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Roebling Fund

A LONG-RANGE FORECAST OF UNITED STATES PRECIPITATION

By
C. G. ABBOT
Research Associate, Smithsonian Institution

(Publication 4390)

CITY OF WASHINGTON
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FOREWORD

A hidden family of harmonic regular periods exists in weather. The periodic members of this family persist with unchanged lengths for scores of years. By determining their average forms and amplitudes for intervals of a thousand months, successful forecasts may be made for years to come; or backcasts may be made for former years and compared to former events. Agreement of such backcasts with the records warrants confidence in future forecasts.

These claims seem preposterous to most meteorologists. Therefore, before proceeding to explain the method and to give forecasts to 1967 for 32 cities of the United States, illustrative forecasts for the years 1950 to 1958 will now be shown and compared to the records of that interval graphically.

Figures 1, 2, and 3 show forecasts (dotted) and the observed march of precipitation, 1950-1958. These curves represent 3-month running means, and are expressed in percentages of normal precipitation. Figure 1 represents precipitation at Madison, Wis., and figure 2 at Nashville, Tenn. The curve at the top of figure 2 will be described later. Figure 3 shows forecast and observation for Sacramento, Calif.

I have computed for several cities coefficients of correlation between my forecasts and the observed precipitation for the years 1950 through 1958. They are as follows: Washington, D. C., 52.3 percent; Cincinnati, Ohio, 57.3 percent; Nashville, Tenn., 59.0 percent; Independence, Kans., 52.0 percent; Madison, Wis., 56.6 percent; Sacramento, Calif., 69.0 percent.

These coefficients indicate that my forecasts are over halfway toward perfect long-range prediction of weather. There still remain undisclosed variables that produce the discrepancy of about 40 percent between my coefficients and perfect correlation.

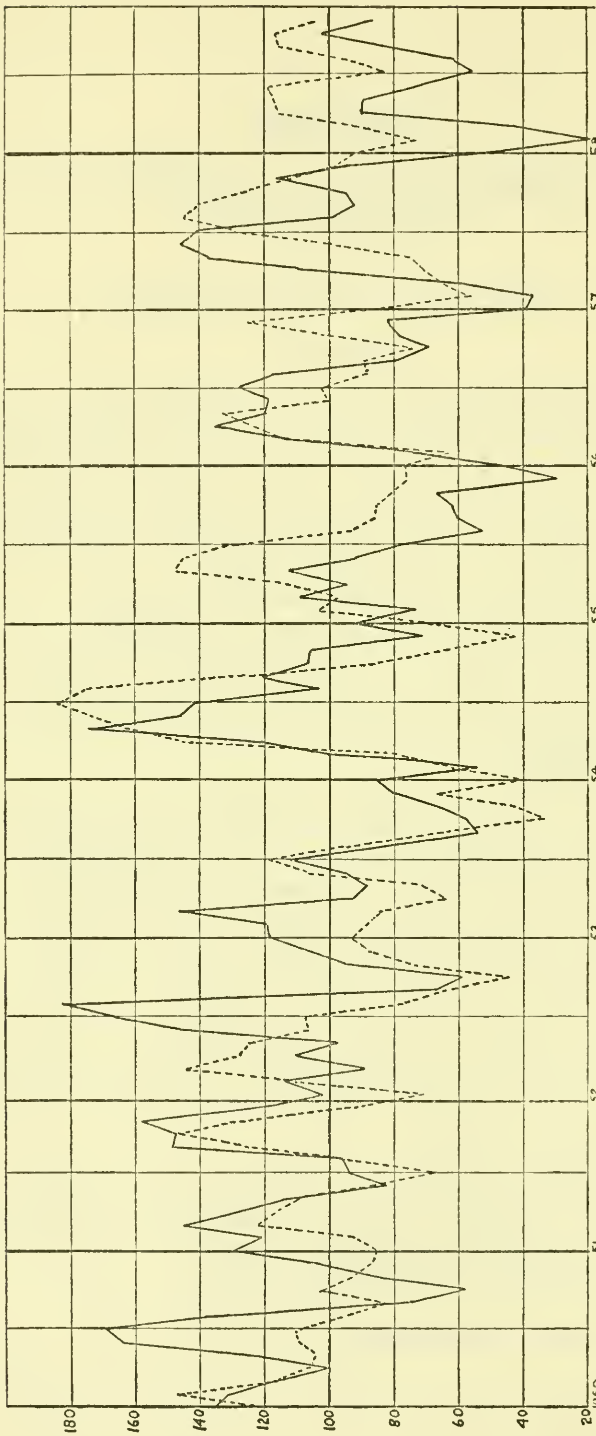


Fig. 1.—Madison, Wis. Forecast and event of monthly departures from normal precipitation, 1950-1958. Normal, heavy horizontal line; forecast, dotted line; event, full curve. All from 3-month running means.

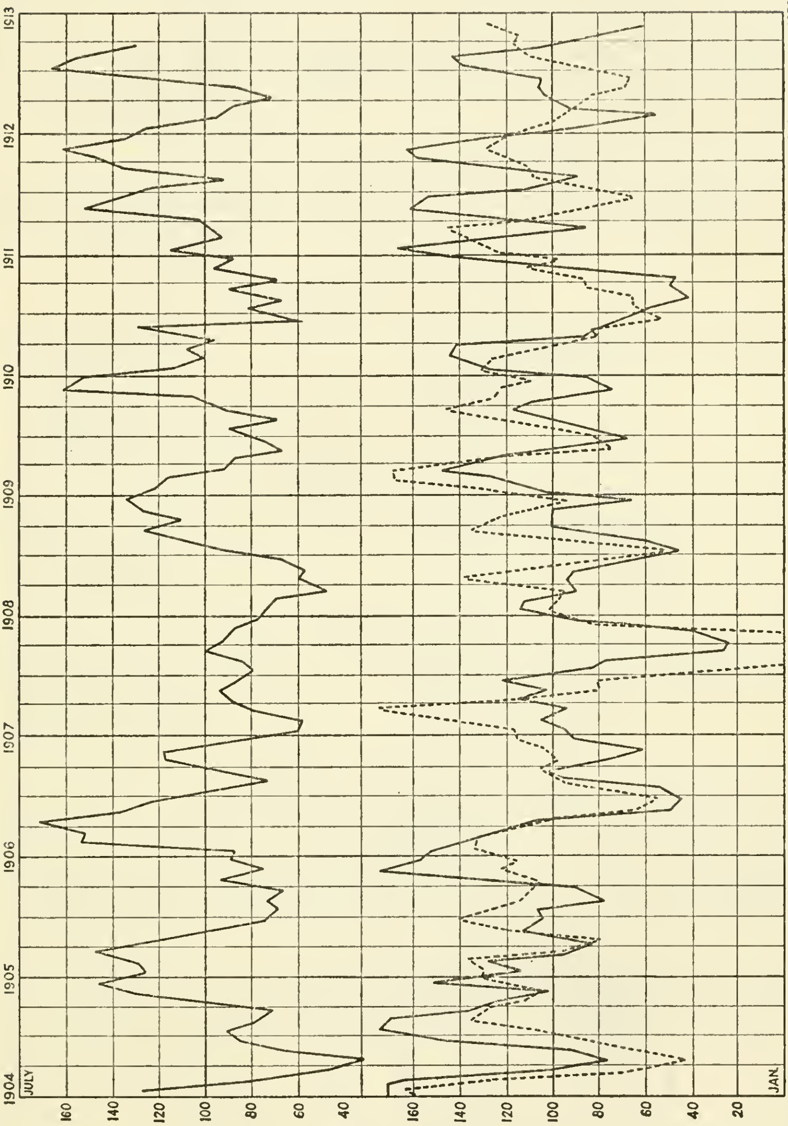


FIG. 2.—Nashville, Tenn. Forecast and event of monthly departures from normal precipitation, 1950-1958. Normal, heavy horizontal line; forecast, dotted line; event, full curve. All from 3-month running means.

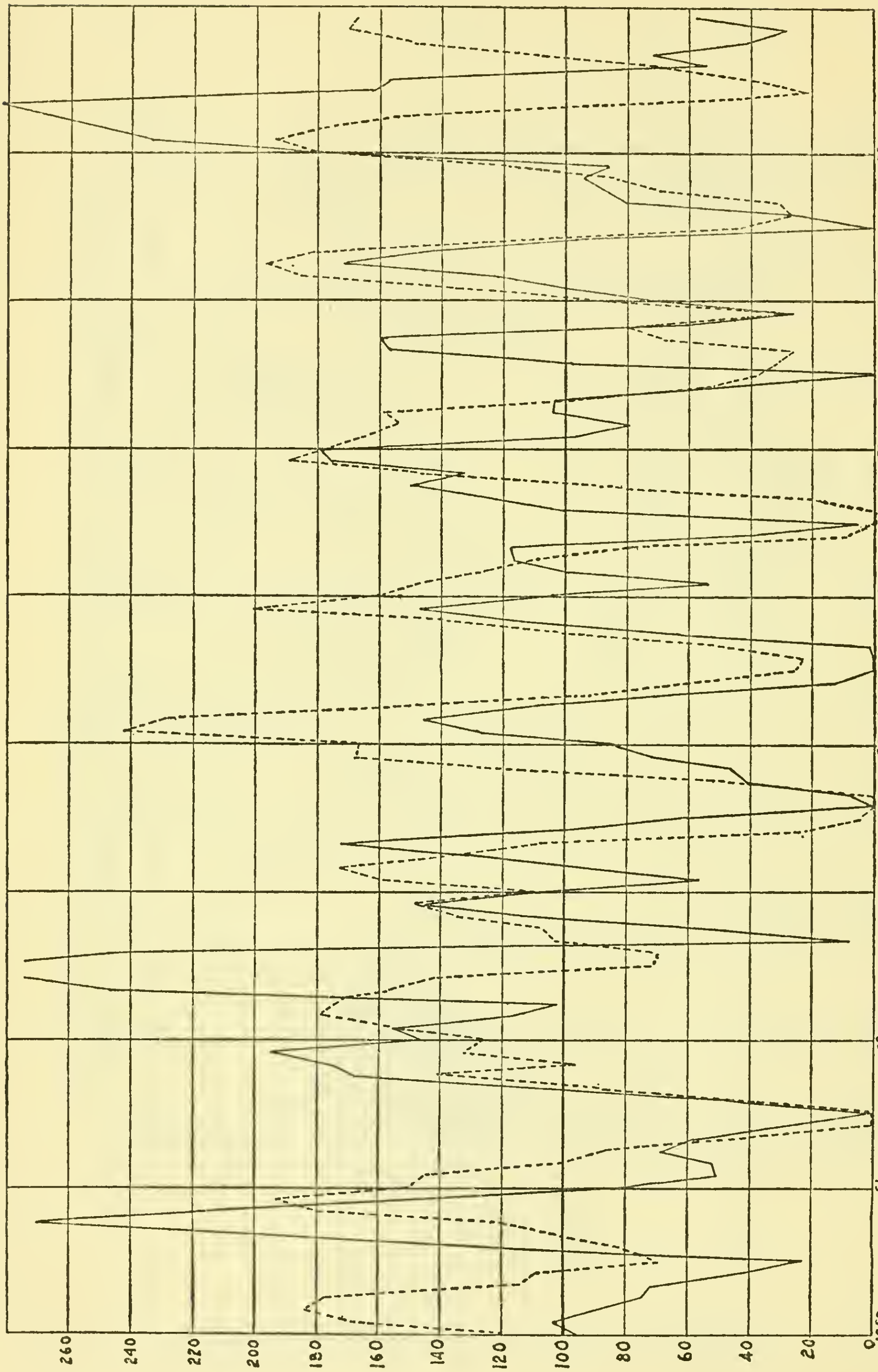


FIG. 3.—Sacramento, Calif. Forecast and event of monthly departures from normal precipitation, 1950-1958. Normal, heavy horizontal line;

FORECASTS OF PRECIPITATION FOR 32 CITIES, 1950-1967

This project was sponsored by the Association for Applied Solar Energy of Phoenix, Ariz., and the Smithsonian Institution of Washington, D. C. Funds for the costs of electronic computations were supplied to the Association by the Valley National Bank and the Arizona Public Service Company. About 7,000 tables of precipitation were electronically computed by Jonathan Wexler, a student at the Arizona State College at Tempe. He ingeniously programmed the machine for this special purpose. Monthly records of precipitation at 32 stations from about the year 1870 were taken from publications generously furnished by the United States Weather Bureau.

