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REORGANIZATION OF ASSISTANT DIRECTORATES

By the DIRECTOR-GENERAL

As many readers of this Magazine are aware, during the last decade the Meteorological Office has carried out extensive research into mathematical methods of producing forecast pressure and temperature charts for short periods (up to 24 or 48 hours) ahead. Much of this work has been done with the *Ferranti Mercury* computer, known in the Office as METEOR. The effort has been concentrated in the Assistant Directorate for Dynamical Research (Met.O. 11) under the leadership of Mr. E. Knighting, with the Deputy Director of Dynamical Research, (D.D.Met.O.(D)), Mr. J. S. Sawyer, F.R.S. and the Director of Research, Dr. R. C. Sutcliffe, F.R.S., exercising general supervision. During the past two years extensive trials of the method have satisfied us that the mathematically produced prebaratics are, on the average, superior to those constructed by time-honoured 'hand' methods, especially on the 500 mb (about 5½ km above sea level) isobaric surface. At the same time, despite the limitations of the relatively small and slow computer employed, it was demonstrated that such charts could be produced on a routine basis in time to be of use to the Central Forecasting Office.

These considerations have led to a decision to introduce numerical forecasting as routine in the preparation of the daily forecasts. This will take place as soon as possible after the completion of the new COMET computing laboratory in which the *English Electric-Leo* KDF 9 computer will replace METEOR.

The immediate task ahead is to transform what have hitherto been research experiments into daily operations. At the same time advantage will be taken of the greatly enlarged facilities and much higher speed of COMET to extend the boundaries of the forecast area and so, it is expected, to enhance the reliability of the forecasts. The incorporation of objective mathematical methods into what has hitherto been mainly a matter of judgement and experience is perhaps the most radical change in weather forecasting techniques that has occurred in the Office since the introduction of upper air charts.

The creation of a large modern computing laboratory within the Office also means that other objectives can now be studied realistically, such as the automatic editing of the incoming messages. Data processing by high-speed methods is now becoming regular practice in many parts of the Office. Other means of automation, such as chart plotters and line-drawing equipment, are also under development.

To cope with these tasks demands some regrouping and redeployment of staff at Headquarters. The Assistant Directorate for Techniques and Training (Met. O.8) has been relieved of its responsibilities for training and retitled 'Forecasting Techniques'. Under its present Assistant Director, Mr. T. N. S. Harrower, it will in future undertake the development of short-range forecasting techniques, paying special attention to mathematical methods and their adoption for routine use. Met.O.8 will also be responsible for manuals on the operational techniques of forecasting. A.D.Met.O. (FT) will report to the Deputy Director of Central Services, (D.D.Met.O.(C)), Mr. B. C. V. Oddie, and will take over some of the staff from Met.O.11.

Met.O.11 will in future be called 'Forecasting Research', thus reviving an old title. It will revert to basic mathematical research in dynamic meteorology (including, of course, numerical forecasting) and will also be responsible for much of the research in synoptic meteorology hitherto carried out by Met.O.12. This work will come under Mr. Knighting as Assistant Director.

Met.O.12 will assume the title of 'Computing and Data Processing.' Mr. G. A. Bull, who was in charge of Met.O.18 (Support Services) will be in control of the computing laboratory and punched-card system and will also be responsible for the development of data processing and automation generally in the Office. He will report to D.D.Met.O.(C).

Met.O.18 will have the title 'Publications and Training'. Mr. C. J. Boyden, who was in charge of the old Met.O.12 (Synoptic Research) will take control of the State Meteorological Library, the Archives and the Cartographic Drawing Office, and publications of the Office. He will also be responsible for the administration of the Training School and the external training programme. This Assistant Directorate will become part of the Research Directorate under D.D.Met.O.(D).

These changes became effective on 1 December 1964. The construction of the extended computing laboratory and the tests of the new installation are not expected to be completed before the spring of 1965. After this a period must be allowed for the necessary trials of the routine operations, but it is confidently expected that before the end of 1965 the change to more objective methods of short-range forecasting will have taken place and the Office will have entered into a new phase.

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WAVES IN AN INVERSION LAYER

By D. R. GRANT

Introduction.—When flying just below a temperature inversion or in an inversion layer, it is common to find large horizontal variations of temperature. The fluctuations are not usually periodic in nature as far as can be seen by inspection of the temperature records. On 18 October 1963, there was a well-marked inversion at a height of about 6500 feet (800 mb) over southern England and an anticyclone to the south was centred over France. On a flight on that day large-amplitude temperature fluctuations were measured which clearly contained a periodic component. Some details of the records are given in this article.

Flight procedure.—Two aircraft of the Meteorological Research Flight equipped with fast-responding instruments made ascents and descents in clear air through the inversion in directions approximately up and down wind. The aircraft were separated in the vertical by 700, 400 or 200 feet, and as nearly as possible one above the other. Some horizontal runs were also made with a vertical separation of about 100 feet. All the measurements were made just to the west of Farnborough, Hampshire, between 1100 and 1230 GMT.

Results.—A temperature sounding made at the start of the flight is shown in Figure 1. Subsequent soundings showed a similar temperature structure, but the height of the base of the inversion varied over a range of about 500 feet. The height of the horizontal flight discussed later is marked on Figure 1, but this is not necessarily the correct height relative to the inversion base. On all soundings, however, the temperature at this level was increasing with height.

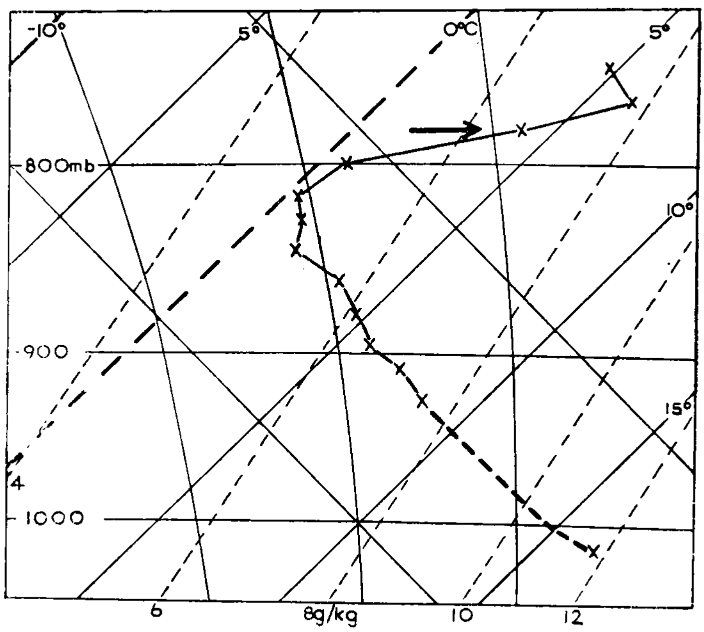

FIGURE 1—TEMPERATURE SOUNDING AT FARNBOROUGH ON 18 OCTOBER 1963

The bold arrow marks the height of level flight.
The pecked line shows where the curve had to be estimated as no temperature readings were available.

The initial ascent and descent showed nothing unusual in the way of temperature fluctuations. Later, however, large fluctuations of temperature were experienced by both aircraft between heights of 6500 and 7000 feet. At this time the aircraft were descending at 500 ft/min separated in the vertical by about 200 feet. Only over a very shallow layer (about 200 feet) was there any correlation between the fluctuations of temperature measured by the two aircraft at the same time. The fluctuations obtained while the aircraft were changing height were wave-like oscillations but they did not extend over one complete wavelength.

When, a little later, the aircraft were flying horizontally with a height separation of about 100 feet and within the inversion layer (i.e. when the temperature was increasing with height), there was a clear correlation between the records, although the amplitude of the fluctuations differed considerably. An example of the temperature records obtained at this time is given in Figure 2.

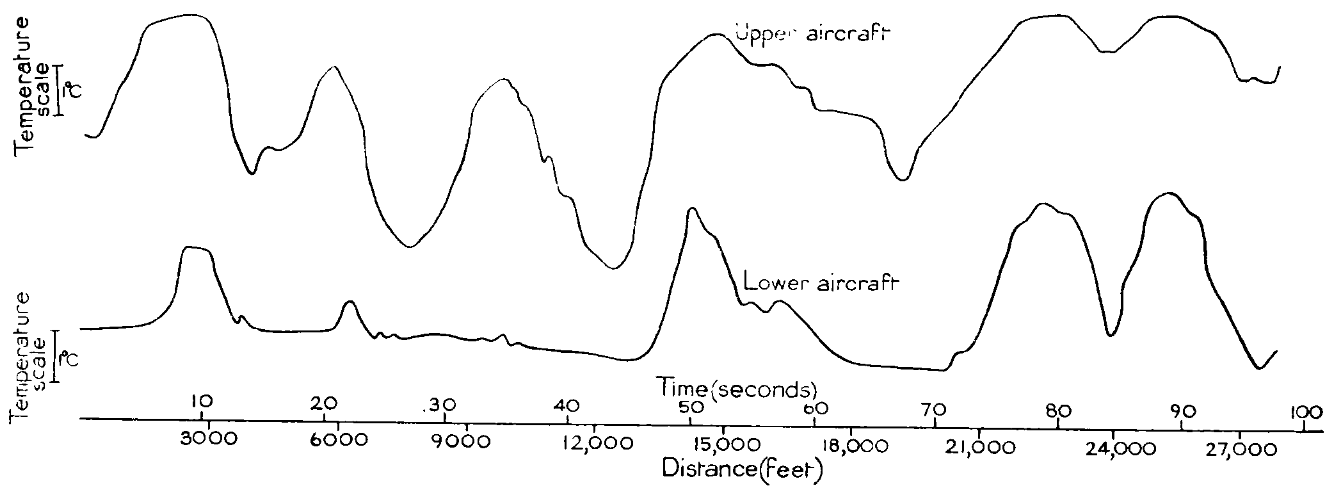

FIGURE 2—SIMULTANEOUS TEMPERATURE RECORDS OBTAINED FROM TWO AIRCRAFT SEPARATED IN THE VERTICAL BY 100 FEET ON 18 OCTOBER 1963

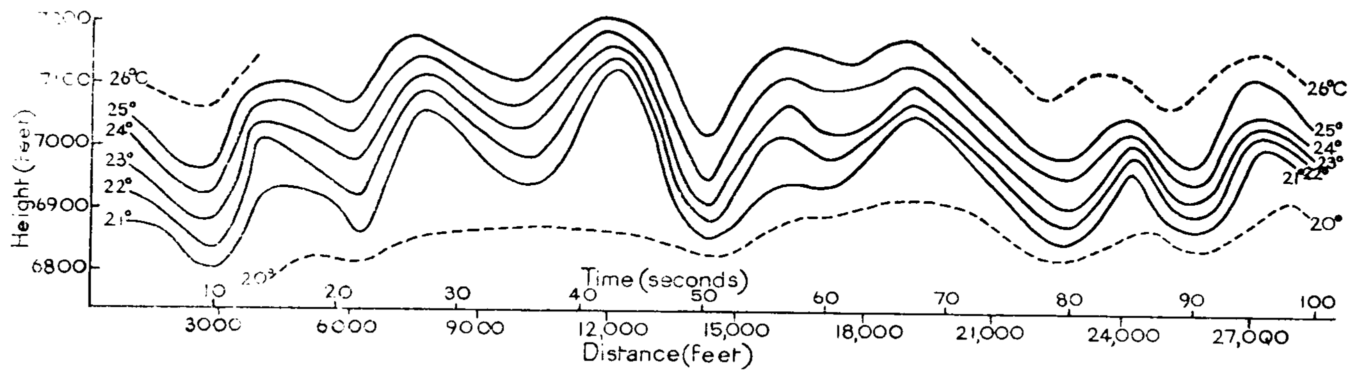

FIGURE 3—VERTICAL CROSS-SECTION OF POTENTIAL TEMPERATURE IN AN INVERSION LAYER ON 18 OCTOBER 1963

At 7500 feet potential temperature was 28°C and at 6500 feet it was 19° with no wave-like fluctuations at either level. The lower, surface layer was near isentropic with potential temperature 15°C.

The periodic nature of the fluctuations and the correlation between the two levels is clearly seen. Simultaneous measurements of humidity showed that the warm air was drier than the cold air. Figure 3 shows a vertical cross-section of potential temperature obtained from the same records as Figure 2. This shows that the maximum crest-to-trough amplitude of the waves in the isentropic surfaces was about 150 feet and the wavelength was about 4000 feet.

When the aircraft were flying at a constant height, the periodic temperature fluctuations were not experienced continuously. It was quite common for the temperature record to become fairly steady for long periods. There are two possible reasons for this. Either the waves were not present at all at certain places or the level at which they were present fluctuated from place to place. The former reason would explain the absence of temperature fluctuations on the early ascents and descents, but the observed variation in the height of the base of the inversion would lead one to expect a variation in the level of the waves from place to place. It is quite possible that both explanations are correct.

Conclusions.—The observations show wave-like variations in the height of the isentropic surfaces in an inversion layer. The waves were confined to a layer about 500 feet thick, their crest-to-trough amplitude being 150 feet and their wavelength being 4000 feet.

Additional note by J. S. Sawyer.—

Comparison with theory of gravity waves.—It is interesting to compute the frequency and velocity of the waves observed on 18 October 1963 if they are interpreted as 'short' internal gravity waves on a simple density discontinuity. In such wave motion it is assumed that the fluid boundaries are sufficiently far distant from the discontinuity not to interfere with the motion and the frequency equation is

$$\upsilon = \left(\frac{\pi g \Delta\theta}{\lambda \theta} \right)^{\frac{1}{2}}$$

(derived from the equation (Lamb[1]) for the velocity of propagation) where υ is the frequency, g the acceleration due to gravity, θ the potential temperature, $\Delta\theta$ the total change of potential temperature from the lower near-isentropic layer to above the inversion, and λ the wavelength. Taking $\lambda = 4000$ feet, $\Delta\theta = 13°K$, and $\theta = 296°K$ we obtain $\upsilon = 3.33 \times 10^{-2}$/second. This gives a period $\tau = 2\pi/\upsilon = 189$ seconds and velocity $= \lambda/\tau = 6.9$ metres/second.

