From a consideration of the mode of formation of cold air and warm air masses it could be expected that a positive difference between air and sea temperatures corresponds to drizzle and a negative difference to shower air. The author has investigated this rule from 620 observations taken at Thorshavn and found that the rule holds good without exception for differences greater than 0.5° C. For smaller differences no definite contradiction could be established. It thus follows that accurate measurements of air and sea temperatures at all international island and ship stations and their report to 1/10° C. or 1/5° F. have great importance for practical weather analysis.

The investigations of the author on horizontal visibility in Scandinavia confirmed the hypothesis that the opalescent turbidity of the warm air mass is notably greater than of the cold air mass.

From a previous work of the author (Wellen und Wirbel, Leipzig, 1924) it is known that surfaces of equal entropy (isentropic surfaces) of the cold mass are inclined upward toward the pole, while in the warm air mass they are almost horizontal. Thus is follows, as is later discussed in detail, that the cold mass easily becomes heterogeneous while the warm air mass with horizontal isentropic surfaces is among the most homogeneous masses of the atmosphere.

By means of aerological data from Holland and Spieglitzer, Schneeberg, the existence of at least two separate air masses is statistically indicated. The potential temperature has at any level two pronounced frequency maxima which correspond to polar air and tropical air.

When two air masses each uniformly homogeneous approach each other nearer than about 1,000 kilometers, the area between them no longer fulfills the conditions of a homogeneous air mass. A frontal zone occurs which can gradually sharpen to a front. Fronts are narrow inclined transition zones of the same vertical extent as the air masses. It is essential that the difference of the values on both sides of the front of at least one of the independent elements (temperature, pressure, wind, humidity) is so great that it has an appreciable effect on the great scale dynamics (of the air mass).

In the troposphere, fronts are continuously produced and destroyed. The author has called these processes frontogenesis and frontolysis. Kinematic frontogenesis consists in the coming together of the equiscalar surfaces of an element through the motion of the individual particles.

In dealing with air masses which are not too extended the field of movement can be treated as linear. The movement itself may be resolved into four partial fields consisting of a translation, a rotation, an expansion, and a deformation. Only through the deformation movement can two particles essentially approach or separate from one another.

As no essential change of volume can occur, a deformation is undergone either as an extension along the principal axis and a contraction along both secondary axis or as a contraction along the principal axis and an extension along the secondary axis. Material particles which at one time form a plane surface will always form a plane surface which during movement alter only their orientation and their distance from the field's center. In a 2-dimensional field the surfaces rotate so that they will ultimately be perpendicular to the axis of greatest contraction.

A symmetrical deformation field with vertical axis produces the following effects—the extension of the principal axis causes dissolution of horizontal inversion zones while contraction brings sharpening.

A 2-dimensional half deformation field with one horizontal axis and an axis directed obliquely upward causes frontogenesis and dissolution of inversions. Contraction along the horizontal axis causes frontolysis, while expansion causes inversion formation.

The choice of entropy surfaces as equiscalar surfaces presupposes advective frontogenesis. Thus from the beginning the entropy surfaces are inclined and advection comprises a permanent deformation-field of which the axis of contraction can not be directly vertical. It thus follows, as has been previously pointed out, that in the warm air mass where the isentropic surfaces are almost horizontal almost no frontogenesis occurs; in the cold mass where they are somewhat inclined, weak frontogenesis; and in frontal zones where they are considerably inclined there is effective frontogenesis.

The general circulation of the earth's atmosphere is divided into several partial circulations. They can be considered as a system of vertical wheels and of horizontal wheels. The hyperbolic points between the wheels are the centers of the deformation fields in the foregoing sense. Frontogenesis and frontolysis develop in the areas between the parts of the general circulation. The effect of the vertical wheels and horizontal wheels will alternately strengthen and oppose each other.

When the general circulation works frontogenetically, areas occur where by preference fronts are formed. The favored frontal zones run east and west. In the intermediate zone where the vertical opposes the horizontal circulation, the resulting effect will be mostly frontolysis so that the air exchange between pole and Equator can go on unhindered.

Doctor Bergeron's book is conceived as the principle introduction to the problem of air masses and front formation. The use of the results for investigating the relations actually occurring in the troposphere will be shown in Part II. The wish may be expressed that we may not need to wait long for this continuation.

ON PERIODICITY IN SERIES OF RELATED TERMS[1]

By SIR GILBERT WALKER, F. R. S.

SUMMARY

In 1927 Yule developed the idea that a series of numbers $u_1, u_2, \ldots, u_n$ expressing the condition of a physical system, such as successive annual sun-spot numbers, might be regarded as due to a series of accidental disturbances from outside operating on some dynamical system with a period or periods of its own, probably subject to damping. The consequent oscillations would vary both in amplitude and in period. In this paper it is shown that if Yule's equation defining the relationship between successive undisturbed terms of the u series is

$$u_u = g_1 u_{x-1} + g_2 u_{x-2} + \ldots + g_s u_{x-s},$$

then, provided n is large, a similar equation holds very approximately between successive values of r_p, the correlation coefficient between terms of u separated by p intervals, i. e.,

$$r_x = g_1 r_{x-1} + g_2 r_{x-2} + \ldots + g_s r_{x-s}.$$

[1] On periodicities in series of related terms, Proc. Roy. Soc. Series A, vol. 131, No. 818, pp. 518-532.

• The subject is treated from the mathematical viewpoint and since no one's views are entitled to greater consideration than those of Sir Gilbert we print in his own words the summary of his conclusions.—ED.

