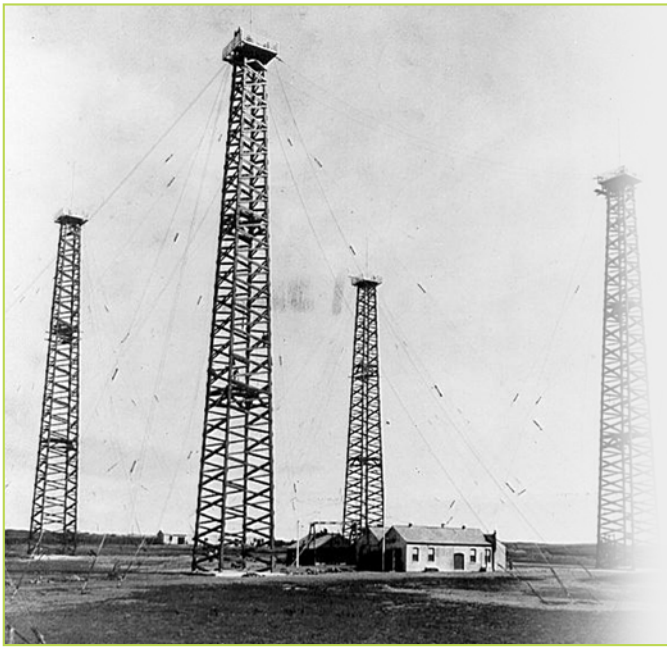
Forecasting Developments

In 1919 a group of Norwegian meteorologists known as the Bergen School laid down the foundations of a new concept in meteorology known as Frontal theory. The group, led by Professor Vilhelm Bjerkenes, described the movement of 'air masses' and 'fronts' which developed in the transition zones between these air masses. The director of the Meteorological Office, William Napier Shaw was introduced to frontal theory in May 1920 and recognised its great significance but in this early period the Office lacked expertise in frontal analysis. As a result, frontal theory was adopted for use internally but it would not be until 1933 that fronts were marked up onto charts issued to the public.

The start of BBC Radio Broadcasting in the early 1920s was a major opportunity for the office. Daily BBC Radio broadcasts from the London station 2LO began on 14 November 1922 and included a same day weather forecast which was read by the announcer from a script produced by the Meteorological Office. More extensive broadcasting of forecasts for the public became a daily service on 26 March 1923 and became particularly important to the agricultural and coastal fishing communities. Experimental weather forecasts on television began as soon as the BBC launched the world's first regular public television service on 2 November 1936. The first weather chart was shown on 3 November. It appeared on the screen and was accompanied by a voice over description of the chart and a short forecast. The experiment lasted until 28 November and was limited to the London area as the radius of the BBCs Alexandra Park Television Station was limited to London. It proved that 'there were possibilities in this method which might have to be reviewed later when television becomes one of the amenities in the lives of the majority of the inhabitants of the country'.[15]

12. MRU Cardington is also part of the Met Office radiosonde network.
13. For more information on the history of meteorological flights and upper air research see: https://www.aerosociety.com/media/4853/the-meteorological-research-flight-and-its-predecessors-and-successors.pdf (accessed January 2021)
14. A radiosonde is a remote sensing device which is attached to a large helium filled balloon and provides observations of pressure, temperature, humidity and wind as it rises through the atmosphere. The earliest radiosondes used radio telegraphy but modern devices use GPS and satellite technology.
15. Meteorological Office Annual Reports for the years end 31 March 1937

Prior to the war weather bulletins for shipping in the Atlantic had been issued using Morse Code. They restarted as a twice daily radio transmission broadcast 1 June 1921. The bulletins were broadcast from the pioneering Marconi Wireless Station at Poldhu in Cornwall and gave forecast transmissions for the Western Approaches in plain language and observations from Blacksod Point, Stornoway, Holyhead, Scilly and Dungeness in code. The weather bulletins became the Shipping Forecast on 1 January 1924 when the now famous names of forecast areas such as Dogger, Forties, Wight and Shannon were heard for the first time. Initially the Shipping Forecast was broadcast using a transmitter belonging to the Air Ministry in London. The service was picked up by the BBC in 1925 and put out twice daily on Long Wave from the BBC station in Daventry, Northamptonshire.[16]



Marconi radio station, Poldhu, c.1902

Forecasts and advice were not limited solely to major areas or customers. Members of the public could always request direct information and the Office provided advice for energy and transport organisations and even the burgeoning British film industry. The annual report for 1925–26 notes 'Particulars of the atmospheric conditions as regards visibility and freedom from smoky fogs in respect of various places in the Home Counties were supplied in response to inquiries as to the places near London which would be most suitable for cinema studios for the production of British films.'

Education

Met Office involvement in education in schools can be traced as far back as 1910 when Napier Shaw noted in an article for Symons Meteorological Magazine that meteorology had fallen off the school curriculum in favour of other sciences which the teachers were more familiar with. As a result, he published 'Forecasting Weather' in 1911. This became the standard British textbook on meteorology. A syllabus was also prepared for elementary schools and spare copies of the Daily Weather Report were sent out to them free of charge. For wider public education Lempfert also published a small book for the layman called 'Weather Science' and the Office amassed a collection of lantern slides to help with teaching. A memorandum was also produced to capture the increasing educational activities of the Office. Education efforts also reached the scouting and guiding associations with support for the development of meteorology based badges and in the 21st Century the Office responded to demand for development opportunities in Science, Technology, Engineering and Maths (STEM) by establishing a network of STEM ambassadors and a Met Office for Schools programme to assist teachers with bringing meteorology back into the classroom.

At the professional level the Office had recognised the need to provide in house training in the latter part of the 1930s. Work had started on the development of a meteorological department in collaboration with Imperial College of Science and Technology but plans were suspended with the outbreak of war on 1 September 1939. Instead the Meteorological Office Training School was established at Berkley Square House in London to teach meteorology to all forecasters and officers of the new Meteorological Section of the RAF Volunteer Reserve. Training began on 15 September 1939.[17]

16. A further service for seafarers was the introduction of the Marine Observer magazine, which was first published in January 1924. The magazine was designed both to provide useful information and as a means of thanking of voluntary observer network for their ongoing work.
17. The Training School moved to Barnwood on the outskirts of Gloucester in autumn 1940 and then to a range of other sites around London before eventually relocating to Stanmore in August 1951.

After the war the Training School provided courses for both new staff and specialist staff (internal and external) on subjects ranging from Merchant Navy forecasting to radiosonde and radar. Training was provided both on site and in the field and soon extended to meteorological staff from the colonies and commonwealth.

4. World War 2

As the political situation in Europe became increasingly unstable through the late 1930s the Office took on and trained additional staff and opened more meteorological stations in preparation for another conflict. From 1 September 1939 meteorological information once again became secret; observations had to be transmitted in code and public forecasts ceased until 9th May 1945. The office separated into its various divisions and these were then dispersed around the country. A small HQ unit remained in London throughout the war, whilst the Forecasting unit temporarily evacuated to Birmingham on 27 August before relocating to the planned location at Dunstable in Bedfordshire in February 1940.

Both the Marine and Climatology Division and the Instruments and Army Division relocated to Wycliffe College at Stonehouse in Gloucestershire in November 1939. Eventually the 70 tonnes of historic and important books and materials, which would now be considered the library and archive, would also join them but not until at least late 1940. Thankfully the Kensington building was not hit during the London Blitz and the collection survived. Staff numbers increased from about 700 to over 6,000 and all members of the office, regardless of rank, were fully integrated into the RAF, an approach that is credited with much of the success of operational meteorology during the war.

Military Support

Military requirements centred around support for the Army and the RAF. Meteorological information was critical to the operation of RAF Bomber and Coastal Commands and was also important in the training of airborne troops. Met Office staff were posted to all theatres of war, both supporting local forecasting and enabling the requirement for airborne transportation of troops and equipment around the globe. 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. A great range of special operations also required support. One of the more well-known of these was the Yalta Conference between Churchill, Roosevelt and Stalin in February 1945. To enable the conference to go ahead the Office established an observation station at Yalta to provide data which assisted in the creation of forecasts for the various leaders' flights.

Support to Civilian Authorities

Although forecasts for the public were suspended throughout the war some civilian groups and authorities required a range of support. In the Summer of 1941, there were fears that incendiary bombs might be used to set light to standing crops and stack yards. The Meteorological Office became involved and worked with the Ministry of Home Security to develop a system of warnings based on the state of ripeness of the crops in relation to ~~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 value did not justify the resource needed for its preparation and distribution. By 1942 the government accepted that despite the potential security risks involved, some form of forecasting was needed to ensure that farmers were able to harvest the grain crops before they were lost to bad weather. A code system was introduced giving 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.

Among the utility companies, gas suppliers needed forecasts in order to support demand and electricity companies required thunderstorm warnings. Transport networks initially reported that they did not require meteorological support but 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 Meteorological Office and it soon became clear that other railway and bus services and local authorities needed help. 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 for weather reports and district weather forecasts to be sent to the Ministry and the Rail Executive Committee. The following code system was used for passing this information on: 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.