Table 1.—*List of stations*

1. Abilene, Tex.	17. Nashville, Tenn.
2. Albany, N. Y.	18. Natural Bridge, Ariz.
3. Albany, Oreg.	19. Omaha, Nebr.
4. Augusta, Ga.	20. Peoria, Ill.
5. Bismarck, N. Dak.	21. Port Gibson, Miss.
6. Charleston, S. C.	22. Rochester, N. Y.
7. Cincinnati, Ohio	23. Sacramento, Calif.
8. Denver, Colo.	24. Salisbury, N. C.
9. Detroit, Mich.	25. Salt Lake City, Utah
10. Eastport, Me.	26. San Bernardino, Calif.
11. El Paso, Tex.	27. Santa Fe, N. Mex.
12. Helena, Mont.	28. Spokane, Wash.
13. Independence, Kans.	29. St. Louis, Mo.
14. Little Rock, Ark.	30. St. Paul, Minn.
15. Madison, Wis.	31. Thomasville, Ga.
16. Montgomery, Ala.	32. Washington, D. C.

Secretary Leonard Carmichael of the Smithsonian Institution assigned Mrs. Lena Hill and Mrs. Isobel Windom to assist me in preparing forecasts. He approved grants from funds given for the study of solar radiation and weather by the late John A. Roebling. I am greatly indebted to Miss M. A. Neill for careful preparation of my manuscript.

I selected 32 cities distributed with approximate uniformity over the United States. The cities chosen are listed in table 1.

THE METHOD

As I suppose no one hitherto has ventured to predict values of precipitation, at definite places, for as much as 8 years in advance, I now indicate briefly how it is done. I quote apposite passages from my former papers,[1] with slight changes dictated by later experience.

Periods in sun and weather.—The sun's radiation which we see and feel, like that of many other stars, is variable. Solar output of radiation seldom exceeds 2 percent in its variation. However, its variation comprises as many as 60 regular periodic pulses, ranging from 1 month or less to 273 months or more. All are exact submultiples (or aliquot parts) of 273 months, as 91, 39, 7 months, and many more. They range in amplitude from 1/50 to 1/4 percent. All go on simultaneously, like overtones of a musical note.

As many as 30 of these exact periods have been found in monthly weather records which have been kept from 1870 and earlier. They occur in records both of precipitation and temperature. Far from being confined to fractions of 1 percent, as in solar radiation, in precipitation they individually range from 5 to 35 percent of the normal average. In temperature they range from 1° to 3° F., and these limits refer to 3-month smoothed records. Owing to the large number of these weather periods, some in plus, some in minus phases at any one time, their combined influence is not usually startlingly great.

Normals.—Long records of weather ordinarily state "normal" monthly values found by taking the monthly averages of all the years tabulated. I have found considerable differences in normals if computed separately for years of high and low sunspot frequencies, respectively. I therefore compute separate monthly normals for years above and below an average of 20 Wolf numbers in sunspot frequency. From these normals I tabulate the departures in temperature, and the percentages of normal precipitation.

The monthly values have too wide jumps to be most useful. I smooth the record by 3-month consecutive means. Thus for February I use (January + February + March) $\times$ 1/3, and similarly for other months.

Lags.—Supposing, contrary to meteorologists' opinion, that the variation of the sun is the real cause of the variation of the weather, since it has identically the same periods, I point out that well-known variations of insolation suffer variable lags in their weather influence, depending on place and time.

Lags of solar effects, as they differ with locality, indicate that the state of the atmosphere is an important factor. The atmospheric

[1] a, Journal of Solar Energy, Sci. and Eng., vol. 1, No. 1, January 1957; b, ibid., vol. 2, No. 1, January 1958; c, Smithsonian Misc. Coll., vol. 122, No. 4, August 1953; d, ibid., vol. 128, No. 3, April 1955; e, ibid., vol. 128, No. 4, June 1955; f, ibid., vol. 134, No. 1, September 1956; g, ibid., vol. 138, No. 3, February 1959.

condition varies not only with locality but with time of the year, prevalence of sunspots, and march of population. To partially meet these difficulties, I tabulate separately for three periods of the year: January-April; May-August; September-December; also with Wolf sunspot numbers above and below 20; also with lapse of time before and after the midpoint of the record. These divisions of the available monthly data lead to computing 220 tables at each station before undertaking a forecast.

Forecasts by periods.—My forecasts are made by adding the effects of 27 regular periodic cycles in precipitation. These cycles, like the harmonics of musical sounds, proceed simultaneously, and are integrally related to a fundamental cycle. This fundamental is 273 months. The harmonics employed are as follows:

TABLE 2.—*Periods used for forecasting*

Fraction	Months	Fraction	Months	Fraction	Months
1/3	91	1/12	22-3/4	1/27	10-1/9
1/4	68-1/4	1/14	19-1/2	1/28	9-3/4
1/5	54-3/5	1/15	18-1/5	1/30	9-1/10
1/6	45-1/2	1/18	15-1/6	1/33	8-3/11
1/7	39	1/20	13-13/20	1/36	7-7/12
1/8	34-1/8	1/21	13	1/39	7
1/9	30-1/3	1/22	12-9/22	1/45	6-1/15
1/10	27-3/10	1/24	11-3/8	1/54	5-1/18
1/11	24-9/11	1/26	10-1/2	1/63	4-1/3

The harmonic family referred to was discovered in the variation of the measures of the solar constant of radiation. Figure 4 shows 26 of over 60 periods discovered in solar variation.[2] Identical cycles were later found in precipitation and temperature by study of long-continued weather records. While the *periods* of the harmonics are invariable, both in the sun and weather, and their *phases* are invariable in solar radiation, their phases shift in weather, depending on atmospheric influences, as will be described below. On account of these phase changes, depending on several variables discovered in my studies of precipitation begun with Peoria, Ill., about 10 years ago, the harmonic family in weather is obscured and hidden, and is as yet unrecognized by most meteorologists. Nevertheless it is verified by an enormous mass of evidence, as will appear below.

No observations required.—Many meteorologists and others suppose that my method of long-range weather forecasting depends on solar observations, but this is not so. The harmonic family referred

[2] See in reference, footnote 1, e, above, figure 3 and table 3.

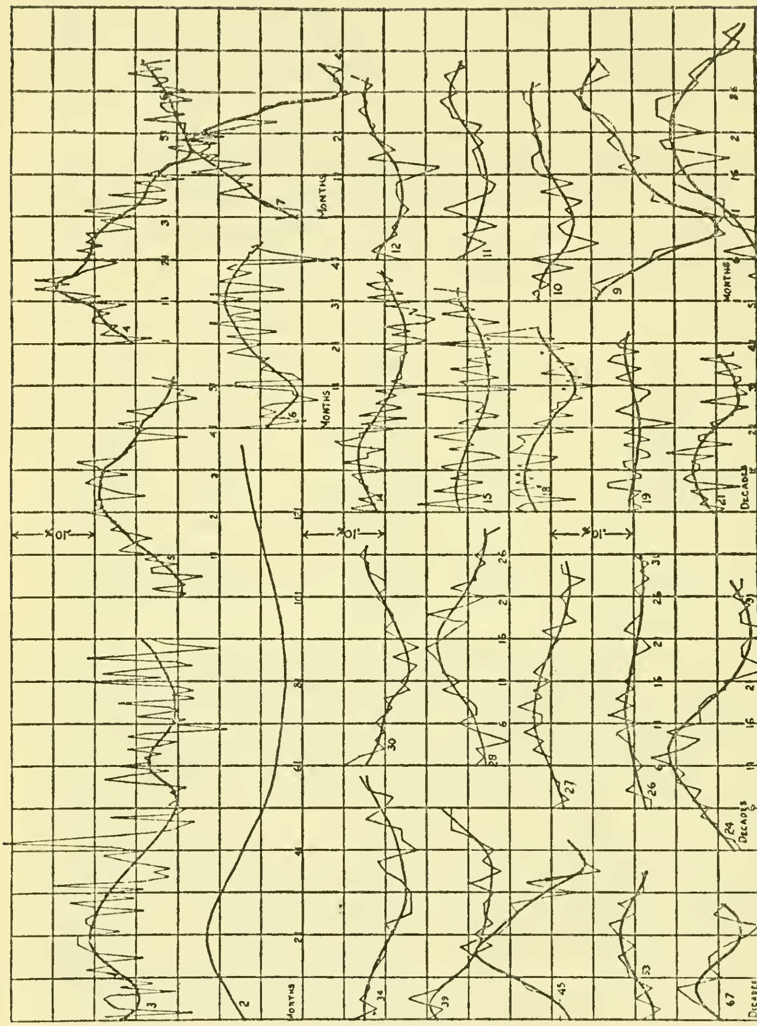


FIG. 4.—Twenty-six periods in solar variation, ranging from 273/67 to 273/2 months in length, all cleared of subordinate interfering integrally related periods. All from Smithsonian solar-constant observations of 1920-1952.

to was indeed discovered by the study of over 30 years of daily "solar-constant" observations of the Smithsonian Astrophysical Observatory. But now that the harmonic family has been found in weather, no observations of any kind are required. It is only necessary to employ a long record of monthly mean values of precipitation, or temperature, to make long-range predictions. These are approximately verified if no *unusual* alterations of atmospheric conditions make the averages from long records inapplicable.

Sports.—As my forecasts depend on the assumption that the *average* conditions of the periods over a thousand months will be projected into the future, it is important not to include wild "sport" values of precipitation in the thousand-month basis. Hence I have diminished sporadic very high values to about two times normal, and have raised sporadic drought values of less than 40 percent of normal to exceed that limiting low value. These limits refer to 3-month smoothed records. For most of my 32 stations these changes are very rare. But in two or three of the desert stations possibly one value in ten was changed to avoid spoiling the representative character of the basis. The considerable measure of success of my forecasts is the main defense of the method used to produce them. If the degree of success is found to be valuable, no doubt those who in future will use the method will greatly improve it by modifications dictated by reason and experience.

Backcasts.—Since my forecasts are made by adding the average effects of 27 harmonic periods over an interval of about 1,000 months, the 12 months of record for any one year can produce only about 1 percent of influence on the forecast for that year, even if those 12 months are among the thousand months employed as a basis. Therefore all forecasts or backcasts are equally sound, whether they relate to time before, within, or after the thousand months of record.[3]

The preceding paragraph is important. The forecasts for 32 cities all extend from 1950 to 1967. The degree of similarity between the forecasts and what happened up to 1958 is the index of their probable agreement from 1959 to 1967.

