Yearly occurrence.	$\frac{1}{\alpha_0}=\mu^3_0 \frac{\Delta^3_0-\Delta^3_1}{\Delta^3_0 \Delta^3_1}$			
Categories of rains.	Stuttgart.		Petrograd.	
	Theoretical.	Actual.	Theoretical.	Actual.
Ordinary rains (1.0–3.0)	30.4	2.1	2.9	2.9
Moderate showers (3.0–5.0)	0.91	0.83	0.08	0.07
Heavy showers (5.0–7.0)	0.16	0.17	0.02	0.00

The average yearly amount of precipitation evidently consists of the sum of precipitation of all categories of rains corresponding to their yearly occurrence and one can express it theoretically by equation $H=S\sqrt{\mu^3}$. If we compute the quantity S for four towns with continental climate we obtain for Stuttgart $S=110$, for Hanover $S=116$; for Ekaterinoslav $S=120$, and for Astrakhan $S=131$. Therefore, one can take for the central region of Europe the middle number with sufficient accuracy and obtain the equation $H=120\sqrt{\mu^3}$. But for countries with humid sea climate the quantity S departs considerably from its average value (for instance, for Petrograd $S=271$). Probably there fall and are recorded very small rains which in a drier continental climate are evaporated without reaching the surface of the earth and therefore escape being recorded.

(12) The largest possible "rain power" for a given place will evidently be such a power as is not surpassed in the course of the complete cycle of periodicity of precipitation for ρ years, and consequently will be $\Delta=\mu\sqrt[3]{\rho}+0.1$. In case the exact climatic number of the country μ is unknown, it can be substituted by yearly average quantity of precipitation H (from the equation $H=120\sqrt{\mu^3}$), from which it becomes approximately $\Delta=0.041\sqrt[3]{H^2}\sqrt[3]{\rho}+0.1$.

The complete cycle of periodicity of precipitation makes up, according to Brückner, $\rho=35$ years, and then the maximal rain power will be $\Delta=0.13\sqrt[3]{H^2}+0.1$. But according to the opinion of the author the complete cycle of periodicity must be a double one—that is, $\rho=70$ years. The maximum possible "rain power" will be somewhat larger, namely, $\Delta=0.17\sqrt[3]{H^2}+0.1$.

For the verification of this formula there were calculated by the author the "powers" of all remarkable showers known to him, from which appeared to be that for the majority of actual observations the "rain powers" do not surpass the calculated value of their power for the period of $\rho=35$, although approaching it closely. That could be expected because the majority of exact meteorological reports seldom embraces a period of observations larger than for 30 to 40 years. Only in nine cases quoted below the actual maximum "rain power" was larger than the theoretical for the period of $\rho=35$ years, but did not reach the theoretical power calculated for the period of $\rho=70$ years.

Country.	Date.	Yearly H.	Theoretical.		Actual.
			Max. $\rho=35$	Δ $\rho=70$	Δ max.
		Feet.			
Budapest	June 26, 1875	435	7.6	9.9	8.5
Paris	Sept. 20, 1867	483	8.1	10.6	9.2
Treuenbrietzen (Brandenburg)	July 31, 1897	506	8.4	10.9	10.8
Vienna	July 21, 1912	566	9.0	11.7	9.9
Breslau	Aug. 6, 1858	585	9.2	11.9	10.1
Schwerin	May 11, 1870	614	9.5	12.4	11.4
Karlsruhe	June 23, 1885	723	10.6	13.8	13.0
Geneva	May 30, 1827	822	11.5	15.0	12.1
Nieder Marsberg	Aug. 6, 1897	975	12.9	16.8	15.4

TABLE 5.—*Rains at Stuttgart recorded during the period 1875–1903, according to Dr. Th. Heyd.*

[The intensity of precipitation in mm./min. is calculated by the author.]