The threat of poison gas attack also remained throughout the war and the Meteorological Office collaborated with the Home Office to develop a system of warnings of weather conditions suitable for the deployment of a poison gas attack. These were then communicated to the various civil defence regions where required. Thankfully poison gas was not deployed by either side during the conflict.

Observations

Obtaining as many accurate observations as possible became critical in order to support the demand for various types of forecasts.

Land

The number of meteorological stations passing observations to the Central Forecasting Division (CFO) at Dunstable increased from 43 to 552 by the end of the war. The observations were passed into CFO and back out to the stations requiring them using a well-developed teleprinter network. All observations could be sent in and transferred to the chart drawing room within thirty minutes ensuing the network was always ready to receive the next set of hourly observations.

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. In occupied Europe weather observations were also classified but there was a significant difference between the two opposing powers. The Allies had cracked the Enigma code and consequently were able to obtain meteorological data from Axis occupied Europe. German weather observations were identified at Bletchley Park and couriered to Dunstable where they were decoded and plotted onto special overlays by a special unit code named IDA. This limited the number of people who knew about the existence of the observations and helped to protect the Enigma secret. Germany in contrast, did not break the allied codes, and their ability to obtain observation data from the Atlantic was severely impacted when the RAF gained air superiority in September 1940.[18] This would prove a critical weakness. In addition, and at great risk, some resistance cells in German occupied territories used covert radios to send observations to assist the RAF. One such was operated by a Dutch resistance group and was hidden behind Rembrandt's famous 'The Night Watch' painting, which had been stored in the Rijkskluis vault in the St Pietersberg Marl Caves of Maastricht along with many of the greatest treasures of the Rijksmuseum. Working with NIOD (the Institute for War, Holocaust and Genocide Studies in Amseterdam) we have established that radio was named 'Margriet' after the Dutch Queen's grand daughter, who was born in January 1943. Margriet was in turn named after the Margriet (daisy) flower which had become a symbol of Dutch Resistance.

Dunstable teleprinter room

Dunstable Wireless receiving room

Marine

Charts remained crucial to the admiralty, and sea ice atlases were particularly important in assisting with the planning and routing of Atlantic and Arctic convoys. The Marine Division supplied all this information and also sought to maintain the Voluntary Observing Fleet (VOF).[19] 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. By May 1945 and despite heavy losses to British shipping throughout the war, the number of regular observing ships stood at 272 and the number of supplementary ships at 208. This was a considerable 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.

18. German charts do not include the Atlantic because they had no observations from the area beyond the occasional U-Boat communication.
19. The Voluntary Observing Fleet consisted of Naval and Mercantile Marine vessels which were supplied with instruments in return for keeping and submitting detailed logs at the end of each voyage.

German Enigma data obtained from U-Boats helped to close the gap in Atlantic data and in July 1940 the Admiralty agreed to charter two defensively armed steamers to be deployed in a weather reporting role with three meteorologists on board. These Weather ships completed a total of 11 voyages before both being sunk in 1941 by U-Boats with the loss of all hands. There were 40 men aboard the Arakaka including meteorologist Sidney Portass and 43 men on the Toronto City including meteorologist Stanley Proud.

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 although 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.[20]

Upper Atmosphere

The need to understand more about the upper atmosphere was brought into sharp relief following the 'Night of the Big Winds' (24–25 March 1944) when an allied bomber stream destined for Berlin which had been forecast to meet winds no stronger than 45 mph encountered winds in excess of 120 mph and was torn apart resulting in the loss of 72 planes. The experimental radiosonde network which had developed slowly and had not reached operational capacity before the start of the war received significant investment and an upper air bench was established to understand more about the upper atmosphere.

The lack of data from the North Atlantic remained a significant problem for forecasters supporting the RAF. In late 1940 a series of meteorological research flights were instigated over the North Atlantic and the North Sea. By the end of 1944 the service had expanded to 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.

High level, deep penetration flights over Europe known as PAMPA flights then followed. 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.

Remote Observation

In addition to manually collected observations several remote methods of obtaining meteorological information were also devised during the war. Locations of lightning flashes were identified using radio signals and enabled forecasters to warm Bomber Command of the location of thunderstorms over Europe. Meanwhile Radar Operators used the noise of returning echoes to identify and differentiate showers, thunderstorms and continuous precipitation on radar displays. They also learned to identify fronts and tropical storms. Radar was also used for wind finding and proved key to being able to measure the speed and direction of upper winds.

20. The last weather ship, OWS Cumulus, was decommissioned on 7 June 1985. She had been purpose built in The Netherlands in 1963 and sold to the UK in 1985 for the symbolic sum of £1 when she replaced OWS Starella. She was returned to The Netherlands in 1996 in exchange for the symbolic £1 (now on display in the National Meteorological Library).

D-Day

Involvement in World War Two also included what is possibly the most important Met Office forecast of all time. In a period of unseasonably changeable weather, forecasters were required to identify a window of settled conditions to enable Operation Neptune, the seaborne part of Operation Overlord, to proceed. The range of tidal and lunar factors that needed to come together were such that only a few days in June were viable and the odds of encountering the correct weather on those days were calculated at roughly 40 to 1.

The operation was originally planned for 5 June. A team of allied meteorologists led by Met Office forecaster James Stagg were tasked with agreeing a forecast. Facilitating such an agreement proved a challenge but Stagg was finally able to advise General Eisenhower that conditions on 5 June were not going to be as required and most particularly that cloud cover would be too much to enable airborne operations. A small and marginal weather window was identified on the 6th June and General Eisenhower decided to go ahead. Although the conditions were not as favourable as the forecast had suggested they were thankfully just good enough. Indeed, the marginality of the weather, and access to data from the North Atlantic worked in the allies' favour.

German forecasters lacked access to the same data and did not identify the weather window. Consequently, additional troops were not sent to the French coast and German General Rommel returned to Berlin to celebrate his wife's birthday. The resulting delays and confusion, in addition to the deliberate allied diversionary tactics aimed at implying the invasion would take place in the Pas de Calais, proved to be very helpful in the establishment of the initial allied bridgehead in Normandy.[21]