Thus the graph expressing the r_p's, which is much smoother than that of the u's, may be used to read off the character of the natural periods of the u's; further various relationships are found between the amplitude of the corresponding terms in the Fourier periods and those of the correlation coefficients.

The analysis is illustrated by applying it to the quarterly values of pressure at Port Darwin, a key center of world weather, which proves to have a strong persistence and to show evidence of not very strongly developed periods of about 34½ months and of about four times this length or 11½ years; the series of data is not long enough to settle whether the former oscillations are damped and are free oscillations, but the latter appear to be imposed from without and are presumably solar in origin.

WULF AND MELVIN ON THE EFFECT OF TEMPERATURE UPON THE ULTRA-VIOLET BAND SPECTRUM OF OZONE AND THE STRUCTURE OF THIS SPECTRUM

The ultra-violet absorption of ozone in the region 3400–2300 Å consists of a large number of bands appearing against a background of continuous absorption. The effect of temperature upon this spectrum has been studied over the range −78° to 250° C. A definite though small effect has been observed. Grossly it manifests itself as an increase in contrast with decreasing temperature. Photometric results show this to be chiefly a decrease in absorption between the band edges, all of the bands appearing to come from normal vibrational levels of very low if not the lowest energy. Though somewhat diffuse, the bands tend to degrade to the red. The observed influence of temperature can be explained as the decrease of intensity in the higher rotational absorption of the bands, and possibly also in the continuous background, with decreasing temperature. Discontinuities in the intensity relations and the regular spacing of certain of the bands have led to a partial vibrational analysis indicating two active vibrational degrees of freedom in the excited electronic state. The observed change in the absorption with temperature may effect somewhat the estimates which have been made of the amount of ozone existing in the upper atmosphere.—(*Bulletin of the American Physical Society, Program of the Washington Meeting, April 16, 1931, volume 6, No. 2, page 42.*)

FATHER E. GHERZI, S. J., ON THE WINDS AND UPPER AIR CURRENTS ALONG THE CHINA COAST AND IN THE YANGTSE VALLEY [1]

The publication under review comes from the well known observatory of Zi-Ka-Wei, near Shanghai, organized more than half a century ago and operated in the interest of meteorology with special application to storm warnings for navigators of the adjacent seas. The present publication has its special appeal to navigators of the air in the Far East.

The upper air data available to Father Gherzi are far too few to afford definite reuslts; nevertheless those at hand in connection with the movement of the clouds and the surface winds, statistics of which are abundant, enable the author to present a picture of free air conditions that is of much value in air navigation.

His pilot-balloon material consists of ascents made at Chefoo by the U. S. S. *Jason* in May, June, July, August, and September, 1928; pilot-balloon ascents were also contributed by H. M. S. *Argus* at Shanghai made in October, November, and December, a few ascents in each month. These ascents though few in number serve to indicate the direction and force of the winter monsoon winds along the China coast. As might be expected these winds are due essentially to the presence and the intensity of the so-called Siberian cold season anticyclone; the center of which may be over the Province of Shantung in China, rather than in Siberia. Father Gherzi concludes that for winter monsoon days the winds aloft back with increase in altitude above the surface. Data for the summer monsoon are much too few to permit the drawing of definite conclusions. Conditions during the summer monsoon are much less ready than during the winter monsoon.

The statistical data of surface winds are given in very great deatil for a number of stations on the China coast. The 240 quarto pages comprised in the report are mostly taken up with data of cloud movement and surface air movement printed in detail for a number of years of record. Appropriate charts and diagrams add to the interpretation of the statistics. The price of the work is $4.50.—*A. J. Henry.*

[1] The winds and upper air currents along the China coast and in the Yangtse Valley Zi-Ka-Wei Observatory, Shanghai, 1931.

RESULTS OF RAINFALL OBSERVATIONS IN WESTERN AUSTRALIA [1]

The present volume is the fifth of a series published by the bureau. Volumes for Victoria (1910), N. S. Wales (1914), Queen Island and South Pacific (1913), South and North Australia (1917) have already been published. The last volume, discussing Tasmania, is under preparation. As soon as the series is completed supplementary volumes are to be published to bring the early issues up to date.

The present volume contains a concise history of the rainfall and weather of western Australia, from the time records began up to the end of 1927. A few of the records go back as far as 1877 and even earlier. The number of stations is 1,374.

The work contains a written tabular history of rainfall by months from 1877 to 1926; a short note on the climate of western Australia; a discussion of the relationships between wheat yield and rainfall; a record of notable meteorological events in the State, e. g., auroræ australis, bush fires, earthquakes, floods, etc. These occupy half of the volume. The second part of the volume contains the annual rainfall data of all stations in western Australia. At the end of the volume annual rainfall maps for western Australia from 1886 to 1927 are published, and also a revised annual rainfall map of Australia.

This publication is valuable to all those interested in the climate of western Australia, but especially to agriculturists and sailors. It lacks a thorough discussion of the rainfall and weather but it is an excellent source book containing the available data and written history of the weather in western Australia. Especially valuable are the numerous maps and charts included in the 387 pages of text.—*Sigismond R. Diettrich.*

[1] Results of rainfall observations made in western Australia, Commonwealth of Australia, Bureau of Meteorology, under the direction of H. A. Hunt, Commonwealth meteorologist, 1929, p. 387.

PROF. ALEXANDER McADIE RETIRES FROM BLUE HILL OBSERVATORY

After sabbatical leave for the first semester of the coming academic year, Alexander McAdie, Abbot Lawrence Rotch professor of meteorology, Harvard University, and director of Blue Hill Observatory, will become professor emeritus.