The variation of this absorption with temperature should be so small that it has been thought appropriate to neglect it completely.

4. ABSORPTION IN THE INTERMEDIATE REGION

The spectroscopic analysis carried out with great resolving power shows that there are only a few extremely weak water lines in the region between 8μ and 25μ. Nevertheless, an absorption of the atmosphere must be assumed in order to account for the measured amount of radiation coming in from the sky. We shall now investigate the way in which this radiation originates (**10**).

It results from formula (1) or formula (4) that each line extends in principle to an infinite distance from its center. Absorption can, therefore, be caused by rather distant lines, provided only these lines are strong enough. This is the case for the absorption between 8μ and 25μ. The intense lines which cause this absorption are located in the very far infrared, namely beyond 30μ. The intensities of these lines are known (**2**). Now from (4) we see immediately that the absorption coefficient i, produced at the frequency ν by these lines, is equal to

$$i(\nu)=\frac{\alpha}{\pi}\sum\frac{i_0}{(\nu-\nu_0)^2},$$

and from (2):

$$i(\nu)=\frac{\alpha_0}{\pi}\frac{p}{p_0}\frac{\sqrt{T_0}}{\sqrt{T}}\sum\frac{i_0}{(\nu-\nu_0)^2}. \tag{11}$$

The sum extends over all the lines in the far infrared, and for each line its center frequency ν_0 has to be substituted. The numerical calculations can readily be carried out; the results for $T=220°$ and $T=300°$ are given in the following table. For convenience, the variation of i with the inverse square root of the temperature as expressed in (11) has already been taken into account. If we define k by

$$i(\nu)=k(\nu,T)\frac{p}{p_0} \tag{13}$$

we have

cm^{-1}	400	450	500	600	700	800	900	1000
k_{220}	2.61	1.43	.96	.54	.35	.23	.18	.14
k_{300}	3.50	1.36	.90	.46	.30	.21	.15	.12

The values above 500 cm^{-1} are very well approximated by the formula

$$k=\frac{78{,}000-240t}{(\nu-200)^2},$$

which may also be extrapolated to larger values of ν than those contained in the table; t is the temperature in centigrade. This formula shows that the absorption has the same character as if it were produced by a single, very strong line located at 200 cm^{-1}. In principle a second term should be added to the one calculated above, namely the absorption caused by the band at 6 μ at great distances from its center. However, if this is done the absorption turns out to be negligible compared with the one given above.

It must now be particularly emphasized that *this absorption does not follow the square root law, but follows the ordinary absorption law* $I=I_0e^{-ix}$, and the values for the absorption coefficient given in the table have to be corrected for air pressure according to formula (13). An inspection of the black-body curve shows that this type of absorption is preponderant in the spectral range covered by atmospheric radiation. The absorption coefficient rises very rapidly towards longer waves. The square root absorption treated in Section 2, however, rises still more rapidly with increasing wavelength, and between 400 and 350 cm^{-1} the two absorption laws give values of comparable order of magnitude. It seems a proper approximation to use the exponential absorption law alone for $\nu>375$ cm^{-1} and to use from there on the square root law, for instance with the numerical values given in formula (9). On the short wave side, the exponential absorption law may be used up to 1250 cm^{-1}, while from there on the square root formula (10) becomes valid. In this way the whole spectral range of the heat radiation of the atmosphere is covered.

REFERENCES

(1) W. M. Elsasser, MONTHLY WEATHER REVIEW *65*, 323 (1937). In equation (5) in this paper a factor 2 should be inserted on the right.
(2) H. M. Randall, D. M. Dennison, N. Ginsburg, and R. L. Weber, Physical Review *52*, 160 (1937).
(3) F. Albrecht, Meteorolog. Zeits. *48*, 476 (1931).
(4) S. D. Cornell, Physical Review *51*, 739 (1937).
(5) C. L. Pekeris, Astrophys. J. *79*, 441 (1934).
(6) W. M. Elsasser. Far infrared absorption of atmospheric water vapor. Astrophysical Jour., 87: 497–507, 1938.
(7) G. Hettner, Annalen der Physik *55*, 476, (1918).
(8) F. E. Fowle, Smithsonian Misc. Coll. vol. 68, No. 6 (1917).
(9) Smithsonian Meteorological Tables, 5th ed., p. 239.
(10) W. M. Elsasser, Phys. Rev., *53*, 768 (1938).