The wavelength may have been overestimated because the aircraft was not necessarily flying perpendicular to the wave fronts and this would lead to an underestimate of the calculated velocity. The wind speed at the inversion level was around 8 m/s, so it is possible that the observed waves were stationary orographic lee-waves. However, it is also possible that the waves were not stationary and were initiated by convection below the inversion as in the experiments reported by Townsend.[2] In view of the light surface winds and absence of high hills round Farnborough this is perhaps the more likely explanation.

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2. TOWNSEND, A. A.; Natural convection in water over ice surface. *Quart. J. R. met. Soc., London*, **90**, 1964, p. 248.

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SOME ASPECTS OF THE CLIMATE OF SOUTH-WEST ASIA

By A. V. DODD
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South-west Asia provides a challenge to the climatologist because of the general lack of meteorological observations in the interior areas of the region; areas which may be as hot as any in the world. In the interior of Arabia, meteorological observations have recently been made in conjunction with oil exploration and some of the climatic blanks are now being filled.

January and July maps of mean and extreme temperature and mean precipitation in south-west Asia, revised in the light of the new data, are presented in this report along with more specific data for the Rub al Khali or 'Empty Quarter' of Saudi Arabia. The maps are estimates of the average and extreme patterns of occurrence. They should be revised when more complete meteorological records are available.

South-west Asia can be delimited on the map by the five bordering seas: the Mediterranean, the Red, the Arabian, the Caspian, and the Black. The influence of the seas, however, is restricted by the prevailing pressure patterns and the restraining influence of mountains so that aridity and continentality characterize most of the area (see Figure 1).

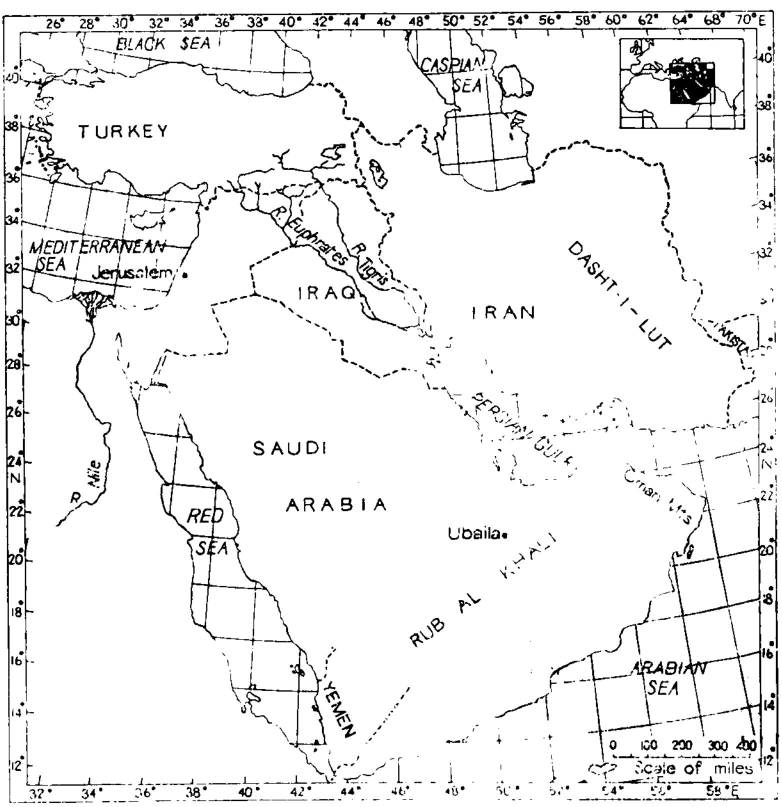


FIGURE 1—MAP OF THE AREA

Winter climate.—In winter a belt of high pressure lies to the north and north-east of south-west Asia over Mongolia and Siberia. Outflowing air from this high dominates the circulation of all south-west Asia except the southern coast of Iran and the southern portion of the Arabian peninsula. Temporary weakening of this high pressure permits modified polar maritime air from the North Atlantic Ocean to invade the area in migrating storms which generally follow the low-pressure track associated with the comparatively warm waters of the Mediterranean Sea. These storms are the major source of precipitation in much of south-west Asia.

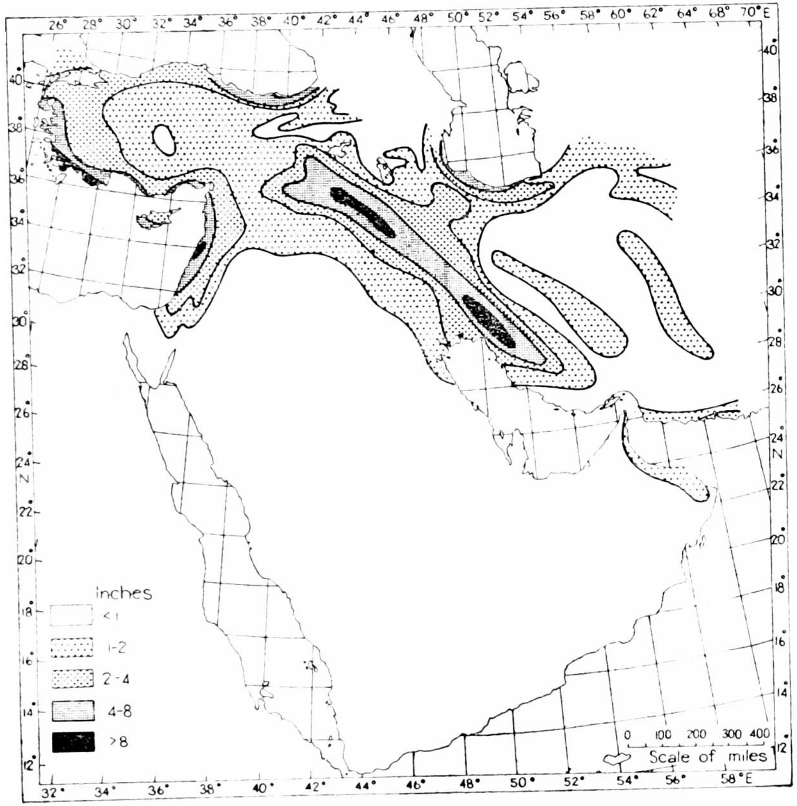
Although winter is the season of maximum precipitation in most of the region, precipitation is plentiful only near the coasts of the three northern seas and on the exposed slopes of the mountains in Turkey and Iran (Figure 2(*a*)). Near the Mediterranean, snow is uncommon at sea level. Farther north and at higher elevations snowfall may be heavy. In the mountains of eastern Turkey high passes are clear of snow only during summer, and even at Jerusalem (2485 feet above MSL) snow depths of three feet have occurred. South of 28°N rainfall is light and snowfall is unusual, although snow occasionally occurs in the southern highlands of Iran and in the mountains of Oman. Heavy snowfalls have been reported at high elevations in Yemen.

Even in winter, part of the south Arabian desert has experienced temperatures above 100°F (Figure 3) and afternoon temperatures are generally above 70°F at elevations below 2000 feet. As far north as the Caspian and Mediterranean littoral, temperatures as high as 80°F occur in January as warm air from the south is drawn into the migratory lows. (In spring and autumn maximum temperatures of above 100°F along the Mediterranean are associated with this same southerly flow of air.) The contrast in air mass as the front passes and cooler maritime air sets in is notable. In Turkey absolute maximum temperatures in January range from near 50°F in the high mountains of the north-east to above 70°F on the Mediterranean and Black Sea coasts. The January mean daily maximum follows a similar pattern with below-freezing averages in the mountains of the east to averages above 50°F on the Mediterranean coast (Figure 4).

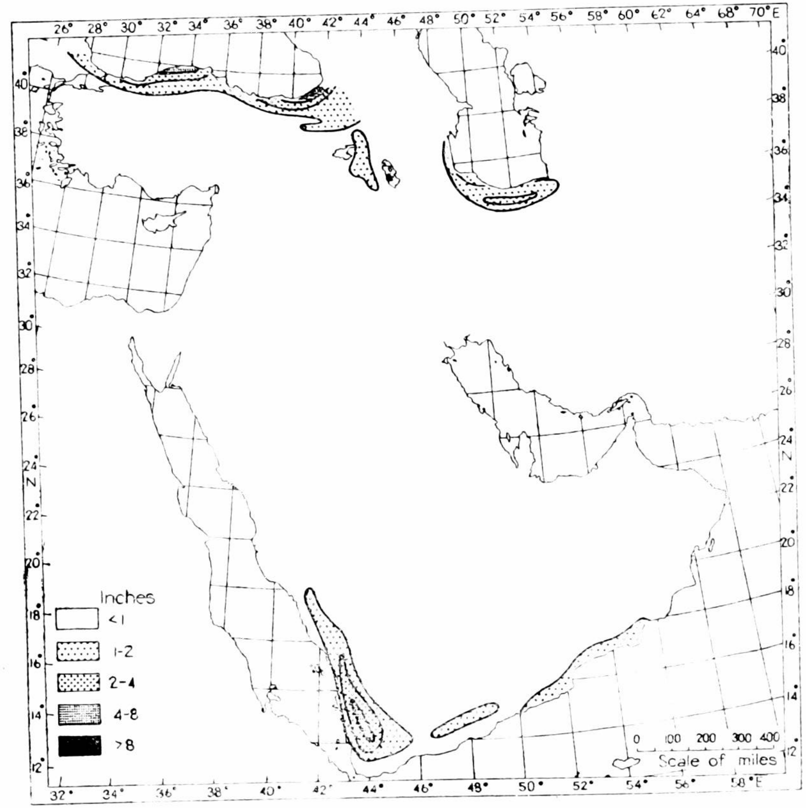
Absolute minimum temperatures in January range from above 60°F at Aden in the extreme south to below -30°F in the mountains of north-eastern Turkey (Figure 5). Similarly, January mean daily minimum temperatures, representative of early morning conditions, range from above 70°F on the Arabian Sea coast to below zero in eastern Turkey and north-western Iran (Figure 6). Frosts have never occurred along the southern coasts and are rare in south-east Arabia.

Summer climate.—In summer the circulation over south-west Asia is controlled by a thermal low centred over north-west India and Pakistan. Low pressure also undoubtedly exists over the interior of Arabia to complicate the circulation over that large land mass. The combination of this low complex with the Azores high to the west results in the transport of dry continental air from the north into the region. Only in the extreme north and in southern Arabia is this pattern broken. In the bulk of the area cloudless skies allow the maximum radiation, and extremely high temperatures result.

Summer precipitation is restricted to southern Arabia, particularly Yemen in the south, and to the border lands of the Black and Caspian Seas in the