The 273-month period.—Daily solar-constant observations proceeded from 1920 to 1952 at Montezuma, Chile. This interval is not long enough to determine the master period accurately. But the 10-1/9-month period in *weather* is a strong one and has long been followed in Washington precipitation. I determined its amplitude for several periods differing slightly from 10-1/9 months. For this pur-

[3] See discussion of backcasts at a later page.

pose I used about 790 monthly mean values of Washington precipitation, all observed when Wolf sunspot numbers exceeded 20. These values were smoothed by 3-month consecutive means, which of course reduces the ranges of percentage departures from normal to about two-thirds of their actual monthly values. Table 3 and figure 5 show the results.

Figure 5 clearly shows that a value of the master period between 273 and 275 months is definitely indicated.

I have preferred 273 months rather than 275 months because it is an integral multiple of the strong periods 7, 13, 39, and 91 months. It cannot be much more than 1/3 percent from the true master period.

TABLE 3.—*Percentage amplitudes of proposed periods*

Period *Months*											Ranges *Percent*
$\frac{271.2}{27}$	105.7	103.4	102.5	100.7	100.9	96.3	97.3	97.9	98.0	97.7	9.4
$\frac{273.0}{27}$	95.7	95.8	93.4	96.1	99.3	102.0	103.7	108.0	104.8	101.1	14.6
$\frac{275.0}{27}$	109.8	102.4	103.3	99.3	95.4	92.9	96.2	97.6	98.8	104.5	16.9
$\frac{277.0}{27}$	94.6	104.4	106.2	101.3	105.8	105.5	94.6	97.5	96.9	93.3	12.9

The subordinate periods.—Of the 27 periods used in forecasting, 12 exceed 15-1/6 months in length. Owing to arrangements used to treat changes of phase, which will be described, 42 tabulations for each city are made of these 12 periodicities. Almost without exception the curves representing these 42 tables betray overriding harmonics of the period in question, from two to eight in number. These overriders must be evaluated and eliminated before the period in question stands free.

I show in table 4 and figure 6 the treatment of one only of the four tables representing the 39-month period in precipitation at Helena, Mont. Eight tabulations of successive runs of this period over the interval of years 1891 to 1917 give the mean values and average deviations from the mean in percentages of normal precipitation. Then five harmonics of 39 months are successively removed, yielding the smooth-curve deviations from 100 percent given in column *S*, and its deviations from what remains after the five removals of harmonics. In the final column of table 4, and the final smooth curve of figure 6, we see the real periodicity of 39 months. The average deviation from curve *a* is 29.6 percent, and that from curve *b* is 2.1 percent. The reduction of 93 percent in deviation is due to removing exact harmonics of 39 months.

Overriding periods.—As another example I quote from footnote 1, g, cited above, showing figure 4 of that reference (here figure 7).

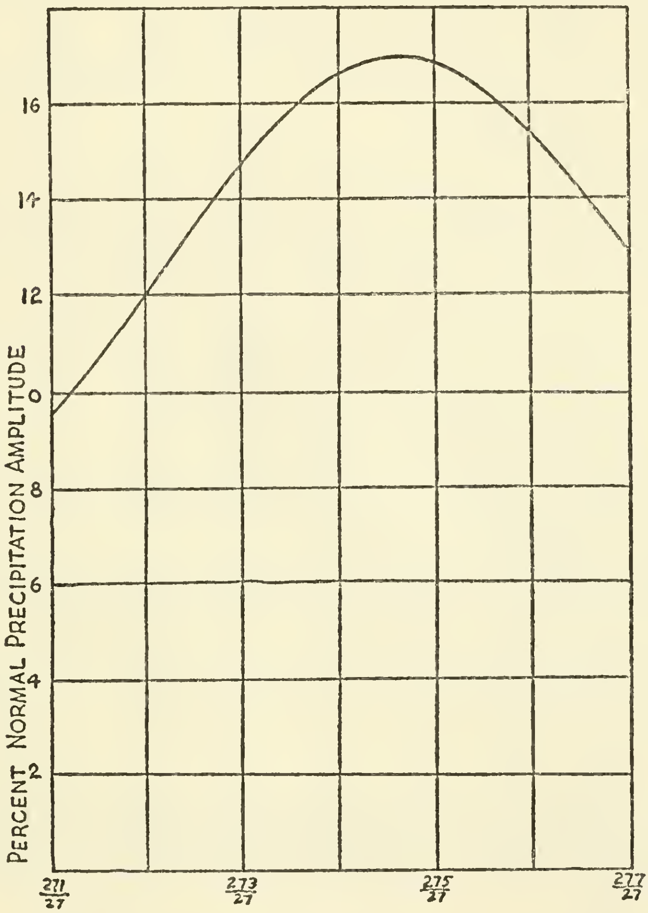


Fig. 5.—Demonstration of 273-month master period in weather.

From the mean of 16 repetitions of the periodicity of 45-1/2 months in Natural Bridge precipitation, the true 45-1/2-month period is cleared of four overriding harmonics.[4] The reader will note what similarity to true sine curves is attained in both the above examples,

[4] Refer also to the clearing of overriders from the period of 68-1/4 months at St. Louis. Note 1, g, figure 3.

when overriding harmonics are computed and removed. From the examples given (out of about 10,000 cases available in my files) the following 10 exact harmonics of 273 months are exposed as follows:

1/4, 1/7, 1/8, 1/12, 1/14, 1/21, 1/28, 1/35, 1/49, 1/56.

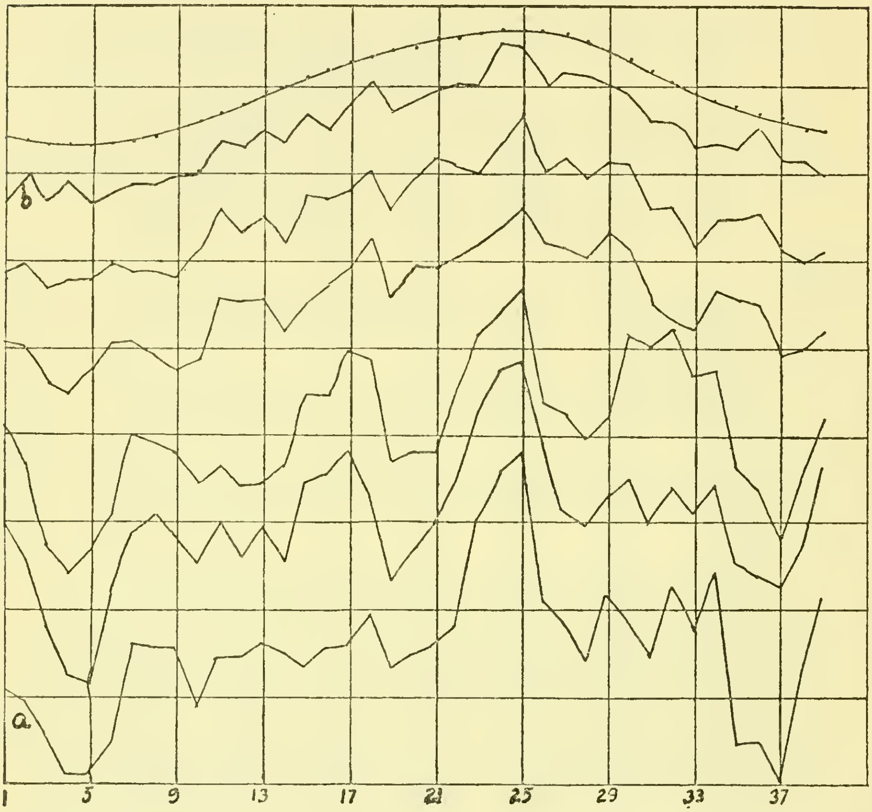


Fig. 6.—Helena, Mont. Thirty-nine-month period in precipitation as cleared of overriding subordinate integrally related periods. Original tabulation, *a;* cleared curve, *b,* with smoothed curve above. Note approximate sine form. Range, 27 percent of normal precipitation.

While most removals of harmonic riders are done to clear periods exceeding 15-1/6 months, many curves representing periods between 9-1/10 and 15-1/6 months required removal of harmonics of 1/2 or 1/3 of their length. An algebraic theorem affords a check on mistakes of computation when clearing half periods.

Let a periodic curve be represented by equally spaced ordinates a, b, c . . . k, l, m, and proceeding further, n, o, p . . . x, y, z.

The mean form of the supposed overriding period of one-half length is:

$$\frac{a+n}{2}, \quad \frac{b+o}{2}, \quad \frac{c+p}{2}, \quad \ldots \quad \frac{k+x}{2}, \quad \frac{l+y}{2}, \quad \frac{m+z}{2}.$$

When this half-length curve is written twice, and subtracted, we have:

$$\frac{a-n}{2}, \quad \frac{b-o}{2}, \quad \frac{c-p}{2}, \quad \ldots \quad \frac{k-x}{2}, \quad \frac{l-y}{2}, \quad \frac{m-z}{2},$$

and following that:

$$\frac{n-a}{2}, \quad \frac{o-b}{2}, \quad \frac{p-c}{2}, \quad \ldots \quad \frac{x-k}{2}, \quad \frac{y-l}{2}, \quad \frac{z-m}{2}.$$

So the last half of the long curve, when cleared of the period of one-half of its length, is exactly like the first half, but with reversed signs.

Grouping of periods.—All weather influences caused by changes in solar rays are subject to lags. For instance, June and noonday are times of highest solar altitudes, but the warmest months and hours occur later. The lag is longer the longer the period of the solar radiation change. These lags are due to atmospheric conditions, and vary from locality to locality, from month to month, from times of great sunspot activity to quiet solar times, and as population and forestation change. Hence, though the family of periods integrally related to 273 months proceeds with perfect regularity in measures of the solar constant, in weather the same family of periods is affected by changes of phase, depending on the locality, the population, the sunspot frequency, and the time of the year. The *periods* are the same in weather that they are in solar radiation, but owing to complex atmospheric influences on the lags the *weather phases* are so altered from time to time that these periods are unrecognizable without a segregation of the data, governed by consideration of these modifying influences.

It is not possible to anticipate and allow for these phase changes precisely. I content myself as follows:

(*a*) The year divided: January to April; May to August; September to December.

(*b*) Solar activity divided: Wolf numbers > 20; Wolf numbers < 20.

(*c*) Secular time divided: first half of tabulated records; second half thereof.

All these divisions of data hold for periods up to 15-1/6 months, or 15 groupings for these periods. The segregation according to the Wolf numbers holds from 18-1/5 months up to 39 months, but not the segregation for times of the year.

