represents the former. Besides the data of cloudiness on account of the manner in which this element is observed is subject to variations due to the personal criterion of the observers, and even the international conventions are not yet agreed on some points in this respect. For instance, when the sky is covered with cirro-stratus it is a doubtful point whether the observer should put 10 (overcast), seeing that these clouds let through the greater part of the sunshine.

As the sunshine has this effect on the specific weight, it might be asked if it has not also an effect on the yield. However, as the cloudiness is closely related to the rainfall it would be difficult, especially with the scanty material at hand, to separate the effect of each of these elements. It is possible, though, that the fact of the maximum yields having been obtained with rainfalls near the minimum is explained, because in these cases the plants have received more sunshine than when the rains have been more abundant.

SECULAR VARIATION OF THE YIELD.

The decennial means of the yield (Table 1) show a constant decrease in the last 30 years. It would be of interest to try and find out the causes of this diminution, and especially in connection with this study, if any change in the climate may be responsible for it.

In a study published in the *Monthly Bulletin* of the Argentine Meteorological Office corresponding to August, 1918, on the periods of drought and excessive rains, it was shown that the rainy periods had increased in the Republic in the last 30 years, and in the Province of Buenos Aires, excepting a relative diminution in 1890–1899, they have been constantly increasing since 1860. Notwithstanding this increase of the rainy periods, in the last years have also occurred periods of intense drought, so it seems that the climate has become more extreme, or the variations above and below normal are greater. These changes in the rainfall may doubtless have some influence on the yield of wheat, but as seen from the foregoing for this cereal the variations of temperature are more important than those of the rainfall.

Taking decennial means of the computed yields (Table 11) we get the following values:

	Kilograms per he tare.
1890–1899	757
1900–1909	703
1910–1919	699

It is seen that these also show a decrease, and as they are computed by means of the temperature, this shows that the average temperature has also changed, or at least the temperature of August to November has increased. We do not know, however, if this variation or that of the rainfall is a real change of climate, that is if it is permanent or if it results from some periodicity, and later that we will get back to the former condition.

The decrease in these computed averages is not as great as that observed according to Table 1. We may conclude therefore that the increase of temperature in spring is responsible for part of the diminution, but not for all. The change in the rainfall may in some part be to blame, but it is probable there are also other causes. One of these is doubtless the gradual extension of the cultivated area toward the west, where the winter rainfall often is insufficient. A proof of this is the fact that the average yield in Córdoba and the Pampa, where wheat growing on a large scale is relatively recent, is less than in Buenos Aires, Entre Rios, and Santa Fé. (See Table 5.)

In other countries the yield generally shows an increase, ascribed to improved methods of cultivation, and if in our country the application of scientific methods were more general, this factor would doubtless counteract those that tend to diminish the yield, and here also the yield would increase instead of decrease.

THE RAINFALL OF VENEZUELA.

By A. J. HENRY.

[Weather Bureau, Washington, D. C., July, 1922.]

The editor has received from Señor Ernesto Sifontes, Venezuelan Meteorological Service, rainfall statistics for 1919–1921 for several stations in that country. It is possible now to bring up to date the record of rainfall for Caracas, originally published in 1911,[1] for each month of the period January, 1891, to December, 1910, and to complete the records for four other stations. The geographical coordinates of all the stations are given in the table next below and the monthly rainfall, in millimeters, is given in Table No. 2 following.

TABLE 1.—*Rainfall stations in Venezuela*[a]—*Geographical coordinates, etc.*

Stations.	Lat. N.	Long. W.	Elevation.	Length of record.	
				Years.	Months.
	° ′	° ′	*Meters.*		
Caracas	10 30	66 56	1,042	31	0
Mérida	8 36	71 9	1,641	6	8
Ciudad Bolívar	8 9	63 33	26	5	3
Calabozo	9 40	67 40	100	3	0
Maracaibo	10 35	71 45	6	3	0

[a] *See* C. E. P. Brooks in *Quart. Jour. Roy. Met. Soc.*, 48:71; also G. Hellmann in *Met. Zeit.*, December, 1921, pp. 375–376.

