TABLE 4.—*Errors in temperatures recalculated with new constants for the formula* $t = C(b^z - 1)$, *Geneva (1836–1860).*

Month.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 mid't	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	C.	−log b.
December	−0.02	−0.01	−0.01	−0.06	−0.07	−0.07	−0.03	0	−0.01	−0.05	−0.10	−0.10	−0.14	0.02	0.00	0.59	0.076
January	0.00	0.05	0.06	0.04	0.00	−0.03	−0.02	0	−0.02	−0.07	−0.10	−0.08	−0.02	0.03	0.00	1.22	0.054
February	.....	−0.02	0.03	0.08	0.13	0.13	0.11	0	−0.11	−0.17	−0.15	−0.05	0.01	0.01	.....	2.30	0.048
March	.....	−0.02	0.01	0.03	0.03	0.00	−0.02	0	0.09	0.25	0.36	0.32	0.00	−0.65	.....	6.89	0.029
April	.....	.....	−0.10	0.01	0.05	0.00	−0.04	0	0.14	0.29	0.30	−0.01	−0.76	.....	.....	25.1	0.0095
May	.....	.....	.....	−0.11	0.02	0.03	0.00	0	0.07	0.11	−0.02	−0.50	.....	.....	.....	55.4	0.0044
June	.....	.....	.....	0.14	0.00	−0.09	−0.10	0	0.15	0.21	0.00	−0.60	.....	.....	.....	5.16	0.057
July	.....	.....	0.08	0.00	−0.04	−0.09	−0.10	0	0.21	0.42	0.42	0.00	−0.97	.....	.....	6.01	0.495
August	.....	.....	−0.34	0.00	0.14	0.09	0.00	0	0.18	0.41	0.45	0.00	−1.07	.....	.....	250.0	0.00144
September	.....	.....	−0.39	−0.01	0.17	0.16	0.05	0	0.07	0.23	0.28	0.01	−0.77	.....	.....	−29.6	−.0082
October	.....	−0.67	−0.28	0.00	0.12	0.11	0.05	0	0.02	0.07	0.11	0.01	−0.32	−0.95	....	−16.6	−.0084
November	−0.08	0.04	−0.01	−0.06	−0.08	−0.08	−0.04	0	0.02	0.02	0.01	0.02	0.00	−0.06	−0.28	1.12	0.065
Arithmetic mean	.....	.....	.....	0.03	0.07	0.07	0.05	0	0.09	0.19	0.19	0.06	.....	.....	.....	.....	0.035
Algebraic mean	.....	.....	.....	0.00	0.04	0.01	−0.01	0	−0.07	0.14	0.13	0.015	.....	.....	.....	.....	.....

TABLE 5—*Errors in temperatures calculated by the formula* $t = -a_1 z + a_2 z^2$, *Geneva (1836–1860).*

Month.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 mid't	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	a_1.	a_2.
December	−0.07	0.01	0.04	0.01	−0.01	−0.02	0.00	0	−0.04	−0.09	−0.15	−0.14	−0.08	0.01	0.03	0.125	0.010
January	−0.10	0.01	0.06	0.06	0.03	0.00	−0.01	0	−0.03	−0.09	−0.13	−0.12	−0.06	0.01	0.00	0.157	0.009
February	.....	−0.07	0.02	0.10	0.16	0.16	0.09	0	−0.12	−0.20	−0.19	−0.08	0.00	0.02	.....	0.268	0.014
March	.....	−0.04	0.00	0.05	0.05	0.02	−0.01	0	0.09	0.23	0.34	0.30	0.00	−0.64	.....	0.470	0.0156
April	.....	.....	−0.28	0.00	0.04	0.00	−0.04	0	0.14	0.29	0.31	00.0	−0.73	.....	.....	0.546	0.006
May	.....	.....	.....	−0.13	0.00	0.02	−0.01	0	0.10	0.12	0.00	−0.47	.....	.....	.....	0.555	0.003
June	.....	.....	.....	0.08	0.00	−0.07	−0.08	0	0.13	0.19	0.00	−0.56	.....	.....	.....	0.695	0.045
July	.....	.....	0.01	0.01	0.00	−0.05	−0.08	0	0.19	0.39	0.39	0.00	−0.91	.....	.....	0.721	0.043
August	.....	.....	−0.34	0.00	0.14	0.09	0.00	0	0.18	0.41	0.45	0.00	−1.07	.....	.....	0.684	0.001
September	.....	.....	−0.38	0.00	0.18	0.16	0.06	0	0.07	0.23	0.28	0.01	−0.77	.....	.....	0.561	−0.005
October	.....	−0.45	−0.27	0.00	0.12	0.11	0.05	0	0.01	0.06	0.10	0.00	−0.33	−0.74	.....	0.323	−0.003
November	−0.06	−0.01	0.00	−0.04	−0.05	−0.05	−0.02	0	0.01	−0.01	−0.01	−0.01	00.0	−0.04	−0.20	0.184	0.013
Arithmetic mean	.....	.....	.....	0.03	0.065	0.06	0.04	0	0.09	0.19	0.20	0.055	.....	.....	.....	.....	.....
Algebraic mean	.....	.....	.....	0.02	0.055	0.03	−0.00	0	0.06	0.13	0.12	−0.00	.....	.....	.....	.....	.....

