M.O. 452

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CONTENTS

FEBRUARY, 1940

NOTICES

It is requested that Books for Review and Communications for the Editor be addressed to the Director, Meteorological Office, Air Ministry, London, W.C.2, and marked "for Meteorological Magazine".

The responsibility for facts and opinions expressed in the signed articles and letters published in this Magazine rests with their respective authors.

THE METEOROLOGICAL MAGAZINE

M.O. 452

AIR MINISTRY : METEOROLOGICAL OFFICE

Vol. 75 FEBRUARY, 1940 No. 889

ICE CONDITIONS IN THE BALTIC AND DANUBE AREAS DECEMBER 1st 1939 TO JANUARY 23rd 1940

By C. E. N. Frankcom, Master Mariner.

Ice conditions in the Baltic, Eastern North Sea and Danube have been more severe this winter than for several years as a natural result of the cold spell over Europe in January. The actual commencement of the ice season was not unduly early—in fact the closing of most of those ports which cannot be kept open occurred at about the average date. It is chiefly in the extension of the area affected to the waters of the Eastern North Sea that the severity of the season is most marked, for it is only in exceptional years that ice is encountered in the North Sea or to any extent in the rivers flowing into that sea. Danish ports have suffered rather exceptionally severely this winter. On the River Danube also conditions have been more severe than usual, but here again the ice did not appear at any unusually early date.

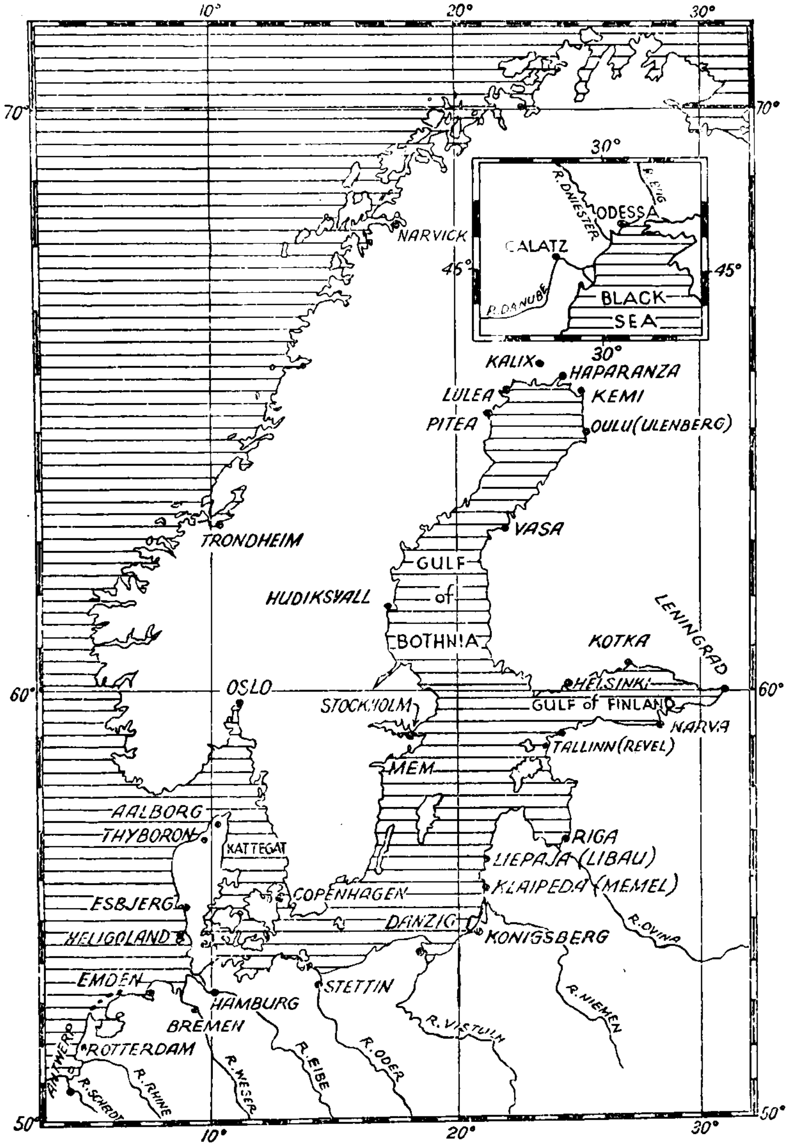
Every winter shipping is more or less seriously hampered in the Baltic and Danube districts owing to the prevalence of ice, but the length of the season and extent of the area affected vary considerably from year to year. The large area and the number of countries, as well as the multitude of ports involved make an analysis of the general ice situation in Europe a rather complex problem, and it is somewhat difficult to convey a clear and comprehensive picture of the extent and severity of the "freeze up," and for any particular winter it is still more difficult to compare conditions with any average. Most of the countries affected publish more or less detailed accounts of conditions in their own waters, both daily and in the form of annual summaries, and the *Deutsche Seewarte* in particular published in peace time a daily map and report showing conditions throughout Baltic waters. Shipping interests in the British Isles are provided with concise daily reports as to conditions in the principal ports affected in *Lloyds List and Shipping Gazette*. The writer is indebted to the Shipping Editor of Lloyds for the information from which this report is built up.

There is apparently very little English literature on the subject of European ice, and the writer is not aware that anything in the nature of a concise report on the general ice situation over a period is normally given embracing all European waters. Owing to the many interests involved, it would appear that such a report might be interesting and helpful both for commercial and scientific purposes.

An attempt is made in this article to describe the state of the ice in the above mentioned areas during the winter 1939–1940 from December 1st to January 23rd. It is hoped that there will be an opportunity of publishing later a further article showing conditions during the latter part of the winter. It seems that the best way of tackling the problem is to lay it out somewhat in the form of a diary, using all the available information, but only dealing with the ports which appear to be the most important and treating the matter as briefly as possible. It will be noted that on account of the war little or no information is at present available concerning the ports of certain countries.

December 1. The first appearance of ice in the Baltic was indicated by the reported withdrawal of the Helsinki Light Vessel from its station.

December 2. Navigation reported closed at Kemi due to ice conditions.



MAP OF BALTIC AREA: DANUBE AREA INSET.

There is not room on the map to show clearly the Sound and the Great Belt. The Sound is the stretch of water between Copenhagen and the Swedish Coast and the Great Belt is the middle passage between the islands to the southward of the Kattegat.

December 4. Navigation closed at Kotka, the last vessel having sailed on December 1.

December 8. Navigation closed at Kalix.

December 11. Navigation closed at Oulu. Last vessel sailed December 7.

December 19. Navigation closed at Haparanda. Reports indicate that several ports in the Gulf of Bothnia (including Pitea, Lulea, Vasa and Hudiksvall) expect to keep open with icebreaker assistance until the end of December or middle January.

By this date it may be considered that the first stage of the " freeze-up " has been reached, badly located ports in the Gulfs of Finland and Bothnia have more or less frozen up, the ice having gradually spread south and west respectively from the heads of these Gulfs.

December 27. Reported from Tallinn that Leningrad harbour is closed owing to ice.

January 2. Esbjerg—soft or new ice, navigation not hindered. Aalborg—navigation difficult for sailing vessels. Most Danish ports report conditions difficult for small vessels. Narva and several other Estonian ports report fast ice; navigation closed.

January 4. Many Danish light buoys withdrawn. Riga—fast ice, navigation difficult for sailing vessels.

January 5. Thyboron—navigation difficult for sailing vessels, owing to soft or new ice.

The freezing of the water has by now gradually spread west through the Baltic, and Danish waters begin to be affected slightly. There has been nothing exceptional reported as yet.

January 6. Drift ice in the East Scheldt. Ameland temporarily cut off from the mainland by ice. River Maas frozen over from Woudrichem to Heusden. Icebreaker sent to Aalborg to free coasting vessels. Navigation difficult for sailing vessels at Esbjerg and Tallinn owing to soft or new ice. More Danish light buoys withdrawn.

January 9. Heavy fast ice at Riga—navigation only possible for powerful steamers.

January 10. More Danish light buoys withdrawn.

January 11. Navigation closed for sailing vessels and difficult for small steamers at Aalborg. Heavy fast ice at Riga—navigation only possible for steamers reinforced against ice.

January 12 and 13. More Danish light buoys withdrawn.

January 14. Drift ice on River Scheldt reported to have torn buoys from their moorings.

In these nine days conditions have deteriorated very rapidly and one sees the first real indication of somewhat abnormal conditions, most particularly in the freezing of the Rivers Scheldt and Maas. Heavy fast ice is encountered in most eastern Baltic ports, and new ice in Danish waters and the rivers of Belgium and Holland is causing difficulties to shipping.

January 17. Heavy fast ice at Tallinn and Riga; navigation kept open by the icebreakers. At Liepaja (pack ice) and Aalborg (drift ice) navigation only possible for powerful steamers. Copenhagen Sound—navigation difficult for sailing vessels owing to soft or new ice. Copenhagen harbour full of firm thick ice. Extremely difficult conditions reported for shipping in all Danish waters. All seven Danish icebreakers hard at work. Fjords in Jutland frozen over. Ice 3 metres thick reported from western end of Limfjord. 23° of frost reported during the night in Denmark. Ice formation observed in the Great Belt. Ice reported in the North Sea off Jutland for the first time in many years, up to 2 miles from the coast in places. Baltic Sea frozen over as far as can be seen from Danish coast.

January 18. More Danish light buoys and light vessels withdrawn. Heavy ice reported in the sea off Riga and in Tallinn harbour; navigation only possible for powerful steamers.

January 19. Heavy drift ice reported in the sea off Liepaja and pack ice in the harbour; navigation only possible for vessels reinforced against ice. More Danish light buoys and Danish and Swedish light vessels withdrawn. Navigation difficult for sailing vessels in Copenhagen Sound and outer harbour. Fast ice reported at Tyboron; navigation only possible for powerful steamers. Ice-breakers necessary in the Great Belt between the islands of Sjaelland and Funen, and in the Sound between Sjaelland and the Swedish coast. Many steamers fast in the ice in the narrow Sound. Danish schooner reported caught in the ice and signalling for help between the islands of Laaland and Fehmarn.

January 20. Ice difficulties reported in the River Scheldt. Navigation reported only possible for powerful steamers at Esthonian ports. All Danish light vessels reported temporarily withdrawn, and more Danish light buoys withdrawn.

January 21. Heavy drift ice reported on the west Scheldt.

January 22. Large steamers unable, on account of packed soft ice and drift ice, to enter Copenhagen harbour without assistance. Most Danish ice-breakers reported more than fully occupied. Copenhagen outer harbour—navigation difficult for small steamers, closed for sailing vessels. Sailing through Danish Belt suspended due to danger of ice combined with that of mines. Very bad ice conditions reported in most Danish ports; navigation being mainly only possible for powerful steamers. River Scheldt—3 steamers which left Antwerp had to return to port because of ice. Tallinn Roads—heavy fast ice, navigation kept open by icebreakers. Riga—heavy fast ice, navigation temporarily closed. Liepaja—pack ice, channel kept open by icebreaker.

January 23. More ice difficulties reported on River Scheldt. Various small vessels bound for Antwerp put into Flushing because of ice. Navigation to Brussels closed by ice. Fast ice reported at Lobith, on the River Rhine.

It is now very apparent from the diary that there has been an exceptionally cold period (some of our readers may have noticed this for themselves !). In the eastern Baltic the fast ice is superseded by pack ice and the ice here has spread out from the harbours some way into the sea. In this section shipping is by now generally restricted to specially constructed vessels.

The reported withdrawal of all Danish light vessels and apparently most of the buoys, the freezing of Copenhagen Harbour sufficiently to impede shipping, and the spread of ice out into the North Sea itself are definite indications of more than usually severe weather. It is unusual for shipping to be held up in the River Scheldt. One is reminded of the severe winter of 1928 to 1929 when considerable ice was reported in the North Sea.

River Danube and Black Sea.

December 31. Thin ice reported at Briala, River Danube. $-11°$ C. during night.

January 1. All navigation on the Danube stopped owing to ice.

January 4. River Danube reported blocked from Sulina to 18th mile post and from 35th to 43rd mile post, and frozen at Orsova. Turkish steamer *Altay* caught in the ice near 42nd mile post. Dredgers and tugs freed a British steamer from the ice near 3rd mile post.

January 5. River Danube reported very seriously blocked with ice. 50° frost reported from Moravia (presumably Fahrenheit).

January 10. Black Sea reported frozen at Odessa for the first time in many years. River Danube—Turkish steamer *Altay* still icebound. Ice-breakers working with difficulty but forced to abandon operations. Ice jams below Galatz. Rivers Pruth and Sereth, also Ishmael, St. George and Machin branches completely frozen. Ice reported to be fast between Isaccea and Tulcea. 38th mile post to sea reported free of ice. Temperature of - 18° C. reported at noon to-day and - 22° C. during previous night.

January 18. Turkish steamer *Altay* still ice-bound, but weather mild, thawing. Icebreakers resuming work.

Reports as to conditions in this region are not so numerous as those from the Baltic, as the ice season tends to start later here. It will be noted that this winter there is about a month's difference between the first reports of ice in the two regions. The high rate of freezing in the Danube and the consequent speedy disorganisation of shipping is a feature of this river, and this is brought out in the diary. The severity of the winter is chiefly shown by the freezing of the Black Sea at Odessa.

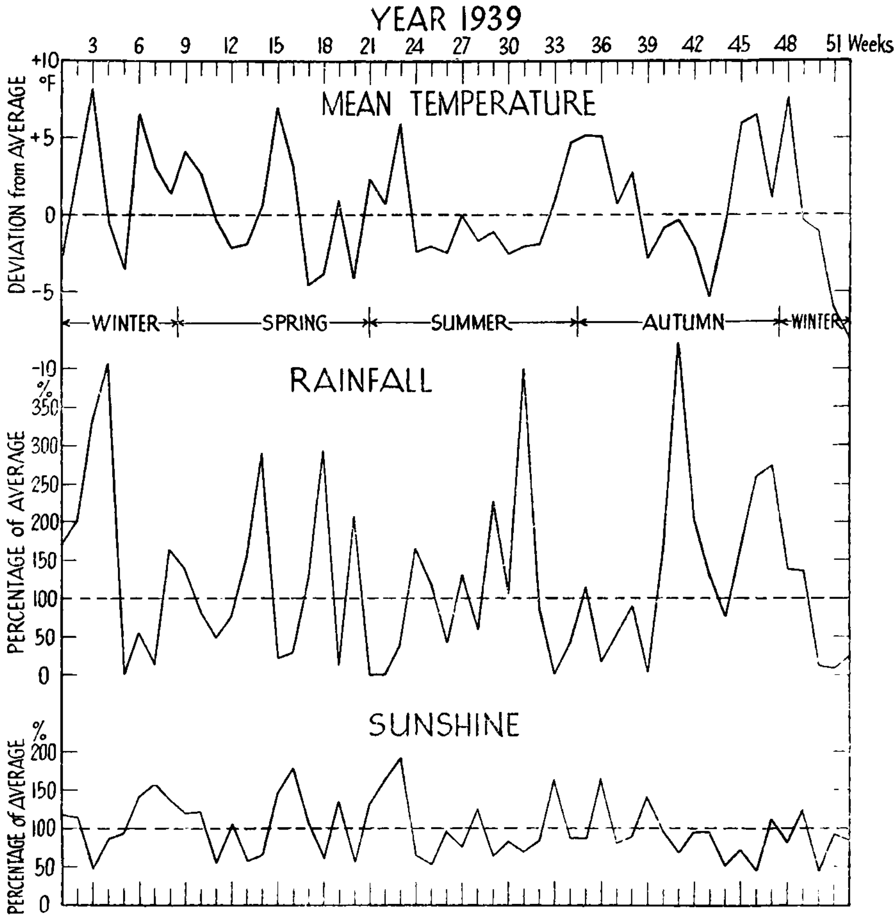
OFFICIAL NOTICE

SUMMER TIME, 1940. Observers are reminded that "Summer Time" will start on February 25th, 1940.

THE WEATHER OF 1939

Perhaps the most notable feature of the weather of 1939 was the excessive rainfall in east and south-east England, chiefly due to the exceptionally heavy rainfall in January, April, October and November. On the other hand the year was dry over a large area in the west of Scotland to the north and west of the Caledonian Canal and over a fairly large coastal area in the west of Ireland. A detailed account of the rainfall of 1939, including intense falls of rain and details of droughts and dry spells, has already appeared in *The Meteorological Magazine*, 1939, pp. 291–3.

Mean temperature for the year slightly exceeded the average, the deviation from the average for the districts ranging from +0·3° F. in Ireland, N to +0·9° F. in Scotland, E and England, NE. There were considerable deviations from the average in individual months; October and December were cold on the whole, January was cold for the most part in Ireland, Scotland and north-west England, and July was cool. Some notably low screen minima were registered during the first week of January; for example 1° F. at Dalwhinnie and Braemar on the 4th and 5° F. at Newport (Shropshire) and 6° F. at Logie Coldstone and Shrewsbury on the 6th. The deficiency in October was considerable in some parts; individual stations in England reported the lowest mean temperature for October since 1926. The cold weather in the latter half of December was, on the whole, most marked in the southern half of the country; among notably low screen minima registered in the last few days were 6° F. at Newport (Shropshire) and 8° F. at Barton (Manchester) on the 29th and 8° F. at Droitwich on the 30th. In the other eight months mean temperature, in general, exceeded the average; November was excessively mild, February mild, particularly from the 5th–12th, while the periods April 9th–16th, May 22nd–31st, June 3rd–7th, August 13th–31st, and September 1st–9th were mainly warm. During the



THE WEATHER IN 1939 IN SOUTH-EAST ENGLAND.

Weekly variations from long-period averages computed from observations at five representative stations.

warm spell in early June the diurnal range of temperature was great; a range of between 40° F. and 50° F. was recorded at many places.

Sunshine was variable, but about average over the British Isles as a whole; the percentage of the average for the districts ranged from 95 in England, E, and the Midlands to 104 in Scotland, W, and Ireland, N, and 105 in the Channel Islands. For the country generally, compared with the average the sunniest months were April, June and October and the dullest, July and November. January was notably sunny in north and west Scotland and unusually dull in south-west England, February was exceptionally sunny in east and south-east England and parts of the Midlands and June was sunny generally, but particularly so in north Ireland. At some places in west and north Scotland and Ireland sunshine was notably excessive in August, and in October also a pronounced excess of sunshine was enjoyed in most of Ireland and west and north Scotland. July and November were markedly dull, with only 74 and 71 per cent. of the average sunshine over the British Isles generally.

Unusually severe gales were infrequent in 1939 but the north-westerly gale on the south-west coasts on the night of January 22nd–23rd was notably severe; a mean hourly velocity of 66 m.p.h. was recorded at the Lizard on the 22nd and at St. Mary's, Scilly, on the 23rd, and gusts of 96 m.p.h. and 92 m.p.h. were registered at Scilly on the 23rd and 22nd respectively, and 91 m.p.h. at the Lizard on the 22nd. The St. Ives lifeboat was capsized in the gale and serious loss of life resulted.

There was considerable snow at times in January; at Cantref (Brecknock) it was 14 inches deep on the 26th and snow was still lying on the 31st and at Stanford Dingley, Berkshire, level snow was 19 inches deep on the morning of the 26th.

The diagram on page 10 shows the weekly variations in temperature, rainfall and sunshine in south-east England in 1939. The variations are given in the form of deviation from the average of temperature and percentages of the average of rainfall and sunshine. The district value is the arithmetic mean of the values for the following stations:—Kew Observatory, Margate, Hastings, Southampton and Marlborough.

L. F. Lewis.

LETTERS TO THE EDITOR

A Green Moon

Dr. F. J. W. Whipple in the November 1937 issue of the *Meteorological Magazine* wrote about a green moon. I observed at Totteridge what appeared to be a light green moon on the morning of Saturday, December 30th, 1939, at 8h. G.M.T. The moon was quite bright and high up in the sky and the morning was clear and frosty. Covering the moon was some cirrus cloud tinged with pink due to sunrise. I presume it was the pinky tinge of the cirrus cloud which made the moon appear light green.

J. MONGER.

46, Great Bushey Drive, Totteridge, N.20.
January 2nd, 1940.

NOTES AND NEWS

Glazed Frost, January, 1940.

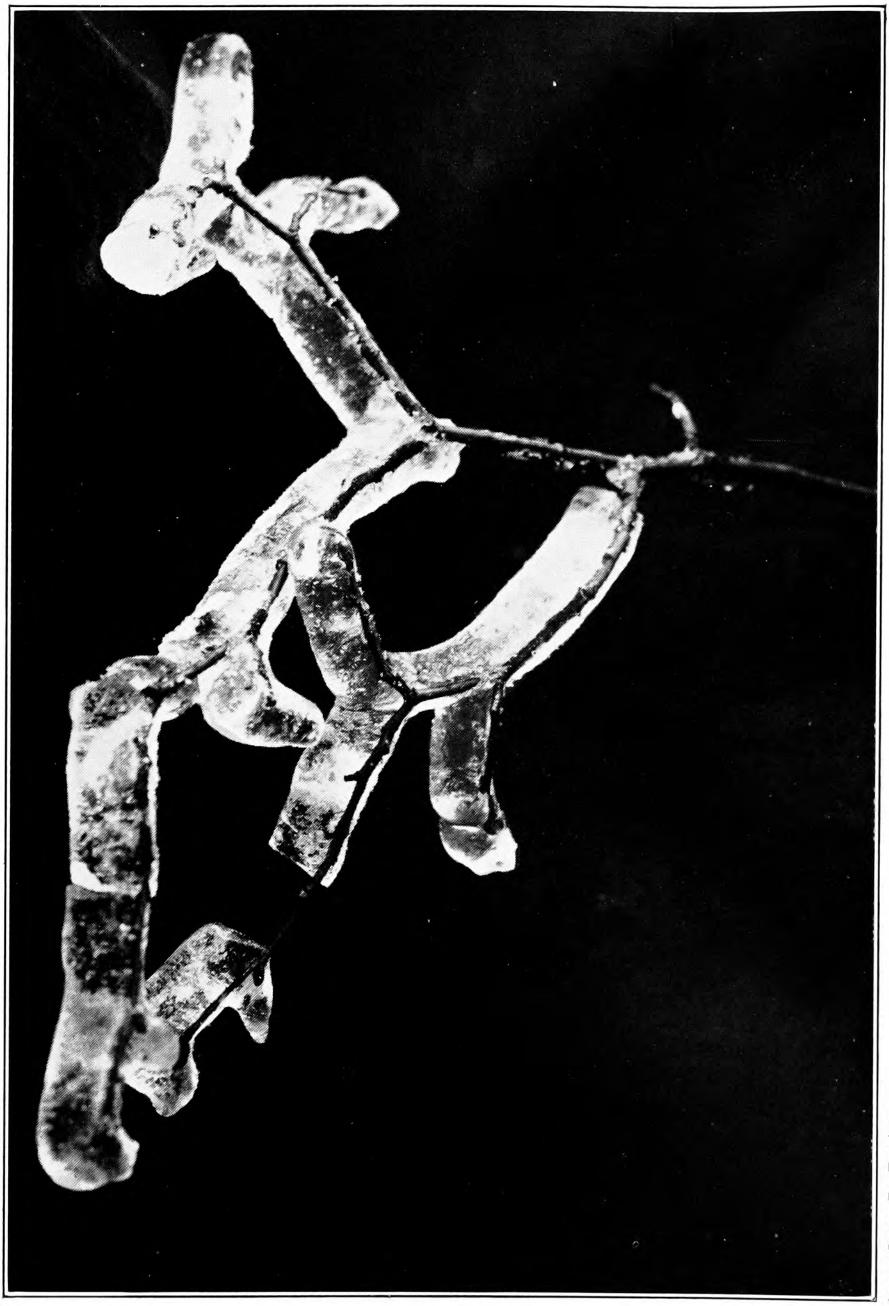
Glazed frost is of comparative rarity in the British Isles. It occurs when rain falls with a temperature below freezing point; a layer of smooth ice, which may attain considerable thickness, is formed upon all objects exposed to the rain. The accumulation of ice is often sufficient to break trees and to bring down telegraph wires. A notable example occurred on the morning of December 21st, 1927, in London and many other parts of England; several thousand street accidents resulted. Some account of this frost is given in the issue of this Magazine for January, 1928, page 280.

The accompanying photographs illustrate the severity of the glazed frost which began on January 27th–28th, 1940.

GLAZED FROST IN GLOUCESTERSHIRE, JANUARY 29TH, 1940

Photographer: S. Poulton.

Face page 13



Glazed Frost, Gloucestershire, January 29th, 1940

Photographer: S. Poulton

The following notes are contributed by Mr. J. Pattinson:—

" During the severe glazed frost at the end of January one of the most remarkable features was the abnormal amount of ice which formed on trees and telegraph wires. Branches and wires were broken with its weight, while in many instances whole trees and telegraph poles fell.

Some measurements were made of the weight of ice formed around small branches and lengths of wire which snapped under the strain. Perhaps one of the most striking was that of a broken telegraph wire. A length of it measuring 4·5 in. and diameter ·05 in. was found to weigh 178 gm., this being 130 times the weight of the wire alone. The diameter of the cylinder of ice formed around the wire was 2·4 in.

Weights of broken twigs were as follows:—

Weight of Twig alone.	*Weight of Ice formed.*	*Ratio.*
0·7 gm.	24·3 gm.	34·7
1·25 gm.	21·75 gm.	17·4
27·0 gm.	146·0 gm.	5·4

In each case the ice was thickest on one side of the object, due to the keen easterly wind which generally prevailed throughout the glazing period.

The trees and wires, in many places, retained their ice formations for seven days, at least."

The following notes on the glazed frost at Hermitage, Berks, are contributed by Mr. J. S. Dines.

" On the morning of January 28th there was a coating of ice inside the funnel of the rain gauge which yielded ·32 in. of water. A further fall occurred on the following night. There was on this occasion some snow in the funnel together with the ice, but I estimate that the latter yielded ·57 in., making a total of ·89 in. of frozen rain in two days. The effect on all outdoor objects was striking. Small twigs were coated with ice to a diameter of 1 in. Blades of grass sticking up through the snow were similarly coated. A laurel bush was held rigid with ice $\frac{1}{4}$ in. thick over its leaves and icicles up to 4 in. long hung from the foliage. The surface of the ground and of walls facing to windward (East) were coated with a uniform layer of ice. The country looked beautiful but the damage done was very great. Few telegraph or telephone wires were left intact and many trees suffered serious damage. It was notable that some silver birch trees up to 20 or 30 feet in height were bent until the tops were resting on the ground and yet recovered when the ice fell from the branches. The temperature during the formation of the glazed frost was just below freezing. The occurrence did not mark the termination of the cold spell as is, I believe, usually the case. Temperature continued generally below freezing for some days and it was a week before the last ice had disappeared from the trees."

Numerous other accounts have been received from various parts of the country.

Lunar Corona formed by Low Cloud at Benson.

A lunar corona formed by low cloud was seen at Benson between 21h. 40m. and 21h. 50m. on the evening of October 26th, 1939. The diameter of the innermost ring varied from 4 to 10 times the diameter of the moon, and the red and yellow rings were clearly distinguishable. The corona was formed by low cloud which extended from 2,000 to 3,000 ft., while fragments at 1,300 ft. occasionally obscured it. These figures were obtained from a number of pilots who had just been flying. The phenomenon was observed again at 22h. 30m., the red, orange and yellow rings being discernible this time. The temperature at 3,000 ft. at 23h. 7m. was found by a pilot to be 30° F.

E. R. INKESTER.

General Rainfall, January, 1940.

	Per cent.
England and Wales	103
Scotland	49
Ireland	102
British Isles	90

Sunshine, January, 1940.

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs	Diff. from average hrs.
Stornoway	32	+ 5	Chester	66	+13
Aberdeen	..	..	Ross-on-Wye	87	+32
Dublin	52	− 5	Falmouth	67	+ 7
Birr Castle	37	−12	Gorleston	..	..
Valentia	76	+32	Kew	52	+ 8

Kew temp., mean, 31.4° F. diff. from average—9.1° F.

OBITUARY

JOSEPH BAXENDELL, F.R.MET.SOC. Readers will learn with regret of the death of Mr. Joseph Baxendell, F.R.Met.Soc., which occurred at Southport on January 14th, 1940. An account of Mr. Baxendell's meteorological work was given in *The Meteorological Magazine* for February, 1937, in connection with his retirement, in June of the previous year, from the position of Borough Meteorologist to the Corporation of Southport, a position which he had held for nearly 50 years, having been appointed to it in 1887 when a mere youth of 18 years. The record is one of which many a man might be proud, but when we recollect that throughout the 70 years of his life Baxendell had to contend with persistent ill health, it becomes indeed remarkable. For weeks—often months—on end he was confined to his room, yet so detailed and conscientious was his scrutiny of the work of his assistants and so thorough the training which he gave them that the records of the Fernley Observatory rank among the most complete and trustworthy in the country.

Though condemned to lead the life of a recluse Baxendell had many friends among meteorologists, with whom he maintained contact by correspondence. On the rare occasions when personal contact was established he proved himself a stimulating companion, once he had got over his initial shyness. It was obviously a source of keen delight to him to meet a kindred spirit with whom he could talk shop, and the visitor in his turn came away stimulated and with new ideas to think over.

Most of Baxendell's published work on theoretical meteorology concerned itself with periodicities, a branch of the subject to which his attention was probably directed early in life by his father, in his day a distinguished astronomer who did much work on variable stars, but Baxendell's interests were by no means confined to that side of the subject. His conversation would range over the whole meteorological field and bore witness to a familiarity with contemporary literature which betrayed wide reading and critical thought. One is glad to think that he was able to maintain his active interest in scientific work up to the end, as evidenced by a note in the current number of the *Quarterly Journal* in which he refers to some work of his father's on the interdiurnal variation of air pressure, published 79 years ago, and applies the method to the Southport records with interesting results.

Baxendell had a keen sense in instrumental design, which is the more remarkable when one remembers that opportunities for developing it by laboratory or workshop practice in his young days were denied him. His outstanding achievement in this field, which constitutes one of his strongest claims to be remembered by posterity, was the design of an anemoscope to record the changes of direction associated with the changes of velocity which the Dines' pressure tube anemometer had brought within the range of observation and study. Prior to the invention of these instruments meteorologists were, in general, content to use anemometers such as the Robinson which were deliberately designed to damp out the minor fluctuations. Attention was concentrated on hourly values and the short period variations were regarded as unwelcome though unavoidable complications which must be disregarded and if possible eliminated by mechanical means. The Dines-Baxendell instrument opened the way for the observational study of wind structure as we now know it.

R. G. K. L.

A. PEARSE JENKIN. We regret to record the death of Mr. Arthur Pearse Jenkin, J.P., which occurred at Trewirgie, Redruth, on January 14th, 1940, at the age of 76. Mr. Pearse Jenkin, who was a native of Redruth, was a man of outstanding personality, and his name was a familiar one throughout West Cornwall for the social work in which he had been actively engaged for many years. He had been a Fellow of the Royal Meteorological Society since 1907, had served on the Council, and contributed in 1912 a paper discussing "A three year period in rainfall." He also maintained a climatological station at Trewirgie, summaries of which were published from 1908 to 1911 in the *Meteorological Record* and from 1912 in the *Monthly Weather Report* of the Meteorological Office. The rainfall record at Trewirgie has been continued since 1880, the earlier records being maintained by Mr. Jenkin's brother. Since 1928 an additional record was forwarded from The Lizard for inclusion in *British Rainfall*. Mr. Jenkin also acted as Secretary of the Cornwall Rainfall Association, which stimulated local interest in the recording of rainfall and resulted in the collection of a number of valuable records.

