mus. A study of curves showing hourly distribution of rainfall at several stations shows most of the rain falling in the afternoon, with the maximum at 3 p. m.

Western coast of South America.—For the western coast of South America three rainfall types are presented. The first is in the area comprised by the region whose southern boundary is about 4° south latitude, and the northern boundary of which is the Isthmus of Panama. The region has a moderately heavy rainfall with a well-marked double maximum (Bogota). The distribution is controlled by the oscillation of the equatorial rain belt, the maxima occurring when the sun is near the zenith and the minima when the sun is farthest north and south.

The latitudes of the southeast trades along the west coast have the second type. This region extends from about 4° south to 30° south latitude and is essentially rainless. The winds from the east descend the western slopes of the Andes as dry, hot winds, having dropped all of their moisture on the eastern slopes. More prevalent still is a southerly [6] wind blowing parallel to the coast. This wind blowing over the cool Humboldt Current carries but a small amount of moisture, and becomes drier still as it draws nearer the Equator. South of latitude 30° the rainfall is controlled by the prevailing westerlies. Here under the régime of these mositure-laden winds the annual amounts are heavy. The northern part (Valdivia) of this region has a well-marked maximum in June and July (winter) with the maximum of cyclones. The southern part (Evangelista) does not have this maximum, the distribution being fairly uniform throughout the year. The westerlies in these latitudes, popularly designated as the "roaring forties" and the "brave west winds," [7] bring a procession of frequent and severe storms throughout the entire year.

Northeastern South America and the basin of the Amazon.—The rainfall of this region is controlled by the trades and the seasonal shifting of the thermal equator. The monthly distribution of rainfall at Georgetown, Paramaribo, and Cayenne is very similar, although the annual total at Cayenne is larger, possibly, on account of its greater exposure to the northeast winds. The maximum occurs during the spring with the maximum monthly amount in May.

Rainfall is plentiful throughout the entire Amazon Basin. The prevailing winds in this region during the greater part of the year are from the east-northeast. These winds are moist when they enter the region, and the forested Amazon being virtually at times an inland sea, the atmospheric moisture is maintained or increased by evaporation. The seasonal maximum throughout the central part of the basin occurs about a month earlier than in northeastern Brazil and in the Guianas. It is interesting to note that the monthly distribution at Manaos is somewhat analogous to that at Cayenne.

Eastern South America, Brazil, Argentina, Paraguay, and Uruguay.—The northern part of this region is under the régime of the southeast trade. On-shore winds from the southeast and an elevated coast line give Pernambuco and stations in this region a heavy rainfall with a primary maximum during the winter when the trades are strongest, and a secondary convectional maximum in summer when the doldrums are south.

Southern Brazil (Sabara and Rio de Janeiro), Bolivia, Paraguay, and the interior of Argentina are subject to a summer convectional maximum occurring when the doldrums are farthest south.

As we reach the latitudes of the westerlies along the Argentine littoral we find that the annual rainfall is well distributed throughout the year, March being somewhat more moist than the other months, and a suggestion of an annual minimum occurring during July. Over the estuary of the Plate thunderstorms are fairly frequent during the warmer season, averaging about 7 per month during December and January.

Going westward from the Argentine coast there is a rapid decrease in the annual rainfall, and the Provinces at the foot of the eastern slope of the Andes (San Juan) are almost as arid as that part of the west coast in the latitudes of the southeast trade.

The southern tip of the continent is well watered on both coasts. Two factors account for the moderate heavy precipitation of southeastern Patagonia, namely, the lowering of the Andean cordillera,[8] and the frequent cyclonic storms of these latitudes.

The graphs and discussion presented herewith have not covered the varied complexity of all rainfall types found in Latin America. Only the most essential of the rainfall types have been included and an attempt has been made to show some of the climatic controls governing these types.

RAINFALL MAP OF SOUTH AFRICA.

By J. R. SUTTON.

[Excerpts from a paper presented before the Royal Society of South Africa, Oct. 20, 1920. Reprinted from *Nature*, London, Dec. 16, 1920, p. 522.]

A contribution to the study of the rainfall map of South Africa. The monthly and annual rainfalls for 567 stations in South and East Africa are given, and the results shown graphically in 13 maps. The isohyets form a system which moves to and fro across the Equator, following the sun with a lag of a month or more. Corresponding with the general movements of the main isohyetal system are the winter rains of the southwest, which advance inland as the summer rains retreat, and vice versa. The paper concludes with a short bibliography of special studies of South African rainfall.

551.578.1 (048) (728.1) (728.4)

RAINFALL IN GUATEMALA AND SALVADOR IN THE YEARS 1908 TO 1920.[1]

By KARL SAPPER.

[Abstracted from *Meteorologische Zeitschrift*, Sept., 1921, pp. 279-281.]