TABLE 6.—*Geneva (1836–1860).*

Mean values taken from previous tables.

Table.	8 p. m.	9 p. m.	10 p. m	11 p. m.	12 mid.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	−log b.
Table 2	1.95	1.38	0.90	0.46	0	−0.49	−0.96	−1.33	−1.48	.....
Table 3	0.07	0.05	0.00	−0.03	0	0.11	0.26	0.30	0.19	0.061
Table 4	0.00	0.04	0.01	−0.01	0	−0.07	0.14	0.13	0.015	0.035
Table 5	0.02	0.055	0.03	−0.00	0	0.06	0.13	0.12	−0.00	.....
The means of the errors, irrespective of sign.										
Table 3	0.30	0.24	0.16	0.08	0	0.13	0.30	0.36	0.27	0.061
Table 4	0.03	0.07	0.07	0.05	0	0.09	0.19	0.19	0.06	0.035
Table 5	0.03	0.065	0.06	0.04	0	0.09	0.19	0.20	0.055	.....

log *b* from −0.065 to −0.035, a variation of 60 per cent of the mean value.

The final conclusion which I wish to draw is that, on theoretical grounds, the exponential is an inconvenient means of expressing the rate of nocturnal cooling. It would seem to be a wiser plan to take the nocturnal temperatures along with the diurnal temperatures, and study both together in the usual manner, by calculating the first few terms in the Fourier series which can be found to represent them.

The details of these calculations may be found in Tables 2–6. The latter sums up the results of the previous tables.

EARLY METEOROLOGICAL DATA FOR SALINE, MICH.[1]

By J. E. BUCHANAN. Dated Cambridge, Mass., May 12, 1908.

There is a certain interest in considering for the first time any old weather records from any portion of the United States, providing they be reliable. This interest is greatly increast if the records come from a locality for which no earlier observations exist.

Last December Prof. Cleveland Abbe received a letter from Mr. George R. Marvin, of Boston, Mass., concerning some old weather records for Saline, Mich., and referred this letter to Prof. R. DeC. Ward, of the Department of Geology and Geography of Harvard University. These observations are the subject of this paper.

The records to which Mr. Marvin referred were kept in the form of a diary by his great-grandfather, Mr. Thomas Pope. In order to understand why Mr. Pope kept such a careful diary, some salient points of his life need to be noted. He was born at New Bedford, Mass., and spent his early life in the New England States. He was graduated from Harvard in 1833, and no doubt acquired a scientific turn of mind while in college. In 1838 he moved to Saline, Mich., near which place he bought a farm, and began farming in a very scientific way for those days. Indications of his scientific methods in farming are seen from his diary, in which he recorded not only weather conditions but all details of farm life. The record of the early years is lost, but we have that portion of the diary which covers the period from September, 1847, to September, 1854.

The record consists mainly of temperature data. Mr. Pope took the temperature three times daily, and there is no record missing in the seven years. He also recorded the first frost, the date when the frost was out of the ground in the spring, the time of planting and harvesting of different crops, and other farm data, only parts of which are tabulated in this article.

