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‘AN EXPERIMENTAL MEASURE’

The first meteorological office at South Farnborough and the Meteorological Office Radio Station Aldershot January 1911 to December 1918

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CONTENTS

Please note that all of the DSIR files which are mentioned in the footnotes are in the National Archives.

ILLUSTRATIONS

THE METEOROLOGICAL OFFICE, SOUTH FARNBOROUGH

January 1911 to November 1913

The origins of the meteorological office at South Farnborough may be traced to discussions between the War Office and the Director of the Meteorological Office (DMO), Dr W.N.Shaw, during the winter of 1910-1911, which culminated on 3 February 1911 with a War Office proposal for the establishment of a Branch Office of the Meteorological Office[1] at South Farnborough. The proposal, addressed to the Treasury and later copied to the Meteorological Office, included an assurance that the War Office would be responsible for accommodation and equipment, plus a laboratory assistant, whilst the Meteorological Office's contribution would be a trained meteorological observer to provide meteorological support for the Balloon Factory on the site (Fig.1)[2].

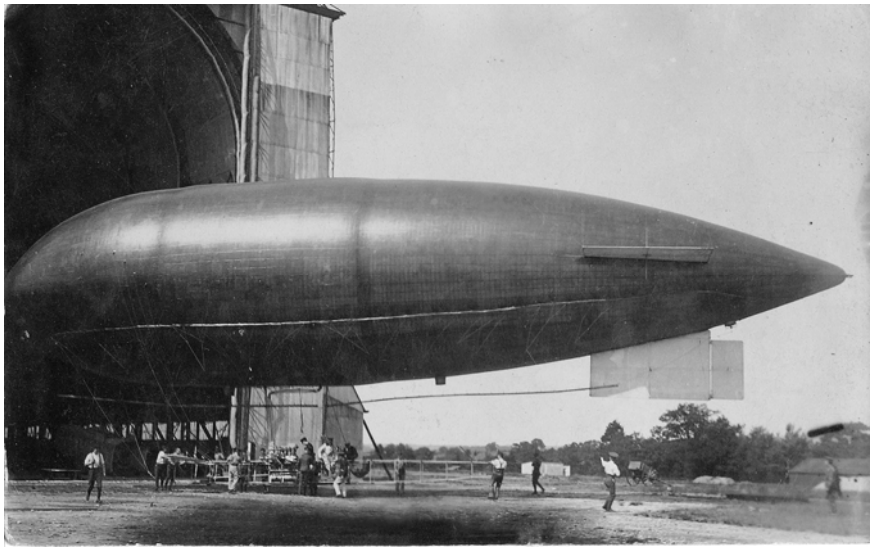

Fig.1
The Army airship 'Beta', photographed at the entrance to one of the Balloon Factory's balloon sheds in 1910.

The Meteorological Committee was not overly enthusiastic but accepted the proposal after obtaining the approval of the Advisory Committee for Aeronautics, which was funding research by J.S.Dines (Fig.2) at Pyrton Hill in Oxfordshire, to transfer the work to the new office. The DMO conveyed this response to the Treasury but advised of the Meteorological Committee's reservations about the matter. When the War Office's proposal was subsequently sanctioned, these reservations led the Treasury to add a rider that it would be considered '*an experimental measure'*.

Fig.2
J.S.Dines at Central Office, Kingsway, circa 1926 (S.Poole).

Early discussions between the DMO and South Farnborough authorities resulted in the meteorological office being allocated three west-facing rooms on the first floor of an administration building that was still in the design stage. In addition, it was agreed that an enclosure would be created in a large open space to the west. Dines was appointed as meteorologist-in-charge, but in the absence of accommodation at the time it was agreed he

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1 The term 'Branch Office of the Meteorological Office' was discontinued during the summer of 1915.

2 Much of this account has been compiled from the *Minutes of the Meteorological Committee* and *Annual Reports of the Advisory Committee for Aeronautics* between 1911 and 1918. References have been given only where statements are based on documents other than the minutes.

would remain at Pyrton Hill until some became available. It was expected that this would be ready by April 1912, but, in the event, building work did not begin until the autumn of that year, by which time the Balloon Factory had become the Royal Aircraft Factory (R.A.F.).

The original intention had been for the office to be manned by a single observer (Dines), but by the spring of 1913 it had become apparent the work would be too much for one man, and in July of that year Harold Billett, a physics graduate from the Royal College of Science, was appointed as Dines' assistant. As construction of the new building was still incomplete, Billett (Fig.3) spent the remainder of the year training at Central Office and working on projects for the DMO[3].

Fig.3
Harold Billett, photographed whilst living in Farnborough during 1914 (P.Summerhayes).

Dines made a number of brief visits to the aerodrome between 1911 and 1913, including one lasting four weeks from 23 October 1912 when, accompanied by G.M.B.Dobson, he established a temporary office. The visit had two objectives: to study the diurnal variation of wind in the surface layers by means of pilot balloons; and to trial arrangements for obtaining observations by telegraph from Central Office (the contemporary name for the Meteorological Office Headquarters)[4] for the preparation of forecasts.

By the summer of 1913 this brief period spent at South Farnborough was the total sum of Dines' forecasting experience, so he spent the latter part of September and early October at Central Office filling a forecasting post in anticipation of starting work at the R.A.F.. Before this, however, Dines had spent the 11th to 19th September, once again in the company of Dobson (now meteorologist-in-charge at the Central Flying School, Upavon)[5], visiting eight German meteorological offices to study the type of support that was provided for aviation[6].

December 1913 – December 1918

After several false alarms, the R.A.F. Administration Building was completed during November 1913 and Dines moved in early the following month.

There is no definitive description of the office's exact location, but the 1921 catechism (Form 3001, later Form 1094) records the datum from which visibility objects were measured as being the office roof. From three of the most distinctive objects listed, together with a contemporary aerial photograph, the building has been identified as one overlooking the airfield with unbroken views across the southern quadrant (Fig.4 – see page 3). The station catechism also records that a sunshine recorder was bolted to the parapet of the office roof 81 m above mean sea level (amsl) and the cistern of the barometer was 78 m amsl – the 3 m difference meaning the rooms occupied by the meteorological office would have been on the top floor.

Changes to the original design had resulted in the three rooms allocated for the meteorological office being at the eastern end of the building (Fig.5 – see page 3). The accommodation consisted of a room overlooking the airfield for the meteorologist-in-charge, a central room with bay windows being designated the computing room and drawing room, leaving the third as a workshop.

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3 DSIR 22/1 (Minutes 456 and 504). Please note that the DSIR files which are mentioned in this and other footnotes are in the National Archives.

4 DSIR 22/1 (Minutes 374 and 389).

5 A meteorological office was established at the Central Flying School, Upavon, in January 1913. R.G.K.Lempfert was briefly in charge before G.M.B.Dobson took post in February.