[1] Ugueto, Luis: *Revista Technica Del Ministerio De Obras Publicas*, 1911, p. 299.

TABLE 2.—*Rainfall (in millimeters) at the stations named.*

CARACAS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1911	1.5	25.5	6.4	40.0	93.0	152.8	153.9	174.8	44.4	61.3	85.5	39.1	878.2
1912	1.8	0	0	3.2	26.9	111.2	139.6	109.8	86.5	44.9	81.0	31.2	636.1
1913	44.9	0.8	13.6	0	53.6	78.3	63.3	90.3	113.6	73.5	87.9	44.5	664.3
1914	0	0	1.0	59.0	80.8	13.1	34.5	60.0	43.3	72.6	4.7	24.7	393.7
1915	19.5	48.1	0	123.5	52.7	129.4	77.0	118.2	110.5	120.1	23.5	5.6	828.1
1916	11.6	33.7	13.9	3.3	44.1	80.5	126.8	168.9	187.8	58.5	145.7	42.0	916.8
1917	15.5	14.7	6.3	52.4	34.3	192.6	155.1	77.6	90.2	60.6	29.3	101.9	830.5
1918	13.7	14.2	12.8	29.7	101.2	124.5	139.6	125.1	33.3	106.8	46.9	10.7	758.5
1919	0	0.3	23.2	113.0	32.1	122.8	63.9	102.5	108.1	95.9	123.1	4.7	789.6
1920	2.2	1.3	6.0	0	92.4	141.6	98.5	79.6	29.5	43.9	78.5	16.3	589.8
1921	25.1	0.3	33.5	16.9	59.1	230.2	95.1	147.9	151.6	141.8	146.7	90.7	1,138.9
Means[a]	21.7	9.7	16.8	42.8	71.0	108.5	111.6	108.6	91.8	96.2	84.2	45.8	808.9

MERIDA.

1915	.....	.....	.....	.....	271.0	230.5	183.3	126.2	182.6	132.4	224.3	9.4	.....
1916	104.8	74.5	131.3	130.7	95.4	235.1	83.7	239.3	132.7	449.8	233.6	53.4	1,964.3
1917	76.3	61.3	34.7	270.3	409.6	186.7	157.5	179.3	172.2	276.0	240.6	118.4	2,182.9
1918	48.0	40.6	79.1	141.5	445.6	185.8	105.7	84.5	133.1	240.3	278.6	43.2	1,826.0
1919	34.3	3.9	54.0	287.2	351.4	215.8	71.6	265.4	177.2	280.9	302.3	147.0	2,191.0
1920	67.7	46.8	88.3	100.8	255.0	144.2	74.8	93.7	164.2	157.1	52.7	37.3	1,282.6
1921	154.6	33.2	197.4	160.2	376.8	88.9	116.2	145.6	122.2	338.2	147.4	68.3	1,949.0
Means	80.9	43.4	97.5	181.8	315.0	183.9	113.3	162.0	154.9	267.8	212.8	68.1	1,063.0

[a] From the full record of 31 years, 1891–1921.

TABLE 2.—*Rainfall (in millimeters) at the stations named*—Continued.

CIUDAD BOLIVAR.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1917	8.5	0	4.5	0.5	65.1	56.7	183.2	280.6	93.3	21.9	65.1	24.2	803.6
1918	20.4	9.1	11.9	25.4	93.9	167.2	122.8	93.2	13.8	125.8	252.7	36.6	973.8
1919	5.2	0	12.4	155.1	135.0	124.8	147.0	194.6	136.3	59.3	39.8	32.5	1,042.0
1920	13.5	11.6	2.2	1.8	90.1	143.3	121.8	108.1	120.0	88.9	71.5	52.0	824.8
1921	0.8	2.0	6.9	31.6	1.6	277.4	325.9	96.0	79.1	170.8	52.3	24.7	1,069.1
1922	25.8	1.6	3.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Means	12.4	4.0	6.8	42.9	77.1	153.9	180.1	154.5	88.5	93.3	96.3	34.0	943.8

CALABOZO.

