M.O. 482 AIR MINISTRY

METEOROLOGICAL OFFICE

THE METEOROLOGICAL MAGAZINE

VOL. 76. NO. 906. DECEMBER, 1947

METEOROLOGICAL OFFICE LIBRARY

BY C. E. P. BROOKS, D.SC. AND G. J. EVANS, B.SC.

The Meteorological Office Library forms part of the Climatology Branch and is housed in the Meteorological Office building at Headstone Drive, Harrow. It has grown steadily since its formation in 1870, and now includes about 35,000 volumes and 10,500 pamphlets in addition to manuscripts, photographs and lantern slides. The contents are not limited to pure meteorology; the aim of successive librarians has always been to collect as much as possible of all published meteorological literature and in addition a representative selection of books on subjects such as physics, mathematics, geography, oceanography, etc., which are likely to be required by the scientific staff in the course of their work. Books and periodicals are obtained in a variety of ways of which the most important is the exchange of publications between the Meteorological Office and other scientific institutions. Some 300 such exchanges are in existence, the great majority being international in character. Book lists, periodicals and abstracts are scanned for references to new books and papers of interest, and if no exchange is possible these are obtained either by a request for an author's copy or by purchase. Many books or reprints are presented directly to the office by the authors themselves.

The Library has a very complete system of cataloguing. All books, reprints and all articles of interest in periodicals, even if no reprint is received, are entered in at least two catalogues:

(1) The "Author Catalogue", in which each entry is on a separate card, arranged alphabetically under authors, and for each author under the first significant word of the title. The number of cards is now approximately 58,000.

(2) The " Subject Catalogue " is on foolscap sheets in loose-leaf covers, classified under subjects and arranged in chronological order. From about 1914 until 1935 the subject classification used was that of the Royal Society's " International Catalogue of Scientific Literature ".

With the advance of meteorology, this classification became obsolete and on January 1, 1936, the Library changed to the Universal Decimal Classification (see below).

Besides these two main catalogues, there are various subsidiary ones. The largest is the " Climatic Index ", in which all publications dealing with any aspect of the climate of a town or country are entered on foolscap sheets in a loose-leaf catalogue, arranged geographically under continent, country, division of country, down to the larger towns. By consulting this catalogue anyone writing an account of the climate of a district can find references to all the literature together in one place.

The " Climatic Index " includes mainly works on the classical descriptive aspect of climate based on monthly averages and extremes. In recent years the synoptic aspect has become important, and a second catalogue has been commenced—"A Regional Bibliography of Synoptic Climatology". This is subdivided geographically, thus assembling together the forecasting problems common to the area concerned. It is of inestimable value to the synoptic meteorologist requiring information concerning an unfamiliar part of the world. There is also a " Bibliography of Upper Air Data " arranged on similar lines but as a card catalogue. It contains details of upper air temperature, pressure, humidity and winds.

The above-mentioned organization is designed chiefly to facilitate the work of individuals attending the library in person. To assist those members of staff unable to use these facilities, the library prepares a bibliography of literature received each month. This monthly *Meteorological Bibliography* forms the basis for the six-monthly bibliography issued by the Royal Meteorological Society. It is supplied to the Heads of Branches in the numbers requested by them, and it is also sent to the main foreign meteorological services. It contains titles and references of all books and papers received during the month and is classified under subjects and numbered. Anyone wishing to borrow any paper noted need only quote the year and month of the bibliography and the number of the entry.

The library also maintains a large selection of photographs and lantern slides which can be borrowed free of charge by members of staff requiring them for lecture purposes. A " Dictionary " catalogue of the lantern slide collection may be borrowed to assist in the choice of slides. The photographic collection has recently been subdivided into subjects, using the Universal Decimal Classification as the basis for the subdivisions.

The Universal Decimal Classification (U.D.C.) which is now the basis of our classifications is a development of a " decimal classification " devised by Melvil Dewey in 1873. The guiding principle is that all knowledge forms one unit, which is divided into ten main classes numbered 0·0, 0·1, . . . 0·9. Each of these is divided in turn into ten sections, giving for example the subclasses 0·10, 0·11, etc. These are further subdivided until the requisite fineness of classification is attained. Natural sciences and mathematics form the class 0·5; this is divided into nine different sciences, of which geophysics forms the division 0·55. Meteorology as a branch of geophysics has the number 0·5515.

On this theory every number begins with 0, and this figure with the decimal point can be taken for granted, but for convenience in reading long series of figures the practice has been adopted of using the point not as a decimal point but as a punctuation to divide the figures into groups, generally of three figures. The number for Meteorology in this practice is 551.5.

The subdivisions of 551.5 were examined by a Commission of the International Meteorological Organization, which in 1935 recommended an extensive revision. The details can be found in the *Quarterly Journal of the Royal Meteorological Society, London*, **62**, 1936, p. 134. Here we may quote the main subdivisions.

551.50 Practical meteorology (methods, data, forecasts).
1 Structure, mechanics and thermodynamics of the atmosphere in general.
2 Radiation and temperature.
4 Atmospheric pressure.
5 Wind.
7 Aqueous vapour and hydrometeors.
8 Climatology.
9 Various phenomena and influences.

This classification is limited strictly to meteorology, making no provision for the many works which deal with the relations between meteorology and other branches of knowledge, such as agriculture. These borderline cases are a difficulty in any scheme of classification. Let us take for example a paper by R. J. Kalamkar, " Micro-climatology in relation to crops ". A meteorologist would naturally wish to include this under meteorology, an agriculturist under agriculture. In the Universal Decimal Classification the problem is handled in a very simple and ingenious way. The number for microclimatology is 551.584, that for crops is 633. If we connect these two numbers by a symbol meaning " relationship ", we have a number for microclimatology in relation to crops. The colon : has been assigned for this purpose, giving the number 551.584: 633. The order of the two related series is reversible and a general library would also include the entry 633: 551.584.

In this way all works on agricultural meteorology are brought together for consultation; the same applies to other subjects. Thus there have been built up bibliographies of meteorology in relation to air transport, civil engineering, water engineering, medicine and a variety of other associated sciences.

In the twelve years which have elapsed since this classification for 551.5 was designed, further advances have occurred, especially in the application of radio and radar to meteorology, and at Toronto last September the Commission of Bibliography and Publications proposed a number of modifications, which are now awaiting acceptance.

In order to bridge as far as possible the break caused by the change of classification in 1936, we prepared "A selected bibliography of meteorological literature, 1901–1935 ", which aimed at giving a list, classified according to the U.D.C., of the more important papers published during those years. This bibliography, which runs to 151 foolscap pages, has proved of great value as a source of rapid reference; copies are available for loan.

The library can assist the staff of the Meteorological Office in five main ways:—

1. By the issue on loan of specific publications. When these are not available in the Meteorological Office Library every effort is made to borrow them from some other library with which we have contacts, such as the Science Library or National Central Library. Members of the staff are asked to take care to give adequate references when requesting publications. Much trouble can be caused to the staffs of the libraries concerned by insufficient or incorrect references. The author, title of work (if known), title of periodical, place of publication, volume number, year and pages of references, should be given whenever possible.

2. By the issue on loan of publications containing specific information or by the provision of bibliographies of special subjects. Here again precision in stating requirements may save a great deal of time and trouble.

3. By keeping track of the special interests of members of the staff engaged on research and calling their attention to publications likely to be of use to them.

4. By the circulation of the *Meteorological Bibliography* referred to above.

5. By the issue on loan of lantern slides, films and photographs. Borrowers should state the full scope of any proposed lecture or display so that in the event of any slide or photograph being out on loan to another borrower, a suitable substitute can be selected from stock. The stock of photographs and lantern slides held is extensive and covers a very wide field. The sizes of the photographs vary considerably but many are suitable for use with an epidiascope.

If a publication is already on loan, the name of the intending borrower is added to a waiting list for the publication. Publications are issued on loan in the first instance for a period of 14 days to staff at home and of one month to staff overseas. Applications for an extension of loan must, in the case of staff in this country, be made after 10 days. Failure to do this may prejudice goodwill arrangements between other libraries and ourselves. Extensions will be arranged providing no waiting list has accrued in the meantime. In general it is expected that the one month from date of receipt to date of return allowed to overseas staff will be sufficient to meet their needs.

The Library does not usually make abstracts of meteorological literature, the general opinion being that abstracts prepared, so to speak, in the void are of comparatively little value, and that it is more useful to make surveys of the literature when required for some special purpose, and devote them to that purpose.

The Library services to other institutions and to scientists not on the staff, are naturally more limited. Loans of books are only made in special circumstances, but a great many technical inquiries are answered. Lantern slides may be borrowed at a charge of 4*s*. for each 20 slides, or part of 20, plus postage. Intending borrowers must state the date by which slides are required.

The purpose of the Library is to be of the utmost assistance to all members of the Meteorological Office, by acting not only as a repository of books, but also as an information bureau. If it is to serve this purpose fully, the co-operation of other members of the staff in making known their needs is necessary, and is always welcomed.

FUNDAMENTAL PROBLEMS IN METEOROLOGY

COMPILED BY THE METEOROLOGICAL RESEARCH COMMITTEE

The Meteorological Research Committee has recently compiled a list of the problems which, in the view of members, are fundamental problems in the science of meteorology today. Some of these problems are suitable for attack by independent workers and steps have accordingly been taken to distribute the list to research workers in the Universities and University Colleges in this country. It is hoped that this action will stimulate interest in meteorological research.

The full list of problems is given below.

Dynamical or mathematical problems

1. Investigation of the formation, persistence and movement of anticyclones and wedges.

2. " Further outlooks " deduced from pressure distribution over northern hemisphere.