Such records are of little value unless taken under proper conditions. To ascertain these conditions, Mr. Pope's daughter, Mrs. E. S. Ritchie, of Cambridge, Mass.; his daughter-in-law, Mrs. W. E. Pope, of Saline, Mich., and his son, Dr. F. H. Pope, of Bothwell, Canada, were consulted personally, or by letter. They agreed as to the manner of taking the temperature, the location of the thermometer, and the other conditions necessary to prove the reliability of the records.

Mr. Pope made readings three times daily, at 6 a. m., 12 m., 6 p. m., local time, not deviating from this time either summer or winter. If Mr. Pope was absent at any time, some one was

[1] A partial report made in the course in advanced climatology given under the direction of Prof. R. DeC. Ward, of Harvard University, 1907–8.

especially instructed to take the temperature. During the whole period the same clock and thermometer were used. The instrument was an ordinary mercurial Fahrenheit thermometer, maker not known. Mr. Pope, as can be determined from the records, also considered it very important to take exact readings, as many of his farm activities were guided by them from year to year. From this we can see that keeping this diary was not a secondary matter with him.

The thermometer was hung against the side of a wooden building under a latticed porch, on the north side of the building, about 6 feet from the ground.

The record for each month consists of four columns, one for the days of the month, and one for each of the three periods in the day when the temperature was taken. One, two, or three months were kept on the same page. Mr. Pope found the mean monthly temperature by adding all the temperatures recorded for the month and dividing by three times the number of days in the month. From these monthly means he found the seasonal and annual means. In the arithmetical work of Mr. Pope no mistake was found.

In the original records no corrections were made for the temperature observations, and as observations made at 6 a. m., 12 m., and 6 p. m. give a mean which is somewhat too high, the matter of corrections was investigated. I found three sets of (negative) corrections which could be used, as follows:

Corrections.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Average.	Authority.
I	.4	.4	.4	1.2	1.2	1.3	1.0	.9	.8	.5	.4	.3	.7	"Mean temperatures and their corrections." A. G. McAdie.
II.....	.6	.6	.7	1.1	1.6	1.8	1.8	1.5	1.1	.8	.5	.4	1.5	Prof. A. J. Henry.
III.....	.5	.6	.7	.9	1.0	1.2	1.3	1.2	1.1	1.0	.6	.5	.9	Smithsonian Contributions to Knowledge, No. 277.

Corrections No. I were calculated from tables given in "Mean temperatures and their corrections," publisht in 1891 by Prof. Alexander G. McAdie, and were based upon twelve years' observations, from 1877 to 1888, at Detroit.

Corrections No. II were very kindly furnisht me by Prof. A. J. Henry, from Weather Bureau records, and were based on hourly readings of the thermograph for ten years at Detroit.

Corrections No. III were given in Mr. Schott's temperature tables in the "Smithsonian Contributions to Knowledge," No. 277, and were based on observations at Toronto, Mohawk, New Haven, and Philadelphia for a period of years, not specified. The corrections sent by Professor Henry were used in this paper, as they represent the average of all, and were based on more accurate data.

TABLE 1.—*Monthly and annual means for Saline, Mich.*
Latitude 42° 10′ N., longitude 83° 47′ W.; altitude 816 feet.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1847...	.....	.....	.....	.....	.....	.....	.....	.....	58.5	46.6	40.0	29.3	.....
1848...	**31.2**	30.7	33.9	**46 0**	**59.6**	**65.9**	**65.6**	**67.5**	54.4	48.4	45.8	29.4	**48.2**
1849...	24.8	23.4	37.5	42.3	54.2	66.8	67.6	66.5	59.8	47.9	45.8	26.2	46.9
1850...	30.8	29.8	32.6	42.8	**52.0**	67.8	72.7	68.7	58.5	48.2	43.1	25.8	47.7
1851...	29.2	**32 5**	**40.2**	**43.7**	56.7	**62.9**	67.7	66.2	62.5	48.3	35.6	**25.1**	47.5
1852...	22.2	21.1	31.7	39.9	56.5	64.8	70.8	66.8	58.7	53.6	34.3	29.7	**45.8**
1853...	26.7	25.1	33.8	44.1	**53.0**	**68.2**	67.5	68.1	61.1	**46.1**	40.0	26.6	46.7
1854...	**20.5**	**25.3**	**34.7**	**45.6**	**56.6**	**66.2**	**73.2**	**71.2**	**64.3**	.....	.....	.....	.....
Means	26.5	26.8	34.9	43.5	55.5	66.1	69.3	68.0	59.7	48.4	40.8	27.4	47.2

Extremes in bold-faced type.