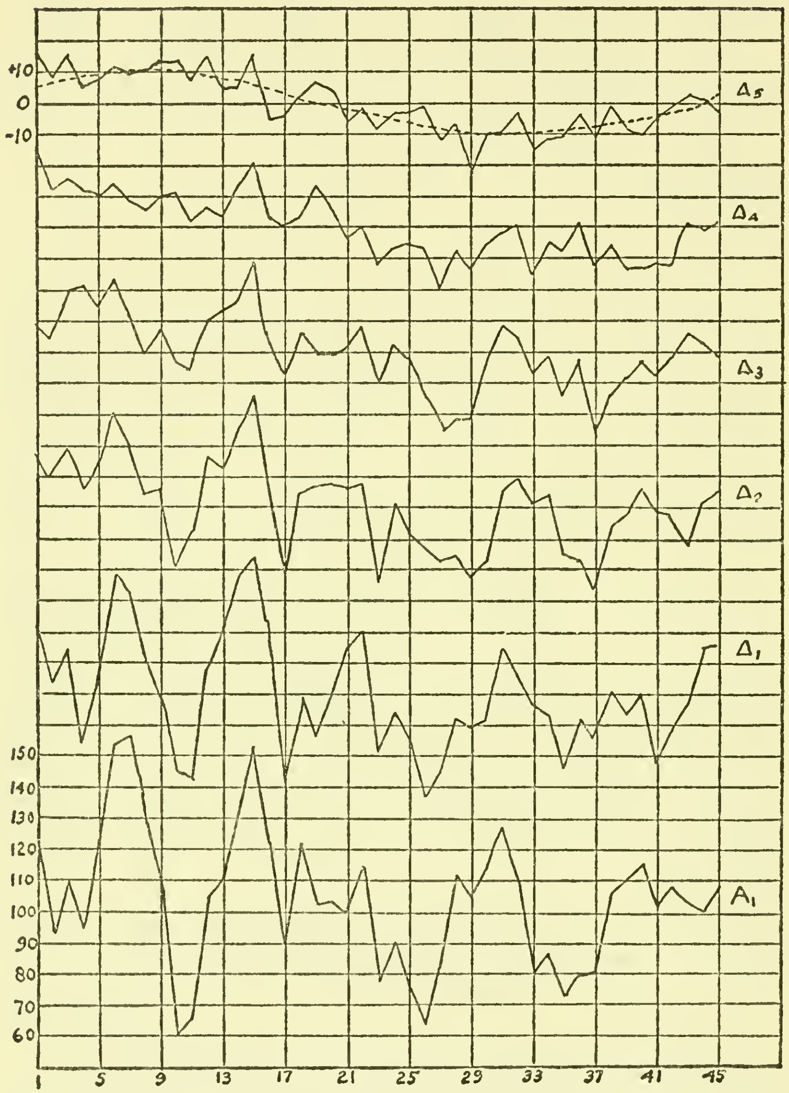


FIG. 7.—Natural Bridge, Ariz. Forty-five-and-one-half-month period in precipitation cleared of overriding subordinate integrally related periods. Range reduced ninefold by clearing.

TABLE 4.—*From three-month running means of precipitation, Helena, Mont.* 39-month period = *p*

Elimination of subordinate periods. Interval 1891-1917
Mean percentages of the normal. Original mean and departures after removing subordinate periods

Original mean of 8 determinations *a*	Average deviations. Percent of normal ppt	Removed periods *p*/2	*p*/3	*p*/5	*p*/7	*p*/8	Smooth = *S*	*p*/8 − *S* Δ	Final mean cleared
102	30	0	+2	−9	−13	−17	−12	−5	88
99	40	−8	−8	−10	−11	−11	−13	+2	87
92	29	−24	−26	−18	−17	−17	−14	−3	86
82	35	−35	−32	−20	−15	−12	−14	+2	86
82	29	−37	−27	−15	−15	−17	−14	−3	86
89	32	−16	−9	−9	−11	−15	−13	−2	87
112	34	−2	0	−9	−13	−13	−13	0	87
111	31	+2	−2	−12	−13	−13	−12	−1	88
111	29	−6	−4	−15	−14	−11	−10	−1	90
98	38	−9	−11	−13	−8	−10	−8	−2	92
109	23	0	−7	+1	+1	−3	−6	+3	94
109	30	−8	−12	0	−4	−4	−4	0	96
112	40	−1	−11	+1	0	0	−1	+1	99
110	40	−9	−7	−7	−6	−3	0	−3	100
107	18	+9	+9	0	+5	+3	+2	+1	102
111	19	+11	+9	+4	+4	0	+4	+4	104
112	34	+16	+19	+8	+6	+6	+6	0	106
119	26	+7	+17	+15	+11	+11	+7	+3	107
97	34	−13	−6	+2	+1	+4	+9	−5	109
100	23	−6	−4	+8	+9	+7	+9	−2	109
102	27	0	−4	+8	+13	+9	+11	−2	111
116	20	+9	+11	+11	+11	+11	+11	0	111
146	16	+25	+13	+14	+10	+10	+12	−2	112
152	20	+35	+28	+18	+17	+20	+13	+7	113
156	33	+37	+33	+22	+23	+19	+13	+6	113
122	34	+17	+7	+5	+10	+10	+13	−3	113
117	21	+3	+5	+13	+13	+13	+12	+1	112
108	16	−1	−1	+11	+9	+12	+11	+1	111
123	27	+6	+4	+16	+12	+10	+9	+1	109
117	21	+10	+13	+13	+12	+8	+8	0	108
109	28	0	+10	+1	+2	+2	+4	−2	104
125	37	+8	+15	−3	+2	+2	+2	0	102
115	26	+2	+4	−7	−7	−4	−1	−3	99
128	32	+9	+5	+3	−1	−3	−3	0	97
89	32	−9	−7	+1	0	−4	−4	0	96
90	33	−10	−12	0	+1	+1	−6	+7	94
81	30	−15	−24	−12	−7	−7	−7	0	93
106	50	−6	−10	−10	−10	−7	−9	+2	91
123	30	+13	+3	−6	−8	−10	−10	0	90

Mean *da* 29.6 percent. Mean Δ 2.1 percent.
Average deviation before clearance 29.6 percent. After clearance 2.1 percent.

NOTE.—Thus the removal of overriding harmonics reduces the average deviation by 93 percent. Of about 10,000 such removals of overriding harmonic periods, probably 4,000 gave fully as satisfactory end results as the 39-month curve at Helena did for the years 1891 to 1917.

Hence for these longer periods there are about four divisions to a period. The secular time segregation holds beyond 39 months, two divisions each for four periods.

The grouping just indicated leads to computing many tables for each station:

Up to 15-1/6 months,	$15 \times 12 = 180$	tables
Thence to 39 months,	$8 \times 4 = 32$	tables
Thence to 91 months,	$4 \times 2 = 8$	tables
Total	220	tables

Shifts of phases.—The numerous groups used for the shortest 15 periods leads to tabulations with so few columns that the mean values of individual periods are of little weight. To remedy this defect, I assume that the forms and amplitudes of periods up to 15-1/6 months in length, and in the same grouping as regards Wolf numbers, will be similar, though in different phase relations. I therefore make superposed graphs of the six tables of one period for each of the two stated conditions of sunspot activity. From inspection checked numerically I am then able to shift the individual curves of the graphs to the same phase relations. Then I take a mean for all six tables and use that generalized mean in forecasting. But when using it in forecasting, I must shift back the generalized mean to the proper phase, as will appear by an example later. Figure 8 gives an example of these shiftings in phase.

NOMENCLATURE, SYMBOLS, AND TIME

As stated above, 27 periods, all aliquot parts of 273 months, are to be used in the forecasts. But, as just stated, these are used in several groups, depending on the length of the periods. Lags, depending on atmospheric conditions, dictated tabulations of 12 independent groupings for the periods of shortest length, that is a_1, b_1, c_1, a_2, b_2, c_2, as tabulated for the period of 9-1/10 months of SS>20 in tables 5 and 6. Besides these, there are six tables a'_1, b'_1, c'_1, a'_2, b'_2, c'_2, for SS<20. However, for periods above 15-1/6 months this extended grouping brings too few columns into the tables to be capable of yielding satisfactory mean values. Hence for periods 273/15 to 273/7, the distinction between months of the year is dropped, thus reducing the number of groupings from 12 to 4 for these 8 periods. For the remaining 4 periods, 45-1/2 to 91 months, the distinction SS>20 or SS<20 is also dropped, reducing their groupings to 2. So there are three different arrangements of assembly, as just explained (12×15)

$= 180 + (8 \times 4) = 32 + (4 \times 2) = 8$, making 220 separate tabulations in all.

In tables of periods 1/18 to 1/63 of 273 months, there are many cases when the number of columns for a_1, b_1, c_1, a_2, b_2, c_2, and a'_1, b'_1,

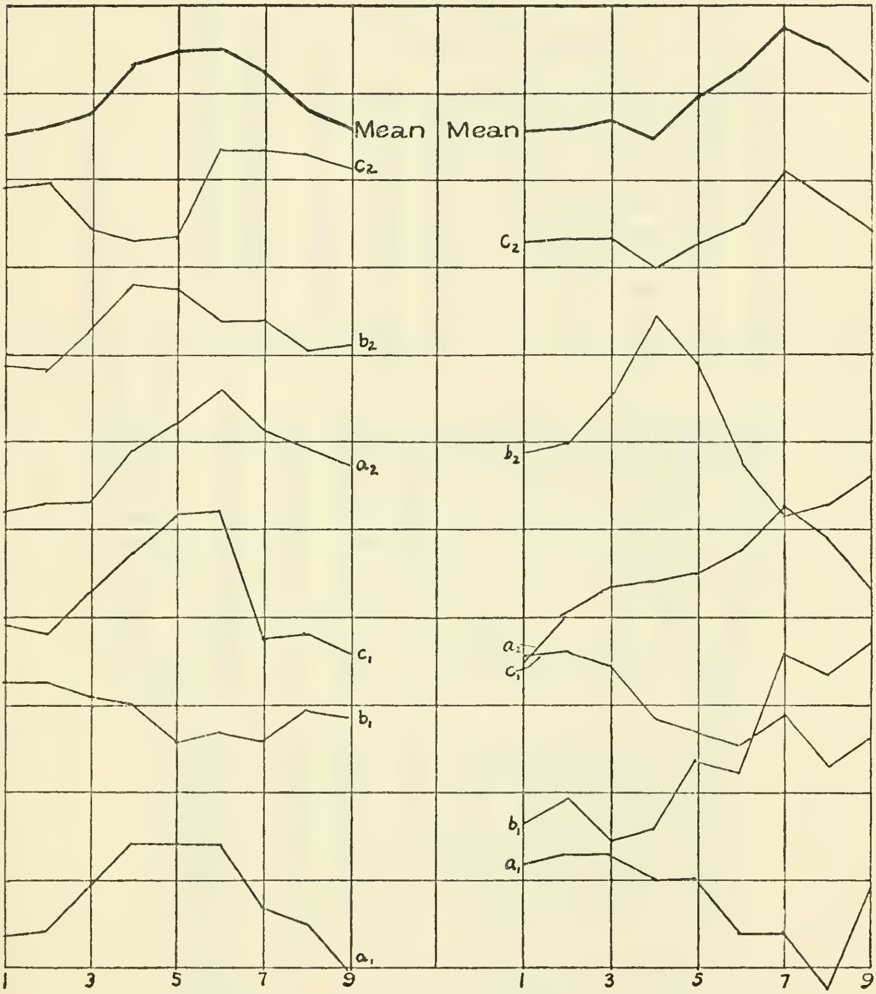


FIG. 8.—Sixfold grouping of periods to form generalized means.

c'_1, a'_2, b'_2, c'_2 are too few to give a trustworthy mean. Accordingly, as I stated above, I have made the assumption that in form and amplitude groups of SS>20 will be fairly similar, though of different phases, and in form and amplitude groups for SS<20 will also be fairly similar, though differing in phases. Making this assumption, I combine into one table $a_1b_1c_1a_2b_2c_2$, merely changing the phases to give best accord, and similarly I combine $a'_1b'_1c'_1a'_2b'_2c'_2$ into a single

TABLE 5.—*Grouping of six tables when SS > 20. Period of 9-1/10 months. Eastport, Me.*

First half of the records, 1891 to 1920

1893 Apr.	1894 Jan.	1896 Apr.	1897 Jan.	1906 Feb.	1909 Mar.	1915 Mar.	1916 Jan.	1918 Apr.	1919 Jan.	Means a_1
64	92	55	62	130	158	79	84	70	72	87
71	47	56	92	164	127	91	66	85	80	88
79	54	98	104	180	87	127	79	96	78	98
103	62	98	179	156	81	129	69	95	109	108
103	89	106	173	116	80	120	96	108	93	108
91	78	123	166	64	133	92	123	108	101	108
51	72	144	108	55	120	66	127	107	86	94
89	47	119	88	70	134	54	109	77	114	90
88	59	80	61	81	78	78	79	70	116	79
						75				

1892 June	1895 July	1898 July	1904 Aug.	1905 May	1907 Aug.	1908 June	1917 July	1920 July	Means b_1
86	115	72	160	81	132	70	167	64	105
114	120	67	162	103	131	76	94	79	105
85	94	134	103	90	128	82	115	88	102
86	94	164	66	102	126	103	77	85	100
59	98	159	77	75	114	77	89	79	92
65	94	117	93	94	128	108	72	75	94
69	65	94	82	83	126	130	100	84	92
75	70	109	53	109	119	168	96	86	98
71	72	86	57	95	112	178	94	103	97
75					78				

1891 Sept.	1894 Oct.	1897 Oct.	1903 Nov.	1906 Nov.	1916 Oct.	1919 Oct.	Means c_1
128	67	80	96	123	77	118	98
100	72	85	94	131	88	104	96
99	71	129	104	148	95	87	105
105	68	146	130	135	106	119	115
104	80	151	142	143	101	140	123
117	83	147	128	116	104	172	124
81	79	105	86	99	95	119	95
89	63	112	70	96	150	92	96
90	73	73	115	101	134	55	92

table. I give samples of this simplification here in tables 5 and 6 for SS>20. Figure 9 shows the matter graphically.

