these columns express the relative ability of different sources of light to produce light of a specific wave length; thus, for instance, if a Heffner lamp, which was used by Miss Koettgen as the standard, should at the yellow wave length 590, give the same intensity as the blue sky, then at the wave length 430, the blue sky would give a violet light that is 61.63 times as intense as the violet light of the Heffner lamp at that point of the spectrum. The author used the spectrum photometer invented by Dr. Arthur Koenig, and the table expresses visual results, and may not apply strictly to chemical or thermal results.

Wave length.	Spectrum color.	Blue sky-light.	Overcast sky.	Bright cloud.	Direct sunlight.	
Microms.						
690	Red.	0.21	0.25	0.37	0.31	0.30
670	Orange.	0.30	0.33	0.46	0.36	0.39
650	Orange.	0.40	0.43	0.56	0.45	0.48
630	Yellow.	0.53	0.57	0.69	0.60	0.62
610	Yellow.	0.74	0.76	0.82	0.79	0.80
590	Yellow.	1.00	1.00	1.00	1.00	1.00
570	Yellow.	1.58	1.57	1.56	1.34	1.34
550	Olive.	2.32	2.24	2.14	1.87	1.86
530	Green.	3.49	3.22	2.95	2.54	2.58
510	Green.	5.75	4.82	4.30	3.68	3.63
490	Blue.	9.41	7.39	6.65	5.56	5.48
470	Blue.	18.17	13.34	11.87	8.65	8.79
450	Blue.	33.95	24.53	19.85	....	13.60
430	Violet.	61.63	36.52	30.73	19.18	19.74

ATMOSPHERIC VAPOR.

The relation between the air and the moisture that it contains is very frequently stated incorrectly in elementary text books on physics and in ordinary popular explanations of meteorological phenomena. The error consists essentially in the idea attached to absorption, as in the sentence "a cubic foot of free air at a temperature of 50° will absorb 4.28 grains of aqueous vapor." This reads as though the writer considered the air in the same light as a sponge. Now, a sponge absorbs water by virtue of its own structure, and if the sponge were not in place the water would not leave its former position in order to ascend into the sponge. It is not so with air. The vapor of water ascends into the air by virtue of certain inherent properties of its own to which the air offers a slight resistance; if the air were absent from a cubic foot of space the vapor would still fill that space. The above quotation should, therefore, read as follows: A cubic foot of space, if saturated at a temperature of 50°, will contain 4.28 grains of aqueous vapor.

It takes a little time for aqueous vapor to diffuse into and thoroughly saturate a given cubic foot of space. It takes a little more time if that space already has air in it, but when the space is finally saturated the amount of the vapor is, so far as can be measured, appreciably the same, no matter whether the air is present or not. We must, therefore, speak of the vapor and the air as coexisting side by side, and it is no more proper to speak of the air as having absorbed the vapor than to speak of the vapor as having absorbed the air.

Owing to the mutual resistance of the air and vapor the molecules of the one do not pass through and among those of the other as freely as they pass through empty space. This gives rise to what is called the coefficient of diffusion or the time required for a unit volume of either gas to completely interpenetrate a unit volume of the other. The time required for this mutual interpenetration is also, of course, the time required for the mutual separation after they have been mixed together. As this time is quite appreciable it follows that both the air and the vapor move along together either horizontally, as wind, or vertically, as in the ascending currents that make clouds. Of course, in such a mixture the temperature of the air and the vapor are precisely the same, and we can not warm or cool one without warming or cooling the other.

If by any process the temperature is lowered below the saturating temperature of 50° F. then the cubic foot of space can not contain so much as 4.28 grains of aqueous vapor and the difference, whatever it may be, must be condensed into particles of water, forming haze, fog, clouds, rain, etc. The cooling just referred to is often brought about by the mere act of expansion as the warm moist air rises in the atmosphere. This expansion implies that work has been done in the interior of the mixture of air and vapor. A mass of perfectly dry air or a mass of perfectly pure vapor would cool by expanding just as the mixture does, but at ordinary temperatures the cooling of the dry air will not convert it into liquid air, whereas the cooling of aqueous vapor can easily convert it into liquid water. We have seen it stated that when the air expands it is, in this rarefied condition, not able to absorb so much aqueous vapor as in its former unexpanded or denser condition. But this is a mistake. Rarefied air at ordinary temperatures in the laboratory will hold as much vapor as denser air at the same temperature. The reason why rarefied air on mountain tops does not ordinarily contain as much vapor as the denser air at the base of the mountain is that the mountain air is cooler; it is the temperature and not the pressure that regulates the quantity of moisture in the upper strata of the atmosphere.

