TABLE 5.—*Monthly and annual mean temperatures at four stations for their longest periods.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Saline, Mich. 1847–1854	26.5	26.5	34.9	43.5	55.5	66.1	69.3	67.9	59.7	48.4	40.8	27.4	47.0
Detroit, Mich. 1873–1905	24.3	25.0	32.9	45.5	57.9	67.8	72.0	69.9	63.1	51.7	38.6	29.5	48.2
Lansing, Mich. 1887–1903	23.0	22.0	32.0	46.0	57.0	67.0	71.0	68.0	61.0	50.0	37.0	28.0	47.0
Adrian, Mich. 1878–1903	24.0	23.0	33.0	47.0	58.0	68.0	72.0	69.0	63.0	54.0	37.0	27.0	47.9

Table 5 shows the means for the longest periods of all stations where data were available. It was impossible to get any records for comparisons from either Ypsilanti or Ann Arbor, except such as have been noted.

TABLE 6.—*Mean temperatures of warmest and coldest days for each year for Saline, Mich.*

Coldest days.			Warmest days.		
Year.	Date.	Mean temperature.	Year.	Date.	Mean temperature.
		°			°
1847–48	December 26.	9	1848	June 17	80
1848–49	January 11.	2	1849	July 10	80.6
1849–50	December 25.	7	1850	July 27	82
1850–51	January 30.	5	1851	July 16	78.6
1851–52	January 19.	5	1852	July 8	80.3
1852–53	January 26.	2	1853	June 22	82
1853–54	January 21.	1.3	1854	August 1	83.6

In Table 6 are given the temperatures of the warmest and coldest days of each of the years. I have also underscored the temperatures of the warmest and coldest days in the period of the seven years. These are not the extremes of the temperatures, but are the true daily means.

TABLE 7.—*Date of first frost and the mean date for the seven-year period at Saline, Mich.*

Year.	Date.	Conditions.
1847	September 14	Very heavy.
1848	September 13	
1849	September 8	Slight.
1851	September 28	
1852	September 16	
1853	August 28	
1854	September 16	
Average	September 13	

TABLE 8.—*Date for each year when frost was out of ground or the ground was free from frost from 1848 to 1854 at Saline, Mich.*

Year.	Date.	Conditions.
1848	March 24	
1849	March 14	Nearly.
1850	March 13	Except under fences.
1851	February 26	
1852	March 14	
1853	March 21	
1854	March 15	
Average	March 14	

TABLE 9.—*Comparison of early frost for four stations for years covered by Table 5.*

Station.	Average date of first killing frost in autumn.	Date of earliest frost recorded.
Lansing, Mich.	September 15	
Detroit, Mich.	October 9	September 17.
Adrian, Mich.	October 11	September 20.
Saline, Mich.	September 13	August 28.

In Tables 7 and 8 are shown the dates in the different years of the first frost and when the frost was out of the ground, and in Table 9 a comparison has been made of the average time of the first killing frost and the date of the earliest recorded frost for the four stations, Lansing, Detroit, Adrian, and Saline. The record as kept by Mr. Pope does not indicate generally the severity of the frost. This undoubtedly accounts for the average in the case of Saline. All the comment that he made concerning the nature of the frost is indicated under "conditions" in the tables.

TABLE 10.—*Various farm activities from 1847 to 1855 for Saline, Mich.*

Year.	Winter wheat.		Clover.	Maize.	Apple trees.
	Sown.	*Harvested.*	*Sown.*	*Planted.*	*Bloomed.*
1847	September 1				
1848	September 22	July 18	March 25	May 10	May 5.
1849	September 17	July 14	March 17	May 18	May 17.
1850	September 11	July 12	March 22	May 16	May 18.
1851	September 3	July 2	March 14	May 13	May 10.
1852	September 14	July 12		May 13	May 21.
1853	September 2	July 8		May 13	May 17.
1854		July 17		May 15	May 12.
1855				May 17	May 11.
Average	September 10	July 12		May 14	May 14.

Table 10 indicates the dates of various farm activities for the different years. There is a rather remarkable uniformity in the dates of planting corn and the blossoming of the apple trees. Also, as we would expect from an observing scientific farmer, if the wheat were sown early it was harvested early and not allowed to overripen.

In this connection it may be worth noting that Mr. Pope very carefully followed what he found to be the best scheme for wheat yield, namely, letting the ground remain idle for a year and fallowing it in the summer. In this as well as in crop rotation he was doubtless a pioneer.

I desire to acknowledge the assistance rendered me by Prof. A. J. Henry, by his advice and by the data furnished me; by Mr. C. F. Schneider, Section Director of Michigan State Weather Service, for reports which he sent me. I am also greatly indebted to Mrs. E. S. Ritchie and to other relatives of Mr. Pope, who have made possible this report.