H. G. LACEY. We regret to record the death, on February 4th, 1940, of Mr. H. G. Lacey, Assistant in the Meteorological Office, at the early age of forty-seven.

Mr. Lacey served in the last War, first with the R.N.A.S. and later with the R.A.F., Meteorological Section. He joined the Meteorological Office in June 1920, and after serving at Outstations and in the Forecast Division was posted to the Marine Division in March 1924, where he remained until the time of his death.

He was a loyal and assiduous worker and with his long experience of the work of the Marine Division was a valued member of its staff. His friendly disposition had endeared him to a large circle of colleagues through the Meteorological Office.

Rainfall: January, 1940: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	2·24	120	*Warw*	Alcester, Ragley Hall.	2·99	155
Surrey	Reigate, Wray Pk. Rd.	2·60	108	,, .	Birminghm, Edgbaston	3·04	151
Kent .	Tenterden, Ashenden.	3·11	145	*Leics* .	Thornton Reservoir...	2·52	127
,, .	Folkestone, I. Hospital	2·91	..	,, .	Belvoir Castle........	1·68	95
,, .	Margate, Cliftonville..	1·82	110	*Rutl'd*	Ridlington	..	..
,, .	Edenb'dg., Falconhurst	2·47	101	*Lincs*.	Boston, Skirbeck.....	..	..
Sussex	Compton, Compton Ho	3·47	109	,, .	Cranwell Aerodrome..	1·95	113
,, .	Patching Farm.......	3·23	124	,, .	Skegness, Marine Gdns	1·58	91
,, .	Eastbourne, Wil. Sq..	3·52	134	,, .	Louth, Westgate.....	..	..
Hants.	Ventnor, Roy.Nat.Hos.	4·12	160	,, .	Brigg, Wrawby St....	1·73	..
,, .	Southampton, East Pk	2·66	100	*Notts* .	Mansfield, Carr Bank..	2·63	122
,, .	Ovington Rectory....	2·52	93	*Derby*.	Derby, The Arboretum	..	..
,, .	Sherborne St. John...	2·50	107	,, .	Buxton, Terrace Slopes	..	..
Herts .	Royston, Therfield Rec	1·99	115	*Ches* .	Bidston Obsy........	2·46	116
Bucks.	Slough, Upton........	2·61	140	*Lancs*.	Manchester, Whit. Pk.	2·06	82
Oxford	Oxford, Radcliffe.....	2·91	161	,, .	Stonyhurst College...	2·00	47
N'hant	Wellingboro,Swanspool	2·65	143	,, .	Southport, Bedford Pk	2·48	97
,, .	Oundle	1·75	..	,, .	Ulverston, Poaka Beck	..	..
Beds .	Woburn, Exptl. Farm.	2·14	125	,, .	Morecambe..........	2·28	87
Cambs	Cambridge, Bot. Gdns.	1·68	112	,, .	Blackpool...........	2·60	95
,, .	March	1·66	104	*Yorks*.	Wath-upon-Dearne ...	2·26	118
Essex.	Shoeburyness........	1·53	113	,, .	Wakefield,Clarence Pk.	2·74	143
,, .	Lexden Hill House....	1·47	..	,, .	Oughtershaw Hall....	2·97	..
Suff .	Haughley House.....	1·32	..	,, .	Harrog'te, HarlowMoor	2·48	96
,, .	Campsea Ashe, High Ho	1·65	91	,, .	Hull, Pearson Park...	2·12	118
,, .	Lowestoft Sec. School.	2·04	122	,, .	Holme-on-Spalding ...	1·93	102
,, .	Bury St. Ed., WestleyH	1·34	75	,, .	Felixkirk, Mt. St. John	2·77	139
Norf. .	Wells, Holkham Hall.	1·25	86	,, .	York, Museum.......	2·26	128
,, .	Thetford W. W.......	1·28	..	,, .	Scarborough.........	1·38	69
Wilts .	Porton, W.D. Exp'lStn	2·62	114	,, .	Middlesbrough.......	1·88	117
,, .	Bishops Cannings	2·46	106	,, .	Baldersdale, Hury Res.	1·40	43
Dorset	Weymouth, Westham.	3·42	..	*Durhm*	Ushaw College.......	1·35	66
,, .	Beaminster, East St ..	2·68	77	*Norl'd*	Newcastle, Leazes Pk.	1·56	79
,, .	Shaftesbury	2·17	..	,, .	Bellingham, Highgreen	1·57	55
Devon.	Plymouth, The Hoe...	2·56	77	,, .	Lilburn Tower Gdns..	1·97	95
,, .	Holne, Church Pk.Cott	5·20	84	*Cumb*.	Carlisle, Scaleby Hall.	·95	38
,, .	Teignmouth, Den Gdns	1·74	60	,, .	Borrowdale,Seathwaite	..	..
,, .	Cullompton	2·44	75	,, .	Thirlmere,DaleHeadH.	..	..
,, .	Sidmouth, U.D.C.....	2·08	..	,, .	Keswick, High Hill...	2·04	40
,, .	Barnstaple,N. Dev.Ath	3·22	98	,, .	Ravenglass, The Grove	2·19	65
,, .	Dartm'r,Cranmere P'l	4·20	..	*West* .	Appleby, Castle Bank.	1·12	35
,, .	Okehampton, Uplands.	2·72	53	*Mon* .	Abergavenny, Larchf'd	3·78	112
Cornw	Bude, School House ..	..	..	*Glam* .	Ystalyfera, Wern Ho..	4·81	76
,, .	Penzance,Morrab Gdns	2·98	79	,, .	Treherbert, Tynywaun	..	..
,, .	St. Austell, Trevarna..	4·05	95	,, .	Cardiff, Penylan......	3·87	105
Soms .	Chewton Mendip.....	3·12	81	*Carm* .	St. Ann's Head.......	..	..
,, .	Long Ashton	2·44	85	*Card* .	Aberystwyth	4·07	..
,, .	Street, Millfield	2·11	89	*Radn'r*	Bir. W. W. Tyrmynydd		
Glostr.	Blockley	3·16	..	*Mont* .	Lake Vyrnwy........		
,, .	Cirencester, Gwynfa ..	2·84	113	*Flint* .	Sealand Aerodrome...	2·82	152
Here .	Ross-on-Wye	2·80	116	*Mer* .	Blaenau Festiniog....	5·96	64
,, .	Kington, Lynhales....	3·57	127	,, .	Dolgelley, Bontddu...	4·00	70
Salop .	Church Stretton......	2·53	100	*Carn* .	Llandudno	2·56	106
,, .	Shifnal, Hatton Grange	1·99	103	,, .	Snowdon, L. Llydaw 9	5·50	..
,, .	Cheswardine Hall	2·44	110	*Angl* .	Holyhead, Salt Island.	6·01	210
Worc .	Malvern, Free Library.	3·78	171	,, .	Lligwy.............	2·83	..
,, .	Ombersley, Holt Lock.	4·06	211	*I.Man*	Douglas, Boro' Cem...	6·57	200

Rainfall: January, 1940: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St.PeterP't.GrangeRd.	..	..	*R&C.*	Stornoway, C.G.Stn.	2·53	52
Wig .	Pt. William, Monreith.	..	..	*Suth* .	Lairg	1·41	43
,,	New Luce School	..	..	,,	Skerray Borgie	2·12	..
Kirk .	Dalry, Glendarroch	4·45	80	,,	Melvich	2·58	78
Dumf.	Eskdalemuir Obs	3·37	62	,,	Loch More, Achfary	2·74	38
Roxb .	Hawick, Wolfelee	1·43	45	*Caith* .	Wick	1·43	58
,,	Kelso, Broomlands	·94	54	*Orkney*	Kirkwall, Bignold Park	1·80	50
Peebs .	Stobo Castle	1·48	49	*Shet* .	Lerwick Observatory.	1·57	37
Berw .	Marchmont House	1·67	74	*Cork* .	Cork, University Coll.	4·08	101
E.Lot.	North Berwick Res	1·04	60	,,	Roches Point, C.G.Stn.	3·72	90
Midl .	Edinburgh, Blackfd. H	·77	44	,,	Mallow, Hazlewood	1·74	..
Lanark	Auchtyfardle	2·06	..	*Kerry.*	Valentia Observatory.	6·44	117
Ayr .	Kilmarnock, Kay Park	2·67	..	,,	Gearhameen	6·01	59
,,	Girvan, Pinmore	2·46	52	,,	Bally McElligott Rec.	2·38	..
,,	Glen Afton, Ayr San.	1·97	39	,,	Darrynane Abbey	4·51	90
Renf .	Glasgow, Queen's Park	3·10	95	*Wat* .	Waterford, Gortmore.	4·18	115
,,	Greenock, Prospect H.	3·50	54	*Tip* .	Nenagh, Castle Lough.	2·22	56
Bute .	Rothesay, Ardencraig.	2·11	47	,,	Cashel, Ballinamona	2·74	73
,,	Dougarie Lodge	2·76	64	*Lim* .	Foynes, Coolnanes	1·56	41
Argyll	Loch Sunart, G'dale	1·62	23	,,	Limerick, Mulgrave St.	2·01	53
,,	Ardgour House	1·35	..	*Clare* .	Inagh, Mount Callan	3·69	..
,,	Glen Etive	..	..	*Wexf* .	Gorey, Courtown Ho	5·37	172
,,	Oban	1·08	..	*Wick* .	Rathnew, Clonmannon	4·58	..
,,	Poltalloch	1·93	38	,,	Newcastle	..	..
,,	Inveraray Castle	2·03	25	*Carlow*	Bagnalstown FenaghH	2·99	95
,,	Islay, Eallabus	5·89	126	,,	Hacketstown Rectory.	4·19	118
,,	Mull, Benmore	..	..	*Leix* .	Blandsfort House	3·22	98
,,	Tiree	..	..	*Offaly.*	Birr Castle	2·48	88
Kinr .	Loch Leven Sluice	1·33	42	*Dublin*	Dublin, Phoenix Park.	3·19	141
Fife .	Leuchars Aerodrome	2·04	112	*Meath.*	Kells, Headfort	4·69	149
Perth .	Loch Dhu	..	..	*W.M* .	Moate, Coolatore	2·71	..
,,	Crieff, Strathearn Hyd.	..	..	,,	Mullingar, Belvedere	3·82	119
,,	Blair Castle Gardens	1·41	42	*Long* .	Castle Forbes Gdns	4·92	148
Angus.	Kettins School	2·17	83	*Galway*	Galway, Grammar Sch.	3·07	83
,,	Pearsie House	1·04	..	,,	Ballynahinch Castle	4·80	77
,,	Montrose, Sunnyside	·89	45	,,	Ahascragh, Clonbrock.	3·38	87
Aberd.	Balmoral Castle Gdns.	1·31	47	*Rosc* .	Strokestown, C'node	3·91	125
,,	Logie Coldstone Sch	..	..	*Mayo.*	Blacksod Point	3·77	74
,,	Aberdeen Observatory.	..	..	,,	Mallaranny	5·19	..
,,	New Deer SchoolHouse	1·40	60	,,	Westport House	2·79	60
Moray	Gordon Castle	1·00	50	,,	Delphi Lodge	7·25	73
,,	Grantown-on-Spey	..	..	*Sligo* .	Markree Castle	2·95	75
Nairn.	Nairn	·86	43	*Cavan.*	Crossdoney, Kevit Cas.	3·59	..
Inv's .	Ben Alder Lodge	..	..	*Ferm* .	Crom Castle	4·23	127
,,	Kingussie, The Birches	·64	..	*Arm'h*	Armagh Obsy	3·02	120
,,	Loch Ness, Foyers	·36	9	*Down.*	Fofanny Reservoir	10·77	..
,,	Inverness, Culduthel R	·76	30	,,	Seaforde	2·29	73
,,	Loch Quoich, Loan	..	..	,,	Donaghadee, C. G. Stn.	4·53	178
,,	Glenquoich	·62	5	*Antrim*	Belfast,Queen's Univ .	6·28	220
,,	Arisaig House	·87	14	,,	Aldergrove Aerodrome	3·31	121
,,	Glenleven, Corrour	·60	7	,,	Ballymena, Harryville.	3·58	96
,,	Ft. William, Glasdrum	1·12	..	*Lon* .	Garvagh, Moneydig	2·49	..
,,	Skye, Dunvegan	1·77	..	,,	Londonderry, Creggan.	2·53	70
,,	Barra, Skallary	2·39	..	*Tyrone*	Omagh, Edenfel	3·47	98
R&C.	Tain, Ardlarach	·96	34	*Don* .	Malin Head	2·63	80
,,	Ullapool	1·54	33	,,	Dunfanaghy	..	..
,,	Achnashellach	94	10	,,	Dunkineely	4·14	..

Climatological Table for the British Empire, July, 1939

STATIONS.	PRESSURE.		TEMPERATURE.							RELA-TIVE HUM-IDITY.	MEAN CLOUD AM'NT	PRECIPITATION.			BRIGHT SUNSHINE.	
			Absolute.		Mean Values.				Mean.							
	Mean of Day M.S.L.	Diff. from Normal.	Max.	Min.	Max.	Min.	½ Max. and Min.	Diff. from Normal.	Wet Bulb.			Am'nt.	Diff. from Normal.	Days.	Hours per day.	Per-cent-age of possi-ble.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1012·0	− 3·8	79	48	67·5	55·2	61·3	− 1·5	56·0	82	7·9	1·79	− 0·38	19	6·0	37
Gibraltar	1016·5	− 0·3	88	62	76·5	64·9	70·7	− 4·1	64·2	83	4·4	0·01	—	1	10·2	72
Malta	1016·6	+ 2·1	103	69	86·6	73·3	79·9	+ 1·6	69·3	62	0·6	0·00	− 0·05	0	12·8	90
St. Helena	1021·4	+ 0·3	66	54	62·3	55·6	58·9	+ 1·1	56·9	91	9·6	6·72	+ 2·65	25	—	—
Freetown, Sierra Leone	1014·1	+ 3·1	88	72	84·8	73·8	79·3	—	73·1	89	8·9	25·78	− 9·80	26	—	—
Lagos, Nigeria	1014·1	+ 0·9	86	69	81·9	73·2	77·5	− 0·5	73·7	92	8·9	12·41	+ 1·91	19	3·9	31
Kaduna, Nigeria	1013·1	—	86	64	81·3	66·2	73·7	− 0·5	68·8	94	8·0	10·42	− 0·20	20	5·7	45
Zomba, Nyasaland	1017·2	− 1·4	81	49	71·8	53·3	62·5	+ 0·5	56·8	80	6·5	0·27	− 0·08	3	—	—
Salisbury, Rhodesia	1020·2	− 1·6	78	35	69·2	43·3	56·3	+ 0·2	48·7	65	2·9	0·11	—	1	9·0	80
Cape Town	1022·2	+ 0·9	81	42	65·5	50·1	57·8	+ 3·1	50·9	85	5·0	3·59	− 0·03	14	—	—
Johannesburg	1022·4	− 1·8	66	32	56·7	39·7	48·2	− 2·2	41·4	69	3·4	2·36	+ 2·03	7	7·6	71
Mauritius	1019·1	− 1·4	80	58	75·6	63·7	69·7	+ 1·4	66·7	79	5·5	3·81	+ 1·53	22	7·3	66
Calcutta, Alipore Obsy.	997·1	− 2·1	95	76	88·7	79·1	83·9	+ 0·2	79·4	90	8·8	14·85	+ 2·15	16*	—	—
Bombay	1003·9	+ 0·0	88	72	84·3	77·2	80·7	− 0·7	77·3	77	9·1	33·08	+ 8·81	21*	—	—
Madras	1004·5	+ 0·0	101	75	95·9	80·2	88·1	+ 0·5	74·3	61	8·7	1·39	− 2·45	3*	—	—
Colombo, Ceylon	1010·3	+ 1·2	86	73	84·2	76·1	80·1	− 1·1	77·0	83	8·1	8·62	+ 4·19	20	6·2	50
Singapore	1009·0	+ 0·1	89	72	86·8	76·6	81·7	+ 0·4	77·9	78	7·3	3·76	− 3·03	16	6·7	55
Hongkong	1001·4	− 3·3	94	74	87·8	78·3	83·1	+ 0·6	78·8	82	7·0	12·69	− 1·73	17	6·4	48
Sandakan	1008·4	—	91	70	88·4	75·4	81·9	+ 0·1	76·9	81	7·3	10·84	+ 4·12	15	—	—
Sydney, N.S.W.	1020·3	+ 2·0	67	49	60·2	43·6	51·9	− 0·8	44·9	74	4·4	1·23	− 3·57	10	6·7	66
Melbourne	1020·8	+ 1·9	65	30	55·1	39·4	47·3	− 1·4	41·8	82	6·0	0·94	− 0·92	15	3·5	35
Adelaide	1021·7	+ 1·5	67	37	59·3	45·5	52·4	+ 0·5	48·4	79	6·6	1·80	− 0·84	17	4·3	43
Perth, W. Australia	1018·1	− 0·9	68	41	62·6	47·8	55·2	0·0	50·7	84	6·8	11·18	+ 4·62	20	4·9	48
Coolgardie	1019·9	0·0	73	33	60·2	40·8	50·5	− 0·7	44·6	77	4·7	1·01	+ 0·14	13	—	—
Brisbane	1019·0	+ 0·6	76	40	66·1	48·6	57·3	− 1·2	51·1	71	4·5	2·00	− 0·20	9	6·3	59
Hobart, Tasmania	1018·0	+ 4·3	60	31	51·2	39·4	45·3	− 0·4	40·7	77	6·0	1·87	− 0·21	15	4·5	48
Wellington, N.Z.	1001·8	− 12·1	59	33	48·1	38·6	43·3	− 4·7	40·6	77	7·4	6·03	+ 0·40	22	3·7	39
Suva, Fiji	1013·6	− 0·4	89	63	78·4	67·4	72·9	− 0·5	68·0	85	5·3	6·53	− 1·60	17	5·2	46
Apia, Samoa	1011·8	− 0·1	87	68	84·7	72·7	78·7	+ 1·5	74·2	75	2·9	3·28	+ 0·30	7	9·7	85
Kingston, Jamaica	1014·7	0·0	94	71	89·6	74·2	81·9	+ 0·2	71·7	73	3·8	2·80	+ 1·18	6	8·0	61
Grenada, W.I.																
Toronto	1014·3	− 0·1	93	50	81·6	61·9	71·7	+ 2·6	62·1	80	4·1	1·72	− 1·12	9	10·8	72
Winnipeg	1012·9	+ 0·6	100	35	83·9	57·0	70·5	+ 4·1	58·1	79	4·9	1·42	− 1·68	5	10·5	66
St. John, N.B.	1013·8	+ 0·2	81	50	71·0	54·1	62·5	+ 2·1	58·4	87	6·4	4·70	+ 1·07	14	7·9	51
Victoria, B.C.	1017·6	+ 0·3	81	47	67·6	51·6	59·6	− 0·5	56·5	87	3·6	1·18	+ 0·76	9	10·3	66

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

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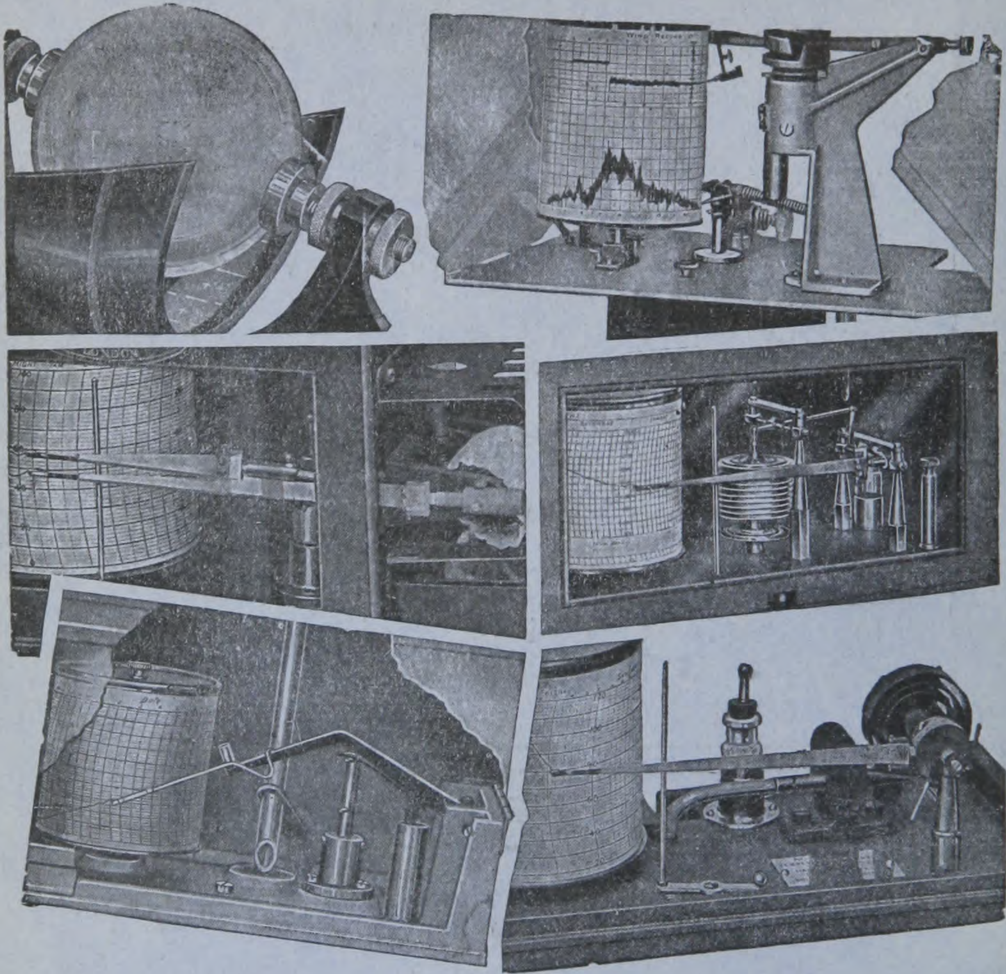

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M.O. 452

THE METEOROLOGICAL MAGAZINE

March 1940 *No. 890, Vol. 75*

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MARCH, 1940

NOTICES

It is requested that Books for Review and Communications for the Editor be addressed to the Director, Meteorological Office, Air Ministry, London, W.C.2, and marked "for Meteorological Magazine".

The responsibility for facts and opinions expressed in the signed articles and letters published in this Magazine rests with their respective authors.

THE METEOROLOGICAL MAGAZINE

M.O. 452

AIR MINISTRY : METEOROLOGICAL OFFICE

Vol. 75 MARCH, 1940 No. 890

THE GLAZED FROST OF JANUARY 1940

The glazed frost which began on January 27th and which was briefly noticed in the *Meteorological Magazine* for February, p. 12, presented a number of points of interest. Numerous reports now available show that it occurred over the greater part of southern and western England and in Wales, from Berkshire and Hampshire in the east to Merioneth and Devon in the west and Cheshire in the north.

The following notes arranged more or less geographically have been summarised from the reports sent in mainly by observers.

In eastern England the glazed frost did not occur, but there was heavy snow on the 27th and again on the night of the 28th to 29th, which according to Mr. D. L. Champion, lay 15 inches deep on level ground in Herts. The snow was " adhesive " and formed cornices on the eastern side of railway cuttings, in some places overhanging by as much as a yard.

The most easterly counties from which occurrences have been reported are Berkshire (by Mr. J. S. Dines in the *Meteorological Magazine* for February), and Hampshire, in both of which the phenomenon was highly developed. In Berkshire the thickness of the ice coating on twigs was about one inch, but long icicles hung from the foliage, showing that the freezing of the falling raindrops was not instantaneous as it appears to have been further west, probably because the drops themselves were larger.

In Hampshire conditions were described by Mr. C. J. P. Cave in a letter to *The Times*. A very fine rain began to fall on the evening of the 27th with an air temperature just above 31° F., but Mr. Cave points out that since temperature had been above freezing point all day, exposed objects cannot have been below freezing point when ice began to form on them, so that the drops of rain and mist must themselves have been super-cooled. Precipitation continued all through the 28th, sometimes fairly heavy, and telephone wires were encased in cylinders of ice more than an inch in diameter, with the greatest thickness on the east. The wind rose on the night of the 28th and branches of trees and telephone posts were brought down by the weight (Mr. Cave calculated that on a single telephone wire between adjacent posts there was 85 to 90 lb of ice). He does not mention icicles and the freezing appears to have been instantaneous. Mr. J. F. Nixon of Micheldever, Hants, gives a similar account, and adds, " I think the most amazing sight of all was to see some pheasants which were unable to fly because their wings had become glued! "

In Gloucestershire reports were received from the neighbourhood of Stroud (see p. 12) and Bristol. On high ground near Stroud the ice formation began about 5 p.m. on the 27th, but at Bristol, further to the south-west, it was not noticed until 4.30 a.m. on the 28th. The diameter of the ice cylinders on telephone wires was again about one inch.

For Herefordshire reports are available from Malvern and Ross-on-Wye. At Malvern the formation began on the night of the 27th to 28th. The coating of clear ice on telephone wires was measured and found to be 1½ inches in diameter. Many branches and some whole trees were brought down; but for the absence of wind the damage would have been much greater. Further to the south-west at Ross-on-Wye, the glazed frost began early on the morning of the 28th. Mr. F. J. Parsons describes it as " rain falling on and off most of the day interspersed with drizzle which froze as it fell. Footpaths and roads were alternately like sheets of glass or covered with a disintegrated mass of small pieces of

R.A.F. Photograph

FIG. 1.—NEAR HULLAVINGTON, JANUARY 30TH, 1940

R.A.F. Photograph

FIG. 2.—CLOSE-UP OF GRASS, JANUARY 30TH, 1940

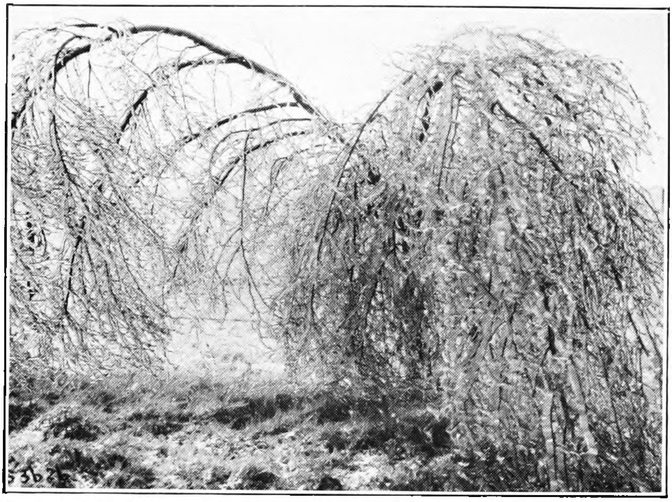

FIG. 3.—TREE BROKEN BY WEIGHT OF GLAZED FROST. PORTON, JANUARY 29TH, 1940

Photographer, O. G. Sutton

FIG. 4.—ICE FORMATION ON TWIGS, JANUARY 29TH, 1940

Photographer, O. G. Sutton

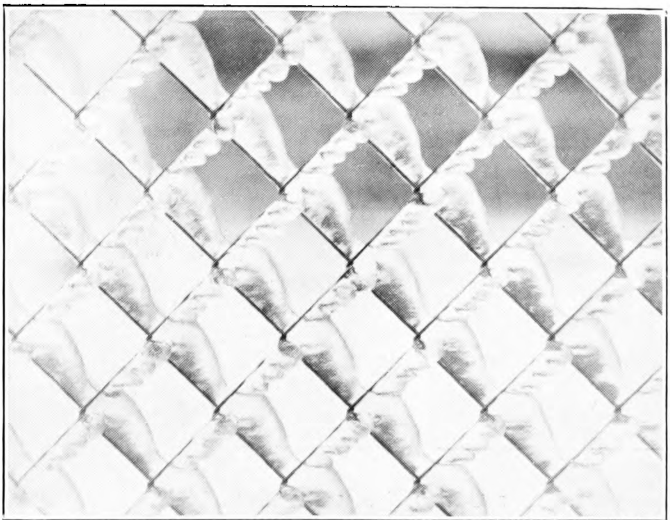

FIG. 5.—CLOSE-UP OF WIRE-NETTING, JANUARY 30TH, 1940

R.A.F. Photograph

ice." He also refers to icicles hanging from the grass-minimum thermometer, so that apparently the freezing was not so complete as in Gloucester.

At Rhayader, Radnorshire, according to Mr. E. Vaughan, rain began to fall with a south-east wind about 15h. on the 27th and from about 17h. it was super-cooled, freezing as it fell. The ice was from three-quarters to one and a half inches thick on the upper side of twigs and rarely more than one quarter inch on the lower side, showing that the freezing was instantaneous. Similar conditions were general in Montgomery, Radnor, Brecon and the high ground of Cardigan but near the sea. The ice was much thicker on the high ground than in the valleys. According to R. G. Sandeman, at Crickhowell in Breconshire, south-east of Rhayader, the glazed frost occurred on the 28th. At Bala, Merioneth, the rain began to freeze as it fell after 18h. on the 27th giving a coating of ice from half to an inch thick. Between Bala and Trawsfynydd for about 2½ miles every telegraph post was either broken or bent. About 11 miles east of Bala the precipitation was in the form of snow and there were deep drifts on the lower ground in Denbigh and Cheshire. Mr. S. E. Ashmore writes that in the Bwlchgwyn district, near Wrexham the precipitation was in the form of dry snow on January 27th; this was followed by a period of sleet, rain and soft hail, and then during nearly the whole of the 28th by small drops of super-cooled water, which froze on everything it touched. The air temperature was about 25° F. Afterwards the air became still colder and snow fell again until the morning of the 29th. On posts, walls, windows, etc. there was a coating of clear ice often several inches thick. The snow had a similar coating, thick enough to support pedestrians and in many places even motor cars. On twigs the ice was often well over two inches thick, adhering to the south-east side. The ice was only disposed symmetrically on objects which had previously been horizontal, such as telephone wires which in some cases seem to have carried cylinders of ice four inches in diameter. There was further glazed frost on the 31st followed by the formation of rime.

At West Kirby, Cheshire, the Rev. E. F. Robson reported a prolonged fall of " frozen rain " which began at 15h. 30m. on January 27th and continued almost without interruption for over 30 hours. Here, however, it seems that the rain froze before reaching the ground.

Returning to south-west England, Lord St. Audries reported that at Bridgwater, in Somerset, rain continued almost without ceasing from midday on the 26th until about 10h. on the 29th. The rain began to freeze as it fell about 21h. on the 28th (at higher levels about midday on the 28th). This is 12 hours later than at Bristol and 24 hours later than Stroud. At Exeter, Devon, Mr. W. N. Lavis reported that a drizzle which froze on contact with the ground began about 20h. on the 30th, two days after Bridgwater. The thickness of the ice was from one eighth to one quarter of an inch. At Princetown, Dartmoor, there was no true glazed frost but rime formed on the 29th. Finally Mr. J. Porter mentioned glazed frost at Garvagh, Co. Londonderry, on the morning of January 31st.