Mathematical examination is needed for these two problems in addition to the empirical study in the Meteorological Office.

3. Large scale air movements in the stratosphere and the extension of dynamical treatment to the stratosphere.

The north or south movement of air in the stratosphere is of great scientific interest in meteorology.

4. Determination of the rate of travel of waves in the atmosphere.

5. Factors governing the travel of depressions.

6. Energy transformations in relation to the development of pressure systems.

7. Investigation of convergence and divergence and geostrophic departure of the wind.

8. Application of statistical methods to vector quantities.

9. Equations of motion.—(*a*) Solution of the equations allowing for the variation of the Coriolis force—extension of Grimes' solution*. See also classic paper by Guldberg and Möhn†.

(*b*) Solution of equations for accelerated motion with constant uniform pressure field and its application to forecasting wind.

(*c*) Solution of equations for accelerated motion by expressing the pressure variation as exponential or circular functions (Fourier series) of the time.

(*d*) Investigation as to the reality of the oscillatory motion arising from geostrophic acceleration. See a paper by Hesselberg on atmospheric oscillations‡.

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*GRIMES, A. ; The movement of air across the equator. *Mem. Malayan met. Serv., Singapore.* No. 2, 1937.

†GULDBERG, C. M. AND MÖHN, M. ; Studies on the movements of the atmosphere. The mechanics of the earth's atmosphere. 3rd collection". *Smithson. misc. Coll., Washington, D.C.*, **51**, No. 4, 1910, p. 122.

‡HESSELBERG, TH. ; Uber oszillatorische Bewungen der Luft. *Ann. Hydrogr., Berlin*, **43**, 1915, p. 311.

(*e*) The effect of friction; decay of atmospheric oscillations (see the paper by Hesselberg, in which it is assumed that the friction is proportional to the velocity); further investigation of the solution for unsteady motion and its extension to include initial departures from appropriate solution for steady state.

(*f*) Investigation of the effect of the movement of air across the isobars on the pressure distribution.

Physical problems

10. The distribution of temperature in the stratosphere.

11. Possible use of water-vapour content to identify air masses in the stratosphere.

12. Possible use of ozone content to identify air masses in the stratosphere.

13. Structure of fronts in the upper troposphere and stratosphere as indicated by temperature, humidity, ozone and winds.

14. Reliable climatological data for upper air from 0 to 25 Km. for each month and all possible parts of the world.

To include temperature, pressure (density), humidity, winds, height of tropopause and giving both average values and variations from day to day and year to year.

Much of this could be compiled now and is badly wanted. Data for less explored parts of the world and humidities of the upper air could be added as they become available. Some work is in hand in the Meteorological Office.

15. Radiation in the atmosphere. (As programme for Gassiot Committee)

(*a*) Measurement of absorption coefficient of atmospheric gases under atmospheric conditions.

(*b*) Theoretical discussion of absorption and radiation of heat by the atmosphere.

(*c*) Calculation of equilibrium temperature for any height, at any latitude and any season including diurnal variation of temperature.

(*d*) Rate at which air masses at different levels would acquire new temperature if transported to different latitudes.

(*e*) Measurement of water vapour at all heights, seasons and latitudes.

(*f*) Measurement of ozone at all heights, seasons and latitudes.

16. Physics of condensation and sublimation of water vapour in the atmosphere.

17. Formation of rain and snow from cloud.

18. Latent heat of vaporization of supercooled water.

Apparently no data available.

19. Factors affecting coalescence of water drops having diameters in the range 1 μ to 7 mm.

Affects development of fog, cloud and rain.

20. Factors affecting the change of state from supercooled water in droplet form to ice.

Affects development of clouds and ice accretion on aircraft.

21. Nature of sublimation nuclei.

22. Radiation from small particles floating in the atmosphere and the consequential effects of the temperature of the particles being different from that of the ambient atmosphere.

Effects of radiation on the lapse rate and stability in a cloud layer.

23. The transfer of air downwards by the drag of a falling raindrop.

The mixing resulting from this process may affect the structure and composition of the lower atmosphere.

24. The fundamental theory of turbulence and its relation to the distribution of eddy velocities in space and time.

The theory of atmospheric diffusion and turbulence has been largely built up on R_ξ the correlation of the eddy velocity of the same particle at various intervals of time ξ. This correlation is not directly observable, nor of itself important. In view of the conditions of continuity and conservation of momentum and vorticity, it seems probable that some relation must exist between R_ξ and the correlation of wind at one point at various intervals of time and at one instant at various points in space. Knowledge of such relations would enable studies in diffusion to be directly linked with wind observations and studies of " bumpiness ". It would also lead to an understanding of the diffusion of water vapour by eddies too large to be observed except in wind variations.

25. The balance between radiation, diffusion and turbulence in the lowest layers of the atmosphere.

(*a*) With reference to fog and dew.

(*b*) With reference to air flow from water surface to land surface and *vice versa*. Kew already have in hand the simultaneous investigation of the diffusion of heat, water vapour and momentum and the flux of radiation. Similar work is also in hand at Rye and Cambridge.

26. Physics of thunderstorms.

Forecasting problems

27. Investigation of factors which govern the formation and dispersal of low stratus cloud.

28. Relation between horizontal temperature gradient and large-scale instability.

Treatment of thunderstorm development to include horizontal temperature gradient as well as vertical temperature gradient.

Instrumental problems

29. Development of a method of measuring air temperatures on high-speed (jet) aircraft which will avoid the application of large airspeed corrections.

30. Design of a new method of humidity measurement in radio-sondes at all heights.

31. Design of a relatively cheap instrument to measure atmospheric ozone.

ZONAL DISTRIBUTION OF HUMIDITY IN THE EARTH'S ATMOSPHERE

BY G. A. TUNNELL, B.SC.

In a recent issue of the Hungarian publication *Idojárás*, Prof. J. Száva-Kováts* has given the results of an investigation into the variations of average water content of the earth's atmosphere with variations in latitude. A variety of data has been used. Prof. Száva-Kováts has given averages of relative humidity and vapour pressure for zones of 5-degree intervals of latitude for land areas and sea areas. A land area or sea area is defined as one which is more than 50 per cent. respectively either land or sea. In addition, the total content of atmospheric moisture has been determined by means of Süring's formula:—

$$a_z = a_0 \, 10^{-z(1+z/20)/6}$$

where a_z is the vapour pressure at a height of z Km. above the earth's surface and a_0 is a constant. The stratosphere has been neglected. An examination of upper air data will show that this formula for averages of vapour pressure is only approximately true and certainly it is a great assumption to apply it to the whole world. However assumptions like this have to be made to get the order of magnitude of the phenomena. Table I gives the results of these calculations.

The second of Prof. Száva-Kováts' tables is given in Table II and it can be seen that the relative-humidity and vapour-pressure data can be used to divide the earth into climatic zones.

Zonal distribution of vapour pressure

(1) Tropical belt in which vapour pressure is higher throughout the year over continents than over the sea.

(2) Two subtropical belts of moderate vapour pressure where throughout the year continental air has less vapour than the sea air, especially in winter.

(3) Two belts of moderate width in which vapour content is small and where the vapour content of continental air is considerably smaller in winter and somewhat bigger in summer than that of the air over the open sea.

(4) Two polar regions of low vapour content where continental and sea air do not seem to differ.

Zonal distribution of relative humidity

(1) Tropical, humid zone where little difference can be found between the humidity of continental and sea air.

(2) Two dry subtropical belts where continental air is much drier than oceanic air during the whole year.

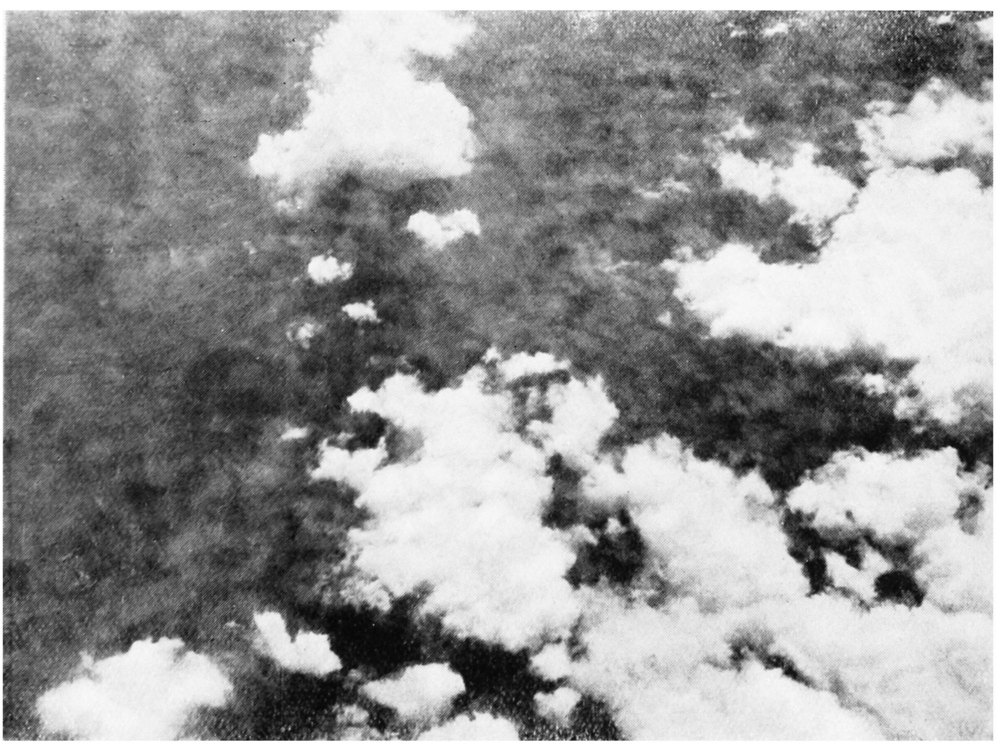
(3) Two humid territories in temperate latitudes inside which there are small differences between continental and oceanic conditions in winter. The continental section of this zone joins with the subtropical zone in summer.