6 DSIR 23/331.

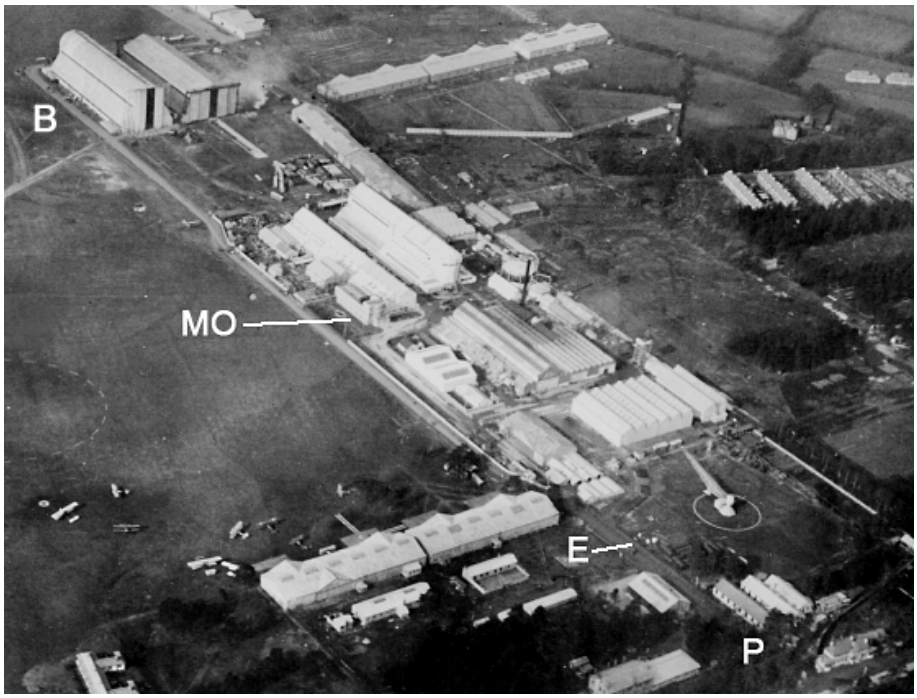


Fig.4
Royal Aircraft Factory South Farnborough, viewed from the south-east in 1915. (Farnborough Air Sciences Trust (FAST) collection).

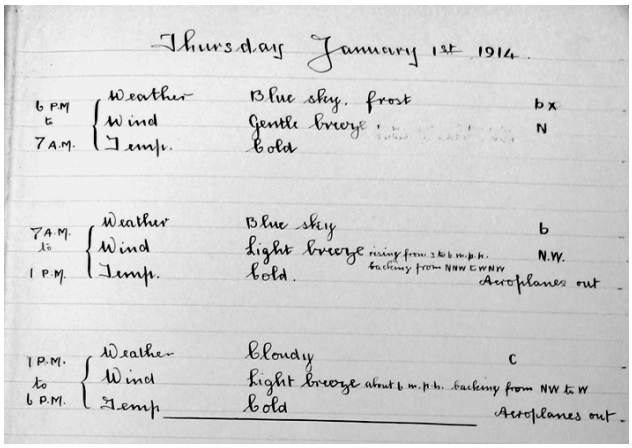
Key: MO = Meteorological office; E = Enclosure; B = Balloon sheds; P = Photo in Figure 9 taken from here.

Fig.5
The Administration Block which housed the meteorological office at South Farnborough nearing completion during the autumn of 1913. The meteorological office was allocated the top three rooms above the entrance. The building was demolished in 2001. (FAST collection)

Billett did not join Dines until 1 January 1914, so for most of December his only companion was H.Allnutt, a R.A.F. mechanic-computer who was employed to work with instruments in the workshop and as a general assistant.

Despite the War Office having had nearly three years in which to prepare, no proper arrangements had been made for all the necessary furniture, fittings and equipment; and during the next three months the office routine was disrupted by carpenters and fitters completing the outstanding work. The office lacked any means of direct outside communication other than by mail or the Marlborough Lines telegraph office some 2.5 km distant. (Marlborough Lines was an Army establishment on the southern outskirts of Farnborough town.) A telephone, which would have made the Office's task so much easier, was not installed until October 1914.

The first recorded observation was a pilot-balloon ascent made from the office roof by Dines on the morning of 9 December 1913. This reached just 500 m; another four were flown during the month, the last, on New Year's Eve, reaching 5.3 km[7]. At the end of December the office was still waiting for an instrument enclosure, so the first entries in the weather diary, on 1 January 1914, were brief summaries of the weather between the main observing hours, 0700, 1300 and 1800 GMT (Fig.6).


Thursday January 1st 1914.

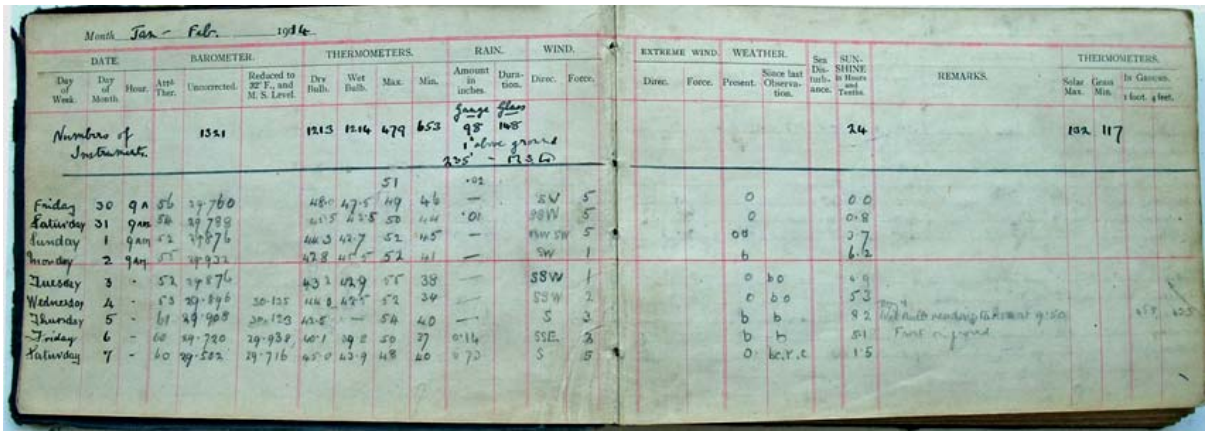
6 PM to 7 A.M. — Weather: Blue sky. frost; Wind: Gentle breeze; Temp.: Cold; b x; N

7 A.M. to 1 P.M. — Weather: Blue sky; Wind: Light breeze rising from 3 to 6 m.p.h. backing from NNW to WNW; Temp.: Cold.; b; N.W.; Aeroplanes out

1 P.M. to 6 P.M. — Weather: Cloudy; Wind: Light breeze about 6 m.p.h. backing from NW to W; Temp: Cold; c; Aeroplanes out.

Fig.6
First entries in the South Farnborough weather diary – 1 January 1914.

An enclosure was established during the month, and instrumental observations began at 0900 GMT on 30 January, a mild, cloudy morning with a strong south-westerly wind (Fig.7). The 0900 GMT observation remained the only daily observation during February, but thrice daily observations (0700, 1300 and 1800 GMT) began on 1 March, and it was from this date that the office was considered to be fully functional.