EXCESSIVE PRECIPITATION AT LOUISVILLE, KY.

By F. J. WALZ, B. S., District Forecaster. Dated Louisville, Ky., May 14, 1908.

Many requests have been made for information bearing on the frequency of excessive precipitation at Louisville. In order to meet the demand for these data, the records have been carefully examined, beginning with 1871, and after careful verification, the entire record of excessive amounts during the past thirty-six years, from January, 1872, to May, 1908, has been tabulated, and appears in Table 1.

Precipitation is considered excessive, (1) when 2.5 inches fall in twenty-four hours, or (2) when the rate of precipitation for any short period is equal to, or exceeds, an inch per hour, provided that the total rainfall amounts to at least five-tenths of an inch. During the thirty-six years considered, there have been 80 instances of rainfall belonging to one or the other of these cases. (See Table 2.) They occurred for the most part during the summer months, as shown by count of cases by months, viz, January 3, February 3, March 3, April 5, May 11, June 12, July 13, August 11, September 3, October 4, November 7, and December 5.

The heaviest rainfall in one day was on July 4, 1896, when 5.50 inches were recorded between 4.52 and 8.30 p. m., and 2.70 inches between 5 and 6 p. m., of which 1.05 inches occurred in an interval of ten minutes. Streets were flooded to a depth of 2 to 4 feet, and the sewers could not carry off the water. Later in the same month, 20th–21st, there was a rainfall of 4.19 inches, being the total of several very heavy showers scattered thru the night and day. Again there was much damage thruout the city. Even heavier rains than this at Louisville fell on this latter date at several places in the interior of the State. At Shelbyville, 30 miles east of Louisville, 7.15 inches fell in twenty-four hours, doing an immense amount of damage.

The greatest precipitation in any one month was 16.46 inches, in July, 1875. Other large monthly amounts were 13.01 inches, July, 1896; 12.11, January, 1907; 11.43, January 1876; 10.53, August, 1888; and 10.02, August, 1879.

There is nothing to indicate any material change in the frequency of excessive rainfalls from one period to another. Thus, out of 80 cases, 24 occurred in the period 1872–1880, 14 in 1881–1890, 18 in 1891–1900, and 24 in 1900–1907. The slight apparent increase in the number in recent years is in some measure due to the introduction of recording gages; the float type of gage was introduced October 1, 1894, and the tipping-bucket type January 1, 1898.

A count of the cases in the individual years indicates a fair distribution, except that the last three years, 1905–1907, include 19 cases. This appears to be due to better methods of measurement during especially heavy periods of rainfall, and not to recurring cycles of excessive rainfall.

TABLE 1.—*Excessive rainfalls at Louisville, Ky., from January, 1872, to May 12, 1908.*