*SZÁVA-KOVÁTS, J.; A légnedvesség övenkénti eloszlása a Földön. *Időjárás, Budapest*, **51**, 1947, p. 9.

Photograph by R.A.F.

APPROACH OF A WARM FRONT, 1425, JUNE 27, 1945

This photograph, taken from 15,000 ft. looking westwards at 50°5′N. 10°30′W. off south-west Eire shows the preliminary stages of a warm front above lenticular strato-cumulus.



Photograph by R.A.F.

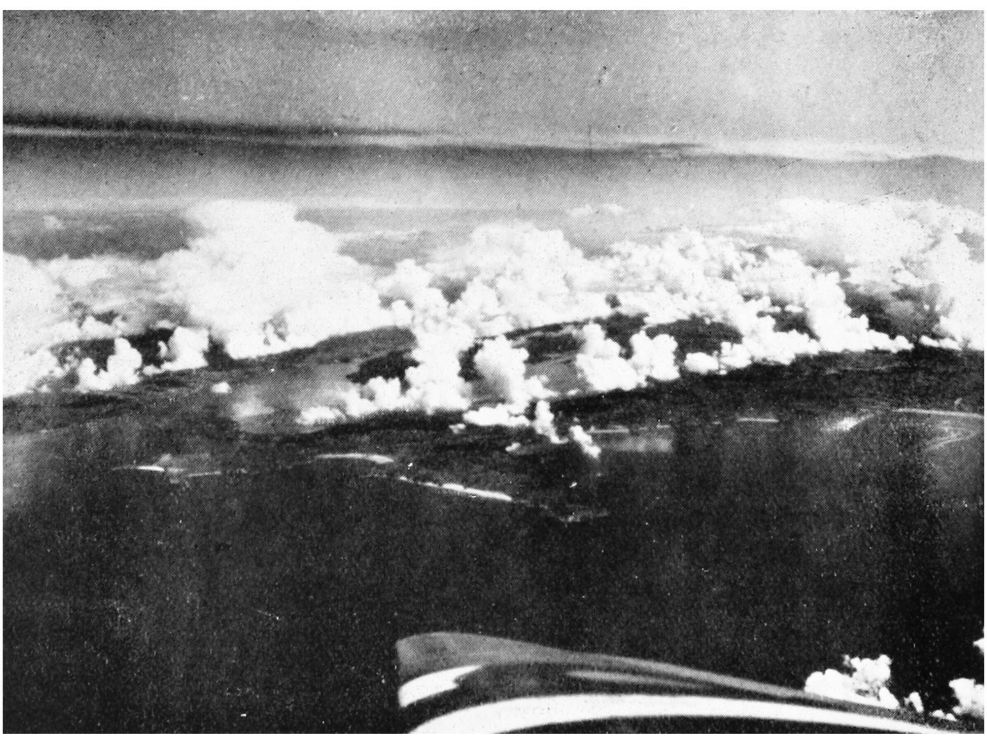
CIRROCUMULUS OVER COBLENZ, 1240, SEPTEMBER 9, 1943

This photograph, taken from 29,000 ft., is a close-up of clouds usually seen from the ground as very tiny dots high in the sky.

Photograph by R.A.F.

FAIR-WEATHER CUMULUS OVER THE ENGLISH CHANNEL, 1605, AUGUST 28, 1944

This photograph, taken from 29,000 ft. looking north-eastwards along the coast of Kent, shows cumulus in fairly regular rows casting shadows on the sea below. The wind at 2,000–3,000 ft. was westerly about 20 kt.



Photograph by R.A.F.

CUMULUS AND CUMULONIMBUS ON AUGUST 20, 1944, AT 1305

This photograph, taken from 29,000 ft. looking east-north-east towards Brest when the surface wind was almost calm, shows reflections of the cumulus clouds in the sea and the control of growth of cumulus on a fine day by sea breezes. The bank of cloud in the distance is associated with a quasi-stationary front over the southern coast of England.

(4) In polar regions conditions are wetter in summer and drier in winter with little difference between continental and sea surfaces.

It is seen that these divisions fit into the general climatic divisions of the earth which are decided ultimately by the movement of the sun and the dynamics of the atmosphere.

TABLE I—AVERAGE AMOUNT OF WATER VAPOUR IN THE ATMOSPHERE

Latitude	Surface Area	Total amount of water present		Average amount of water present	
		January	July	January	July
	10^3 Km^2	Km.^{3}	Km.^{3}	Kg./m.^{2}	Kg./m.^{2}
90—85°N.	971	0·8	11·4	0·71	9·86
85—80°N.	2,902	3·2	30·2	1·10	10·52
80—75°N.	4,814	7·1	55·5	1·49	11·63
75—70°N.	6,691	13·4	90·8	2·02	13·60
70—65°N.	8,511	22·4	137·2	2·66	16·33
65—60°N.	10,270	35·9	191·4	3·51	18·72
60—55°N.	11,953	55·9	248·8	4·69	20·83
55—50°N.	13,542	84·2	308·8	6·35	22·81
50—45°N.	15,026	123·0	378·3	8·04	25·17
45—40°N.	16,400	179·4	466·2	10·85	29·42
40—35°N.	17,647	257·6	564·4	14·90	31·99
35—30°N.	18,761	349·0	644·0	18·91	34·30
30—25°N.	19,730	441·4	715·8	22·70	36·35
25—20°N.	20,551	560·7	796·2	27·62	38·83
20—15°N.	21,214	711·0	878·9	33·43	41·60
15—10°N.	21,716	846·5	955·5	39·01	44·23
10— 5°N.	22,053	944·6	1000·8	42·83	45·58
5— 0°N.	22,224	995·6	1012·7	44·79	45·87
0— 5°S.	22,224	1010·7	988·0	45·63	44·77
5—10°S.	22,053	993·6	938·5	45·34	42·43
10—15°S.	21,716	940·5	831·0	43·51	40·30
15—20°S.	21,214	844·5	676·0	40·03	31·50
20—25°S.	20,551	743·1	549·9	36·45	26·63
25—30°S.	19,730	656·0	474·4	33·61	23·97
30—35°S.	18,761	564·4	403·9	30·19	21·50
35—40°S.	17,647	462·6	327·6	26·22	18·70
40—45°S.	16,400	345·2	253·4	21·18	15·92
45—50°S.	15,026	249·5	193·4	16·22	13·70
50—55°S.	13,542	182·9	149·6	13·58	11·84
55—60°S.	11,953	147·6	119·0	12·50	9·94
60—65°S.	10,270	109·7	81·5	10·85	7·91
65—70°S.	8,511	77·3	40·5	9·22	4·75
70—75°S.	6,691	54·7	16·7	8·32	2·51
75—80°S.	4,814	35·4	6·4	7·45	1·35
80—85°S.	2,902	20·0	2·0	6·95	0·70
85—90°S.	971	7·7	0·7	6·60	0·57
	509,950†	13,077·1†	14,539·4†	25·64‡	28·51‡

These data are for the atmosphere below the stratosphere.

† Total. ‡ Average.

It is of interest to examine Table II more closely. The zone extending 10°N.–10°S. is the zone of equatorial rains in which there is no geostrophic wind control. Further north to 22½°N. and further south to 22½°S. are zones with one cold season, two hot seasons and a distinct wet season. The uneven distribution of land and sea makes these zones unsymmetrical. Over land and sea the summer (July) vapour pressure in the northern zone is higher than the summer (January) vapour pressure in the southern zone, probably because the