(*a*) January



(*b*) July

FIGURE 2—MEAN PRECIPITATION

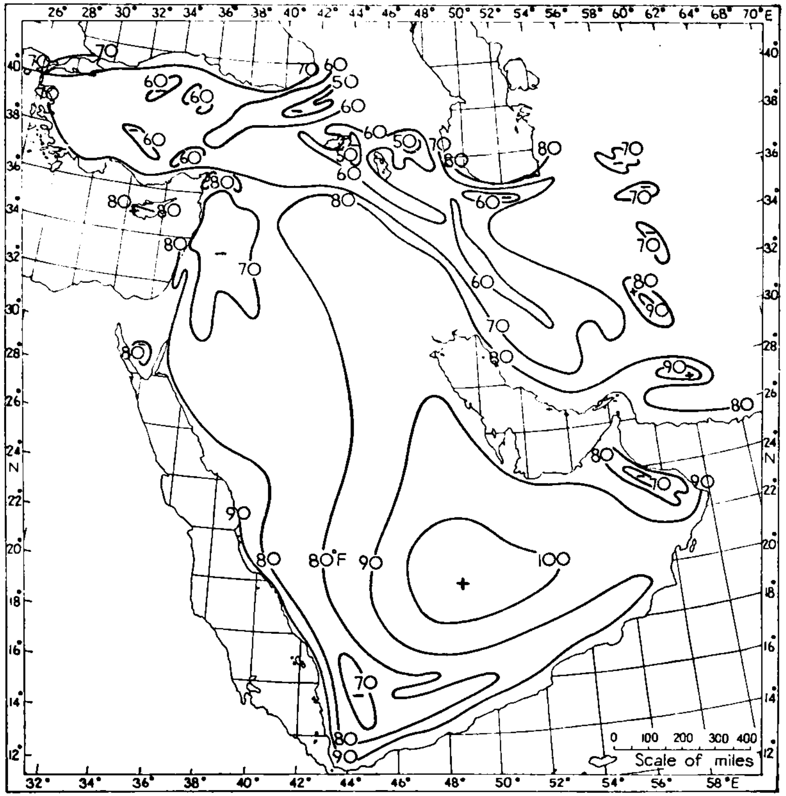


FIGURE 3—JANUARY ABSOLUTE MAXIMUM TEMPERATURE

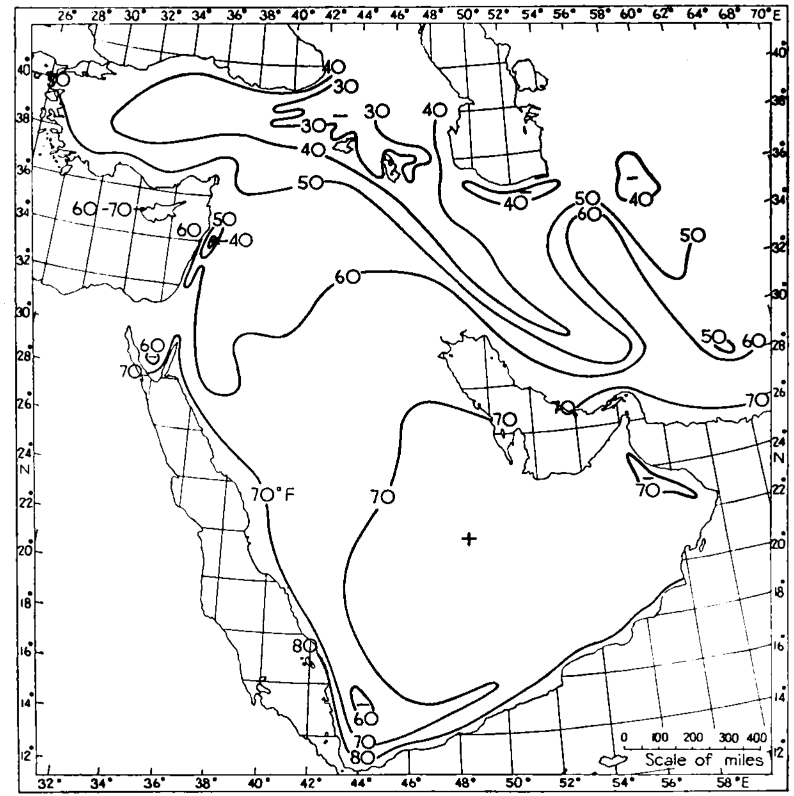


FIGURE 4—JANUARY MEAN DAILY MAXIMUM TEMPERATURE

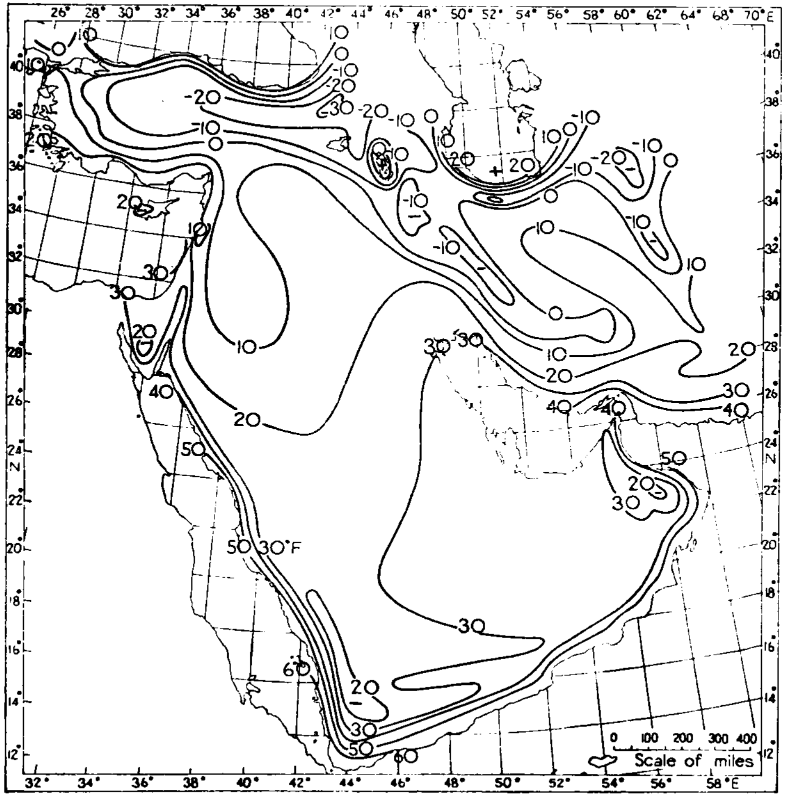


FIGURE 5—JANUARY ABSOLUTE MINIMUM TEMPERATURE

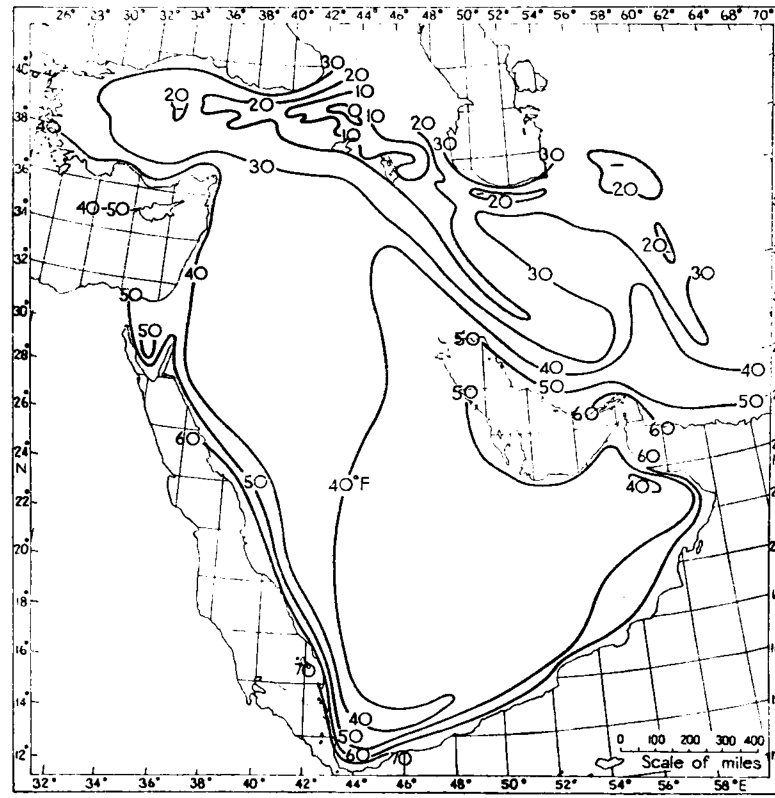


FIGURE 6—JANUARY MEAN DAILY MINMIUM TEMPERATURE

north (Figure 2(*b*)). Some precipitation can be expected each July along the Mediterranean coast near the border of Turkey and Syria, and in the mountains of Iran and Turkey. However in the bulk of south-west Asia any summer may be entirely rainless and in the interior of Iran some stations have never reported rain in June, July, or August.

The most pleasant summer weather in south-west Asia is experienced in the highlands of Yemen where radiation is reduced by clouds associated with the south-west monsoon, and temperatures are moderated by the higher elevations. Rainfall is ample for local farming and for underground supply of water to favoured locations in the Arabian desert.

The distribution of absolute maximum temperatures in south-west Asia is shown in Figure 7. Observations at drilling sites of the Arabian-American Oil Company show that a large part of the interior of Saudi Arabia has absolute maximum temperatures above 120°F, and it is expected that if longer records were available, temperatures above 130°F would have been recorded in the interior of the Arabian desert. Although confirming records are not available, it is likely that the Dasht-i-Lut, a large basin in south-western Iran, is almost as hot. Temperatures above 120°F have also been observed in the Tigris-Euphrates Valley and inland from the Persian Gulf in Iran. The areas of south-west Asia which have not experienced temperatures above 100°F in July are limited to the higher mountains in the north, and to mountains and part of the coastal strip in the south.

Mean daily maximum temperatures are above 110°F in a vast area extending from southern Arabia 1300 miles to northern Iraq and then in a narrow band through southern Iran (Figure 8). The Dasht-i-Lut also has extremely high temperatures. The highest mean temperature in Iran, 106°F in July, was reported from Shahdad on the edge of this basin. The occurrence of mean daily minimum temperatures above 80°F in the Dasht-i-Lut, in much of southern Arabia, and on the littoral of the Persian Gulf and Red Sea further illustrate the torrid summer conditions in south-west Asia (Figure 9). Some stations on the immediate coasts of the Red Sea and Persian Gulf have no record of July temperatures below 70°F (Figure 10).

The largest hot area of south-west Asia is the virtually unpopulated Rub al Khali, an area in south-east Arabia of some 400,000 square miles covered mainly by sand dunes. The extreme heat experienced in the Rub al Khali is illustrated by the temperature trace during a 10-day period at Ubaila (Figure 11). On only one day did the temperature fail to reach 120°F during this period and on 23 July 1954 the minimum temperature for the day was 100°F. Not only was it hot, but at times it was humid. Although afternoon relative humidities were deceptively low, usually below 20 per cent, they often indicated high absolute humidities. The highest dew-point during the 10-day period was 79°F at 0600 local time on 25 July. Later in the summer dew-points above 80°F were observed. When high temperatures are accompanied by high humidities intolerable conditions occur. It is easy to understand the translation of Rub al Khali—abode of emptiness.

A clue to the source of high humidity lies in the fact that rain fell twice during the 10-day period illustrated. It is felt that Ubaila is near the northern