From these summaries some interesting points emerge:

1. The area covered by glazed frost lay to the south-west of a sharp line from Hampshire to North Wales.
2. The time of commencement became progressively later in the direction north-east to south-west. This is shown in the isochrones represented by the full lines of fig. 6. The broken lines in that figure show the position of a " front " with which the glazed frost was associated.

The distribution of winds and temperatures on January 27th to 30th showed a cold front running east or south-east across the English Channel. To the south-west of this front the wind was south-westerly and the temperature about 50° F., while to the north-east the

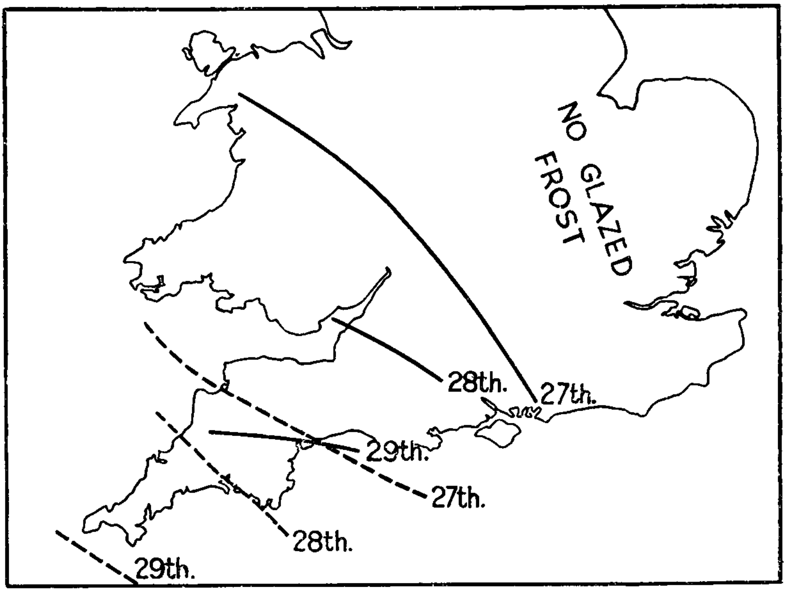

FIG. 6.—ISOCHRONES AT BEGINNING OF GLAZED FROST AND POSITION OF FRONT AT 18H. ON SUCCESSIVE DAYS

[Reports received after this article was in the press show that the formation of glazed frost began in the Midlands on the 25th and 26th, and extended on the 26th and 27th eastwards as far as Cambridge, Hampstead and Bexhill.]

wind was easterly and the temperature below freezing point over the greater part of southern England. On the north-eastern side of the front there must have been a marked inversion at a height of a few thousand feet. Fine rain falling from this warm upper layer was cooled below 32° F. in the underlying cold layer, but the droplets were able to survive without freezing until they struck some solid object, such as a tree, telephone wire or road, when they froze instantly.

The front moved very slowly south-westwards from the Severn Estuary to the Scilly Isles, and the beginning of the glazed frost followed in its wake. The duration and thickness of ice were greatest in the east and north, where the damage was enormous. Several observers stated that the woods looked as if they had been stripped by shell-fire. The ice was slow to melt and there was even a second occurrence of glazed frost on February 3rd.

Mr. R. Alan S. Thwaites of the North Wales Power Co. Ltd., contributes some interesting notes* on the interruption in the electricity supply of North Wales, due to ice accretion on power transmission lines. He attributes the trouble to fine particles of ice and rain freezing round the overhead conductors. In isolated positions on high ground the normal three-eights inch diameter was sometimes increased to more than four inches. The extra weight together with a wind of high velocity was in some instances enough to break the conductor, bend the iron work, smash the insulator pin and even to drag the poles to within six feet of the ground. The ice was so hard that it could only be removed with a hammer, all attempts to remove it by ropes or long rods being quite ineffective.

The ice accretion in the Wrexham area was opaque and irregular while in the Dolgarrog area it was clear.

LETTERS TO THE EDITOR

The Severn Bore

On Sunday February 25th, 1940, the highest predicted tide of the year occurred in the Bristol Channel, a height of 45·9 feet above datum being attained at King Road at Avonmouth. Range of tide on that day was as great as 47·3 feet, low water being 1·4 feet below datum.

Having frequently heard of the Severn Bore I journeyed to Stone Bench, about 2 miles below Gloucester, to see this phenomenon. It was high water at King Road at 9h. 36m. G.M.T. I got to Stone Bench. where the river runs alongside the road, at about

* A similar note appeared in the *Electrical Review* Feb. 9th, 1940.

9h. 15m. The current was flowing strongly down river at about 5 knots I reckoned when we arrived, and continued to do so without any apparent abatement until the moment of arrival of the Bore, which occurred at 9h. 30m. and which forcibly and suddenly reversed this current.

Just before 9h. 30m. a solid wall of water was observed sweeping round a curve of the river below which we stood. It advanced upstream at an estimated speed of about 12 knots, the height of its crest, as far as I could judge, being about 6 feet. The wave had no tendency whatever to break except on the sides where it washed up against the bank.

I was impressed by the relentless forward march of this wave and the orderly way in which it wheeled round bends of the river, like troops wheeling in line with the inside man marking time. The only sound was the swishing noise of the water against the banks.

There was very little wind at the time, with a high barometer. Bearing in mind the effect of barometric pressure and wind upon tides one presumes that had there been a fresh south-westerly wind and low pressure, the Bore would have been much higher and more impressive and it would perhaps have caused flooding in places.

Immediately the Bore had passed up river the water level was, of course, raised about 5 to 6 feet and the tide began to run strongly upstream. The tide continued to flood strongly at Stone Bench for about one hour after the Bore had passed, slack water occurring at 10h. 30m. I should say the actual rise of the tide was about 10 feet. Flood tide is experienced at Gloucester for about four days only, near the time of full and change of the moon, and lasts about one hour. The Bore itself starts 2 miles above Sharpness at a rate increasing from $3\frac{3}{4}$ knots at first to $13\frac{3}{4}$ knots at Rosemary, after which it gradually decreases.

C. E. N. FRANKCOM.

Meteorological Office, Stonehouse, Glos.
March 1st, 1940.

The Study of Air Mass Analysis—A correction

In the September-October, 1939, issue of *The Meteorological Magazine* there appeared a review by Mr. C. J. Boyden of my series of articles "An Introduction to the Study of Air Mass Analysis."

Mr. Boyden commented on the point that the American practice, according to one of my articles, is to indicate the occluded front on the surface weather map directly below the upper trough of warm air. Unfortunately, this statement of mine was an error which appeared in the early editions of the articles and was undiscovered until quite recently (after the printing of the 4th edition). The common practice in America, which I believe is generally accepted throughout the meteorological services of the world, is to draw the occluded front on the surface weather map along a line separating polar air originally occupying the region ahead of the warm front from polar air which has come from the region behind the cold front. In cases of warm-front type occlusions the position of the upper air trough (sometimes called the upper cold front) is also indicated if it is well defined by observations, particularly by a discontinuity of pressure tendency.

JEROME NAMIAS.

Massachusetts Institute of Technology,
Cambridge, Mass., U.S.A.
November 16th, 1939.

Snow Shower with Cloudless Sky

Although falls of snow or ice crystals with clear sky are reported to occur fairly frequently in more northerly latitudes, they are of sufficient rarity in England to warrant placing them on permanent record. Such a fall was observed at Wyton at about 12h. 30m. G.M.T. on January 17th, 1940, its duration being some fifteen minutes.

At 12h. the sky was 2/10 to 3/10 covered with stratus cloud at about 2,000 feet, moving from NNW. By 12h. 30m. the sky was clear and a steady fall of snow crystals began which attracted considerable attention. Towards 13h., after the snow had ceased, patches of stratus cloud again crossed the station. At Upwood, some seven or eight miles to NNW, 8/10 of cloud at 1,000 to 2,000 feet was reported at 12h.; this slowly decreased to 1/10 by 13h. Winds at 1,500 feet were also available for that station which showed the direction to be 340 degrees from north and the speed 25 m.p.h.

As there was considerably more cloud at Upwood than at Wyton during the period 12h.–13h. it seems probable that the snow had formed somewhere to NNW and drifted down with the wind (temperature was below freezing point at all heights), rather than produced by the small amount of cloud which had crossed Wyton earlier.

This phenomenon was also observed at Huntingdon, some three miles to SW of Wyton.

Meteorological Office, Wyton. WM. JAMES.
January 20th, 1940.

Auroral Glow and Sunspots

During the foggy high-pressure weather of the first week of January, the fog which had on the morning of the 3rd been of the type E (Observers' Handbook, 1934, page 59) cleared as the pressure steadied after a 36 hours fall of 7·0mb. At about 22h. 15m. G.M.T., a fairly bright but rather ill-defined auroral glow was visible, though none of the characteristic colours were observed.

On the following day, and on the 5th and 6th, about 10h. 15m. G.M.T. a peculiarly large sunspot, visible to the naked eye, was seen to the right-hand corner of the sun, which shone red through the film of fog. Actually the sunspot was double, consisting of a large and a smaller spot connected by a thin line.

I wonder if any other readers have observed similar auroral light, coinciding with this large spot.

FERGUS MACPHERSON.

7, Wardie Crescent, Edinburgh 5.
January 7th, 1940.

NOTES AND NEWS

Early Weather in China.

An interesting article on "Meteorological Records from the Divination Inscriptions of Shang," by K. A. Wittfogel, in the *Geographical Review* for January, 1940, throws some light on the climate of Northern China between about 1600 and 1100 B.C. On the site of a famous oracle, a large number of bones have been found, inscribed with questions and dated. Many of the questions refer to the occurrence of rain, others to agriculture, war, hunting, etc. The author reasonably assumes that, for example, the inquirer would not ask for rain unless experience had shown that there was a chance of rain at that season; in other words, the weather expectancy reflects the climate of the time. Sufficient dated questions have been found to give the relative frequency of rain throughout the year. The type of question shows that in spring rain is generally desired rather than expected, whereas in summer the opposite is the case. The author concludes that the annual distribution of rainfall resembled the present, but perhaps there was slightly more rain, especially in summer. There are few references to snow and this combined with the frequency of winter rain, points to a higher temperature than the present. The agricultural questions point to a longer growing year, and the probability of a warmer climate is further supported by the presence among the remains of bones of animals now only found in more southerly regions. The general conclusion is therefore that the climate of Northern China from 1600–1100 B.C. was warmer and perhaps rainier.

There is even some evidence of fluctuations within this period; one reign, which is alternatively dated as 1325 to 1267 or 1273 to 1214, is indicated as having slightly more summer rainfall than the average for the whole. It must be more than a coincidence that

C. E. P. Brooks ("Climate Through the Ages") shows a rainfall maximum about 1275 B.C. in both Europe and Western Asia.

Deerness Climatological Station.

The old climatological station at Deerness in Orkney has ceased to function since September, 1939, when Mr. W. J. Moar, who was responsible for the observations, was transferred on appointment to the headship of Stenness School on the other side of the island.

The history of the station is of interest. The late Mr. Magnus Spence, who had made meteorological observations at Swanbister between 1885 and 1890, moved to Deerness Schoolhouse in March, 1891, and then set up the meteorological station which has continued there uninterruptedly for more than 48 years. Mr. Spence maintained the observations personally until his retirement early in 1919. His work was of the highest quality and during the strenuous war years, 1914–1918, he somehow found it possible, in addition to his work as a schoolmaster, to act as a telegraphic reporter for the Meteorological Office.

After Mr. Spence's retirement the observations were carried on for a time by Mr. William Delday, a local farmer, but Mr. Moar, who had succeeded Mr. Spence at the school, soon became interested in meteorology and began to undertake a large share of the observing duties. Since Mr. Delday's death in 1929 Mr. Moar has been solely responsible for the conduct of the station. The high standard of observation set by the late Mr. Spence was fully maintained by Mr. Moar.

Climatologically, Orkney will now be represented only by the station at Bignold Park, Kirkwall.

H. E. C.

Mr. W. G. Kendrew.

We have pleasure in announcing that Mr. W. G. Kendrew has been appointed University Reader in Climatology at Oxford.

General Rainfall, February, 1940.

	Per cent.
England and Wales	123
Scotland	57
Ireland	128
British Isles	106

Sunshine, February, 1940.

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	62	+ 7	Chester	36	−26
Aberdeen	45	−25	Ross-on-Wye	18	−51
Dublin	39	−36	Falmouth	49	−31
Birr Castle	49	−17	Gorleston	30	−45
Valentia	67	+ 1	Kew	23	−38

Kew temp., mean, 38.0° F. diff. from average—3.1° F.

REVIEWS

Vertical currents in the first few kilometres over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate, by K. P. Ramakrishnan. Simla, Ind. Met. Dept. Sc., Notes VII 81, 1939.

It is to be expected that in a country like India where solar radiation is intense, strong vertical currents will occur and will affect the rate of ascent of balloons, particularly in the latter part of the day. For this reason the " tail method " has been used in following balloons in India for many years past so that the height at any instant can be computed. Recently a self-recording theodolite has been brought into use at a few stations for night ascents, working on the basis of a uniform rate of ascent and this has suggested the desirability of examining the errors which would result if a uniform rate were assumed for all ascents. The present paper is the result. Since April 1st, 1937, regular daily ascents have been made at Poona in the afternoon as well as in the morning so that ample data are available for examination. Graphs showing the height of the balloon against time for a succession of days in May and November, 1937, are plotted and from these it is clear that while in the morning the rate of ascent agrees closely with that given by formula on most days, in the afternoon wide deviations frequently occur. In the region between 0 and 4 km. over a period of 12 months, in the mornings 93 per cent. of the balloons rose at a rate within 10 per cent. of that given by the formula and no deviation of as much as 30 per cent. occurred, whereas in the afternoons the percentage within 10 per cent. was only 51 and in 12 per cent. of the cases the deviation exceeded 30 per cent. If the balloon is assumed to rise at the "formula" rate the effect of an error in the assumed rate of ascent is twofold. In the first place the wind velocity deduced at any particular minute is in error and in the second place this velocity is ascribed to a height which is erroneous. The combined effect of these two errors may be considerable and a table is given showing the errors introduced by assuming a constant rate of ascent on six individual occasions. Errors of 90° in direction and 20 km/hr in velocity occur. Unfortunately it is not stated whether the six ascents chosen to illustrate this effect are random ones or extreme cases.

As regards the magnitude of the vertical currents the rate in the afternoon is generally of the order of 3–5 km/hr though on rare occasions it rises to 10 km/hr. If a balloon with a tail ascends through layers where the wind varies with height the tail will necessarily move out of the vertical. The error in the results deduced from the tail method of calculation can in this case be calculated. In an appendix to the paper the author examines this point and concludes that such errors are unimportant.

It may be mentioned that the tail method is widely used in the British Meteorological Office and it has been found that while it is superior in most cases to the simple method of assuming a uniform rate of ascent its accuracy leaves a good deal to be desired compared with the two theodolite method. The present author appears to place considerable reliance on the results given by the tail method and the curves published in the paper certainly seem to suggest that good results are obtained from it. It would be of interest to know whether the readings are smoothed in any way before use or whether any special technique is employed in taking them. While an immense amount of information is now obtained every day regarding the horizontal currents in the atmosphere practically nothing is published about the vertical currents, and if for no other reason the present paper is to be welcomed in that it does direct attention to the importance of vertical currents and give some information regarding their magnitude.

J. S. DINES.

The cyclonic storms in Northern New Zealand on the 2nd February and the 26th March, 1936, by M. A. F. Barnett, Ph.D. Wellington Met. Office, Note No. 22, 1938.

In this paper Dr. Barnett has discussed two storms which travelled over North Island, New Zealand, during 1936. They are illustrated by synoptic charts drawn at 24-hour intervals. Observations are available at 12-hour intervals, but the stations at which they are made are scattered widely with the result that the frontal analysis appears of necessity to be rather speculative. This is mentioned in no way in disparagement of this most interesting paper but because it is felt that the really important part of the contribution is the reaction of the storms and the fronts.

To take the second of Dr. Barnett's cases first, in the first chart of this storm the low pressure area is drawn as associated with a front in low latitudes and as having reached an advanced stage of occlusion. Without more detailed information it is not possible to dogmatize but the evidence of the charts is not inconsistent with it being a true circular storm in its early stages without any very definite frontal structure. By the time, however, when it was crossing New Zealand there was a warm front occlusion formed in front of the storm. Whether this occlusion was formed by the circulation of the storm or the storm was due to the presence of the occlusion, there are not sufficient data to say, but to the present reviewer the former is a possibility by no means to be neglected.

The other case which Dr. Barnett discusses is an abnormality in that the example chosen was the worst storm for 38 years and did very extensive damage.

In its early stages the maps show the storm associated with a decidedly speculative frontal structure, moving south-south-east towards New Caledonia. At the same time there was cold air moving north eastwards over South East Australia with a decided cold front preceding it. The movement of this cold front cannot (at any rate on the charts presented) be traced with any precision, but by some means between the chart for January 31st and that for February 2nd there was a linking up between the rotating storm and the front. At the same time there was a great intensification of the depth of the storm. A similar type of linking up of a revolving storm with a pre-existent front has been known to occur off the Eastern Coasts of the United States, but the process of the linking has not been traced. The present reviewer cannot but contemplate the possibility that the immediate effect of the proximity of the rotating storm to the front was a new development of low pressure on the front and that this new development rapidly masked the old storm centre, as was the case illustrated in the Quarterly Journal of the Royal Meteorological Society, Volume 63, page 355. A process such as that would account for the sudden leap forward of the centre between January 31st and February 2nd. But, however the linking occurred, there is no question but that the marriage of the revolving storm and the front produced a cyclone with a very marked warm sector, which tore its way across North Island spreading flood and ruin in its train.

C. S. Durst.

Birmingham and Midland Institute. Records of Meteorological Observations taken at the Observatory, Edgbaston, 1939, Price 2s. Falmouth Observatory. Report of the Observatory Committee with Meteorological Notes and Tables for the year 1939.

We are pleased to note that these two valuable meteorological reports are published as usual. The daily Edgbaston records are edited by the observer, Mr. A. L. Kelley, and the monthly means and extremes are compared with those of the past 40 or 50 years. The Falmouth report is presented by the Hon. Secretary to the Observatory Committee, Mr. H. Dent Gardner, and includes full notes, monthly summaries with monthly normals and annual extremes for 1871 to 1935, compiled by Mr. W. Tregoning Hooper, Superintendent of the Observatory.

OBITUARY

A. E. PYCOCK. The death of Mr. A. E. Pycock severs another of the links with the early history of the Meteorological Office. He was active and apparently in good health up to the end and passed away peacefully in his sleep in the early morning of February 9th in his 75th year.

Mr. Pycock was appointed to the staff of the office in September, 1887 when it was in Victoria Street, Westminster, for duty in the Telegraph Branch, the forerunner of the Forecast Division. At that time there was no information available to the forecaster westward of Valencia and we are told in the Annual Reports that the morning observations at British and Irish stations were taken at 8 a.m. and " the majority of the telegrams usually arrive between 9 a.m. and 10 a.m."

The greater part of his service was spent, however, in the Statistical Branch (now the Climatology Division) where he was identified particularly with the production of the Weekly and Monthly Weather Reports, until he retired on pension in 1931.

This note would not be complete without reference to the fact that he was, for many years, a well-known humorous entertainer and, under the name of Fred Edwards, appeared frequently at evening concerts in various parts of London and in the Provinces.

He will always be remembered for his remarkably happy and cheerful disposition and as a very steady and conscientious man in his official work.

DR. C. C. VIGURS. It is with much regret that we announce the death on January 24th, 1940 of Dr. C. C. Vigurs, for many years Medical Officer of Health at Newquay.

Dr. Vigurs was responsible for the meteorological station at Newquay from 1903 and although in 1936 he had given up most of the actual observational work he continued the supervision of the station.

He took a keen and lively interest in meteorology and did much work in local climatology. He often contributed to this Magazine and his annual reports on the weather of Newquay were widely circulated and did much to increase the popularity of the town. In addition he was well known for his botanical work and for his interest in local legends and folk-lore.

Dr. Vigurs will long be remembered in the Meteorological Office not only for his valuable meteorological work but also for his characteristic letters and comments; his racy and unconventional style were often a relief to more sober official correspondence.

ERRATUM

Climatological Table for the British Empire, July 1939. Page 20.

Sydney, N.S.W. Absolute Min. *For* 49 *read* 39.

Rainfall: February, 1940: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	1·41	84	*Warw*	Alcester, Ragley Hall.	2·45	148
Surrey	Reigate, Wray Pk. Rd.	2·59	118	,, .	Birminghm, Edgbaston	2·38	141
Kent .	Tenterden, Ashenden.	1·72	87	*Leics* .	Thornton Reservoir...	3·00	180
,, .	Folkestone, I. Hospital	2·11	..	,, .	Belvoir Castle........	2·53	151
,, .	Margate, Cliftonville..	1·52	110	*Rutl'd*	Ridlington	..	..
,, .	Edenb'dg..Falconhurst	2 50	113	*Lincs*.	Boston, Skirbeck.....	..	..
Sussex	Compton, Compton Ho	4·91	186	,, .	Cranwell Aerodrome..	2·16	144
,, .	Patching Farm.......	2 96	134	,, .	Skegness, Marine Gdns	2·69	176
,, .	Eastbourne, Wil. Sq..	2·54	114	,, .	Louth, Westgate.....	2·01	105
Hants.	Ventnor, Roy.Nat.Hos.	3·94	188	,, .	Brigg, Wrawby St....	1·74	..
,, .	Southampton, East Pk	2·95	128	*Notts* .	Mansfield, Carr Bank..	2·56	133
,, .	Ovington Rectory....	3·82	147	*Derby*.	Derby, The Arboretum	..	..
,, .	Sherborne St. John...	2·90	132	,, .	Buxton, Terrace Slopes	2·56	68
Herts .	Royston, Therfield Rec	1·59	103	*Ches* .	Bidston Obsy........	2·16	129
Bucks.	Slough, Upton.......	1·92	113	*Lancs*.	Manchester, Whit. Pk.	1·88	98
Oxford	Oxford, Radcliffe.....	2·19	134	,, .	Stonyhurst College...	2·14	64
N'hant	Wellingboro,Swanspool	2·26	140	,, .	Southport, Bedford Pk	2·24	107
,, .	Oundle	2·50		,, .	Ulverston, Poaka Beck	..	..
Beds .	Woburn, Exptl. Farm.	1·83	124	,, .	Morecambe..........	1·72	68
Cambs	Cambridge, Bot. Gdns.	2·00	156	,, .	Blackpool	1·86	83
,, .	March	2·02	157	*Yorks*.	Wath-upon-Dearne...	4·49	280
Essex.	Shoeburyness........	1·10	89	,, .	Wakefield,Clarence Pk.	2·77	162
,, .	Lexden Hill House....	2·26	..	,, .	Oughtershaw Hall....	2·81	..
Suff .	Haughley House.....	·99	..	,, .	Harrog'te,HarlowMoor	1·90	87
,, .	Campsea Ashe, High Ho	1·36	99	,, .	Hull, Pearson Park...	1·66	100
,, .	Lowestoft Sec. School.	1·29	92	,, .	Holme-on-Spalding...	2·17	129
,, .	Bury St. Ed.,WestleyH	1·58	105	,, .	Felixkirk, Mt. St. John	1·56	92
Norf..	Wells, Holkham Hall.	..	..	,, .	York, Museum.......	1·37	91
,, .	Thetford W. W.......	1·52	..	,, .	Scarborough.........	1·42	85
Wilts .	Porton, W.D. Exp'lStn	2·96	149	,, .	Middlesbrough.......	1·80	138
,, .	Bishops Cannings	3·11	147	,, .	Baldersdale, Hury Res.	..	..
Dorset	Weymouth, Westham.	..	..	*Durhm*	Ushaw College.......	2·01	126
,, .	Beaminster, East St ..	4·68	155	*Norl'd*	Newcastle, Leazes Pk.	2·19	143
,, .	Shaftesbury	3·49	..	,, .	Bellingham, Highgreen	1·15	45
Devon.	Plymouth, The Hoe...	5·39	181	,, .	Lilburn Tower Gdns..	1·80	90
,, .	Holne, Church Pk.Cott	9·87	179	*Cumb*.	Carlisle, Scaleby Hall.	2·12	95
,, .	Teignmouth, Den Gdns	4·22	159	,, .	Borrowdale,Seathwaite	6·50	58
,, .	Cullompton	3·76	135	,, .	Thirlmere,DaleHeadH.	..	..
,, .	Sidmouth, U.D.C.....	3·77	..	,, .	Keswick, High Hill...	1·76	36
,, .	Barnstaple,N. Dev.Ath	3·59	132	,, .	Ravenglass, The Grove	1·60	52
,, .	Dartm'r,Cranmere P'l	8·50	..	*West* .	Appleby, Castle Bank.	1·18	40
,, .	Okehampton, Uplands.	5·43	124	*Mon* .	Abergavenny, Larchf'd	3·78	118
Cornw	Bude, School House ..	..	..	*Glam* .	Ystalyfera, Wern Ho..	6 25	122
,, .	Penzance,Morrab Gdns	5·04	151	,, .	Treherbert, Tynywaun	9·81	..
,, .	St. Austell, Trevarna..	6·72	175	,, .	Cardiff, Penylan......	3·47	118
Soms .	Chewton Mendip.....	3·36	100	*Carm* .	St. Ann's Head........	5·27	188
,, .	Long Ashton	2·29	97	*Card* .	Aberystwyth	4·71	..
,, .	Street, Millfield	2·10	107	*Radn'r*	Bir. W. W. Tyrmynydd	4·75	..
Glostr.	Blockley	2·98	..	*Mont* .	Lake Vyrnwy........	4·25	..
,, .	Cirencester, Gwynfa ..	3·06	135	*Flint* .	Sealand Aerodrome...	2·45	160
Here .	Ross-on-Wye........	2·20	109	*Mer* .	Blaenau Festiniog....	6·95	93
,, .	Kington, Lynhales....	3·26	131	,, .	Dolgelley, Bontddu...	5·68	128
Salop .	Church Stretton......	..	..	*Carn* .	Llandudno	2·81	144
,, .	Shifnal, Hatton Grange	2·24	138	,, .	Snowdon, L. Llydaw 9	13·20	..
,, .	Cheswardine Hall	2·91	163	*Angl* .	Holyhead, Salt Island.	4·07	167
Worc .	Malvern, Free Library.	2·91	162	,, .	Lligwy............ ..	3·89	..
,, .	Ombersley, Holt Lock.	2·51	153	*I.Man*	Douglas, Boro' Cem ..	4·18	131

Rainfall: February, 1940: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St.PeterP't.GrangeRd.	3·64	84	*R&C.*	Stornoway, C.G.Stn...	1·91	45
Wig .	Pt. William, Monreith.	2·44	79	*Suth* .	Lairg...............	1·14	37
,, .	New Luce School.....	2·73	71	,, .	Skerray Borgie.......	1·31	..
Kirk .	Dalry, Glendarroch...	2·09	41	,, .	Melvich............	1·05	35
Dumf.	Eskdalemuir Obs.....	2·83	57	,, .	Loch More, Achfary..	2.97	45
Roxb .	Hawick, Wolfelee	1·25	38	*Caith* .	Wick..............	·71	31
,, .	Kelso, Broomlands....	1·11	65	*Orkney*	Kirkwall, Bignold Park	1·18	37
Peebs .	Stobo Castle.........	1·37	50	*Shet* .	Lerwick Observatory.	2·21	70
Berw .	Marchmont House....	1·55	75	*Cork* .	Cork, University Coll.	7·93	213
E.Lot.	North Berwick Res...	·81	52	,, .	Roches Point, C.G.Stn.	5·41	146
Midl .	Edinburgh, Blackfd. H	·87	53	,, .	Mallow, Hazlewood ..	5·67	..
Lanark	Auchtyfardle	1·20	..	*Kerry.*	Valentia Observatory.	7·07	136
Ayr .	Kilmarnock, Kay Park	1·44	..	,, .	Gearhameen.........	10·09	113
,, .	Girvan, Pinmore	1·92	45	,, .	Bally McElligott Rec.	5·24	..
,, .	Glen Afton, Ayr San..	2·00	45	,, .	Darrynane Abbey....	5·36	116
Renf .	Glasgow, Queen's Park	1·57	53	*Wat* .	Waterford, Gortmore.	5·56	173
,, .	Greenock, Prospect H.	2·50	47	*Tip* .	Nenagh, Castle Lough.	3·17	102
Bute .	Rothesay, Ardencraig.	1·84	46	,, .	Cashel, Ballinamona..	4·19	133
,,	Dougarie Lodge......	1·90	50	*Lim* .	Foynes, Coolnanes....	3·99	125
Argyll	Loch Sunart, G'dale..	..	..	,, .	Limerick, Mulgrave St.	4·28	137
,,	Ardgour House	4·38	..	*Clare* .	Inagh, Mount Callan..	7·07	..
,,	Glen Etive	4·87	57	*Wexf* .	Gorey, Courtown Ho..	4·53	161
,,	Oban...............	2·68	..	*Wick* .	Rathnew, Clonmannon	4·40	..
,,	Poltalloch...........	2·98	69	,, .	Newcastle...........	..	..
,,	Inveraray Castle	4·18	62	*Carlow*	Bagnalstown FenaghH	5·38	212
,,	Islay, Eallabus	3·19	76	,, .	Hacketstown Rectory.	5·63	188
,,	Mull, Benmore.......	7·00	63	*Leix* .	Blandsfort House	4·80	179
,,	Tiree	2·98	87	*Offaly.*	Birr Castle	3·86	..
Kinr .	Loch Leven Sluice....	1·65	58	*Dublin*	Dublin, Phoenix Park.	3·33	186
Fife .	Leuchars Aerodrome..	1·02	58	*Meath.*	Kells, Headfort......	2·99	111
Perth .	Loch Dhu	4·05	54	*W.M* .	Moate, Coolatore.....	3·38	..
,, .	Crieff, Strathearn Hyd.	2·40	68	,, .	Mullingar, Belvedere..	3·43	123
,, .	Blair Castle Gardens..	1·58	57	*Long* .	Castle Forbes Gdns ..	4·62	163
Angus.	Kettins School.......	2·30	98	*Galway*	Galway, Grammar Sch.	4·02	132
,, .	Pearsie House	2·88	..	,, .	Ballynahinch Castle ..	4·42	86
,, .	Montrose, Sunnyside..	1·49	81	,, .	Ahascragh, Clonbrock.	2·52	82
Aberd.	Balmoral Castle Gdns.	1·20	46	*Rosc* .	Strokestown, C'node..	4·48	169
,, .	Logie Coldstone Sch ..	..	..	*Mayo.*	Blacksod Point	2·84	70
,, .	Aberdeen Observatory.	1·70	83	,, .	Mallaranny..........	4·13	..
,, .	New Deer SchoolHouse	1·89	89	,, .	Westport House......	4·23	107
Moray	Gordon Castle	·90	47	,, .	Delphi Lodge........	10·56	125
,, .	Grantown-on-Spey ...	·85	40	*Sligo* .	Markree Castle.......	3·67	105
Nairn.	Nairn...............	·63	35	*Cavan.*	Crossdoney, Kevit Cas.	3·78	..
Inv's .	Ben Alder Lodge.....	..	..	*Ferm* .	Crom Castle	3·69	126
,, .	Kingussie, The Birches	1·04	..	*Arm'h*	Armagh Obsy........	2·78	125
,, .	Loch Ness, Foyers....	..	..	*Down.*	Fofanny Reservoir ...	8·60	..
,, .	Inverness, Culduthel R	1·48	66	,, .	Seaforde	3·49	114
,, .	Loch Quoich, Loan...	..	..	,, .	Donaghadee, C. G. Stn.	2·09	90
,, .	Glenquoich..........	3·90	38	*Antrim*	Belfast,Queen's Univ .	3·05	123
,, .	Arisaig House	3·01	61	,, .	Aldergrove Aerodrome	2·17	90
,, .	Glenleven, Corrour ...	2·89	44	,, .	Ballymena, Harryville.	2·51	77
,, .	Ft. William, Glasdrum	3·42	..	*Lon* .	Garvagh, Moneydig...	2·46	..
,, .	Skye, Dunvegan	4·71	..	,, .	Londonderry, Creggan.	3·15	99
,, .	Barra, Skallary	2·27	..	*Tyrone*	Omagh, Edenfel......	3·21	108
R&C.	Tain, Ardlarach......	1·20	48	*Don* .	Malin Head..........	2·91	98
,, .	Ullapool	1·20	28	,, .	Dunfanaghy	..	..
,, .	Achnashellach	4·17	57	,, .	Dunkineely..........	3·27	..

