METEOROLOGICAL SERVICE OF THE ARMY.[1]

By Maj. Gen. G. O. SQUIER, Chief Signal Officer, United States Army.

[Reprinted from "Aeronautics in the United States at the Signing of the Armistice, Nov. 11, 1918." New York, 1919, pp. 26-28.]

In August, 1917, the Chief Signal Officer directed Lieut. Col. R. A. Millikan to organize an Army Meteorological and Aerological Service, the purpose of which was threefold:

(a) To provide the American Expeditionary Forces with all the meteorological and aerological information needed.

(b) To supply the aviation fields, the coast artillery stations, the ordnance proving grounds, and the gas-warfare service within the United States with such meteorological and aerological data as might be useful to them.

(c) To undertake for the first time in the history of the world the problems of mapping the upper-air currents over the United States, the Atlantic, and western Europe in aid of aviation, and particularly with reference to trans-Atlantic flight.

In carrying out the first of these projects, there were selected approximtely 550 men of high qualifications, most of them physicists or engineers, who were given a two months' course in meteorological and aerological theory and observations at College Station, Tex. Three hundred and fourteen of these men were sent overseas where they have been operating as an effective and well-organized branch of the work of the American Expeditionary Forces. In addition to furnishing a general weather forecast for the American Expeditionary Forces, this service has supplied a meteorological unit to each aviation post, each gas-service post, each artillery post, and each sound-ranging post of the American Army in France. Under the effective direction of Maj. [now Lieut. Col.] W. R. Blair, one of the most experienced aerologists of the United States, commissioned for the service from the Weather Bureau, about 20 upper-air stations were established in France and England and a forecast based on data furnished by these stations made regularly to the American Expeditionary Forces.

For the accomplishment of the second element of the program, 28 stations manned by 150 men, all carefully picked at the start and well trained at College Station, have been established for furnishing local data as to either surface or upper-air conditions, or both, to the flying fields, artillery posts, and proving grounds in this country. The largest of these stations is that at the Aberdeen Proving Ground, which is manned by 22 men and furnished to the Bureau of Ordnance all necessary data for the determination of ballistic wind which, in view of the development of high-angle fire, has become altogether indispensable for the construction of range tables needed for obtaining accuracy in the work of the artillery.

In carrying out the third element of the program, 26 meteorological stations were established, placed at carefully selected points over the whole of the United States, which stations have been manned by trained observers who telegraph to Washington each day observations on wind velocities at all altitudes up to 35,000 feet. In one instance these observations have been carried to 65,000 feet. On the basis of these observations, a daily forecast of upper-air winds is now being issued. The use which such forecasts may serve, both in connection with the aviation mail service and ultimately with the trans-Atlantic service, may be seen from the fact that above the level of 10,000 feet, 95 per cent of the winds in both the United States and Europe are from west to east and often attain velocities in excess of 100 miles an hour. On November 6, 1918, at Chattanooga, Tenn., a velocity of 154 miles an hour at an altitude of 28,000 feet was observed. It is because of this easterly direction of these upper air currents that all of the long flights thus far made have been from west to east. The importance of a forecast of such currents for the purpose of long flights will be appreciated as soon as the foregoing facts are understood. An airplane capable of a velocity of 154 miles an hour in still air either would remain stationary or travel at 308 miles an hour depending on whether it was headed into or with a wind of the velocity of that observed at Chattanooga.

All of the aerological work so far mentioned has been done with the aid of theodolites especially designed by Maj. W. R. Blair for this service. Sixty of these have been built for the work in this country and 20 shipped abroad.

The problem of exploring the upper-air currents over the Atlantic was at first thought insoluble on account of the absence of fixed bases, but the Meteorological Service has developed propaganda balloons which already have flown at an average altitude of 18,000 feet from Omaha to New Jersey, a distance of more than 1,000 miles. The success of the project now has made possible the mapping of the upper-air highways across the Atlantic, for arrangements are being made to send up from both coastal stations and from trans-Atlantic steamers these long-range balloons designed for from 2,000 to 3,000 mile flights, and adjusted to maintain a constant altitude and to drop in Western Europe their records of average winds in these heretofore unchartable regions. The importance of this work for the future of aviation needs no emphasis.

The success which the Meteorological Service has attained would have been wholly impossible had it not been for the intimate and effective cooperation which has been extended to it in all of its projects by Director C. F. Marvin and the entire staff of the United States Weather Bureau.

[1] Cf. "A Signal Corps School of Meteorology," MO. WEA. REV., Dec., 1918, 46:560-562. More extended accounts of war meteorological work of the Weather Bureau, Signal Corps, and Naval Aviation Service will be published in an early number of the REVIEW.—ED.

INFLUENCE OF WEATHER ON MILITARY OPERATIONS.

[Bibliography.]

From the beginning of the war, Prof. R. De C. Ward collected carefully the press and other reports which mentioned the influence of weather on military operations. These he brought together into 19 very interesting articles which appeared in Popular Science Monthly (now Scientific Monthly), the Journal of Geography, the Journal of the Military Service Institution, and the Scientific Monthly from 1914 to 1919. Some brief abtracts of these papers have appeared in Science,[1] Nature,[2] and elsewhere, but no abstract can do justice to the detailed originals. Therefore, instead of trying to present a summary of these papers, it is thought best to present the bibliography

[1] Cf. Science, June 30, 1916, N. S., vol. 53, pp. 934-935.
[2] Cf. Nature, Aug. 29, 1918, vol. 101, pp. 514-15.

(prepared by Miss M. Welch), especially since most of the articles are in readily accessible journals.

