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NOTES FROM THE WEATHER BUREAU LIBRARY.

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RETROSPECTIVE.

In glancing back over the lustrum that has elapsed since these notes were interrupted, one is impressed by the facts that (1) there has appeared no great new trend of activity in meteorological research, comparable to the birth of aerology, as a coherent branch of science, which made the opening decade of the present century forever memorable in the history of meteorology; and that (2) the development of aerology has engrossed a major share of attention. The year 1909 was marked by the matured Humphreys-Gold explanation of what a few years ago was generally called the "isothermal layer," but is now almost universally known as the "stratosphere." The inappropriateness of the former name is illustrated by the record of a sounding balloon sent up from Batavia in December of last year. At the bottom of the stratosphere, 10.2 miles above the earth, was found the amazingly low temperature (1) of −90.9° C. (−131.6° F.), while above that level the temperature steadily rose to −57.1° C. (−70.8° F.) at the maximum altitude reached by the balloon, viz, 16.2 miles. This strong gradient is inconsistent with the idea of "isothermality."

A task still in progress is the determination of the relations between conditions aloft and weather changes at the earth's surface. In 1912 Dr. W. N. Shaw, director of the British Meteorological Office, introduced the idea of a "substratosphere." This he defines as "a layer of atmosphere just under the stratosphere, at the height of about 9 kilometers in the region of the British Isles, which apparently often marks the height at which the velocity of the wind is a maximum, and may be regarded as the layer of origin of the changes of pressure which are the dominant features of our weather maps." While the concluding words of the foregoing definition involve a debatable hypothesis, the notion of a transition-layer between troposphere and stratosphere seems convenient. Some characteristics of the substratosphere are discussed by Dr. A. Schmauss, director of the Bavarian meterological service, in the current number of Beiträge zur Physik der freien Atmosphäre. (Bd. 6, Heft 3.)

Yet higher "spheres" than the stratosphere still belong to the realm of speculation. In 1911 Dr. Alfred Wegener suggested that the physical characteristics of a hydrogen atmosphere such as, in view of the atomic weight of this gas, may be presumed to overlie the stratum in which nitrogen prevails, would entitle it to be regarded as a distinct "shell" of the atmosphere. At greater heights he suggests that the predominating constituent of the atmosphere may be a hitherto unknown gas, lighter than hydrogen, and perhaps identical with the hypothetical "coronium" of the solar corona. This he calls "geocoronium," and he sees in it the origin of the most conspicuous line, hitherto unidentified, in the spectrum of the aurora. He computes that geocoronium constitutes 0.00058 per cent of the atmosphere by volume at the earth's surface, but 93 per cent at an altitude of 500 kilometers. Thus the four shells of the atmosphere according to Wegener (2) are, in ascending order: Troposphere, stratosphere, hydrogensphere, geocoroniumsphere. Dr. O. Tetens (3), since the "auroral line" is also found in the spectrum of the zodiacal light, prefers to call the hypothetical light gas of the upper atmosphere "zodiacon." These speculations have been recorded here at some length on account of their prominence in current literature, but it should be noted that the "auroral line," although no longer attributed to the heavy gas krypton, is still susceptible of various interpretations, and is therefore an unsafe basis for hypotheses concerning the structure of the atmosphere. L. Vegard (4), who has redetermined the position of the line by observations made at Bossekop, considers it an argon line.

Aerology has been annexed to the field of polar exploration with interesting results. Long series of upper-air soundings were made by the recent expeditions of Scott and Filchner in the Antarctic, and by Jost and Stolberg, at Godhavn, on the west coast of Greenland, in 1912–13. The latter observers sent up 120 pilot balloons, for one of which they claim the hitherto unprecedented altitude of 39 kilometers (24.2 miles) above sea level.(5) They were unable to find at any altitude evidence of a regular circumpolar whirl in the atmosphere.

A timely summary of the immense body of international kite and balloon observations was prepared by Mr. E. Gold in 1912, and has recently been published as Geophysical Memoir No. 5 of the British Meteorological Office.

The application of aerology to the needs of the aeronaut has given birth to a new subbranch of science, "aeronautical meteorology." Its content is perhaps best represented and delimited in a very practical little work by Dr. Franz Linke, entitled "Aeronautische Meteorologie" (2 vols., Frankfurt a. M., 1911).

At the beginning of the year 1911 the world's first aeronautical weather bureau was organized in Germany. Observations of the air currents at various altitudes are made daily with pilot balloons at a score of stations scattered over that empire and telegraphed to the Lindenberg Observatory, whence bulletins are issued to all parts of the country for the guidance of aeronauts.