PSYCHROMETRIC CHARTS

By JOHN G. ALBRIGHT

[Case School of Applied Science, Cleveland, Ohio]

The accompanying psychrometric charts, constructed by the author, have been used for some time and have proved to be very helpful and convenient where extreme accuracy is not desired. They were constructed from values given in *Psychrometric Tables* and *Relative Humidity, Centigrade Temperature*, publications of the United States Weather Bureau. The values given for a barometric pressure of 29 inches were used. From these charts the relative humidity, absolute humidity and dew point can be readily found from the wet- and dry-bulb values. Chart 1 is designed for use when the temperatures are given in Fahrenheit and Chart 2 is for reference when the temperatures are given in Centigrade.

The temperatures of the dry bulb are plotted along the horizontal direction and are represented by the vertical lines, the values of which are indicated at the top. The differences between the wet- and dry-bulb thermometer temperatures are plotted along the vertical direction and are represented by the horizontal lines, the values of which are indicated at the left. Relative humidities are represented by the solid lines that slope upward to the right; their values are indicated at the right margins. Absolute humidities are represented by the broken lines that slope upward more sharply to the right; their values are indicated at the bottom of the chart.

The procedure for obtaining the relative humidity, the absolute humidity, and the dew point from wet- and dry-bulb thermometer readings is given in the following example. If the dry-bulb thermometer reads 90° F. and the wet-bulb thermometer reads 80° F., giving a

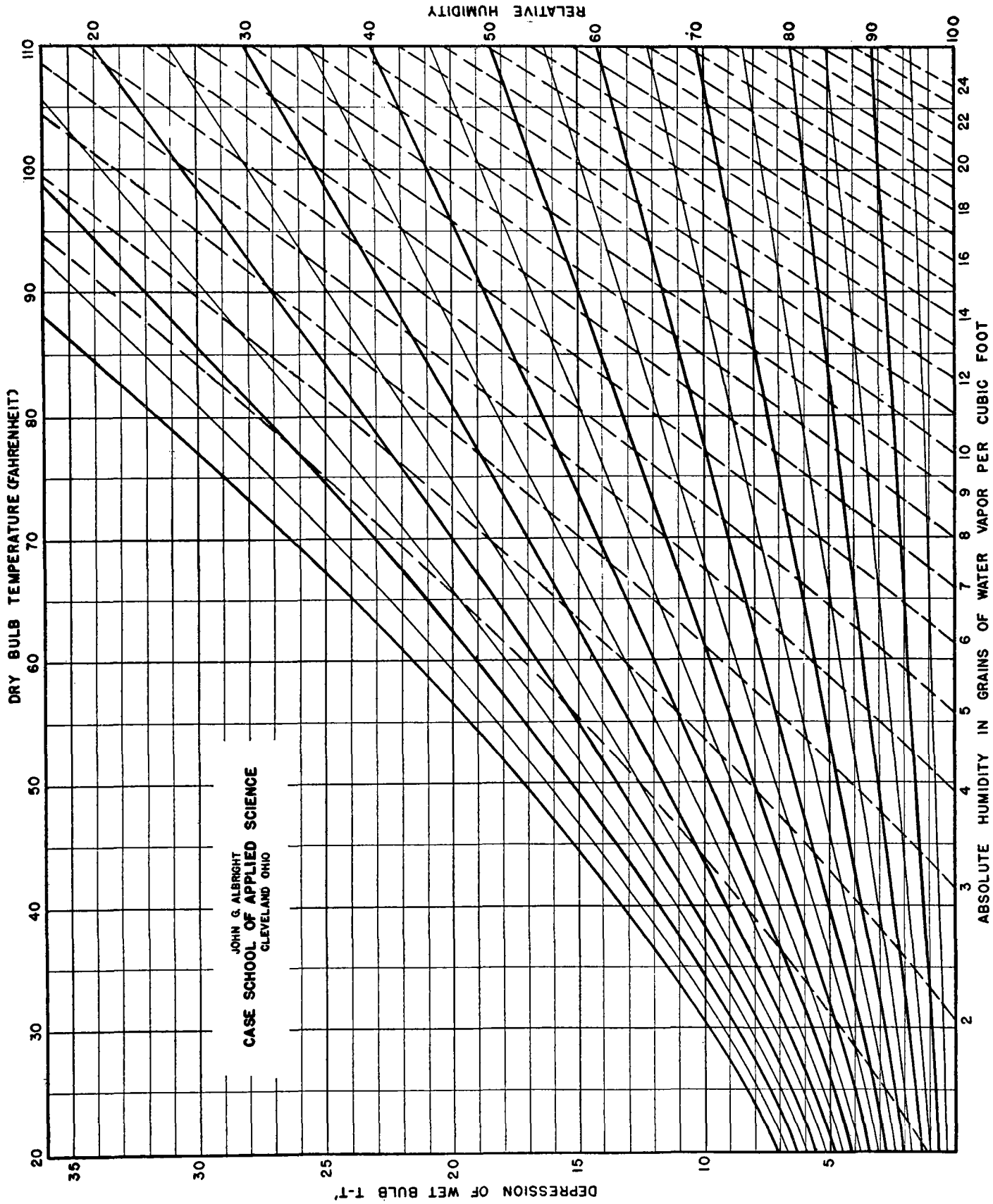
RELATIVE HUMIDITY
20
30
40
50
60
70
80
90
100
DRY BULB TEMPERATURE (FAHRENHEIT)
110
100
90
80
70
60
50
40
30
20
ABSOLUTE HUMIDITY IN GRAINS OF WATER VAPOR PER CUBIC FOOT
2
3
4
5
6
7
8
9
10
12
14
16
18
20
22
24
DEPRESSION OF WET BULB T-T'
35
30
25
20
15
10
5
JOHN G. ALBRIGHT
CASE SCHOOL OF APPLIED SCIENCE
CLEVELAND OHIO