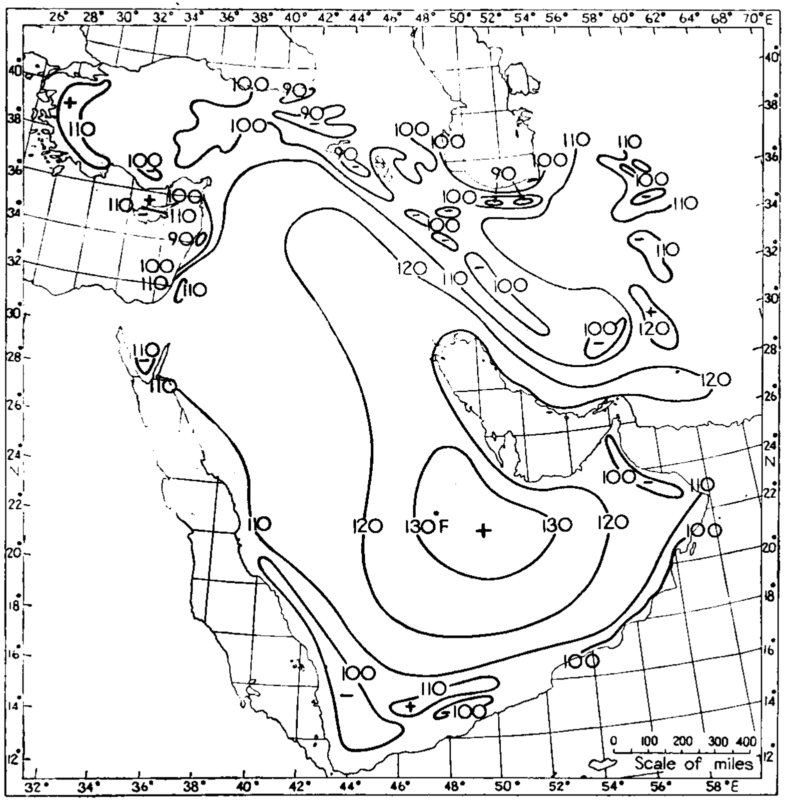


FIGURE 7—JULY ABSOLUTE MAXIMUM TEMPERATURE

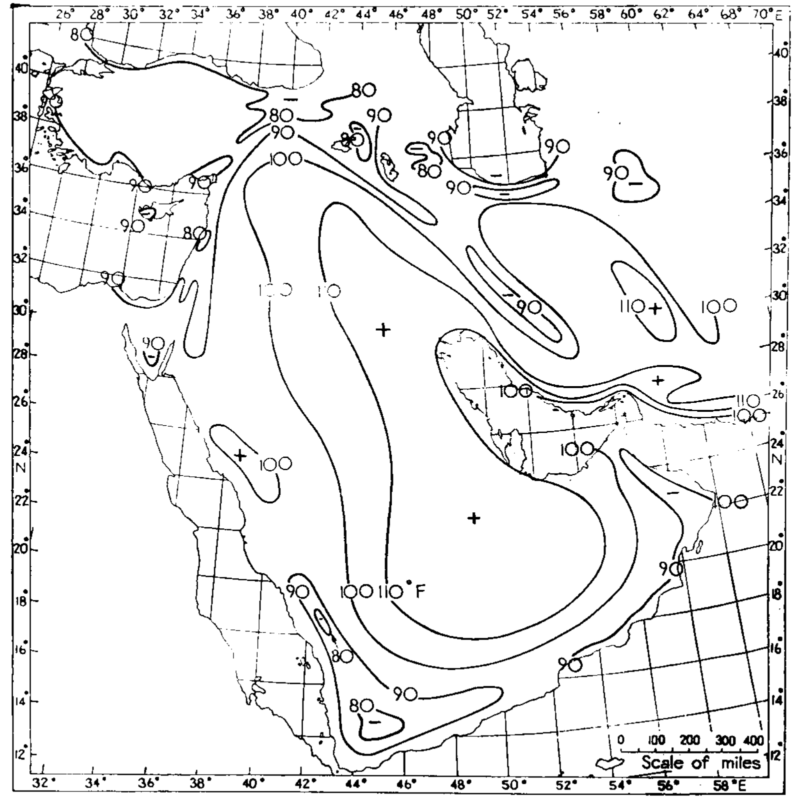


FIGURE 8—JULY MEAN DAILY MAXIMUM TEMPERATURE

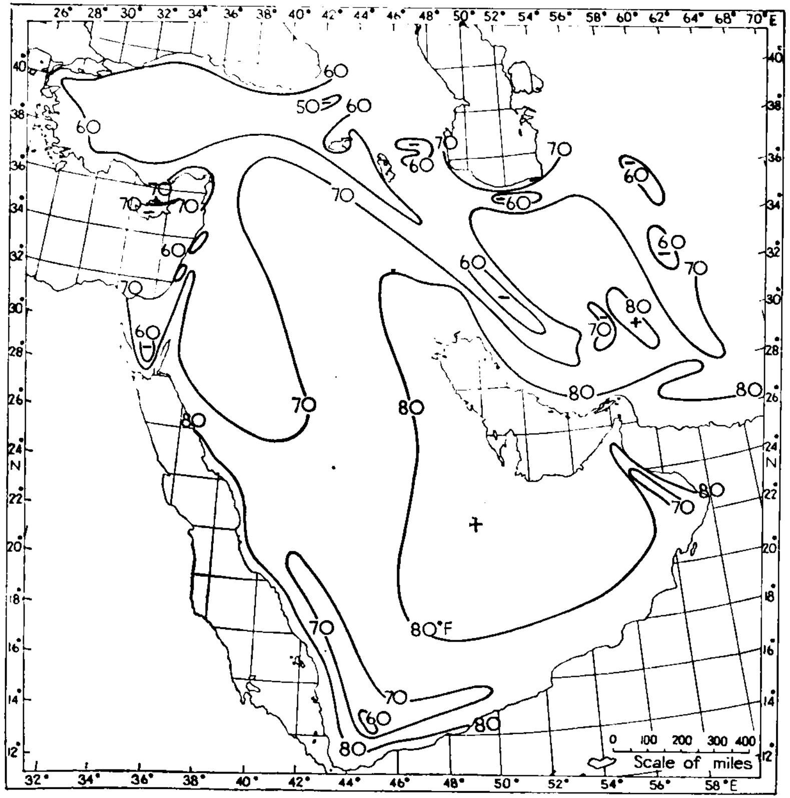


FIGURE 9—JULY MEAN DAILY MINIMUM TEMPERATURE

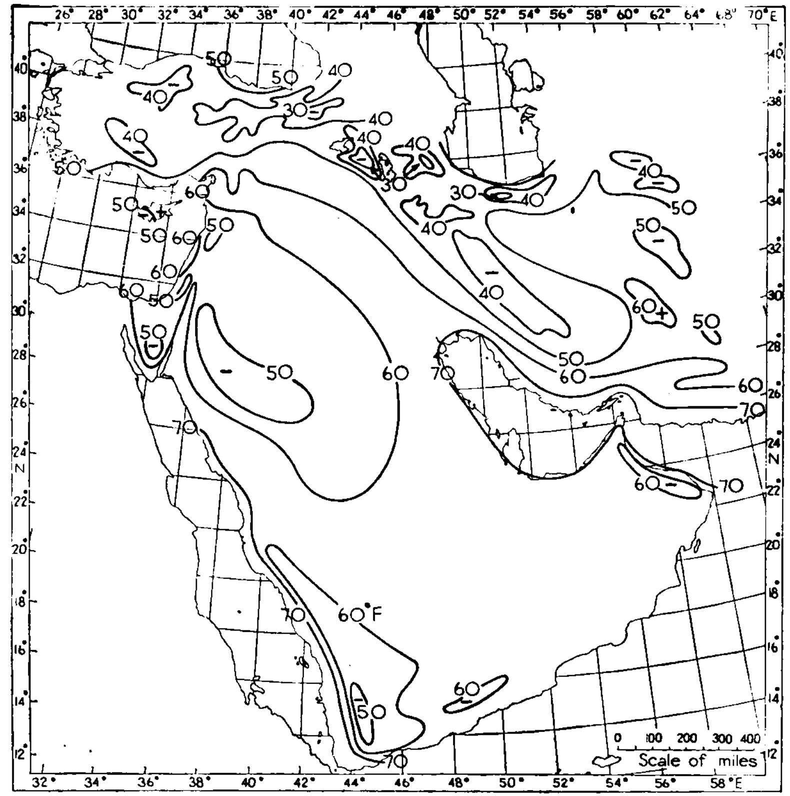


FIGURE 10—JULY ABSOLUTE MINIMUM TEMPERATURE

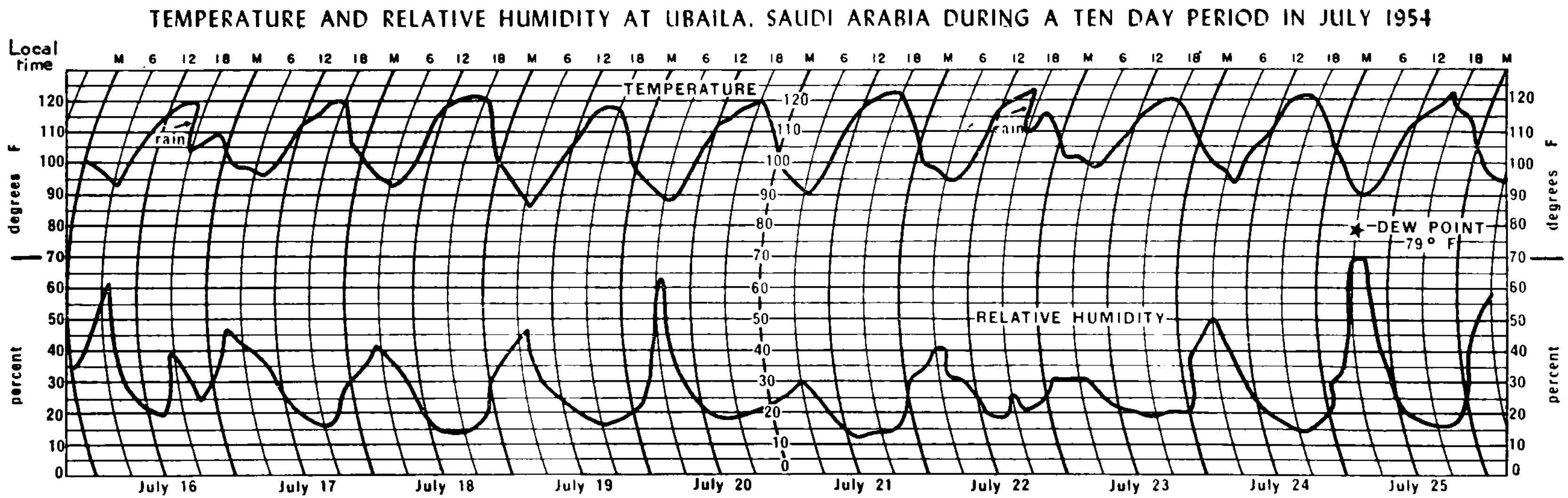


FIGURE II—TEMPERATURE AND RELATIVE HUMIDITY TRACES AT UBAILA limit of penetration of the south-west monsoon and therefore is subjected to the convective showers that are associated with the influx of moist air from the Arabian Sea.

Acknowledgements.—The efforts of a number of people are involved directly or indirectly in the preparation of this report. The climatic maps were generalized from maps prepared by climatologists of Earth Sciences Division, United States Army Natick Laboratories, Natick, Massachusetts and were drawn by A. Greenwald. Much of the data for Arabia, including the hygrothermograph traces for Ubaila, were obtained from the Arabian-American Oil Company by the Air Weather Service, USAF.

A special word of appreciation is due to the personnel, unknown to the author, who are responsible for the observations at Ubaila.

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DISTRIBUTION OF CROPS WITH RESPECT TO MEAN POTENTIAL SOIL MOISTURE DEFICIT AT THE END OF AUGUST

By JUDITH M. WALKER

Introduction.—It is a well-established fact that plants need moisture to live, and that some plants need more than others. In view of this fact, it was decided to do a survey of crop distribution in England and Wales to find out if the soil moisture deficit at the end of August is related to the percentage ratios between the areas allocated to certain crops as compared with areas for other crops, i.e. whether a particular pattern of farming is related to availability of moisture.

Method of analysis.—The counties were grouped into the regions shown in Table I. The county rainfall averages are taken from tables of averages for the period 1916–50[1] and estimated potential transpiration averages for April to August were extracted from tables of monthly averages for the period 1930–49[2]. By subtracting rainfall from transpiration, a value was obtained for each county of mean potential soil moisture deficit at the end of August. By suitable weightings by areas, values of the deficit were also obtained for the regions.

The following data were extracted from *Agricultural Statistics*[3] for each county in 1960.

Total farm acreage (crops, grass and rough grazing); crops and grass acreage; grass acreage; rough grazing acreage; lucerne acreage; corn acreage (wheat, barley and oats); wheat and barley acreage; oats acreage; corn and orchard acreage. The following percentage ratios were then obtained for each county and for each region:

(*a*) Lucerne to grass
(*b*) Grass to crops and grass
(*c*) Rough grazing to total farm
(*d*) Grass and rough grazing to total farm
(*e*) Corn and orchard to crops and grass
(*f*) Wheat and barley to corn
(*g*) Oats to corn

TABLE I—MEAN POTENTIAL SOIL MOISTURE DEFICIT FOR ALL COUNTIES OF ENGLAND AND WALES AND PERCENTAGE RATIOS OF CROPS IN 1960

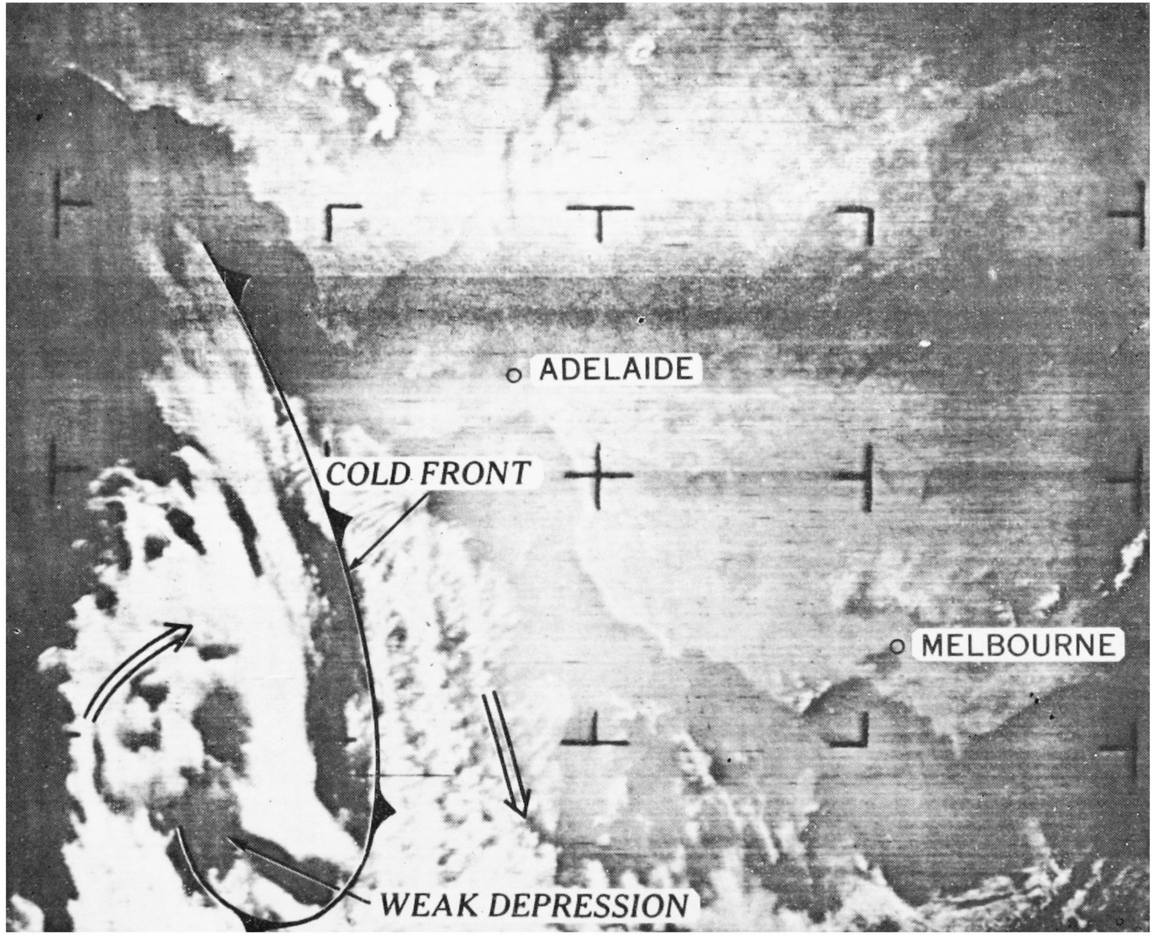
	Mean potential soil moisture deficit (inches)	Col. (*a*)	Col. (*b*)	Col. (*c*)	Col. (*d*)	Col. (*e*)	Col. (*f*)	Col. (*g*)
		percentage ratios						
(A) NORTH-EAST	—0.30	0.02	73	37	83	19	61	42
Durham	0.00	0.02	65	24	74	26	36	42
Northumberland	—0.60	0.02	77	44	87	15	67	43
(B) NORTH-WEST	—3.93	0.02	83	37	89	11	35	61
Cumberland	—5.05	0.04	85	41	91	9	9	84
Lancashire	—1.50	0.01	78	22	83	14	51	47
Westmorland	—8.45	0.00	93	54	97	5	13	81
C) YORKSHIRE	1.34	0.10	58	25	68	30	80	22
East Riding	3.30	0.18	41	2	42	44	83	16
North Riding	0.70	0.10	63	33	75	27	83	27
West Riding	—1.20	0.07	66	28	75	23	73	25
(D) NORTH-EAST MIDLANDS	4.11	0.66	43	6	48	37	85	13
Derbyshire	0.25	0.10	79	21	83	16	56	37
Lincolnshire: Kesteven	5.55	1.88	34	1	34	46	91	9
Lincolnshire: Lindsey	4.40	0.45	37	1	37	43	88	11
Lincolnshire: Holland	5.15	0.12	15	1	17	35	91	8
Nottinghamshire	4.05	1.18	47	1	47	40	81	18
(E) CENTRAL MIDLANDS	3.71	0.42	64	1	65	29	79	19
Leicestershire	3.35	0.21	69	1	69	25	70	27
Northamptonshire	4.35	0.71	61	1	61	31	85	14
Rutland	3.95	0.38	54	1	54	35	89	10
Warwickshire	3.30	0.35	65	1	65	28	76	20
(F) WEST MIDLANDS	2.72	0.17	73	5	75	19	68	23
Cheshire	2.05	0.06	78	7	72	15	48	37
Herefordshire	3.35	0.12	71	4	72	20	72	25
Shropshire	3.00	0.16	72	6	74	20	71	17
Staffordshire	1.70	0.16	77	4	77	17	71	19
Worcestershire	3.90	0.46	65	3	66	24	76	21
(G) SOUTH-EAST MIDLANDS	5.31	2.42	28	1	29	49	91	8
Bedfordshire	5.00	1.32	34	1	34	44	91	8
Cambridgeshire	5.80	3.40	19	1	20	52	92	7
Hertfordshire	4.70	2.69	42	2	43	47	89	11
Huntingdonshire	5.30	1.63	27	1	28	49	93	7
(H) EAST ANGLIA	5.59	4.29	27	3	29	50	91	8
Essex	6.15	3.09	31	3	33	50	92	8
Norfolk	5.20	4.61	26	4	29	47	91	8
Suffolk	5.60	5.20	26	3	28	54	90	8
(J) SOUTH-EAST	5.45	0.89	57	5	59	31	81	18
Kent	6.25	1.40	47	3	49	37	83	16
Middlesex	5.85	0.07	59	8	61	23	82	17
Surrey	5.60	0.95	65	4	66	24	79	19
Sussex	4.50	0.49	66	6	68	26	79	19
(K) SOUTH MIDLANDS	3.79	1.07	63	3	64	30	87	11
Berkshire	4.45	2.56	52	4	54	39	90	9
Buckinghamshire	4.50	0.76	69	2	69	26	83	15
Gloucestershire	2.55	0.45	70	4	72	24	87	11
Oxfordshire	4.45	1.76	57	2	57	37	88	11
(L) SOUTH	3.84	0.69	64	12	68	28	90	9
Dorset	4.00	0.30	76	8	78	18	87	11
Hampshire	4.50	0.94	53	15	60	36	90	9
Isle of Wight	4.90	0.59	66	12	69	23	84	14
Wiltshire	3.00	0.55	66	10	69	28	91	8
(M) SOUTH-WEST	0.68	0.14	79	16	82	14	65	15
Cornwall	0.40	0.09	75	13	78	17	57	9
Devonshire	0.35	0.13	78	21	83	15	66	19
Somerset	1.60	0.21	83	8	85	11	79	18
(N) NORTH WALES	—2.18	0.08	86	36	91	9	24	56
Anglesey	1.65	0.05	87	13	88	9	30	61
Caernarvonshire	—10.00	0.09	88	60	95	9	13	61
Denbighshire	0.20	0.08	86	35	91	10	20	57
Flintshire	3.30	0.13	85	10	94	11	37	45
(P) CENTRAL WALES	—5.29	0.06	86	51	93	9	17	67
Brecknockshire	—5.30	0.05	86	62	95	7	17	81
Cardiganshire	—3.75	0.10	82	39	89	12	11	66
Merioneth	—10.30	0.06	91	72	98	5	2	79
Montgomeryshire	—4.75	0.07	88	42	93	9	29	52
Radnorshire	—1.30	0.06	85	43	91	8	15	81