Month and year.	2.50 inches or more in 24 hours.		Excessive amounts for short periods.			Month and year.	2.50 inches or more in 24 hours.		Excessive amounts for short periods.		
	Amount.	Date.	Amount.	Time.	Date.		Amount.	Date.	Amount.	Time.	Date.
				Hr.m.						*Hr.m.*	
Jan., 1876...	3.48	18	.....	.....	.....	July, 1877..	2.64	18	.....	.....	.....
Jan., 1898...	2.55	22	.....	.....	.....	July, 1892..	.....	.....	2.00	1:50	3
Jan., 1907...	3.23	2	.....	.....	.....	July, 1894..	.....	.....	1.00	1:00	19
Feb., 1880...	2.51	13	.....	.....	.....	July, 1896..	5.50	4	2.70	1:00	4
Feb., 1882...	2.97	20	.....	.....	.....	July, 1896..	4.19	20–21	1.29	1:00	21
Feb., 1883...	2.68	6–7	.....	.....	.....	July, 1897..	.....	.....	1.39	1:00	10
Feb., 1908...	2.70	4–5	.....	.....	.....	July, 1901..	.....	.....	1.13	0:30	3
Mar., 1890...	2.51	10–11	.....	.....	.....	July, 1906..	.....	.....	0.59	0:30	27–28
Mar., 1897...	.....	.....	0.50	0:15	23	July, 1907..	.....	.....	0.63	0:20	9
Mar., 1898...	.....	.....	1.19	1:00	16–17	July, 1907..	.....	.....	0.79	0:30	15
Mar., 1908...	.....	.....	0.62	0:25	31	July, 1907..	.....	.....	0.55	0:15	18
Apr., 1872...	3.56	8	.....	.....	.....	Aug., 1878..	.....	.....	0.63	0:15	19
Apr., 1880...	4.06	15–16	.....	.....	.....	Aug., 1879..	2.97	15–16	.....	.....	.....
Apr., 1883...	3.64	5–6	.....	.....	.....	Aug., 1879..	3.78	24–25	.....	.....	...
Apr., 1887...	3.28	22–23	.....	.....	.....	Aug., 1882..	3.27	24	.....	.....	.....
Apr., 1892...	2.50	20–21	.....	.....	.....	Aug., 1884..	2.87	28–29	.....	.....	.....
May, 1872...	.....	.....	0.99	0:40	25	Aug., 1888..	2.87	20–21	0.54	0:30	1
May, 1873...	.....	.....	1.34	0:50	1	Aug., 1891..	2.82	2	2.50	2:00	2
May, 1878...	.....	.....	1.30	1:05	27	Aug., 1898..	3.68	8–9	2.66	1:23	8
May, 1880...	3.89	29–30	.....	.....	.....	Aug., 1905..	.....	.....	0.60	0:15	7
May, 1889...	2.99	29–30	.....	.....	.....	Aug., 1905..	.....	.....	1.00	0:46	23
May, 1902...	3.53	22–23	1.08	1:00	23	Aug., 1907..	.....	.....	0.54	0:20	20
May, 1903...	2.97	31–1	1.05	0:15	31	Sept., 1879..	2.99	2–3	.....	.....	.....
May, 1905...	2.64	13–14	.....	.....	.....	Sept., 1896..	2.74	27–28	.....	.....	.....
May, 1906...	.....	.....	0.83	0:18	31	Sept., 1905..	.....	.....	0.65	0:20	1
May, 1906...	.....	.....	0.66	0:25	4	Oct., 1876..	4.12	29	.....	.....	.....
May, 1906...	.....	.....	0.85	0:20	31	Oct., 1880..	3.23	15	.....	.....	.....
May, 1908...	.....	.....	0.67	0:20	6	Oct., 1883.	3.34	28–29	.....	.....	.....
June, 1872...	3.02	3	.....	.....	.....	Oct., 1893..	2.63	2–3	.....	.....	.....
June, 1878...	2.92	17	0.95	0:37	27	Nov., 1878..	2.81	26–27	.....	.....	.....
June, 1881...	.....	.....	0.78	0:27	16	Nov., 1883..	2.91	21–22	.....	.....	.....
June, 1890...	.....	.....	1.22	1:00	15	Nov., 1900.	3.16	20–21	.....	.....	.....
June, 1890...	.....	.....	0.84	0:30	19	Nov., 1900..	2.50	24–25	.....	.....	.....
June, 1895...	2.66	19–20	0.51	0:05	4	Nov., 1905..	2.81	28–29	1.00	0:46	28
June, 1896...	2.87	22–23	1.00	0:10	23	Nov., 1906..	2.85	17–18	.....	.....	.....
June, 1896...	.....	.....	1.37	0:46	23	Nov., 1906..	3.15	19–20	.....	.....	.....
June, 1901...	.....	.....	1.25	1:00	20	Dec., 1873..	3.87	3	.....	.....	.....
June, 1902...	.....	.....	1.12	0:53	15	Dec., 1875..	2.99	23–24	.....	.....	.....
June, 1905...	.....	.....	0.48	0:15	7	Dec., 1879..	3.07	23–24	.....	.....	.....
June, 1905...	.....	.....	1.00	1:00	19	Dec., 1880..	2.83	4	.....	.....	.....
July, 1875...	2.97	11–12	.....	.....	.....	Dec., 1905..	2.86	1–2	.....	.....	.....
July, 1875...	3.68	29	.....	.....	.....						

TABLE 2.

NUMBER OF EXCESSIVE PERIODS OF RAINFALL.

1872.....3	1881.....1	1890.....3	1899.....0
1873.....3	1882.....2	1891.....1	1900.....2
1874.....0	1883.....4	1892.....2	1901.....2
1875.....3	1884.....1	1893.....1	1902.....2
1876.....2	1885.....0	1894.....1	1903.....1
1877.....1	1886.....0	1895.....1	1904.....0
1878.....3	1887.....1	1896.....5	1905.....8
1879.....4	1888..... .1	1897.....2	1906.....6
1880..... .5	1889.....1	1898.....3	1907.....5

RECAPITULATION BY MONTHS.

January..... 3	May.....11	September..... 3
February..... 3	June 12	October..... 4
March..... 3	July.....13	November..... 7
April..... 5	August.....11	December..... 5

RECAPITULATION BY PERIODS.

1872–1880, inclusive 24	1891–1900, inclusive.....18
1881–1890, inclusive 14	1901–1907, inclusive.....24

A NEW FORMULA FOR COMPUTING THE SOLAR CONSTANT FROM PYRHELIOMETRIC OBSERVATIONS.

By H. H. KIMBALL.

[Read before the U. S. Weather Bureau Committee, April 29, 1908.]