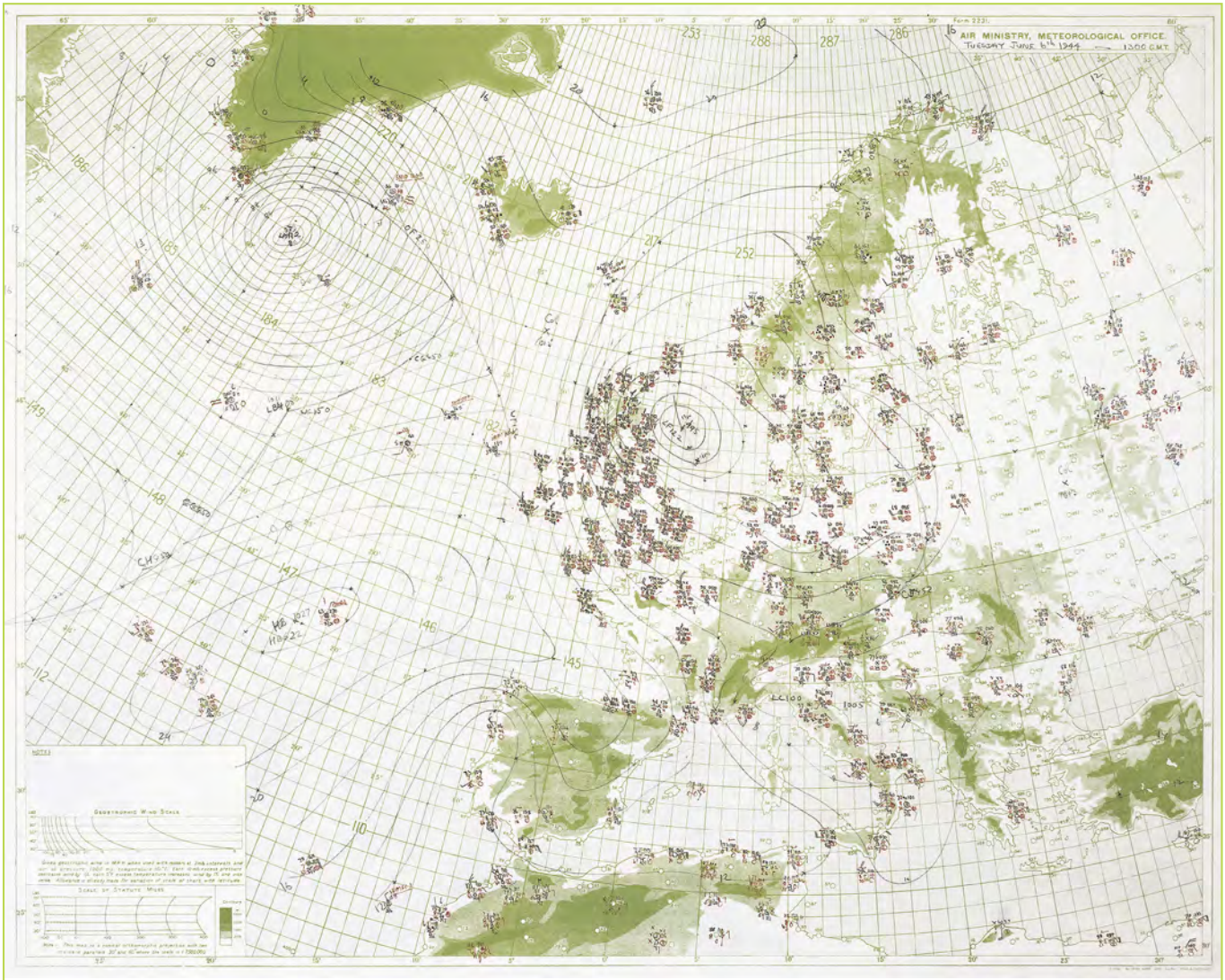


Chart for 0100 5th June 1944 indicating a weather window for 6th June

21. For further information on the work of the Office during WW2 please see the National Meteorological Archive Remember Factsheet: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/library-and-archive/library/publications/factsheets/remember_world-war-one-and-two.pdf (Accessed January 2021)

5. Post War Developments–into the technological era

The World Meteorological Organisation

An increasingly dense global observation network supplying land, marine and upper air data had developed during the war. It would prove of immediate use in response to the rise of international travel after 1945. The International Meteorological Organisation recognised that it would need to adapt and evolve in order to meet the growing needs of a global meteorological network and the World Meteorological Convention was signed on 11 October 1947 and came into force on 23 March 1950. On 17 March 1951 the International Meteorological Organisation formally became the World Meteorological Organisation (WMO) and was recognised by a UN resolution.

Radar

The potential for the use of radar in meteorology was first recognised during World War Two, when radar operators began to recognise rainfall features on the display units. In 1946 the first Meteorological Office radar was commissioned at East Hill, Dunstable. It was a repurposed ex RAF air defence radar and the only way to record information was for the operator to take photographs of rainfall patters appearing on the cathode ray tube display unit at regular intervals.

The early radar system could only be used for very limited research purposes but it demonstrated the value of the technology in meteorology and resulting decades of research and development in collaboration with the Plessey Radar Company laid the foundations for the launch of the operational weather radar network in 1985.[22]

The current weather radar network consists of 15 radar units which provide detailed coverage for the British Isles. In 2018 the process to replace all of the UK weather radar network with new units designed by the Met Office radar systems team was completed. By this time the oldest radar in the network at Hameldon Hill had been working reliably since 1974. The new units use technological improvements such as dual polarisation measurements and dopplar technology to improve reliability of data, measure winds within storms, detect changes in humidity and even measure the size and shape of raindrops and snowflakes. These advancements feed into improvements in the accuracy of weather and flood forecasts, especially for high-impact events affecting local communities.[23]

Satellites and remote sensing

The launch of the Russian Sputnik Satellites in 1957 and 1958 represented a major step forward in meteorology and was followed by the first American satellites in 1958. All the satellites carried an array of instruments designed to collect upper air data which greatly improved knowledge of the high atmosphere. The first successful weather satellite, TIROS 1, was launched on 1 April 1960. TIROS 1 was built to test experimental techniques for obtaining footage of cloud patterns and for the first time it enabled meteorologists to see complete weather systems and to relate cloud patterns, movements and distributions to isobars and observations. It opened a new dimension in meteorology with the possibility of understanding the movement of weather systems over the oceans and also hugely advanced the understanding of extratropical depressions.

The potential use of satellites to obtain and share global weather data was immediately apparent, but it would take some time for the technology to catch up. Even so TIROS 2, launched on 11 November 1960, already carried an instrument designed to measure radiation from the earth and the atmosphere. The early satellites lasted only a few hundred days but TIROS 7, 8 and 9 all remained operational for several years. They also carried infra-red sensors enabling the first 24 hr imaging of weather systems.

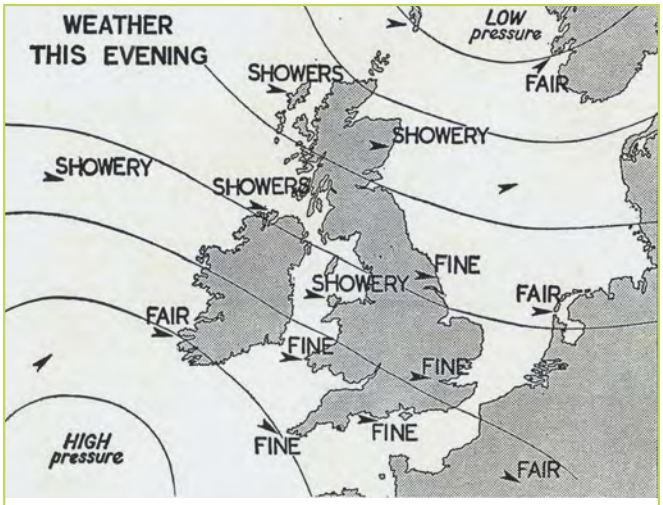
The last TIROS satellite, TIROS 10, was launched on 2 July 1965 and was followed by the American ESSA (Environmental Science Services Administration), NIMBUS and ARIEL satellites, the latter two of which carried instruments to measure temperature and ozone in additional to providing regular satellite images.

Meteorological rockets were also developed in order to obtain data from high altitudes. Rockets were trialled in Scotland and in Australia and in April 1963 a Skylark rocket sponsored by the Office reached an altitude of 230 kilometres. Rockets proved costly and so the Office also continued to develop the less expensive Radiosonde technology for high altitude remote sensing. Britain's first automatic weather station was tested at Bracknell in late 1963 and the network soon expanded across the country.

22. For more information on the history of weather radar please see Kitchen, M. and Illingworth, A. 2011 'From Observations to Forecasts – Part 13: The UK weather radar network past, present and future' Weather, 66 issue 11. Available at: https://rmets.onlinelibrary.wiley.com/doi/10.1002/wea.861
23. https://www.metoffice.gov.uk/services/business-industry/water/radar-improvements

Weather Forecasters and Weather Centres

Public weather forecasts resumed on 9th May 1945, the day after the announcement of Victory in Europe. The television network had extended since 1936 and the first regular television chart appeared on the screen at 5 pm on 29 July 1949. Soon there was demand for something more interactive than a chart on a screen and as a result two members of Met Office staff, George Cowling and Tom Clifton, were selected to become the first television weather forecasters. Cowling presented the first live forecast at 19:55 on 11 January 1954.



First regular television weather chart 29 July 1949

First TV Weathermen George Cowling and Tom Clifton.

Television forecasts used special charts printed on thin card onto which isobars and fronts were pre-drawn in a quick drying black ink using a thick, felt-nibbed fountain pen. During the broadcast the forecaster used sticks of charcoal to demonstrate expected movements and changes. By 1957 forecasts were also being provided for commercial television companies and broadcasting in colour began in the Autumn of 1967. Meanwhile more localised public reach was improved by the opening of Weather Centres at Kingsway and Glasgow in 1959 followed by Manchester in 1960.

Defence Forecasting

Meteorology had been associated with military operations since the First World War but in the period after the D-Day invasion small mobile meteorological units were formed from Met Office staff serving in the RAF Volunteer Reserve and were deployed into France to support operations at temporary military airfields. It is from these units that the modern Mobile Meteorological Unit, MMU, traces its origins. The term Mobile Meteorological Unit was first used in 1953 and the modern MMU came into being in 1961 in response to the Kuwait Crisis. Civilian Meteorological Staff deployed in uniform in support of the newly created RAFVR Meteorological Branch and by late 1962 the MMU was permanently established with 38 Group. The unit was equipped with its own accommodation, meteorological and communications equipment and was expected to deploy at short notice anywhere within the NATO area.

The MMU supported many exercises and operations but from the 1970s was used less and less and by Easter 1982 there were suggestions that it should be disbanded. With the outbreak of the Falklands War (Operation Corporate) just weeks later this thinking was rapidly reversed and an MMU unit was deployed to the South Atlantic complete with new computing equipment which members of the unit had to learn to use, unpack and set up in a field environment. Teams at the Met Office also re-wrote the Southern Hemisphere model in a weekend to extend beyond 30 degrees south to ensure that the MMU had as much information as possible. Since then the MMU has continued to deploy in support of UK military operations overseas including UN Peacekeeping Operations, the Gulf War and Operations Telic and Herrick.[24]

24. Operation Telic–Operations in Iraq 2003–2001; and Operation Herrick–Operations in Afghanistan 2002–2014.

Experimental Numerical Weather Prediction

Research became part of the standard ethos of the Office during the post war period and this was soon put to use collaborating with the global community to investigate methods of improving short range forecasting. Initially Forecasting had lagged noticeably behind post war improvements in instrumentation and availability of observations but this was about to change. Work started on both finding a 'meteorological electronic brain [that] could be constructed to deal in an orderly manner with the immense amount of information available daily and provide much more accurate prebaratics'[25] [26] and also on developing L.F. Richardson's rules for Numerical Weather Prediction to take account of developments over the previous 30 years.