The author has made an attempt to bring together and unify the climatological data of the Republics of Salvador and Guatemala, in which countries the war practically disrupted meteorological work. The following table summarizes the available rainfall records gathered together from various sources.—*C. L. M.*

[6] R. DeC. Ward, Climate of South America, *Bulletin of the American Geographical Society*, 1903-357, pp. 353-360.
[7] R. DeC. Ward, *Climate*, G. P. Putnam's Sons, [illegible]
[8] R. DeC. Ward, Climate of South America, *Bulletin of the American Geographic Society*, 1903, 35:359.
[1] *Regenfall in den Republiken Guatemala und El Salvador in den Jahren 1908 bis 1920.*

TABLE 1.—*Results of rainfall measurements in Guatemala and Salvador.*

[Means for given periods in mm.]

Station	San Luis.	La Concepcion.	La Candelaria.	El Sororro.	El Reposo.	San Francisco, Miramar.	Santa Amalia.	El Rosario, Bola de Oro.	Bolivar.
Department	San Marcos.	San Marcos.	San Marcos.	San Marcos.	Quezaltenango, Costa Cuca.	Quezaltenango, Costa Cuca.	Quezaltenango, Costa Cuca.	Quezaltenango, Costa Cuca.	Quezaltenango, Costa Cuca.
Altitude	650 meters.	820 meters.	860 meters.	(?)	180 meters.	740 meters.	800 meters.	900 meters.	1,000 meters.
Period	1909–1919	1909–1919	1909–1919	1916–1919	May, 1913–Dec., 1919.	1908–1919	1909–1919	1911–1919	1909–1919
January	49.9	35.5	41.9	58.9	30.6	30.9	29.0	43.8	44.5
February	92.8	51.9	49.0	102.1	31.7	35.7	27.8	31.4	42.3
March	123.6	114.2	107.1	106.9	51.5	69.0	63.2	70.3	86.3
April	311.5	266.8	261.5	270.1	164.0	242.9	232.5	195.9	241.9
May	608.8	514.7	508.9	708.2	267.8	495.0	421.7	448.0	511.1
June	712.2	639.2	650.4	780.1	496.1	647.5	639.3	608.4	692.5
July	539.7	463.7	448.9	640.8	319.4	440.3	513.8	476.3	557.2
August	658.0	519.1	545.6	643.0	390.5	591.5	630.3	539.1	647.0
September	792.0	691.0	672.4	821.1	428.3	753.3	822.6	657.9	812.6
October	697.4	600.2	630.7	527.6	522.5	689.3	709.3	560.4	651.7
November	250.5	138.5	111.9	256.2	105.0	144.7	173.4	151.0	187.7
December	58.7	89.7	87.5	82.3	2.7	55.2	46.0	50.1	66.0
Year	4,895.1	4,124.5	4,115.8	5,057.5	2,741.6	4,194.4	4,308.9	3,832.8	4,540.8
Max. in month	Sept. 16: 1,031.6	Sept. 9: 1,113.4	Sept. 9: 1,126.2	Sept. 18: 969.6	Oct. 17: 1,013.0	Sept. 9: 1,244.6	Sept. 19: 1,055.9	Sept. 18: 1,018.6	Sept. 18: 1,235.3
Min. in month	Dec. 12: 0	Jan., Feb. 10: 0 Feb. 12: 0	Jan., Feb. 10: 0 Feb. 12: 0	Jan. 19: 1.3	Dec. 13, 14, 16–19: 0 Feb. 15, Mar. 16, Feb. 18: 0	Jan. 10, Feb. 19, Mar. 9, Dec. 10: 0	Jan. 12: 0	Dec. 18: 4.9	Dec. 18: 0
Max. in year	1909: 5,946.1	1909: 5,352.5	1916: 5,554.0	1916: 5,355.0	1917: 3,487.4	1909: 6,065.0	1916: 5,880.7	1916: 5,179.3	1916: 6,745.0
Min. in year	1912: 3,966.4	1914: 3,025.1	1912: 3,204.8	1919: 4,834.0	1919: 2,704.4	1913: 2,850.6	1914: 2,760.2	1914: 2,689.0	1912: 3,405.9