Chart 1.

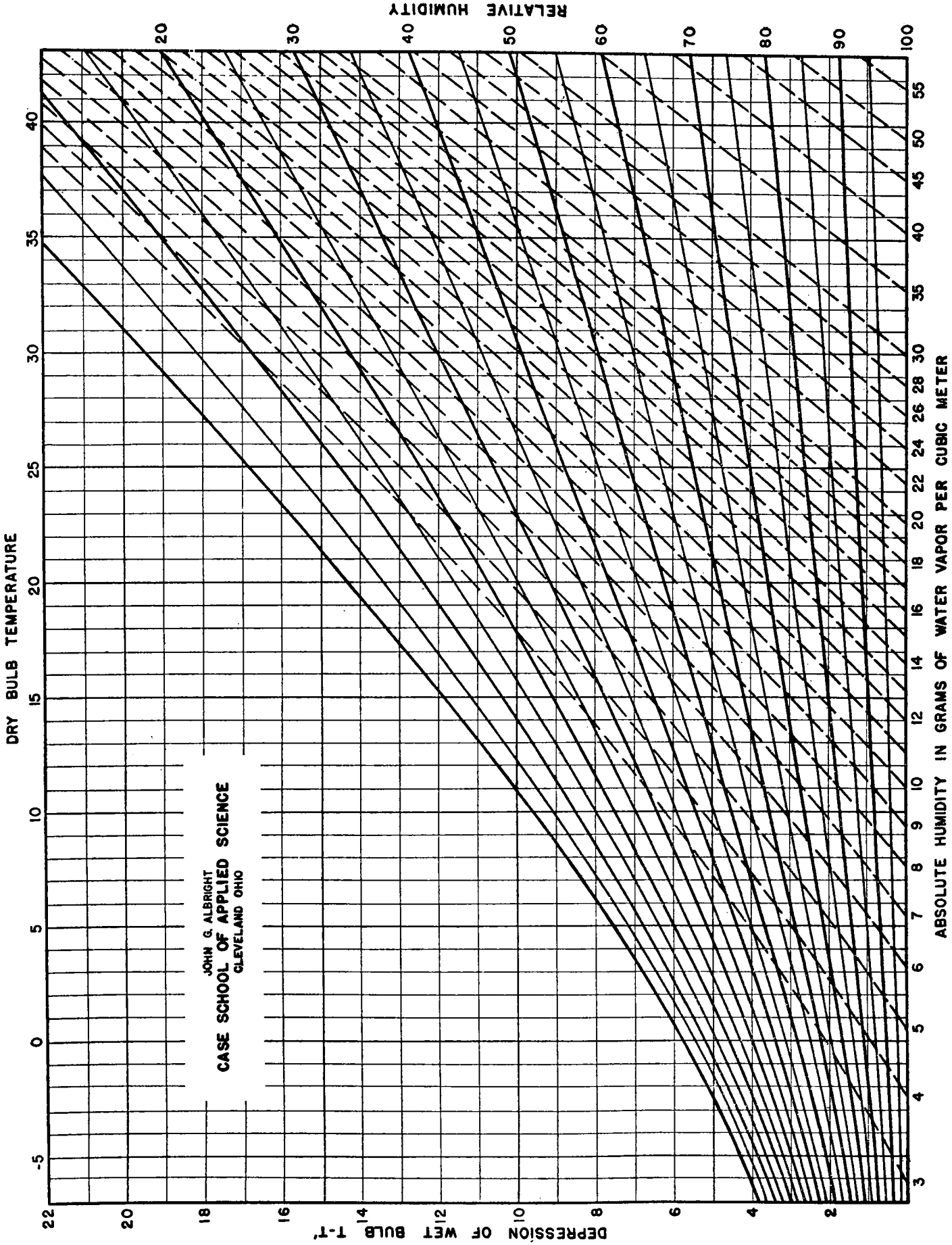
RELATIVE HUMIDITY
20
30
40
50
60
70
80
90
100
DRY BULB TEMPERATURE
-5
0
5
10
15
20
25
30
35
40
ABSOLUTE HUMIDITY IN GRAMS OF WATER VAPOR PER CUBIC METER
3
4
5
6
7
8
9
10
12
14
16
18
20
22
24
26
28
30
35
40
45
50
55
DEPRESSION OF WET BULB T-T'
22
20
18
16
14
12
10
8
6
4
2
JOHN G. ALBRIGHT
CASE SCHOOL OF APPLIED SCIENCE
CLEVELAND OHIO