1919	0	0	135.0	170.0	199.5	197.4	182.0	209.0	161.3	108.3	33.0	0	1,395.5
1920	0	0	0	3.5	91.0	99.5	270.0	198.0	198.8	156.0	61.0	0	1,077.8
1921	0	132.9	41.0	177.0	69.0	204.6	273.6	226.8	66.9	66.8	64.3	0	1,322.9

MARACAIBO.

1919	0	0	2.0	40.5	36.7	8.0	41.3	43.9	96.7	37.8	13.4	0.7	321.0
1920	0	1.7	3.0	0	91.7	84.0	48.5	25.5	100.4	105.1	16.3	2.3	478.5
1921	0	0	2.4	19.8	117.7	12.0	45.0	21.8	20.1	87.3	20.6	23.7	370.4

The statistics of the above table show that at least two distinct types of rainfall prevail in Venezuela, first the type exhibiting two well-marked maxima, the principal one occurring in May, the second and inferior one in October. The principal dry season falls in winter and the lesser one in July and August. This type is represented by the station Merida, in the mountain region of the northwest; a similar type prevails in Colombia to the westward, especially near the Equator. The second Venezuelan type is represented by the elevated station of Caracas the capitol of the Republic and also by Bolivar on the Orinoco, about 200 kilometers from its mouth. The characteristics of this second type are a principal maximum in summer (northern) and a secondary maximum in autumn. The dry season falls in winter. Figure 1 shows the two types very clearly.

The amount of rain which falls on the lowlands of Venezuela is never very great, even at Caracas, elevation 1,042 meters (3,419 feet), the greatest rainfall in 31 years being 1,202.9 mm. in 1892 (47.36 inches). About double that amount may fall in the higher regions of the mountains of western Venezuela. The greatest annual amount for example at Merida, 6 years observations, was 2,182.9 mm. Places at sea level and also in the interior have relatively small amounts, thus Maracaibo on the lake of the same name on the average of 3 years has but 390 mm. (15.35 inches). January and February at that station and also at Calabozo are sometimes without measurable rain. (See Table 2.) Many more observations are necessary however before conclusions can be confidently put forward.

The annual flood in the Orinoco.—Señor Sifontes has also supplied us with summaries of two annual floods in the river above mentioned. The details follow. Flood of 1918: The river began to rise April 11 and the rise ended August 13; the total rise was 12.21 meters (40.03 feet); the river then fell slowly until March 23, 1919, at which time the total fall amounted to 13.73 meters (45.03 feet). The total rise in the 1919 flood amounted to 14.74 meters (48.4 feet). The flood ended on August 23.

NORMALS FOR BRAZILIAN STATIONS.

The new Meteorological Service attached to the Brazilian Ministry of Agriculture, Industry, and Commerce, established in May, 1921, under the direction of Dr. J. de Sampaio Ferraz, has just issued a valuable collection of climatic normals for that country.[1]

This publication, which was compiled by Meteorologists H. Silva and L. Rodrigues, contains daily normals of the principal climatic elements for Rio de Janeiro, based in part on records for the 39 years 1882–1920, though the data for some elements are derived from shorter periods.