Research progressed well and was assisted by the connections and influence of the Swedish meteorologist Carl Rossby who had begun to work on hand calculated predictions using simple mathematical models of the atmosphere during the 1940s. Now Rossby and other meteorologists joined forces with John von Neumann, a mathematician from the Institute for Advanced Study in Princeton, who had started working on a computer to carry out mathematical calculations.

The work was slow and not entirely successful but proved that Richardson's idea could work. The global effort to refine the mathematics behind NWP continued throughout the 1950s and included the first attempts to produce a realistic simulation of atmospheric conditions over the earth. The first practical test of Numerical Weather Prediction took place in Sweden when it was used to produce the forecasts for a major military manoeuvre during Autumn 1954. Comparisons with more traditional forecasting techniques showed that the new method was clearly more accurate, and so the age of NWP began.

The earliest computers in the UK were based at Manchester University, the National Physical Laboratory and Cambridge University. The Meteorological Office Research Division had played a significant role in the early development of NWP but progress was constrained by lack of a dedicated Met Office computing resource. To progress and prove the concept of NWP, they would need to work with an institution that already owned a computer.

Forward thinking catering firm J Lyons were the first to see the commercial potential for the use of computers to organise the distribution of cakes and other perishable items. Inspired by a factfinding tour of the US in 1947 and taking the Cambridge University computer as their starting point Lyons began work in 1949 and by 1951 they had built the world's first business computer, the Lyons Electric Office (LEO1). In October 1951 Fred Bushby from the Met Office Forecast Research Division attended a course on the use of the Cambridge computer and by the end of the year Bushby and his assistant Mavis Hinds were experimenting with the earliest Met Office use of computer-based forecasting concepts on LEO 1 at the Lyons headquarters in Hammersmith London. As a result, the Lyons computer not only handled the company accounts and logistics, but also factored in the Met Office weather forecast to influence the goods carried in their "fresh produce" vans!

Following these early experiments the Met Office needed access to a more powerful computer and so began working with the Ferranti Mark 1 computer at the University of Manchester, which they used for two to three nights per week. A major leap forward came in 1955 when the government granted the Office funds to purchase its own computer.

25. Prebaratics was a term introduced by Ernest Gold to describe forecast charts for the North Atlantic and western Europe.
26. Ernest Gold 'Weather forecasts' Symons Memorial Lecture delivered 16 April 1947, published in the Quarterly Journal of the Royal Meteorological Society Vol 73, pp. 151–185 1947.

Ferranti Mercury computer (Meteor) at Dunstable, c. 1959

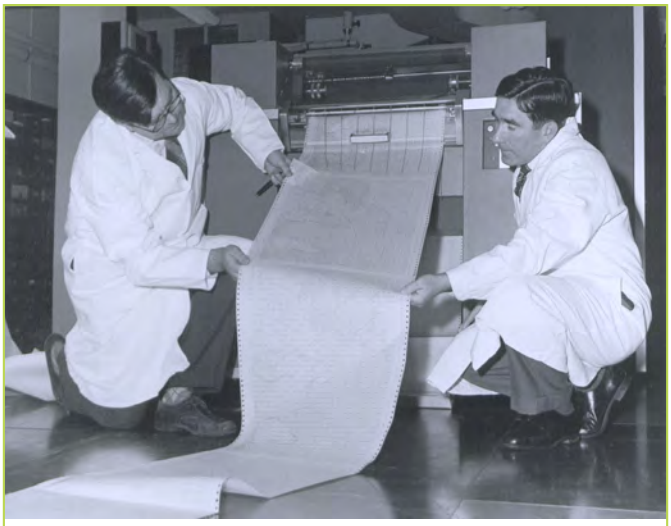
The new Ferranti Mercury computer, nicknamed 'Meteor', was ready for use at Dunstable in 1959. It was the first computer in the world dedicated solely to research on NWP and enabled the production of regular experimental NWP forecasts for the first time. Although work progressed quickly it soon became clear that a larger computer would be needed if numerical weather prediction was ever to be used operationally. The Office would need to move to larger premises with space for a new computer but thankfully plans for a relocation to Bracknell were already well underway.

Met Office Bracknell and Operational NWP

After decades scattered across the country the Meteorological Office departments, with the exception of the training school, were brought into the new building in Bracknell in 1961.[27] It would be another 10 years before the training school moved from Stanmore to much better facilities at Shinfield Park in Reading where it was close to both the office and the Department of Meteorology at the University of Reading. The Central Forecasting Office moved from Dunstable to Bracknell on 30 September 1961 with no break in service. Now that the office was in a larger building a new computer could finally be purchased and installed. A KDF9 electronic computer nicknamed Comet (cost £400,000) was installed during the summer of 1965. The old Meteor computer was reassembled in the Chemical Defence Experimental Establishment at Porton Down.

Within days of taking up his post as the new director of the Met Office on 1 October 1965 Basil John Mason made the decision to move from experimental to operational NWP forecasting and routine forecasts were issued twice a day from Monday, 2 November. On 2 November the office held its first ever Press Conference. All who attended saw the first operational forecast chart emerge from the printer and were given souvenir copies of it. The forecast was accurate, and the launch proved a great success but the computer was not powerful enough to forecast rainfall intensity and only had sufficient observations and speed to operate at three levels in the atmosphere. Calculations indicated that a computer powerful enough to predict rainfall amounts would need to be eighty times faster than Comet.

27. Due to lack of space the Instruments Division moved out in 1971 to Beaufort Park.



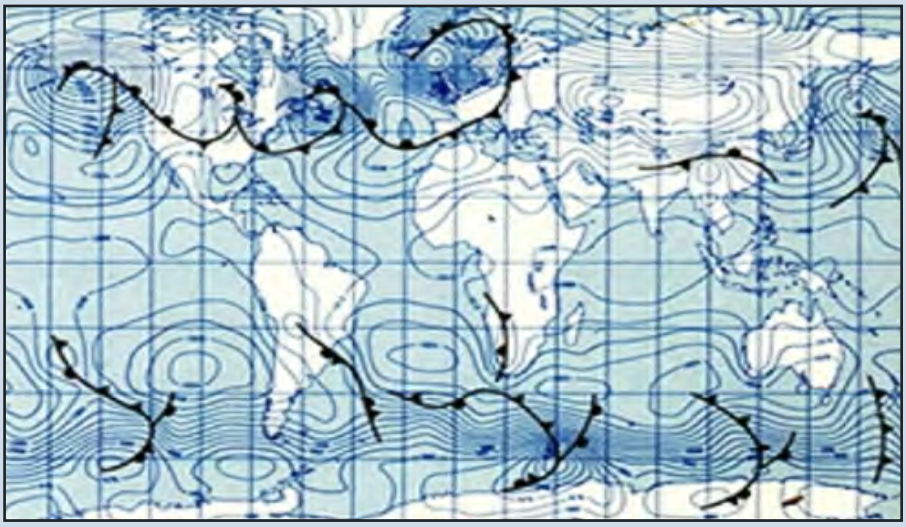
First operational forecasting output coming from the line printer

Director General holding output with the KDF9 computer in the background

Requests for a newer, more powerful computer were approved and an IBM 360/195 was installed in December 1971. It could run a ten-level model and also benefitted from vast increases in the availability of atmospheric data. This data came from improvements in radiosondes[28], automatic weather stations,[29] radar,[30] satellites including the European Space Agency's first geostationary satellite[31], the development of the first meteorological buoys[32] and the establishment of major global data collection campaigns run by the WMO's Global Atmospheric Research Programme (GARP) which would later become the World Climate Programme.

Inevitably the IBM machine soon needed improvement and in 1975 an IBM370/158 was added to the existing machine. COSMOS, as this was known, was in turn replaced by the first supercomputer in early 1982. The computer, a CDC Cyber 205, was capable of 400million operations per second and was able to run the first global operational forecasting model. The global forecast model ran to 24 hours ahead and included an extension to 15 levels in the atmosphere and the addition of a multi-level ocean model. It went live just in time to assist in operations surrounding the Falklands War. The response to the Falklands crisis demonstrated both the flexibility of the models and the skills held within the office. In early 1982 the experimental Southern Hemisphere model did not extend beyond 30 degrees South. Following a major programming effort over the weekend of 3–4 April 1982 the model was extended, and the new global model came into operation four months ahead of schedule.