THE METEOROLOGICAL USE OF THE TERM "LOCAL."

The adjective "local" in the expressions "local rain," "local storm," "local wind," "local frost," etc., seems to require some special definition, so that the word may be used in a fairly uniform sense by all meteorologists. As preliminary to any attempt at a definition it will be best to collect together a few examples illustrating the wide range of ordinary usage.

The storm of September 6, 1895, in Oklahoma County, Okla., is stated in the Bulletin of the State Weather Service for that month to have been "the heaviest rainfall and thunderstorm of the season; it was purely *local in nature* and extended only over an area of 300 square miles."

A very heavy rain in southeastern Indiana is said to have given rise to "local floods" and destruction of crops over a region about 7 miles in diameter.

A series of "local rains" on the southern coast of Florida covered a region parallel to the coast for 50 miles north and south, and from 1 to 5 miles broad east and west.

A tornado is a "local phenomenon" whose destructive winds are felt at irregular intervals over a region that may, in an extreme case, be a 100 miles long and 1 mile wide, but is more apt to be from 5 to 20 miles long and scarcely $\frac{1}{8}$ of a mile wide.

A "local cloudburst" may occur in a mountain valley and over an area of scarcely $\frac{1}{4}$ of a square mile.

Is it possible to attach any definite idea to the term local? Judging from the preceding usages a West India hurricane begins as a "local whirl" in mid-Atlantic, grows into an extensive disturbance over the West Indies and our Atlantic coast, becomes a general storm in the North Atlantic, and disappears by merging into the "general circulation of the Northern Hemisphere."

The terms local and general are necessarily indefinite, and are needed for use with that understanding. But in order to give precision to our observations, it is hoped that observers will, when practicable, specify approximately the area in square miles over which any phenomenon is visible rather than content themselves with an indefinite word or usage.

WATER MEASUREMENTS FOR IRRIGATION.

The meteorologist measures the rainfall by the vertical depth of the equivalent layer of water that falls into the mouth of his gauge. Assuming that the catch of his gauge is a fair sample of the rainfall over a large region in his neighborhood—which is often far from being true—he may compute the total quantity of water that falls upon any field or any drainage basin or river watershed. From this he gets a crude idea of the rainfall needed in order to perfect his crops, but it is a very crude idea because the crop only uses an exceedingly small percentage of this rainfall, the rest being partly absorbed in the ground and stored away for future dry seasons, partly returned to the air by evaporation, and mostly flowing off to the river by surface drainage. The total quantity needed for the ripening of a crop, when the water is carefully conserved, is a matter that is being determined by the experience of those who are farming by irrigation, and this style of farming which is common enough in our dry regions promises to become of fundamental importance for the whole country. There is no section of the United States that is not liable to droughts severe enough to affect the crops. A farm that covers a large area may in a dry season produce enough on the lowlands to counterbalance the loss of the crop on the uplands, but a small farmer can not afford to thus risk the loss of his whole crop, and must, therefore, be ready to raise his crops by artificial irrigation. But to irrigate requires either a windmill to pump up water from wells and reservoirs, or else a pond, ditch, or reservoir on some higher ground. In any case one must know what amount of water he needs, how large a reservoir must be built, and how powerful a windmill is required to do the work of pumping. To this end the ordinary meteorological method of measuring rainfall must be supplemented by a table of cubic measures.