Chart 2.

difference of 10° between the wet- and dry-bulb thermometer readings, the intersection of the horizontal line marked 10° with the vertical line marked 90° is found. It is then observed that this point of intersection lies upon a line that indicates a relative humidity of 65 percent. This point of intersection also lies between lines indicating an absolute humidity value between 9 and 10 grains of water vapor per cubic foot. If the interpolation is carefully made, the absolute humidity is found to be about 9.6 grains of water vapor per cubic foot. Passing to the bottom edge of the chart this value of the absolute humidity as determined is found to coincide with a dry-bulb temperature of about 76° F. Since the bottom edge of the chart coincides with the 100 percent relative humidity line, saturation would occur at 76° F. for an absolute humidity of 9.6 grains of water vapor per cubic foot, and the dew point of the air in question would therefore be 76° F.

Chart 2 is used in the same manner; the temperature readings are given in the Centigrade scale and the absolute humidity is given in grams per cubic meter.

NOTES AND REVIEWS

On Early Tornadoes in Georgia: Correction.—The following comments are quoted from a letter received from Col. John P. Finley, relative to the "Note on Early Tornadoes in Georgia," by George W. Mindling, MONTHLY WEATHER REVIEW, 66: 14, 1938:

In the preparation of my several papers on tornadoes I was required to be brief, especially as to tabulations, in order to lessen the cost of publication. Accordingly the location of a tornado or a hailstorm was usually indicated by the name of one town, county, or township in the entire track. To have gone into details would have very much increased the cost of publication. The 50 buildings recorded opposite the town of Toccoa, Ga., does not mean that these structures were all destroyed at that place, or even one of them, but somewhere along the path of the storm. For complete details in every instance, the student must refer to the original records of the Signal Service and voluntary observers of the period, on file in the Records Division of the United States Weather Bureau at Washington. These records were supplemented by newspaper clippings, collected at the time of the occurrence of the storms.

As to the paragraph concerning the tornado reported to have occurred at Davisboro, Washington County, Ga., at 6 p. m., February 18, 1884, my records show that it occurred on the 19th. In my Professional Paper No. XVI, published in 1885, and in the American Meteorological Journal of 1890 (State Tornado Charts) tornadoes were reported from 23 counties in Georgia on February 19, 1884. The tornadoes in Washington County, Ga., were reported to the Signal Service by John D. Roberts, of Sandersville, county seat, and by J. M. Minor, of Sun Hill.