28. The Mk3 radiosonde, which was designed and built in house, was the first fully automatic upper-air measurement equipment used operationally anywhere in the world.
29. These were initially located in remote areas, especially on rigs but by the end of the 1970s the Meteorological Office Weather Observing System (MOWOS) was in use at a number of land based sites around the British Isles.
30. The importance of the radar in rainfall measuring led to the formation of a National Weather Radar Network consisting of interlinked, automated radars. The first, at Camborne, was set up in the summer of 1978. Upavon, Clee Hill and Hameldon Hill were in place by 1980.
31. Launched on 23 November 1977
32. Different types of buoys were tested throughout the 1970's



An example of early global NWP forecast output

The Unified Model

The next step for NWP was the development of the Unified Model in 1990. In the 1980s, the Met Office had been running global and mesoscale weather forecast models and a global climate model.[33] They each used different Fortran codes and a replacement supercomputer offered the chance to combine global, mesoscale weather and climate simulations in one modelling system, which became the Unified Model.[34] The was the first time that weather and climate model configurations were available in the same modelling system.

The UM was implemented operationally in June 1991 on a new supercomputer, a Cray Systems C90 Y-MP-8 which replaced the Cyber 205. The new Cray was capable of one thousand million calculations per second. A year later the office gained a second Y-MP-8 funded by the Department of the Environment specifically for the Hadley Centre climate research programme. The latest addition was twice as fast as the first Cray demonstrating the increased pace of developments in computing technology. The UM continues to develop in step with each improvement in computing power and scientific advances. It can be coupled to other models representing different aspects of the Earth's environment such as ocean waves, sea-ice, land surface, atmospheric chemistry and the carbon cycle enabling Earth Systems Modelling. It is also highly versatile, modelling on a range of time and space scales to produce global and regional climate and weather predictions.

With growing interest in use of the UM for research and operations outside the Met Office, a UM User Group was established in 2008. In 2012, the House of Commons recognised that "It is a testament to the Met Office that its Unified Model is licensed to other national meteorological services. Collaboration with these international partners helps the Met Office to further test and develop its models and should be encouraged."[35] By 2014, the UM Partnership had been formed, which at the time of writing, included operational centres such as the Bureau of Meteorology and CSIRO (Australia), Korea Meteorological Administration, Met Service Singapore, Ministry of Earther Science (India), National Institute of Water and Atmospheric Research (New Zealand), South African Weather Service and the US Air Force. These organisations use the UM for global and regional modelling applications at different timescales, and contribute to joint scientific and technical research programmes.

33. https://www.metoffice.gov.uk/weather/learn-about/how-forecasts-are-made/computer-models/history-of-numerical-weather-prediction#:~:text=The%20Met%20Office%20involvement%20in,second%20generation%20model%20in%201979 (Accessed January 2021)
34. https://ukscience.org/_Media/UM_User_Guide.pdf (Accessed January 2021)
35. https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/162/16204.htm (Accessed January 2021)

Aviation Forecasting

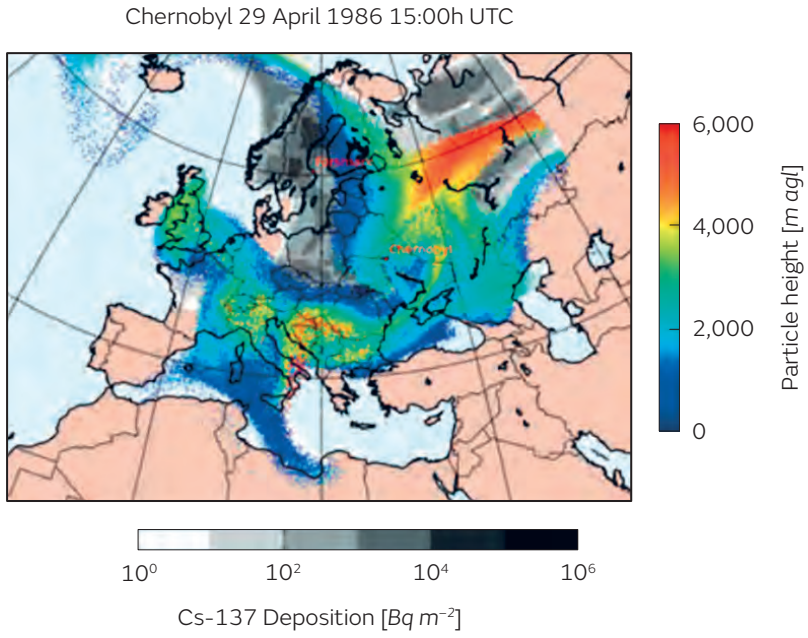
Services for aviation continued to form a critical activity throughout the late 20th century and continue to do so into the 21st. In 1984 the Met Office became one of two World Area Forecasting Centres, the other being at the National Oceanic and Atmospheric Administration (NOAA) in New York. There are still only two WAFCs and each provides back up for the other. No flight can take off without obtaining weather information and the WAFCs ensure that all aircraft have access to real-time weather data and forecasting. Significant weather charts, produced every six hours, give a broad overview of the weather relevant to individual flights such as jet streams, the locations of cumulonimbus clouds and turbulence, erupting volcanoes and tropical cyclones. In addition, gridded data sets of wind and temperature, and hazard information can now be integrated into flight planning software to create efficient and safe flight plans.

Climate Research, NAME and Sting Jets

As early as the 1970s the Meteorological Office numerical model outputs began to indicate changes in the global climate and impacts from the increasing carbon dioxide content of the atmosphere. This evidence, backed up by the work of other modelling and research around the world, was one of the key drivers behind the establishment of the WMO World Climate Programme in 1980. In addition, the University of East Anglia founded a Climatic Research Unit which would go on to work closely with the Office on several projects.

By 1988 Climate Change was receiving increasing political interest and the first Intergovernmental Panel on Climate Change (IPCC) was held in November 1988. This was followed by a speech given by Prime Minister Margaret Thatcher to the General Assembly of the UN on 8 November 1989 devoted entirely to the subject of the environment and climate change. In the speech she announced the creation of a new scientific centre for the prediction of climate change. It was later announced that this new department would be part of the Met Office and the Hadley Centre opened on 25 May 1990. It has since become one of the foremost centres for climate science research and modelling in the world.

The height of the Cold War era also saw many concerns about the impact of nuclear war and the possibility of a Nuclear Winter. The Office carried out some research into the potential impacts of nuclear warfare on the weather but soon concerns moved to a real event – the Chernobyl nuclear reactor explosion on 26 April 1986. After initial denials that the explosion had taken place radioactive material was discovered in Sweden on 28 April and official details were finally released. On the 29th the Central Forecasting Office at Bracknell started to calculate trajectories in order to estimate when and where the plume might cross the British Isles. Working with a team of specialists in atmospheric dispersion the Office discovered that the plume would indeed cross the British Isles and media communication was put in place to warn a range of communities about the expected deposition via rainfall and dry deposition.[36]



Dispersion forecast of the radioactive plume following the Chernobyl accident reconstructed using a modern version of NAME

36. The Office had first begun to investigate the needs of the nuclear industry following the fire at the Windscale nuclear plant in Cumbria in 1957 and it was thus well prepared to react in 1986.

As a result of Chernobyl and the accuracy of the subsequent dispersion forecasts the Meteorological Office was designated lead agency in the development of a model to forecast atmospheric dispersion and deposition following any future nuclear incident. The resulting NAME (Numerical Atmospheric-dispersion Modelling Environment) model has since been applied to an ever growing range of atmospheric transportation and dispersion problems including greenhouse gases, air quality forecasting, and emergency response to events such as nuclear incidents (Fukushima, 2011); volcanic eruptions (Eyjafjallajökull, 2010),[37] industrial fires and animal diseases such as Foot and Mouth and Bluetongue.

Although the various forecasting models were very effective, they were not infallible, as was proven by the Fastnet storm of 14 August 1979 and the gale of 15–16 October 1987. In the first case meteorologists correctly assessed that the model was not indicating a deep enough low and intervened to manually change the forecast to a more accurate outcome, in the second early modelling predicted the storm well, but nearer to the event the models indicated that the main force of the storm would be felt no further north than the English Channel. A feature of both storms but especially the 1987 gale was a type of low-level jet stream, now commonly referred to as a 'sting jet' which was largely unknown in 1979 and was still being researched in 1987.

Although the 1987 storm was considerably better forecast than the newspapers chose to report there were nevertheless lessons to be learned. The most significant among these were further improvements to the model and recognition of the need for a more powerful supercomputer[38], the establishment of a new buoy network to obtain a greater supply of observations from the ocean areas west of the France and Iberian peninsula and a new type of warning system. FLASH warnings were introduced in 1988 and were issued via news channels in the form of an on-screen message to warn of severe weather. In 1990 they developed into the National Severe Weather Warning Service in use today and were one of the earliest pieces of information available on the first Met Office Website which went live in 1995.[39]

The National Severe Weather Warnings initially covered snow, ice, wind and rain but in 2018 the range was increased to include lightning, thunderstorms, fog and extreme heat. The first Red 'extreme heat' warning was issued for 18–19 July 2022 and proved well founded. On the 19 July the UK maximum temperature broke the 40 degrees Celsius barrier for the first time with the peak of 40.3 degrees Celsius recorded at Coningsby in Lincolnshire. The extreme weather on this day led to 46 stations meeting or exceeding the previous maximum temperature record of 38.7 set at Cambridge Botanical Gardens in 2018 of which 30 recorded 39 degrees Celsius or above and seven, including Coningsby, recorded temperatures equal to or over 40 degrees.