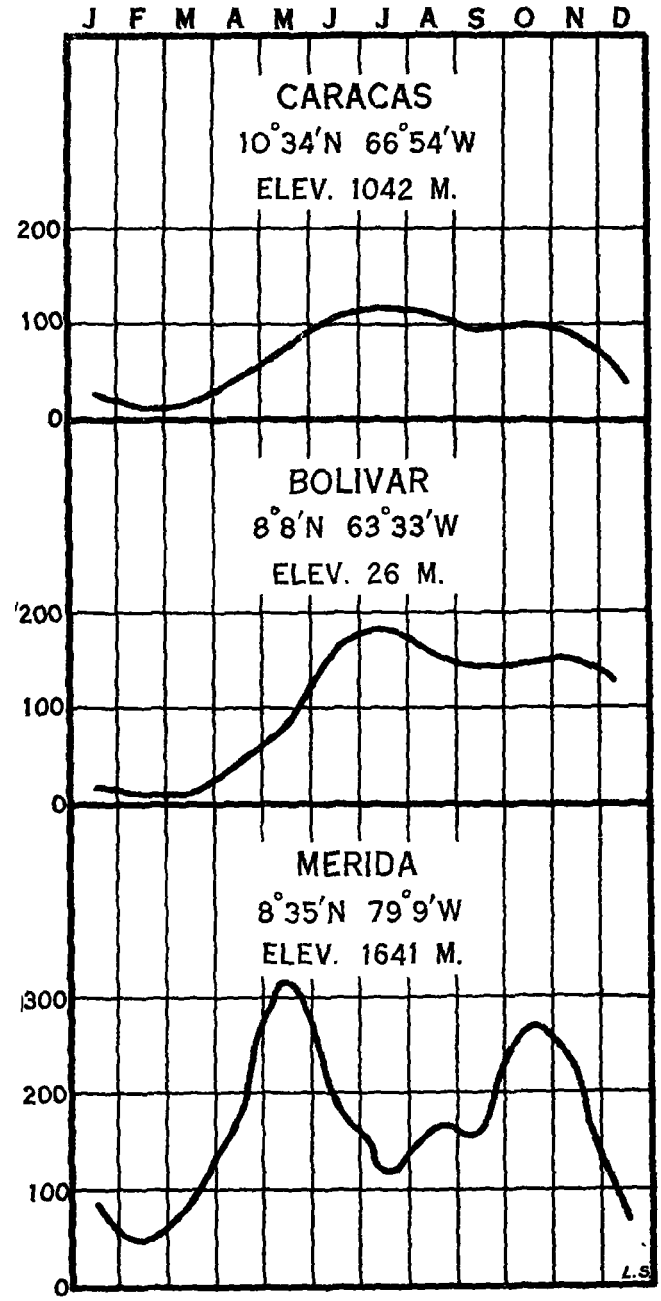

FIG. 1.—Monthly rainfall distribution at Venezuelan stations.

Monthly values of various elements are also given year by year for the total period available. The second half of the work contains monthly normals for the stations belonging to the National Meteorological Service, based chiefly on data for the whole or a part of the decade ending 1919.

In the preface the director states that on its establishment the new service was confronted with the formidable

[1] Brazil. Directoria de meteorologia. Boletin de normaes. Observações meteorologicas feitas no ex-Observatorio nacional, hoje Instituto central, do Rio de Janeiro, e nas estações da rêde nacional. Campos: Officinas graphicas. 1922.

task of bringing up the arrears of the annual bulletins of meteorological observations which began and ended with the bulletin for the year 1910, published in 1914 by the former Directoria de Meteorologia e Astronomia. Before beginning the publication of this extensive series it was thought best to prepare the collection of normals which has just appeared. He states that the publication should be regarded as provisional in character. The observations at Rio are lacking in homogeneity on account of various methods of exposure and observation, and in any case it is difficult to obtain representative data for that city on account of its extremely irregular topography. The observations at field stations were taken by comparatively untrained observers in most cases. Nevertheless this publication is a noteworthy contribution to the climatology of Brazil, furnishing a more comprehensive collection of normals than has heretofore appeared for that part of the world.—*C. F. T.*

CONCERNING THE HALO OF 46°.

By LOUIS BESSON.

[Paris, France, June 26, 1922.]

In the MONTHLY WEATHER REVIEW of March, 1922, Professor Hastings calls the attention of meteorologists to the halo of 46°, which he believes can be explained by prisms horizontally oriented.

By a singular coincidence the Ellendale phenomenon, whose description is read just following, furnishes a positive answer on this question. If the "bright halo of 46°" observed by Mr. Ling at 11:58 a. m. had been produced by horizontal prisms this luminous arc would have been tangent to the circumzenithal arc instead of being separated from it by a distance of 4° or 5°.