TABLE II—ZONAL DISTRIBUTION OF HUMIDITY OVER CONTINENTAL AND SEA SURFACES

	Latitude	Vapour Pressure				Relative Humidity			
		January		July		January		July	
		Continental	Sea	Continental	Sea	Continental	Sea	Continental	Sea
		mm.	mm.	mm.	mm.	%	%	%	%
Polar	90—85°N.	—	0·2	—	2·0	—	80·1	—	85·9
	85—80°N.	0·1	0·4	2·3	4·4	80·0	80·3	82·0	85·5
	80—75°N.	0·3	0·6	5·0	4·9	80·1	80·7	80·2	84·2
	75—70°N.	0·4	1·0	5·9	5·7	80·2	81·7	77·0	82·4
Temperate	70—65°N.	0·6	1·7	7·1	6·7	80·4	82·8	75·0	82·4
	65—60°N.	0·9	2·3	8·4	7·8	80·7	83·6	73·8	83·7
	60—55°N.	1·1	2·9	9·7	8·6	81.6	84·5	72·5	84·9
	55—50°N.	1·4	3·9	10·8	9·3	81·8	84·2	70·1	85·5
	50—45°N.	1·8	5·1	11·9	10·5	78·3	82·7	65·7	84·3
	45—40°N.	2·6	6·4	12·8	12·9	72·2	80·3	61·4	81·6
Subtropical	40—35°N.	3·8	8·2	13·6	15·4	68·1	78·1	60·2	78·4
	35—30°N.	5·3	10·3	14·5	16·6	66·5	76·7	61·4	75·5
	30—25°N.	6·7	12·1	15·5	17·3	65·4	76·4	63·5	74·7
	25—20°N.	8·3	14·2	16·7	18·3	64·6	76·7	66·4	76·0
	20—15°N.	11·3	16·7	18·5	19·3	64·3	77·6	69·2	78·6
	15—10°N.	15·3	18·6	20·5	20·0	65·8	79·2	76·2	82·5
Equatorial	10— 5°N.	19·0	19·8	21·5	20·3	72·8	81·9	83·5	84·8
	5— 0°N.	21·0	20·4	21·6	20·6	81·7	84·5	85·0	85·0
	0— 5°S.	21·6	20·5	20·8	20·2	85·1	85·2	83·5	84·2
	5—10°S.	21·3	20·4	18·8	19·2	83·4	85·2	79·1	82·3
Subtropical	10—15°S.	19·6	19·9	16·0	17·6	78·8	84·6	72·6	80·1
	15—20°S.	16·6	18·7	12·4	14·9	71·1	82·9	66·8	78·5
	20—25°S.	13·4	17·2	9·0	12·8	64·3	80·2	63·6	77·9
	25—30°S.	12·5	15·8	7·3	11·5	61·6	78·0	63·9	78·0
	30—35°S.	11·8	13·9	6·8	9·9	62·3	77·1	68·3	78·9
	35—40°S.	10·8	11·8	6·0	8·1	65·1	77·8	73·3	80·7
Temperate	40—45°S.	9·5	9·3	5·1	6·7	68·5	80·6	77·2	82·4
	45—50°S.	7·9	7·0	4·5	5·5	72·9	83·1	80·8	83·7
	50—55°S.	6·6	5·8	4·1	4·6	77·0	84·1	82·8	84·5
	55—60°S.	—	5·2	—	4·0	—	84·9	—	85.0
	60—65°S.	—	4·5	—	3·1	—	85·1	—	84·2
	65—70°S.	3·9	3·7	1·6	1·9	82·7	84·0	81·7	82·4
Polar	70—75°S.	3·4	3·3	0·8	1·0	81·9	82·4	80·3	80·7
	75—80°S.	3·0	1·5	0·4	0·3	81·3	81·8	79·4	80·0
	80—85°S.	2·8	—	0·2	—	80·8	—	78·7	—
	85—90°S.	2·7	—	0·2	—	80·6	—	78·2	—

The horizontal lines dividing the zones are an approximate average division.

more extensive monsoon climates bring northwards greater amounts of moisture. The winter vapour pressures are slightly higher over land in the south and lower over the sea. These are the zones of SE. trades, NE. trades and monsoons. However, there is far more maritime influence in the southern zone, and the impression is given that sea temperatures control the southern zone while the great land heat controls the northern one.

From $22\frac{1}{2}°$ to 40°N. and S. are zones which contain much of the world's desert areas. Again there is the smoothing maritime influence in the southern hemisphere. The vapour pressure in the north is lower over land than over sea. The difference is greater in winter than in summer because of the great summer evaporation due to the high temperatures. However, these high temperatures cause a fall in relative humidity. The effects in the southern hemisphere are similar but less in magnitude.

Further polewards from 40°N. or S. are the temperate regions of depressions in which land and sea areas are similar, except in continental areas very far from the sea in the northern hemisphere where the high temperature in summer lowers the relative humidity and raises the vapour pressure. The remaining zones are the polar areas whose atmospheric water content is controlled by seasonal temperatures.

Prof. Száva-Kováts has examined humidity gradients and shown that discontinuities in gradient occur at the edges of climatic zones. This gives good backing to the use of humidity data in identifying air masses. If an air mass moves from one climatic zone to another it will take the characteristics of its first zone to the second. This investigation has shown that it is sound for humidity characteristics to be used in identifying the sources of air masses.

Finally the balance between evaporation and rainfall has been considered, with the resulting movement of water vapour which must take place to make up deficits in some places and surpluses in others.

According to these estimates the average water-vapour content of the earth's atmosphere is 13,808 $Km.^3$ of liquid water while the total annual rainfall as well as annual evaporation are each 511,080 $Km.^3$ of liquid water. Thus average rainfall and evaporation are 37 times the average water content of the earth's atmosphere.

Table III (Prof. Száva-Kováts' Table IV) shows the variations of the water economy of each zone from the average for the earth and gives the deficits and surpluses of the zones. It is doubtful whether in this table the evaporation data can be very reliable especially over areas like the Sahara desert; because so long as land surfaces can supply moisture freely then estimates of evaporation become feasible; but when areas are not giving moisture freely then their supplies of atmospheric moisture are complex. These difficult surfaces are spread over great areas in all continents.

The following conclusions are given by the paper concerning the water economy of the main climatic zones.

(1) There is little rainfall or evaporation in polar regions.

(2) Temperate regions show a great excess of rainfall over evaporation and are transition regions between the polar lack and subtropical surplus of evaporation.

(3) Subtropical zones are characterised by a great lack of rainfall and surplus of evaporation.

(4) The equatorial zone is marked by its rainfall surplus and lack of evaporation.

The movements of moisture given in the table are an expression of average conditions. The movement of water vapour to the equatorial regions is not true, for example, during the wet season in the African Sudan. At this time of the year moisture most definitely moves away from equatorial regions

TABLE III—WATER CIRCULATION OF THE ATMOSPHERE

Latitude	$\frac{R}{v} - 37$	$\frac{E}{v} - 37$	$\left(\frac{R}{v} - 37\right)v$	$\left(\frac{E}{v} - 37\right)v$	R	E	Balance and movement
				10^3 *cubic kilometres*			
90—80°N.	−17·7	−30·9	− ·40	− ·70	·44	·14	= + 1.87
80—70°N.	−10·0	−28·8	− ·85	− 2·40	2.25	·68	
							+20·23 ↑
70—60°N.	+ 3·7	−20·9	+ ·73	− 4·04	7·89	3·11	
60—50°N.	+18·8	+ 0·6	+ 6.56	+ ·21	19·47	13·12	= +18·36
50—40°N.	+13·1	+ 0·6	+ 7·52	+ ·34	28·74	21·51	
40—30°N.	− 1·7	+ 1.6	− 1·55	+ 1·45	32·23	35·04	
30—20°N.	−10·9	+ 2·2	−13·77	+ 2·76	32.73	49·24	= −33·83
20—10°N.	− 8.3	+ 0·2	−14·07	+ ·33	48·67	63·18	↓
10— 0°N.	+ 4·4	− 5·8	+ 8·76	−11·46	81·89	61·69	= +20·20 { +13·60
0—10°S.	− 4·6	− 1·8	− 9·19	− 3·53	63·53	69·16	+ 6·60
							↑
10—20°S.	− 6·8	+ 2·9	−11·22	+ 4·77	49·68	65·61	
20—30°S.	− 8·4	+ 5·8	−10·26	+ 7·02	34·57	51·95	= −46·63
30—40°S.	+ 1·6	+10·3	+ 1·46	+ 9·05	33·99	41·67	
40—50°S.	+35·9	+10·2	+18·71	+ 5·31	37·98	24·62	↓
50—60°S.	+54·1	−10·4	+16·21	− 3·11	27·29	7·98	= +39·19
60—70°S.	+19·1	−23·0	+ 2·96	− 3·55	8·68	2·16	+40·03
70—80°S.	−19·6	−33·6	− 1.11	− 1·90	·98	·19	= + 0·84
80—90°S.	−32·3	−35·7	− ·49	− ·54	·07	·02	

E = Average annual evaporation of liquid water over whole zone.
R = Average annual rainfall received by the whole zone.
v = Average water-vapour content of atmosphere over whole zone.

If E_0, R_0, v_0 are average conditions for the earth, then

$$R_0 = E_0 = 37 v_0$$

$$\text{or} \quad R_0/v_0 = E_0/v_0 = 37$$

Therefore R/v—37 and E/v—37 are the differences from the average earth conditions of each zone where E, R, v are the values for the particular zone. The last column (Balance and movement) gives the excess of rainfall over evaporation, a negative sign implying an excess of evaporation over rainfall. More details of the annual rainfall over the earth for 5-degree zones of latitude can be found in a paper by W. Meinardus.*

to subtropical regions. It is very necessary in this case not to particularise from average figures because the equatorial region is the richest in moisture of any zone, and any exchange of air mass at the surface must lead to a loss of moisture by the equatorial zone. The belt of tropical rains has a seasonal movement and it must be true that there is always a flow of moisture into this belt.

ERRATUM

August, 1947, PAGE 179, line 26; *for* "at 1130" *read* "at 1115".

*MEINARDUS, W.; Die Niederschlagsverteilung auf der Erde. *Met. Z., Braunschweig*, **51,** 1934, p. 345.

METEOROLOGICAL RESEARCH COMMITTEE

The 51st meeting of the Meteorological Research Committee was held on October 30, 1947.

Following the circulation to Universities of the list of fundamental problems (see p. 269) a request had been received by the Committee for a member to give a talk at one of the Universities on the mathematical problems of meteorology. This was arranged.

The papers considered by the Committee included one, by R. J. Murgatroyd, on some anomalous sound-reception experiments carried out during the war. The work described in this paper marks a big advance on other observations of this type, partly due to the fact that the explosions were deliberately organised for this purpose.

Another paper, by Dr. A. H. R. Goldie, dealt with the estimated distribution of temperature, pressure and wind up to 45 Km. on the basis of the most recent observations, and there was also a discussion of the diurnal variation of upper air temperatures as measured by the Kew Mark I radio-sonde following a report by J. Piegza.