The measurement of solar radiation is still a capital problem, as it was five years ago. The most definite step in advance has been Abbot's redetermination of the solar constant (1.922 standard calories per square centimeter per minute at mean solar distance, with fluctuations to the extent of about 10 per cent). Abbot (6) is now endeavoring to check these results by means of observations obtained at great altitudes with sounding balloons. Much attention has recently been devoted to attempts to measure separately the kind or kinds of radiation having most influence upon plant growth and other biological processes (7).

In the field of dynamical meteorology, or atmospheric mechanics, a new personality has arisen, viz, Prof. V. Bjerknes, whose elaborate treatise on "Dynamic Meteorology and Hydrography" is in course of publication by the Carnegie Institution and who is also issuing a

series of memoirs from the Geophysical Institute of the University of Leipzig. Of Bjerknes's large work, Mr. Gold, the British authority on meteorological physics, says that—

> it does not contain new discoveries or throw much fresh light on individual atmospheric phenomena, but it presents what is fundamental in our knowledge of the physics of the atmosphere in a new way and makes possible the application of methods which have hitherto been disregarded because of the immense labor involved in dealing with even a single case.

Renewed attention has been directed to agricultural meteorology, though the limits and aims of this subject are still rather vague. At the instance of the International Institute of Agriculture, in Rome, a commission on Agricultural Meteorology has been organized under the International Meteorological Committee. A special service of agricultural meteorology has been established in France, and one which was founded some years ago in Russia has recently attracted general notice.

In the United States the attention of agricultural meteorologists has been given chiefly to the improvement and the theory of frost protection, especially by means of "orchard heating," though there has also been much investigation of weather-crop correlations. Agriculture throughout the world suffers immense losses from hailstorms (amounting, according to one estimate, to $200,000,000 a year), and for centuries some practical means of mitigating this scourge has been eagerly sought. "Hail shooting" dates from the middle ages. This expedient gave place to the "hail rod," or *paragrêle* (imitated from the lightning rod), toward the end of the eighteenth century. In 1896 "hail shooting" was revived, and it is still practiced (with cannons, bombs, and rockets) on a vast scale; and, finally, in 1911, a new form of *paragrêle*, fantastically named the "electric Niagara," came into widespread use in France. The last-named device is nothing more than an overgrown lightning rod, and its inefficacy in averting hailstorms not only follows from scientific considerations but also appears to have been amply demonstrated by the experience of French husbandmen during the past two years. Hailstorm insurance (**8**) is growing apace in Europe (where it dates from the eighteenth century), but is a rarity in the United States.

In atmospheric electricity no such expansion in apparatus and methods has been witnessed during the past lustrum as occurred about the beginning of the century in consequence of the discoveries of Linss, Elster and Geitel, C. T. R. Wilson, Gockel, and others. Observations have been more fully standardized, but their interpretation continues to be a difficult problem. The discovery of ionization has, however, had far-reaching results; as, for example, in furnishing the basis for a plausible theory of thunderstorm electricity (**9**). The mechanism of the lightning flash has been the subject of brilliant investigations by B. Walter, of Hamburg, whose double-camera method of lightning photography was first announced in 1910 (**10**), and who has since supplemented this with a stereoscopic process.

Atmospheric optics remains a strikingly neglected branch of knowledge. Physicists, astronomers, and meteorologists, especially in English-speaking countries, continue to report their individual observations of halos, rainbows, and the like without reference to the existing body of knowledge on these subjects and in language suggesting that Bravais, Mascart, Pernter, and the other specialists in this field have lived in vain. However, the situation has recently improved. Besson's compendious account of the known forms of halo (**11**) has furnished a much-needed manual for observers of this particular group of photometeors. The remarkable halos seen in the eastern United States November 1–2, 1913, stimulated interest in halo observing in this country. Simpson's observations during Capt. Scott's last Antarctic expedition led to the interesting announcement that coronas are probably never due to ice, but always to water (or dust), thus suggesting a new means of ascertaining the constitution of clouds (**12**).

In weather forecasting undoubtedly the salient feature of recent progress has been the enlargement of the field of observation, through the establishment of new stations and the addition of wireless reports from vessels. Wireless telegraphy has also brought certain remote land stations into the telegraphic weather-reporting *réseau;* e. g., Spitzbergen, far within the Arctic circle, and the subantarctic station at Macquarie Island. During Dr. Douglas Mawson's recent sojourn in Adelie Land telegraphic weather reports were received in Australia from the Antarctic continent itself—a notable milestone in the history of science—and a similar undertaking in the far north forms part of the program of the Crocker Land expedition, now installed in Greenland. Printed daily synoptic charts have notably expanded in several cases; e. g., the Russian chart now extends from Iceland to eastern Siberia, and, since January 1, 1914, the United States Weather Bureau has published daily telegraphic weather charts that girdle the globe. European forecasters evince much confidence in the observation of pressure changes (the "barometric tendency") according to Ekholm's method, and the indications of isallobaric charts (**13**).