An attempt has been made to develop an empirical formula by means of which the solar constant may be computed from pyrheliometric observations with an accuracy comparable with the accuracy of the observations themselves.

As suggested by Ångström,[1] if we express the coefficient of general atmospheric transmission for any wave length by the equation

$$y_\lambda = \varphi(\lambda) \quad \ldots\ldots\ldots\ldots \quad (1)$$

and the corresponding intensity of solar radiation by

$$I_\lambda = \Psi(\lambda) \quad \ldots\ldots\ldots\ldots \quad (2)$$

then the radiation received at the surface of the earth after the solar rays have past thru an atmospheric diffusing layer of thickness m will be exprest by

$$Q_m = \int_{\lambda_1}^{\lambda_2} \Psi(\lambda)\,[\varphi(\lambda)]^m\, d\lambda \quad \ldots\ldots\ldots\ldots \quad (3)$$

Since the function $\Psi(\lambda)$ is not exprest by any known law, the problem may be simplified by assuming a dispersion, x, that will give a solar spectrum of constant intensity. Such a dispersion has been computed from Abbot's values of the intensity of the normal solar spectrum outside the atmosphere.[2]

Equation (3) now takes the form—

$$Q_m = \int_{x_1}^{x_2} [\varphi(x)]^m\, dx \quad \ldots\ldots\ldots\ldots \quad (4)$$

TABLE 1.—*Vertical transmission of atmosphere.*

λ	x	Above Washington.		Above Mount Wilson.	
		Observed.	Computed.	Observed.	Computed.
0.387	0.0133	0.430	0.433	0.6844	0.6599
0.390	0.0171	0.445	0.454	0.6897	0.6754
0.3942	0.0245	0.499	0.482	0.7090	0.6981
0.3987	0.0334	0.535	0.510	0.7180	0.7183
0.4037	0.0435	0.553	0.533	0.7301	0.7360
0.4091	0.0541	0.564	0.555	0.7411	0.7509
0.4147	0.0641	0.575	0.572	0.7504	0.7627
0.4210	0.0751	0.587	0.588	0.7654	0.7739
0.4275	0.0866	0.594	0.603	0.7728	0.7841
0.4343	0.0987	0.611	0.617	0.7852	0.7936
0.4417	0.1122	0.631	0.631	0.7917	0.8030
0.4494	0.1267	0.639	0.645	6.8054	0.8120
0.4578	0.1427	0.647	0.659	0.8165	0.8210
0.4666	0.1595	0.666	0.672	0.8274	0.8294
0.4762	0.1777	0.674	0.685	0.8308	0.8377
0.4861	0.1962	0.689	0.697	0.8378	0.8454
0.4974	0.2144	0.702	0.708	0.8469	0.8523
0.5094	0.2352	0.710	0.720	0.8591	0.8596
0.5226	0.2576	0.717	0.732	0.8645	0.8668
0.5370	0.2818	0.725	0.743	0.8683	0.8740
0.5525	0.3073	0.740	0.755	0.8751	0.8810
0.5697	0.3346	0.745	0.766	0.8742	0.8879
0.5889	0.3641	0.751	0.778	0.8785	0.8948
0.6098	0.3948	0.768	0.789	0.8890	0.9015
0.6333	0.4280	0.791	0.800	0.9068	0.9082
0.6610	0.4636	0.815	0.812	0.9235	0.9149
0.6925	0.5013	0.835	0.823	0.9340	0.9216
0.7280	0.5408	0.850	0.834	0.9449	0.9280
0.7690	0.5819	0.860	0.845	0.9522	0.9343
0.818	0.6250	0.871	0.856	0.9588	0.9404
0.877	0.6707	0.883	0.867	0.9631	0.9466
0.946	0.7148	0.892	0.876	0.9675	0.9521
1.034	0.7610	0.906	0.886	0.9687	0.9576
1.127	0.8010	0.912	0.894	0.9706	0.9621
1.239	0.8407	0.915	0.902	0.9711	0.9664
1.367	0.8762	0.917	0.909	0.9746	0.9702
1.508	0.9082	0.923	0.914	0.9775	0.9733
1.648	0.9337	0.933	0.919	0.9756	0.9758
1.786	0.9545	0.926	0.922	0.9724	0.9778
1.924	0.9709	0.916	0.925	0.9800	0.9793
2.060	0.9817	0.904	0.927	0.9600	0.9803
2.196	0.9880	0.909	0.928	0.9740	0.9809
2.316	0.9919	0.894	0.929	0.9649	0.9812
2.428	0.9947	0.875	0.929	0.9251	0.9815

[1] Méthode nouvelle pour l'étude de la radiation solaire par Knut Ångström. Nova Acta Regiæ Societatis Scientiarum Upsaliensis. Ser. 4. Vol. 1, N. 7.

[2] Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. II, p. 105.