Climatological Table for the British Empire, August, 1939

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1016·6	+ 1·3	80	50	70·7	56·1	63·4	+ 1·7	57·3	90	7·8	3·43	+ 1·19	12	5·6	39
Gibraltar	1015·4	− 1·1	81	63	77·3	66·0	71·7	− 4·3	64·6	82	3·3	0·00	—	0	10·7	79
Malta	1016·8	+ 2·0	95	69	86·1	73·9	80·0	+ 0·9	71·9	71	2·7	0·04	− 0·10	1	10·8	80
St. Helena	1020·5	− 0·6	65	52	61·5	54·5	58·0	+ 1·0	55·4	88	8·7	2·77	+ 0·28	23	—	—
Freetown, Sierra Leone	1013·5	+ 2·4	87	68	82·9	73·8	78·3	—	72·5	87	9·2	25·70	−10·87	25	—	—
Lagos, Nigeria	1013·9	+ 0·9	83	68	80·6	72·0	76·3	− 1·6	72·6	92	9·0	5·56	+ 2·92	15	2·5	20
Kaduna, Nigeria	1012·5	—	87	63	80·6	66·6	73·6	− 0·7	69·1	95	9·0	11·51	− 0·81	27	4·0	32
Zomba, Nyasaland	1016·8	− 0·1	82	51	74·6	56·6	65·6	+ 0·7	60·2	74	4·7	1·53	+ 1·16	4	—	—
Salisbury, Rhodesia	1020·6	+ 0·7	79	38	73·1	47·3	60·2	0·0	51·5	58	2·3	0·18	—	1	9·4	82
Cape Town	1020·6	+ 0·3	80	37	64·8	48·4	56·6	+ 1·0	50·1	85	6·1	2·69	− 0·68	15	—	—
Johannesburg	1022·4	− 0·5	72	29	62·7	42·2	52·5	− 1·9	43·3	64	4·6	1·19	+ 0·68	4	8·5	76
Mauritius	1021·1	+ 0·5	78	53	74·7	61·2	67·9	− 0·6	64·2	69	4·9	1·13	− 1·12	20	7·9	70
Calcutta, Alipore Obsy.	999·3	− 1·7	95	75	87·8	78·5	83·1	− 0·1	79·4	90	9·2	21·66	+ 8·28	20*	—	—
Bombay	1005·0	− 0·9	89	72	84·9	76·5	80·7	− 0·1	76·6	84	8·6	10·87	− 3·58	19*	—	—
Madras	1004·3	− 1·2	101	75	96·2	80·1	88·1	+ 2·1	74·4	61	7·3	0·86	− 3·68	3*	—	—
Colombo, Ceylon	1009·8	+ 0·5	86	73	84·0	77·3	80·7	+ 0·5	76·6	80	7·3	6·76	+ 3·52	7	7·3	59
Singapore	1008·7	− 0·8	90	72	85·9	75·9	80·9	− 0·2	77·3	81	8·4	7·76	− 0·19	17	5·5	45
Hongkong	1002·4	− 2·4	93	72	87·2	77·4	82·3	+ 0·2	77·8	80	5·8	12·82	− 1·58	20	6·7	52
Sandakan	1006·8	—	92	73	89·7	76·6	83·1	+ 1·3	76·6	77	8·0	1·51	− 6·38	5	—	—
Sydney, N.S.W.	1007·0	−11·2	81	58	66·0	48·1	57·1	+ 2·1	48·6	56	3·3	2·94	− 0·03	7	7·6	70
Melbourne	1005·4	−12·6	67	33	57·1	44·9	51·0	0·0	46·7	75	7·8	4·35	+ 2·48	27	2·2	20
Adelaide	1010·1	− 9·1	69	35	60·4	44·7	52·5	− 1·5	48·8	78	6·2	3·13	+ 0·59	20	4·9	45
Perth, W. Australia	1020·6	+ 1·7	69	39	63·1	48·8	55·9	− 0·1	48·4	53	5·6	8·69	+ 3·04	23	6·4	59
Coolgardie	1015·4	− 3·9	74	33	62·1	41·9	52·0	− 3·6	47·1	72	3·6	0·84	− 0·15	9	—	—
Brisbane	1010·7	− 8·5	88	41	70·8	50·4	60·6	+ 0·2	52·1	58	1·7	2·29	+ 0·28	4	9·3	83
Hobart, Tasmania	999·6	−13·8	60	35	53·0	42·6	47·8	− 0·2	43·8	76	8·4	4·20	+ 2·37	30	3·4	33
Wellington, N.Z.	1002·4	−12·7	60	34	53·3	42·6	47·9	− 0·7	45·6	79	6·6	5·91	+ 1·42	18	4·5	43
Suva, Fiji	1011·8	− 2·4	89	62	80·0	69·0	74·5	+ 0·9	69·8	85	6·6	6·55	− 1·74	18	5·6	49
Apia, Samoa	1010·1	− 2·2	86	67	84·5	74·3	79·4	+ 1·6	74·9	74	3·7	2·13	− 1·50	9	9·4	80
Kingston, Jamaica	1012·8	− 0·7	94	70	90·3	74·0	82·1	+ 0·6	71·9	78	2·2	1·33	− 2·22	4	8·3	65
Grenada, W.I.	1007·1	− 5·5	92	72	90·0	75·0	82·5	+ 2·8	76·6	76	3·5	3·53	− 5·80	14	—	—
Toronto	1014·2	− 1·2	87	57	81·3	63·2	72·3	+ 5·1	62·7	80	2·8	4·17	+ 1·38	7	10·2	73
Winnipeg	1012·7	− 0·5	94	46	79·8	55·8	67·8	+ 4·0	55·5	83	4·5	5·51	+ 3·35	14	8·6	59
St. John, N.B.	1016·3	+ 1·0	84	51	74·1	57·4	65·7	+ 5·1	60·4	86	6·2	1·64	− 2·22	11	8·0	57
Victoria, B.C.	1017·2	+ 0·3	87	50	71·3	53·0	62·1	+ 2·4	57·2	75	3·4	0·31	− 0·33	4	10·7	75

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

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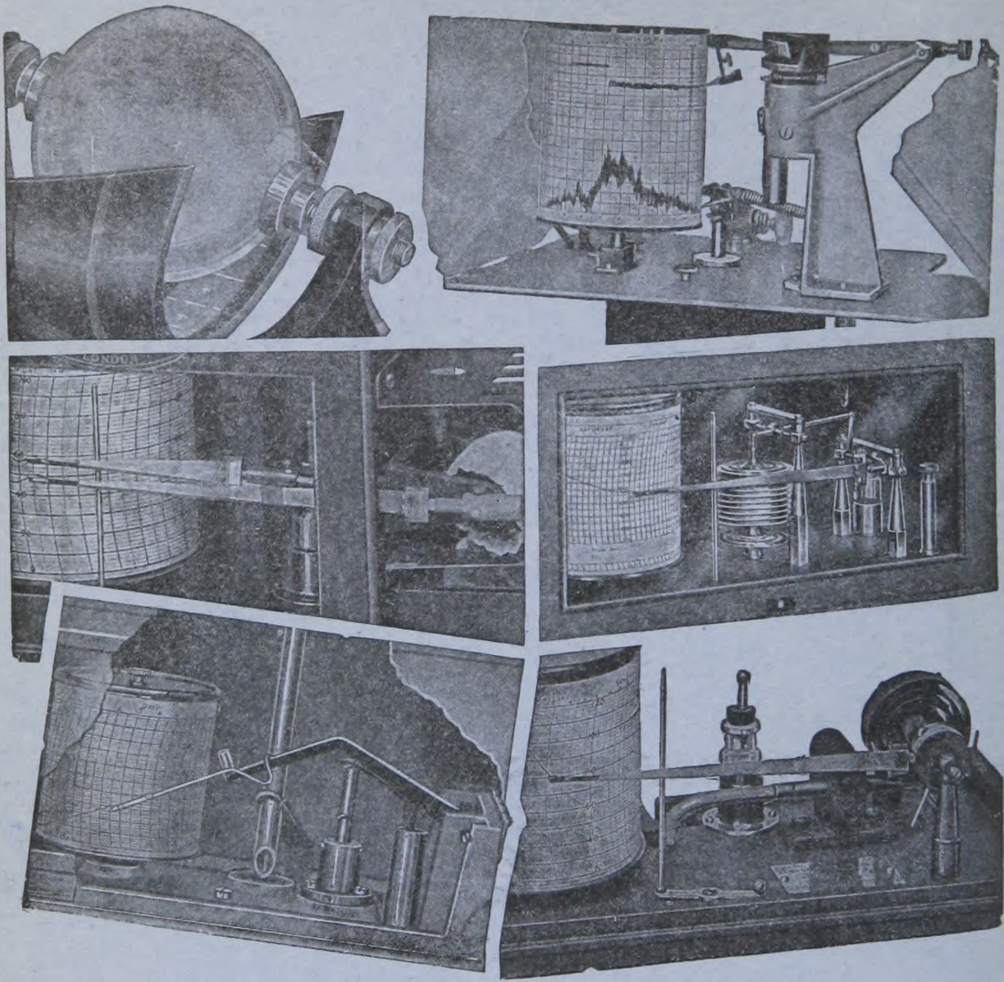

M.O. 452

THE METEOROLOGICAL MAGAZINE

April 1940 *No. 891, Vol. 75*

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APRIL, 1940

NOTICES

It is requested that Books for Review and Communications for the Editor be addressed to the Director, Meteorological Office, Air Ministry, London, W.C.2, and marked "for Meteorological Magazine".

The responsibility for facts and opinions expressed in the signed articles and letters published in this Magazine rests with their respective authors.

THE METEOROLOGICAL MAGAZINE

M.O. 452

AIR MINISTRY : METEOROLOGICAL OFFICE

Vol. 75 APRIL, 1940 No. 891

SNOWFALL IN THE BRITISH ISLES

By Gordon Manley, M.A., M.Sc.

The occurrences of snow or sleet in the British Isles may, broadly, be divided into two types. The first, general snow or sleet lasting for some hours over a considerable area, is likely to occur whenever the temperature of the cold air-supply, in a vigorous depression moving on a southerly track, is sufficiently low. This is most commonly associated with continental-arctic or continental-polar air, and heavy snowfalls from December to mid-March arise, more often than not, in connexion with depressions moving from north-west to south-east or west to east at this season. Hence, in southern Britain, heavy snowfall usually occurs on an east or south-east wind. The warming effect of the North Sea is, however, noteworthy especially in the earlier winter months, when cold rain or sleet often falls in the immediate neighbourhood of the east coast, turning to snow a few miles inland. The warming effect of the Irish Sea is also to be observed close to the east coast of Ireland. It is clear that snowfalls of this type are likely to be heavier and more frequent on the east side of the country, and that even quite small hills are likely to receive a decidedly increased fall for orographic reasons. Further, as Scotland is likely to remain in the cold sector of many depressions crossing England on more northerly tracks, the frequency of "continuous snowfalls" of this type may be expected to increase somewhat with latitude, although at low levels this is offset to some degree by the greater breadth of the North Sea. In late winter and early spring, however, continuous snowfall may occur in eastern Scotland not only with continental air but also when Arctic-maritime air spreads behind a deepening depression in the North Sea, often with a north-east wind at the surface.

Heavy and continuous snowfall, or sleet-fall, is less common in the west of the British Isles, especially in regions which are orographically sheltered from the east. But one cause of snowfalls—the polar-air depression—is capable, on occasion, of affecting very large areas even in the milder districts (cf. February, 1933, April, 1917 and May, 1935) and the suggestion has been made by Mr. Bonacina (*British Rainfall,* 1936) that there is a tendency for such depressions to develop in these milder western regions of Great Britain. It is clear that no part of these islands is altogether free from the possibility of a heavy fall of snow, although such falls appear to be particularly rare in extreme south-west Ireland, more so than in Cornwall, for example.

Apart from " continuous snowfall " many minor falls of sleet or snow are due to scattered showers on the edge of a depression. Further, the British Isles are very liable to coastal " instability showers " due to the frequency with which cold air reaches us over a warm sea. In maritime-Arctic air these " north-wind showers " are very frequent on all coasts facing north and north-east, especially where the ground rises sharply as in Buchan, East Lothian and Cleveland; and in winter, continental air crossing the North Sea frequently becomes unstable and gives showers on the north-east coasts, while south-east England remains free. Often, indeed, the amount of snow in these showers is quite sufficient to give a persistent cover and the estimates of snow-cover made elsewhere by the present writer (*Q.J. Roy. Met. S.,* January, 1939) allow for this near the coasts. The effect is also notable toward the north coast of north Wales (average at Bidston, 16·2 days with snow; Southport, 10·4). It is chiefly on account of these passing showers that the number of days with snow at low levels in Scotland is so much greater than in England, although the mean winter temperatures are much the same.

As British winter temperatures are so often between 35° and 40° on low ground, the frequency of snow or sleet, rather than rain, increases sharply with altitude and in late winter even maritime-polar air gives sleet or snow on higher ground in the North. The snow-dusted hills of Galloway or Cumberland, on a bright February morning with a fresh west wind, are very characteristic.

The comparison of observations

Statistics of the number of days of snowfall are among the first to be demanded in temperate climates. In the British Isles, however, records were not widely kept until 1912, since when observers have been instructed to note as " a day with snow," any day on which snow or sleet is observed to fall between midnight and midnight. From 1912 onward an increasingly consistent series of records is available. The widespread provision of aerodromes during and after the last war, with regular meteorological observations, led to a most valuable addition to the somewhat scattered and variable records kept during the first few years 1912–20; further, the continuity of many records was more or less broken during this period.

Records of the frequency of snowfall thus depend primarily upon eye observation and are therefore particularly dependent on the extent to which continuous watch may be kept. The keenest amateur observer may often find himself in difficulty when he has to decide whether a shower which passed during the night, or even during the day in his absence, was of rain or sleet. Elsewhere, especially on the coast, observers may find it difficult to decide whether a slight wintry shower, largely composed of soft hail, should be counted as snow.

With continuous precipitation and a lapse-rate approaching that for saturated air, a pedestrian out-of-doors will probably observe flakes of wet snow visible in the rain when the surface temperature is 37°; but a motorist is likely to catch sight of some melting flakes on his windscreen with the temperature 38°, and a keen watcher behind the windows of his observatory may do the same. It is easily perceived therefore that numerous occasions will arise when two neighbouring observers at the same level will differ in their decision whether snow is or is not to be recorded. There is, too, the problem of the "occasional flakes" which commonly drift down almost imperceptibly from an overcast sky in cold weather. Such occurrences indeed should be strictly counted towards "a day of snow" according to the definition, but are often likely to be overlooked as "insignificant"; quite a justifiable attitude from the practical standpoint.

For a variety of reasons, therefore, marked differences arise in some years with regard to the total number of days with snow between, for example, a first-class observatory, a neighbouring aerodrome and a third-order climatological station making a single daily observation. Careful analysis and comparison, however, show that a high standard of observation is maintained at such places as lighthouses, aerodromes and "telegraphic" stations. While the standard does not generally rise as high as that maintained at the "first-class observatories" which are able to keep strict account of occasional flakes and the like, we may regard the number of days of snow recorded at such stations as representing, for any given district, the days with significant snow- or sleet-fall which would be generally observed at that level by day and night watchers. This "high standard of observation" has been used in the plotting of the accompanying map. Shorter-period records have been used with some care and adjusted as far as possible to the period 1912–1938. About 155 stations have been used and, while the averages for individual stations may at times differ a little from those given by the map, the difference rarely becomes notable.

Hence, it should be stated that the average number of days with snow recorded at the first-class observatories, and also by at least two amateur observers whose

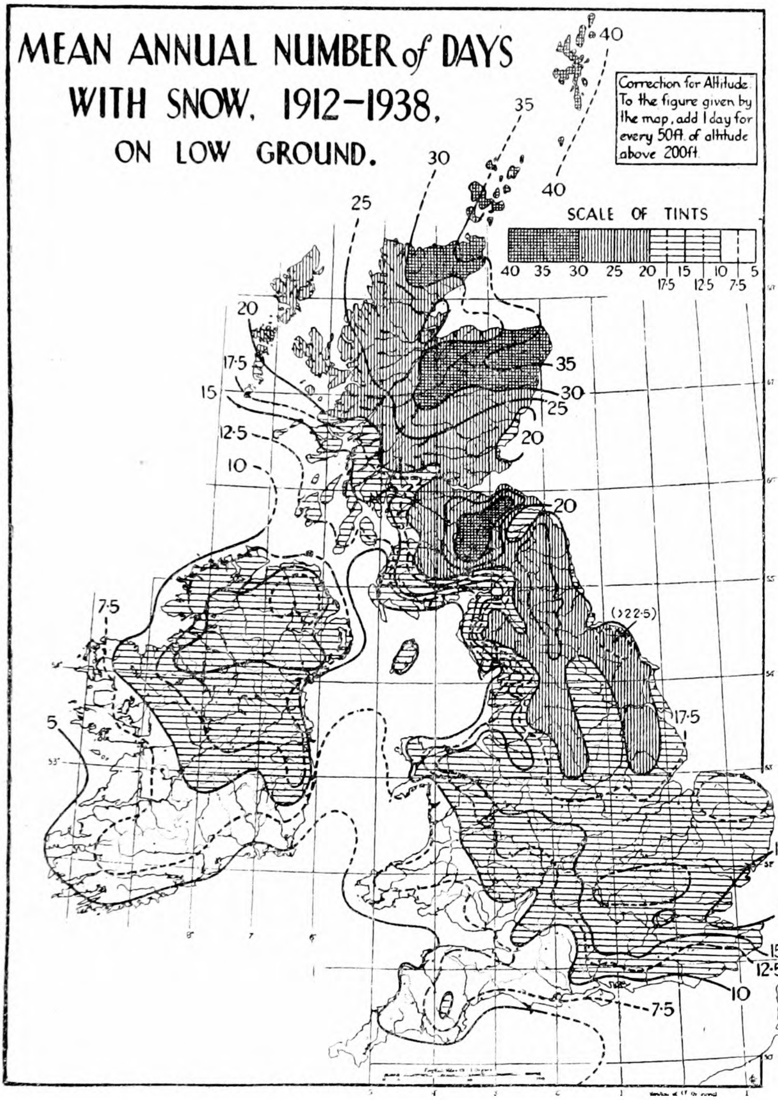


FIG. 1

exceptional keenness is known to the writer, is generally from 10 per cent. to 25 per cent. greater than the figure given by " good standard observation ". Similarly, the third-order stations generally, though not invariably, give averages a little below those at neighbouring stations, e.g. lighthouses, at which a night watch is more easily kept.

Broadly therefore the map, which is the first of its kind for these islands represents, with regard to low ground, the average annual number of days of " significant " or " generally observed " snowfall, including sleet, over the period 1912–1938. It brings out very well the effect of latitude, and of proximity to the colder air-supplies of winter [cf. Scilly 3·5, Stornoway 23·6 days; Valentia 5·4, Felixstowe 12·9 days].

The Altitude Correction, and the Effect of Relief.

It was found that the averages for coastal and lowland stations were in general agreement, up to 200 feet. Above this, analysis of several groups of records at different altitudes in the same district (e.g. valleys in the eastern Pennines) indicated that the annual total of days increased, roughly, by one for every sixty feet of altitude above the sea. The annual total can however be more conveniently reckoned, without serious error, by adding one day for every fifty feet above 200 feet. All the totals from high-level stations were therefore " corrected to low ground " on this basis.

The map however still shows, when this correction is applied, that certain areas show a decided increase in number of days with snow, quite apart from any question of altitude; this we may very largely attribute to the effect of orography, in giving rise to showers on many days when the lowlands are free. We may instance the rapid rise in the annual total between the Firth of Forth and the Lammermuirs, even without the additional effect of fall of temperature due to altitude. The orographically-sheltered shores of Morecambe Bay are decidedly free from snowfall, while increases are noteworthy on the Lincolnshire Wolds and those of Yorkshire with, again, a well-defined diminution over the southern Vale of York. The greater frequency of "instability showers", even on low-lying shores, is well shown in north Norfolk. In Scotland the difference between the north of Buchan and the more sheltered Kincardine–Fife coast is paralleled on a smaller scale between north and south Sutherland, and between the Lammermuirs and the Merse.

Some features of the map suggest that passage of air over a long stretch of snowy upland may at times lead to snow being recorded rather than rain at stations immediately in the lee of the upland. It is for example noteworthy that over the same series of years the number of snowy days in Manchester regularly exceeds that at Sealand (20, against 14). This appears also to be borne out by the well-defined increase in the south Midlands as compared with the Fens (Oxford 18, Cambridge 14) and there is some reason to believe that the increase in the south Midlands may be rather greater than the map shows, although records are rather scanty in some areas.

The diminution in the annual totals in inner London is well marked (Camden Square 10, Kensington 11, Kew 15, Greenwich 18, taken to whole numbers). Elsewhere one may note a well-defined decrease in the average annual total on Salisbury Plain when compared with high Hampshire. The lowest totals come from south-west Cornwall where the chance of snow (about 3 days annually) is definitely lower than in either the Channel Isles or any part, so far as we know, of the Irish coast, although nearly approached in extreme south-east Ireland near Waterford. In the far north the rapid increase from Barra to the Shetlands is noteworthy, and in relation to temperature the frequency of snow or sleet in the Shetlands is undoubtedly high, although it lies as a rule for only short periods.

The isopleths for Ireland have in many places been drawn somewhat tentatively in view of the lack of stations. Northern Ireland compares well with south-east England, and there is evidence for a sharp increase in the totals with distance from the sea, near the east coast.

Indeed, the map brings out the effect of several factors and when in addition the altitude correction is applied it is to be observed that the uplands of Banffshire at 1,200 feet may expect snow or sleet in significant amounts on as many as 55 days yearly. The northern Pennine valleys at 1,500 feet may expect between 50 and

55 days, in the highest inhabited region in the British Isles; and the higher farms in Peeblesshire may expect almost as many.

The map may also be correlated with the general impression of " snowiness " which we have with regard to different districts; it appears also to bear out that really heavy falls of snow in our western districts are associated with polar-air depressions moving on abnormal tracks.

Average Monthly Number of Days with Snow.

In the course of this investigation the number of days with snow for each month has been taken out for a certain number of stations. While there is not space here for an extensive discussion, some outstanding features may be mentioned. It is still true that April as a rule gives slightly higher totals than November, while the chance of snow in May is about equal to that in October. January, February and March have in most places nearly equal numbers of days; March however slightly exceeds January and February over the greater part of our eastern coastlands and in Ireland. Inland stations and those to the west and south of hilly districts have commonly a maximum in January or February. There is, however, no marked difference in the figures in most places and we may make the generalisation that, of every twenty days with snow in these islands, one occurs in November, three in December, four in each of the months January—February—March and two in April. One of the remaining two days is also divided between the three months January to March, and one is divided between October and May in most districts, other than the mild south-west.

The problems involved in the cartographical representation of snow-cover in these islands are of another order; the mapping of this element however is also nearing completion. It is hoped that the two maps will serve for some time all those who are interested in this aspect of the British climate.

LETTERS TO THE EDITOR

Upward Discharge of Lightning from Cloud

In the first of the two letters which appeared on page 178 of this Magazine for July, 1939, Mr. C. J. P. Cave asked whether any discharge between a cloud and the upper atmosphere had actually been observed. My friend, Mr. J. A. McHowden, with whom I have been associated for some years in Nigeria in combating the effects of lightning on the transmission lines of an extensive electric power system, informed me on April 21st, 1933, on his arrival from that country, that he had seen such

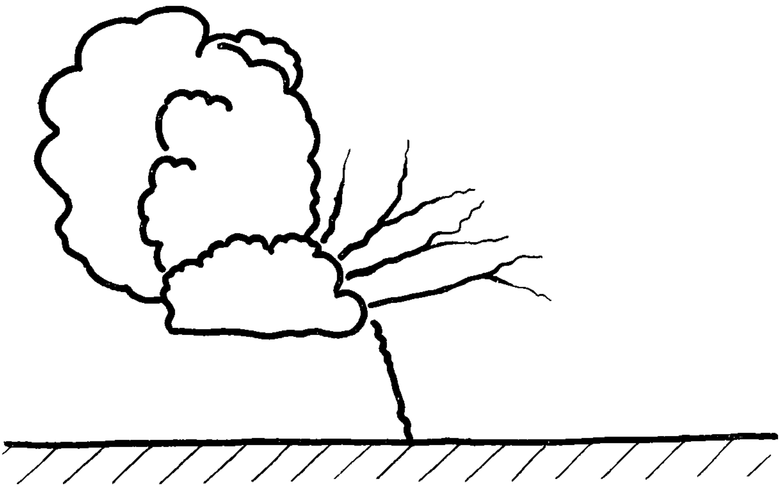


FIG 1

a discharge and made a sketch, which I append. He said that the cloud first discharged an ordinary flash between the cloud and the ground, and two minutes afterwards produced a series of purple flashes, which ended in the clear sky. These events occurred on a bare plateau at 4,000 feet altitude in a season when "tornadoes" are prevalent. These are violent line squalls and herald the wet season.

I may say that I met Mr. McHowden first in 1925 and I arranged with him to keep me informed of any unusual lightning phenomena.

JOHN F. SHIPLEY.

Royal Meteorological Society,
49, Cromwell Road, London, S.W.7.
January 23rd, 1940.

One Aspect of the Great Freeze-up

In the early hours of January 20th, the cold spell tightened with extra vigour to penetrate sixteen inches of soil and so freeze the water in the supply pipes connecting the main to houses in our village. Nature completed her handiwork by laying a thick carpet of snow, which, though protecting the ground somewhat from further frost, also effectively insulated the frost already established below the surface. Days passed without any sign of change in the weather. It was generally agreed that, even if warmer air did come along, the pipes below the surface would remain frozen until the top covering of snow and ice had disappeared. Nature decreed otherwise, however. On January 31st, while the earth still lay under its mantle of snow and the air temperature remained below freezing point, water once again flowed through the pipes underground. What nature was unable to do from above she did from below—for obviously the thaw had crept upwards.

WM. JAMES.

Wyton.
February 10th, 1940.

Sun Pillar and Mock Sun observed at Exeter, Devon

At 6h. 40m. G.M.T. on March 9th, 1940, a fairly well formed sun pillar with mock sun was observed before the sun itself came into view over nearby hills. At the lower end, the pillar appeared to come from behind a lenticular patch of altocumulus and extended through the mock sun, which was about 20° in height and slightly brighter than the pillar, finally tailing off indefinitely in an area of striated cirrus about 30° above the horizon.

The pillar was faintly yellowish-white in appearance and showed no glittering, while the mock sun was more white and somewhat hazy in outline. No portion of the mock sun ring could be identified. At 6h. 50m. G.M.T. the mock sun had assumed the form of an oval, light patch with the upper portion of the pillar still faintly discernible, while by 6h. 55m. G.M.T. the whole sun, deep red in appearance, had come into view and was rapidly outshining the preceding phenomena.

As a point of interest it may be mentioned that during the early afternoon of the same day, at 13h. 40m. G.M.T. and for some considerable time afterwards, the solar halo of 22° was observed, this showing some development of the inner red coloration.

W. N. LAVIS.

5, Mayfield Road, Heavitree,
Exeter, Devon.
March 9th, 1940.

Fog Bow observed in Sussex

An excellent example of a fog bow was observed at Waldron, East Sussex between 8h. and 8h. 30m. G.M.T. on March 16th, 1940. A faint red and blue coloration was noticed on the outside and inside of the bow respectively. The fog droplets were very plainly visible if viewed against the sun. Visibility at the time was 110 yards and the sky above the fog cloudless. The readings of the dry and wet bulb thermometer at 7h. were respectively 30·8° F. and 30·5° F., relative humidity 97 per cent. The fog cleared at 8h. 40m.

A. E. MOON.

The Furnace, Horam, East Sussex.
March 18th, 1940.

NOTES AND NEWS

Auroral Notes, November 1939 to January 1940.

There was little auroral activity during November and December 1939 but the phenomenon was observed at some Scottish stations on 6 and 8 nights respectively. On none of these occasions was it of more than moderate intensity.

In January aurora was seen on 18 nights, and at several places displays of unusual intensity were reported. On the 1st and 2nd it was seen at four widely separated stations, viz. Wick, Duntuilm in Skye, St. Abbs Head and Peterborough. Mr. G. E. D. Alcock who observed the display at Peterborough on the 1st, noted a greenish glow between northwest and north-east at 17h. 45m. reaching up to 10 degrees of altitude. The aurora brightened considerably throughout the evening and at 22h. the glow was very bright and covered the whole northern sky with a greenish light up to 40 degrees of altitude in the NNW. An auroral band of the same greenish colour was seen at Peterborough in the southeastern sky at 0h. 20m. on January 3rd. The band varied from 3 to 5 degrees in width, and at one time was distinctly bent at one point. Observation ceased at 01h. 15m. At Lerwick, on the 3rd, aurora appeared at 17h. 40m. in the shape of a horseshoe, about 10 degrees in radius and centred 40 degrees above the south horizon. The inner edge was sharp, the outer edge diffuse. There was the semblance of a halo at times until the formation of angles gave it a hexagonal shape. The display, which lasted for nearly three hours, varied considerably in intensity. It was brightest about 20h. 5m. when bands with ray structure appeared in the north-east at an elevation of 10 degrees, and again at 20h. 30m. when there was an active arc with ray structure above the north horizon to an elevation of 10 degrees. Fortrose, Nairn and Edinburgh also reported aurora on the 3rd. A display on the 4th was seen at

Wick, Fortrose, Nairn, St. Abbs Head and Eskdalemuir. Lerwick reported aurora on the 5th and 6th. An auroral glow was seen at Foynes, County Limerick, on the latter evening, and again on the 7th. At Peterborough, on the 9th, a brilliant cone of green light was visible in the east after 21h. 10m. The cone rose to an altitude of 40 degrees. About 22h. it began to fade and retreat northwards and was last seen 45 minutes later. On the 10th aurora was observed at Lerwick, Kirkwall, Wick and Nairn.