Table 1 gives the monthly and annual mean temperatures based on the diary kept by Mr. Pope. The figures in bold-faced type represent the highest and lowest temperatures in each column for the given number of years.

TABLE 2.—*Monthly mean temperature for Ann Arbor, Mich.*
Latitude 42° 16′ N., longitude 83° 34′ W., altitude 850 feet.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°	°	°	°	°	°	°	°	°			
1854.....	21.4	25.9	35.6	47.0	58.7	68.5	75.1	73.9	66.0	.....	.....	.....

TABLE 3.—*Monthly and annual means for Detroit, Mich.*
Latitude 42° 20′ N., longitude 83° 3′ W., altitude 597 feet.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	°	°	°	°	°	°	°	°	°	°	°	°	°
1847...	.....	.....	.....	.....	.....	.....	.....	.....	59.4	33.9	36.8	24.2	.....
1848...	26.2	28.6	30.8	47.8	58.0	67.2	65.7	70.1	55.9	45.8	30.1	25.7	46.0
1849...	21.5	23.3	36.0	44.9	56.7	71.2	73.8	70.3	63.4	49.0	47.1	27.4	48.7
1850...	31.2	29.8	34.7	43.6	55.6	71.4	76.0	72.2	61.8	49.8	44.3	25.9	49.7
1851...	30.6	33.2	40.3	46.2	57.9	65.9	70.7	67.8	65.2	50.1	36.4	25.9	49.2
1852...	22.6	28.0	33.2	41.8	58.4	70.1	74.3	72.7	60.5	57.1	37.9	32.2	49.2
1853...	29.8	29.8	37.4	53.9	59.8	70.0	74.9	75.1	67.1	49.7	43.0	30.1	51.7
1854...	23.8	26.6	36.6	45.0	58.7	69.3	74.9	73.0	65.8	.....	.....	.....	.....
Means.	26.5	28.5	35.6	46.2	57.9	69.3	72.9	71.6	62.4	47.9	39.5	27.5	48.1

Tables 2 and 3 represent the only observations for these same months in that section of Michigan. Table 2 covers but nine months of this period, and the observations were taken 3½ miles east-southeast of Ann Arbor, which is 10 miles northeast of Saline. The observations were made at 7 a. m., 2 and 9 p. m. Comparing these observations with corresponding observations in Table 1, the remarkable similarity of the mean temperatures of these two places, Saline and Ann Arbor, is apparent.

Table 3 gives data for Detroit, for the entire period represented in Table 1 for Saline. There is not the same agreement in the mean temperatures of Detroit and Saline as is noticeable in the case of Ann Arbor and Saline. This is in part due to the differences in location. In Table 4 an attempt is made to show that the mean temperatures of Detroit compared with two stations (Lansing and Adrian) having more nearly the same conditions as Saline, range a degree or so higher. The records of these two stations were taken from Professor Henry's Climatology of the United States.

TABLE 4.—*Comparison of means for Detroit and Lansing, for the same period, also for Detroit and Adrian, Mich.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	°	°	°	°	°	°	°	°	°	°	°	°	°
Detroit, Mich. 1887–1903	24.2	24.2	33.1	46.9	58.0	67.8	72.5	70.9	63.4	51.5	39.0	29.2	48.5
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
Detroit, Mich. 1878–1903	24.4	25.9	33.9	48.0	58.2	67.2	72.3	69.8	63.7	53.0	39.4	29.3	48.5
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

The records for Detroit were taken from a table in the report for March, 1907, of the Michigan section of the climatological service of the Weather Bureau. The longest record for Lansing is from 1887 to 1903, inclusive, and the data for Detroit were reduced to the same period. In the case of Adrian the period extended from 1878 to 1903, and the means for Detroit were also reduced to the same period. A comparison of these means for Detroit, Lansing, and Adrian shows a higher temperature for Detroit.

There is another reason for the disagreement of the contemporary data for Detroit and Saline. The observations that were made at Detroit were taken at various hours, so that it is impossible to reduce such data to the true means, as in the case of Saline.

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.