The final combinations of two sets of six tables each, with phases shifted to harmonize, is given in figure 9 and table 7, both from Eastport data.

TABLE 6.—*Grouping of six tables when SS > 20. Period of 9-1/10 months. Eastport, Me.*

Second half of the records, 1925 to 1956

1925 Feb.	1928 Feb.	1937 Mar.	1940 Apr.	1941 Jan.	1947 Feb.	1950 Feb.	1956 Mar.	Means a_2
77	76	44	76	48	127	116	106	84
68	72	66	71	50	116	116	129	86
64	82	89	63	50	136	87	119	86
69	96	77	75	68	166	117	113	98
83	109	63	126	54	198	107	89	104
91	129	74	117	91	134	162	95	112
93	129	95	128	93	88	114	88	103
124	119	102	83	101	50	102	93	97
122	87	67	84	105	69	111	101	95

1926 Aug.	1927 May	1929 Aug.	1930 May	1936 June	1939 July	1945 July	1946 May	1948 Aug.	1949 May	1951 Aug.	1952 May	1955 June	Means b_2
63	95	92	55	97	87	100	134	94	90	159	130	60	97
136	135	93	95	91	78	66	83	64	71	135	121	80	96
145	185	87	107	77	73	110	68	104	54	139	131	89	105
150	189	74	100	101	84	157	80	130	104	159	99	87	116
92	180	76	55	92	103	170	82	138	111	200	105	87	115
90	178	104	41	112	65	130	75	127	153	184	81	65	108
85	167	103	51	104	61	127	112	127	111	145	95	113	108
70	119	101	65	91	56	119	119	116	138	107	110	102	101
70	91	69	76	52	79	166	145	108	113	96	136	126	102
			84			154							

1925 Nov.	1928 Nov.	1934 Dec.	1935 Sept.	1937 Dec.	1938 Oct.	1941 Oct.	1947 Nov.	1950 Nov.	Means c_2
116	72	125	71	56	110	79	74	181	98
91	76	111	89	56	73	84	120	194	99
99	84	102	66	59	65	61	98	165	89
112	93	63	85	70	74	59	101	114	86
96	93	54	60	76	92	87	88	139	87
82	112	62	102	104	125	81	141	150	107
81	95	68	103	131	109	86	146	144	107
73	80	81	119	131	93	70	176	132	106
71	63	89	117	146	94	81	121	149	103
				112					

The meaning of the symbols on figure 9 is as follows:

ok, no shift.
↑, shift backward.
↓, shift forward.
Subscripts, number of months shifted.

TABLE 7.—*Phase adjustment. The 6-1/15-month period*

Division = Time before and after 1900.
Category = Records when Wolf sunspot numbers ≷ 20.
Phase shifts indicated: ok, ↑N, ↓N, drawn dotted below.
Basis of forecast, over 1,000 monthly records smoothed by 3-month running means. Forecasts employ 27 periods all exact submultiples of 273 months.
Phases shift with changing atmospheric conditions, but periods remain, and are of the exact lengths found i solar variation. It requires 220 tables electronically computed to make a forecast for one station.

CATEGORY 2 ASSEMBLY

$a_1\uparrow_1$	$b_1$ok	$c_1\uparrow_3$	$a_2$ok	$b_2$ok	$c_2$ok	Mean	Δ
105	95	108	100	96	95	100	+1
102	95	106	93	97	88	97	−2
100	94	95	92	93	80	92	−7
106	92	104	97	94	88	97	−1
105	103	98	106	100	91	101	+2
103	114	108	105	101	99	105	+6
						6 | 593	
						99	

CATEGORY 1 ASSEMBLY

$a_1\uparrow_3$	$b_1\downarrow_1$	$c_1$ok	$a_2$ok	$b_2\uparrow_2$	$c_2$ok	Mean	Δ
120	95	100	105	96	117	107	+
108	86	100	91	94	110	98	
110	86	100	90	92	100	95	−
92	97	102	87	84	88	91	−
105	91	104	91	90	93	93	−
110	98	103	102	94	97	101	+
						6 | 586	
						98	

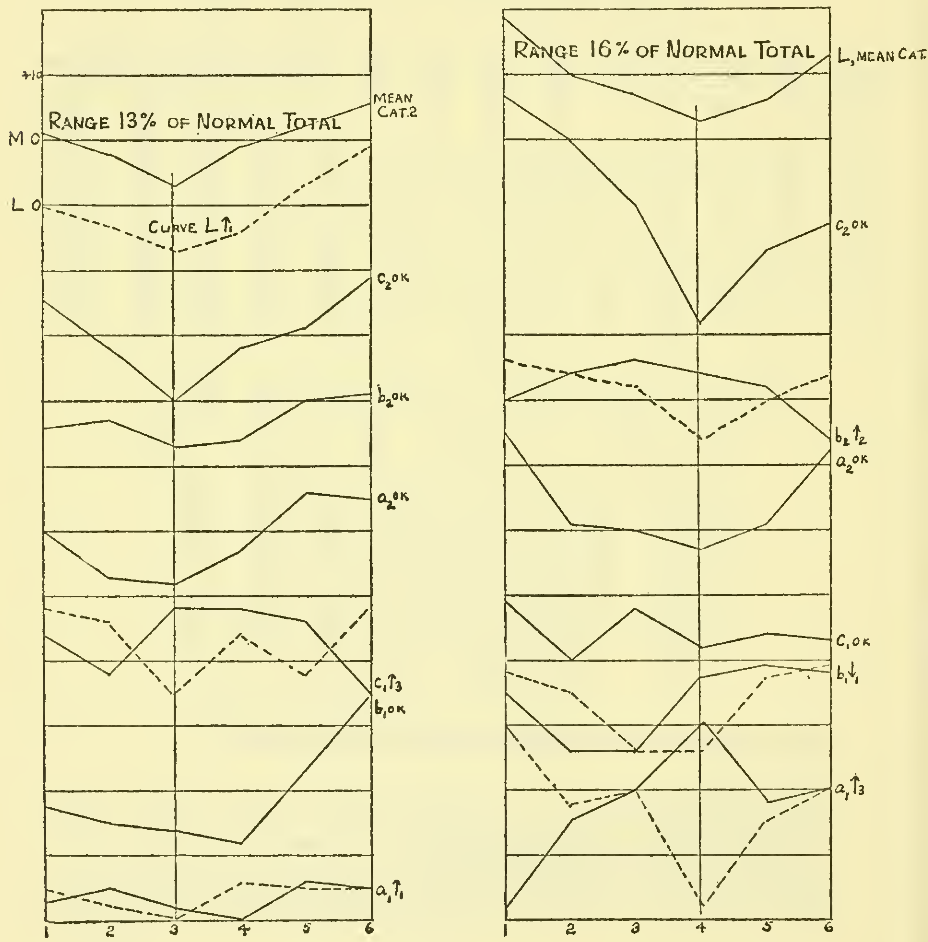


FIG. 9.—Phase shifts in sixfold grouping of periods.

Times.—The growth of population, destruction of forests, multiplying of oil engines, automobiles, and airplanes alter the properties of the atmosphere and thereby shift phases of periods. Hence, as stated above, I divide the thousand months of records into first and second halves and compute the phases and amplitudes within the two parts separately.

TABLE 7a.—*The sixfold groupings.* The 9-1/10-month period. Eastport, Me.*

Values in percentages of normal precipitation

A. WOLF SUNSPOT NUMBERS BELOW 20

$a_1\uparrow 4$	b_1 ok	$c_1\uparrow 4$	a_2 ok	$b_2\downarrow 3$	c_2 ok	Σ	Σ ÷ 6	Δ
101	83	94	90	63	106	537	89	−9
88	88	91	101	66	107	547	90	−8
88	79	98	107	73	107	552	92	−6
75	82	81	108	78	100	509	88	−10
97	97	93	110	80	106	583	97	−1
104	95	111	115	91	110	626	104	6
106	111	112	105	109	122	685	114	16
106	107	109	118	98	116	654	109	11
101	114	97	107	76	109	604	101	2
						Mean	98	

B. WOLF SUNSPOT NUMBERS EXCEED 20

a_1 ok	$b_1\downarrow 3$	$c_1\downarrow 1$	a_2 ok	b_2 ok	$c_2\uparrow 2$	Σ	Σ ÷ 6	Δ
87	92	92	84	97	89	541	90	−10
88	98	98	86	96	86	552	92	−8
98	97	96	86	105	87	569	95	−5
108	105	105	98	116	107	639	106	6
108	105	115	104	115	107	654	109	9
108	102	123	112	108	106	659	110	10
94	100	124	103	108	100	629	105	5
90	92	95	97	101	98	573	96	−4
79	94	96	95	102	99	565	94	−6
						Mean	100	

* The shifting of phases is indicated by arrows as in figure 9 and table 7. The accompanying subscripts indicate the number of months shifted up or down.

Not only so, but considerable differences of amplitude between the two halves are sometimes found. As forecasts are for present and future time, weights, as 2/1, 3/1, or 4/1, are given to favor the second half when considerable differences in amplitude of periods between the two halves appear. It matters not whether the later amplitudes are the less or the greater, the larger weight is ascribed to amplitudes of the second half. If a backcast were to be made to long ago, the weights would of course be reversed.

At some chosen date all periods must be in the same phase and preferably in zero phase. I chose 1957-0 as this zero date. To insure that any particular period will be in zero phase with 1957-0 it is necessary to compute ahead from the start at about the year 1870. This may be done as follows. Take the period 8-3/11 months for example.

From 1870 to 1957, 87 years, there are 1,044 months. About 126 periods of 8-3/11 months would cover this interval. But a date must be chosen which is an exact integral multiple of 8-3/11. The nearest is that which gives 121 periods in the interim. Multiplying, we find that 121 periods require 1,001 months, or 83 years 5 months. Sub-

Table 8.—*Repeated 8-3/11 months and round numbers*

1	8.2737	8	7	57.9089	8
2	16.5454	9	8	66.1816	8
3	24.8181	8	9	74.4543	8
4	33.0908	8	10	82.7270	9
5	41.3635	8	11	90.9997	8
6	49.6362	9			

tracting these figures from 1957-0 we find 1873-7. Thus a suitable starting point is August 1873. But it was assumed that the record begins about 1870-0. If so, 43 months would be lost. One therefore counts backward from 1873-7 five periods, and therefore begins with March 1870.