As a result of the warning Network Rail issued 'do not travel' warnings and rail routes were several disrupted due to rails buckling and overheard lines sagging. Flights were suspended at Luton after heat affected the runway, some roads began to melt and required gritting, and fires broke out in several locations. It was widely agreed that the likelihood of the temperature in the UK reaching 40 degrees without the effects of human-induced climate change was extremely low.[40]

37. The Met Office is one of nine Volcanic Ash Advisory Centres. As part of the work on the Eyjafjallajökull response the office carried out a wide range of tests on the ash plume including flying the research aircraft into it. This damaged the engines and proved that volcanic ash could indeed damage aircraft engines.
38. An ETA 10 supercomputer was purchased in 1989 through 'internal economies'
39. Initially different types of FLASH warnings were issued depending upon whether the severe disruption would occur in the next few hours or the next few days but with NSWWS time to arrival was replaced by severity of impact.
40. More information on the extreme heat of July 2022 can be found here https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_03_july_heatwave_v1.pdf

6. The Met Office in a new Millennium

From MOD to Executive Agency

The Meteorological Office had been part of the Air Ministry (later renamed the Ministry of Defence) since 1918, and prior to that it had been a part of Treasury and the Board of Trade but all this was to change following the publication of the Improving Management in Government: The Next Steps report in February 1988. The report suggested that the executive functions of government should be carried out by units within Civil Service departments known as 'agencies'. Each agency would be staffed by civil servants and directed by a chief executive and would be given specific briefs to avoid overlap.

Chief Executives would be responsible for performance and would be accountable to departments or parliament. On Monday, 2 April 1990 the Met Office became an Executive Agency within the Ministry of Defence. The move gave the Office more autonomy with the ability to benefit from commercial opportunities whilst remaining the state meteorological service. The Met Office was granted its own coat of arms in 1991. The Latin motto translates as 'to predict the weather through science'. A sentiment of which founder Robert FitzRoy would have approved.

Met Office Coat of Arms, granted by the College of Arms in 1991

A further change in 1996 saw the Office become a Trading Fund and begin operating on a more commercial basis. On 18 July 2011, after 93 years as part of a government department focused primarily on the armed services, ownership of the Met Office moved from the Ministry of Defence to the Department for Business, Innovation and Skills (BIS). In 2016 further government restructuring saw BIS become the new Department for Business, Energy and Industrial Strategy (BEIS). When the office was founded in 1854 it was as part of the Board of Trade; 157 years later with the move out of the Ministry of Defence and into a government department focused on business and scientific innovation it had gone almost full circle.

As part of the Machinery of Government changes the Met Office found itself on the move again in early 2023, this time to the new Department for Science, Innovation and Technology which took on policy responsibilities from BEIS and the Department for Digital, Culture, Media and Sport.

The move to Exeter

By 1999 concrete cancer had degraded the structure of the Met Office HQ Building in Bracknell beyond repair and with an expanding and increasingly technology driven organisation the building was no longer fit for purpose. Options for relocation included nearby sites such as Shinfield Park in Reading or Beaufort Park in Bracknell or a move of much greater distance to either Exeter or Norwich. The final decision to relocate the Office in its entirety roughly 150 miles south west to Exeter was based on a range of factors including the capacity of the local electricity infrastructure to power the super computer, the suitability of the site, the positive and welcoming response from the local authority and feedback from a staff survey. It was a major move but enabled the whole office including the training school to be co-located for the first time in its history.

More than 80% of the staff chose to move with the office and the first of them began to work from Exeter in June 2003. Almost all had arrived by the time the building was formally handed over on 18 December. The last element to move was the Archive, which transferred from Bracknell to nearby Great Moor House in March 2005. One of the greatest challenges for the relocation was the transportation of the two Cray T3E super computers each of which had to be individually loaded onto trucks and transported to Devon under guard with the first being rebuilt and operational before the second could be moved. As with the move from Dunstable to Bracknell the move was achieved with no break in operational forecasting.

Met Office building FitzRoy Road, Exeter

Flood Forecasting Centre

The Meteorological Office established the Storm Tide Warning Service following the devastating East Coast floods of 31 January and 1 February 1953[41] but after the destructive flooding of 2007 questions were asked about whether flood events as a whole could be better forecast and managed. As a result the Environment Agency and the Met Office established the joint Flood Forecasting Centre. This combination of expertise significantly improved the usefulness and reliability of extreme rainfall forecasts and warnings. The Office also established a web based Emergency Support Service providing free access to weather observations and forecasts as well as information specifically generated for emergency events.

This service was later enlarged by the provision of a network of Civil Contingencies Advisors with the ability to provide tailored forecasting and potential impact advice to emergency services. Such location specific expertise was of critical importance in forecasting for and responding to the potential Whaley Bridge dam collapse following heavy rainfall in August 2019.

41. Over 300 lives were lost and almost 100,000 hectares of land flooded across Eastern England including Lincolnshire, Suffolk and Essex.

Space Weather

The potential impacts created by space weather were added to the UK Government Risk Register in 2011. Space weather can knock out satellites and mobile communications and can cause significant problems for the energy industry. In an increasingly globalised and connected world reliant on satellite communications and specialised technology the impacts of space weather became clear. The Met Office began forecaster training for Space Weather in late 2011 and started operational forecasting in 2012. In late 2013 funding for a formal operations centre was secured and the Met Office Space Weather Operations Centre (MOSWOC) was created.

It began 24/7 operations in April 2014 and was officially opened on 8 October by the then Science Minister Greg Clarke. MOSWOC is one of three global Space Weather centres, the other two both being in the US (NOAA Space Weather Prediction Centre and US Air Force 557th Weather Wing). Capability continued to develop and an Aurora Prediction model (OVATION) providing 30-minute forecasts of the position and intensity of the aurora was introduced in November 2017.

Met Office Space Weather Operations Centre

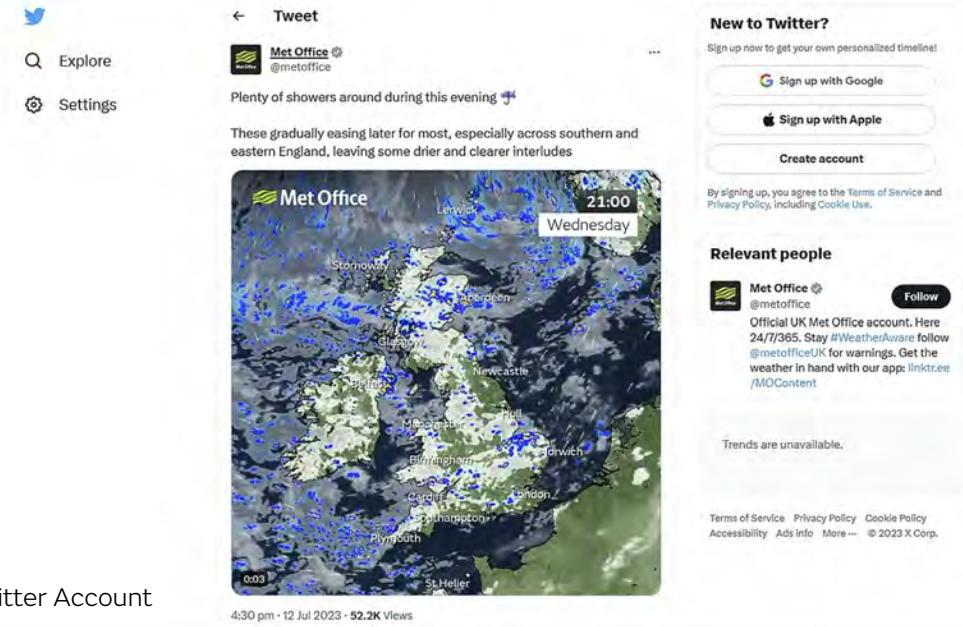
International Work

The Met Office had begun to provide reliable hurricane forecasts to the United States and other sensitive areas as early as 1997 but global weather and climate support really went from strength to strength during the 21st Century with the development of specialist forecasting support for countries prone to cyclone and tsunami damage such as the Philippines, and the introduction of Weather and Climate Science to Services Partnerships (CSSPs and WCSSPs). Each partnership is country specific, but all seek to develop partnerships which harness UK scientific expertise to build the basis for strengthening the resilience of communities vulnerable to weather and climate variability. CSSPs and WCSSPs now exist between the Met Office and China, India, South Africa, Brazil, and South East Asia and cover everything from improved forecasting and prediction on Lake Victoria to the role of the Amazon rainforest in climate change mitigation.