Month Jan – Feb. 1914

DATE. Day of Week	Day of Month	Hour.	BAROMETER. Attd Ther.	Uncorrected.	Reduced to 32° F., and M. S. Level.	THERMOMETERS. Dry Bulb.	Wet Bulb.	Max.	Min.	RAIN. Amount in inches.	Duration.	WIND. Direc.	Force.	EXTREME WIND. Direc.	Force.	WEATHER. Present.	Since last Observation.	Sea Disturbance.	SUN. SHINE in Hours and Tenths.	REMARKS.	THERMOMETERS. Solar Max.	Grass Min.	In Grass. 1 foot. 4 feet.
Numbers of Instruments.				1321		1213	1214	679	653	Gauge 98 1" above ground 325' – 13.5 O.	Glass 108								24		132	117	
Friday	30	9 A	56	29.760		48·0	47·5	51 49	46	—	·02	SW	5			0			0·0				
Saturday	31	9am	56	29.789		46·5	42·5	50	44	·01		SSW	5			0			0·8				
Sunday	1	9am	52	29876		44·3	42·7	52	45	—		WNW SW	5			0 d			3·7				
Monday	2	9am	55	29.932		47·8	41·5	52	41	—		SW	1			b			6·2				
Tuesday	3	-	52	29876		43·2	42·9	55	38	—		SSW	1			0	b 0		0·9				
Wednesday	4	-	53	29·848	30·135	44·8	42·5	52	34	—		SSW	2			c	b 0		5·3				
Thursday	5	-	61	29·908	30·173	43·5	—	54	40	—		S	3			b	b		8·2				
Friday	6	-	60	29·720	29·938	46·1	39·2	50	37	0·14		SSE.	2			b	h		5·1				
Saturday	7	-	60	29·582	29·716	45·0	43·9	48	40	0·72		S	5			0	bc.r.c		1·5				

Fig.7
The first instrumental observations at South Farnborough, 30 January to 7 February 1914; from the Daily Register.

Enclosure and instruments

There is no written record as to the location of the enclosure, but the 1921 station catechism describes a 9.75 x 9.75 m enclosure surrounded by a 2 m high open iron fence, containing two Stevenson screens and a shed in the north-east corner; these are clearly visible in the 1915 aerial photograph, some 220 m due east of the meteorological office (Fig.4). When observations first started the enclosure contained a single thermometer screen, grass minimum thermometer, rain gauge plus two earth thermometers, and it was not until August that it was fully instrumented (Fig.8 – see page 5). The surrounding fence did not offer the best security – the black-bulb thermometer, first exposed in July, making an enticing target for stones thrown by passers-by.

[7] The register of South Farnborough pilot balloon ascents.

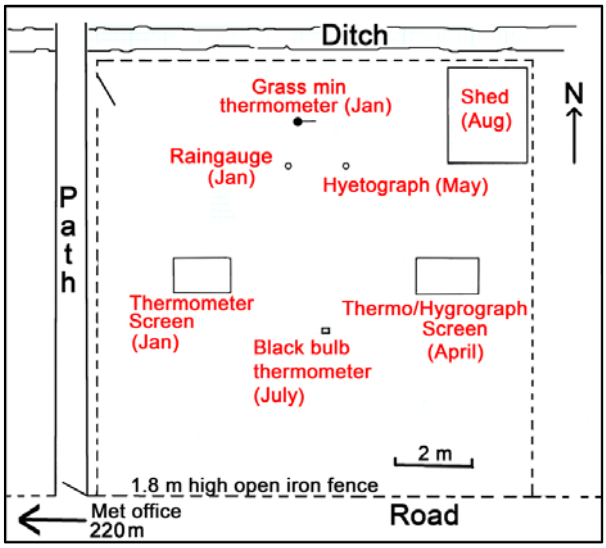


Fig.8
A sketch of the probable configuration of the South Farnborough enclosure in August 1914. Although the 1921 catechism describes the surrounding fence as being 2.1 m high, a contemporary photograph of the area (Fig.9) suggests it is more likely to have been 1.8 m.

Other than the very distant view in Fig.4, there is no image of the enclosure, but a photograph looking towards the R.A.F. entrance from Farnborough Road (now the A325), provides some idea of the environs during 1914 (Fig.9).

Although the position of the enclosure was just acceptable in the first instance, the R.A.F. authorities planted lime and beech trees around, and shrubs inside, the enclosure during the autumn of 1915. Matters were made worse the following June when a bank, some 2 m high, was built just beyond the ditch on the north boundary. These changes contravened agreements that the R.A.F. should provide a suitable site for meteorological instruments, but complaints were '*disregarded on the ground of the convenience of the factory or airmen, or of the disfiguring appearance of a proper station*'. This lack of appreciation of the meteorological office's needs was to cause increasing problems during the following years, and by 1924 the enclosure was little more than a small woodland clearing (Fig.10 – see page 6).

Amongst the original requirements for instruments was an anemograph in the office, but it was not until January 1917 that an anemobiagraph was installed on the office roof. In the meantime, the nearest anemograph was that belonging to the R.A.F, located on the Army golf course about 800 m to the south (Cave, 1917).

Fig.9
The entrance to the Royal Aircraft Factory (viewed from what is now the A325), probably taken during the autumn of 1914. The windows of the meteorological office are just visible at the top of the dark building immediately in front of the tall, light-coloured, balloon hanger in the background. The enclosure was beyond the street-lamp on the right. (FAST collection)

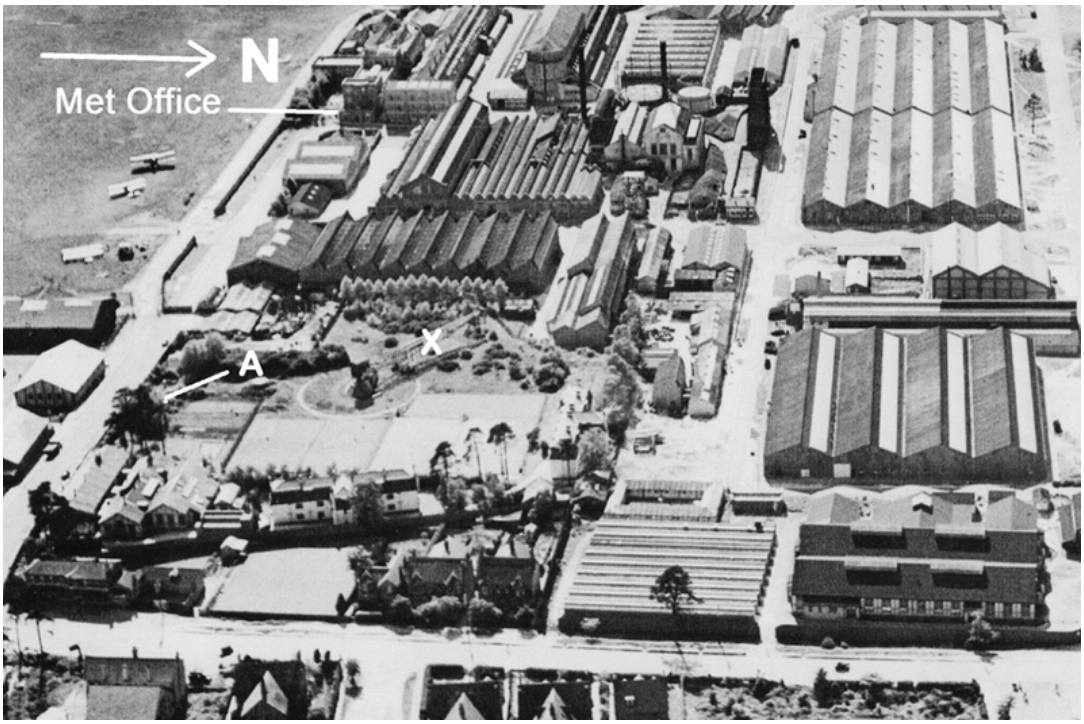
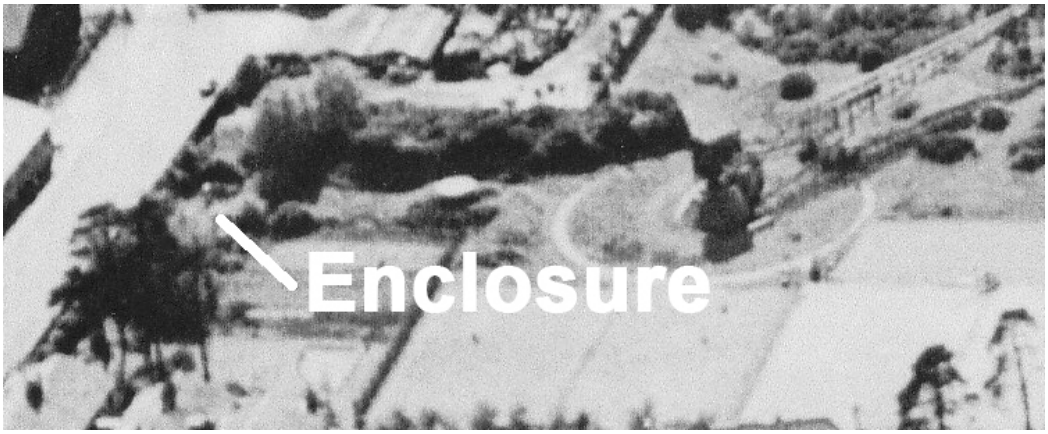