An acre of ground covers 43,560 square feet, therefore 12 inches of rainfall means 43,560 cubic feet of water per acre. This may be converted into gallons or into pounds weight, if we choose, by the following considerations; one gallon contains 277.274 cubic inches, there are, therefore, 6.2321 gallons in a cubic foot; a gallon of pure water at 62° F., as weighed in the atmosphere, weighs 10 pounds. It will, however, be simpler for our present purposes to measure the water in cubic feet. The quantity of water per acre for a given depth of rainfall is expressed in cubic feet in the following table:

Rainfall (depth).	Equivalent per acre.
Inches.	*Cubic feet.*
0.10	363
0.50	1,815
1.00	3,630
2.00	7,260
3.00	10,890
4.00	14,520
5.00	18,150
6.00	21,780
7.00	25,410
8.00	29,040
9.00	32,670
10.00	36,300
11.00	39,930
12.00	43,560

In gauging the amount of water in streams the unit of measurement is a rate of flow equivalent to 1 cubic foot of water per second of time, and the carrying capacity of a ditch must be expressed in these units.

Another standard of measurement is the so-called miner's inch, but this is quite an indefinite term, inasmuch as the flow of water corresponding to a miner's inch varies with the structure of the gate or sluiceway and the construction of the aperture through which the water flows, so that actual experiment has shown that the miner's inch, as used in Colorado, is equivalent to 11.7 gallons of water per minute, while that used in California is 9 gallons per minute.

MELTING SNOW AND RIVER FLOODS.

The floods in the Mississippi and Missouri are often attributed to the influence of melting snow in the Rocky Mountain Region, but this is really only a small item in comparison with the rainfall in the lower Missouri, the upper Mississippi, the Arkansas, and the Ohio watersheds. The recent great flood in the Mississippi was demonstrably caused by a combination of floods due to such rainfall. In connection with the experimental study of the development of agriculture by irrigation, the question of water supply, whether it comes from artesian wells or rain, from rivers or from melted snow, has been especially studied at the Agricultural Experiment Station of the State Agricultural College at Fort Collins, on the Cache a la Poudre River. In the course of this investigation measurements of the discharge, expressed in cubic feet per second, were made at stations on the Poudre and the Platte Rivers, after shutting off all the head gates leading into the irrigation ditches. Full accounts of the studies that have been made in connection with irrigation have been published in the bulletins of the Experiment Station, Nos. 9, 13, 16, 22, 26, 27, 33. From the last bulletin, dated January, 1896, it appears that the first gauging of the Poudre River was made in October, 1885, and the discharges in successive years at the gauging station, in cubic feet per second, were as follows:

	Cubic feet per second.	Rainfall since Jan. 1.	Rainfall within 3 weeks.
		Inches.	*Inch.*
1. 1885, October 12-15	127.609	....	....
2. 1889, October 14-17	68.723	11.22	0.34
3. 1890, October 16-18	80.776	13.12	0.70
4. 1891, October 23-30	97.58	14.62	0.19
4*a*. 1891, November 3	107.01	4.62	0.19
5. 1892, March 10-12	65.02	2.72	0.83
6. 1892, October 5-8	62.92	13.94	0.00
7. 1893, November 9-11	52.47	6.28	0.00
8. 1894, March 13-15	99.21	0.85	0.00
9. 1894, August 20-23	268.07	9.25	0.08
10. 1895, October 9-14	66.47	16.60	0.00

The measurements made below the gauging station show that the water which passes any point is not only that flowing in the channel just above, but is increased by an additional amount due to seepage, which is very large in the sandy soil of the Poudre and Platte valleys. In the spring time this seepage largely represents the water that has settled into the surrounding soil from melted snow, while in the summer time it results from drainage and rainfall. The discharge of the river proper at the Fort Collins gauging station, which is in the canyon about 12 miles above the college and above the head gates of all the principal canals, might be expected, therefore, to increase with the melting of snow on the higher lands to the westward, but the actual gaugings seem to indicate that the snow water, which permeates the soil very slowly, is not so important as the rainfall of the spring and summer months. The seepage is greatly favored by the warmth of the soil, since heat decreases the viscosity of water. This effect has been studied by Professor Carpenter and found to be appreciable. The average discharge at the gauging station, as deduced from records of a number of years, varying between three and twelve for the different months, is as follows:

	Cubic feet per second.		Cubic feet per second.
January	110	July	1,018
February	83	August	362
March	70	September	173
April	237	October	136
May	1,245	November	81
June	2,017	December	74

In continuation of these normal values the following items of daily discharge are quoted from the weekly Poudre River bulletins that are now issued by Prof. L. G. Carpenter of the experiment station. His bulletins, Nos. 1 and 4, for