Messrs. J. S. Sawyer and D. Dewar contributed a paper giving seasonal charts of the mean height of the tropopause over the earth. There were also two papers by F. Pasquill dealing with the measurements of evaporation from a field by means of measurement of the gradient of humidity in the lowest few feet of the atmosphere and computation of the upward flux of water vapour.

METEOROLOGICAL OFFICE DISCUSSIONS

The Meteorological Office held the opening Monday evening discussion of the present session in the lecture theatre of the Science Museum on November 17, 1947. Mr. R. H. Clements opened the discussion, which dealt with the paper by J. Bjerknes and J. Holmboe entited " On the theory of cyclones ", published in the first number of the *Journal of Meteorology**.

Mr. Clements explained that in this paper the tendency equation was invoked to demonstrate that large-scale pressure variations at the surface depended on the integral of the horizontal divergence. Choosing first a simplified trough pattern, the longitudinal and transversal divergence terms were estimated qualitatively using the concept of isobaric channel flow, resulting in the requirement of a mean relative zonal wind greater than a certain critical value for eastward transport of the trough. The application to baroclinic westerly currents was given.

The main portion of the paper was devoted to suggesting a mechanism for cyclogenesis postulating vertical motion as the trigger factor. The tendency equation was used to define two limiting cases between which actual cases were likely to lie, and by choosing a reasonable in-between case an explanation was offered for the formation and intensification of a wave disturbance in a baroclinic westerly current with a low level of non-divergence. Tentative explanations were also put forward for the seasonal cycle, the damping out of waves in the stratosphere and the development of tropical storms.

J. Met., Milton Mass.* **1, 1944, p.1.

Closed systems in the lower levels were then considered and it was demonstrated how closed cyclonic isobars tended to pile up air to the east and oppose eastward motion. The general cyclone pattern with closed isobars below and sinusoidal isobars above was then discussed leading to an explanation of the life history of a cyclone.

The Director then threw the meeting open to discussion asking whether the work in the paper had been tested in the synoptic field. Dr. Sutcliffe, whilst recognising that the paper was an important contribution and, in particular, noteworthy for the absence of any mention of ideal fronts, nevertheless considered that the treatment was too idealised. Mr. Sawyer was highly sceptical of qualitative treatment generally, saying that in reaching conclusions borne out by facts one was not entitled to assume that the methods used were therefore correct. Mr. Matthewman subsequently put this objection in more concrete form by pointing out that although the authors had dealt with the divergence of gradient winds the divergence of non-gradient winds brought other terms into the picture, and these terms were potentially important. Mr. Bannon was dissatisfied with the scant respect the paper showed for vertical motion. Mr. Miles gave a brief account of some work that had been carried out in America on the slopes of the axes of tropical storms as far as it touched on the paper under discussion.

In the course of the discussion and in his closing remarks, Mr. Clements said he could find cases in which the critical speed was exceeded with no motion of the trough; that he was dissatisfied with the whole concept of isobaric channel flows, in particular showing that the assumption of zero transversal divergence in some cases meant that the longitudinal divergence was also zero. He was also in some difficulty about the limits set down in the cyclogenesis section of the paper as they did not allow upward motion with falling pressure and *vice versa.*

ROYAL METEOROLOGICAL SOCIETY

At the meeting of the Society, held at 49 Cromwell Road, on November 19, with Prof. G. M. B. Dobson, President, in the Chair, the following papers were read:—

N. P. Sellick—Note on the dynamics of development.

It had been hoped that Mr. Sellick, Director of the Rhodesian Meteorological Service, who had been visiting this country on his way back from meetings in Canada and the United States, would have been present to read his "Note on the dynamics of development" but unfortunately he had been unable to extend his stay sufficiently. In his absence Dr. Sutcliffe gave a brief account of the paper.

The author had dealt with a hypothetical case in which a horizontal slice of air rotating with constant angular velocity was, by the imposition of a uniform field of convergence, constrained to increase its rate of rotation to another steady value. An average convergence of 10^{-5} sec.$^{-1}$ was required to change a rotation of 5×10^{-6} to $7{\cdot}41 \times 10^{-6}$ sec.$^{-1}$ in six hours in the average latitude chosen (where $2\omega \sin \phi = 10^{-4}$ sec.$^{-1}$).

From the equations of motion the associated pressure field was determined, and it was shown that a fall of pressure of 5·4 mb. at the centre of a depression of 400 Km. radius was required. It was thus inferred that the average divergence in the column of air above would be only $2 \cdot 5 \times 10^{-7}$ or roughly 1/40 of the convergence required to produce the circulation. Thus in this case, which illustrated a general principle, the amount of divergence involved in creating circulation was much greater than that involved in creating pressure changes.

Mr. Gold and Prof. Sheppard joined in the discussion, and amongst the points to which attention was drawn were the highly artificial assumptions made as well as the rather sudden jump from a rotating slice to the whole atmosphere. Dr. Sutcliffe thought however that the paper did illustrate a very important principle of general application which was by no means so widely known as it might be.

S. Petterssen and W. C. Swinbank—On the application of Richardson's criterion to large-scale turbulence in the free atmosphere.

Mr. W. C. Swinbank introduced this paper by referring briefly to Reynolds' original work on the eddy motion of incompressible fluids. Reynolds, by considering the various forms of energy involved in such motion, showed that the kinetic energy of eddying will increase if the rate of working of the shearing stresses exceeds the rate at which eddying energy is degraded into heat energy. L. F. Richardson adapted Reynolds' treatment to the case of a compressible fluid, in particular to the atmosphere, where the eddies must do work as they expand. By considering all the forms of energy involved in a large atmospheric block, including radiation, heat transfer and potential energy as well as those considered by Reynolds, Richardson had derived a criterion showing that the kinetic energy of eddying will increase if the work done by the shearing stresses exceeds the work done against gravity, and *vice versa*.

Twelve diagrams were then shown each referring to a layer of air 50-mb. deep, and extending in all from 900 to 300 mb., in which were plotted simultaneous observations of vertical wind shear and lapse rate of temperature. The observations totalled over 1,500, and covered a period of 3 months. It was obvious from the diagrams that, if Richardson's criterion were correct, turbulence in the troposphere would be nearly always decreasing. Using as a principle that over a long period of time there would be no net change in the turbulent state of the atmosphere it was clear that observation could be reconciled with theory only by modification of Richardson's analysis. This could most obviously be done in respect of his rather arbitrary assumption that the coefficients of eddy diffusion of heat and momentum were identical. The speaker explained how, by dropping this assumption and using the principle that there is no net change of turbulence over a long period, the data had been re-analysed to determine the ratio of these coefficients. It turns out that the ratio of the coefficient for heat to that for momentum is remarkably constant at about 0·65 throughout the troposphere.

The discussion that followed could have left Fellows in no doubt that turbulence is an aptly named subject. The whole gamut of turbulent processes was covered, ranging from references to " eddies " of synoptic dimensions by Prof. P. A. Sheppard and Mr. E. T. Eady (who finds an application of a form of Richardson's criterion to large-scale air-mass behaviour) to a contribution from Mr. E. L. Deacon referring to turbulence in a shallow layer near the ground. Dr. R. C. Sutcliffe (questioning whether the criterion could be applied to 50-mb. layers) was of the opinion that shearing stresses were not primarily responsible for creating turbulence, but rather that turbulence was diffused upwards to all levels from the earth's surface. Mr. E. Gold and Mr. J. S. Sawyer asked whether Richardson had taken account of turbulence advected into the layers under consideration, and Dr. J. M. Stagg, welcoming an investigation into turbulent problems in the free atmosphere, suggested that the data might have been further analysed to see whether the ratio of the coefficients varied with stability.

ROYAL ASTRONOMICAL SOCIETY

A geophysical discussion on atmospheric turbulence was held by the Royal Astronomical Society on October 24, 1947, with Professor D. Brunt in the Chair.

The discussion was opened by Prof. O. G. Sutton who outlined briefly the difficulties encountered and the methods adopted in dealing with turbulence in the atmosphere. The standard equations of motion for a viscous fluid contain terms depending on the products of eddy velocities and for this reason are intractable mathematically. A more fundamental difficulty however arises from the fact that the pattern of flow varies with the speed. The viscosity of a fluid may be regarded either as the characteristic governing the velocity profile in the fluid, or as an agency for diffusing momentum or it may be related to the shearing stresses. If we postulate the existence of an eddy coefficient in the turbulent flow in the atmosphere, observations show that it is many times greater than the corresponding molecular coefficient, but that it is of the same order of magnitude whether we consider transfer of heat or momentum. This is satisfactory but the theory fails when it is found that the eddy coefficient is a function of position, i.e. of distance from the boundary.

An alternative treatment due to Prandtl introduces the idea of a mixing length analogous to the mean free path in kinetic theory, and development of this idea relates the mixing length to the shearing stress in the air.

Prof. Sutton concluded by stressing the need for more attention to be paid to turbulence in the free air, remote from boundary influences.

Prof. Sheppard then gave a short discussion of the problem of the aerodynamic drag of the atmosphere and boundary-layer profiles. Laboratory experiments have led to a relation between the velocity u at a distance z from a rough boundary surface, a length characteristic of the roughness, the shearing stress in the fluid at the surface and a constant known as Kármán's constant. This relation indicates that u varies as $\log z$. A similar relation has been found in the lowest layers of the atmosphere but without measurement of the drag of the atmosphere on the earth's surface and it was not possible to say that the relation was the same as in laboratory work. In some recent work Prof. Sheppard has measured the drag at the earth's surface, and from this has been able to show that, under adiabatic conditions, the law for the velocity profile determined in the laboratory applies also to variation of wind with height in adiabatic conditions in the lowest layers of the atmosphere.