Fig.10
RAE South Farnborough in 1924, viewed from the east-north-east. (FAST Collection)
In the picture above, 'A' is the enclosure in 1924 and 'X' the 1928 position.
In the picture below, detail from A is shown. The encroachment of vegetation around and in the enclosure can clearly be seen.



Observing and Returns

In addition to routine surface observations, pilot balloon ascents were made from the office roof whenever conditions allowed[7], initially once daily at about 0700 GMT, but a second was later added at midday. Most balloons were followed to a height of more than 1 km, and it was unusual for a month to pass without at least one ascent reaching between 4.5 and 5 km – the highest being 16.8 km on 1 October 1917[8]. The exercise could be quite time-consuming, as even on 'normal' days the slide-rule computations to calculate the winds at the end of an ascent could take up to an hour to complete (Dobson, 1914).

Coloured balloons of various shades were used for this work (reds, blues, greens and an off-white), the colour used on any one day being chosen to give the best contrast against the sky – for example, red for a cloudless blue sky or dark blue for a cloud sheet (Watson-Watt, 1957)[9].

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8 DSIR 23/1044

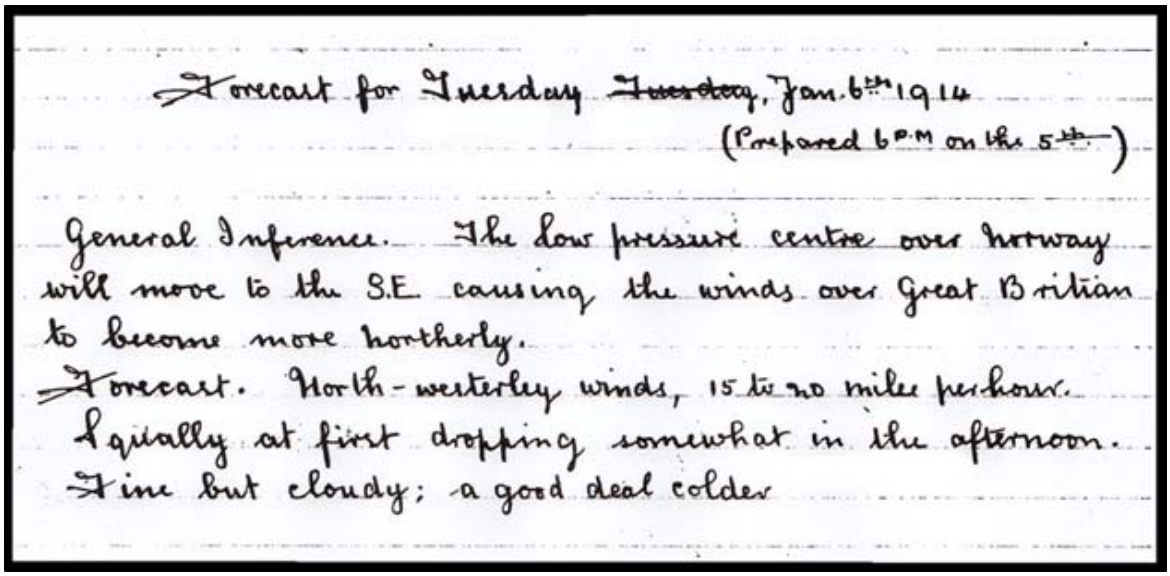
9 Coloured balloons continued in use until Watson Watt designed a multi-coloured filter for the eye-piece of the theodolite, possibly during 1916. Thereafter the off-white balloons became the norm.

At first, the 0700 and 1300 GMT observations were immediately telegraphed to Central Office on completion, along with the results of pilot-balloon ascents, but reports for 1800 GMT were held over until the following morning. This was not very efficient, but even though a telephone was installed in October 1914 it was not used to disseminate observations until November 1915. By the end of 1917, however, all data were telephoned to Central Office on completion[10].

Climatological returns were rendered immediately the full observing routine was established, the first appearing in the April 1914 *Monthly Weather Report*, but daily observations did not appear in the *Daily Weather Report* until 16 May 1915. Interestingly, the early Forms 3001/1094 for South Farnborough record that daily observations were started on 1 March 1914, but this date is changed to June 1913 in the 1935 return. No explanation was offered for the change, and although there are no observations of any sort before January 1914 all subsequent catechisms repeat what was undoubtedly an error.

Forecasts

A forecast for the following day was prepared each weekday evening from charts constructed from 1800 GMT observations. Since these were telegraphed from Central Office and had to be delivered by hand from the Marlborough Lines telegraph office, it was mid-evening before a forecast was ready. Although the *Annual Report* for the year ending 31 March 1914 records that forecasts were prepared from 1 January 1914, the first recorded forecast was prepared by Dines on the evening of 5 January (Fig.11). The emphasis was very much on wind speed as this, more than anything else, determined whether a day was fit for flying. There is no record of any other forecast being routinely prepared at South Farnborough.


Forecast for Tuesday ~~Tuesday~~, Jan. 6th 1914
(Prepared 6 P.M on the 5th)

General Inference. The low pressure centre over Norway will move to the S.E causing the winds over Great Britian to become more northerly.

Forecast. North-westerly winds, 15 to 20 miles per hour. Gradually at first dropping somewhat in the afternoon. Fine but cloudy; a good deal colder

Fig.11
First forecast issued by Dines on the evening of 5 January 1914 (not in Dines' hand).

Shortly after the declaration of war in August 1914 the Royal Naval Air Service (RNAS) at Dover requested an issue of forecasts and other information at 0400 GMT. As the South Farnborough meteorological office had been established to meet the needs of the R.A.F. and the Royal Flying Corps (RFC), of which the RNAS was initially part, it fell to Dines and Billett to respond to the demand. At the time there were no overnight observations on which to base such early morning forecasts, and these had to be arranged before work could begin. Consequently, it was not until September that the forecasts were first issued - not only to Dover but other RNAS stations as well. With just two forecasters, poor communications and the necessity of maintaining a daytime service for the aerodrome, the arrangement soon proved impractical and the following month the work was transferred to Central Office.