The weather factor in the great war. [Title varies.] (Popular sci. monthly, N. Y. v. 85. Dec. 1914. p. 604–613; Journal of geography, Madison, Wis. V. 13. Feb., Mar., June, 1915. p. 169–171; 209–216; 315–317. V. 14. Nov., 1915; June, 1916. p. 71–76; 373–384. V. 15. Nov., 1916; Apr., 1917. p. 79–86; 245–251. V. 16. Oct., Nov., 1917; Apr. 1918. p. 47–51; 86–90; 291–300.)

Weather and the war. (Journal of the military service institution, Governor's Island, N. Y. v. 61. July–Aug. 1917, p. 43–50; Sept.–Oct. 1917, p. 145–155; Nov.–Dec. 1917, p. 293–302.)

Weather controls over the fighting in the Italian war zone. (Sci. monthly, N. Y. v. 6, Feb., 1918. p. 97–105.)

Weather controls over the fighting in Mesopotamia, in Palestine, and near the Suez Canal. (Sci. monthly, N. Y. v. 6, Apr., 1918. p. 289–304.)

Weather controls over the fighting during the spring of 1918. (Sci. monthly, N. Y. v. 7. July, 1918. p. 24–33.)

Weather controls over the fighting during the summer of 1918. (Sci. monthly, N. Y. v. 7. Oct. 1918. p. 289–298.)

Weather controls over the fighting during the autumn of 1918. (Sci. monthly, N. Y. v. 8. Jan., 1919. p. 1–15.)

In *The Windsor Magazine* (London), a British author, E. D. Ushaw, has published on the same subject from somewhat different sources. See extensive quotation in *The Literary Digest* (New York), Mar. 29, 1919, pp. 88, 91 and 94.—C. F. B.

MEASUREMENTS OF THE SOLAR CONSTANT OF RADIATION.

By C. G. ABBOT,

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By invitation of Prof. Marvin, Chief of the United States Weather Bureau, the Smithsonian Institution will communicate from time to time, as received, the measurements of the solar constant of radiation which are being made by its observers at Calama, Chile. The present paper gives in Table 1 the values which have been received hitherto from the station, beginning with July 27, 1918.

The values are being communicated daily by telegraph from Calama to Buenos Aires and by letter to Rio de Janeiro, as the meteorological services of Argentina and Brazil are conducting a test of their value for purposes of forecasting. The usefulness of the solar constant results for this purpose is not so firmly established as to warrant the expense of telegraphing the results to the United States, but in order to put them as speedily as feasible before meteorologists, Prof. Marvin has thought good to arrange for their regular publication in the MONTHLY WEATHER REVIEW.

It is to be understood by the reader that these values are preliminary, and subject later to detailed revision and occasional change as they will be published in extenso by the Smithsonian Institution; but the changes which will be made in such revision will probably be small, and oftentimes no change at all will occur.

The solar constant of radiation as here defined is the intensity of the solar radiation as it would be outside of the earth's atmosphere at mean solar distance. It is determined by the use of the spectro-bolometer and pyrheliometer in the manner described by the writer in the MONTHLY WEATHER REVIEW for January 1919 (vol. **46**, pp. 1–3), where an account of the South American Expedition of the Smithsonian Institution is given.

In the following publications we shall give values of the solar constant in calories per square centimeter per minute, values of the atmospheric transmission coefficient at wave length 0.50 microns, indications of the trustworthiness of the results, indications of the humidity of the air prevailing at the earth's surface and also as integrated through the whole path of the earth's atmosphere between the observer and the sun, and, finally, notes as may be desirable, explanatory of the results of individual days.

In estimating the trustworthiness of the individual values, the following criteria are employed: First, as to the internal evidence of the goodness of the observations. This depends upon the mutual support offered by the six bolographic observations of a given day. If the transparency of the atmosphere remains unchanged during the several hours required to determine it, the logarithms of intensities at each of the several wave lengths where measurements are made in the solar spectrum should be proportional to the air mass traversed by the solar beam in the atmosphere. In other words, the logarithmic plot whose ordinates are logarithms of intensity and whose abscissæ are air masses (or roughly secants of the sun's zenith distance) should approach a straight line for each individual wave length in the spectrum. Noting the proportion of 40 different wave lengths for which this criterion is well supported on a given day, the observers draw their conclusion as to whether the constancy of the transparency for the day was excellent, very good, good, or poor, and they indicate this judgment by the letters E, VG, G, and P. Sometimes they further qualify these characters by the symbols + and −. Thus E− indicates a day on which the logarithmic plots were generally very straight, but not quite as satisfactory as for a day marked E. When the mark given is E+, it indicates that no improvement on the merit of the day from the point of view of the logarithmic plots could reasonably be hoped for. Days marked G−, or P are entitled to little weight unless the defect of the observations should be explainable by reason of earthquakes or magnetic storms which, while they might introduce irregularities in the spectrobolographic determinations, would yet be independent of variations of the transparency of the air.

It is a weakness of the method that the determinations of the atmospheric transmission require several hours of unchanged transparency of the air. We are developing an empirical method, based upon the full spectro-bolometric method, by means of which we hope to shorten the period required to determine the solar constant to a few minutes, and it is possible that the application of this new method may enable us to materially improve the results.

Further conclusions as to the merits of individual determinations are based upon visual examination of the sky during the period of observation. If cirrus clouds are seen in the same quarter of the sky as the sun, and especially if they spring up during the observations, or pass off during the observations, this fact tends to weaken the day's result. Also, if there has been during the days immediately preceding, or if there follows in the immediately succeeding days, a period of cloudiness, this weakens the result. Special considerations of this character should be taken into account in the estimation of the merit of the day. It is regretted that the sky has