This was followed by a short discussion by Mr. F. Pasquill of some recent experimental work on evaporation from the surface of a field. His results indicated that wind velocity and water-vapour density both follow a logarithmic

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LIGHTNING AT WUNSTORF, JUNE 5, 1947

These photographs were taken looking south from the meteorological office at Wunstorf, near Hanover. The top photograph was taken at 0152, the bottom at 0158 as the thunderstorm moved from south to north over the airfield.

METEOROLOGICAL OFFICE DISPLAY TRAILER IN THE LORD MAYOR'S SHOW, 1947

(see p. 284)

law in respect of their variation above the surface. From these results the rate of evaporation from the grass surface can be computed. These showed reasonable agreement with evaporation measured by other methods.

Mr. Pasquill also dealt briefly with the turbulent diffusion of spores and pollen, and outlined a method of computing this diffusion using the normal turbulence theory.

A number of speakers took part in the general discussion which followed. Amongst these was Mr. E. L. Deacon who demonstrated a slide giving results of some experimental measurements of temperature and velocity gradient which strongly emphasised the importance of the Richardson number in turbulent flow in the lowest layers of the atmosphere.

A. C. BEST

MEETING OF THE ROYAL GEOGRAPHICAL SOCIETY

On November 10, 1947, Mr. H. H. Lamb of the Meteorological Office gave a lecture to the Royal Geographical Society under the title "Topography and weather in the Antarctic". Mr. Lamb was the meteorologist loaned to United Whalers Ltd. for the 1946–7 Antarctic whaling expedition, in which he accompanied the floating factory *Balaena* to the southern ice. The task included forecasting weather for whale-spotting reconnaissance flights by the expedition's Walrus aircraft over the remotest tracts of the Southern Ocean and some of the least known stretches of the coast of Antarctica.

The distinctive feature of this task was the experimental establishment of a weather forecasting service in regions over 1,500 miles from the next regular observing and reporting stations and close to unknown land. This land was seen on several days and, in bright weather, several ranges of coastal mountains up to about 4,000 ft. high were sketched. When the vessel was in 65°S. 112°E. the coastal mountains were probably only 25 to 30 miles away. Careful and accurate identification of cloud features in the manner familiar to experienced meteorological observers provided some useful checks in cases of doubtful appearance of land and helped to give an idea of the height of the coastal mountains, when these were boldly seen.

This does not appear to be one of the most mountainous stretches of the coast of Antarctica, but naturally orographic effects were noticeable in the weather off shore. It was essential for forecasting purposes to make some assumptions about the shape of the unknown land and its coast. This basic need of the forecasting work could only be supplied by reasoning from the observed effects on winds and weather, which luckily appeared very marked and regular. Geographical interest has been attached to this unusual process of reasoning back from meteorological effects to diagnose the nature of the land-relief acting as cause. The results could only be put forward as suggestions to explorers as to what to look for; but they may in the meantime be justified as provisional working assumptions for geographers and others, since the weather forecasting work on the *Balaena* for which they were first used gave results that exceeded expectations. Certain information received since from Admiral Byrd's recent expedition and a German expedition in 1939 also tends to support this work.

A tentative outline of the coast of Antarctica between 100° and 120°E. was shown; and, by indirect reasoning from the *Balaena* daily weather maps, the existence of a major topographical barrier in East Antarctica between about 70°S. 97–100°E. and 80°S. 80°E. was mooted. This barrier, which is probably the main crest of the Antarctic ice-cap, may continue as the backbone of East Antarctica to near the Greenwich meridian in 80°S.

Other points of interest included:

(i) suggested regional differences of climatic character in different longitudes around Antarctica, on which of course local effects are superimposed;

(ii) controlling influence of the subtropical high-pressure cells, which steer the disturbances of higher latitudes and thereby made possible the completion of the weather maps over the wide spaces of the Southern Ocean; and

(iii) discovery from after-checks that the most reliable of the weather maps were those in the series which were experimentally extended right across the south pole. The gain in understanding of the interrelation of events in different longitudes around the southern hemisphere apparently justified the attempt, in spite of the sparsity of the reports available when the maps were drawn. An objective check of the daily weather forecasts issued for 24 to 36 hours ahead on the whaling grounds throughout the expedition suggests the same conclusion.

LETTERS TO THE EDITOR

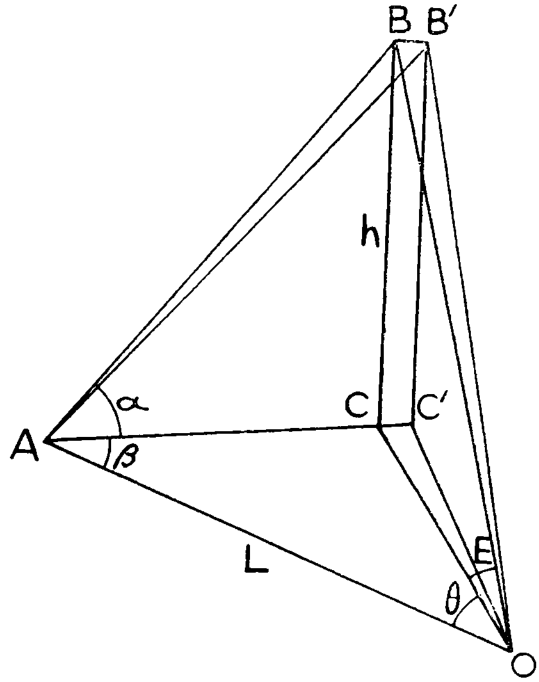
An azimuthal method of measuring cloud height with a searchlight

In the *Meteorological Magazine* for May, 1947, p. 102, Mr. Bilham describes an azimuthal method of measuring cloud height with a searchlight. He claims that this gives much higher accuracy for cloud heights above 2,000 ft. than the usual method using a vertical beam and measuring the elevation of the spot of light. There seems to be a serious fallacy in the theory, however, namely the assumption that because it is possible to measure the elevation of the spot of light to the nearest whole degree it is also possible to measure its azimuth with the same accuracy.

That this is not so is evident from the figure, which is based on Fig. 2. of Mr. Bilham's article. BB′ represents the uncertainty in the position of the spot of light, and by analogy with the ordinary cloud searchlight this subtends one degree at the eye, i.e. angle BOB′ = 1°. But the corresponding uncertainty in the azimuth is angle COC′ = angle BOB′ × OB/OC = angle BOB′× secE. The following table shows values of E and sec$E$ for various values of the azimuth (taking $\alpha = 80°$, $\beta = 45°$):

Azimuth θ	20	30	40	50	60	70	80	90	100	110	120
Elevation E	69·8	75·8	78·9	80·6	81·7	82·3	82·7	82·8	82·7	82·3	81·7
sec$E$	2.90	4·08	5·19	6·12	6·93	7·46	7·87	7·98	7·87	7·46	6·93

The values of sec$E$ give the error (in degrees) to be expected in measuring θ, and it is seen that this amounts to 6–8° for azimuths greater than 50°, i.e. cloud heights greater than about 4,300 ft. (using a 1,000-ft. base line). If the errors shown in Fig. 3 of Mr. Bilham's article are multiplied by the corresponding values of sec$E$ they no longer show any improvement on the errors of the " elevation " curve. Similar considerations show that the accuracy of the azimuthal method with a 200-ft. base line is likely to be much less than that claimed, which is based on an error of only one degree in the azimuth.



A—Searchlight.
BB′—Spot of light on cloud.
C, C′—Points, on ground, vertically below B, B′.
O—Point of observation.

A qualitative assessment of the relative accuracy of elevation and azimuth measurements is given by imagining the sky covered by a network of latitude and longitude lines with the " north pole " at the zenith. Latitude would then correspond to altitude and longitude to azimuth. If a cloud searchlight spot was seen against such a network in latitude 80°, its longitude could clearly be measured much less accurately than its latitude owing to the longitude lines being much closer together.

J. R. BIBBY

[The same difficulty in the use of the method proposed by Mr. Bilham has also been pointed out by Rear Admiral Schuyler, U.S.N. (Retd.), 1506, 34th St., N.W., Washington, D.C.—Ed. *M.M.*]

[It is certainly true, as Mr. Bibby points out, that the advantage of the azimuthal method will be nullified if the probable error of a measurement of azimuth is substantially greater than the probable error of a measurement of elevation. The same point was made by Mr. F. Graham Millar of the Meteorological Service of Canada in a document presented to the Commission for Instruments and Methods of Observation at the recent Toronto meeting. There has been some delay in starting the trials at Dunstable, and we therefore do not yet know what precision in measuring the azimuth of the spot of light produced by the beam is realisable. I hope this information may shortly be available.—E. G. BILHAM]

A simple method of making hypostereograms of clouds with a single camera

In your August number Mr. Tricker described a method of taking stereoscopic photographs of clouds by taking advantage of the drift of the clouds. The method is not new. It was described by me in an article in the *Quarterly Journal of the Royal Meteorological Society, London*, **43**, 1917, p. 81, and a stereoscopic pair of photographs of a cumulonimbus cloud, taken in 1911, appeared opposite the same page.

C. J. P. CAVE

Stoner Hill, Petersfield.

NOTES AND NEWS

Presentation to Mr. E. Gold

The presentation of a farewell gift from the Staff of the Meteorological Office to Mr. E. Gold on his retirement, was made by the Director before the Monday evening discussion on November 19, 1947, in the lecture theatre of the Science Museum.