[10] DSIR 23/1083

Unfortunately, Central Office was similarly understaffed, so Dines was drafted in to help, and he was soon spending half of each month working night duties in London. All Central Office forecasts were copied to South Farnborough, and in December 1914 the locally produced evening forecast was discontinued.

Daily routine and staff changes

The working day was extremely long, starting at 7 am[11] and not finishing until the forecast for the following day was issued at 9 pm[12]**.** Whilst only three observations were recorded daily in the daily register, it is probable that some non-instrumental observations were made at intermediate hours; indeed, from December 1917, two-hourly reports were being telephoned routinely to Hendon airfield[10].

The office soon developed a list of customers requiring meteorological support, and the two meteorologists found much of their time was fully occupied with the observing and pilot balloon programme, making returns and providing advice to the airfield authorities. The returns included the tabulation of anemograms for other locations, this task being delegated by Central Office. Allnutt was similarly employed, not only in observing and statistical work, but also in the workshop, assisting in the repair and maintenance of instruments.

Nonetheless, both Dines and Billett found time for research studies, including one by Billett to determine the structure of gusts using a tetranemograph (a four-headed anemograph developed by the R.A.F.) which he commenced soon after arriving in January 1914[13]. Although Billett prepared a preliminary report in April 1914, and did all the work, his name did not appear in the list of authors when the final paper was presented to the Advisory Committee for Aeronautics in October (Dines and Short, 1913)[14].

It must have been difficult to complete all the routine work of the office with just three men, especially between June 1914 and February 1915, when one or the other was on holiday or working elsewhere. Dines, for example, spent nearly half of his time at Central Office working night duties to prepare the early morning forecasts for the RNAS, and there was leave to be taken and sickness to be dealt with. This meant there were long periods when the responsibility for running South Farnborough devolved to Billett and, given the long days and a need for weekend observations, it is remarkable the observing routine remained unbroken.

This led to Billett requesting the Meteorological Committee to consider an increase in salary in recognition of his greater responsibility and long hours. When his request, made in January 1915, was met with an offer of books in lieu of cash Billett promptly resigned, married and left for a meteorological post in Pretoria[15]. His sudden departure left the Meteorological Office in some difficulty as Allnutt had been replaced by H.S.Pain during January, leaving Dines as the only person with meteorological experience and knowledge of the needs of South Farnborough. During the following months there was a considerable turnover of Professional Assistants: A.H.R.Goldie, C.D.Stewart, E.L.Hawke (a Voluntary Assistant) and F.Entwistle. None stayed very long, but all subsequently had distinguished careers in meteorology.

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11 Meteorological observations were always made at Greenwich Mean Time, but otherwise the time datum used in reports and references is unclear, especially as British Summer Time was introduced in May 1916. For convenience it is assumed that for other than routine observations the time datum is local time; 'am' denotes the hours between midnight and midday, and 'pm' the hours between midday and midnight.

12 DSIR 23/442

13 DSIR 22/1 (Minute 512)

14 The publication date of this report is in error as work on the project did not start until January 1914.

15 Billett joined the South African Infantry (SAI) later in the year. The SAI sailed for England early in 1916 before joining the British Expeditionary Force in France. He lost his life during a night attack on enemy positions near Eaucourt l'Abbaye in France on 16 October 1916 (Booth and Davies, 2008).

However, the office was fortunate when C.J.P.Cave volunteered his services as an Honorary Inspector in February, and he became a stabilising influence during this period of uncertainty. An amateur but extremely gifted meteorologist, Cave immediately found himself deputising for Dines during another of his absences at Central Office. Cave was to deputise on other occasions in the following months until succeeding Dines as meteorologist-in-charge at the end of October 1915.

Before then, however, R.A.Watson Watt[16] had been appointed as Professional Assistant as a replacement for Entwistle in late September (Fig.12). A graduate with a BSc (Engineering), he had joined the Meteorological Office at the DMO's request to further the work Cave had started in developing a system for locating thunderstorms from the electrical discharges (atmospherics) they emitted (Jones, 2004). His appointment proved to be the last significant change of personnel until Cave transferred to Central Office on 1 June 1917.

Watson Watt succeeded Cave as meteorologist-in-charge and immediately found himself in a difficult situation. All the young men with the necessary qualifications to fill the Professional Assistant's post had joined the Army, and for the next four months Watson Watt had to run the office with just the assistance of a lady clerk and the computer-mechanic, the situation not easing until E.L.Hawke returned to South Farnborough in October 1917.

Fig.12
R.A.Watson Watt in 1935 (STFC, Rutherford Appleton Laboratory)

The Meteorological Office Radio Station, Aldershot – detection of thunderstorms

It had been the DMO's belief that once a meteorological office was established at South Farnborough the inter-mingling of aviators and meteorologists would result in a better understanding of the effect of meteorology on aviation, and lead to *novel lines* of research[12]. In the event, the anticipated communication between the two groups never materialised and, disappointed at this lack of progress, he proposed that a meteorologist with pilot training should be appointed as a Professor of Meteorology to pursue this work[17].

The man selected was Major G.I.Taylor RFC, who joined the meteorological office, on attachment, during February 1916. Unfortunately, although he became involved in a number of projects in respect of aircraft performance for the R.A.F., he made no impact in providing meteorologists with insights into the way meteorological conditions affected aircraft or aviation. Though he did conduct some research, studying the variation of wind speed near the ground and also the problem of forecasting fog, this was work that could have been undertaken by any earthbound meteorologist. Compared with the invaluable contributions being made in respect of cloud structure and lapse rates by a young RFC airman flying operational sorties over France during this period (Douglas, 1916 and 1917), Taylor's time at South Farnborough could hardly be considered a success. Yet, whilst holding the post of Professor of Meteorology, Taylor was paid at the rate of £500 per annum – £380 more than Billett, who had been refused an increase in his £120 per annum salary despite doing the work of two men at times.

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16 Watson Watt did not hyphenate his name until after his investiture in 1942. Thus, references written by him after this date are credited to Watson-Watt; all others lack the hyphen.

17 DSIR 23/487

In fact, it was Cave, shortly after his arrival in February 1915, who initiated the only truly novel line of research to be conducted at South Farnborough. In private life Cave had been using a Fenyi-Zukotinsky lightning recorder, which had no directional facility and was simply used to record the presence of lightning discharges (Fig.13), but the DMO encouraged him to install the apparatus at South Farnborough with a view to developing it for use as an aid to give warnings of approaching thunderstorms. To improve the process, Cave, at the suggestion of Dr R.Whiddington (later Major Whiddington RFC), a radiotelegraphic expert of the R.A.F., constructed a radio direction finding unit to detect the direction from which the radio waves generated by lightning discharges (atmospherics) were arriving, and in June he made his first attempts to obtain bearings on atmospherics (Cave and Watson Watt, 1923). In the absence of suitable accommodation in the immediate vicinity of the meteorological office, and requiring an aerial about 65 ft (20 m) high[18], the work was conducted in an abandoned Army wireless station some 3 km distant at Smallshot Bottom, Aldershot (Fig.14 – see page 11). First referred to as 'Smallshot Bottom', this small sub-unit of the South Farnborough meteorological office became known as the Meteorological Office Radio Station during the summer of 1917[19] (Fig.15 – see page 11).