On the 11th it was seen at many places in Scotland and as far south as Waddington (Lincolnshire),Peterborough and Foynes. At Waddington, Mr. L. G. Hall observed it at 21h. 15m. when it extended through about 60 degrees of arc. He writes: "The horizon was light; there was a dark horizontal band, with another light band above. This upper light band diffused gradually into the starry sky and the total vertical extent of the aurora was variable, the maximum being, perhaps, 10 degrees of elevation . . . . By 22h. 15m. the aurora attained maximum brightness and considerable streamer effects were seen. At 22h. 20m. a light swept across the sky from east to west, like a distant line of searchlights coming into operation one at a time. After this, there was considerable variation in intensity and the aurora gradually faded until it became indistinguishable by 01h." At Peterborough, Mr. Alcock observed a very fine display on the north-west horizon at 18h. 15m. The light was of a beautiful golden colour. At 19h. 45m. a brilliant arch of light arose above the horizon, and golden luminous clouds drifted eastwards above it. This maximum brilliancy lasted but a few minutes but the arch remained steady and prominent until 21h. 45m. when there was another outburst; detached clouds and vertical streamers were then visible for some time moving eastwards. It had begun to fade at 23h. 15m. and disappeared rapidly. Mr. F. E. Dixon at Foynes observed the phenomenon at 22h. 5m. as a homogeneous arc, the maximum elevation of the base being 7 degrees. Five minutes later he noted rays to 20 degrees, chiefly from azimuth 355 degrees to 20 degrees. The arc became faint and faded about 22h. 30m.

Aurora was seen at Lerwick and St. Abbs Head on the 12th. Reports were also received from Lerwick of its occurrence on the 16th, 18th and 24th, from Kirkwall on the 17th, and from Wick, Braemar and Oban on the 18th. Mr. Donald McNaughton observed the display at Oban at 17h. 35m. as a pencil of faint white light dancing in the northern sky. As dusk came on a whole " curtain " of light, pale green in colour, was discerned extending from approximately NW to NNE. The base of this curtain was largely obscured by cloud but appeared to be about 20 degrees above the horizon. It was at its brightest between 17h. 45m. and 18h. 5m. during which time its higher parts assumed a dull brick-red hue. It faded slowly and by 18h. 30m. had almost disappeared. Lerwick also reported very bright and active curtains between north-north-west and east-north-east around 17h. 55m. on that evening. Their elevations varied from 15 to 20 degrees.

At Nairn aurora was observed on the 29th, 30th and 31st. The display on the last night of the month was also seen at Gordonstoun and at Duntuilm in Skye. At the latter place the display appears to have been a brilliant one. Mr. Seton Gordon observed it at 20h. 30m. as a very bright and broad ray of light spanning the heavens from west to east. It was like a searchlight, faintly tinged with red, and quite distinct from the lesser greenish rays which, at the same time, were rising from the northern horizon.

H. E. C.

The freezing of a Tidal River.

The river Parrett at Bridgwater was frozen over for some days in January, 1940. The frost began on January 9th and lasted until the 24th, being most intense on the morning of January 21st. The river tides vary from about 18 feet to about 6 feet at the neap high tide in January. At low tide there may be a good depth of water in a wet time, but on this occasion we only had about 0·16 of rain between January 1st and 24th so that at low tide there was very little water in the river. The freezing commences with nearly circular cakes of ice averaging about a yard across with turned up edges owing to collisions. These float up and down with the tide. Not until the neap tide approaches can these cakes coalesce and the interstices close up. For several days the river in Bridgwater was quite frozen, excepting perhaps for a small pool, possibly kept open by the flocks of black-headed gulls. I am not aware that anyone skated on the river on this occasion as they did in 1895, but people crossed on the ice, and there was a fairly large patch good enough for skating upon. I think it was upon January 23rd that a tide of 10 feet was expected. I understood that the water flowed up under the ice, lifting it and breaking it up, and within a few hours the fragments were again floating up and down with the tide.

The higher tides come up with a Bore of about 18 inches, often with about four breaking waves a few feet apart. The tide then rushes up with great rapidity, with high water in about an hour and a half. However, its force is so great that it " over-shoots the mark " and the level falls about a foot while the tide is still running up-stream, and the fall is quite gradual to low tide.

In 1895 the freezing of the river was about February 18th when bonfires were lit on the ice. The rainfall here for February, 1895 was only 0·16 so that, as on the present occasion, very little water was flowing down the river. There is still a legend that an ox was roasted on the ice. If so, it was before the writer came to Bridgwater in 1887 and it must have been after the blizzard of January 18th, 1881.

The accompanying photograph which is reproduced by courtesy of Messrs. Basker, shows the ice after the tide had broken it up.

HENRY CORDER.

Mr. J. Durward.

We have pleasure in announcing that Mr. J. Durward has been awarded the Order of Rafidain (4th Class, Civil) by the Iraq Government for services rendered to the country in the development of a meteorological Service.

General Rainfall, March, 1940.

	Per cent.
England and Wales	123
Scotland	118
Ireland	133
British Isles	124

Sunshine, March 1940

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	78	−31	Chester	121	+ 7
Aberdeen	107	− 2	Ross-on-Wye	122	+ 6
Dublin	94	−21	Falmouth	142	+ 6
Birr Castle	99	−12	Gorleston	123	− 5
Valentia	119	+ 3	Kew	121	+13

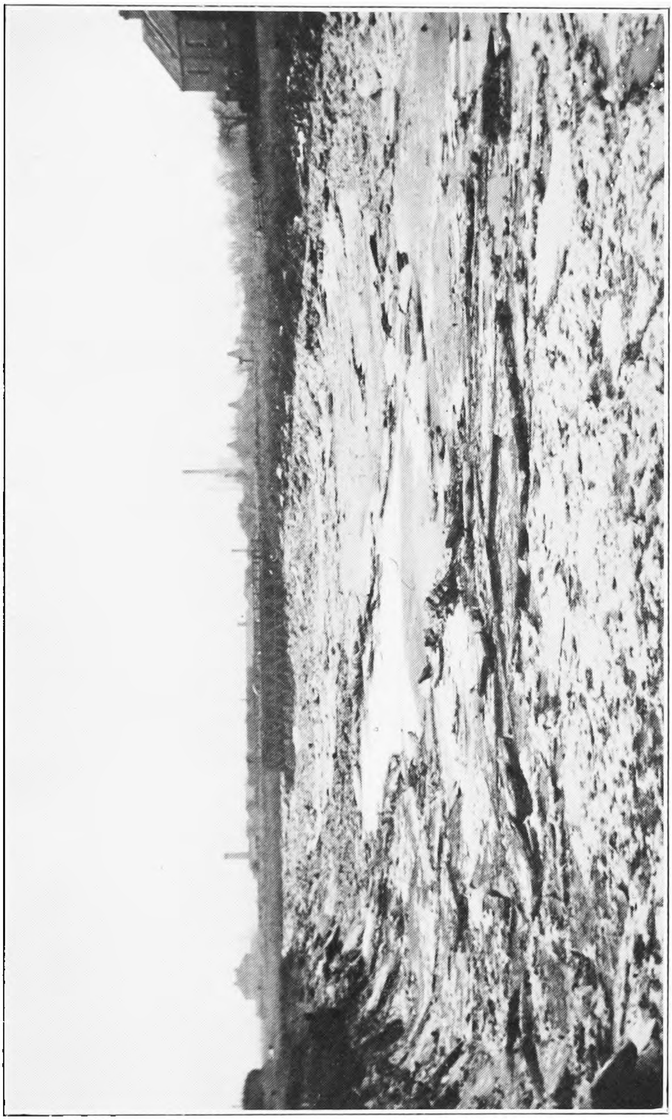
Kew temp., mean, 43.7° F. diff. from average − 0·2° F.

CORRIGENDA

Captain Frankcom referring to his letter on "The Severn Bore" (page 26 in the March number) points out that the time of high water at King Road was at 8h. 36m. G.M.T. *not* 9h. 36m. G.M.T.

Climatological Table for the British Empire, August 1939, page 40.

Sydney N.S.W. Absolute Min. *For* 58 *insert*—
It is hoped to give a correct value later.



Photograph by Messrs. Basker, Bridgwater

THE RIVER PARRETT AT BRIDGWATER, JANUARY, 1940

REVIEW

One day telleth another, by Stephen and Margaret Ionides, $8\frac{1}{2}$-in. × $5\frac{1}{4}$-in., pp. xii + 324 *illustrations,* London, Edward Arnold & Co., 1939. 10/6 net.

Although this book is not directly concerned with meteorology, it contains a miscellany of pleasantly told facts and anecdotes about seasons, the calendar and related topics not without interest to meteorologists in their leisure hours. As the authors point out in their first chapter, "Time," man's early interest in the seasons and thereby in astronomy arose directly from seasonal changes of weather; it was in effect the first essay in long-range forecasting. But the first attempts went sadly astray because the phases of the errant moon refuse to fit in with the solar year. "In the end the harassed calculators cast the moon out," but other confusions in the calendar, such as the unfair discrimination against February, and the absence of any word other than "day" for the whole period of 24 hours, remain to bother us.

Anyone reading the chapters on the Sun, Moon, Eclipses, etc. will absorb without tears a great deal of sound astronomical information, and the student of climatic changes cannot do without a knowledge of "Precession."

The later chapters of the book give the history of the practical application of astronomy to Navigation and Geography, and its misapplication in Astrology, while the final chapter on Cosmology is an interesting essay on man's progression from mythology to exact knowledge.

The dish is pleasantly garnished with a wealth of historical anecdote, some of it very much to the point, and a final word must be given to the numerous illustrations, including a great wealth of handsome photographic plates.

C.E.P.B.

Rainfall: March, 1940: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	3·51	192	*Warw*	Alcester, Ragley Hall.	2·10	122
Surrey	Reigate, Wray Pk. Rd.	3·28	140	,, .	Birminghm, Edgbaston	1·64	86
Kent .	Tenterden, Ashenden.	2·92	130	*Leics* .	Thornton Reservoir...	2·14	116
,, .	Folkestone, I. Hospital	2·54	..	,, .	Belvoir Castle........	2·09	115
,, .	Margate, Cliftonville..	2·54	160	*Rutl'd*	Ridlington	..	..
,, .	Edenb'dg., Falconhurst	3·17	128	*Lincs* .	Boston, Skirbeck.....	1·57	101
Sussex	Compton, Compton Ho	4·26	154	,, .	Cranwell Aerodrome..	1·69	121
,, .	Patching Farm.......	4·13	192	,, .	Skegness, Marine Gdns	..	..
,, .	Eastbourne, Wil. Sq..	2·85	125	,, .	Louth, Westgate.....	1·90	90
Hants .	Ventnor, Roy.Nat.Hos.	3·61	176	,, .	Brigg, Wrawby St....	1·58	..
,, .	Southampton, East Pk	3·20	140	*Notts* .	Mansfield, Carr Bank..	1·97	94
,, .	Ovington Rectory....	3·19	123	*Derby* .	Derby, The Arboretum	3·37	211
,, .	Sherborne St. John...	3·08	137	,, .	Buxton, Terrace Slopes	3·56	86
Herts .	Royston, Therfield Rec	3·09	169	*Ches* .	Bidston Obsy........	2·25	118
Bucks .	Slough, Upton.......	2·80	159	*Lancs* .	Manchester, Whit. Pk.	2·78	123
Oxford	Oxford, Radcliffe.....	2·54	154	,, .	Stonyhurst College...	3·84	104
N'hant	Wellingboro, Swanspool	2·32	130	,, .	Southport, Bedford Pk	2·04	91
,, .	Oundle	..	..	,, .	Ulverston, Poaka Beck	5·12	132
Beds .	Woburn, Exptl. Farm.	2·93	170	,, .	Morecambe..........	3·59	128
Cambs	Cambridge, Bot. Gdns.	2·94	200	,, .	Blackpool	2·70	113
,, .	March	2·04	129	*Yorks* .	Wath-upon-Dearne...	1·56	90
Essex .	Shoeburyness........	2·75	204	,, .	Wakefield, Clarence Pk.	2·03	113
,, .	Lexden Hill House....	2·75	..	,, .	Oughtershaw Hall....	6·10	..
Suff .	Haughley House.....	2·72	..	,, .	Harrog'te, Harlow Moor	1·93	83
,, .	Campsea Ashe, High Ho	2·67	159	,, .	Hull, Pearson Park...	1·70	93
,, .	Lowestoft Sec. School.	2·78	173	,, .	Holme-on-Spalding...	1·82	101
,, .	Bury St. Ed., Westley H	3·86	204	,, .	Felixkirk, Mt. St. John	2·03	103
Norf. .	Wells, Holkham Hall.	1·66	102	,, .	York, Museum.......	1·75	104
,, .	Thetford W. W.......	2·88	..	,, .	Scarborough.........	2·01	112
Wilts .	Porton, W.D. Exp'l Stn	2·52	127	,, .	Middlesbrough.......	2·02	129
,, .	Bishops Cannings	2·28	101	,, .	Baldersdale, Hury Res.	3·67	118
Dorset	Weymouth, Westham.	3·10	150	*Durhm*	Ushaw College.......	1·98	90
,, .	Beaminster, East St ..	3·54	121	*Norl'd*	Newcastle, Leazes Pk.	1·91	93
,, .	Shaftesbury	2·65	..	,, .	Bellingham, Highgreen	4·16	141
Devon .	Plymouth, The Hoe...	3·66	126	,, .	Lilburn Tower Gdns..	3·26	123
,, .	Holne, Church Pk.Cott	5·77	107	*Cumb* .	Carlisle, Scaleby Hall.	5·50	224
,, .	Teignmouth, Den Gdns	2·44	94	,, .	Borrowdale, Seathwaite	15·75	150
,, .	Cullompton	2·90	106	,, .	Thirlmere, Dale Head H.	..	..
,, .	Sidmouth, U.D.C.....	2·40	..	,, .	Keswick, High Hill...	5·76	128
,, .	Barnstaple, N. Dev.Ath	2·18	83	,, .	Ravenglass, The Grove	4·67	151
,, .	Dartm'r, Cranmere P'l	5·50	..	*West* .	Appleby, Castle Bank.	2·82	105
,, .	Okehampton, Uplands.	4·39	106	*Mon* .	Abergavenny, Larchf'd	2·06	68
Cornw	Bude, School House ..	..	..	*Glam* .	Ystalyfera, Wern Ho..	5·94	111
,, .	Penzance, Morrab Gdns	3·37	105	,, .	Treherbert, Tynywaun	8·12	..
,, .	St. Austell, Trevarna..	3·91	114	,, .	Cardiff, Penylan......	3·43	109
Soms .	Chewton Mendip.....	3·59	101	*Carm* .	St. Ann's Head.......	2·88	106
,, .	Long Ashton	2·65	105	*Card* .	Aberystwyth	3·17	..
,, .	Street, Millfield	2·19	109	*Radn'r*	Bir. W. W. Tyrmynydd	4·50	..
Glostr.	Blockley	2·09	..	*Mont* .	Lake Vyrnwy........	4·74	..
,, .	Cirencester, Gwynfa ..	2·95	128	*Flint* .	Sealand Aerodrome...	2·19	127
Here .	Ross-on-Wye	1·60	179	*Mer* .	Blaenau Festiniog....	9·87	126
,, .	Kington, Lynhales....	1·79	73	,, .	Dolgelley, Bontddu...	4·39	89
Salop .	Church Stretton......	2·35	..	*Carn* .	Llandudno	1·40	69
,, .	Shifnal, Hatton Grange	1·44	78	,, .	Snowdon, L. Llydaw 9	15·15	..
,, .	Cheswardine Hall	2·62	124	*Angl* .	Holyhead, Salt Island.	2·05	78
Worc .	Malvern, Free Library.	1·54	79	,, .	Lligwy.............	2·19	..
,, .	Ombersley, Holt Lock.	1·40	82	*I.Man*	Douglas, Boro' Cem...	5·21	176

Rainfall: March, 1940: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern .	St.PeterP't.GrangeRd.	3·51	142	*R&C* .	Stornoway, C.G.Stn...	2·22	57
Wig .	Pt. William, Monreith.	5·11	179	*Suth* .	Lairg...............	2·15	69
,, .	New Luce School.....	6·85	194	,, .	Skerray Borgie.......	3·73	..
Kirk .	Dalry, Glendarroch...	5·04	112	,, .	Melvich............	3·66	128
Dumf.	Eskdalemuir Obs.....	6·49	132	,, .	Loch More, Achfary..	7·37	114
Roxb .	Hawick, Wolfelee	4·32	129	*Caith* .	Wick	1·78	78
,, .	Kelso, Broomlands....	2·76	142	*Orkney*	Kirkwall, Bignold Park	3·41	117
Peebs .	Stobo Castle.........	3·60	124	*Shet* .	Lerwick Observatory.	4·96	157
Berw .	Marchmont House....	3·43	129	*Cork* .	Cork, University Coll.	2·73	91
E.Lot.	North Berwick Res...	2·63	140	,, .	Roches Point, C.G.Stn.	2·96	98
Midl .	Edinburgh, Blackfd. H	2·24	114	,, .	Mallow, Hazlewood ..	2·16	..
Lanark	Auchtyfardle	3·87	..	*Kerry*.	Valentia Observatory.	3·41	75
Ayr .	Kilmarnock, Kay Park	4·59	..	,, .	Gearhameen.........	6·80	84
,, .	Girvan, Pinmore	6·55	174	,, .	Bally McElligott Rec.	3·39	..
,, .	Glen Afton, Ayr San..	..	..	,, .	Darrynane Abbey....	2·92	72
Renf .	Glasgow, Queen's Park	5·01	192	*Wat* .	Waterford, Gortmore.	2·35	86
,, .	Greenock, Prospect H.	5·26	113	*Tip* .	Nenagh, Castle Lough.	2·76	89
Bute .	Rothesay, Ardencraig.	5·13	143	,, .	Cashel, Ballinamona..	2·50	92
,,	Dougarie Lodge......	4·20	120	*Lim* .	Foynes, Coolnanes....	2·81	95
Argyll	Loch Sunart, G'dale..	6·26	113	,, .	Limerick, Mulgrave St.	2·33	79
,,	Ardgour House	7·94	..	*Clare* .	Inagh, Mount Callan..	5·08	..
,,	Glen Etive	..	..	*Wexf* .	Gorey, Courtown Ho..	2·62	113
,,	Oban	4·08	..	*Wick* .	Rathnew, Clonmannon	2·46	..
,,	Poltalloch...........	5·19	135	,, .	Newcastle..........	..	..
,,	Inveraray Castle	5·84	92	*Carlow*	Bagnalstown FenaghH	2·53	104
,,	Islay, Eallabus	4·25	111	,, .	Hacketstown Rectory.	2·45	87
,,	Mull, Benmore.......	8·30	78	*Leix* .	Blandsfort House	2·32	89
,,	Tiree	3·89	116	*Offaly*.	Birr Castle	2·12	88
Kinr .	Loch Leven Sluice....	3·22	108	*Dublin*	Dublin, Phoenix Park.	1·40	72
Fife .	Leuchars Aerodrome..	2·84	146	*Meath*.	Kells, Headfort......	4·40	160
Perth .	Loch Dhu	7·40	112	*W.M* .	Moate, Coolatore.....	3·16	..
,, .	Crieff, Strathearn Hyd.	4·00	125	,, .	Mullingar, Belvedere..	3·68	136
,, .	Blair Castle Gardens..	2·68	102	*Long* .	Castle Forbes Gdns ..	5·83	198
Angus.	Kettins School.......	2·72	112	*Galway*	Galway, Grammar Sch.	4·65	155
,, .	Pearsie House	2·22	..	,, .	Ballynahinch Castle ..	7·71	151
,, .	Montrose, Sunnyside..	2·70	130	,, .	Ahascragh, Clonbrock.	4·97	149
Aberd.	Balmoral Castle Gdns.	2·26	79	*Rosc* .	Strokestown, C'node..	4·92	178
,, .	Logie Coldstone Sch ..	..	..	*Mayo*.	Blacksod Point	5·14	125
,, .	Aberdeen Observatory.	2·35	98	,, .	Mallaranny..........	8·69	..
,, .	New Deer SchoolHouse	2·38	92	,, .	Westport House......	7·11	182
Moray	Gordon Castle	3·44	148	,, .	Delphi Lodge........	12·34	148
,, .	Grantown-on-Spey ...	..	..	*Sligo* .	Markree Castle.......	6·44	186
Nairn.	Nairn..............	2·30	123	*Cavan*.	Crossdoney, Kevit Cas.	5·56	..
Inv's .	Ben Alder Lodge.....	..	..	*Ferm* .	Crom Castle	5·21	168
,, .	Kingussie, The Birches	2·27	..	*Arm'h*	Armagh Obsy........	3·85	164
,, .	Loch Ness, Foyers....	..	..	*Down*.	Fofanny Reservoir ...	..	..
,, .	Inverness, Culduthel R	1·76	80	,, .	Seaforde	4·46	153
,, .	Loch Quoich, Loan...	..	..	,, .	Donaghadee, C. G. Stn.	4·21	191
,, .	Glenquoich..........	..	..	*Antrim*	Belfast,Queen's Univ .	4·31	169
,, .	Arisaig House	4·89	104	,, .	Aldergrove Aerodrome	4·82	192
,, .	Glenleven, Corrour ...	5·62	97	,, .	Ballymena, Harryville.	5·12	163
,, .	Ft. William, Glasdrum	5·89	..	*Lon* .	Garvagh, Moneydig...	4·24	..
,, .	Skye, Dunvegan	4·65	..	,, .	Londonderry, Creggan.	6·22	194
,, .	Barra, Skallary	3·48	..	*Tyrone*	Omagh, Edenfel......	4·75	151
R&C.	Tain, Ardlarach......	1·85	75	*Don* .	Malin Head..........	4·98	172
,, .	Ullapool	3·85	92	,, .	Dunfanaghy	4·67	146
,, .	Achnashellach	5·97	83	,, .	Dunkineely..........	5·00	..

Climatological Table for the British Empire, September, 1939

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1019·9	+ 2·5	77	44	66·2	53·4	59·8	+ 2·5	53·7	87	7·3	0·91	− 0·96	9	5·4	43
Gibraltar	1015·2	− 2·0	85	59	75·6	64·9	70·3	− 2·1	63·3	80	4·7	1·47	—	8	9·0	73
Malta	1013·5	− 2·8	87	65	80·7	71·1	75·9	− 0·1	70·8	80	5·0	4·68	+ 3·41	10	7·8	63
St. Helena	1019·4	− 0·3	67	53	63·3	55·3	59·3	+ 2·8	56·1	87	9·3	1·10	− 1·08	18	—	—
Freetown, Sierra Leone	1013·4	+ 2·8	86	71	82·7	73·5	78·1	—	72·9	91	8·4	24·86	− 3·62	25	—	—
Lagos, Nigeria	1013·3	+ 1·1	83	65	81·8	71·7	76·7	− 2·0	72·4	91	8·7	0·67	− 4·92	4	4·9	40
Kaduna, Nigeria	1012·2	—	88	63	82·3	65·5	73·9	− 2·0	68·6	94	7·5	15·63	+ 4·13	29	5·7	47
Zomba, Nyasaland	1014·1	+ 0·5	88	51	79·9	58·7	69·3	− 0·2	61·9	68	4·1	0·16	− 0·18	2	—	—
Salisbury, Rhodesia	1016·0	0·0	85	40	76·6	50·2	63·4	− 3·0	53·5	52	2·0	0·24	—	2	9·2	77
Cape Town	1019·4	+ 0·3	90	45	70·1	50·7	60·4	+ 2·5	52·8	76	5·7	1·19	− 1·05	12	—	—
Johannesburg	1019·6	− 0·2	76	29	67·9	45·6	56·7	− 2·7	46·0	49	3·2	0·72	− 0·24	3	9·2	77
Mauritius	1020·2	+ 0·1	83	54	78·1	64·2	71·1	+ 1·0	67·3	70	5·1	1·89	+ 0·49	16	7·3	61
Calcutta, Alipore Obsy.	1004·2	− 0·3	95	76	89·5	78·8	84·1	+ 0·9	79·7	90	7·9	10·85	+ 0·84	17*	—	—
Bombay	1008·6	+ 0·6	87	73	85·3	76·5	80·9	0·0	76·1	85	7·0	5·39	− 5·29	10*	—	—
Madras	1006·9	+ 0·4	101	73	93·5	77·7	85·6	+ 0·4	76·0	76	8·1	5·22	+ 0·37	10*	—	—
Colombo, Ceylon	1010·8	+ 0·9	87	73	85·7	77·1	81·4	+ 0·2	77·1	77	7·3	4·97	+ 0·21	16	7·2	59
Singapore	1010·3	+ 0·5	87	71	84·6	75·1	79·9	− 1·2	76·9	81	8·5	12·25	+ 5·46	17	4·2	35
Hongkong	1009·4	+ 1·1	92	69	86·0	77·1	81·5	+ 0·5	75·2	72	5·7	4·87	− 4·82	13	6·2	51
Sandakan	1009·7	—	92	72	88·7	75·1	81·9	+ 0·2	76·5	82	7·7	10·20	+ 0·87	16	—	—
Sydney, N.S.W.	1018·7	+ 2·6	85	—	67·6	50·0	58·8	− 0·4	51·6	57	4·5	2·91	+ 0·05	8	7·0	59
Melbourne	1017·1	+ 1·3	75	35	63·0	46·3	54·7	+ 0·6	48·9	64	7·0	2·11	− 0·33	14	4·7	40
Adelaide	1021·0	+ 3·5	80	38	65·4	46·6	56·0	− 1·2	50·8	60	6·6	0·88	− 1·20	11	5·9	50
Perth, W. Australia	1021·8	+ 3·8	87	41	69·0	50·1	59·5	+ 1·3	54·2	64	4·4	0·43	− 2·99	6	8·4	71
Coolgardie																
Brisbane	1014·1	− 3·5	84	44	73·8	51·0	62·4	− 2·8	56·0	58	1·3	0·45	− 1·55	3	10·2	86
Hobart, Tasmania	1009·9	− 1·1	69	34	57·7	41·8	49·7	− 1·3	45·1	67	6·8	3·14	+ 1·07	23	5·9	50
Wellington, N.Z.	1013·4	− 1·2	62	36	56·3	44·3	50·3	− 1·3	48·1	76	7·6	2·86	− 1·11	11	5·7	48
Suva, Fiji	1015·0	+ 0·7	89	61	80·0	68·5	74·3	− 0·2	68·5	78	6·7	6·25	− 1·44	15	5·4	45
Apia, Samoa	1011·9	− 0·3	86	71	83·7	73·9	78·8	+ 0·6	74·9	80	6·8	7·87	+ 2·76	18	6·8	57
Kingston, Jamaica	1012·8	+ 0·6	93	72	90·0	74·4	82·2	+ 0·7	72·2	81	4·3	2·82	− 1·21	10	7·6	62
Grenada, W.I.																
Toronto	1016·5	− 1·3	92	41	69·8	53·6	61·7	+ 1·4	54·1	86	6·0	2·52	− 0·15	13	5·9	47
Winnipeg	1013·6	− 0·2	87	23	66·0	44·6	55·3	+ 1·6	45·3	88	6·7	1·62	− 0·60	10	6·2	49
St. John, N.B.	1015·3	− 2·1	80	31	63·7	48·8	56·3	+ 0·4	51·7	87	6·7	3·91	+ 0·17	14	5·0	40
Victoria, B.C.	1016·8	+ 0·4	75	47	65·7	50·4	58·1	+ 2·0	54·5	80	4·5	0·31	− 1·50	5	7·6	60

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

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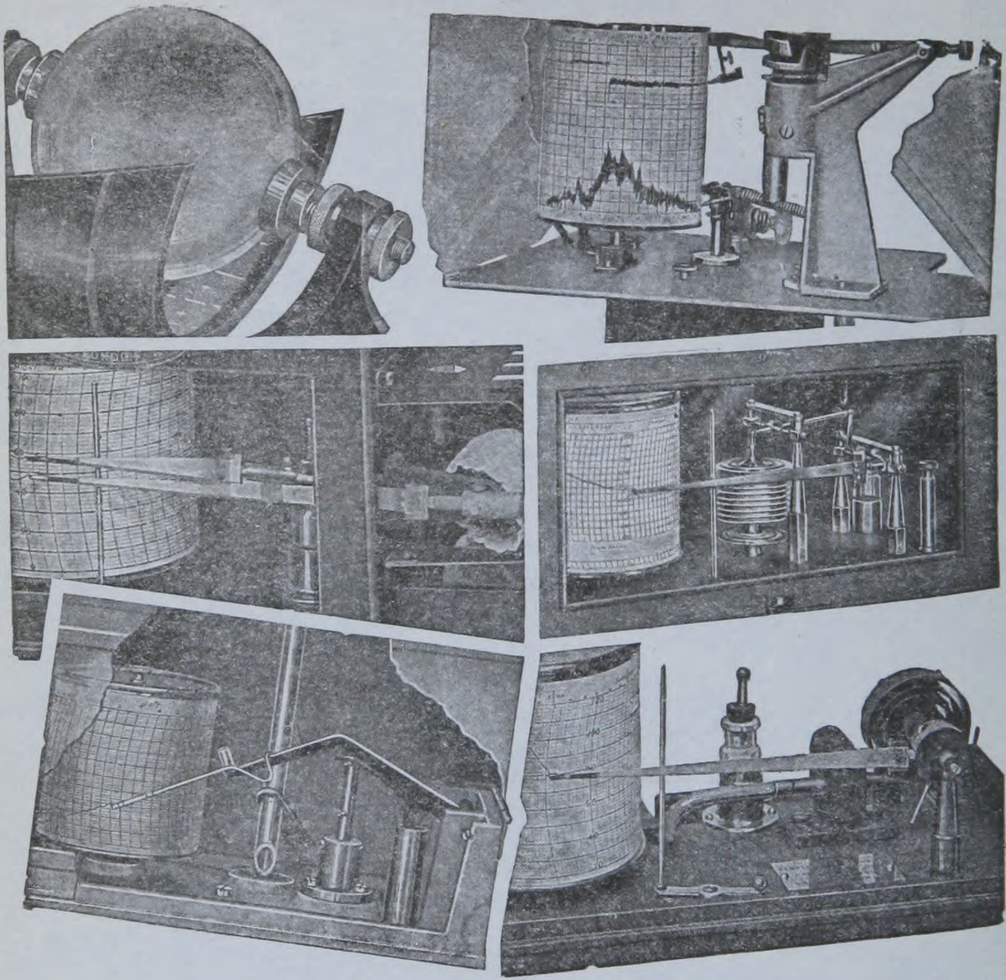

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May 1940 *No. 892, Vol. 75*

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MAY, 1940

NOTICES

It is requested that Books for Review and Communications for the Editor be addressed to the Director, Meteorological Office, Air Ministry, London, W.C.2, and marked "for Meteorological Magazine".