To face p.48

Photograph by G. Yates

PLATE I—SITE OF THE BASE CAMP AT STATION B IN ICELAND DURING THE BRITISH SCHOOLS EXPLORING SOCIETY'S EXPEDITION IN 1960

See page 52.



Photograph by the Australian News and Information Bureau

PLATE II—PHOTOGRAPH TAKEN BY NIMBUS A AT MIDDAY ON 14 SEPTEMBER 1964, AS THE SATELLITE SPED NORTHWARDS OVER THE SOUTHERN OCEAN AND SOUTH-EASTERN AUSTRALIA

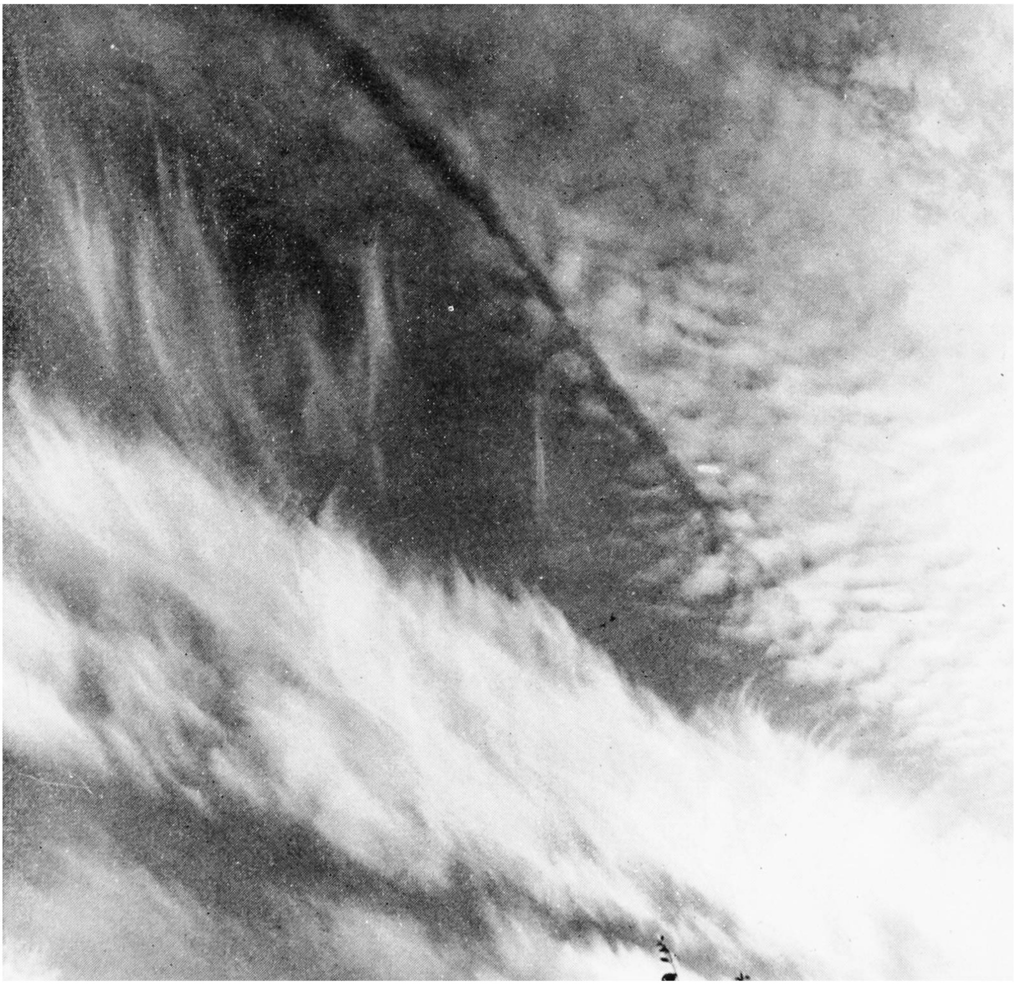
(See page 62).

Photograph by the Australian News and Information Bureau

PLATE III—THE AUTOMATIC PICTURE TRANSMISSION UNIT AT THE ROYAL AUSTRALIAN AIR FORCE BASE AT LAVERTON, NEAR MELBOURNE

The antenna tracks the satellite, picks up its signals and relays them to the Bureau of Meteorology's central analysis office in Melbourne (see page 62).

*To face p.*49



Photograph by R. K. Pilsbury

PLATE IV—CIRRUS CLOUD ASSOCIATED WITH A JET STREAM OVER SOUTHERN ENGLAND ON 22 JUNE 1963

The photograph was taken at Bracknell at about 1600 GMT with the camera facing towards the north-east, and the cloud can be compared with that in Plates III and IV in the *Meteorological Magazine* of March 1964.

TABLE I—MEAN POTENTIAL SOIL MOISTURE DEFICIT FOR ALL COUNTIES OF ENGLAND AND WALES AND PERCENTAGE RATIOS OF CROPS IN 1960—*contd.*

	Mean potential soil moisture deficit (inches)	Col. (*a*)	Col. (*b*)	Col. (*c*)	Col. (*d*)	Col. (*e*)	Col. (*f*)	Col. (*g*)
					percentage ratios			
(Q) SOUTH WALES	—3.43	0.06	87	26	90	7	37	49
Carmarthenshire	—4.45	0.04	93	23	94	4	13	65
Glamorgan	—6.15	0.04	89	42	94	6	53	32
Monmouthshire	—0.70	0.13	88	19	90	6	59	36
Pembrokeshire	—1.20	0.03	78	19	83	13	36	51

The columns show percentage ratios as follows:
(*a*) (Lucerne) to (grass)
(*b*) (Grass) to (crops + grass)
(*c*) (Rough grazing) to (total farm)
(*d*) (Grass + rough grazing) to (total farm)
(*e*) (Corn + orchard) to (crops + grass)
(*f*) (Wheat + barley) to (corn)
(*g*) (Oats) to (corn)

Plots were then made of the percentages against the mean soil moisture deficit, and the best curves drawn visually, as shown in Figures 1, 2 and 3. Figure 1 shows the lucerne to grass ratio. In this figure, regional and county

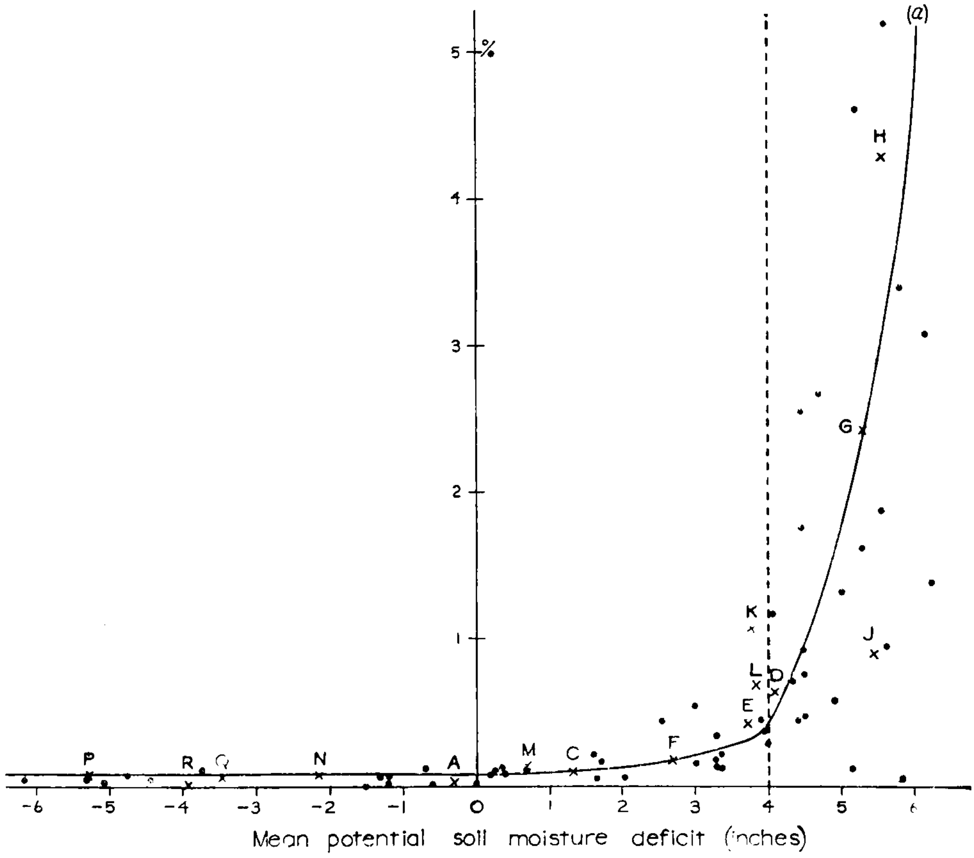


FIGURE 1—PERCENTAGE RATIOS OF LUCERNE TO GRASS IN 1960 FOR REGIONS AND COUNTIES LISTED IN TABLE I COMPARED WITH THE MEAN POTENTIAL SOIL MOISTURE DEFICIT

x Percentage ratios for regions indentified by letters as shown in Table I.
. Percentage ratios for counties listed in Table I.
Line (*a*) shows percentage ratio (lucerne) to (grass)—see Col. (*a*) in Table I.
- - - - 4-inch deficit line.

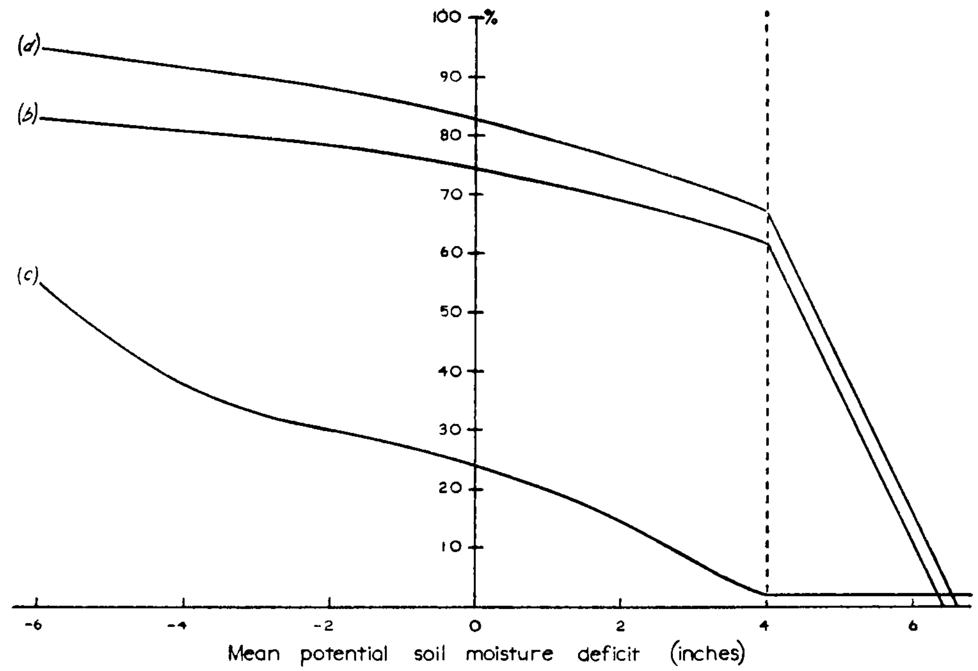


FIGURE 2—PERCENTAGE RATIOS OF GRASSLANDS IN 1960 COMPARED WITH THE MEAN POTENTIAL SOIL MOISTURE DEFICIT

The lines show percentage ratios as follows (see Col. (*b*), (*c*) and (*d*) in Table I):
(*b*) (Grass) to (crops + grass)
(*c*) (Rough grazing) to (total farm)
(*d*) (Grass + rough grazing) to (total farm)
– – – – 4-inch deficit line.