This was the very beginning of the detection of thunderstorms by radio-telegraphy, and in his first report to the Advisory Committee for Aeronautics *Detection of approaching thunderstorms by radio-telegraphy*, Cave demonstrated that it was indeed possible to take bearings on atmospherics[18]. Nonetheless, it was not until 1 December 1915 that the concept was definitely proven, when directional bearings on atmospherics around midday, which indicated a thunderstorm in a southerly direction, were subsequently confirmed by reports of a thunderstorm at Selsey, 65 km south of Smallshot Bottom[20].

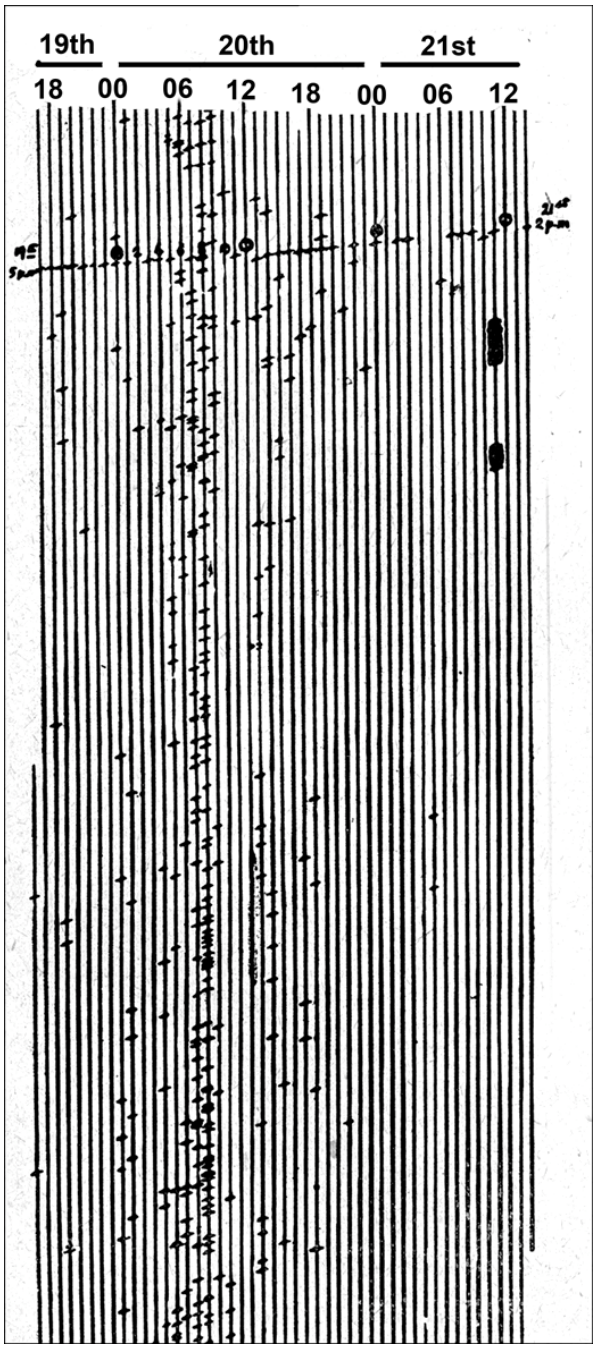

Fig.13
Lighting discharges within a range of about 400 km from South Farnborough as recorded by Cave's automatic lightning recorder, 19-21 January 1916 (see also Fig.18). This particular chart shows a peak of atmospheric activity between 6 am and 9 am on 20 January. The marks near the top of the chart are hourly times marks.
(Reproduced from Cave, 1917)

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18 DSIR 23/592

19 DSIR 23/1043

20 From Watson Watt's hand-written notes for a presentation entitled *Wireless and weather* circa 1922. Documents in the Ditton Park Archives at the Science and Technology Council, Rutherford Appleton Laboratory.

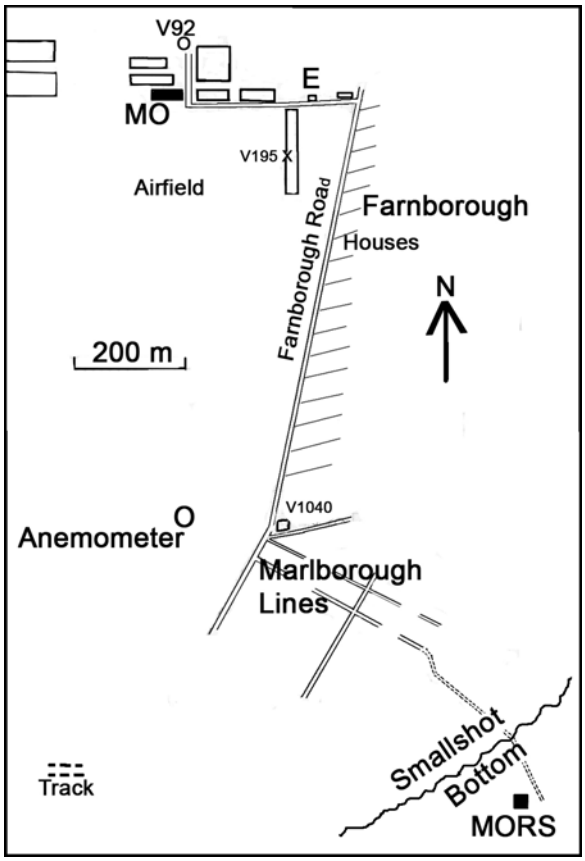

Fig.14
South Farnborough and environs in 1915 (not to scale south of the anemometer).

Key: MO = meteorological office, E = enclosure, V1040 = 1040 m visibility object, MORS = Meteorological Office Radio Station