Dynamic meteorologists and aerologists have led a campaign in behalf of new meteorological units, especially dynamic units of atmospheric pressure on the C. G. S. system ("bars," etc.) and centigrade degrees of temperature reckoned from absolute zero (**14**). These units are now fully and officially established in aerology, and are coming into use on weather maps (e. g., the United States Weather Bureau's synoptic chart of the Northern Hemisphere).

FORTHCOMING METEOROLOGICAL MEETINGS.

On September 8–12 a conference is to be held at Edinburgh for the purpose of discussing "the various aspects of the physical sciences in their application to the study of weather." The special occasion of such a meeting is that the British Association holds its sessions this year in Australia, and will be attended by comparatively few persons from the mother country. The scope of the papers to be read at the Edinburgh conference will, it is hoped, include the physical and observational aspects of meteorology, climatology, medico-climatology oceanography, limnology, atmospheric electricity, terrestrial magnetism, and seismology. Sir John Murray, the eminent oceanographer and marine biologist, who died the middle of March, was to have presided over the meeting, while the honorary secretary of the organizing committee is Mr. F. J. W. Whipple, Meteorological Office, South Kensington, London. The membership fee is 10 shillings. During the same month (September, 1914) an international meteorological congress is to be held at Venice, under the auspices of the Italian Meteorological Society. It will include five sections, viz, climatology,

agricultural meteorology, aerology, marine meteorology, and pure meteorology. The subscription to the congress is 10 lire, and applications are to be addressed to the general secretary, Rev. Emilio Hoenning O'Carroll, director of the Patriarchal Observatory, Venice. It should be noted that this congress will not be one of the official assemblies of meteorologists pertaining to what is known as the "International Meteorological Organization." These official assemblies are now held triennially, and are either meetings of the International Meteorological Committee (e. g., the one held in Rome last year) or International Meteorological Conferences (comprising the directors of all official weather services). No meeting of this series has been designated a "congress" since that held in Rome in 1879. The coming meeting in Venice will, however, be analogous to the unofficial congresses held in Chicago, in 1893, and in Paris, in 1900.

UPPER-AIR RESEARCH IN INDIA.

The Government of India has sanctioned a scheme of upper-air observation, to extend over 10 years, and to cost about $100,000. The headquarters are to be at Agra, where an observatory is building, and where it is proposed to send up sounding-balloons twice a week to the greatest heights attainable. There will also be four or five auxiliary stations, at which instruments will be sent up to moderate altitudes (2 or 3 miles), especially to obtain information of value to the forecasters. Mr. J. H. Field will be in charge of this work.

REFERENCES AND NOTES.

(1) The "record" low temperature heretofore measured anywhere in the atmosphere is — 91.9° C. (—133.4° F.), observed above Batavia Nov. 5, 1913. In this case the clockwork of the meteorograph failed to work; hence the altitude at which the minimum temperature prevailed is uncertain.

(2) Wegener's fullest presentation of these views will be found in his "Thermodynamik der Atmosphäre," Leipzig, 1911.

(3) Arb. K. Preuss. Aeron. Obs. Lindenberg, 7, 1911, p. 236.

(4) Phys. Zeit., 14, 1913, p. 677 ffg.

(5) A. de Quervain, "Quer durchs Grönlandeis," München, 1914, p. 175. The previous "record" for any aeronautical device was 35,080 meters (21.8 miles) attained by a sounding balloon sent up from Pavia, Italy, Dec. 7, 1912. The American "record" is 32,643 meters, at Avalon, Cal., July 30, 1913.

(6) Journ. Wash. Acad. Sci., 4, 1914, p. 109.

(7) The literature is voluminous and not yet summarized. See, as examples, the record of C. Dorno's suggestive observations in his "Studie über Licht und Luft des Hochgebirges" (Braunschweig, 1911), or the abstract of H. A. Spoehr's researches in Yearbook Carnegie Inst., 1913, p. 83–84.

(8) In Germany alone insurance of this class amounted to $825,000,000 in 1911.

(9) G. C. Simpson, in Proc. Roy. Soc. Lond., A, 82, 190, p. 169–172, and Mem. Indian Met. Dept., 20, 1910, p. 141–332.

(10) Jahrb. Hamb. Wiss. Anstalten, 27, 1909, 5. Beiheft, Hamburg, 1910.

(11) L. Besson, "Les différentes formes de halos et leur observation." Bull. Soc. Astr. France, March–May, 1911; also published separately.

(12) Q. J. Roy. Met. Soc., 38, 1912, p. 291 ffg.

(13) See a résumé of this subject in W. N. Shaw's "Forecasting Weather," London, 1911, p. 337 ffg.

(14) The most comprehensive presentation of this subject is that given in the "Observer's Handbook" of the British Meteorological Office for 1913, p. ix ffg.