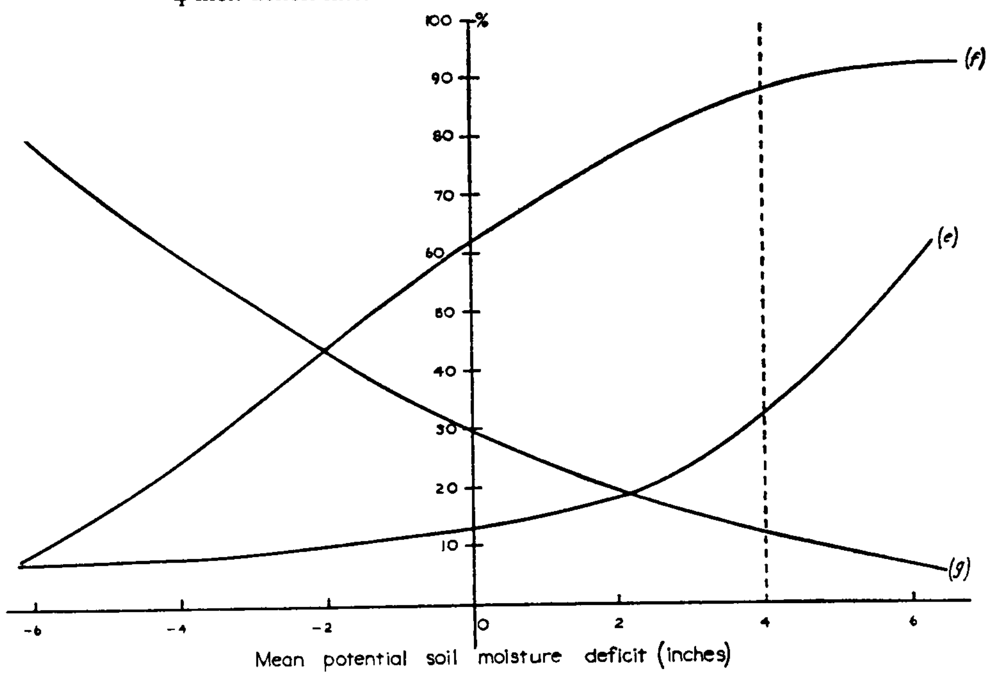


FIGURE 3—PERCENTAGE RATIOS OF CEREAL CROPS IN 1960 COMPARED WITH THE MEAN POTENTIAL SOIL MOISTURE DEFICIT

The lines show percentage ratios as follows (see Col. (*e*), (*f*) and (*g*) in Table I):
(*e*) (Corn + orchard) to (crops + grass)
(*f*) (Wheat + barley) to (corn)
(*g*) (Oats) to (corn).
– – – – 4-inch deficit line.

values are shown, to give some idea of the scatter obtained. Details are not shown in Figures 2 and 3, but there is a similar scatter. In Figure 2 lines (*b*), (*c*) and (*d*) show the grassland ratios and in Figure 3 lines (*e*), (*f*) and (*g*) show the cereal crop ratios.

Discussion.—The resulting lines represent the states of crop distribution which have been reached by independent choice of crops among the farmers of England and Wales. There appears to be a definite relationship between the percentage of land a farmer allots to one particular crop as compared with another crop or crops, and the mean potential soil moisture deficit at the end of August.

Lucerne.—Figure 1, line (*a*). The percentage of lucerne rises very gradually with increase in potential soil moisture deficit up to a deficit of 4 inches; beyond this point the percentage rises sharply.

Grasslands.—Figure 2, line (*b*). There is a gradual decline in the percentage of grass to crops and grass with rise of potential soil moisture deficit up to a deficit of about 4 inches. When the deficit rises above this, the percentage of grasslands decreases rapidly.

Line (*c*). The percentage of rough grazing to total farm acreage falls off fairly steeply with a rise in potential soil moisture deficit up to a deficit of about 4 inches. With a higher deficit than this, the percentage remains at a steady level of about 2.

Line (*d*). This is very similar to line (*b*). A gradual decrease occurs in the percentage of grassland to total farm acreage with a rise in potential soil moisture deficit, until the deficit reaches 4 inches. The percentage then drops sharply as the deficit increases.

Cereal crops and orchards.—Figure 3, line (*e*). The percentage of corn and orchard land to the total crop and grass acreage rises fairly sharply as potential soil moisture deficit increases.

Line (*f*). The percentage of barley to total corn rises with increasing potential soil moisture deficit, levelling off as the deficit exceeds 4 inches.

Line (*g*). The percentage of oats to total corn falls off as the potential soil moisture deficit increases, though the falling-off seems to be less steep as the deficit rises above 3 inches.

It is significant that if the potential soil moisture deficit rises above 4 inches, grass shows definite signs of wilting. Lucerne however, continues to grow with a soil moisture deficit above that at which grass dies.

Corn crops and orchard trees both have deep roots, and the pattern of lines (*e*) and (*f*) might therefore be expected. The pattern of oats in line (*g*) is less predictable. However, no account has been taken of any temperature factors, which might provide additional explanation of crop distribution.

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BAROMETRIC PRESSURES IN CENTRAL ICELAND

By I. Y. ASHWELL, M.A., Ph.D.
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Summary.—A method of converting pressures obtained on the central plateau of Iceland during the summer of 1960 to sea level is described. These readings are probably the first obtained in central Iceland from a mercury barometer.

Synoptic charts plotted with the aid of these readings indicate powerful topographical control of the weather, especially under anticyclonic conditions.

Introduction.—Most of the central plateau of Iceland (Figure 1) is an uninhabited desert of rock and sand, at a height of over 300 metres above sea level. Ice-caps occur along the central ridge, running from south-east to north-west, and also along the south coast, with tops rising above 3000 m. A large area of the plateau is enclosed in the ring of the ice-caps Vatnajökull, Hofsjökull, Langjökull and Myrdalsjökull.

During an expedition to this area in the summer of 1951 it was noticed that the ice-cap Hofsjökull generated its own wind system on occasions, and that winds blowing outward from the periphery of the ice-cap then occurred.[1] It was suggested that when a depression travels along the south coast of Iceland the wind systems of the various ice-caps could cause an extension of the low-pressure area into the central plateau, with troughs extending like fingers into the spaces between the ice-caps.

Further work by a succeeding expedition of the British Schools Exploring Society in 1956, the base camp of which was located at Station A (Figure 1(*a*)), just to the south of Langjökull, showed that 63 per cent of all 144 measured winds during a seven-day period blew from the ice-cap.[2] It was further noted that, with pressure low to the south of Iceland, and prevailing north-east winds, there was a diurnal pressure fluctuation, when the pressure fell until about midday, and then rose sharply with the onset of a wind from the glacier. It was suggested that under these synoptic conditions, a topographic low was formed in the lee of the ice-caps, although the extent of this phenomenon away from Station A was a matter of inference.[3] It was not found possible to deduce sea-level pressures, because the readings were taken from aneroid barometers, and only differences between the readings at Station A, and those at Reykjavik, on the coast, were considered. However, it was clearly desirable to carry out an investigation with a mercury barometer, and to try to establish some correlation with sea-level values.

A third expedition in the summer of 1960 was based at Station B (Figure 1(*a*) and Plate I). Two Meteorological Office long-range mercury barometers were carried with the expedition, but despite the greatest care in handling, one was found to be broken on arrival at Station B. The other performed satisfactorily for an observation period from 31 July to 7 September. Although there was no check on this instrument in the field, it was found, when checked by the Instruments Division of the Meteorological Office, to be subject to the original corrections applied in the field. Whilst this is not absolute proof of its accuracy in the field, the results obtained with the instrument suggest that it was accurate. This paper is concerned with these results.

Local conditions.—The base camp was sited some 4 km from the north-eastern edge of Langjökull, at the base of the low range of hills bordering the

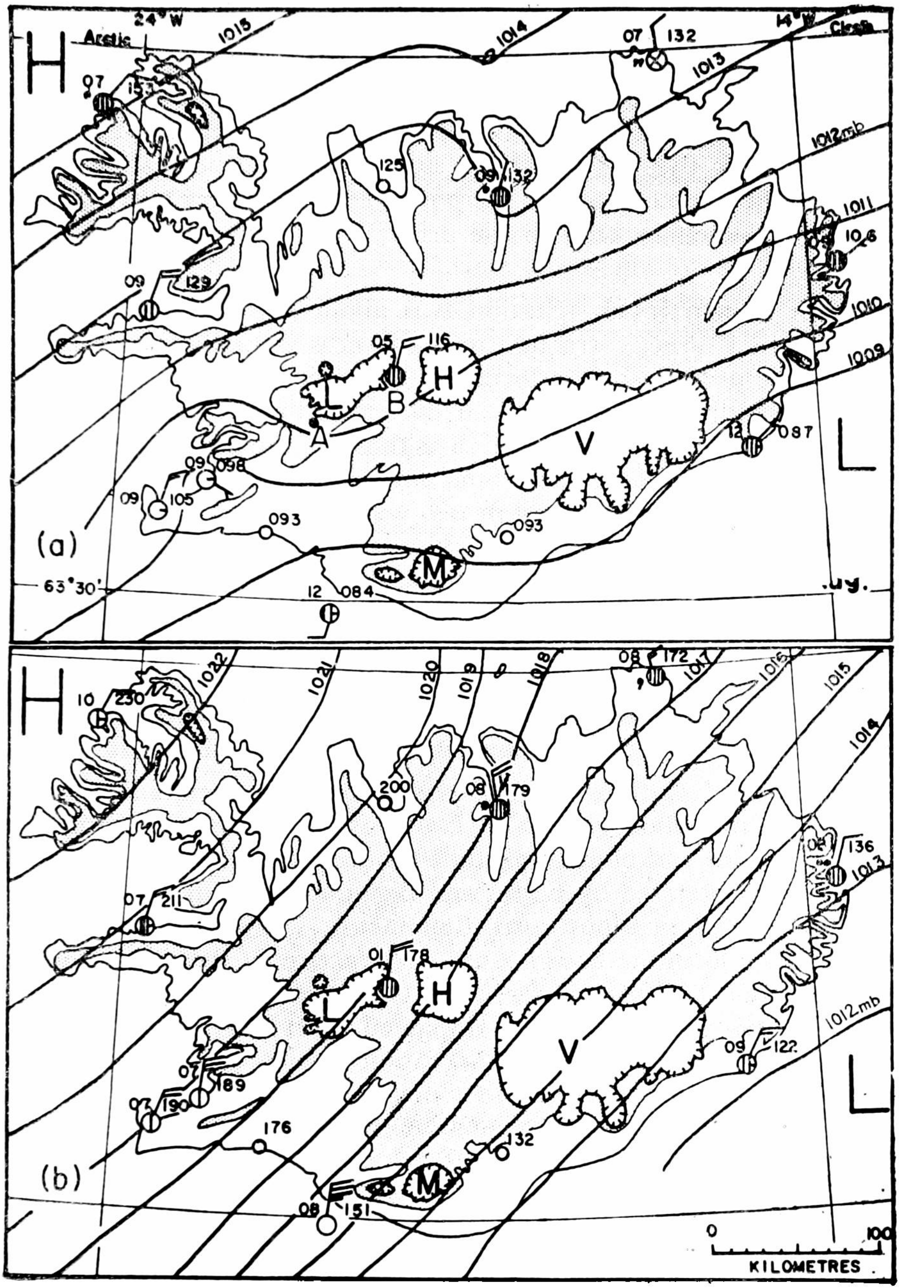

FIGURE I—SYNOPTIC SITUATIONS WITH GENERALLY NORTH-EAST WINDS OVER ICELAND

Land over 300 metres is shaded. Isobars are at 1-mb intervals.
Ice-caps: V – Vatnajökull M – Myrdalsjökull
H – Hofsjökull L – Langjökull
(*a*) 0000 GMT on 15 August 1960
A – Site of observations in 1956. B – Site of observations in 1960.
Clearer skies and disturbance of the isobars in the south-west indicate some topographical control of the weather.
(*b*) 0000 GMT on 17 August 1960
Strong winds allow of little topographical control.

ice-cap. The barometer was set up in a tent, and was mounted on a strong wooden pole sunk a metre into the ground. Corrections were applied to each reading for gravity, instrument error, and instrumental temperature; these corrections were consolidated into a table for convenience. The readings were thus only corrected for the station level of 695 m above sea level. This level is possibly a metre or two on the high side, since the nearest geodetically-established height is some 12 km to the north, and the survey over this distance could not be expected to keep to the original accuracy of the triangulation point.