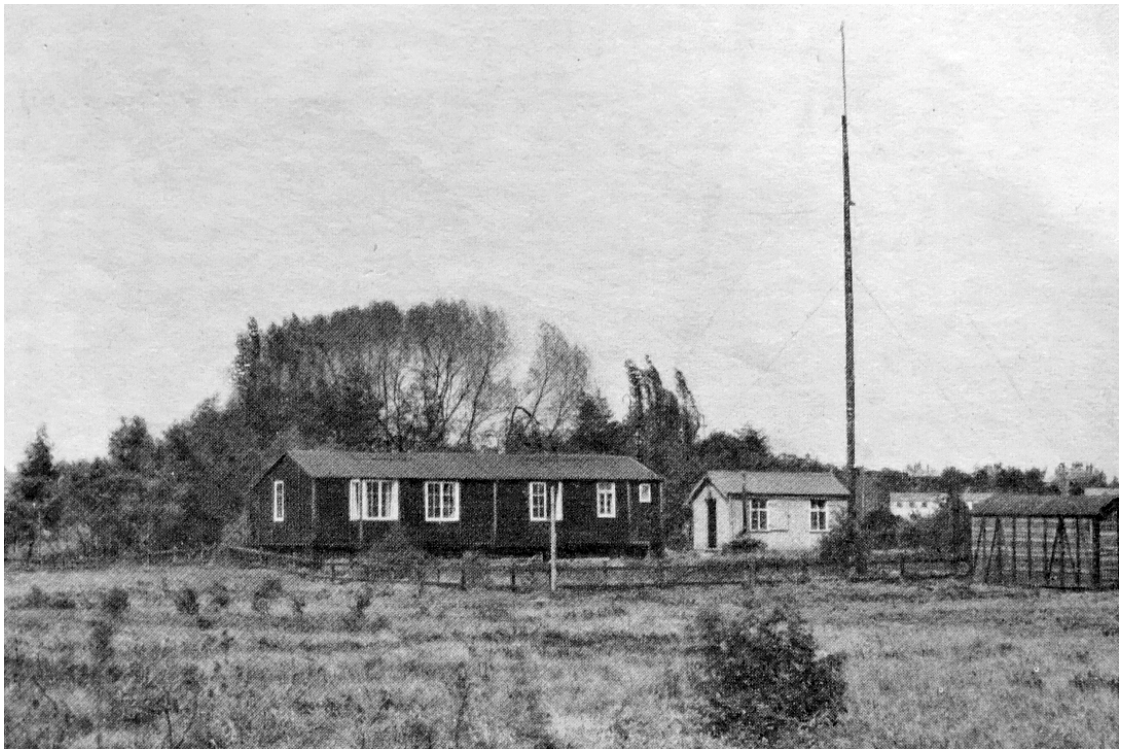

Fig.15
The Meteorological Office Radio Station at Smallshot Bottom, in September 1916, probably viewed from the north-north-east. The white hut contains the electrical apparatus, whilst the hut to the left is the living quarters provided by the Meteorological Office for Watson Watt. The mast is not the original, but one erected at the beginning of the year.

Following this early success, approval was obtained from the Admiralty to involve some of its Radio Direction Finding (RDF) stations in the project. This involvement started at the beginning of March 1916, and for the remainder of the war twelve RDF stations provided bearings on atmospherics several times daily. The concept was soon proven. The first atmospheric located this way was recorded near Christchurch at 9 pm[11] on 26 April 1916, (Shaw and Watson Watt, 1919). Although the absence of any reports of thunderstorms meant the position could not be validated, there was no such problem during the evening of 24 July when atmospherics located over Tipperary were confirmed by reports of heavy thunderstorms (Fig.16).

More successes followed, perhaps one of the most noteworthy instances being on 9 August 1916, when an area of atmospherics was tracked from mid-Biscay at 8 am to south-west France at 8 pm (Figure 17)[21].

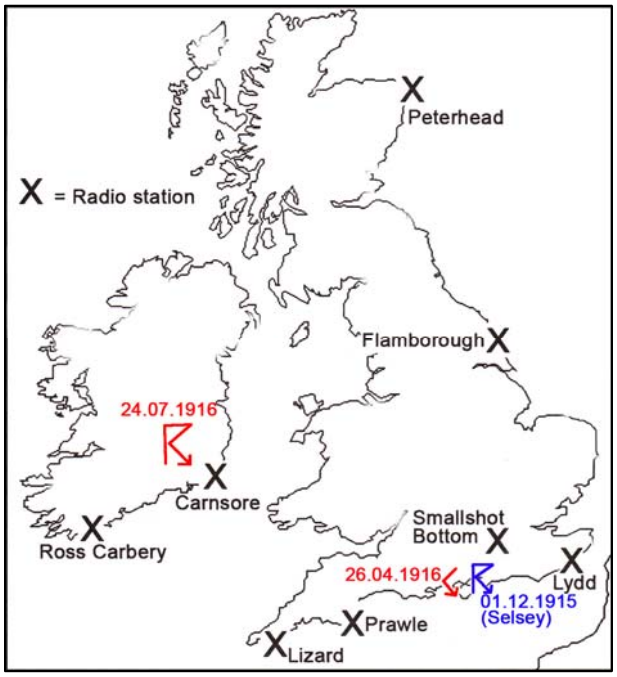

Fig.16
The locations of some of the RDF stations that reported the bearings of atmospherics to South Farnborough. Atmospherics on a south-south-westerly bearing from Smallshot Bottom on 1 December 1915 were confirmed by a thunderstorm at Selsey. First atmospherics found by triangulation were in the vicinity of Christchurch on 26 April 1916. Atmospherics over Ireland were fixed from bearings taken at Ross Carbery, Lizard and Smallshot Bottom, and confirmed by surface observations.

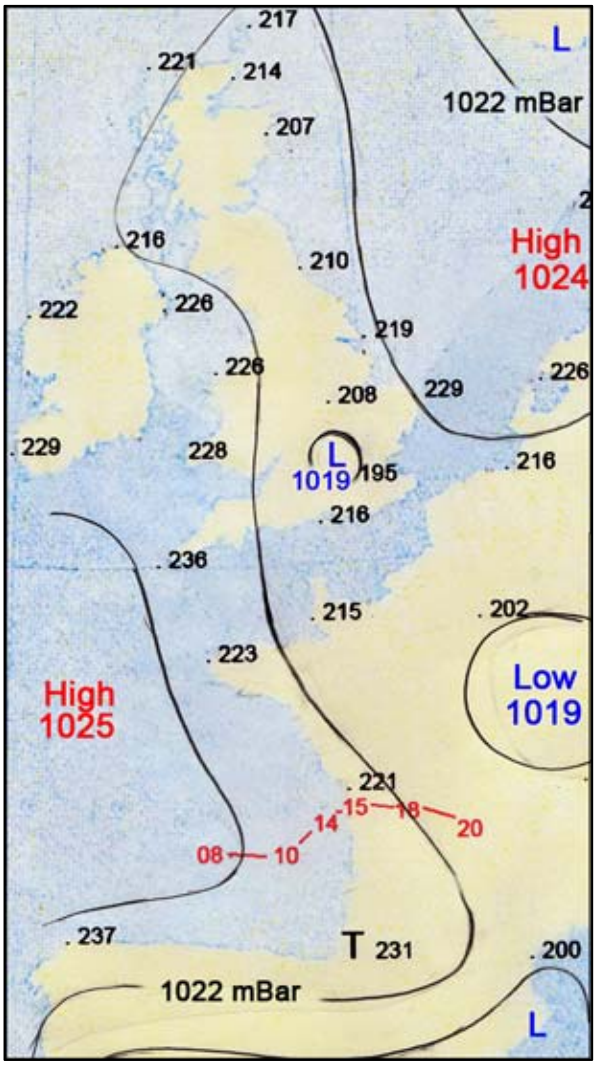

Fig.17
1800 GMT chart for 9 August 1916, showing the track of an area of atmospherics between 8 am and 8 pm. Thunderstorms were reported from a number of locations in south-west France from mid-afternoon until after midnight.

[21] DSIR 23/962

Cave remained in overall charge of the project but Watson Watt rapidly became the acknowledged specialist and was responsible for the development of the prototype apparatus and techniques (Fig.18). Owing to the distance between Smallshot Bottom and the meteorological office, it was not possible to monitor the apparatus continuously, but the project was considered of such importance that during the summer of 1916 the Meteorological Office provided a portable residential hut in order that Watson Watt could live on site, so as to be close at hand to make observations and conduct research when off-duty. The hut remained his home until the end of the war.

Fig.18
The interior of the Meteorological Office Radio Station at Smallshot Bottom photographed in 1919. The lightning recorder is the large instrument on the table to the left. (Rutherford Appleton Laboratory)

Although all references to the Radio Station place it in a shallow valley known as Smallshot Bottom about 74 m amsl, it was actually just to the south on Smallshot Hill, 84 m amsl. Since the building was surrounded by scrubland, and the top of the aerial mast was the highest point in the immediate vicinity, it was an 'interesting' place in which to work when thunderstorms were in the offing. At such times sparks would shoot across non-conducting parts of the circuit, and Watson Watt later wrote:[20]

> '*I have very lively recollections of observing on a direction finder under such conditions in 1917, and of the very unpleasant feeling when a discharge chose to include my wrist, adjusting a condenser, in its path*.'