Station	El Pensamiento.	Santa Sofia.	Morelia.	Magdalena.	Setal.	Chinasayub.	Chimax.	Samac.	Seritquiché.	San Salvador.
Department	Quezaltenango. (Chuvá.)	Chimaltenango.	Chimaltenango.	El Quiché.	Alta Verapaz.	Alta Verapaz.	Alta Verapaz.	Alta Verapaz.	Alta Verapaz.	Republic of Salvador.
Altitude	1,200 meters.	760 meters.	980 meters.	2,200 meters.	730 meters.	950 meters.	1,306 meters.	1,300 meters.	.....	657 meters.
Period	1909–1919	1912–1919	1909–1919	1913–1919	1914–1920 except 1918.	1914–1920	1912–1920	1920	1920	1912–1920
January	36.4	47.0	51.0	6.5	314.9	313.7	146.2	189.0	201.0	13.7
February	44.2	58.0	74.0	3.0	334.7	256.4	101.6	245.2	119.0	13.5
March	102.2	100.0	105.4	30.9	283.3	222.1	131.7	172.0	64.0	24.7
April	213.1	256.4	190.7	34.1	286.7	288.3	143.7	132.1	77.0	72.8
May	411.8	641.3	581.9	80.7	311.9	335.3	199.2	354.0	474.0	167.8
June	668.4	816.4	763.8	170.6	462.6	519.0	285.5	651.3	818.0	298.0
July	488.5	693.5	559.4	139.5	405.9	512.3	250.4	228.5	690.0	306.8
August	547.8	680.9	708.3	137.7	402.7	396.4	234.7	195.0	417.0	298.9
September	621.7	941.4	901.7	181.3	576.1	588.5	263.7	743.4	781.5	260.0
October[1]	531.3	785.4	788.4	109.6	728.5	812.5	317.5	651.2	405.5	281.5
November[1]	144.7	186.4	183.3	29.2	773.6	653.4	308.2	941.2	396.0	42.3
December[1]	61.0	46.6	46.4	5.9	498.0	514.4	184.5	400.8	69.0	20.3
Year[1]	3,862.4	5,253.3	4,954.3	979.0	5,378.9	5,412.3	2,566.9	4,903.7	4,512.0	1,800.3
Max. in month	June 10: 1,138.5	July 16: 1,182.2	Oct. 9: 1,220.8	June 17: 286.5	Nov. 14: 1,182.5	Oct. 17: 1,257.0	Oct. 17: 545.0	Nov. 20: 941.2	Mar. 20: 64	.....
Min. in month	Feb. 15: 3.0	Dec. 19: 0	Jan. 10, Dec. 11, Feb. 14: 0	5 times Jan., 4 times Feb. & Mar. 1 time May 3 times Dec.: 0	May 15: 129.0	Mar. 17: 85.0	Feb. 13: 26.0	Apr. 20: 132.1	June 20: 818	.....
Max. in year	1916: 4,512.0	1916: 6,084.5	1919: 5,545.3	1916: 1,312.1	1920: 6,603.5	1920: 6,452.0	1920: 2,996.2	.....	.....	1918: 2,119.0
Min. in year	1912: 3,002.0	1914: 3,588.5	1914: 3,704.5	1914: 458.0	1916: 4,199.5	1919: 4,645.0	1919: 1,877.0	.....	.....	1912: 1,478.5

[1] 10-year mean: Break in record, Oct. to Dec., 1918.

RELATION BETWEEN THE RAINFALL, THE TEMPERATURE, AND THE YIELD OF CORN IN ARGENTINA.[1]

551.578.1 : 551.524 : 633
(82)

By N. A. HESSLING.

[Translated from the Spanish by G. B. Diehl.]

Among the diverse factors that determine the variations in the yield of crops, the fluctuations of the meteorological elements are, without doubt, the most important, and among these precipitation must occupy the principal place. We know, naturally, that if the rainfall is insufficient, the crops fail or diminish; also that excessive rains are prejudicial. But we need to know more exactly what conditions are more favorable for crops, what is the minimum of rain for a normal crop, and when the rains turn to excessive or prejudicial.

A study of these relations has interest, not alone from the scientific point of view, but also from the practical side. In fact, J. Warren Smith and H. A. Wallace have demonstrated that, knowing the rainfall and the mean temperature during the critical period of growth, it is possible to forecast the crop of corn in the United States with more or less certainty. (Mo. WEATHER REV., February, 1914, and August, 1920.) This, like other practical applications that these studies can have, depends naturally upon the degrees of connection between the determining factors and the yields. That connection is more apparent for certain cultivations than for others, and for similar cereals it is more marked in certain regions than in others, according to the greater or lesser presence of other factors that complicate the result.

In general, the connection is not so intimate that one can utilize it in forecasting, as indicated above, but whatever the method, it is of interest to determine scientifically what the relations are for each cereal.

We begin with corn, for it is the cereal that appears to be most affected by meteorological variations. The yield data are taken from the *Statistical Agriculturist*, published annually under the direction of the Office of Statistics and Agriculture. On page 53 of that publication

[1] Relaciones entre la lluvia, la temperatura y el rendimiento del maiz. *Boletin Mensual*, Oficina Meteorologica Nacional, Oct., 1918, pp. 487–492.