EXTRACTS FROM THE MONTHLY WEATHER REVIEW OF THE SIGNAL SERVICE, UNITED STATES ARMY, APRIL 1880: At or near Toccoa, Stephens County, and Mount Airy, Habersham County. These counties are in the extreme NE. portion of Georgia, close to the South Carolina border. The date was April 3, 1880. Toccoa, county seat, Stephens County. In Washington County, in the east central portion of the State on April 4, 1880. Both of these dates were associated with low pressure area No. 1, central on the 3rd and 4th in lower Michigan, with the depression extending southward and conditions favorable to the occurrence of violent local storms in the SE. quadrant. Cautionary signals were ordered at stations throughout the entire Lake Region on April 3 and 4.

Violent local storms, in unusual numbers, occurred during April. Tornadoes, causing loss of life or doing serious injury to property, were reported from Georgia on the 3rd, 4th, and 24th, and from various other States, on other dates. At Dalton, Whitfield County, April 3, p. m., tornado passed 6 miles north of town, extending across Connasauga River into Murray County; 2 persons killed, many injured, and 18 houses completely demolished; path about 1 mile wide; two opposing currents of wind were observable during the progress of the storm, one from the west, the other and most violent from the east. This tornado crossed Grass Mountain near the point at which a similar storm passed in 1878. April 3, near midnight, tornado and waterspout between Mount Airy and Toccoa, Ga. It passed through Murray County, reaching Cherokee 100 miles distant about 2 a. m. Heaviest rainfall for years. About 12 miles of Air Line Railway washed out and bridge over Tugalo River, Stephens County. Hail reported as large as a man's fist. The county is sparsely settled, yet 50 dwellings of all kinds were leveled, 3 persons killed and many badly injured. A hog was found 40 feet from the ground in the fork of a tree. Its passage resembled a cloud of smoke and fire rolling on the ground. Length of path unknown; average about 1 mile. Remarkable amount of rain reported, but no figures given. Elbert County, Ga., south of Stephens County on border of South Carolina, tornado on April 3 passed through north part of county, blowing down many houses and the largest trees.

Washington County, Ga., April 4, during afternoon, tornado passed through southwestern portion of county, demolishing many buildings; track one-half mile wide; direction SW. to NE. At Gainesville, Hall County, Ga., April 4, hailstones 1 inch in diameter. At Savannah, Chatham County, Ga., April 4, hail 1½ inches in diameter; much glass broken; gardens seriously damaged.

The author of the note was misled in the case of the Toccoa storm by not realizing that the name of a locality was used to designate the entire course of the tornado.—*Editor.*

BIBLIOGRAPHY

[RICHMOND T. ZOCH, *in Charge of Library*]

By AMY D. PUTNAM

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Anniversary volume, dedicated to Professor Kôtarô Honda on the completion of twenty-five years of his professorship, by his friends and pupils. Sendai. 1936. 3, 8, 8, 1126 p. illus., port., diagrs. 26½ cm. (On cover: The science reports of the Tôhoku imperial univ. First series.) Various authors. Text in English, German, or French. "Bibliography," by Nisaku Shibata: p. [1109]–1126.

Baltimore. Department of education.
Why the Weather Bureau is important to all people. Occupational classes. Baltimore. January 1937. 42 p. 27½ cm. Mimeographed.

Brice, William Malcolm.
A city laid waste; tornado devastation at Gainesville, Ga., April 6, 1936. Compiled by W. M. Brice. [Atlanta.] c1936. [5]–127 p. illus. 26½ cm.

Fox, R. Fortescue, *ed.*
British health resorts, spa, seaside, inland (including New Zealand, South Africa, and Canada). London. 1935. 263 p. illus., maps. 25 cm.

Heim, Albert.
Bergsturz und Menschenleben. Zürich. 1932. 218 p. 24½ cm.

International commission for the study of clouds.
Atlas internacional dels núvols i dels estats del cel. 1. Atlas general. Barcelona. 1935. illus., plates (part col.) 31½ cm. At head of title: Comitè meteorològic internacional. Commissió d'estudi dels núvols.