Dates.	Intensity of precipitation (mm./min.).	Quantity of precipitation (e/sec. ha.).	Duration of precipitation (mins.).
1875—Aug. 31	1.20	200	7
1876—June 7	0.54	90	10
July 29	0.38	63	29
1877—June 20	0.67	112	34
June 21	1.20	200	60
July 14	0.44	74	15
July 18	0.35	58	10
1878—May 12	0.25	42	90
May 14	0.40	67	10
June 14	0.59	99	44
July 27	0.43	71	45
Aug. 7	0.34	56	17
Aug. 7	0.49	82	13
1879—Apr. 26	0.26	44	10
1880—May 14	0.62	104	10
June 11	0.55	91	35
July 1	0.59	99	16
Aug. 13	0.25	42	19
Sept. 8	0.28	47	10
Sept. 18	0.34	57	25
1881—July 9	0.76	124	12
July 16	0.22	37	75
1882—May 30	0.82	137	18½
May 30	0.73	121	12½
1883—May 8	0.52	86	20
July 10	0.85	142	22
July 10	1.04	174	15
July 23	2.50	417	3

Conforming to the above, the calculation for the rain power $\Delta=i\sqrt{t}$ and climatic numbers of country $\mu=\Delta\sqrt[3]{\rho}$ give a new method of working with meteorological observations, allowing us to establish some laws for phenomena of precipitation and obtain by theoretical means deductions confirmed by observations. Therefore, it is very desirable to include in all meteorological records information concerning the rain amounts h and duration t, also the calculated quantities of the rain power Δ. Summarizing the latter for many stations with regard to their duration, occurrence, and departure from their passage above some neighboring points of observations, and so on, and also studying the dependence of climatic factor for different countries μ from the location of points of observation relative to the mountain ranges and tracks of cyclones and their elevation above the sea level, it is possible to open new ways of exploration through the extremely abundant but hardly accessible virgin forest in which appears now the vast amount of meteorological observations concerning the rainfall of many thousands of stations in the whole world.

DISCUSSION.

By H. R. LEACH and R. E. HORTON.

[Voorheesville, N. Y., July 24, 1923.]

The suggestion that storms can be classified according to their "rain power" is worthy of further study. Once its true relation to other storm characteristics is established, and its frequency equation determined, most of the storm characteristics of a certain locality can be expressed in two or three simple equations, the constants of which may possibly hold for relatively large areas, as suggested in the paper.

The formula given for "rain power," $\Delta=i\sqrt{t}$ is not satisfactorily proven and is not in accordance with more recent intensity-duration formulas. The assumption that the power of a given storm is constant is not conclusively shown and it seems just as logical to assume that the power may suffer depletion as the storm progresses. The intensity formulas more generally give the equation of an envelope curve embracing maximum intensities of all storms, rather than the intensity-duration relation of a single storm.—*H. R. L.*

The author evidently confuses storm with cloud in some degree. His first formula, $i=\frac{h}{t}$, is true of course of the total amount of precipitation in a storm where t is the total time, but the derivation of the basic formula for maximum rain intensity in a time interval t, given and used by the author, viz, that $\Delta=\frac{h}{\sqrt{t}}$, certainly does not follow from it. That is a form of expression sometimes used, especially in Europe, for relative rain intensities of equal frequency in storms of short duration. Of the hundred or more rain intensity formulas which have been published in the United States only a few take this form. More commonly an expression of the type $i=\frac{a}{b+t}$ fits the data better. My own preference is for a formula of the exhaustion type, $i=a\ e^{-kt^n}$. In each of the above formulas the intensity is finite, i. e., $\frac{a}{b}$ or a, for $t=0$; whereas the intensity formula used by the author gives an infinite intensity or precipitation rate for zero time, which is certainly incorrect. Nevertheless, the author's formula can be used to approximately or roughly represent rain intensity-time relations in short storms most anywhere, and so far as that feature of the paper is concerned he gives some data which have not hitherto appeared in English.