New Communication Channels

In 2015 the BBC announced that after almost 100 years the Met Office would no longer hold the contract to provide its weather forecasts. The contract was due to end on 30 September 2017 but in the end was continued until the new provider, MeteoGroup, was able to provide a sufficiently reliable service in 2018.

The loss of the contract made national news and questions were asked in Parliament which resulted in clarification that the BBC would still be required to communicate Met Office National Severe Weather Warnings whenever these were in place. Although public reach was reduced through the loss of the BBC contract the Met Office adapted by exploiting a range of Social Media channels. The Office launched its first social media channel, Twitter, in January 2009 followed by Facebook in December 2010. Another major step forward saw the development of the Met Office App, which launched in May 2016. The App was extremely successful with over 3million downloads in its first year.



Met Office Twitter Account

Supercomputing in a new Millennium

During the early 2000s the Office focused on interpreting the medium range ensemble model output from the European Centre of Medium Range Forecasting (ECMWF) rather than producing its own. As both the Unified Model and weather science developed it became clear that ensemble forecasts would also be useful in short range forecasting and so the office developed the Met Office Global and Regional Ensemble Prediction System (MOGREPS) in 2005. Following extensive testing MOGREPS became operational in 2007.

The current Cray XC40 Supercomputer was installed between 2015 and 2017. It is made up of three Supercomputers. Two are located in the main HQ building and operate the forecasting models. The third is located in the new Richardson Building on the Exeter Science Park. It is more than twice as powerful as the two in the HQ building combined and is dedicated to facilitating weather and climate research.

In addition to providing computing capacity for Met Office scientists it is also accessible to scientific research collaborators around the world. The computing capability is in use by a wide range of collaborators working on broad spectrum of weather and climate subjects and the range is always increasing. In 2020 it included a range of epidemiological research projects into the impacts of weather on the spread of COVID-19.


CRAY
CRAY
Met Office
Flood
forecasting

Director Generals and Chief Executives

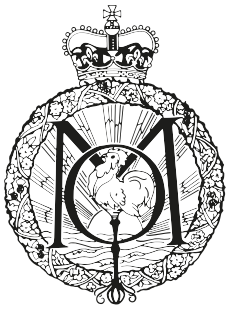
1854–1865 Vice Admiral Robert FitzRoy
1867–1900 Robert Henry Scott
1900–1920 Sir William Napier Shaw
1920–1938 Sir George Clarke Simpson
1938–1953 Sir Nelson Johnson
1953–1965 Sir Graham Sutton
1965–1983 Sir John Mason
1983–1991 Sir John Houghton
1992–1997 Lord Julian Hunt
1997–2004 Peter Ewins
2004–2005 David Rogers
2005–2007 Mark Hutchinson
2007–2015 John Hirst
2015–2018 Rob Varley
2018–present Professor Penelope (Penny) Endersby

Directors of Research/Chief Scientists

1906–1920 H.G.K. Lyons
1920–1939 Rudolf Gustav Karl Lempfert
1922–1947 Ernest Gold
1947–1954 Archibald Hayman Robertson Goldie
1955–1965 Reginald Cockroft Sutcliffe
1965–1976 John Stanley Sawyer
1976–1982 Kenneth Hope Stewart
1982–1985 Philip Goldsmith
1985–1989 Andrew Gilchrist
1989–1991 Keith Browning
1991–2002 Paul Mason
2002–2008 John Mitchell
2009–2016 Dame Julia Slingo
2017–present Professor Stephen Belcher

Met Office Logo's through time

1911–1939



1939–1978

1978–1990

1990–1997

1997–2000

From 1911 – 2000 the Met Office logo was based upon the image of a weather vane and earned the nickname the 'chicken on a stick'

2000–2006

2006–present

In 2000 a new logo was introduced. The waves represent both the waves of the ocean-atmosphere system and the electromagnetic waves through which meteorological information is communicated.

Met Office History Timeline

Met Office

Buildings related (HQ, Observatories, Out Stations etc.)
Computers and modelling related
Forecasting related
Chief Executives and previous equivalents

1853 September–First International Meteorological Conference after which a number of countries including Great Britain founded Meteorological Services.

1854 1 August–Meteorological Department of the Board of Trade established at 1-2 Parliament Street, Westminster.

1854 Retired Royal Naval Captain (later Vice Admiral) Robert FitzRoy appointed Meteorological Statist to the Board of Trade; the first head of the Office.

1855–1858 FitzRoy develops a specialised barometer to help fishing communities predict storms and save lives.

1859 25–26 October Royal Charter Gale caused the loss of 133 ships and 800 lives including the Royal Charter and caused public outcry.

1860 FitzRoy laid out plans for the establishment of a Storm Warning Service in a report to the Board of Trade.

1860 1 September–first observations received from the new telegraphic reporting network–simultaneous observations to enable synoptic forecasting.

1861 6 February–first gale warning issued using a system of cones and drums to signal to shipping. The system remained in use until 1 June 1984.

1861 1 August–First Public Weather Forecast.

1865 30 April–Death of Robert FitzRoy.

1866 Following the outcome of the Galton Report management of the Department was handed to the Royal Society and all forecasting stopped.

1867 Robert Henry Scott appointed Director.

1867 25 February–Meteorological Department becomes the Meteorological Office – a title it would retain until 1988 when it was shortened to Met Office.

1867 30 November–Storm warning service re-established due to public pressure with the first new warning issued on 10 January 1868. This storm warning service, now better known as the Shipping Forecast, has continued without interruption ever since.

1867–1868 Establishment of Kew, Glasgow, Aberdeen, Stonyhurst, Armagh, Valentia and Falmouth meteorological observatories.

1869 Meteorological Office moved to new offices in 63 Victoria Street. It was recognisable by the display of noticeboards on the first floor balcony giving the sea-state at Dover and the weather at Valentia, Scilly, Holyhead, Yarmouth and the Needles.

1879 1 April – public forecasts in newspapers restart following development of science.

Rome Congress 1879 foundation of the International Meteorological Organisation. Head of the Meteorological Office Robert Henry Scott served as secretary.

1883 Ben Nevis Observatory Established (closed 1904).

1900 Sir William Napier Shaw appointed Director.

1909 10 January–first weather observation received from a vessel (SS Corsican) using Marconi's wireless technology.

1905 Management of the office transfers back from the Royal Society. It was controlled by a Meteorological Committee appointed by the Treasury but was not part of any specific government Board.

1910 Meteorological Office moves to new office on the corner of Exhibition Road and Imperial Institute Road, Kensington.

1911 'Forecasting Weather' published by head of the office Napier Shaw. This became the standard textbook on meteorology and in addition a syllabus was prepared for elementary schools and spare copies of the Daily Weather Report were sent free of charge to schools.

1914 First Met Office outstation established at Benson to support the Royal Aircraft Factory.

1915 Summer–Establishment of the Meteorological Field Service, known as Meteor R.E. – the Met Office was now operational in support of the military.

1916 24 October–First military operational forecast.

1919 Due to lack of space the forecasting and Marine divisions move to Kingsway (Canada House).

1919 1 July–Control of the Met Office passes to the Air Ministry due to the paramount important of meteorology to the developing aviation industry and the RAF.

1920 Sir George Clarke Simpson appointed Director.

1920 The Meteorological Office adopted frontal theory internally in order to develop expertise. They were not used on public charts until 1933.

1922 Publication of Weather Prediction by Numerical Process by mathematician and NWP pioneer Lewis Fry Richardson. Richardson had done much of this groundbreaking work whilst on rest breaks from working as a driver for a Friends Ambulance Unit in the battlefields of France.

1922 14 November–First radio weather forecast. Daily broadcasts from the BBC London station 2LO included a same day weather forecast which was read by the announcer from a script produced by the Meteorological Office. More extensive broadcasting of forecasts for the public became a daily service on 26 March 1923, these forecasts were particularly important to the agricultural and coast fishing communities.

1924 1 January–First Shipping Forecast. These broadcasts developed into the Shipping Forecast on 1 January 1924 when areas such as Dogger, Forties, Wight and Shannon were heard for the first time. Initially broadcast using a transmitter belonging to the Air Ministry in London, the service was picked up by the BBC in 1925 and put out twice daily on Long Wave from the BBC station in Daventry, Northamptonshire.

1920s Outstations known as 'distributive stations' were established at a range of commercial aerodromes. Initial priority was given to routes between London, Paris and Brussels but soon meteorological staff were based not only around Britain but also abroad. The first bases were at Malta and Heliopolis in Egypt but as air travel became global so too did the associated meteorological services.

1924 1 November–RAF Meteorological Flight established and has continued to operate research and observation gathering sorties ever since.

1930 4 October–Crash of Airship R.101 killing 48 of the 54 on board including Lord Thomson Secretary, of State for Air; Sir Sefton Branker, Director of Civil Aviation, and meteorologist Maurice Giblett. The disaster marked the end for British airships and the Meteorological Office Airship Division although the site at Cardington is still the base for the Met Office Meteorological Research Unit.