The responsibility for facts and opinions expressed in the signed articles and letters published in this Magazine rests with their respective authors.

THE METEOROLOGICAL MAGAZINE

M.O. 452

AIR MINISTRY : METEOROLOGICAL OFFICE

Vol. 75 MAY, 1940 No. 892

OCEAN CURRENTS

By E. W. Barlow, B.Sc.

Ocean currents are usually considered as being mainly within the province of the oceanographer, but there is a very considerable degree of analogy between the movements of the surface and sub-surface currents of the oceans and those of the surface and upper wind-currents of the atmosphere. The analogy is, however, not a perfect one. There is no obstruction to wind by land masses on anything like the scale of that confining water movements, at the surface and at all depths, by, for example, the east coast of Africa. Neither has the atmosphere a definite limit such as is afforded by the depth of the oceans. There is a pronounced difference between the movements of the atmosphere and those of the hydrosphere. Ocean currents have no appreciable effect in the production of wind; on the other hand the surface currents of the oceans are mainly, though not entirely, produced by the direct or indirect effect of wind.

This external agency largely determines surface water movements and also plays a part in the production of sub-surface water movements near long stretches of coastline. As this agency is meteorological the relation between the two sciences is intimate. Furthermore the efficient study of the relationship demands a more complete and more accurate knowledge of the surface winds over the oceans, constituting the greater part of the earth's surface, than we have yet attained. Knowledge of surface ocean currents has been, until quite recent years, considerably less complete and less accurate than that of surface winds.

Oceanography and meteorology meet also in the common ground of sea temperature. Difference of sea temperature is one of the agencies controlling water movements, not only at the surface but at all depths, while this element is important to the meteorologist in several ways, such as in connection with climatology, with fog formation and with the study of general atmospheric circulation, since the movement of warm water masses constitutes one of the means whereby heat is transferred from lower to higher latitudes.

The source of the bulk of current observations is the voyage of an ordinary merchant ship. The method used to determine a current is as follows. The ship is at a known position, found by astronomical observation or land fixes. Proceeding on her voyage the position is again determined after an interval by similar means. The dead reckoning position is also worked out, this being the position in which the ship should be by reason of her course and speed during the interval, after certain allowances have been made. The vector difference of the dead reckoning and true positions gives the speed and direction of the current. The method is subject to error and is not capable of great precision, but it is the only practicable way of obtaining observations in quantity. As the errors are not likely to be systematic in the long run, the mean of a considerable number of observations in a limited region, spread over a number of years, should give a fair approximation to the true current. Mechanical devices for current measurement are only practicable in survey ships or those of oceanographical expeditions.

The possibility of measuring current may thus be said to date from 1765, when Harrison invented the chronometer, enabling longitude at sea to be accurately determined. Nevertheless, by cruder forms of observation or calculation, the existence, and probably some vague idea of the strength, of the more pronounced currents in regions commonly navigated was known long previously. The first chart of the Gulf Stream was published in 1770 by Dr. Benjamin Franklin. The nineteenth century saw the development of current charts of the oceans, but it was not until 1924 that the systematic statistical representation of the mean force and direction of current, and the percentage frequency of currents of different strengths and directions, was begun, in the Marine Division of the Meteorological Office.

Variations of atmospheric pressure have no measurable direct effect on the production of current. Apart from wind friction at the surface, there are two agencies which give rise to current, (*a*) slope of the sea surface, producing a horizontal pressure gradient, such as is established by the wind blowing obliquely over, or parallel to, a coastline, with consequent banking of water against the coast or withdrawal of water from the coast, (*b*) differences of density of the water. Density of sea water depends almost wholly on differences of temperature and salinity; the relative proportion of the various salts is remarkably constant. The range of density in any stratum, or between higher and lower strata, is small, but is sufficient, in the higher levels of the ocean, to produce very definite water movements. As in the case of air movement, all water movement, whatever its origin, is influenced by the deflective force due to the earth's rotation. The theoretical consideration of the formation of currents by wind action is very complex and the work that has been done by Ekman and others is based on certain simplifying assumptions.

The surface currents may be broadly divided into two classes, drift currents and gradient currents. Drift currents are produced by the frictional effect of wind blowing in the same general direction over a considerable extent of sea for a sufficiently long time. Such currents do not extend to any great depth, the actual depth depending on the mean wind force and on the latitude. It is about 140 feet for wind force 3 in lat. 50°, 540 feet for wind force 8 in lat. 50° and 835 feet for wind force 5 in lat. 5°. Owing to the deflective force of the earth's rotation, the direction of the surface flow of a drift current in deep water is about 45° to the right of the wind direction (northern hemisphere). Below the surface the speed of the current decreases, and the angle of deflection increases, until at the depth where the frictional influence of the wind ceases there is a very weak current flowing in a direction exactly opposite to that of the surface current. The integration of these movements in the stratum of water affected gives a resultant transport in a direction 90° to the right of the wind direction (northern hemisphere). Pure wind drift currents are only of importance in the general circulation when they are formed by the action of permanent or semi-permanent winds, the trades and monsoons, or by predominant wind.

The most important gradient currents are those formed at an extended coastline. Ekman has shown that the effect of steady or predominant wind blowing parallel to, or obliquely over, such a coast is to produce a deep-seated current, the midwater current, running parallel to the coastline. The direction of the current is determined in the same way as in Buys Ballot's law, substituting water slope for pressure gradient. This current is stronger than that produced by wind friction and may extend to much greater depths. The current at the surface is the resultant between the midwater current, which extends to the surface, and the direction which the surface current would take if the same wind were producing a wind drift alone. In some cases there are gradient currents along extended coastlines, due to the piling up of water from another current impinging on the coast. An example is the Agulhas Current, the more northern part of which is known as the Mozambique Current, due to the piling up of water on the east African coast by the Equatorial Current of the Indian Ocean. The Agulhas Current transports water from the Indian Ocean to the South Atlantic Ocean where it largely compensates the withdrawal of water from the south-west African coast by the Benguella Current.

These coastal currents are of major importance and include the strongest currents of the ocean. Besides the Agulhas Current, there are others whose names are well known, the Gulf Stream, the Kuro Siwo, the Peru or Humboldt Current and the East African Coast Current. Investigation is showing that in many, and probably all, cases the axis of maximum strength of these currents lies along the edge of the continental shelf (the 100-fathom line). In connection with these currents and the conformation of the side of the continental shelt, upwelling of cold water takes place from the ocean bottom to the region between the main current and the coast. Such upwelling is marked in the cases of the Gulf Stream, the Benguella Current and the Peru Current. This upwelling tends to produce a cold counter-current, usually of weak and intermittent character, running close inshore in the opposite direction to the main current.

It cannot be said that the formation of the coastal currents is at yet fully understood. The Gulf Stream has been explained on Ekman's theory as being caused by the prevailing south-westerly winds drawing water away from the eastern coast of the United States, yet these winds only prevail from May to August. On the other hand there is a definite accumulation of water from the South Equatorial Current of the Atlantic Ocean and the Mississippi river in the Gulf of Mexico. Off the mouth of this river the sea-level has been found to be 3–4 feet higher than that at Sandy Hook. The excess of water appears to emerge down the eastern side of the Gulf of Mexico and through Florida Strait, where the Gulf Stream is strongest.

Density differences in the open ocean, away from the great coastal currents, do not produce surface currents as strong as those caused by wind, but they are responsible for the whole of the sub-surface circulation in these regions beneath the shallow stratum influenced by wind. Such currents on the whole decrease with increasing depth in the ocean, since the greatest variations of temperature and salinity are found in the upper layers. The water movements at the ocean bed appear to be very slight. Density currents can be computed from an adequate number of temperature and salinity observations at various depths made at two stations. These observations form part of the routine of oceanographical expeditions and evidence is accumulating of pronounced stratification of the water between surface and bottom, with lines of convergence and divergence at the surface, vertical interchange taking place at the convergences.

An interesting surface current, not due to wind, and which flows in opposition to the prevailing wind, was found when the Indian Ocean currents were charted. In the Arabian Sea and Bay of Bengal the south-west monsoon and the coastal conformation produce a current flowing clockwise round the coast. The north-east monsoon similarly produces a counter-clockwise circulation, but only during its earlier and stronger period. After January, while the north-east monsoon still persists, the current gradually reverses to the clockwise direction. The explanation of this appears to be the gradual cooling by the monsoon of the water at the heads of these large bays. By January a temperature difference of about 5°F. is set up between the water at the heads and the mouths of the bays. This gives rise to a slope of the sea surface. The clockwise current so produced tends to die out as the temperature difference lessens in subsequent months but the south-west monsoon arrives in time to preserve the direction of the current and enhance its strength.

Some surface currents are due to the combined action of wind and density difference; in other cases these factors might act in opposition. The Gulf Stream is deflected to the right by shallowing water south-west of Newfoundland. It continues its course across the Atlantic Ocean as a weak current maintained by the prevailing south-westerly winds. It is enhanced, however, by the sea temperature being colder to the north of it than to the south. The deflection of a coastal current to the right by shallowing water (northern hemisphere) is deducible by theory. Conversely the deflection of such a current in a region the depths of which have not been properly sounded may suggest the existence of a submarine ridge or other form of shallowing depth. This occurred during the charting of Indian Ocean currents in connection with the deflection of the great East African Coast Current, during the south-west monsoon, eastwards from the coast south of Cape Guardafui. The existence of a great ridge running from the coast in a curve to as far as the Chagos Archipelago was soon afterwards discovered by the John Murray Expedition in 1933–1934, the least depth of the ridge below the surface being 1,000 fathoms. This has been named the Carlsberg Ridge.

The East African Coast Current between lats. 3°S. and 3°N., in May to July, is the strongest current so far investigated. It flows for a distance of 500 miles during this period, with a mean speed of 50–60 miles per day. Further north it is less strong. The Gulf Stream flows with a similar strength through Florida Strait between February and October, but the distance over which this strength is maintained is less. Over short distances the strongest current in the world appears to be that found south of Sokotra, where the East African Coast Current is deflected eastwards from the coast by the Carlsberg Ridge, during the period of the south-west monsoon. Between lats. 9° and 10°N., longs. 53° to 55°E., the mean current during July to September is from 70 to over 90 miles per day. Such a mean speed corresponds to exceedingly strong individual current observations at times, since the range of current strength is always considerable. The three strongest currents so far recorded in this region are one of 168 and two of 144 miles per day (7 and 6 knots). The strongest current observations in the coastal currents are as follows:—Agulhas Current, 121 miles per day, Gulf Stream 120 miles per day, 118 miles per day in the main body of the East African Coast Current, and 96 miles per day in the East Australian Coast Current. The currents of the North Pacific Ocean have not yet been treated statistically.

The strength of the currents which are essentially wind drifts is markedly less. The mean strength of the

South Equatorial Currents of the three oceans for each quarter of the year is given in the table below. It will be noted that there is considerable difference in the strength in different oceans, also in different longitudes of the same ocean.

Strength of South Equatorial Currents (miles per day)

Region.	Nov. to Jan.	Feb. to Apr.	May to July	Aug. to Oct.
Indian Ocean, 6° S. to 18° S., 90° E. to 100° E.	6	3	5	8
,, ,, 6° S. to 18° S., 70° to 80° E.	5	6	6	5
,, ,, north of Madagascar	11	8	24	21
Atlantic Ocean 3° N. to 6° S., 5° W. to 12° W.	8	7	12	8
South Pacific Ocean 2° S. to 6 °S., 84° W. to 108° W.	13	10	13	15
,, ,, ,, 0° S. to 6° S., 108° W. to 124° W.	12	15	15	19
,, ,, ,, 0° S. to 6° S., 124° W. to 148° W.	13	18	12	14
,, ,, ,, 0° S. to 6° S. 148° W. to 172° W.	12	23	11	14

The table also gives an idea of the seasonal variation of currents, which is found to differ considerably in magnitude, being hardly noticeable in some cases and marked in others. Seasonal variation may be mainly in speed only, or in direction only, or both. In monsoon currents the greatest speeds can usually be related to wind strengths. The Equatorial Currents, when represented by monthly values, show two maxima during the year, which in the course of the same current may not occur at exactly the same time. Furthermore in the South Equatorial Current of the Pacific the principal maximum on the eastern side of the ocean becomes the secondary maximum on the western side.

The mean monsoon drifts in open sea are not very strong, that of the China Sea from November to January being 11–16 miles per day and in the Arabian Sea in August to October being 5–13 miles per day. The means of currents in the region of the permanent oceanic anticyclones are often much less than these values. It must however be remembered that all currents, even the strongest, are very variable, and the greater the variability the smaller the mean. Even in the regions of weakest mean current, actual currents of 12–24 miles per day are not infrequently met. The strong coastal currents show remarkable instances of current temporarily flowing in complete opposition to the usual current. Over considerable stretches of the great South Equatorial Current of the Pacific, extending over 7,000 miles between South America and New Guinea, the flow is steadier than any other current so far investigated.

In general the current circulation of an ocean is clockwise in the northern hemisphere and anti-clockwise in the southern hemisphere. Too much insistence must not however be placed on the idea of circulation of surface currents. It is becoming obvious that surface currents alone do not compensate for the movements of water masses observed. The surface circulation of mean current is not always perfectly continuous in direction, while there are obvious discontinuities in volume. For example, the great mass of water carried westwards by the wide equatorial currents is out of all proportion to the volume of the rest of the surface circulation. The great equatorial flows are partly compensated by the east-flowing counter-equatorial currents, which do not however always extend right across the ocean, and partly by upwelling from below the surface.

A considerable amount of work has already been done on the seasonal variation of current and a beginning is being made with some of the other problems that present themselves. Many more observations of surface current, covering longer periods, will be required for these investigations. Up to the present, except perhaps in a few restricted areas, the data are quite insufficient to provide an answer to the question whether currents vary in strength, width or position from year to year. The much greater knowledge of the water movements of the oceans, at all depths, which it is hoped will be attained in the future, will depend upon an adequate co-operation of meteorologist and oceanographer, and in each of these sciences much more data will be required before the structure of the oceans begins fully to reveal itself.

LETTERS TO THE EDITOR

Note on Mr. Poulter's photograph of cirrus zig-zags

The usual explanation of these cirrus zig-zags* is that they consist of streamers of ice crystals which fall into layers of air having different velocities. The sharpness of the zig-zags will depend upon the magnitude of the differences and the rate at which the crystals fall.

If a trail of them should fall from one layer of air into another moving more slowly by an amount equal to the rate at which the crystals are falling, then the trail will be bent at an angle of about 45 degrees to the vertical, thus:

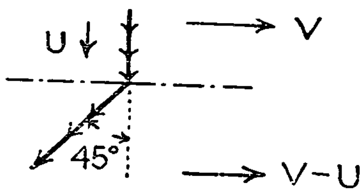

FIG. 1.

Now the rate of fall of cirrus particles certainly does not exceed 1 m.p.h. The cirrus trail in Mr. Poulter's diagram is bent *at about 45 degrees to the vertical.* Yet

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* See page 233 of the September–October, 1939, issue of this Magazine.

here the difference in velocity is stated to be about 6 m.p.h., a difference which should bend the trail almost horizontally. It may be that this was so, and that it is an effect of perspective that the trail appears to be bent much less sharply. If not, however, it is evident that the usual explanation of the bend is in this instance incorrect.

The obvious inference is that the cloud was not a falling trail at all, but that it was formed in a stream of air rising at about 6 m.p.h.

F. H. LUDLAM.

Meteorological Office, Mount Batten.
March, 1940.

Marked discontinuities of temperature at Oxford

The accompanying thermogram from this station is perhaps of enough interest to justify publication. It shows the very marked discontinuities of temperature

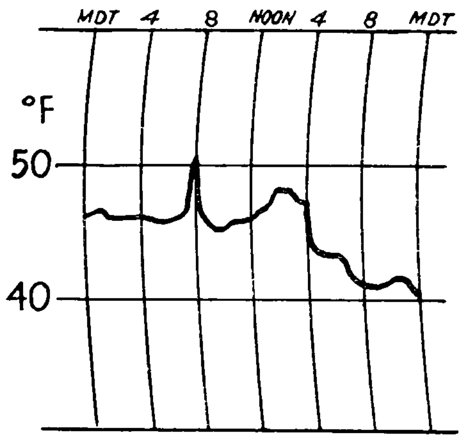

FIG. 1. OXFORD THERMOGRAM, NOVEMBER 27TH, 1939.

before and behind the warm sector of a shallow secondary depression which moved very rapidly across the south of England on November 27th, 1939. The steepness of the trace between 7h. G.M.T. and 9h. 30m. G.M.T. is the more remarkable in view of the obtuseness of the angle between the warm and cold fronts. Oxford seems to have been about the apex of the warm sector, for autographic records 15 miles north and beyond give no indication of a warm sector. At Oxford, and for at any rate some miles to the south, the wind was light and backed slowly to southward in front of the warm front, was south-westerly in the warm sector, and then veered rapidly to north with the sharp fall in temperature. The sky was overcast throughout, and the clouds became extremely dense and low with heavy rain in the warm sector.

W. G. KENDREW.

Radcliffe Meteorological Station, Oxford.
January 12th, 1940.

NOTES AND NEWS

Temperature under different conditions of exposure.

In December 1937 the meteorological station at Hinaidi, 7 miles SSE of Baghdad, was closed and an observation station opened at the Airport about one mile west of Baghdad.

The Hinaidi temperature record which extends over 15 years is probably the most homogeneous record available locally. The method of observation and site did not change during this period and it is usual to use the mean values for Hinaidi as a standard of comparison for temperatures taken near Baghdad. Mean daily values of maximum and minimum temperature for 1923–1936 at Hinaidi are extensively used for comparison purposes.

It was felt however that a direct comparison between the temperatures taken at the Airport and the mean values of temperatures at Hinaidi could not be made because of the difference in exposure. At the Airport the screen is sited on a lawn with a permanent grass cover whereas at Hinaidi the exposure was a typical desert one.

During August 1939 in addition to the observation made in the standard screen on the lawn at the Airport, observations were made of the maximum and minimum temperatures on a typical desert site about 100 yards further west. The results were as follows.

AUGUST 1939

	Lawn Exposure	Desert Exposure	Roof Exposure
Mean Max.°F.	106·3	108·6	108·3
Mean Min.°F.	75·2	74·2	76·4

The desert exposure gave the highest readings without exception and the difference was always between 2 and 3 degrees. It seems fairly obvious then that during the hot months the Airport maximum temperatures require an addition of approximately 2° F. before they can be compared with the mean values of Hinaidi. During the cold months, it is unlikely that any such " correction " would be necessary.

As regards minimum temperature the desert exposure gives practically always the lowest readings—the differences varying from 0° F. to 3° F., the mean being 1° F.

As it would often be a considerable advantage in Iraq to expose all instruments on the flat roofs of buildings, temperature observations were also made during August from a screen exposed on the Airport roof 35 feet above the ground. This roof has a layer of mutti 8 to 9 inches thick with a thin layer of bitumen about 2 inches below the surface. The roof is sufficiently large to allow the screen to be placed about 16 feet from any of the walls. The site was approximately midway between the screens referred to in the previous paragraph.

It was found that the maximum temperatures were in practically every case the same as those taken over the desert surface, but the minima were invariably higher—the average difference between the roof and the aerodrome being 2·2°F. The higher minimum was to be expected because of the outward nocturnal radiation from a fairly large building and of the greater height above the ground.

It is possible, however, that with a smaller building and a lower roof, that a roof exposure would give quite good results and steps will be taken to confirm this as soon as possible.

The screens used in the above experiment were identical in pattern, the thermometers of the sheathed type occupied the same relative position in each screen and the heights of the thermometer bulbs above the " ground " were the same in all cases to within one or two inches.

J. DURWARD.

Heavy snows on May 14th, 1294.

The remarkable snows which fell in London on May 14th, 1294, are described by an early and anonymous chronicler as " the grettest snowe that evere was seyn before thys tyme " and the writer gives an extremely doggerel Latin verse celebrating the event. Robert Fabyan, a much later chronicler, also refers to this event and quotes the Latin verse in much more satisfactory form. He adds: " The whiche verses may thus be englysshed as hereafter foloweth:

The morowe folowynge Tiburce and Valerian
The blessyd seyntes, of snowe fyll such plentie,
That at that daye was no lyvynge man,
That myght remembre of so great quantyte.
The northyn wynde blewe with suche fyerste,
That houses, tryes, with herbys, it overcast
And many other harmes by lande, and eke by see,
Of that wynde came, the whyle that it dyd laste."

C. E. BRITTON.

Belvoir Castle.

In connection with the recent death of the Duke of Rutland we should like to recall that a climatological station has been maintained at Belvoir Castle since 1855. Records have been published from 1855–1867 and from 1896 to date.

General Rainfall, April, 1940.

	Per cent.
England and Wales	110
Scotland	108
Ireland	137
British Isles	118

Sunshine, April, 1940.

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	144	− 6	Chester	114	−25
Aberdeen	100	−44	Ross-on-Wye	127	−15
Dublin	118	−41	Falmouth	131	−56
Birr Castle	127	−25	Gorleston	132	−32
Valentia	127	−34	Kew	126	−20

Kew temp., mean, 49.2 diff. from average + 1.5° F.

REVIEW

The General Circulation of the Atmosphere over India and its Neighbourhood, by K. R. Ramanathan and K. P. Ramakrishnan. Memoirs of the India Met. Dept., Vol. XXVI, Part X, Delhi, 1939.

The authors of this publication are to be congratulated on the clear and concise way in which they have presented, both as regards winds and thermal conditions, a much more complete survey of the problem than has been attempted before of the circulation of the upper atmosphere over India.

In their acknowledgment at the end of the paper the authors state that the work is based on a large amount of observational material, collected over a period of 20 years. The area studied is roughly from Lat. 8°N. to 35°N. and Long. 50°E. to 100°E., extending from the Persian Gulf to lower Burma and from the North-west Frontier Province to Travancore. The principal characteristics of the upper wind and the temperature distribution in each month are described with their relation to the more important climatological features such as monsoons and storms. Tables of resultant and predominant winds and also frequencies of directions of cloud movement are given in appendices.

Charts showing the mean air movement in each month over the Indian region at different heights up to 8 km., from observations of pilot balloons, at the observatories of the India Meteorological Department are given at the end of the book. As the charts of the pilot balloon winds refer mainly to days of clear weather there are also small inset charts showing the movement of low, medium and high clouds for the five months January, April, July, October and November. Wind-roses for selected stations are inset at the bottom of the charts for the lower levels. Isotherms of upper air temperature deduced from the change of wind with height are also given on the charts.

The following are some of the points discussed and conclusions reached:—

(i) The boundaries between upper easterly and westerly winds in the different months. It was found that the most striking feature of the circulation is the regular seasonal northward and southward movement of this boundary. This is well illustrated in the diagrams, Figs. 3–8, which show the distribution in six months of the year of the westerly and easterly components of the wind at different levels and at latitudes varying from 10° to 30°N.

(ii) The influence of the Himalayas and adjacent mountain ranges on the circulation. It was found that in the north a great influence is exercised on the circulation throughout the year by the mountain systems up to a height of 6 km.

(iii) The increase of temperature in the upper levels over regions of heavy rainfall. It is concluded that regions of heavy rainfall become regions of high temperature and also of divergence of air at heights above 6 km.

(iv) The greater northward movement of air in cloudy weather than in clear weather. It was found that during the winter and hot seasons pilot balloon winds show that, on the average, the winds of the westerly circulation of the higher latitudes turn towards south and south-east and join the easterly circulation, but in cloudy weather in the same period the opposite is the case, air coming from the east turns towards the north and north-east.

There is a diagram, Fig. 2, showing the life-history of steadily rising air; it would possibly have been an advantage here if there had been a short explanation below the diagram to explain that the line drawn to represent the direction of the wind was supposed to be rising upwards from out of the page, as at the first glance this is not very obvious and the description on which the diagram is based is given in the text several pages back.

This publication should prove very useful to anyone who is writing on or studying the subject of the upper winds over India, and is a very valuable contribution towards the co-ordination of data for the study of the general circulation of the upper atmosphere.

E. W. WOODRUFF.

OBITUARY

ERNEST ARMITAGE.—We regret to record the death on April 6th, 1940, of Mr. Ernest Armitage, J.P., of Stroud. Mr. Armitage, who was well known in Gloucestershire and Herefordshire for his social and business activities, maintained a rainfall record at his residence, Berrimans, from 1909 until his death. It is hoped that this long and useful record will be continued.

ERRATA

Rainfall Table, January, 1940, page 19.
Seaforde. *For* 2·29/73 *read* 5·81/184.
Belfast, Queens Univ. *For* 6·28/220 *read* 5·28/185.
General Rainfall, January, 1940, page 14.
Ireland. *For* 102 *read* 104.
British Isles. *For* 90 *read* 89.
Rainfall Table, March, 1940, page 58.
Ross-on-Wye. *For* 1·60/179 *read* 1·60/79.

Rainfall: April, 1940: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	1·74	113	*Warw*	Alcester, Ragley Hall.	2·56	151
Surrey	Reigate, Wray Pk. Rd.	2·54	152	,, .	Birminghm, Edgbaston	4·80	276
Kent .	Tenterden, Ashenden.	1·58	98	*Leics* .	Thornton Reservoir...	2·40	141
,, .	Folkestone, I. Hospital	1·47	..	,, .	Belvoir Castle........	1·33	87
,, .	Margate, Cliftonville..	·83	61	*Rutl'd*	Ridlington		
,, .	Edenb'dg., Falconhurst	1·75	94	*Lincs*.	Boston, Skirbeck.....	1·10	81
Sussex	Compton, Compton Ho	1·20	60	,, .	Cranwell Aerodrome..	1·12	85
,, .	Patching Farm.......	1·14	65	,, .	Skegness, Marine Gdns	1·13	84
,, .	Eastbourne, Wil. Sq..	1·36	75	,, .	Louth, Westgate.....	2·05	123
Hants.	Ventnor, Roy.Nat.Hos.	·91	54	,, .	Brigg, Wrawby St....	2·08	..
,, .	Southampton, East Pk	1·22	66	*Notts* .	Mansfield, Carr Bank..	1·64	95
,, .	Ovington Rectory....	1·09	58	*Derby*.	Derby, The Arboretum	1·75	102
,, .	Sherborne St. John...	1·14	64	,, .	Buxton, Terrace Slopes	3·49	119
Herts .	Royston, Therfield Rec	1·76	112	*Ches* .	Bidston Obsy........	1·73	106
Bucks.	Slough, Upton.......	1·83	128	*Lancs*.	Manchester, Whit. Pk.	1·94	101
Oxford	Oxford, Radcliffe.....	1·77	111	,, .	Stonyhurst College...	3·57	132
N'hant	Wellingboro, Swanspool	2·31	155	,, .	Southport, Bedford Pk	1·97	106
,, .	Oundle	1·60	..	,, .	Ulverston, Poaka Beck	3·29	110
Beds .	Woburn, Exptl. Farm.	2·46	164	,, .	Morecambe..........	1·90	92
Cambs	Cambridge, Bot. Gdns.	1·24	91	,, .	Blackpool	1·93	103
,, .	March	1·18	89	*Yorks*.	Wath-upon-Dearne...	2·00	127
Essex.	Shoeburyness	1·38	114	,, .	Wakefield, Clarence Pk.	2·10	125
,, .	Lexden Hill House....	1·56	..	,, .	Oughtershaw Hall....	2·66	..
Suff .	Haughley House.....	1·15	..	,, .	Harrog'te, HarlowMoor	2·30	115
,, .	Campsea Ashe, High Ho	1·34	95	,, .	Hull, Pearson Park...	1·53	98
,, .	Lowestoft Sec. School.	1·33	90	,, .	Holme-on-Spalding...	1·50	90
,, .	Bury St. Ed., WestleyH	1·48	97	,, .	Felixkirk, Mt. St. John	1·52	91
Norf..	Wells, Holkham Hall.	1·07	84	,, .	York, Museum.......	1·77	111
,, .	Thetford W. W.......	1·38	..	,, .	Scarborough.........	1·74	112
Wilts .	Porton, W.D. Exp'lStn	1·22	73	,, .	Middlesbrough.......	2·00	146
,, .	Bishops Cannings	2·70	134	,, .	Baldersdale, Hury Res.	2·28	94
Dorset	Weymouth, Westham.	1·47	89	*Durhm*	Ushaw College.......	1·58	84
,, .	Beaminster, East St ..	1·62	68	*Norl'd*	Newcastle, Leazes Pk.	·76	48
,, .	Shaftesbury	1·91	..	,, .	Bellingham, Highgreen	1·57	73
Devon.	Plymouth, The Hoe...	2·52	111	,, .	Lilburn Tower Gdns..	1·51	76
,, .	Holne, Church Pk.Cott	4·62	128	*Cumb*.	Carlisle, Scaleby Hall.	1·43	73
,, .	Teignmouth, Den Gdns	3·03	151	,, .	Borrowdale, Seathwaite	4·75	69
,, .	Cullompton	2·81	124	,, .	Thirlmere, DaleHeadH.	4·52	93
,, .	Sidmouth, U.D.C.....	3·22	..	,, .	Keswick, High Hill...	2·57	84
,, .	Barnstaple, N. Dev.Ath	3·28	155	,, .	Ravenglass, The Grove	1·52	61
,, .	Dartm'r, Cranmere P'l	6·50	..	*West* .	Appleby, Castle Bank.	1·37	70
,, .	Okehampton, Uplands.	5·25	165	*Mon* .	Abergavenny, Larchf'd	2·96	117
Cornw	Bude, School House ..	2·73	144	*Glam* .	Ystalyfera, Wern Ho..	3·82	101
,, .	Penzance, Morrab Gdns	4·45	183	,, .	Treherbert, Tynywaun	5·19	..
,, .	St. Austell, Trevarna..	3·39	120	,, .	Cardiff, Penylan......	2·76	110
Soms .	Chewton Mendip.....	2·81	95	*Pemb* .	St. Ann's Head........	1·94	95
,, .	Long Ashton	2·20	101	*Card* .	Aberystwyth	2·34	..
,, .	Street, Millfield	2·63	134	*Radn'r*	Bir. W. W. Tyrmynydd	4·44	120
Glostr.	Blockley	2·19	..	*Mont* .	Lake Vyrnwy........	4·70	156
,, .	Cirencester, Gwynfa ..	1·75	94	*Flint* .	Sealand Aerodrome...	2·15	148
Here .	Ross-on-Wye	3·91	206	*Mer* .	Blaenau Festiniog....	5·97	107
,, .	Kington, Lynhales....	2·70	136	,, .	Dolgelley, Bontddu...	3·54	97
Salop .	Church Stretton......	3·52	..	*Carn* .	Llandudno	2·04	121
,, .	Shifnal, Hatton Grange	2·98	177	,, .	Snowdon, L. Llydaw 9	8·70	..
,, .	Cheswardine Hall	2·98	170	*Angl* .	Holyhead, Salt Island.	2·56	123
Worc .	Malvern, Free Library.	2·67	148	,, .	Lligwy.............	2·34	..
,, .	Ombersley, Holt Lock.	2·10	138	*I. Man*	Douglas, Boro' Cem...	4·64	190