Correction to sea level.—Station B is about 100 km from the sea and 695 m high so that direct correction to sea level is virtually impossible by the use of the simple pressure-height formula. The situation is complicated by the fact that in Iceland, in summer, the air over the sand and rock of the central plateau heats up to temperatures as high as those on the coast, and assumptions of normal temperature gradients become untenable. The problem of correction for synoptic purposes can be solved in two ways.

The first is perhaps the most satisfactory for such an isolated area, and involves correction upwards to one of the standard pressure surfaces. This was used with success in the relation of pressures on the summit of the Greenland ice-cap to the 700 mb charts.[4] However, in that case, the altitude difference between 'Northice' station and the 700 mb surface was never very great. In the present case, with pressures near 900 mb it was felt that this method of correction upward would not have been adequate for the detailed results required.

The method used was the second alternative, a correction down to sea level. In the central plain regions of North America, the same problems of distance from oceans and of great altitudes above datum level also exist. These problems were investigated by Ferrel and Bigelow. By a painstaking review of the observations and previous correction factors, Bigelow[5] drew up recommendations which form the basis for present practice. It should be pointed out here that, although the formula to be discussed below is based on theoretical considerations, some of the values employed in it are dependent on local factors found by a long series of observations which are lacking in central Iceland. It has been found convenient in this discussion to use the practice developed in Canada (Meteorological Branch, Department of Transport)[6] as being more relevant to Icelandic conditions.

The reduction equation.—As put forward by Bigelow, this equation was in the form

$$p_o = p_s + (\mathrm{d}p + a + b + c) \qquad \ldots (1)$$

where p_o is sea-level pressure,

p_s is station pressure,

$\mathrm{d}p$ is the weight of the fictitious column of air extending from sea level to the station level, and computed from the hypsometric formula,

a is the so-called plateau correction of Ferrel,

b is a correction for the assumed mean value of humidity of the fictitious air column,

c is a term originally introduced to even out inconsistencies in corrected readings. It is now largely ignored because of improvements in the other factors.

In this equation, the term dp is derived by integration of the hypsometric formula to an exponential expression, and subsequent expansion as an infinite series. The later terms of this series are ignored, being so small as to contribute a negligible error compared with those of other factors.

This results in

$$p_o - p_s = p_s \frac{490}{460 + T_M} \left\{ x + \frac{x^2}{2} \right\} \qquad \ldots (2)$$

where T_M = mean temperature at time of observation in °F. To eliminate diurnal changes, the practice is to make $T_M = \frac{1}{2}(t_h + t_{h-12})$ where t_h is the temperature for h, the hour of observation, and t_{h-12} is the temperature 12 hours previous to h,

x = $h/26111$ where h is the elevation of the station above sea level in feet.

In equation (1) the plateau correction a is given by

$$a = C \times \Delta T \times H_s \qquad \ldots (3)$$

where C = constant (0.0355 for mb units),

H_s = elevation of station in 1000's of feet above sea level,

ΔT = difference between T_M, the mean air temperature at time of observation and T_s, the mean annual temperature of the station.

In equation (1) the humidity correction b is, in Canadian practice, deduced from the Smithsonian tables[7] for the relevant height and T_M conditions.

Sources of error in the equation.—The potential sources of error probably lie in the following terms:

(i) In equation (2), h, elevation above sea level; only by a detailed levelling survey would it be possible to be certain that any height in central Iceland was closer than ±2.5 m to the correct height.

(ii) In equation (3), ΔT, the difference between the mean temperature of the observation period and T_s, the mean annual temperature, is uncertain because the term T_s is almost completely unknown. This is discussed below.

(iii) H_s suffers from the same lack of surveyed accuracy as h above. The humidity correction b is assumed to be for normal conditions. However, because of adiabatic warming, central Iceland often has relative humidity values as low as 20 per cent and, when more accurate values of other terms are obtained, it would seem that a recalculation of the term b for more representative conditions of plateau humidity is advisable.

The mean annual temperature T_s.—Although no stations have been operated on the high plateau of Iceland near the ice-caps for a continuous period long enough to obtain an annual temperature, readings have been made for over half a century at Grimsstadir on the lower edge of the plateau at G (see Figure 2(*a*)). Station B lies about half-way between Grimsstadir and Reykjavik (R in Figure 2(*a*)) in the south-west.

In August 1960, Reykjavik had a mean temperature 0.6°C above the average of 10.6°C, while Grimsstadir registered 1.0°C below its average of 7.2°C.[8] It seems probable that, like Reykjavik, Station B had conditions giving temperatures slightly above average. The measured mean temperature for Station B

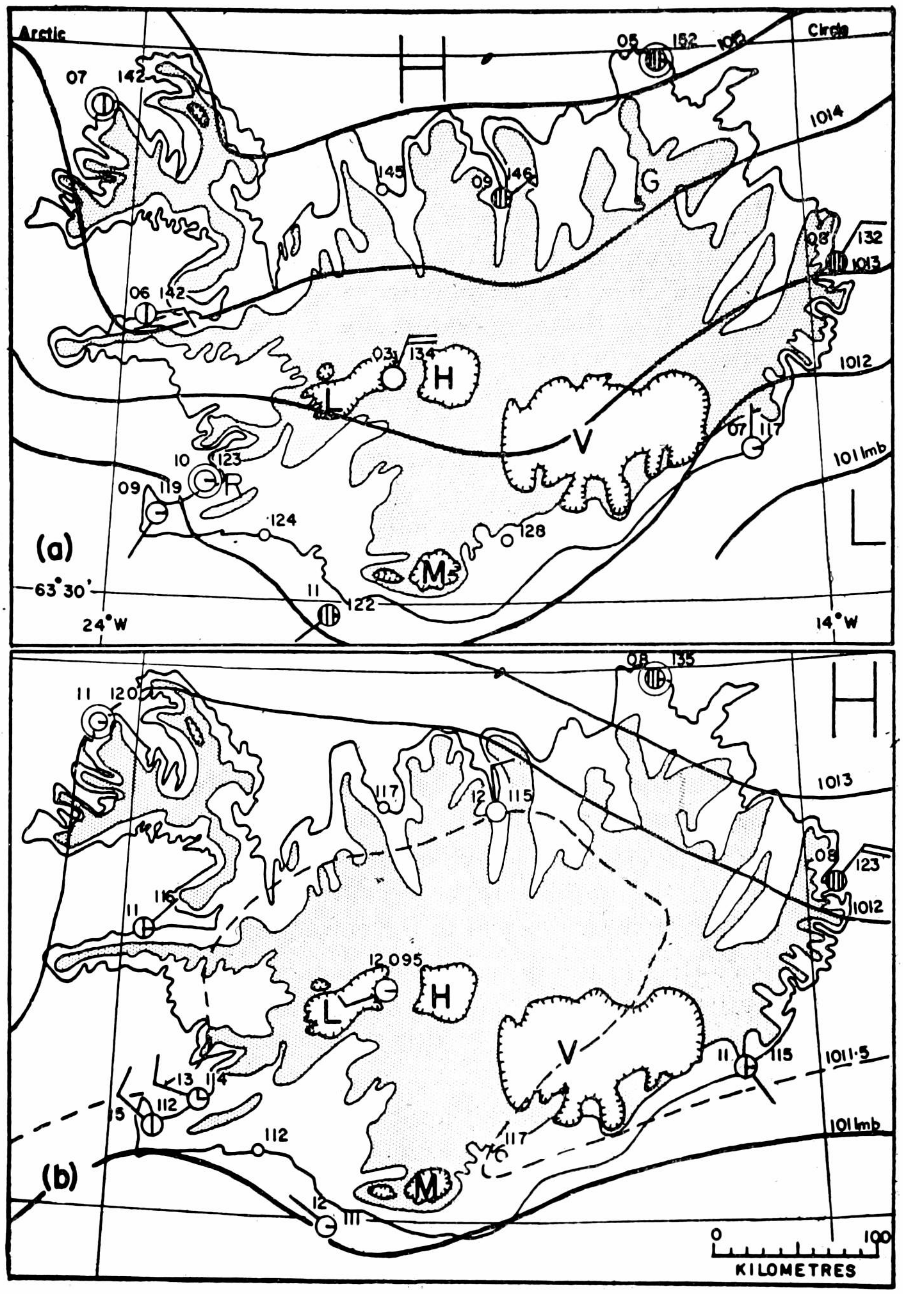

FIGURE 2—SYNOPTIC SITUATIONS WITH LIGHT NORTH-EAST WINDS OVER ICELAND

R – Reykjavík G – Grimsstadir
Other details as in Figure 1.
(*a*) 0000 GMT on 19 August 1960
Slack anticyclonic gradient at night.
(*b*) 1500 GMT on 19 August 1960
Low pressure over the central plateau in mid-afternoon.

was 6.3°C and it is asumed here that the mean for August is 6.0°C. This may well be a high estimate especially since the difference in altitude between Station B and Grimsstadir would indicate a lower average at Station B.

The march of temperature at stations in Iceland differs considerably depending on the altitude of the station and its location. Reykjavik, in a marine environment, has a much more moderate climate than Grimsstadir although the summer temperatures are closer together[8] (Table I). It seems likely that Station B has a continental type of temperature régime similar to that of Grimsstadir. If, therefore, it is assumed that the temperature curve is of the same type as that of Grimsstadir and that the mean annual temperature of Station B is 1.2°C below that of Grimsstadir, as was the mean in August, then T_s for Station B will be –0.7°C. This is likely to be high on many accounts, and in particular because of the proximity of Station B to the ice-cap Langjökull, whereas Grimsstadir is far from any of the ice-caps.

TABLE I—MEAN MONTHLY TEMPERATURES AT REYKJAVIK AND AT GRIMSSTADIR

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
						degrees Celsius							
Reykjavik	–0.6	–0.2	0.5	2.6	6.3	9.6	11.3	10.6	7.8	4.3	1.4	0.0	4.5
Grimsstadir	–5.6	–4.9	–4.5	–1.7	2.1	7.1	9.6	7.2	4.2	0.1	–3.6	–4.9	0.5

Reykjavik is 17.8 m and Grimsstadir 385.9 m above MSL.

At the other extreme, figures are available for the Britannia Sø Station of the British North Greenland Expedition, at a higher latitude (77°N) but a lower altitude (231 m) than Station B. This station lay just to the east of the Greenland ice-cap. Figures for two 12-month periods gave annual mean temperatures of –9.5° and –10.0C.[9]

For the purpose of this paper, a mean annual temperature has been estimated at a point on the scale about half-way between conditions at Grimsstadir and those in Greenland. T_s for Station B is thus assumed to be –5.0°C, and an error of a few degrees will not make much important difference to the size of the correction factor in equation (3).

Calculation of the correction factor.—Changes have been made in equation (1) to allow for use of altitudes in metres instead of feet, and °C instead of °F.

Using the following values $h = 695$ m and $T_s = -5.0$°C, equation (2) becomes

$$dp = p_s \times \frac{273}{273 + T_M} \times 0.09109$$

and equation (3) becomes

$$a = 0.04499\ (T_M + 5).$$

These two factors have been combined into the correction factors in equation (1) which become

$$p_s \times \frac{273}{273 + T_M} \times 0.09109 + 0.4499\ (T_M + 5) + b.$$

Table II shows the main values of corrections for the ranges of temperature and pressure experienced at Station B.

Typical synoptic situations.—Values derived from Table II are used to illustrate situations occurring with low pressures to the south of Iceland. The

TABLE II—CORRECTIONS TO BE ADDED TO READINGS OF PRESSURE AT STATION B FOR REDUCTION TO SEA LEVEL

Mean station temperature, T_M *degrees Celsius*	Station pressure, p_s in millibars 920	925	930	935	940	945
	Correction to be added *millibars*					
0	83.88	84.34	84.79	85.25	85.70	86.16
1	83.60	84.06	84.51	84.96	85.42	85.87
2	83.32	83.78	84.23	84.68	85.13	85.58
3	83.05	83.50	83.95	84.40	84.85	85.30
4	82.77	83.22	83.67	84.12	84.57	85.02
5	82.50	82.96	83.39	83.84	84.29	84.74
6	82.23	82.68	83.12	83.57	84.01	84.46
7	81.96	82.41	82.85	83.29	83.74	84.18
8	81.70	82.14	82.58	83.02	83.47	83.91
9	81.43	81.87	82.31	82.76	83.20	83.64
10	81.17	81.61	82.05	82.49	82.93	83.37
11	80.91	81.35	81.79	82.23	82.66	83.10
12	80.65	81.09	81.53	81.96	82.40	82.84

Station B is 695 m above MSL.

flow of air in a generally north-easterly direction is controlled markedly by the local conditions over Iceland. With strong winds and thick cloud cover, the isobars run straight over the country (Figure 1(*b*)), but with moderate wind-speeds, local interruptions to air flow occur (Figure 1(*a*)). With clear skies on the outskirts of an anticyclone, pressure over the central plateau in mid-afternoon is low (Figure 2(*b*)). The low pressure is indicated particularly by Station B, but to a lesser extent also by the stations surrounding the plateau and by the onshore winds which were observed.

Acknowledgements.—Thanks are due to the Meteorological Office, London, to the Meteorological Branch, Department of Transport, Canada, and to the Icelandic Weather Office, for help with instruments and advice. The observations were carried out by members of the 1960 Expedition of the British Schools Exploring Society, and the author wishes to thank, in particular, his fellow meteorologist, Mr. N. G. Brown, and the boys who did the hard work of continuous observation.

The working-up of the results has been aided by a grant from the Research Fund of the University of Alberta.

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* See also 'Present methods used by the Canadian Meteorological Branch for reducing atmospheric pressure to mean sea level' an unpublished office memoranda of the Department of Transport, Meteorological Branch, Canada.