1936 3 November to 28 November–First experimental televised weather charts (BBC television launched on 2 November 1936). Charts were accompanied by a spoken description and a short forecast. Experiment was successful but paused until the broadcasting network had enlarged.

1938 Sir Nelson Johnson appointed Director.

1939 27 August–CFO relocates temporarily to Birmingham whilst buildings are completed at Dunstable, Bedfordshire. It moves to Dunstable in February 1940.

1939 November–Instruments Division and Marine and Climatology Division, relocated to Wycliffe College, Stonehouse, Gloucestershire. The historic books and documents (c.70tons) were not moved until at least late 1940. Thankfully the Kensington building was not hit during the Blitz. Head Quarters remained in London throughout the war.

1939 15 September–Establishment of the Meteorological College at Berkeley Square House, London. Moves around several times during the war.

1941 Both of the first Ocean Weather Ships were sunk with the loss of all hands including three meteorological office staff per vessel.

1944 4-6 June–D-Day forecasting: culmination of months of work with forecasting which first identified the approach of poor weather which delayed the original planned date of D-Day on 5th June, and then the weather window which enabled the invasion to go ahead on the 6th.

1949 29 July–Start of regular broadcasting of weather charts on television to accompany forecast scripts.

1951 17 March–World Meteorological Organisation founded (following the signing of the World Meteorological Convention on 11 October 1947).

1951 August–Training school relocates to Stanmore.

1951 October–Fred Bushby attends a course on computing at Cambridge University. By the end of the year he and Mavis Hinds were experimenting with the earliest Met Office computer-based forecasting concepts on the Lyons Electric Office (LEO 1) at the Lyons catering firm headquarters. As a result, the Lyons computer not only handled the company accounts and logistics, but also factored in the Met Office weather forecast to influence the goods carried in their "fresh produce" vans!

1953 Sir Graham Sutton appointed Director (post renamed Director-General on 1 July 1957).

1954 11 January–First full televised weather forecast. Meteorologists George Cowling and Tom Clifton were selected to become the first television weathermen and George Cowling presented the first live forecast at 19:55 on 11 January 1954. By 1957 forecasts were also being provided for commercial television companies.

1957 Forecasting for nuclear industry first investigated following the fire at Windscale Nuclear Power Plant in Cumbria.

1959 First electronic computer installed at Dunstable–a Ferranti Mercury computer nicknamed 'Meteor'. It was the first computer dedicated solely to research on NWP and regular NWP forecasts could now be produced for the first time although this was still only experimental.

1959–1960 Opening of Weather Centres at Kingsway, Glasgow and then Manchester.

Early 1960s Creation of the Mobile Meteorological Unit, which was formed as part of the RAF Tactical Communications Wing.

1960 1 April–First successful Weather Satellite launch (TIROS1). It enabled meteorologists to see complete weather systems and to relate cloud patterns, movements and distributions to isobars and observations for the first time.

1961 Meteorological Office moves to Bracknell.

Late 1963 Britain's first automatic weather station tested at Bracknell.

1965 Summer–New KDF Super Computer (Comet) installed – capable of operational NWP.

1965 Sir John Mason appointed Director-General.

1965 2 November–First operational NWP forecast. Met Office hosts its first Press Conference to publicise the event.

1967 Autumn–Introduction of colour television and forecasts in colour.

1971 Met Office college moves to Shinfield Park, Reading. Instruments Division moves out from HQ Bracknell to Beaufort Park where it becomes the primary site for development of instruments.

1978 National Weather Radar Network established consisting of interlinked, automated radars. The first, at Camborne, was set up in the summer of 1978. Upavon, Clee Hill and Hameldon Hill were in place by 1980.

1980 WMO World Climate Programme established.

1982 First Met Office Super Computer Cyber205. The new machine was able to run the first global operational forecasting model, just in time to assist in operations surrounding the Falklands War.

1982 April MMU deploys to the South Atlantic. Although in existence since the 1960s this was its first well known deployment. Since then the MMU has continued to deploy in support of military operations wherever in the world UK Forces are deployed including UN Peacekeeping Operations, the Gulf War and Operations Telic and Herrick.

1983 Sir John Houghton appointed Director-General (post renamed Chief–Executive 2 April 1990).

1984 Met Office becomes World Area Forecasting Centre (WAFC London). The Met Office is one of only two World Area Forecast Centres - the other is WAFC Washington (NOAA). Both provide international aviation forecasting charts and gridded data for inclusion in flight planning software.

1985 7 June Last Ocean Weather Ship OWS Cumulus decommissioned.

26 April 1986 Chernobyl Nuclear Disaster leads to the development of the NAME (Numerical Atmospheric dispersion Modelling Environment) model. Since then NAME has been applied to an ever growing range of atmospheric transportation and dispersion problems including greenhouse gases, air quality forecasting, and emergency responses to events such as nuclear incidents, volcanic eruptions, industrial fires and animal diseases.

1988 The Meteorological Office formally becomes the Met Office after the shortened term was used on the front of the Annual Report for 1987.

1988 Introduction of FLASH warnings as part of the response to the 1987 storm. These developed into the National Severe Weather Warning Service in 1990.

November 1988 First Intergovernmental Panel on Climate Change (IPCC).

1990 2 April Met Office became an Executive Agency with the MoD.

1990 25 May Met Office Hadley Centre for Climate Science and Services opens.

1991 June Unified Model implemented operationally on new Cray C90 Y-MP-8 Supercomputer.

1992 Lord Julian Hunt appointed Chief Executive.

1992 Second Cray C90 Y-MP-8 Supercomputer purchased specifically for Hadley Centre research.

1995 Met Office website launched.

1996 Met Office became a Trading Fund.

1997 Peter Ewins appointed Chief Executive.

2003 Met Office relocates to Exeter, for the first time all departments are on site except for the archive which is located just a few minutes walk away in Great Moor House.

2004 David Rogers appointed Chief Executive.

2005 Mark Hutchinson appointed Chief Executive.

2005 Ensemble forecasting implemented. The Met Office Global and Regional Ensemble Prediction System (MOGREPS) was developed when the value of ensemble forecasts at shorter ranges became evident. It became fully operational in 2007.

2007 John Hirst appointed Chief Executive.

2007 27 November Met Office launches its first YouTube channel.

2009 1 April Flood Forecasting Centre established at Exeter HQ. Collaboration between Met Office and the Environment Agency.

2009 January Met Office launches its first Social Media channel (Twitter). This is followed by Facebook in December 2010, Instagram in June 2013, Snapchat in 2017 and TikTok in 2019.

2010 Eruption of Eyjafjallajokull volcano. The office carried out a wide range of tests on the ash plume including flying the research aircraft into it. This damaged the engines and proved that volcanic ash could indeed damage aircraft engines.

2011 After 93 years as part of MoD the Met Office moved to the Department for Business, Innovation and Skills (BIS). In 2016 this became the Department for Business, Energy and Industrial Strategy (BEIS).

2014 April Met Office Space Weather Operations Centre (MOSWOC) opened and began 24hr operational forecasts.

2015 Robert Varley appointed Chief Executive (first person to be promoted to the post from inside the organisation in its history).

2015–2017 New Supercomputer Cray XC40 installed. This consisted of two operational computers and one dedicated to weather and climate research.

2015 Beginning of storm naming (collaboration between Met Office and Met Éireann. First storm, 'Storm Abigail' 10 November 2015.

2016 Completion of new Supercomputer building on Exeter Science Park to house the research and collaboration Supercomputer. It was named Richardson after Lewis Fry Richardson.

2016 May Launch of Met Office App. This received over 3million downloads in its first year alone.

2018 March After almost 100 years the contract to provide forecasts to the BBC passes from the Met Office.

2018 April New National Severe Weather Warnings launched. Lightning, Thunderstorm, Extreme Heat and Fog added to pre-existing NSWWS for Rain, Snow, Wind and Ice. First Red Extreme Heat warning issued covered 18–19 July 2022. The UK maximum temperature passed 40 Degrees Celsius for the first time on 19 July with a record temperature of 40.3 degrees celsius observed at Coningsby in Lincolnshire.

2018 Professor Penelope (Penny) Endersby appointed Chief Executive.

17 March 2020 At the onset of the COVID-19 crisis the Office becomes an almost entirely remote working organisation overnight with the majority of staff, including forecasters, working from home.

2021 For the first time since its foundation the Met Office ceases to have a presence in London following the closure of its Victoria Street office.

2023 February Met Office owning department BEIS is split into three new departments and the Met Office moved to DSIT (Department for Science, Innovation and technology).

2023 February Met Office is granted Category 2 Responder status; enshrining the importance of National Severe Weather Warnings and the role of the Met Office in the resilience community in law

2023 November Met Office and Google Arts and Culture Partnership project page is launched creating a significant new global reach and engagement opportunity and including a range of stories coving many aspects of weather and climate history and current work.

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