Relative to this may I be permitted to recall that on December 21, 1910,[1] I observed a circumzenithal arc not touching the halo of 46°, and that my associate M. Dutheil observed on February 18, 1912, a short arc 3° above the large halo.[2]

It is very rare that the nonoriented prisms by adding in this way their effect to that of the others reveal their existence in a manner so characteristic, but there are seen rather frequently halos of 46° that have so manifestly the form of a perfect circle that they could be attributed only to such prisms. I could cite rather numerous examples in our observations at Montsouris.

Professor Hastings objects that the halo of 46° appears only when the sun is not too high. I gave, in 1909, in my memoir on the theory of halos [3] figures that indicate in effect that the phenomenon presents a very decided maximum of frequency for a solar elevation of near 20°. What does that prove? Simply that the prisms that produce it have a tendency to orient themselves and that their balancings are of limited amplitude.

It is about the vertical that these balancings appear to be executed. To simplify, let us consider only the highest point of the halo of 46°. It is readily seen that if the sun is at 22° 8′ elevation innumerable vertical prisms are effective. If the sun is 10° higher or lower, that is to say at 32° 8′ or at 12° 8′, it would be necessary that the prisms incline 10° in one direction or in the other. If the sun is at 42° 8′ or at 2° 8′ balancings of 20° will be necessary.

I shall add that the prisms whose axes oscillate about the horizontal contribute to the production of the halo of 46° when the sun is slightly elevated, but they bring forth especially the lateral parts, while the prisms near the vertical give the upper part.

Most often, but not always, the persistent existence of the maximum of intensity, whether above or at the side, betrays the tendency of the generating crystals toward a definite orientation. This remark is not peculiar to the halo of 46°. It is true also of the halo of 22°, for all observers know that of it there is seen especially the culminating part or the segments at the elevation of the sun.

It can happen that there is taken for an arc of the halo of 46° a supralateral tangent arc or an arc bitangent to this halo, the coloring being of the same order as that of the halo, from which they are usually difficult to distinguish.

At Montsouris in the first years we sometimes must have made this error, all the more pardonable in that there was not yet certainty as to the real existence of these tangential arcs foreseen by the intuition of Bravais. However, their reality is no longer in doubt, and we have learned to recognize them rather well even when they are very short by their colors, which are more vivid than those of the halo of 46°, and by the accompanying appearance of the tangential arc of 22°. The possibility of a mistake in this regard does not preclude the fact that just as there is a halo of 22° there is also a circular halo of 46° produced by prisms of 90°, whose position is near that of the minimum of deviation in accord with the old explanation by Cavendish.

I find in my notes figures showing under what conditions there appeared 79 halos of 46° observed at Montsouris from 1898 to 1908. It is, perhaps, not without interest to reproduce them here.

Phenomena visible at the same time as the halo of 46° or a little previous.

	Per cent.
Halo of 22°, not brilliant, alone	30
Halo of 22°, brilliant, or rather brilliant, alone	27
Parhelia	13
Tangential arcs of 22°, with parhelia	11
Tangential arcs of 22°, without parhelia	11
No phenomena	5
No definite indications	3

When the halo of 46° accompanies a halo of 22° that is brilliant and uniformly so, it may be asked if it is not produced "secondarily" by two successive refractions in prisms of 60°. Its radius would then be 44°. Among our numerous measurements there were three that gave this result, but correctness was not certain.

This is a point to which I take the liberty of directing the attention of observers.

[1] *Annales de l'Observatoire de Montsouris.* Tome XI, p. 47.
[2] *Loc. cit.* Tome XII, p. 241.
[3] *Loc. cit.* Tome X, p. 186.

TORNADOES IN WISCONSIN.

By W. P. STEWART, Meteorologist.

[Weather Bureau, Milwaukee, Wis.]

June 15, 1922.—During the evening of June 15, 1922, a destructive thunder squall and tornado swept over parts of four counties in northwestern Wisconsin, causing the loss of eight lives, injuries to about 100 persons, and property damage estimated at $500,000.