The gift consisted of a barograph, Plutarch's " Parallel Lives of the Greeks and Romans " (6 volumes), an attache case fitted as an escritoire, and a cheque.

The Director, before making the presentation and expressing the good wishes of the Staff to Mr. Gold for his well earned retirement, gave the address on Mr. Gold's career summarised in the November number of this magazine.

Mr. Gold, returning thanks, referred to numerous events, grave and gay, in the history of the Meteorological Office during the past 40 years. He said one of his first connexions with international meteorology had been a request to Sir Napier Shaw, who was about to attend the meeting of the International Committee in 1913, to obtain a symbol for sleet. Sir Napier Shaw, however, returned to say that sleet could not be recognised as such and had had to be called " rain and snow mixed". Recalling the introduction of the millibar he recited a poem on the virtues of " Miss Milly Bar". He thanked by name all his personal assistants and typists throughout the years.

Turning to the gifts, he said he had always had an affection for barographs since Sir Douglas Haig's barograph had played the game by him when he had had to adjust it on the night before the battle of Loos in 1915. As for Plutarch, he would greatly appreciate those volumes of the lives of great men, while the escritoire would be like the archdeacon's gaiters which he would never be without, even in bed. He said that when, in 1575, Queen Elizabeth visited his native city of Coventry, in accepting the gifts of the townspeople, she told the mayor that the best of them was the spirit in the hearts of the givers. Similarly he too appreciated much more than the gifts the good wishes of the givers which they conveyed.

Lord Mayor's Show procession, November 10, 1947

The Meteorological Office has produced exhibits illustrating its work at numerous exhibitions, shows and displays, but had not, before the Lord Mayor's Show of 1947, taken part in a moving pageant.

The Lord Mayor of London-elect, Sir Frederick Wells, selected " The Country comes to Town " as the theme for the Show of 1947. The Meteorological Office, asked to participate, had to conform to the theme and produce an exhibit illustrative of its work for agriculture.

The aspect of this work selected was the preparation of forecasts for farmers. There was no opportunity, since each exhibit can only be seen by individual spectators for some 10 to 20 seconds, of referring to any of the other work performed for agriculture.

The display was mounted on a " Queen Mary " trailer, normally used for transporting aircraft. A partition was built along the centre of the " Queen Mary " painted on each side with four panels. The first of these showed a meteorological reconnaissance aircraft, a weather ship and a radio-sonde station. The second and third consisted of an outline weather map and a farmhouse kitchen respectively, while the fourth showed a harvesting scheme. These were headed :—" Information comes from air, sea and ground—to the forecaster—the farmer hears the B.B.C. weather forecast."

On the floor in front of the panels were fixed, suitably labelled, a Stevenson screen with thermometers and a rain-gauge, while slung from the roof was a radio-sonde.

A forecaster sat at his table spread with charts and coloured pencils under the appropriate heading, while alongside the farmhouse kitchen sat a " farmer " listening to a " wireless set."

To provide the more light-hearted touch, traditional in the Lord Mayor's Show, pilot balloons were released at intervals from the rear of the vehicle.

G. A. BULL

REVIEW

Observations made at secondary stations in the Netherlands Indies, by H. P. Berlage, Jr. Vol. XXIV (1942). 4to. 15 in. × 10½ in. pp. viii + 35. Royal Magnetic and Meteorological Observatory, Batavia [1947]

For many years before the war the Royal Observatory, Batavia, had published annually the observations made at their secondary stations in the Netherlands Indies. These stations, manned by native observers, were well distributed and made a valuable contribution to knowledge of climatic conditions in equatorial islands.

When, in 1942, the Netherlands Indies were overrun by the Japanese, the Director and staff of Research Associates of the Observatory were imprisoned, and it seemed certain that the continuity of records extending over many years would be interrupted. Some stations were in fact destroyed, but the majority continued in operation, and it speaks very highly for the devotion and zeal of the observers that a large amount of climatological data was accumulated.

A special welcome should therefore be accorded the present volume which contains the observations made in Java and Madura in 1942. The records relate to about 100 stations, and the elements represented consist of pressure, temperature, humidity, rainfall, wind and sunshine.

P. H. MEADE

WEATHER OF OCTOBER, 1947

The weather of October was mainly anticyclonic throughout the month over the greater part of Europe. An anticyclone occupied the British Isles and central Europe on the 1st to 5th and persisted over southern and central Europe until the 13th. It receded eastwards on the 14th, but a new anticyclone came in from the Atlantic on the same day and moved gradually eastwards to central Europe by the 18th. From the 20th to the end of the month it lay mainly over Scandinavia. The weather in the British Isles was affected to some extent by a deep depression over Iceland on the 9th, but the only real disturbance was caused by a depression which moved north-eastwards into south-west England on the 22nd and then turned south-east. This gave heavy rain in parts of the south-west, amounting to two inches at Scilly.

The pressure chart for the month shows a large area of pressure exceeding 1020 mb., extending from Ireland to the Black Sea and including southern Scandinavia ; from Scotland to Denmark, pressure was 10 mb. above normal. By contrast, pressure was low (5 mb. below normal) south of Greenland; over eastern North America conditions differed little from normal.

The weather over the British Isles was distinguished by a deficiency of rainfall. In England and Wales it was the driest October in a record going back to 1869. In England and Wales, also, the period June to October 1947 was drier than any similar period back to 1869 ; it ranked with 1921, the total rainfall for the five months being 8·7 in. in 1947 compared with 9·1 in. in 1921. In Scotland the month, though dry, was not nearly so dry as October 1946. The month was generally rather warm, particularly in Scotland and Northern Ireland. Warm days occurred at times, mainly from the 4th to the 13th, temperature reaching 75°F. at Long Sutton, Blandford, Totnes and Ellbridge on the 6th and at Wilmington on the 13th. On the other hand cold easterly winds kept day temperatures low during the last six days, while severe frosts were registered locally on the 21st, 22nd and 30th, for example 22°F. at Milford, Surrey, on the 21st. Sunshine appreciably exceeded the average in the west and south of England and Wales but was deficient on the whole in north-east England. In Scotland it was generally dull but an excess occurred in the extreme north-west, round the Moray Firth and in south Ayrshire. Although anticyclonic conditions prevailed for the most part and the total run of the wind was considerably below the average, mean hourly velocities of gale force were registered at Lerwick on the 12th, at Stornoway on the 11th and 12th, and at Scilly and the Lizard on the 22nd and 23rd.

The general character of the weather is shown by the following table :—

	Air Temperature			Rainfall		Sunshine	
	Highest	Lowest	Difference from average daily mean	Percentage of average	No. of days' difference from average	Percentage of average	Percentage of possible duration
	°F.	°F.	°F.	%		%	%
England and Wales	75	22	+1·6	20	—11	108	33
Scotland ..	71	23	+2·8	56	—4	93	25
Northern Ireland..	71	31	+3·4	60	—7	103	27