We now come to considering periods ending in fractions of a month. We may make tables of accumulation for them. Again using the period 8-3/11 months, table 8 results.

For most of the periods of inexact months, tables to 91 months suffice. But for such as 12-9/22, 13-13/20, 24-9/11 and 27-3/10 the tables must be carried on to 273 months.

RESULTS OF FORECASTS

Having treated of most of the features of the method, the remainder of this paper will disclose the results of these forecasts of precipitation. As I have stated, I discovered discrepancies sometimes as great as 10 percent between the published monthly normals and new normals obtained by separating years when Wolf sunspot numbers are respectively above and below 20. As my new normals may be of value to other investigators of periodicity I first give in table 9 the two sets of normals for the 32 cities I have investigated.

The cities are in alphabetical order. The months in the first column apply for all cities. Precipitation is given in inches. Columns A and B give monthly normals for times when Wolf sunspot numbers are respectively *less* and *more* than 20.

Departures; observation minus forecast 1950-1958.—There are 20 cities showing (1950-1958) departures in *level* of 4 percent or more from the values given in table 9. This is to be expected. One could not suppose the mean precipitation, 1950-1958, would be identical with the average precipitation, 1870-1958. Table 9a gives all the cities where such differences of 4 percent or more occurred.

When I come to give tables and maps of forecasts, 1959-1967, I shall not use table 9a to correct the maps, but shall quote the results as they are determined from table 9. Persons interested may apply the values of Δ, table 9a, as corrections in *level* to the *forecasts,* using them in reverse of the signs given in table 9a.

Sunspot effect on normals.—Lest readers think the differences between mean precipitation values attending high and low sunspot frequency are merely due to the sparsity of evidence, considering the irregularity of precipitation, I call attention to the numbers of months entering into the mean values of table 9. For nearly all of the stations approximately a thousand months participated. That indicates about 600 for high sunspot frequency, about 400 for the low. Dividing by 12, there were about 50 values per monthly mean for sunspots exceeding 20 Wolf sunspot numbers, and about 33 per month for the low sunspot frequencies.

Referring to table 9, the yearly sums show seven cities where sunspot frequency makes no more than 1 percent difference in the totals. For seven other cities low sunspot activity brings more precipitation, with an average difference of 5 percent. For the remaining 18 cities precipitation averages 5-1/2 percent higher at high sunspot frequency. While the discovery and elimination of these differences by computing new normals was of importance in my forecasting, seasonal differences made the elimination of the sunspot effect imperative. Thus at Salisbury, N. C., precipitation averages 17 percent *higher* with *low* Wolf numbers, January-April; 9 percent *lower,* May-August; and 11 percent *higher,* September-December, for Wolf numbers below 20 than for those above 20.

Credibility of forecasts.—It is difficult to compress within the limits of a paper, aimed to be available at moderate price to all who desire

TABLE 9.—*Normal monthly precipitation after 1870 through 1957 in inches*

A = Wolf number < 20; B = Wolf number > 20.

	Abilene, Tex. A	Abilene, Tex. B	Albany, N.Y. A	Albany, N.Y. B	Albany, Oreg. A	Albany, Oreg. B	Augusta, Ga. A	Augusta, Ga. B	Bismarck, N.D. A	Bismarck, N.D. B	Charleston, S.C. A	Charleston, S.C. B	Cincinnati, O. A	Cincinnati, O. B	Denver, Colo. A	Denver, Colo. B
January	0.7	0.9	2.4	2.4	6.8	6.3	3.4	3.7	0.4	0.5	2.7	3.2	3.1	3.6	0.3	0.5
February	1.1	0.8	2.5	2.2	4.4	5.6	4.0	4.1	0.4	0.5	3.1	3.4	2.6	3.0	0.5	0.5
March	1.1	1.1	2.5	3.3	4.1	4.2	4.4	4.4	0.9	0.9	3.1	3.3	4.2	3.7	1.1	1.0
April	2.7	2.2	2.6	2.8	2.7	2.6	3.3	3.4	1.3	1.6	2.8	2.5	2.9	3.0	1.8	2.1
May	4.1	3.9	3.2	3.0	2.3	2.1	2.8	3.3	2.4	2.1	3.9	3.1	3.2	3.7	2.1	2.4
June	2.0	2.9	3.5	3.6	1.5	1.2	4.3	4.2	3.8	3.1	4.7	4.8	3.7	3.9	1.2	1.5
July	1.7	1.9	3.8	3.3	0.3	0.4	4.8	5.1	2.3	2.3	6.3	6.5	3.5	3.4	1.6	1.7
August	1.5	2.0	3.7	3.5	0.5	0.4	4.4	4.9	1.7	1.9	5.5	6.1	3.7	2.9	1.4	1.4
September	2.1	2.4	3.3	3.4	1.7	1.7	3.1	3.4	1.4	1.2	5.2	4.5	2.6	2.6	0.7	1.0
October	2.5	2.4	2.9	3.0	3.5	3.2	2.8	2.1	1.0	0.8	3.8	3.2	2.2	2.5	0.8	1.0
November	1.5	1.0	2.7	2.9	5.9	6.2	2.4	2.6	0.5	0.6	2.4	2.4	2.7	3.1	0.5	0.6
December	1.4	1.0	2.4	2.5	6.6	7.1	3.6	3.4	0.4	0.5	2.8	3.1	3.0	2.8	0.7	0.5
Year	22.4	22.5	35.5	35.9	40.3	41.0	43.3	44.6	16.5	16.0	46.3	46.1	37.4	38.2	12.7	14.2

	Detroit, Mich. A	Detroit, Mich. B	Eastport, Maine A	Eastport, Maine B	El Paso, Tex. A	El Paso, Tex. B	Helena, Mont. A	Helena, Mont. B	Independence, Kans. A	Independence, Kans. B	Little Rock, Ark. A	Little Rock, Ark. B	Madison, Wis. A	Madison, Wis. B	Montgomery, Ala. A	Montgomery, Ala. B
January	1.9	2.2	3.9	3.5	0.33	0.48	0.6	0.8	1.2	1.6	4.4	4.8	1.0	1.8	4.5	4.8
February	2.1	2.1	3.3	3.1	0.38	0.35	0.5	0.6	1.8	1.5	3.7	4.0	1.4	1.3	5.3	5.1
March	2.8	2.3	4.3	2.9	0.23	0.28	0.8	0.7	2.4	2.4	5.1	4.5	2.1	2.0	6.1	6.2
April	2.4	2.8	2.9	2.7	0.23	0.21	1.0	0.9	4.0	3.8	5.0	4.9	2.3	2.7	4.7	4.6
May	3.4	3.4	2.8	2.6	0.30	0.27	2.1	1.8	5.2	4.4	4.5	4.9	3.6	3.4	3.6	3.6
June	2.9	3.5	3.2	2.7	0.68	0.44	2.0	2.4	4.6	5.4	2.9	3.9	3.5	4.2	3.7	4.1
July	3.2	3.1	2.9	2.7	1.61	1.70	0.8	1.2	3.8	3.7	3.7	3.1	4.0	3.5	4.3	5.0
August	2.6	2.8	3.3	2.8	1.40	1.58	0.8	0.7	3.0	2.9	3.3	3.2	3.2	3.2	4.0	3.8
September	2.8	2.6	3.0	2.9	1.06	1.09	0.9	1.2	4.1	3.9	3.5	2.7	3.6	3.4	3.3	3.0
October	2.4	2.5	3.7	3.0	0.59	0.76	0.8	0.7	2.8	3.0	2.1	3.1	2.2	2.3	2.5	2.0
November	2.2	2.4	3.2	3.6	0.46	0.37	0.6	0.7	2.0	2.0	3.7	4.2	1.9	1.8	3.0	3.1
December	2.3	2.2	3.6	3.4	0.41	0.47	0.5	0.7	2.0	1.4	4.2	3.8	1.5	1.5	5.1	4.7
Year	31.0	31.9	40.1	35.9	7.58	8.00	11.4	12.4	36.9	36.0	46.1	47.1	30.3	31.1	50.1	50.0

	Nashville, Tenn. A	Nashville, Tenn. B	Natural Bridge, Ariz. A	Natural Bridge, Ariz. B	Omaha, Nebr. A	Omaha, Nebr. B	Peoria, Ill. A	Peoria, Ill. B	Port Gibson, Miss. A	Port Gibson, Miss. B	Rochester, N.Y. A	Rochester, N.Y. B	Sacramento, Calif. A	Sacramento, Calif. B	Salisbury, N.C. A	Salisbury, N.C. B
January	4.6	5.0	2.2	2.6	0.7	0.8	2.1	1.5	5.5	5.3	2.7	2.6	3.3	3.7	3.8	3.7
February	4.3	4.1	2.8	2.8	0.8	0.9	1.4	1.8	5.0	5.2	2.6	2.5	2.7	3.0	4.1	3.8
March	5.5	5.0	2.2	2.5	1.6	1.1	2.7	3.0	6.2	5.5	3.2	2.8	2.2	2.5	5.5	4.0
April	4.4	3.9	1.1	1.6	2.1	2.7	3.2	3.1	6.1	4.8	2.7	2.5	1.2	1.2	4.1	3.3
May	3.7	3.7	0.5	0.6	3.2	3.5	4.2	3.6	3.9	4.7	2.5	2.8	0.5	0.6	3.6	4.1
June	3.6	3.3	0.3	0.4	4.5	4.3	3.5	3.7	4.5	4.3	2.7	2.8	0.2	0.1	4.1	4.1
July	4.0	3.9	2.5	2.8	3.2	3.6	3.5	3.8	4.7	4.7	2.5	3.1	0.0	0.0	4.7	5.8
August	3.9	3.0	2.7	3.7	3.3	3.0	3.1	2.3	3.4	4.0	2.8	2.7	0.0	0.0	5.1	5.0
September	3.4	3.0	1.6	2.4	3.0	2.8	3.5	4.1	2.8	2.5	2.6	2.4	0.1	0.2	3.9	3.1
October	2.1	2.6	1.5	1.6	1.7	2.3	2.4	2.6	2.0	2.6	2.4	2.7	0.7	0.8	3.0	2.9
November	3.0	3.7	1.8	1.8	1.0	1.2	2.4	2.7	3.4	4.1	2.6	2.5	1.8	1.6	2.2	2.9
December	4.4	3.6	2.6	2.6	1.0	0.8	1.9	1.8	7.1	4.8	2.7	2.4	2.9	3.5	4.4	3.5
Year	46.9	44.8	21.8	25.4	26.1	27.0	33.9	34.0	54.6	52.5	32.0	31.8	15.6	17.2	48.5	46.2