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SYMPOSIUM ON THE BIOLOGICAL SIGNIFICANCE OF CLIMATIC CHANGES IN BRITAIN

By J. G. COTTIS

Many disciplines were represented at the Institute of Biology's symposium held in London on 29 and 30 October 1964, to examine the nature and magnitude of Britain's climatic changes in relation to biological responses, especially those of importance to agriculture.

The theme of the first session was the assessment of the dimensions of climatic change, the opening speaker being Mr. H. H. Lamb of the Meteorological Office. He outlined the main stages of Britain's climatic history over the past 10,000–15,000 years, treating the last 1000 years in more detail; he described the remarkable warming of our climate over the period from about 1890 to the 1930's, which affected the length and dependability of the plant growing season, but warned that extrapolation of the climatic reversal since about 1940 is no guide to the future. Climatic forecasting must await a better understanding of the physical influences and mechanisms involved, particularly in the general circulation.

It is currently fashionable to accept that climate is changing but Lamb warned that the facts must be put into proper perspective, which only fuller knowledge and careful numerical assessment can give. He dealt quantitatively with recent trends of temperature, rainfall, lying snow, etc., relating these to selected agricultural and horticultural practices (such as trying to grow exotic fruit crops, e.g. apricots, peaches and grapes), and demonstrated changes in circulation of wind and ocean currents.

Professor D. J. Crisp of the Marine Science Laboratory, Anglesey, spoke on the effects of climate and weather on marine organisms and stressed the distinction between average climatic conditions on the one hand and isolated periods of abnormal weather on the other. It seems that gradual changes in the climate over a number of years are more effective in modifying the general pattern of distribution of species than are relatively short periods of severe weather such as the cold winter of 1962–63. Dr. J. A. Taylor of the University College of Wales followed with a paper on climatic change as related to soil variables and altitudinal thresholds; taking examples from the maritime uplands he discussed how undisturbed soil profiles can help to register the ebb and flow of ecological frontiers in response to changes of climate. He also described some well-marked changes of distribution of bracken and molinia grass in Wales in recent decades and related these to climatic variation but, in subsequent discussion, doubts were raised as to whether such distribution changes could fairly be regarded as effects of climate variation in view of known changes of grazing management and land use.

The afternoon session selected some effects of climatic change and their implications, and covered a wide range of subjects. Dr. F. H. Perring of the Nature Conservancy discussed the advance and retreat of the British flora but he stressed that change in climate, or macroclimate, is but one factor involved and that man's disturbance of the environment often over-rides other factors. Mr. R. J. H. Beverton and Mr. A. J. Lee of the Ministry of Agriculture, Fisheries and Food Fisheries Laboratory at Lowestoft, outlined recent changes in distribution of cod and herring, and described how these may be related to variation in sea temperatures.

Professor F. L. Milthorpe of Nottingham University said there is little doubt that variations in climate are responsible for appreciable variations in yields of agricultural crops even in countries as free of catastrophic changes as Britain, but he described attempts to derive quantitative relationships between plant yield and the weather components as having been largely unsuccessful because of inadequate definition or understanding of the environmental variables. Nevertheless he asserted that much progress had been made towards understanding the environmental needs of a crop for optimum growth and yield. Professor J. P. Hudson, also of Nottingham University, dealt with the agronomic implications of long-term weather forecasting, reminding us that climate limits the choice of crops and varieties while weather causes deviations from the expected levels of yields; more knowledge is needed on the response of plants, and varieties of plants, to weather. Developments in long-range weather forecasting suggest many interesting possibilities for prediction and control of seasonal and varietal yields, and in the planning and management of crops.

The opening speaker on the second day of the symposium was Mr. W. H. Hogg of the Meteorological Office, who examined the climatic factors involved in choice of site, particularly for horticultural crops. He gave examples of how standard (macroclimatic) data are applied to choice of site for crops but emphasized that mesoclimatic factors must be carefully considered in relation to the horticultural potential of any area. At present our knowledge of local deviations from the macroclimate is sketchy, especially in country of varied topography, and he suggested a number of specific topics on which more information would be valuable.

Dr. K. L. Blaxter of the Hannah Dairy Research Institute related climatic factors to the productivity of different breeds of livestock. His paper was concerned with the direct effects of cold on farm stock and with comparative aspects of cold tolerance. The distribution of breeds of cattle in Britain still reflects in some respects their source of origin but there is little evidence that climatic factors play much of a role in determining distribution now, largely because of improved farming technology; however, there are distinct differences in the cold tolerance of hill sheep compared with lowland breeds. Dr. Blaxter explained that cold tolerance in animals was increased by better feeding so that adequate nutrition combined with the provision of simple shelter was the best insurance against a severe winter.

Climatic adaptation of local varieties of forage crops was the subject of the paper read by Dr. J. P. Cooper of the Welsh Plant Breeding Station. He described the main climatic factors limiting crop production in the Mediterranean, European, and maritime Atlantic regions, and gave some experimental results. Over much of eastern Britain average winter temperatures and summer precipitation are both marginal for active growth so that comparatively small seasonal or altitudinal changes in either temperature or water supply have a disproportionately large effect on the length of the growing season. Dr. Cooper ended with a plea for more detailed studies of field environment, especially of the microclimate in and around a crop.

Mr. L. P. Smith of the Meteorological Office opened the final session of the symposium by discussing possible changes in our seasonal weather, emphasizing that these were not to be regarded as forecasts but that he was intent on examining aspects of present-day farming practice that were most sensitive to possible future climate changes. Some changes would be generally regarded as beneficial to British agriculture but the main threat of increased difficulties leading to depressed yields or lower profitability appeared to him to come from the possibility of drier winters (inadequate replenishment of natural water storage), colder springs (a later start to growth), wetter summers (haymaking and grain harvesting more difficult, with greater disease problems) and wetter autumns (presenting difficult operational problems, especially on heavy land). More simply, coldness and wetness at both ends of the growing season would be the most serious threat.

Professor A. N. Duckham of Reading University presented the last paper, on 'Agricultural Perspectives', expressing confidence in farmers' capacity to cope with the effects of possible climate changes, partly because of the vast increase in available power. He discussed the weather sensitivity of tillage crops and thought that further mechanization, irrigation and better weather data, together with agronomic advances, will enhance the reliability of such crops. Professor Duckham went on to survey other weather sensitive-aspects of British farming. In subsequent discussion, he suggested that if our summers became wetter and cooler and conditions were too difficult for cereals—for example in East Anglia—then farmers would naturally adopt the alternative of root crops and grass; but he pointed out that the resilience of British agriculture was bought at a high price, that of costly machinery and fertilizers.

The Chairmen at the four sessions were Mr. L. P. Smith, Professor A. H. Bunting (Reading University), Professor J. E. Nichols (University College of Wales) and Sir Joseph Hutchinson (School of Agriculture, Cambridge University).

With twelve papers to consider or digest, there was insufficient time for much general discussion. Apart from questions seeking clarification or elaboration of points raised in the papers, discussion ranged over such matters as the possible misuse of statistical handling of data, economic and political considerations, the prospects of improved mechanization, the loss of agricultural land to urban growth, the potential value of upland sites and land reclamation generally.

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WEATHER SATELLITES WILL HELP AUSTRALIAN FORECASTERS

By N. CARRICK
News and Information Bureau, Australia.

Australia's weather forecasting facilities will be vastly improved when weather satellites regularly orbit the earth.

The first NIMBUS satellite transmitted such valuable information to two 'read-out' stations in the State of Victoria that three new stations, at Perth, Western Australia; Darwin, Northern Territory and Brisbane, Queensland, are planned. NIMBUS A, launched by the United States National Aeronautics and Space Administration (NASA) from Vandenberg Air Force Base, on 28 August 1964, stopped transmitting signals when its two solar paddles jammed recently. However, the United States plans to launch another satellite soon and to have satellites continually in orbit.

Australia, like other countries in the southern hemisphere, has its weather pattern dominated by air masses which move across the continent from mainly the south-west, and sometimes from the north. As there are no weather stations in the southern part of the Indian Ocean and the Southern Ocean, and as few ships which could radio information ply these seas, Australian meteorologists suffer from a serious lack of detailed information of cloud formations in these areas. The first NIMBUS satellite, which orbited the earth each 98 minutes at a height of 575 miles, relayed to 'read-out' stations photographs of cloud formations (Plate II) which assisted meteorologists to make forecasts. Victoria had two 'read-out' stations receiving photographs from NIMBUS A while it was transmitting. One was at the Royal Australian Air Force Base at Laverton near Melbourne (Plate III), and the other at the University of Melbourne.

NIMBUS A, when passing in range of the two stations, transmitted signals which were then relayed to the Bureau of Meteorology in Melbourne. The signals were then taped and fed through a facsimile machine operated on the same principal as a normal picturegram unit. The resulting pictures showed cloud formations over a vast area—and also showed one extremely interesting sidelight. The photographs taken from 575 miles up showed the southern Australian coastline clearly—and proved just how accurate the map makers were.

Australian authorities hope to have the 'read-out' station in Perth completed soon and the other two in Darwin and Brisbane within the next few years.

REVIEWS

Weatherwise, the technique of weather study, by N. L. Peter. 8 in × 5¼ in, pp. ix + 179, *illus.*, Pergamon Press Ltd., Headington Hill Hall, Oxford, 1964. Price: 25*s.*

This book, intended primarily for yachtsmen, scans many aspects of meteorology, and the author attempts to discuss not only weather typical of the British Isles and its coastal waters but also that of other parts of the world, particularly the tropics and Australia. Also included is a section on oceanography, a subject closely allied to meteorology but only rarely mentioned in elementary meteorological texts.

Much ground is covered in less than 200 pages and simplification of many concepts is inevitable. Unfortunately some chapters suggest that the author lacks a clear understanding of his subject. When at a loss to explain the physical or meteorological relationship between two concepts he frequently resorts to using the verb 'to tend' or the noun 'tendency.' The most unsatisfactory section is that on Visibility where the reader would be both confused and misled. In addition the book contains numerous factual errors. It is expensive at 25*s.* and in the reviewer's opinion cannot be recommended.

D. M. HOUGHTON

Meteorology and climatology for sixth forms and beyond, second edn by E. S. Gates. 9½ in × 7½ in, pp. 207, *illus.*, George G. Harrap & Co. Ltd., 182 High Holborn, W.C.1, 1963. Price: 16*s.*

This book was first published in 1961, and was reviewed in the *Meteorological Magazine* in October 1961.

In this edition the author has made slight amendments to the text and certain diagrams. There is some confusion regarding the tropopause and this needs to be rectified, e.g. on p. 115 there is a statement about "aircraft which now operate outside the troposphere and well within the tropopause," and on the same page there is a reference to "this transition zone" which would seem to imply that the tropopause is a layer of some considerable thickness. It is also surprising to find in Figure 105, that Vancouver is still selected as an example of a west European climate.

The book has been improved by a considerable extension of the bibliography, and by the addition of four appendices, one of which gives monthly and annual values of temperature and precipitation for over 450 stations throughout the world.

Although the book is intended primarily for the geography student, it should prove stimulating to the young physicist and to the keen amateur.

W. R. GALLOWAY

Physics of the air, by W. J. Humphreys. $8\frac{1}{4}$ in × $5\frac{1}{4}$ in, pp. xvi + 676, *illus.*, Constable & Co. Ltd., 10 Orange Street, W.C.2, 1964. Price: $3.

The first edition of this classic textbook appeared in 1920, and was followed by the second and third editions in 1929 and 1940. The present 'Dover Edition' is an unabridged reprint of the third edition.

With the advance in knowledge of the atmosphere which has occurred since 1940, many parts of the book have become obsolete: in particular, is this true of the physics of the upper atmosphere of which little was known in 1940. The section dealing with atmospheric optics, however, is still a standard reference on the subject.

W. R. GALLOWAY

NOTES AND NEWS

Canadian Meteorological Service

Mr. J. R. H. Noble has been appointed as Director of the Meteorological Branch of the Department of Transport. Dr. T. G. How was named in an earlier announcement in the *Meteorological Magazine* of July 1964 but declined the appointment for health reasons.

Irish Meteorological Service

Mr. A. Bourke has been appointed to succeed the late Dr. M. Doporto as Director of the Irish Meteorological Service. Mr. Bourke is at present Vice-President of the International Society of Biometeorology.

LETTER TO THE EDITOR

202 Meteorological Reconnaissance Squadron

Having had almost continuous connexions with both No. 202 Squadron and Meteorological Reconnaissance Flights over a long period, I found the article by Mr. R. F. M. Hay in the November 1964 *Meteorological Magazine* most interesting.

One incident which is not recorded is worthy of note. During its war-time service at Gibraltar No. 202 Squadron was engaged on normal Coastal Command operations, the Gibraltar meteorological flights ('Nocturnal') being performed by Halifax aircraft. In 1944, however, the availability of serviceable

Halifax aircraft became so low that for a period regular meteorological sorties could not be made. To ease the situation, it was arranged that some flights would be taken over by the Catalina aircraft of No. 202 Squadron. Instruments were fitted in a very simple manner, air meteorological observers joined the regular flying-boat crew and the first meteorological flight was made by the Squadron on 28 June 1944. The full 'Nocturnal' track was followed, with some limitation to, I believe, about 10,000 ft, in the height of the vertical ascent. Except in this respect the flight was entirely normal and highly successful and was repeated on several subsequent occasions during the following weeks.

This was probably the first full meteorological flight to be performed by an RAF flying-boat, and certainly the first to be performed by No. 202 Squadron, which was later to become so closely associated with 'Bismuth' until its termination in 1964.

Meteorological Office, Bracknell A. L. MAIDENS

HONOUR

The following award was announced in the New Year Honours List, 1965:

B.E.M.

H. D. Henley, Technical Class Grade III, Meteorological Office, Kew Observatory. Mr. Henley retired from the Office on 26 September 1964.