By the beginning of 1918, the Thunderstorm Inquiry, as the work at the Radio Station was known, had advanced as far as existing arrangements would allow. The concept of locating thunderstorms by radio-telegraphy had been proven, and to improve techniques Watson Watt proposed the establishment of another two Meteorological Office Radio Stations, one at Eskdalemuir and another at either Armagh or a site in south-east Ireland, with all three stations working with the same wavelengths. The proposal was supported by the DMO, but there was one major obstacle – a lack of trained staff caused by those with the necessary qualifications being on active service. There being no immediate solution, Watson Watt continued working as before.

South Farnborough – other work

Although not connected directly with meteorological research, and only peripherally involving the South Farnborough meteorological office, a practice evolved during 1916 which, although passing unremarked in Meteorological Office annals, was to have a profound impact on the work of the Meteorological Office for the next 43 years. Early in the year, Lieutenant (later Sir) Henry Tizard of the Central Flying School Experimental Flight at Upavon, realising the need to include air temperatures in the calculations that determined aircraft performance, fitted thermometers to aeroplanes under test in order to obtain temperature data at fixed levels during a flight (Clark, 1965, and Tizard, 1917).

The aircraft tested at Upavon were those designed and built by the R.A.F., so it was natural that the procedure also became routine at South Farnborough. At the time, Central Office had no use for these data, but from October 1916 the temperatures recorded during these flights were forwarded to the Meteorological Section at the General Headquarters of the British Expeditionary Force in France[22], where they were used in the preparation of 'Meteor telegrams'[23].

Later the following year the temperatures were occasionally forwarded to Central Office, and this became standard practice in January 1918[24], although it is unclear what use was made of them. In a letter to Sir Richard Glazebrook of the Advisory Committee for Aeronautics, dated 13 June 1918, the DMO, writing about upper air temperatures obtained during aeroplane ascents, said: [25]

> *Observations have now been coming in for some little time from Ipswich, G.H.Q. France, and occasionally from the R.A.F. South Farnborough. Another question which is up to me for solution is how best these observations can best be utilised …*

After Watson Watt became meteorologist-in-charge at the beginning of June 1917, the lack of a suitably qualified assistant meant that much of his time was taken up with the routine work of the office, and as a result little progress was made with the atmospherics research at Smallshot Bottom. Nonetheless, he still found time for other, less high profile, studies. During the last year of the war, these included the exploration of ways of determining cloud heights. In the first instance, Watson Watt found that an 80 cm Mark II Infantry Rangefinder (loaned by the Command School of Musketry) could be used to determine satisfactorily the height of low cloud during daylight. Lasting just two months, January and February, the only reference to the trial was a brief note in the office's *Report of Work to the Advisory Committee for Aeronautics* for February 1918[26].

Three months later he revisited an idea Cave had previously trialled during December 1916 – the measurement of cloud height at night using a height nephoscope on the office roof centred on a patch of cloud illuminated by a vertical searchlight beam. The searchlight was part of the airfield defences and, although Cave considered his trial successful, for some reason the only reference made to it was in an unpublished *Report of Work* for December 1916[27] and was never developed further. Watson Watt's 1918 trial ran until the searchlight unit was disbanded at the end of November. It involved a single observation being made each evening between one and two hours after sunset. He used much the same procedure as Cave, but with a modified direct reading nephoscope fitted to the corner of his living accommodation at Smallshot Bottom. With a baseline of 2.5 km from the sighting point to the searchlight, he

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22 DSIR 23/877

23 'Meteor' telegrams, containing wind and temperature data for Battery Commanders to use for ballistic corrections, were issued routinely by the G.H.Q. Meteorological Section.

24 DSIR 23/1102

25 DSIR 23/1223. The temperature reports from Ipswich actually came from the Testing Squadron at Martlesham Heath (formerly the Experimental Flight of the Central Flying School at Upavon), whilst those from G.H.Q. France actually came from the Meteorological Flight at Berck.

26 DSIR 23/1121

27 DSIR 23/909

successfully recorded cloud heights to approximately 4000 m by nephoscope and 7300 m by sextant[28].

Near closure

By 1918 the South Farnborough monthly reports of work were listing an impressive list of recipients for forecasts, reports and other meteorological advice, plus an increasing number of telephone requests from other airfields for current weather observations, so there was good reason to suppose the meteorological office had become an intricate part of airfield and aviation infrastructure.

Yet, despite this, early in 1918 the very existences of both the meteorological office and Meteorological Office Radio Station were threatened. In the first instance, the R.A.F. advised it required some, if not all, of the accommodation used by the meteorological office, whilst in the second the Army wanted to reoccupy the land on which the Radio Station stood.

The lack of enthusiasm shown by the Meteorological Committee when the South Farnborough office had first been proposed seven years previously appeared not to have changed, and, despite the consistently positive Reports of Work, its response, signed by Colonel H.G.Lyons in October, was a proposal to close the office completely, on the grounds the staff would be better employed at the meteorological observatories which were experiencing considerable staff shortages[29]. Confusingly, the same letter also recommended the Radio Station should remain – meaning there could be no staff saving!

That the Meteorological Committee considered closing the only airfield meteorological office at which its staff could gain experience in aviation meteorology was incomprehensible, especially as less than three months later the same Colonel Lyons was extolling the importance of meteorology to aviation (Lyons, 1919).

Fortunately, the matter was allowed to rest, pending the results of Government discussions on the future of post-war meteorological services, and both survived. However, although the research being conducted at the Radio Station was actively encouraged by two DMOs, Shaw during the war and his temporary successor Colonel Lyons, the same support was not forthcoming from Dr G.C.Simpson when he succeeded to the post in 1920.

Simpson took the view that this type of research was not the responsibility of the Meteorological Office[30] (Watson-Watt, 1957), and later that year the Radio Station was transferred to the Radio Research Board (RRB) of the Department of Scientific and Industrial Research (DSIR). As a result of this short-sighted decision, it would be 25 years from Cave's first attempt to take bearings on atmospherics before the Meteorological Office began developing its own network of stations to locate atmospherics by radiotelegraphy – and for 'SFERIC' to become an integral part of meteorological vocabulary (Air Ministry [AHB], 1954).

Footnote

This account does not record all the contributions made to meteorology by the South Farnborough meteorological office between 1913 and 1918. Although the work on the detection of thunderstorms was the only truly novel line of research, the other lines of research work were equally important and should be properly recognised – even if the Meteorological Committee was unable to appreciate their import.

Watson Watt continued his work after transferring to the RRB, and by 1923 had developed a direction finder capable of determining bearings on single atmospherics. By 1927, the

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28 DSIR 23/9431

29 Minutes of the Meteorological Committee, 4 December 1918; Minute 733.

30 Minutes of the Meteorological Committee, 27 October 1920; Minute 863.

apparatus was installed at two locations, Slough and Cupar (near Leuchars), and in regular use by the RRB.

Very little of the meteorological research conducted at South Farnborough was ever made known to the wider meteorological community, a strange oversight by the DMO. For example, apart from a report to the Advisory Committee for Aeronautics[28], the pioneering work on the use of searchlights to measure cloud base at night passed unnoticed. In fact, there was little night flying during the immediate post-war years, and such few airfields that had meteorological offices were staffed only for daytime flying. In the event, it was not until 1934 that the first cloud searchlight was installed at Croydon Airport.

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