Rainfall: April, 1940: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St. Peter P't. Grange Rd.	1·41	70	*R&C.*	Stornoway, C.G.Stn...	3·88	135
Wig.	Pt. William, Monreith.	2·46	112	*Suth.*	Lairg...............	3·58	155
„	New Luce School.....	2·72	102	„	Skerray Borgie.......	2·91	..
Kirk.	Dalry, Glendarroch...	2·53	83	„	Melvich............	2·14	92
Dumf.	Eskdalemuir Obs.....	3·85	113	„	Loch More, Achfary..	6·67	138
Roxb.	Hawick, Wolfelee	1·50	66	*Caith.*	Wick	2·92	147
„	Kelso, Broomlands....	1·45	92	*Orkney*	Kirkwall, Bignold Park	..	..
Peebs.	Stobo Castle.........	2·50	120	*Shet.*	Lerwick Observatory.	4·40	192
Berw.	Marchmont House....	1·85	92	*Cork.*	Cork, University Coll.	3·51	134
E.Lot.	North Berwick Res...	1·93	138	„	Roches Point, C.G.Stn.	3·93	147
Midl.	Edinburgh, Blackfd. H	2·17	148	„	Mallow, Hazlewood ..	2·99	..
Lanark	Auchtyfardle	2·91	..	*Kerry.*	Valentia Observatory.	..	..
Ayr.	Kilmarnock, Kay Park	1·94	..	„	Gearhameen	5·20	90
„	Girvan, Pinmore	1·81	61	„	Bally McElligott Rec.	3·42	..
„	Glen Afton, Ayr San..	2·44	81	„	Darrynane Abbey....	3·65	106
Renf.	Glasgow, Queen's Park	2·80	142	*Wat.*	Waterford, Gortmore.	3·15	126
„	Greenock, Prospect H.	3·26	95	*Tip.*	Nenagh, Castle Lough.	3·17	126
Bute.	Rothesay, Ardencraig.	2·55	86	„	Cashel, Ballinamona..	3·37	137
„	Dougarie Lodge......	2·30	81	*Lim.*	Foynes, Coolnanes....	3·70	152
Argyll	Loch Sunart, G'dale..	4·04	97	„	Limerick, Mulgrave St.	4·42	183
„	Ardgour House	4·50	..	*Clare.*	Inagh, Mount Callan..	5·17	..
„	Glen Etive	..	..	*Wexf.*	Gorey, Courtown Ho..	3·48	159
„	Oban	2·20	..	*Wick.*	Rathnew, Clonmannon	3·47	..
„	Poltalloch	2·51	83	„	Newcastle...........	..	..
„	Inveraray Castle	3·76	82	*Carlow*	Bagnalstown FenaghH	2·96	129
„	Islay, Eallabus	3·73	130	„	Hacketstown Rectory.	3·93	149
„	Mull, Benmore.......	7·90	102	*Leix.*	Blandsfort House	3·53	135
„	Tiree	1·94	79	*Offaly.*	Birr Castle	2·52	117
Kinr.	Loch Leven Sluice....	2·90	151	*Dublin*	Dublin, Phoenix Park.	3·28	181
Fife.	Leuchars Aerodrome..	1·06	67	*Meath.*	Kells, Headfort......	3·95	158
Perth.	Loch Dhu	5·00	105	*W.M.*	Moate, Coolatore.....	3·20	..
„	Crieff, Strathearn Hyd.	2·68	122	„	Mullingar, Belvedere..	3·78	159
„	Blair Castle Gardens..	2·16	102	*Long.*	Castle Forbes Gdns ..	3·14	131
Angus.	Kettins School.......	1·37	75	*Galway*	Galway, Grammar Sch.	3·39	144
„	Pearsie House	2·39	..	„	Ballynahinch Castle ..	4·96	140
„	Montrose, Sunnyside..	1·21	66	„	Ahascragh, Clonbrock.	4·02	158
Aberd.	Balmoral Castle Gdns.	1·62	75	*Rosc.*	Strokestown, C'node..	3·33	151
„	Logie Coldstone Sch ..	1·44	72	*Mayo.*	Blacksod Point	2·86	99
„	Aberdeen Observatory.	2·30	123	„	Mallaranny..........	4·56	..
„	New Deer SchoolHouse	2·91	146	„	Westport House......	4·03	149
Moray	Gordon Castle	1·80	103	„	Delphi Lodge........	3·93	121
„	Grantown-on-Spey ...	..	..	*Sligo.*	Markree Castle.......	3·82	144
Nairn.	Nairn..............	1·47	98	*Cavan.*	Crossdoney, Kevit Cas.	3·61	..
Inv's.	Ben Alder Lodge.....	..	..	*Ferm.*	Crom Castle	3·98	155
„	Kingussie, The Birches	1·78	..	*Arm'h*	Armagh Obsy........	2·92	139
„	Loch Ness, Foyers....	..	..	*Down.*	Fofanny Reservoir ...	7·99	..
„	Inverness, Culduthel R	1·74	105	„	Seaforde	5·15	197
„	Loch Quoich, Loan...	..	..	„	Donaghadee, C. G. Stn.	2·87	143
„	Glenquoich	..	..	*Antrim*	Belfast, Queen's Univ .	4·64	208
„	Arisaig House	2·35	66	„	Aldergrove Aerodrome	3·47	164
„	Glenleven, Corrour ...	5·76	142	„	Ballymena, Harryville.	4·10	155
„	Ft. William, Glasdrum	3·61	..	*Lon.*	Garvagh, Moneydig...	4·56	..
„	Skye, Dunvegan	2·64	..	„	Londonderry, Creggan.	4·42	172
„	Barra, Skallary	1·91	..	*Tyrone*	Omagh, Edenfel......	3·86	147
R&C.	Tain, Ardlarach......	3·71	188	*Don.*	Malin Head..........	4·12	170
„	Ullapool	3·09	100	„	Dunfanaghy	3·93	169
„	Achnashellach	5·39	95	„	Dunkineely..........	4·03	..

Climatological Table for the British Empire, October, 1939

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min.	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1011·5	− 2·5	64	33	54·0	43·7	48·9	− 2·0	44·5	89	8·0	4·92	+ 2·22	16	2·9	27
Gibraltar	1015·2	− 2·0	77	51	69·0	59·6	64·3	− 2·1	58·6	82	6·3	6·36	—	16	6·3	56
Malta	1015·9	− 0·1	91	58	77·3	66·7	72·0	+ 1·1	65·5	76	5·8	6·05	+ 3·18	5	8·4	74
St. Helena	1017·7	− 1·3	65	54	62·6	55·4	59·0	− 1·5	56·2	91	9·9	1·30	− 0·01	17	—	—
Freetown, Sierra Leone	1011·6	+ 1·6	86	69	83·2	73·1	78·1	—	73·0	90	8·5	18·00	+ 5·38	27	—	—
Lagos, Nigeria	1011·7	+ 0·7	86	69	82·8	71·7	77·3	− 2·4	72·7	92	8·3	3·62	− 4·15	7	5·3	45
Kaduna, Nigeria	1010·0	—	91	62	87·0	65·6	76·3	− 1·4	69·1	90	6·6	7·44	+ 4·69	11	7·7	65
Zomba, Nyasaland	1011·4	+ 0·6	90	59	84·8	64·9	74·9	+ 0·8	67·4	65	3·4	2·54	+ 1·02	4	—	—
Salisbury, Rhodesia	1011·4	− 0·6	88	49	80·8	57·6	69·2	− 1·5	58·1	45	2·8	2·08	—	5	7·8	62
Cape Town	1016·6	− 0·8	85	48	73·6	53·9	63·7	+ 2·5	57·2	72	5·2	0·25	− 1·40	5	—	—
Johannesburg	1013·0	+ 0·2	82	47	73·3	53·0	63·1	+ 0·3	54·2	58	4·4	3·01	+ 0·45	13	8·8	69
Mauritius	1018·5	+ 0·3	82	59	79·2	64·8	72·0	− 0·7	67·1	65	5·2	1·09	− 0·58	14	7·8	63
Calcutta, Alipore Obsy.	1010·0	+ 0·6	93	70	88·8	76·1	82·5	+ 3·2	77·1	88	5·8	9·48	+ 4·58	14*	—	—
Bombay	1009·5	− 0·3	95	72	88·5	76·5	82·5	+ 0·1	75·9	80	4·1	0·17	− 1·50	1*	—	—
Madras	1008·2	− 0·7	95	73	89·1	76·1	82·6	+ 0·3	76·5	83	6·4	5·05	− 6·10	11*	—	—
Colombo, Ceylon	1010·3	− 0·3	87	71	81·7	75·1	78·4	− 2·1	77·5	81	7·8	12·83	− 0·53	23	5·7	47
Singapore	1010·1	+ 0·4	88	72	85·0	75·1	80·1	− 1·0	77·4	80	8·7	10·80	+ 2·73	23	4·5	37
Hongkong	1012·7	− 1·0	92	65	83·2	74·3	78·7	+ 1·8	71·3	67	5·3	1·41	− 3·53	5	6·6	57
Sandakan	1009·3	—	90	72	87·3	74·7	81·0	− 0·4	76·8	83	8·2	9·86	− 0·47	24	—	—
Sydney, N.S.W.	1019·1	+ 4·3	83	—	68·8	54·5	61·7	− 1·9	56·8	64	6·2	1·98	− 0·87	13	6·8	53
Melbourne	1017·5	+ 2·7	85	39	67·6	47·6	57·6	− 0·1	52·4	58	6·7	2·07	− 0·56	13	5·6	43
Adelaide	1018·3	+ 2·3	93	39	73·7	49·4	61·5	− 0·4	54·2	47	5·7	0·98	− 0·76	12	8·0	62
Perth, W. Australia	1016·7	− 0·1	92	43	71·1	54·1	62·6	+ 1·8	57·1	60	5·4	2·27	+ 0·05	9	8·5	66
Coolgardie																
Brisbane	1018·5	+ 2·3	82	52	75·0	57·8	66·4	− 3·4	60·8	63	5·0	2·31	− 0·22	9	8·4	66
Hobart, Tasmania	1013·6	+ 3·3	80	36	62·0	45·0	53·5	− 0·6	49·0	59	6·9	1·28	− 0·98	18	6·2	47
Wellington, N.Z.	1017·0	− 3·9	67	39	59·0	45·5	52·3	− 2·1	49·4	71	7·4	2·80	− 1·28	12	6·8	52
Suva, Fiji	1013·5	+ 0·3	88	68	81·8	71·3	76·5	+ 0·7	71·6	79	7·4	8·63	+ 0·34	21	4·2	34
Apia, Samoa	1010·5	− 1·0	89	70	85·4	74·3	79·9	+ 1·5	75·0	70	5·6	11·17	+ 4·79	8	8·1	65
Kingston, Jamaica	1010·8	− 0·7	94	71	89·0	73·9	81·5	+ 1·0	72·2	85	8·3	9·09	+ 1·63	14	7·0	59
Grenada, W.I.																
Toronto	1015·9	− 1·6	76	29	57·2	42·9	50·1	+ 1·5	43·6	86	6·2	1·89	− 0·68	10	4·8	43
Winnipeg	1014·2	− 0·7	63	15	44·5	29·1	36·8	− 3·9	30·9	82	8·1	0·32	− 1·05	6	2·5	23
St. John, N.B.	1014·6	− 1·2	68	25	54·5	40·7	47·6	+ 2·3	43·2	87	7·6	5·47	+ 0·93	17	4·1	37
Victoria, B.C.	1018·8	+ 1·7	67	35	56·8	46·0	51·4	+ 1·1	49·4	93	7·2	3·31	+ 0·74	14	4·2	39

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

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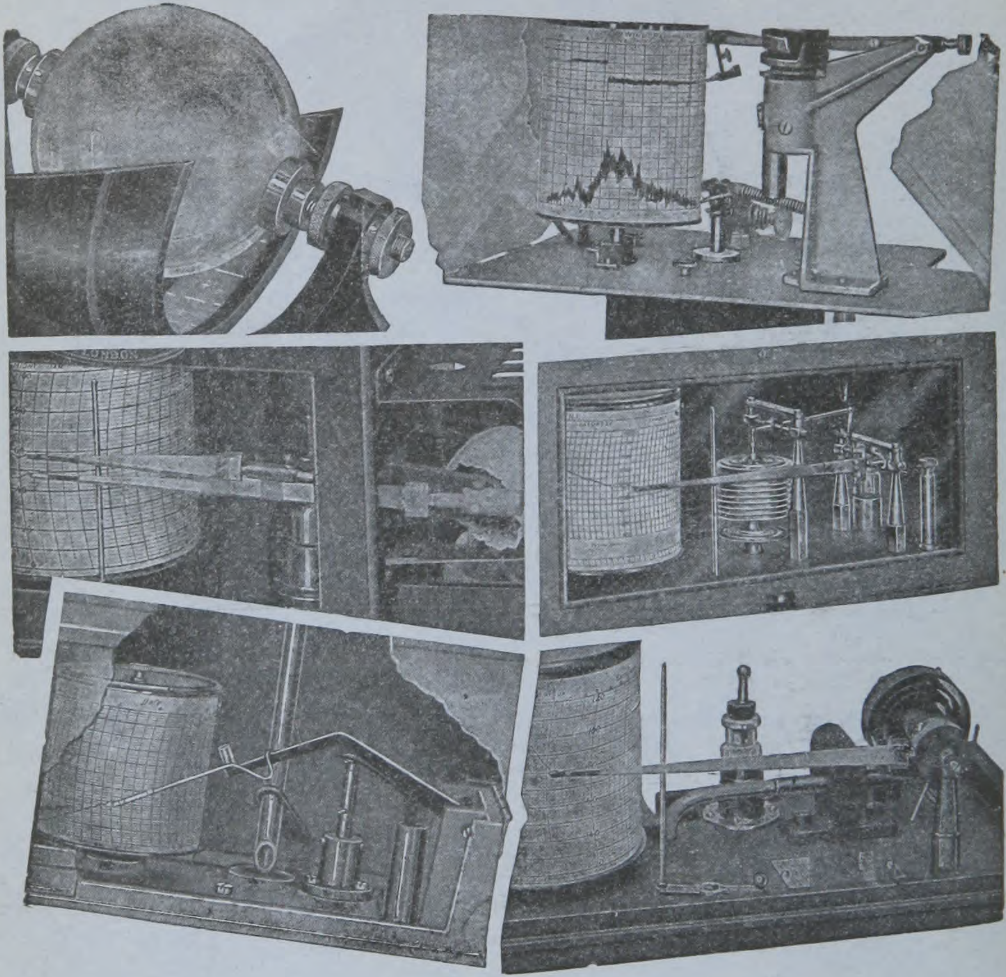

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RECENT METEOROLOGICAL DISLOCATIONS

By the late Joseph Baxendell.

[*This article, which is one of the last from Mr. Baxendell's pen, was written in April, 1939. Mr. Baxendell died in January, 1940.*]

Few people, certainly few elderly people, are now without a belief that our weather since the Great War has frequently been much more unusual in character than that experienced for a long time previously; and meteorologists have statistics to prove this. Admittedly, prolonged severe frosts have been rare, but that itself is a notable circumstance. It appears, therefore, to be worth while to bring together and summarise various statements from recent meteorological publications and from other sources outlining these abnormal happenings.

In some countries, and in few directions even in the British Isles, the changes began very early in the present century, but that which I will venture to term the " great dislocation " occurred shortly after the war. Since then, as shown by Scherhag and Loewe the great majority of winters in and around the Arctic regions of the Northern Hemisphere have been abnormally warm. One result is a retreat of the sea ice towards the Arctic by some 150 miles (a state of matters unheard of during last century), and the thickness of the cold water surface layer in the Arctic Ocean has been halved; these obviously are cumulative effects. Scherhag finds that a rise of temperature in less high latitudes of central Europe set in at the opening of the present century but that the Arctic was not affected until about 1922. It was about that time that there occurred in our own country the abrupt general meteorological dislocation which has more or less upset all weather and climatic elements. The disturbance has not been limited to this country and its immediate surroundings nor even to the Northern Hemisphere alone; its effects have been very noticeable so far away as Australia. For example, this is strikingly shown by Mr. E. A. Cornish in the third curve of Fig. 4, on page 487 of the *Quarterly Journal of the Royal Meteorological Society* for October, 1936. For the remainder of this article I shall for the most part confine my remarks to Great Britain.

It is common knowledge that since the war many long period meteorological " records " have been broken and, in many instances, several times at the observatories and at the older stations. This has been especially the case with the totals or means for individual months in all parts of the year; it has also been very noticeable in the day-to-day oscillations of air pressure and other elements. At the same time, several permanent changes, of undoubted significance, have arisen abruptly. The notable increase of winter temperature, if caused by an increase in the carbon dioxide content of the atmosphere, would have required an impossibly gigantic increase of consumption of coal and oil, etc., to produce it. Moreover other changes, in elements meteorologically more fundamental than temperature, also have taken place: a few may be instanced.

As shown in detail in the annual report of the Fernley Observatory for 1937, the frequencies of both NE and SW winds on the Lancashire coast were very materially reduced. In fourteen out of the last seventeen years, the total duration of winds from each of these two octants has been below—and several times greatly below—the average of the previous 23 years (exact records having begun in 1899). In the case of the SW wind, the most striking reduction has been in the month of April, where the totals in *every* year since 1920 have been below the previous average. (Another new feature of the English

April, from the early twenties until 1937, its general dullness, is well known.) Reasonably summarised autographic records of wind direction, for a sufficient number of years past, are deplorably few in this country, but I find from good eye-observations at Eastbourne—i.e. in nearly the opposite part of England to Southport—that the average annual frequency of NE winds there, from 1923 to 1938, was actually less than half, and that of SW winds, little more than half, of their respective average values for the period 1912 to 1922. At Southport, wind speed has been 9 per cent. less during the last 17 years than previously, and the average annual number of gales has been almost halved. Another noteworthy change since the "dislocation" has been a great reduction in the snowfall in coastal areas west of the lower Pennines. The average annual depth of all such falls at Southport, since then, amounts to less than a third of that recorded for many years previously.

But probably the most striking effect of this great change that has yet come to light, has been the havoc it has wrought with even the best authenticated meteorological periodicities. The shortest cycles disappeared first, indeed a little *before* the war; those of the order of a few years received staggering blows directly *after* that event, and terms even some decades in length then became more or less badly mauled. These last, however, do apparently still exist (though some of them in much feebler form), amidst the large, irregular, variations that have intruded. In brief, the periodic meteorological waves have fared in much the same way as those of light when a thick smoke cloud, or a fog intervenes; the short violet waves are completely lost, but the long red, and especially the infra-red, to a material extent carry through.

Scientific meteorologists who specialise in the investigation of periodicities, do not, of course, use that term in its strictly mathematical sense, but in the way in which astronomers commonly employ it in alluding to the irregular 11-year sunspot period and the quasi-periodic variations of numbers of the so-called long-period

Variable Stars. Yet, even considered from the mathematical standpoint, the meteorological cycles of nearly 5·1 and 3·1 years, and some much shorter ones, apparent in records 100 to 150 years long, have recently been admitted to have been " real " up to the war (or thereabouts), by competent statisticians who have applied to them the severe tests for reality devised by Sir Gilbert Walker and others. It must therefore have been a really great meteorological dislocation that wrought such havoc with them.

One sometimes sees incautious statements, as for example that some element in a certain country was dominated successively by cycles of, say, five, three, and two years, each of which in turn broke down. On the contrary, the truth really is that each of these periodicities existed, with only temporary irregularities from as far back as records extend (in some cases for a century and a half) until about 20 years ago, each being especially persistent and marked in its own particular habitat, but sometimes appearing for many years in pronounced form elsewhere, at times reinforced, and at times masked, by one or more interfering cycles.

Much misapprehension has arisen through searching for periodicities in unsuitable records, i.e. either at places (e.g. on our NE and E coasts) where, or in elements (e.g. surface temperature) in which few are operative to any material extent. The five-year (5·05 years) cycle was first found in rainfall of the Atlantic type (in north-west England) but has been *most* notable in wind direction at places so far apart as London and Southport. The three-year (3·09 years) was most persistently marked in some of the south-eastern counties, both in rainfall and wind, though analyses of 90 years' records of rainfall at Bolton, Lancashire, and of 1½ centuries of air pressure at London, showed it very definitely. Halving of those two last-named records shows that the amplitudes of the mean sine waves of the earlier and the later halves are, in each case, almost identical; while the rainfall phases nearly coincide with the opposite phases of air pressure, the rainfall maxima apparently *slightly* preceding the air pressure minima—a very natural circumstance. The "two-year" (really, 2·19, and 1·88, years) cycles were other similarly long-standing periodicities, found in various elements and places. Information regarding the notable pre-War quasi-periodic terms of the order of a few weeks, will be found on page 11 of the *Annual Report of the Fernley Observatory, Southport** for the year 1928; but these had come to their sudden end long before then.

That surface-temperature should have proved to have been one of the most unfruitful of all meteorological elements in which, in England, to search for periodicities, is not surprising, and even transient recurrent wave-motion is not shown in it. Many years ago, when describing the short (10 to 30 minutes) wave-like oscillations of pressure, wind direction and velocity, and relative humidity, frequently recorded on and near our western coasts during the passage of anti-cyclonic wedges or ridges in winter and by night, I mentioned that such did not appear in thermograms. The clearly marked occurrence of these even in humidity, but their entire absence from surface temperature, has recently been independently observed and noted by G. A. Bull, from records at Abbotsinch.

The several old meteorological periodicities that either disappeared or were severely mauled, in the general dislocation, and have not since been restored (some of which, however, possibly only migrated to other areas), have apparently been succeeded in England by (*a*) a few presumably entirely new ones, (*b*) a marked strengthening of certain old, but (in *this* country) previously very weak terms, and (*c*) the incursion into England, certainly in northern areas, of important periodic variations hitherto in operation, for so far back as records extend, in other areas, e.g. in neighbouring higher latitudes. Of these, the most important one so far traced is that of 3¾ years, discovered by Dr. Goldie, in winds in Scotland, etc., and found by me to have appeared suddenly in the frequency of W and NW winds

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* See Note at end of this article.

at Southport about the middle of the war, since which time it has functioned with surprising regularity, a very high maximum at the right time (the *sixth* consecutive one) having given us the great prevalence of westerly winds that characterised last year (1938).

It is not unlikely that several of the changes outlined above may prove to be of a fairly enduring character, but in regard to one matter a rather strong word of caution is necessary. It is highly improbable that anything like the *whole* of the increase of winter temperature will remain. The earliest statistics of this element show that it is one in which large and prolonged waves of abnormal and subnormal values appear in smoothed curves. Whether these major variations are, as some meteorologists have suggested, of a quasi-periodic character or not, it is quite possible that the spell of warm winters in recent decades has already largely spent itself; the winter of 1938–39 *may* possibly even have been a definite indication of this. (The lengthy series of dull Aprils has certainly been terminated by the occurrence of two of the sunniest on record, viz., those of 1938 and 1939.) In any case, as the late Mr. W. H. Dines, when mentioning his own belief that our winters were becoming somewhat warmer, was careful to add, occasional severe ones will, doubtless, still occur for a long time to come. Obviously, this is increasingly likely now that violent extremes have become so common in most meteorological elements. It should, however, certainly be mentioned here that H. Helm Clayton has recently stated, after an examination of all available data, that the number of icebergs is from two to three times as great in years of sunspot maxima as in those of sunspot minima; this may account, at least partly, for the prevalence of northern oceanic ice in the present year.

Note.—The Southport Corporation desire it to be known that copies of any of the Annual Reports of the Fernley Observatory up to that for 1938 (since 1919 also published by the Meteorological Office, under the name Southport Auxiliary Observatory), may be obtained, free of charge (except for postage), on application to the Chief Librarian, Atkinson Central Library, Lord Street, Southport, Lancs.

LETTERS TO THE EDITOR

The freezing of a tidal river

I was very interested in Mr. Corder's note in the April number of the Magazine. I believe, however, that the tide which eventually broke the ice was the one of January 24th, the predicted height of which was 14 ft. 4 ins., this tide, however, only attained about 10 ft. From my own observations the 10 ft. tide of January 23rd did not reach Bridgwater as the river was so badly obstructed lower down with what can only be termed "ice bergs". At Dunball, below Bridgwater, the river is several hundred feet wide and with the exception of a small channel was entirely blocked with huge mounds of ice which were very similar to small ice bergs and varied from 5 to 10 ft. in height. I have some photographs of the freezing of the river in 1895 and in 1881. The one in which the fire is shown was stated to have been taken in 1895 and to represent the roasting of an ox, though Mr. Corder does not appear to agree that an ox was roasted on that occasion. However, it is quite clear that a substantial fire was lit on the ice.

I do not think that any of our other rivers produced unusual phenomena except that in some cases when the ice broke up, huge blocks were carried over the flood banks and were scattered over the river-side fields for quite a distance from the rivers.

E. L. KELTING.

Somerset Rivers Catchment Board,
West Quay, Bridgwater, Somerset.
April 19th, 1940.

NOTES AND NEWS

Halo phenomena on March 7th, 1940.

Unusual halo phenomena were reported from three places on March 7th. At Bircham Newton near Kings Lynn, Norfolk, the display as described and sketched by Mr. R. M. Poulter, took the form shown in fig. 1.

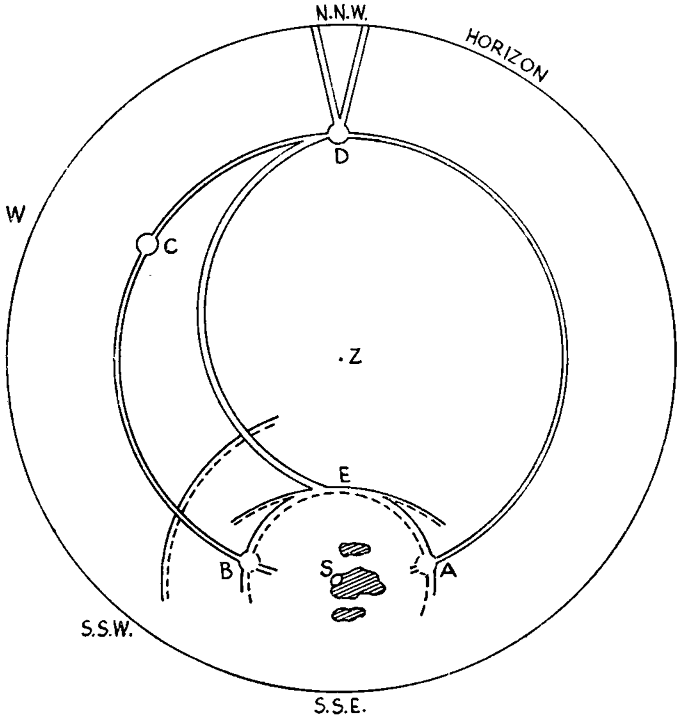

FIG. 1. HALO PHENOMENA AT BIRCHAM NEWTON ON MARCH 7TH, 1940.

Coloured orange - - -
White

It lasted from 8h. 30m. to 11h. G.M.T. The halo of 22° was coloured, with two brilliant coloured mock suns just outside the halo at A and B and the upper tangent arc at E, also showing colours. A part of the halo of 46° was also visible. The mock sun ring was almost complete and showed a white mock sun at a distance of 117° from the sun and another (anthelion) opposite the sun.

The most unusual phenomena, however, were a white arc of about 60° radius from the mock sun at D to the top of the 22° halo, and at 180° from the sun a white inverted V resembling searchlight beams 5° to 7° apart at the horizon converging to the mock sun.

A less complete display (fig. 2) was sketched by

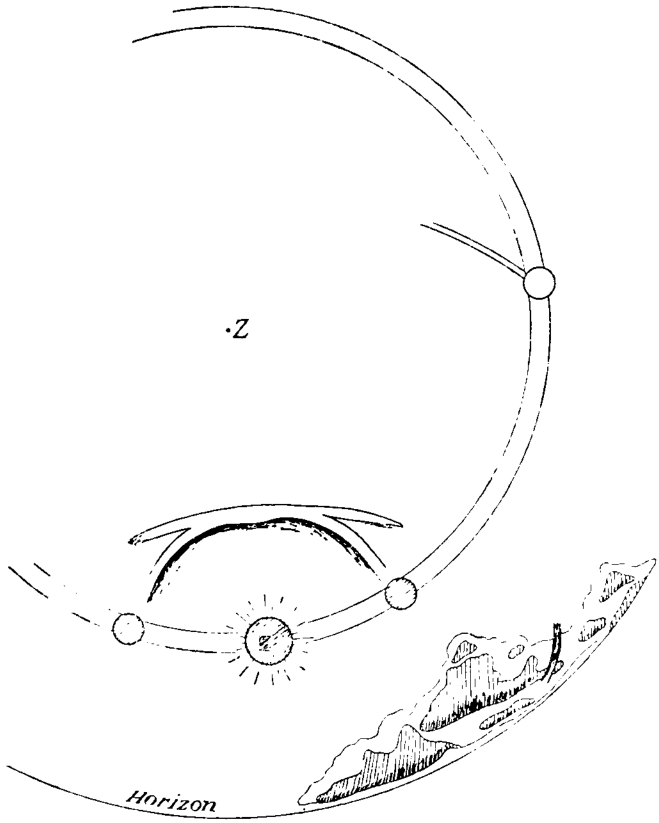

FIG. 2. HALO PHENOMENA AT WHITSTABLE ON MARCH 7TH, 1940.

Cumulus cloud is indicated on the horizon, with part of the 46° halo behind it.

Mr. G. S. Dunkin at Whitstable between 12h. and 13h. G.M.T. on the same date. The upper part of the 22° halo was seen, with part of the upper tangent arc and two brilliant coloured mock suns. A small arc which may have been part of the 46° halo, was seen near the horizon on the right. A large part of the mock sun ring was visible, with a white mock sun 90° to the right of the sun and a very faint oblique white arc passing through it.

At Epsom Mr. K. R. Patrick observed a mock sun to the south of the sun at 16h. 55m. This lasted about four minutes. At 17h. 8m. another much brighter mock sun formed to the north of the sun, with parts of the 22° halo and mock sun ring. The mock sun ring and halo were coloured. The haloes formed in a slowly moving sheet of thin striated cirrostratus.

The anthelion at D is rare; it is usually attributed to light passing in through the vertical side of a horizontal columnar ice crystal, and out again through the same side, or in through the side above and out through the side below, after two internal reflections, at the base and the opposite side. It therefore requires that a considerable number of ice crystals should float in a stable position with their axes and two faces horizontal. An alternative explanation due to Besson is that they are formed by reflection in re-entrant right angles of crystal aggregates falling with their axis of symmetry vertical. On the latter basis the oblique arcs from the 22° halo to the anthelion and beyond would result from oscillations of the axis of symmetry about the vertical, but other explanations have also been given. The mock sun reported as 117° from the sun is no doubt the parhelion of 120°, which is attributed either to internal reflection across two adjacent columnar faces of hexagonal prisms of ice or to double reflexion at re-entrant angles of 120° in crystal aggregates.

The mock sun at 90° from the sun shown by Mr. Dunkin is also very rare. The short oblique arc passing through this mock sun is apparently a part of the rare halo of 90°. Various tentative explanations have been given; in this example the fact that both halo and mock sun were white shows that they were probably due entirely to reflection and not to refraction.