There is a suggestion of something very much more important in this paper; *that is, the proposition that there is for each locality a maximum or limiting value of nature's capabilities in the way of rain production*, but of course it has nothing whatever to do with the size of or amount of moisture in any cloud. Strangely enough, engineers invariably recognize the existence of this maximum but since no way seems hitherto to have been devised to determine its value, the majority of rain intensity and flood formulas are in such form that the existence of the maximum is not taken into account. I do not think the author's method of arriving at this so-called maximum value of Δ is satisfactory. Even if the Brückner cycle was much more perfect than it generally is, even then one cycle differs from another in magnitude of its maximum and minimum points to a considerable degree. There is, therefore, no certainty that the absolute maximum rain intensity for any interval may not somewhat exceed, though probably not much, any value observed, even in two Brückner cycles. I happen to have been studying this question of limiting or maximum possible rainfall rates very carefully. I fully believe in the existence of maximum values, as the author suggests, but I furthermore believe (and have worked them out to test my theory for many cases) that a frequency formula for various intensities can be devised in which the constants determined from the more frequent and better known observations will lead to a curve having an asymptote, the position of which is the limiting value of rainfall for the given duration, and this position can be determined.

Within the past few weeks Mr. Leach has been working out these limiting values of annual rainfall in this way for several of the longer New England rainfall records. In general the indicated maximum annual rainfall so determined is slightly, but sometimes only slightly, in excess of any value ever observed. Nearly all the records used cover seventy years or more.

To some extent the natural maximum limitations of rainfall, say for a single storm, can, I think, be approximated from meteorological conditions, although I have approached the subject entirely from a statistical viewpoint. In consideration of the importance of the subject, and the fact that I do not think there is a word in relation to it in print anywhere, a symposium on this very question—*Is there a limiting maximum amount of rain which nature can produce at each locality in any chosen time interval; and if so, how may this limit best be determined?*—would, I think, be fruitful of valuable results.

Gorbatchev's paper could be used in digest or abstract form to introduce such a discussion. It occurs to me that Bjerknes' Theory of the Cyclone, especially in relation to the formation of rain, points the way roughly to an analysis of the meteorological conditions which limit the possible amount of rain which can be produced at a given place during the passage of a cyclonic storm.—*R. E. H.*

CITY PLANNING AND THE PREVAILING WINDS.

CLARENCE J. ROOT, Meteorologist.

[Weather Bureau Office, Springfield, Ill., July 17, 1923.]

Much interest has been manifested during recent years in the city planning and zoning movement. The planning of cities is hardly a modern idea. As long ago as 1789 Maj. Pierre Charles L'Enfant, an engineer officer who had served with our troops in the Revolution, was commissioned to lay out a capital city for the young Nation. Washington to-day is an example of the advantages to be had in planning the future of our cities. Most of our cities were not planned, but just grew, and efforts are now being made to rectify the mistakes of the past and to plan for the future.

The city of Springfield, Ill., is about to adopt a city plan. The experts have completed the surveys and have submitted the tentative plan. This contemplates for the future city, among other things, a union railroad station, an industrial district, the creation of a large lake in the valley of the Sangamon River, and a civic center. The civic center is to be a memorial to Abraham Lincoln, and will occupy several blocks grouped about the Lincoln homestead. It is planned to have a wide boulevard lead from the union station, through the Lincoln civic center, to the State capitol building, and thence to the Lincoln tomb in Oak Ridge Cemetery.

In locating the industrial zone, Mr. Myron H. West, who supervised the work, placed it in the extreme northeast part of the city. Consideration was given to the source of water supply, proximity to coal mines and to railroads and terminals, housing conditions, and available sites for industrial plants. The matter of prevailing wind direction was an important factor, however, in choosing this location. The idea is to so locate industries that the smoke, gases, and noises will not be wafted over the city.

An examination of the 44-year weather record at the Springfield station discloses the fact that the prevailing wind direction is from the northwest during January