RAINFALL OF OCTOBER, 1947

Great Britain and Northern Ireland

County	Station	In.	Per cent of Av.	County	Station	In.	Per cent of Av.
London	Camden Square ..	·07	3	*Glam.*	Cardiff, Penylan ..	1·15	24
Kent	Folkestone, Cherry Gdns.	·36	9	*Pemb.*	St. Ann's Head ..	1·77	40
,,	Edenbridge, Falconhurst	·45	13	*Card.*	Aberystwyth	·51	12
Sussex	Compton, Compton Ho.	1·13	25	*Radnor*	Bir. W. W., Tyrmynydd	1·26	19
,,	Worthing, Beach Ho. Pk.	·82	23	*Mont.*	Lake Vyrnwy	1·67	28
Hants.	Ventnor, Roy. Nat. Hos.	1·56	40	*Mer.*	Blaenau Festiniog ..	1·84	18
,,	Fordingbridge, Oaklands	1·07	26	*Carn.*	Llandudno	·55	16
,,	Sherborne St. John ..	·73	21	*Angl.*	Llanerchymedd ..	·40	9
Herts.	Royston, Therfield Rec.	·17	6	*I. Man.*	Douglas, Boro' Cem. ..	·78	17
Bucks.	Slough, Upton ..	·13	5	*Wigtown*	Pt. William, Monreith ..	1·34	34
Oxford	Oxford, Radcliffe ..	·41	14	*Dumf.*	Dumfries, Crichton R.I.	·99	25
N'hant.	Wellingboro', Swanspool	·19	8	,,	Eskdalemuir Obsy. ..	1·54	29
Essex	Shoeburyness	·32	14	*Roxb.*	Kelso, Floors	1·07	37
Suffolk	Campsea Ashe, High Ho.	·29	11	*Peebles.*	Stobo Castle	1·16	34
,,	Lowestoft Sec. School ..	·34	12	*Berwick*	Marchmont House ..	·97	25
,,	Bury St. Ed., Westley H.	·25	9	*E. Loth.*	North Berwick Res. ..	1·12	38
Norfolk	Sandringham Ho. Gdns.	·32	11	*Midl'n.*	Edinburgh, Blackf'd. H.	1·22	45
Wilts.	Bishops Cannings ..	·52	16	*Lanark*	Hamilton W. W., T'nhill	1·48	45
Dorset	Creech Grange	1·91	38	*Ayr*	Colmonell, Knockdolian	1·74	39
,,	Beaminster, East St. ..	1·02	23	,,	Glen Afton, Ayr San. ..	2·06	40
Devon	Teignmouth, Den Gdns.	·97	25	*Bute*	Rothesay, Ardencraig ..	2·29	52
,,	Cullompton	·70	17	*Argyll*	Loch Sunart, G'dale ..	4·38	67
,,	Barnstaple, N. Dev. Ath.	1·58	35	,,	Poltalloch	..	..
,,	Okehampton, Uplands	2·42	40	,,	Inveraray Castle ..	5·62	80
Cornwall	Bude School House ..	1·40	34	,,	Islay, Eallabus ..	2·77	58
,,	Penzance, Morrab Gdns.	1·81	39	,,	Tiree	1·87	41
,,	St. Austell, Trevarna ..	2·18	41	*Kinross*	Loch Leven Sluice ..	1·99	58
,,	Scilly, Tresco Abbey ..	2·59	68	*Fife*	Leuchars Airfield ..	1·41	54
Glos.	Cirencester	·43	13	*Perth*	Loch Dhu	5·45	76
Salop	Church Stretton ..	·33	9	,,	Crieff, Strathearn Hyd.	2·76	70
,,	Cheswardine Hall ..	·62•	20	,,	Blair Castle Gardens ..	1·85	60
Staffs.	Leek, Wall Grange P.S.	·45	13	*Angus*	Montrose, Sunnyside ..	1·55	56
Worcs.	Malvern, Free Library	·44	15	*Aberd.*	Balmoral Castle Gdns...	2·00	56
Warwick	Birmingham, Edgbaston	·40	14	,,	Aberdeen Observatory	1·99	66
Leics.	Thornton Reservoir ..	·34	12	,,	Fyvie Castle	2·33	61
Lincs.	Boston, Skirbeck ..	·21	8	*Moray*	Gordon Castle	1·51	48
,,	Skegness, Marine Gdns.	·19	7	*Nairn*	Nairn, Achareidh ..	1·16	51
Notts.	Mansfield, Carr Bank	·18	6	*Inv's*	Loch Ness, Foyers ..	2·30	68
Ches.	Bidston Observatory ..	1·09	33	,,	Glenquoich	8·38	84
Lancs.	Manchester, Whit. Park	·53	16	,,	Ft. William, Teviot ..	5·54	78
,,	Stonyhurst College ..	·85	19	,,	Skye, Duntuilm ..	3·18	58
,,	Blackpool	·49	13	*R. & C.*	Ullapool	2·35	50
Yorks.	Wakefield, Clarence Pk.	·77	27	,,	Applecross Gardens ..	3·27	55
,,	Hull, Pearson Park ..	·59	20	,,	Achnashellach	5·47	72
,,	Felixkirk, Mt. St. John	·64	22	,,	Stornoway Airfield ..	3·08	63
,,	York Museum	·83	31	*Suth.*	Lairg	2·26	61
,,	Scarborough	·58	19	,,	Loch More, Achfary ..	6·57	84
,,	Middlesbrough	·28	9	*Caith.*	Wick Airfield	1·62	55
,,	Baldersdale, Hury Res.	1·04	26	*Shet.*	Lerwick Observatory ..	2·61	66
Norl'd	Newcastle, Leazes Pk.	·77	25	*Ferm.*	Crom Castle	2·25	69
,,	Bellingham, High Green	·93	24	*Armagh*	Armagh Observatory ..	1.94	71
,,	Lilburn, Tower Gdns...	·70	19	*Down*	Seaforde	1.71	48
Cumb.	Geltsdale	·59	16	*Antrim*	Aldergrove Airfield ..	1.86	62
,,	Keswick, High Hill ..	·90	16	,,	Ballymena, Harryville ..	1.86	50
,,	Ravenglass, The Grove	·65	15	*Lon.*	Garvagh, Moneydig ..	2·16	61
Mon.	Abergavenny, Larchfield	·61	15	,,	Londonderry, Creggan	2.40	65
Glam.	Ystalyfera, Wern Ho. ..	1·83	27	*Tyrone*	Omagh, Edenfel ..	1·99	54

CLIMATOLOGICAL TABLE FOR THE BRITISH COMMONWEALTH, JUNE, 1947

Stations	Pressure: Mean of day M.S.L.	Pressure: Diff. from normal	Temperatures: Absolute Max.	Temperatures: Absolute Min.	Temperatures: Mean values Max.	Temperatures: Mean values Min.	Temperatures: Mean values ½ (Max. and Min.)	Temperatures: Mean values Diff. from normal	Temperatures: Wet bulb	Relative Humidity	Mean Cloud Amount	Precipitation: Total	Precipitation: Diff. from normal	Precipitation: Days	Bright Sunshine: Daily mean	Bright Sunshine: Percentage of possible
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	%	tenths	in.	in.		hrs.	%
London, Kew Observatory	1015.1	—1.7	91	46	70.2	54.1	62.1	+2.6	57.5	71	6.9	3.17	+1.02	14	6.5	39
Gibraltar	1016.3	—1.0	86	59	80.3	66.0	73.1	+2.6	68.3	80	4.4	0.03	—	1	—	—
Malta	1015.1	—0.1	89	62	83.1	66.8	74.9	+2.2	67.6	53	1.8	0.00	—	0	12.5	86
St. Helena	1018.3	—1.7	68	52	62.7	56.0	59.3	—0.5	56.2	95	8.7	3.42	+0.60	20	—	—
Freetown, Sierra Leone	1012.8	+2.5	88	69	84.5	75.0	79.7	+0.8	76.0	86	7.7	13.32	—6.72	24	5.4	43
Lagos, Nigeria ..	1012.9	+0.5	92	69	86.1	71.9	79.0	—0.5	77.6	90	8.8	10.64	—	18	3.5	28
Kaduna, Nigeria ..	1011.6	—	91	63	86.7	68.6	77.7	+1.0	72.0	79	7.9	7.33	+0.24	19	8.1	64
Chileka, Nyasaland ..																
Salisbury, Rhodesia ..																
Cape Town ..	1022.3	+2.2	81	36	62.3	46.5	54.4	—1.3	48.5	85	5.2	1.76	—2.74	13	—	—
Germiston, South Africa	1024.3	—	69	25	62.2	38.9	50.5	—	41.8	59	1.7	0.00	—	0	8.5	81
Mauritius																
Calcutta, Alipore Obsy.	998.3	—1.0	99	75	93.7	80.7	87.2	+2.1	80.8	85	8.0	8.96	—2.95	16	5.2	39
Bombay	1004.2	+0.2	95	77	91.9	81.4	86.7	+2.7	79.4	78	6.1	3.61	—16.26	9	6.9	52
Madras	1003.4	—0.4	104	78	100.7	83.0	91.9	+1.9	75.5	56	6.5	0.36	—1.61	2	7.4	57
Colombo, Ceylon ..	1009.3	+0.7	88	74	85.9	80.2	83.1	+1.5	77.2	82	8.8	10.55	+3.23	26	5.0	40
Singapore	1008.9	0.0	92	71	88.4	75.7	82.1	+0.6	78.0	82	—	7.54	+0.67	11	—	—
Hongkong	1006.1	+0.3	92	73	85.8	77.5	81.7	+0.3	78.0	88	—	21.64	+5.94	28	2.8	21
Sydney, N.S.W. ..	1016.4	—1.5	72	40	64.8	48.4	56.6	+1.9	48.3	66	3.7	2.15	—2.59	6	7.2	73
Melbourne	1015.6	—2.9	66	36	58.4	44.0	51.2	+0.8	45.0	75	6.6	1.17	—0.89	12	3.5	37
Adelaide	1018.3	—1.1	72	44	62.1	48.1	55.1	+1.5	49.7	70	6.5	1.90	—1.18	17	3.8	39
Perth, W. Australia ..	1015.0	—3.0	74	40	66.3	53.7	60.0	+3.2	56.1	75	7.0	10.41	+3.47	26	3.9	39
Coolgardie	1017.2	—1.7	81	34	66.4	46.2	56.3	+3.5	48.2	69	4.3	0.48	—0.78	5	—	—
Brisbane	1018.7	+0.4	78	41	71.2	49.2	60.2	0.0	52.9	59	1.8	0.29	—2.50	1	8.9	85
Hobart, Tasmania ..	1008.5	—5.8	67	34	53.1	41.9	47.5	+0.5	43.2	75	7.8	7.50	+5.27	22	3.1	34
Wellington, N.Z. ..	1007.5	—7.4	60	39	52.5	43.5	48.0	0.0	45.5	82	8.6	11.02	+6.25	21	2.8	30
Suva, Fiji	1013.5	—0.1	86	62	79.5	70.6	75.1	+0.4	71.1	82	8.2	13.35	+6.64	22	3.5	32
Apia, Samoa ..	1011.0	—0.6	89	71	86.5	73.8	80.1	+2.3	76.8	83	5.8	11.88	+6.53	19	6.7	59
Kingston, Jamaica ..	1014.0	+0.2	96	73	89.9	76.1	83.0	+1.7	75.2	68	4.2	0.32	—3.78	2	7.9	60
Grenada, W. Indies ..	1014.3	+1.0	87	73	85.5	77.1	81.3	+2.3	77.8	84	7.8	7.00	—1.25	20	—	—
Toronto	1014.3	—0.4	89	42	74.0	55.0	64.5	+0.7	55.0	70	5.1	4.53	+1.87	9	9.0	59
Winnipeg	1010.1	—1.7	80	29	70.4	50.1	60.3	—2.0	51.3	81	6.8	3.68	+0.57	14	6.8	42
St. John, N.B. ..	1015.4	+1.9	81	39	62.5	46.9	54.7	—1.8	50.5	84	7.0	6.26	+2.99	13	6.7	43
Victoria, B.C. ..	1015.3	—1.5	75	41	68.1	48.6	58.3	+1.3	49.3	89	6.9	1.41	+0.57	10	9.1	57