	Salt Lake, Utah A	Salt Lake, Utah B	San Bernardino, Calif. A	San Bernardino, Calif. B	Santa Fe, N.Mex. A	Santa Fe, N.Mex. B	Spokane, Wash. A	Spokane, Wash. B	St. Louis, Mo. A	St. Louis, Mo. B	St. Paul, Minn. A	St. Paul, Minn. B	Thomasville, Ga. A	Thomasville, Ga. B	Washington, D.C. A	Washington, D.C. B
January	1.2	1.4	3.2	3.2	0.4	0.7	2.0	2.0	1.9	2.5	0.9	1.0	3.8	4.0	3.3	3.3
February	1.3	1.4	3.2	3.3	0.7	0.7	1.3	1.8	2.5	2.5	0.8	1.0	4.4	4.1	2.9	2.9
March	1.9	1.9	2.4	2.7	0.8	0.8	1.2	1.3	3.3	3.5	1.2	1.6	4.4	4.6	4.1	3.4
April	1.9	1.9	1.3	1.3	0.8	1.0	1.0	1.1	3.5	3.9	2.2	2.2	3.3	3.8	3.4	3.4
May	1.6	1.8	0.4	0.6	1.0	1.3	1.2	1.4	4.2	4.3	3.1	3.5	3.4	3.6	3.7	3.8
June	0.8	0.8	0.1	0.1	1.2	0.9	1.2	1.4	4.1	4.2	4.0	4.3	5.8	4.8	4.0	3.8
July	0.5	0.5	0.0	0.0	2.4	2.1	0.6	0.6	3.3	3.3	3.1	3.2	6.8	6.8	4.3	4.4
August	0.7	0.8	0.1	0.1	2.0	2.1	0.7	0.5	3.3	3.4	3.1	3.3	5.3	6.2	4.4	4.2
September	0.6	0.9	0.1	0.1	1.4	1.6	0.8	0.9	3.5	3.1	3.3	3.1	4.7	4.8	4.1	3.2
October	1.5	1.4	0.6	0.6	1.0	1.0	1.4	1.3	2.5	2.9	2.0	2.1	2.8	2.3	3.4	2.9
November	1.2	1.4	1.4	0.9	0.7	0.5	1.9	2.0	2.5	2.9	1.3	1.5	2.1	2.6	2.6	2.6
December	1.4	1.3	2.4	2.5	0.7	0.7	2.1	2.2	2.4	2.4	0.9	1.0	4.0	3.9	3.2	3.0
Year	14.6	15.5	15.2	15.4	13.1	13.4	15.4	16.5	37.0	38.9	25.9	27.8	50.8	51.5	43.4	40.9

it, the results and comments representing this project. Even with 32 stations, the United States is so vast in area and so varied in contrasting conditions that with the fullest use of my results no adequate country-wide coverage of the expected precipitation to 1967 can be made. As stated above, confidence in the forecasts must depend largely on the fidelity with which the first half of the forecast, 1950-1958, inclusive, fits the observed record.

Table 10 presents in parallel columns for all 32 stations the monthly percentage departures of forecasts and observed records, 1950-1958, from the normals given in table 9.

That readers may see from a graphical standpoint to what degree the forecasts represent the events, I present figure 10. It gives the march of forecasts and events from 1950 to 1958 for Cincinnati, one of the best, and Denver, a less favorable station.

TABLE 9a.—*Percentage departures (O-F) 1950-1958, from table 9*

City	Abilene	Augusta	Bismarck	Charleston	Cincinnati
% Δ	—12	—17	—6	—11	+4
City	Detroit	Eastport	Helena	Independence	Little Rock
% Δ	—4	+23	—11	—17	+4
City	Natural Bridge	Peoria	Sacramento	Salisbury	Salt Lake
% Δ	—7	—6	—4	—5	—7
City	San Bernardino	Santa Fe	St. Louis	St. Paul	Thomasville
% Δ	+10	—17	—8	—11	—9

Figure 10 shows for a more favorable and a less favorable station a graphic view of data taken from table 10.

A glance at figure 10 shows for both cities an obvious similarity of the features of the forecasts and of the events for the majority of months covered. There are, to be sure, differences in *amplitude* of features observed and forecasted. In many cases the forecast, built on average conditions of about 1,000 previous months, hits the features found in the observed record from 1950 to 1958 on the exact months. But in the better station, as well as in the worse, there occur relative displacements of features common to both forecast and event. These displacements are rarely as great as 5 months for any station, but may extend through durations sometimes as great as several years before returning to agreement.

Displacements of features.—Several years ago I published the account of a forecast for 104 years of St. Louis precipitation, including a comparison with the observed records. I quote from my discussion *

* Text continued on page 44.

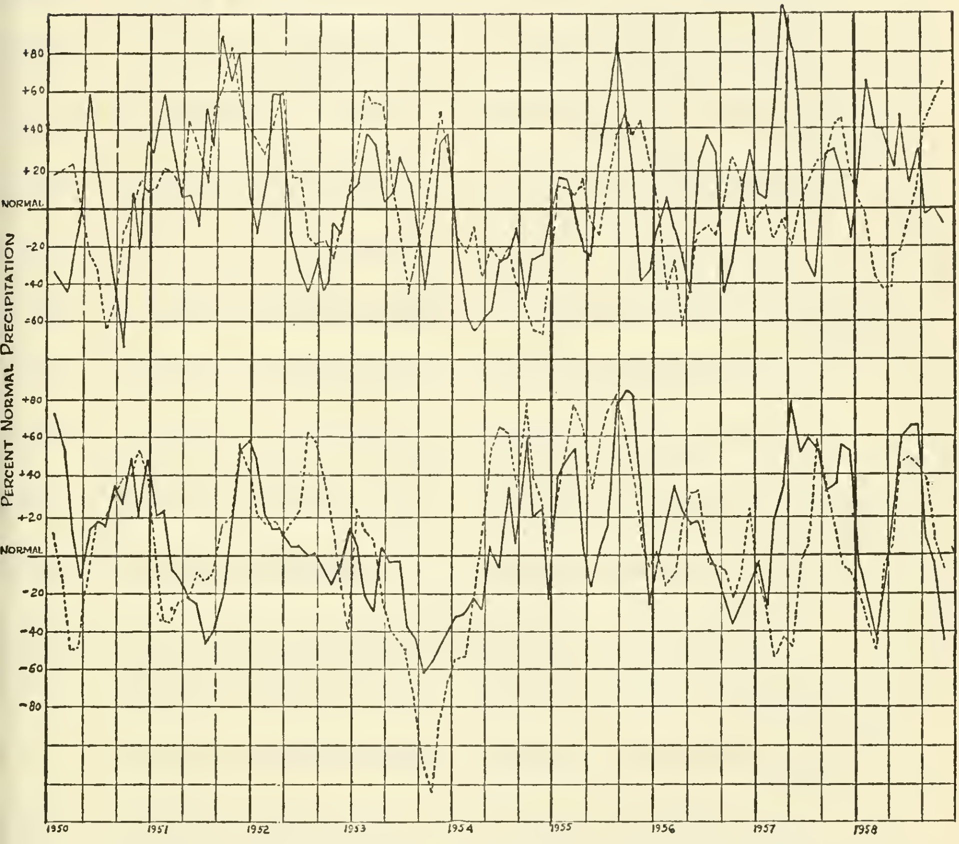


FIG. 10.—Comparison of forecasts and events, 1950-1958. Upper curves, Denver, Colo.; lower curves, Cincinnati, Ohio. Forecasts, dotted lines; events, full curves.

TABLE 10.—*Forecast and observation, 1950-1958*

A

	Abilene, Tex.			Albany, N. Y.			Albany, Oreg.			Augusta, Ga.			Bismarck, N. Dak.			Charleston, S. C.			Cincinnati, Ohio			Denver, Colo.		
1950	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	91	90	—1	117	127	+10	108	132	+24	65	45	—20	113	139	+26	100	49	—51	111	172	+61	119	67	—52
Feb.	77	55	—22	135	133	—2	86	152	+66	40	37	—3	124	215	+91	88	50	—38	88	152	+64	120	57	—63
Mar.	109	58	—51	154	103	—51	71	102	+31	20	53	+33	133	185	+52	85	65	—20	50	110	+60	123	71	—52
Apr.	109	89	—20	127	78	—49	42	81	+39	32	100	+68	127	178	+51	104	66	—38	51	88	+37	81	97	+16
May	77	101	+24	138	72	—66	69	54	—15	56	74	+18	118	86	—32	120	104	—16	82	113	+31	77	159	+82
June	74	149	+75	122	80	—42	114	75	—39	84	142	+58	84	66	—18	124	90	—34	115	118	+3	68	122	+54
July	64	203	+139	108	116	+8	117	110	—7	103	96	—7	72	53	—19	119	108	—11	120	115	—5	37	90	+53
Aug.	102	225	+123	104	126	+22	146	124	—22	114	128	+14	90	85	—5	129	104	—25	128	135	+7	50	69	+19
Sept.	80	139	+59	100	115	+15	171	155	—16	124	88	—36	103	93	—10	139	109	—30	139	125	—14	85	26	—59
Oct.	38	41	+3	87	83	—4	153	149	—4	142	107	—35	74	87	+13	116	96	—20	140	149	+9	100	108	+8
Nov.	57	2	—55	111	108	—3	148	145	—3	151	103	—48	64	77	+13	101	85	—16	152	120	—32	116	77	—39
Dec.	105	3	—102	136	122	—14	131	116	—15	131	81	—50	91	91	0	89	67	—22	139	148	+9	108	133	+25
1951																								
Jan.	128	31	—97	132	133	+1	82	103	+21	101	70	—31	119	131	+12	76	79	+3	100	121	+21	112	129	+17
Feb.	130	55	—75	123	134	+11	82	117	+35	97	70	—27	106	103	—3	97	77	—20	66	123	+57	120	158	+38
Mar.	114	77	—37	123	132	+9	87	81	—6	98	78	—20	93	76	—17	88	56	—32	63	91	+28	118	130	+12
Apr.	144	86	—58	133	118	—15	51	77	+26	93	63	—30	84	40	—44	111	72	—39	75	86	+11	110	106	—4
May	172	97	—75	145	99	—46	14	37	+23	110	50	—60	88	54	—34	101	83	—18	79	77	—2	143	107	—36
June	169	99	—70	144	107	—37	45	37	—8	94	63	—31	85	100	+15	119	73	—46	90	73	—17	131	91	—40
July	100	65	—35	125	117	—8	76	13	—63	87	74	—13	81	168	+87	103	91	—12	87	53	—34	113	150	+37
Aug.	46	41	—5	109	133	+24	95	42	—53	90	87	—3	42	166	+124	92	78	—14	91	60	—31	149	132	—17
Sept.	0	34	+34	108	146	+38	109	108	—1	125	82	—43	96	126	+30	79	91	+12	117	76	—41	162	188	+26
Oct.	32	43	+11	103	153	+50	99	136	+37	157	99	—58	99	50	—49	74	95	+21	122	116	—6	184	166	—18
Nov.	64	35	—29	105	146	+41	110	144	+34	150	96	—54	159	87	—72	75	88	+13	156	154	—2	154	179	+25
Dec.	117	43	—74	94	124	+30	92	106	+14	123	87	—36	171	155	—16	97	85	—12	143	159	+16	142	106	—36
1952																								
Jan.	92	47	—45	95	107	+12	70	101	+31	107	88	—19	144	213	+69	140	100	—40	120	148	+28	134	87	—47
Feb.	56	75	+19	110	84	—26	73	89	+16	111	99	—12	137	174	+37	148	117	—31	117	120	+3	127	114	—13
Mar.																								