The characteristic shape of the 22° mock sun is clearly shown in the photograph, Fig. 3, from Bircham Newton, which also indicates faintly the position of the mock sun ring.

[*Facing page 90*

Photographer—R. M. Poulter.

FIG. 3. MOCK SUN AT BIRCHAM NEWTON, MARCH 7TH, 1940, 11h. G.M.T.

Haloes, March 25th and April 12th, 1940.

Mr. G. E. D. Alcock sent a sketch of a halo display seen at Peterborough, Northants, on the morning of March 25th between 8h. and 10h. 30m. The 22° halo was comparatively faint but showed mock suns on either side. That on the left was brilliantly coloured with colours of the spectrum. A part of the white mock sun ring extended outwards from each of these mock suns. A large part of the upper arc of contact was visible, with very bright colours, especially red. Higher in the sky was also another coloured arc, probably the upper arc of contact of the 46° halo.

Mr. Alcock also observed, on April 12th, the upper arc of contact of a 46° halo which he describes as the most brilliant halo spectacle he has ever seen, the colours being as bright as in a vivid rainbow. It excited much interest in the neighbourhood.

Solar halo observed from Waddington, Lincs, on May 12th, 1940.

The special feature of this halo was a vertical beam OC and a luminous area at the arc of contact, ECF. The halo was visible from about 19h. 30m. to 19h. 38m.

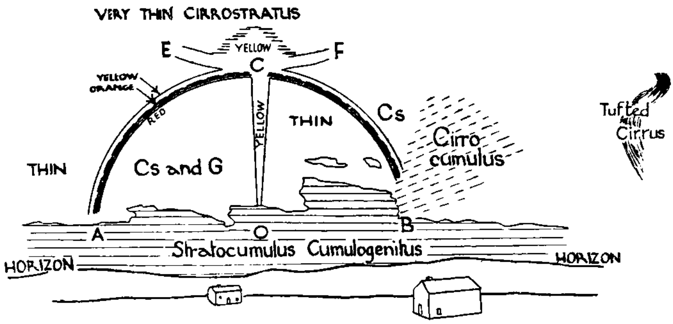

FIG. 1. SOLAR HALO OBSERVED FROM WADDINGTON, MAY 12TH, 1940.

Note: " Cs and G " should read " Cs and Ci."

G.M.T. during which time the sun was setting behind a layer (trace) of stratocumulus (cumulogenitus). An area of cirrus and cirrostratus had developed rapidly in the west but did not reach above 45°. The visibility at the time was abnormal for this locality, being between 20 and 30 miles. On the northern side of the halo was a patch of cirrocumulus which partly masked the lower portion of the halo at that side. When the halo began to disappear it was noticed that the cirrostratus was gradually changing to cirrocumulus. The colouring of the halo was quite strong, the outer edge having a greenish yellow tinge. The elements OC and ECF were a bright yellow.

Other features observed were:—

(i) AB subtended an angle of 43° approximately.
(ii) The elevation of C above the horizontal was 23°.
(iii) Direction of CO from Waddington was 297° (true).

G. W. RADGE.

Sun pillar and halo observed at Digby, Lincs, on May 12th, 1940.

On May 12th, 1940, a fairly well formed sun pillar and 22° halo with upper arc of contact and a portion of the mock sun ring on either side of the halo were observed. The phenomenon was observed to increase and decrease in brilliance between 19h. and 20h. G.M.T. and reached its maximum extent at 19h. 30m., a quarter of an hour before sunset. The sun was obscured behind strato-cumulus cloud low down on the horizon and the phenomenon was observed through very thin and very high altocumulus, the cirrostratus being almost invisible.

The sun pillar was yellowish white in appearance and at the top of the pillar, at the point of contact of arc and ring, was a bright oval patch with red coloration on the side nearest the sun, and white on the other side.

D. C. EVANS.

White rainbow at Cardiff.

On April 6th Mr. W. H. Ireson observed a white rainbow. It was first seen at 6h. 43m. G.M.T. when it was only three-quarters developed. By 6h. 46m. it was fully formed. At 6h. 53m. it began to disappear, the centre first, and by 6h. 55m. only a small part on the left remained. The arc was approximately two degrees wide with a slight brownish tint on the outer edge. The centre was at 280° and the elevation 28°. The cloud in the area consisted of altocumulus.

Royal Meteorological Society.

A meeting of the Society was held on Wednesday, May 22nd, in the Society's rooms at 49, Cromwell Road, South Kensington. Sir George Simpson, K.C.B., C.B.E., F.R.S., President, was in the Chair.

The following papers were read and discussed:—

A new approach to the study of the seasonal incidence of British rainfall.—By P. R. Crowe, B.Sc.

The rainfall records for the period 1881-1930 of seventy British stations are analysed by a method of direct comparison of monthly values which does not involve the calculation of means. Taking the country as a whole the periods of most rapid change in precipitation conditions are shown to have been from June to August and from December to February. There is, however, a considerable amount of regional contrast, particularly in comparison of August with October values, whilst the distribution of anomalous conditions in September is also of interest. The analysis is then carried back to the period 1831-1880 for twelve stations. Rapid rainfall transitions during that period fell between April and June, October and December. The rainy period was thus the same length as in the later half century but occurred earlier in the year. At the same time the September anomaly disappeared.

The formation of depressions of the khamsin type.—By M. G. Elfandy, D.I.C., B.Sc.

A further study has been made of the conditions in spring which produce khamsin conditions in Egypt. Depressions are then formed which travel from west to east to the south of, and roughly parallel to, the north African coast; and, as a rule, while the more vigorous depressions usually originate far to the west of Egypt, shallow depressions form in Egypt or slightly to the west of it. Such depressions are regarded as produced in the manner suggested by Margules—unstable conditions prevailing between intensely heated air to the south and cool air to the north, the moisture of the air being unimportant. The cold air is due to an anticyclonic distribution in the Mediterranean, while the hot air is drawn northward from the Sudanese low when it suffers large oscillations towards the north. These oscillations are in the main brought about by the travelling depressions, the current bringing the hot air being specially strong when the depresssions reach the Red Sea.

A Dutch radio-meteorograph.—By C. M. A. Insje and J. L. van Soest.

This paper contains an account of the radio-meteorograph which has been developed in Holland in order to secure accuracy, lightness and cheapness. Following Moltchanov's principles, it sends out letters in the Morse code which can be received on an ordinary short-wave receiving set. One valve is employed. The signaller is driven by a small electric motor and the set is operated by either one or two 4½-volt flashlight batteries, according to the height to be reached. The total weight is 585 grams. Experience shows that a very large proportion of the radio-meteorographs are recovered in good condition, fit for further use.

Auroral Notes, February to April, 1940.

There was fairly frequent but not strong auroral activity in February. Displays, which were never of more than moderate intensity, were noted at Lerwick on the 8th, 10th, 11th, 12th, 13th, 15th, 22nd, 24th, 27th and 28th. The phenomenon was also observed in Skye on the 9th, at Wick on the 11th, at Gordon Castle on the 12th, at Aberdeen on the 23rd and at Nairn on the 28th.

In March, aurora was seen on 14 nights but observations earlier than the 24th were confined to the Shetlands, where it was observed on the 4th, 6th, 8th, 9th, 12th, 13th, 16th, and to a single report from Wick on the 9th. The only noteworthy display in this period was on the 12th when, under a cloudless sky, some striking effects were noted at Lerwick. The display commenced at 19h. 50m. with a glow in the north up to 20 degrees of altitude. By 20h. 40m. bundles of rays, and bands with ray structure, from WNW to ENE extended up to the zenith. Diffuse homogeneous bands stretched across the sky from east to west, passing 15 degrees south of the zenith. At 21h. 57m. a curtain, bright in intensity, extended from West to NE with bundles of rays over the northern sky converging to a corona in the zenith. Changes in form and intensity continued until about 22h. 35m. when the whole aurora became faint.

During the period 23rd to 26th March an intense magnetic storm occurred. Telegraph and telephone wires were made inoperative for a time and transatlantic cable services were also upset during the afternoon of the 24th. On the night of the 24th auroral displays were widely seen, reports coming from Fortrose, Nairn, Aberdeen, Edinburgh, Paisley, Wolfelee, Thornaby-on-Tees and Cromer. At Thornaby-on-Tees Mr. R. F. M. Hay observed a corona at 21h. 5m. centred at altitude 80 degrees, azimuth 160 degrees (i.e. to SSE). Streamers extended up to the corona from about 20 degrees above the north horizon and there were red patches of glow at altitude 60 degrees, azimuth 220 degrees, and altitude 50 degrees, azimuth 90 degrees. The corona consisted of thick masses of streamers (generally pale yellow) pointing radially inwards to a clear patch of sky about 6 to 7 degrees angular diameter, with an irregular patch of glow inside it like an unclosed ring. Upper clouds interfered with observations between 21h. 25m. and 22h. 10m. but a faint glow extending to 20 degrees of altitude was seen between NW and NE at 22h. 15m. At 23h. low cloud made further observation impossible. Aurora was observed on the 25th at Kettins, Balfron, Paisley and Newton Stewart; on the 26th at Auchincruive; on the 27th at Wick and Nairn; and on the 28th at Aberdeen and as far south as Tiverton (Devon).

There was renewed intense magnetic disturbance from March 29th to 31st, and reports of aurora on March 29th were received from widely scattered stations including Wick, Duntuilm in Skye, Paisley, Kilmarnock, Ross-on-Wye, Salisbury and Exeter. Mr. F. J. Parsons, who observed the display at Ross-on-Wye, writes: " In the NW and North the sky was bright with a whitish grey light, not unlike the long all-night twilight experienced on cloudless nights at mid-summer, but much brighter and extending higher into the zenith. It was bright enough to render the stars almost invisible. About 22h. 45m. a slender pillar of light extended from the horizon, remaining vertical and stationary for some time. Its rays did not finish abruptly on meeting the under surface of clouds but continued above them. The bright auroral light lasted well into the early hours ". At Exeter, Mr. W. N. Lavis observed the northern sky to be illuminated as if by lingering twilight between

19h. and 20h. and at 21h. 15m. the whole of this sector was lit by a steady, faint, rose-pink glow, tailing off at an elevation of about 40 degrees near the apparent position of the constellation Cassiopeia. At 22h. 20m. the light had assumed the form of a faint bluish-white cigar-shaped glow extending roughly from NNW to NNE at a height of about 35 degrees. The phenomenon was still persisting when observations were discontinued about 22h. 30m. Throughout the period of observation the sky was clear with bright stars. Aurora was seen at many places in Scotland on the 30th, from Kirkwall in the north to Eskdalemuir in the south. On the 31st it was reported from Lerwick and Wick.

During April aurora was observed on nine nights at various Scottish stations. It was seen at Wick and Aberdeen on the 1st and at Lerwick, Strathy, Wick, Nairn and Leuchars on the 2nd. At Lerwick homogeneous arcs of moderate intensity appeared at 20h. 35m. on the 2nd from NW to NE at an altitude of 10 degrees. Five minutes later the form changed to arcs of ray structure, bright in intensity. For rather more than an hour there were short periods of rapidly changing auroral form. At one time bundles of rays appeared, followed by arcs with ray structure, and then by diffuse luminous surfaces extending over the northern half of the sky up to 40 degrees altitude. Aberdeen and Eskdalemuir noted aurora on the 3rd, and Lerwick, Nairn and St. Abbs Head on the 4th. A single report on the 8th came from Paisley. The phenomenon was next reported on the 21st at Lerwick. It was seen again at Lerwick on the 24th, and at Nairn, Aberdeen and St. Abbs Head on the 25th. The last observations in April were on the 26th when it was observed at Wick, Leuchars and St. Abbs Head.

H. E. C.

The Great Drought of 1540.

The year 1540 was extremely hot and dry both in England and in central Europe, probably the hottest on record. In England rain fell only six times between February and September 19th.

General Rainfall, May, 1940.

	Per cent.
England and Wales	72
Scotland	64
Ireland	68
British Isles	69

Sunshine, May, 1940.

The distribution of bright sunshine for the month was as follows:—

	Total hrs.	Diff. from average hrs.		Total hrs.	Diff. from average hrs.
Stornoway	167	−12	Chester	218	+52
Aberdeen	209	+39	Ross-on-Wye	199	+13
Dublin	177	− 3	Falmouth	250	+43
Birr Castle	165	− 4	Gorleston	266	+43
Valentia	236	+52	Kew	247	+49

Kew temp., mean 56.6° F. diff. from average + 2.1° F

OBITUARY

DR. T. W. WOODHEAD.—We regret to announce the death on March 5th, 1940, of Dr. T. W. Woodhead, who as Honorary Director of the Tolson Memorial Museum was responsible for the meteorological station there from 1921 onwards.

The museum was planned by Dr. Woodhead and the meteorological station was installed there in continuation of an earlier station at Egerton Cemetery.

Dr. Woodhead was well known for his biological and educational work. His studies of the succession of floras represented by pollen in peat-bogs contributed materially to the study of climatic changes in Britain.

Rainfall: May, 1940: England and Wales

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Lond'n	Camden Square......	1·05	60	*Warw*	Alcester, Ragley Hall.	3·24	157
Surrey	Reigate, Wray Pk. Rd.	1·71	94	,, .	Birminghm, Edgbaston	2·65	124
Kent .	Tenterden, Ashenden.	·99	63	*Leics* .	Thornton Reservoir...	·84	42
,, .	Folkestone, I. Hospital	·71	..	,, .	Belvoir Castle........	·70	33
,, .	Margate, Cliftonville..	·10	6	*Rutl'd*	Ridlington	..	..
,, .	Edenb'dg.,Falconhurst	2·64	142	*Lincs*.	Boston, Skirbeck.....	1·23	70
Sussex	Compton, Compton Ho	1·76	79	,, .	Cranwell Aerodrome..	1·31	72
,, .	Patching Farm.......	1·00	54	,, .	Skegness, Marine Gdns	..	..
,, .	Eastbourne, Wil. Sq..	1·62	98	,, .	Louth, Westgate.....	1·21	60
Hants.	Ventnor, Roy.Nat.Hos.	·79	46	,, .	Brigg, Wrawby St....	1·18	...
,, .	Southampton, East Pk	·31	15	*Notts* .	Mansfield, Carr Bank..	1·10	52
,, .	Ovington Rectory....	·41	19	*Derby*.	Derby, The Arboretum	1·34	67
,, .	Sherborne St. John...	·71	37	,, .	Buxton, Terrace Slopes	1·24	40
Herts .	Royston, Therfield Rec	1·37	71	*Ches* .	Bidston Obsy........	2·18	115
Bucks.	Slough, Upton.......	1·62	96	*Lancs*.	Manchester, Whit. Pk.	1·36	64
Oxford	Oxford, Radcliffe.....	1·49	80	,, .	Stonyhurst College...	1·14	40
N'hant	Wellingboro,Swanspool	1·04	54	,, .	Southport, Bedford Pk	2·43	116
,, .	Oundle	..	..	,, .	Ulverston, Poaka Beck	1·77	56
Beds .	Woburn, Exptl Farm.	1·57	81	,, .	Morecambe..........	1·79	78
Cambs	Cambridge, Bot. Gdns.	1·60	91	,, .	Blackpool...........	1·95	89
,, .	March	1·07	62	*Yorks*.	Wath-upon-Dearne ...	·74	36
Essex.	Shoeburyness........	1·00	77	,, .	Wakefield,Clarence Pk.	·48	24
,, .	Lexden Hill House....	·38	..	,, .	Oughtershaw Hall....	1·10	..
Suff .	Haughley House.....	1·70	..	,, .	Harrog'te, HarlowMoor	·86	39
,, .	Campsea Ashe, High Ho	·22	15	,, .	Hull, Pearson Park...	·89	46
,, .	Lowestoft Sec. School.	1·33	83	,, .	Holme-on-Spalding ...	1·21	60
,, .	Bury St. Ed.,WestleyH	·78	43	,, .	Felixkirk, Mt. St. John	·98	52
Norf..	Wells, Holkham Hall.	1·01	63	,, .	York, Museum.......	2·08	105
,, .	Thetford W. W.......	1·23	..	,, .	Scarborough.........	·47	25
Wilts .	Porton, W.D. Exp'lStn	·39	23	,, .	Middlesbrough.......	1·55	81
,, .	Bishops Cannings	1·44	74	,, .	Baldersdale, Hury Res.	..	..
Dorset	Weymouth, Westham.	..	..	*Durhm*	Ushaw College.......	1·41	65
,, .	Beaminster, East St ..	1·82	88	*Norl'd*	Newcastle, Leazes Pk.	·87	44
,, .	Shaftesbury	1·14	..	,, .	Bellingham, Highgreen	1·85	77
Devon.	Plymouth, The Hoe...	1·54	74	,, .	Lilburn Tower Gdns..	·82	35
,, .	Holne, Church Pk.Cott	2·15	68	*Cumb*.	Carlisle, Scaleby Hall.	1·76	74
,, .	Teignmouth, Den Gdns	1·53	84	,, .	Borrowdale,Seathwaite	1·75	25
,, .	Cullompton	1·23	57	,, .	Thirlmere,DaleHeadH.	2·07	43
,, .	Sidmouth, U.D.C.....	1·91	..	,, .	Keswick, High Hill...	1·23	39
,, .	Barnstaple,N. Dev.Ath	1·16	56	,, .	Ravenglass, The Grove	1·50	54
,, .	Dartm'r,Cranmere P'l	1·90	..	*West* .	Appleby, Castle Bank.	1·05	48
,, .	Okehampton, Uplands.	1·83	68	*Mon* .	Abergavenny, Larchf'd	2·67	100
Cornw	Bude, School House ..	1·84	100	*Glam* .	Ystalyfera, Wern Ho..	2·01	58
,, .	Penzance,Morrab Gdns	·57	26	,, .	Treherbert, Tynywaun	2·14	..
,, .	St. Austell, Trevarna..	1·58	65	,, .	Cardiff, Penylan......	2·39	98
Soms .	Chewton Mendip.....	3·03	110	*Pemb* .	St. Ann's Head........	·88	44
,, .	Long Ashton	2·68	127	*Card* .	Aberystwyth	2·64	..
,, .	Street, Millfield	2·75	147	*Radn'r*	Bir. W. W. Tyrmynydd	2·50	73
Glostr.	Blockley	2·10	..	*Mont* .	Lake Vyrnwy........	2·94	93
,, .	Cirencester, Gwynfa ..	1·36	66	*Flint* .	Sealand Aerodrome...	2·39	131
Here .	Ross-on-Wye	2·19	103	*Mer* .	Blaenau Festiniog....	2·25	43
,, .	Kington, Lynhales....	2·19	94	,, .	Dolgelley, Bontddu...	2·15	65
Salop .	Church Stretton......	2·79	..	*Carn* .	Llandudno	2·63	148
,, .	Shifnal, Hatton Grange	2·13	103	,, .	Snowdon, L. Llydaw 9	3·25	..
,, .	Cheswardine Hall	1·81	82	*Angl* .	Holyhead, Salt Island.	1·53	78
Worc .	Malvern, Free Library.	2·60	120	,, .	Lligwy.............	1·88	..
,, .	Ombersley, Holt Lock.	3·14	153	*I.Man*	Douglas, Boro' Cem...	1·15	46

Rainfall: May, 1940: Scotland and Ireland

Co.	Station.	In.	Per cent of Av.	Co.	Station.	In.	Per cent of Av.
Guern.	St.PeterP't.GrangeRd.	1·20	71	*R&C.*	Stornoway, C.G.Stn.	1·67	69
Wig	Pt. William, Monreith.	1·49	63	*Suth*	Lairg	1·14	45
,,	New Luce School	1·55	55	,,	Skerray Borgie	1·56	..
Kirk	Dalry, Glendarroch	1·80	57	,,	Melvich	1·23	60
Dumf.	Eskdalemuir Obs	1·47	45	,,	Loch More, Achfary	3·90	89
Roxb	Hawick, Wolfelee	..	..	*Caith*	Wick	1·74	84
,,	Kelso, Broomlands	1·45	75	*Orkney*	Kirkwall, Bignold Park	1.50	72
Peebs	Stobo Castle	1·64	72	*Shet*	Lerwick Observatory.	1.65	79
Berw	Marchmont House	1·23	50	*Cork*	Cork, University Coll.	2·19	97
E.Lot.	North Berwick Res	1·58	79	,,	Roches Point, C.G.Stn.	2·28	94
Midl	Edinburgh, Blackfd. H	1·70	83	,,	Mallow, Hazlewood	1·21	..
Lanark	Auchtyfardle	·92	..	*Kerry*	Valentia Observatory.	1·59	50
Ayr	Kilmarnock, Kay Park	·82	..	,,	Gearhameen	2·00	38
,,	Girvan, Pinmore	1·62	55	,,	Bally McElligott Rec.	1·88	..
,,	Glen Afton, Ayr San.	1·55	52	,,	Darrynane Abbey	1·25	42
Renf	Glasgow, Queen's Park	1·16	48	*Wat*	Waterford, Gortmore.	2·24	97
,,	Greenock, Prospect H.	·85	26	*Tip*	Nenagh, Castle Lough.	1·50	61
Bute	Rothesay, Ardencraig.	1·82	60	,,	Cashel, Ballinamona	1·68	71
,,	Dougarie Lodge	2·32	84	*Lim*	Foynes, Coolnanes	·80	34
Argyll	Loch Sunart, G'dale	1·83	51	,,	Limerick, Mulgrave St.	·98	41
,,	Ardgour House	3·27	..	*Clare*	Inagh, Mount Callan	3·16	..
,,	Glen Etive	..	..	*Wexf*	Gorey, Courtown Ho	·71	32
,,	Oban	2·24	..	*Wick*	Rathnew, Clonmannon	·79	..
,,	Poltalloch	2·90	100	,,	Newcastle	..	..
,,	Inveraray Castle	1·72	44	*Carlow*	Bagnalstown FenaghH	1·14	46
,,	Islay, Eallabus	..	..	,,	Hacketstown Rectory.	1·19	46
,,	Mull, Benmore	3·90	52	*Leix*	Blandsfort House	1·26	52
,,	Tiree	..	..	*Offaly*	Birr Castle	·90	40
Kinr	Loch Leven Sluice	·88	36	*Dublin*	Dublin, Phoenix Park.	·99	48
Fife	Leuchars Aerodrome	1·12	57	*Meath.*	Kells, Headfort	..	..
Perth	Loch Dhu	1·20	27	*W.M.*	Moate, Coolatore	2·78	..
,,	Crieff, Strathearn Hyd.	1·62	65	,,	Mullingar, Belvedere	2·93	120
,,	Blair Castle Gardens	1·37	67	*Long*	Castle Forbes Gdns	2·68	104
Angus.	Kettins School	1·59	59	*Galway*	Galway, Grammar Sch.	2·23	90
,,	Pearsie House	1·82	..	,,	Ballynahinch Castle	2·26	63
,,	Montrose, Sunnyside	1·32	65	,,	Ahascragh, Clonbrock.	1·94	70
Aberd.	Balmoral Castle Gdns.	1·11	48	*Rosc*	Strokestown, C'node	3·10	129
,,	Logie Coldstone Sch	1·39	56	*Mayo.*	Blacksod Point	2·22	79
,,	Aberdeen Observatory.	1·50	64	,,	Mallaranny	2·90	..
,,	New Deer SchoolHouse	1·40	64	,,	Westport House	2·35	79
Moray	Gordon Castle	1·73	82	,,	Delphi Lodge	4·43	73
,,	Grantown-on-Spey	..	..	*Sligo*	Markree Castle	3·20	114
Nairn.	Nairn	1·37	76	*Cavan.*	Crossdoney, Kevit Cas.	3·83	..
Inv's	Ben Alder Lodge	..	..	*Ferm*	Crom Castle	2·47	89
,,	Kingussie, The Birches	1·10	..	*Arm'h*	Armagh Obsy	·92	39
,,	Loch Ness, Foyers	..	..	*Down.*	Fofanny Reservoir	2·42	..
,,	Inverness, Culduthel R	1·58	85	,,	Seaforde	1·60	61
,,	Loch Quoich, Loan	..	..	,,	Donaghadee, C. G. Stn.	1·65	73
,,	Glenquoich	3·30	60	*Antrim*	Belfast,Queen's Univ	1·12	48
,,	Arisaig House	3 70	107	,,	Aldergrove Aerodrome	1·29	57
,,	Glenleven, Corrour	1·80	47	,,	Ballymena, Harryville.	1·83	64
,,	Ft. William, Glasdrum	..	..	*Lon*	Garvagh, Moneydig	1·20	..
,,	Skye, Dunvegan	..	..	,,	Londonderry, Creggan.	1·90	73
,,	Barra, Skallary	1·19	..	*Tyrone*	Omagh, Edenfel	1·75	68
R&C.	Tain, Ardlarach	1.93	85	*Don*	Malin Head	1·67	68
,,	Ullapool	2·02	79	,,	Dunfanaghy	..	..
,,	Achnashellach	2·72	61	,,	Dunkineely	2·31	..

Climatological Table for the British Empire, November, 1939

STATIONS.	PRESSURE. Mean of Day M.S.L.	PRESSURE. Diff. from Normal.	TEMPERATURE. Absolute. Max.	TEMPERATURE. Absolute. Min.	TEMPERATURE. Mean Values. Max.	TEMPERATURE. Mean Values. Min.	TEMPERATURE. Mean Values. ½ Max. and Min	TEMPERATURE. Mean Values. Diff. from Normal.	TEMPERATURE. Mean. Wet Bulb.	Relative Humidity.	Mean Cloud Am'nt	PRECIPITATION. Am'nt.	PRECIPITATION. Diff. from Normal.	PRECIPITATION. Days.	BRIGHT SUNSHINE. Hours per day.	BRIGHT SUNSHINE. Percentage of possible.
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	0–10	in.	in.			
London, Kew Obsy	1011·5	− 3·1	58	31	52·9	44·6	48·7	+ 5·2	45·9	92	7·8	4·43	+ 2·21	24	1·2	14
Gibraltar	1020·6	+ 2·6	70	51	64·4	55·3	59·9	− 0·1	54·7	82	5·3	2·97	—	8	6·7	66
Malta	1017·9	+ 2·0	78	50	67·6	59·4	63·5	− 0·4	57·7	75	4·7	1·33	− 2·24	7	6·4	63
St. Helena	1017·3	− 0·3	67	54	63·4	56·1	59·7	+ 1·2	56·7	94	9·7	2·39	+ 1·21	15	—	—
Freetown, Sierra Leone	1011·5	+ 2·1	87	70	81·7	75·1	78·4	—	74·0	89	7·4	3·26	− 1·86	12	—	—
Lagos, Nigeria	1011·4	+ 1·3	89	70	86·0	73·4	79·7	− 2·0	74·4	94	7·5	0·54	− 2·13	6	6·2	53
Kaduna, Nigeria	1011·3	—	91	53	88·6	58·3	73·5	+ 4·4	58·7	57	2·9	0·00	− 0·21	0	9·5	82
Zomba, Nyasaland	1010·5	+ 1·6	93	59	83·4	64·9	74·1	+ 1·5	68·8	75	5·8	1·52	− 3·56	11	—	—
Salisbury, Rhodesia	1011·3	− 0·5	85	53	77·8	58·4	68·1	− 2·6	60·9	63	4·9	5·87	—	12	6·9	53
Cape Town	1016·3	+ 0·5	92	49	77·2	57·6	67·4	+ 3·0	60·5	68	3·6	1·19	+ 0·10	6	—	—
Johannesburg	1012·2	− 0·4	83	42	71·4	52·2	61·8	− 1·9	54·8	62	5·2	8·34	+ 3·38	13	7·8	58
Mauritius	1015·7	− 0·4	87	60	83·5	67·1	75·3	− 0·2	69·8	63	4·5	1·11	− 0·65	16	8·4	65
Calcutta, Alipore Obsy	1011·9	− 1·4	88	57	84·2	65·4	74·8	+ 1·3	66·5	79	3·3	0·35	− 0·30	1*	—	—
Bombay	1010·4	− 1·6	94	68	90·3	72·9	81·6	+ 1·0	70·9	72	2·0	0·15	− 0·30	1*	—	—
Madras	1009·6	− 1·7	89	60	83·9	72·0	77·9	− 1·0	73·9	87	7·4	13·00	− 0·61	10*	—	—
Colombo, Ceylon	1009·8	− 0·2	88	71	84·5	73·9	79·2	− 0·8	76·1	81	7·1	19·71	+ 7·95	20	6·0	51
Singapore	1009·3	− 0·1	89	73	85·4	75·3	80·3	− 0·3	77·4	78	8·0	9·47	− 0·44	15	5·1	43
Hongkong	1015·9	− 1·7	87	54	76·6	67·4	72·0	+ 2·4	65·7	71	7·1	4·83	+ 3·09	5	4·1	37
Sandakan	1008·5	—	92	73	86·7	74·9	80·8	− 0·1	77·2	84	8·2	9·37	− 5·35	20	—	—
Sydney, N.S.W.	1011·9	− 1·9	93	49	74·5	60·1	67·3	+ 0·3	60·9	61	6·4	2·05	− 0·80	13	8·1	58
Melbourne	1012·0	− 2·4	90	41	69·8	51·1	60·5	− 0·8	53·7	60	7·7	4·58	+ 2·35	17	5·6	40
Adelaide	1014·2	− 1·1	93	44	75·3	54·5	64·9	− 2·1	56·5	50	7·1	3·58	+ 2·44	13	6·6	47
Perth, W. Australia																
Coolgardie																
Brisbane	1013·8	− 1·6	92	56	80·8	63·9	72·3	− 1·2	66·5	63	6·2	2·54	− 1·19	9	8·5	63
Hobart, Tasmania	1008·4	− 1·2	88	39	64·3	48·2	56·3	− 0·9	51·4	60	7·4	3·88	+ 1·41	20	6·1	42
Wellington, N.Z.	1015·7	+ 3·6	74	41	62·8	50·5	56·7	− 0·1	53·8	72	7·9	2·37	− 1·15	13	6·3	44
Suva, Fiji	1011·9	+ 0·8	89	67	82·1	70·4	76·3	− 0·8	71·2	77	7·3	10·82	+ 1·03	19	5·6	43
Apia, Samoa	1008·6	− 0·9	88	73	85·6	75·2	80·4	+ 1·7	76·4	76	6·1	5·98	− 3·85	15	8·5	67
Kingston, Jamaica	1010·8	− 1·6	92	69	85·1	72·3	78·7	− 0·6	71·5	91	7·1	25·97	+22·94	17	5·1	45
Grenada, W.I.																
Toronto	1023·4	+ 6·1	62	20	43·4	30·4	36·9	− 0·1	30·2	73	6·2	0·32	− 2·31	5	4·0	41
Winnipeg	1021·2	+ 3·8	61	5	41·6	20·5	31·1	+ 9·8	23·4	77	4·5	0·06	− 1·01	3	4·3	47
St. John, N.B.	1016·6	+ 2·0	53	16	40·9	27·6	34·3	− 2·4	28·3	77	5·1	2·16	− 2·25	6	5·1	53
Victoria, B.C.	1018·5	+ 2·6	59	42	52·2	44·7	48·5	+ 4·0	47·0	86	8·7	4·17	− 1·24	24	2·1	23

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

(52049) Wt. 23/26/3717 1200 6 40 Hw. G.377,6