May	57	33	−24	113	139	+26	93	110	+17	141	79	−62	71	39	−32	170	114	−56	117	105	−12	110	89	−27
June	68	34	−34	103	108	+5	84	92	+8	146	84	−62	76	64	−12	155	97	−58	124	105	−19	116	66	−50
July	22	13	−9	86	82	−4	84	97	+13	127	97	−30	79	70	−9	117	97	−20	162	101	−61	83	57	−26
Aug.	30	45	+15	69	72	+3	85	21	−63	121	103	−18	85	46	−39	92	88	−4	158	102	−56	80	72	−8
Sept.	56	33	−23	46	68	+22	121	29	−92	93	88	−5	98	25	−73	75	92	+17	138	93	−45	82	57	−25
Oct.	79	148	+69	46	82	+36	119	24	−25	113	55	−58	65	22	−43	57	97	+40	114	85	−29	73	92	+19
Nov.	135	143	+8	76	108	+32	125	49	−76	112	59	−53	49	19	−30	35	78	+43	86	96	+10	98	87	−11
Dec.	107	146	+39	126	140	+14	130	102	−28	102	75	−27	73	46	−27	46	70	+24	71	114	+43	109	109	0
1953																								
Jan.	124	47	−77	126	141	+15	151	131	−20	99	118	+19	93	69	−24	76	87	+11	123	104	−19	129	113	−16
Feb.	101	46	−55	108	137	+29	79	133	+54	158	106	−52	126	124	−2	101	81	−20	113	78	−35	160	137	−23
Mar.	99	66	−33	104	147	+43	58	97	+39	144	117	−27	168	159	−9	90	73	−17	109	70	−39	153	132	−21
Apr.	107	80	−27	110	213	+103	50	124	+74	125	105	−20	208	188	−20	87	93	+6	77	104	+27	152	102	−50
May	160	94	−66	81	174	+93	18	128	+110	122	124	+2	172	175	+3	100	87	−13	62	98	+36	108	108	0
June	119	149	+30	73	134	+61	36	103	+67	101	95	−6	128	123	−5	71	82	+11	55	99	+44	87	127	+40
July	124	135	+11	69	62	−7	58	121	+63	66	76	+10	84	82	−2	71	91	+20	50	62	+12	54	113	+59
Aug.	77	115	+38	86	72	−14	125	91	−34	64	92	+28	73	42	−31	80	90	+10	23	56	+33	77	81	+4
Sept.	82	86	+4	81	95	+14	147	128	−19	40	82	+42	91	62	−29	106	71	−35	0	38	+38	100	57	−43
Oct.	64	79	+15	86	85	−1	135	87	−48	81	69	−12	76	76	0	96	88	−8	0	43	+43	158	89	−69
Nov.	62	60	−2	97	94	−3	136	116	−20	98	84	−14	71	96	+25	107	80	−27	14	52	+38	149	132	−17
Dec.	36	52	+16	105	91	−14	156	132	−24	129	102	−27	73	104	+31	109	65	−44	34	60	+26	122	137	+15
1954																								
Jan.	33	47	+14	113	113	0	117	129	+12	95	113	+18	14	83	+69	99	75	−24	45	69	+24	84	79	−5
Feb.	26	47	+21	125	104	−21	101	118	+17	68	67	−1	64	84	+20	104	71	−33	47	70	+23	77	42	−35
Mar.	93	58	−35	129	104	−25	56	104	+48	61	74	+13	64	58	−6	102	56	−46	76	79	+3	90	34	−56
Apr.	155	92	−63	113	124	+11	0	80	+80	94	82	−12	72	74	+2	89	48	−41	105	71	−34	63	41	−22
May	162	91	−71	97	124	+27	65	125	+60	87	85	−2	93	75	−18	106	62	−44	153	106	−47	79	44	−35
June	144	39	−105	78	103	+25	136	162	+26	72	93	+21	103	118	+15	126	75	−51	166	93	−73	72	71	−1
July	125	20	−105	58	93	+38	179	212	+33	62	88	+26	164	144	−20	137	85	−52	163	135	−28	77	73	−4
Aug.	100	32	−68	50	86	+36	181	170	−11	18	69	+51	169	177	−92	114	93	−21	133	107	−26	60	90	+30
Sept.	96	58	−38	80	90	+10	141	133	−8	44	52	+8	160	133	−27	75	104	+29	180	160	−20	27	50	+23
Oct.	122	76	−46	97	87	−10	143	102	−41	57	59	+2	92	85	−7	52	114	+62	139	120	−19	34	73	+39
Nov.	167	78	−89	93	110	+13	109	104	−5	77	69	−8	96	25	−71	47	121	+74	127	124	−3	32	74	+42
Dec.	236	88	−148	101	101	0	91	78	−13	103	94	−9	103	44	−59	22	111	+89	102	77	−25	66	95	+29

(continued)

TABLE 10.—*continued*

A

	Abilene, Tex.			Albany, N. Y.			Albany, Oreg.			Augusta, Ga.			Bismarck, N. Dak.			Charleston, S. C.			Cincinnati, Ohio			Denver, Colo.		
	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
1955																								
Jan.	249	71	—178	102	101	—1	88	62	—26	112	75	—37	94	77	—17	49	85	+36	131	139	+8	111	117	+6
Feb.	254	75	—179	94	92	—2	120	73	—47	170	72	—98	116	82	—34	73	94	+21	158	149	—9	110	116	+6
Mar.	202	60	—136	104	112	+8	116	119	+3	189	92	—97	100	95	—5	86	89	+3	178	154	—24	107	101	—6
Apr.	282	92	—180	96	80	—16	92	125	+33	253	118	—135	89	106	+17	121	68	—53	166	109	—57	117	78	—39
May	160	128	—32	107	65	—42	105	117	+12	85	123	+38	71	146	+75	117	71	—46	132	84	—48	96	73	—23
June	114	130	+16	104	43	—61	123	128	+5	118	87	—31	123	124	+1	126	79	—47	160	106	—54	85	123	+38
July	83	105	+22	82	74	—8	121	107	—14	135	62	—73	109	92	—17	119	97	—22	174	118	—56	112	147	+35
Aug.	89	104	+15	65	89	+24	137	113	—24	135	58	—77	114	107	—7	106	83	—23	183	177	—6	136	185	+49
Sept.	126	95	—31	95	183	+88	136	113	—23	110	59	—51	114	94	—20	105	79	—26	165	185	+20	148	148	0
Oct.	116	75	—41	79	175	+96	152	150	—2	65	87	+22	144	144	0	83	92	+9	134	182	+48	138	120	—18
Nov.	76	23	—53	78	153	+75	152	168	+16	58	74	+16	110	102	—8	86	94	+8	104	114	+10	145	61	—84
Dec.	75	35	—40	105	82	—23	158	156	—2	67	61	—6	136	158	+22	79	66	—13	95	74	—21	127	67	—60
1956																								
Jan.	141	89	—52	120	86	—34	136	149	+13	61	65	+4	102	101	—1	83	74	—9	102	92	—10	105	85	—20
Feb.	168	98	—70	97	138	+41	118	137	+19	84	100	+16	106	125	+19	98	88	—10	86	120	+34	57	106	+49
Mar.	128	107	—21	103	141	+38	117	91	—26	85	119	+34	57	61	+4	104	73	—31	93	133	+40	71	89	+18
Apr.	94	47	—47	131	130	—1	82	94	+12	81	78	—3	98	109	+11	106	81	—25	119	122	+3	38	74	+36
May	72	38	—34	142	83	—59	46	79	+33	76	63	—13	74	88	+14	108	86	—22	130	118	—12	61	54	—13
June	79	18	—61	171	74	—97	31	68	+37	79	44	—35	94	126	+32	101	84	—17	131	120	—11	87	124	+37
July	88	26	—62	118	67	—51	63	58	—5	79	52	—27	110	119	+9	114	87	—27	96	101	+5	90	135	+45
Aug.	73	25	—48	84	97	+13	74	42	—32	108	76	—32	96	109	+13	109	89	—20	95	94	—1	85	126	+41
Sept.	61	36	—25	81	86	+5	108	105	—3	136	86	—50	79	79	0	118	73	—45	91	76	—15	103	53	—50
Oct.	47	42	—5	96	90	—6	105	87	—18	149	78	—71	93	109	+16	103	64	—39	78	63	—15	124	75	—49
Nov.	88	74	—14	116	91	—25	114	94	—20	139	54	—85	123	110	—13	110	59	—51	91	74	—17	114	114	0
Dec.	64	69	+5	97	93	—4	172	45	—127	134	51	—83	102	129	+27	94	54	—40	124	84	—40	86	128	+42

1957																								
Jan.	93	114	+21	101	80	−21	145	66	−79	124	57	−67	98	62	−36	52	62	+10	87	98	+11	95	108	+13
Feb.	95	98	+3	113	47	−66	118	106	−12	107	62	−45	131	55	−76	41	69	+28	71	72	+1	100	105	+5
Mar.	104	177	+73	130	58	−72	91	115	+24	88	60	−28	119	60	−59	72	98	+26	47	117	+70	84	148	+60
Apr.	119	229	+110	123	97	−26	84	144	+60	90	105	+15	81	88	+7	102	115	+13	58	135	+77	94	204	+110
May	111	240	+129	112	104	−8	45	114	+69	82	100	+18	88	106	+18	135	118	−7	52	179	+127	81	191	+110
June	116	151	+35	124	99	−25	45	127	+82	116	93	−23	78	94	+16	139	114	−25	97	151	+54	103	150	+47
July	65	46	−19	97	60	−37	102	97	−5	86	52	−34	68	79	+11	107	142	+35	109	159	+50	113	72	−41
Aug.	79	60	−19	104	54	−50	133	82	−51	79	99	+20	83	72	−11	122	132	+10	158	152	−6	124	62	−62
Sept.	64	109	+45	111	61	−50	165	83	−82	91	129	+38	110	115	+5	123	126	+3	136	131	−5	125	126	+1
Oct.	92	185	+93	106	71	−35	158	69	−89	113	192	+79	146	111	−35	94	142	+48	117	135	+18	141	128	−13
Nov.	118	162	+44	94	109	+15	117	98	−19	100	149	+49	130	115	−15	71	110	+39	94	156	+62	144	119	−25
Dec.	152	155	+3	120	136	+16	98	104	+6	93	142	+59	164	78	−86	78	126	+48	92	152	+60	118	82	−36
1958																								
Jan.	139	142	+3	106	152	+46	91	133	+42	80	93	+13	121	128	+7	125	107	−18	79	96	+17	102	119	+17
Feb.	163	165	+2	132	122	−10	95	107	+12	105	95	−10	100	116	+16	121	121	0	60	43	−17	98	164	+66
Mar.	160	166	+6	95	103	+8	80	107	+27	92	113	+21	98	103	+5	115	164	+49	50	58	+8	63	139	+76
Apr.	148	124	−24	106	85	−21	79	88	+9	90	92	+2	110	44	−66	134	154	+20	95	91	−4	58	139	+81
May	84	107	+23	134	80	−54	99	116	+17	89	86	−3	131	70	−61	142	144	+2	113	122	+9	58	121	+63
June	66	109	+43	143	87	−56	117	73	−44	93	89	−4	132	79	−53	134	66	−68	146	158	+12	78	145	+67
July	92	114	+22	81	76	−5	119	58	−61	150	93	−57	142	76	−66	118	79	−39	149	162	+13	98	112	+14
Aug.	77	149	+72	83	84	+1	98	33	−65	152	88	−64	118	50	−68	116	83	−33	146	166	+20	109	129	+20
Sept.	85	146	+61	76	80	+4	97	57	−40	157	37	−120	99	45	−54	92	98	+6	136	109	−27	145	96	−49
Oct.	70	135	+65	73	104	+31	88	95	+7	132	26	−106	114	132	+18	89	80	−9	107	96	−11	154	100	−54
Nov.	102	83	−19	64	85	+21	95	91	−4	90	38	−52	100	152	+42	86	60	−26	93	54	−39	163	92	−71
Dec.	123	34	−89	75	81	+6	90	122	+32	72	36	−36	126	141	+15	64	72	+8	83	107	+24	146	139	−7

(*continued*)

Table 10.—*continued*

B

	Detroit, Mich.			Eastport, Maine			El Paso, Tex.			Helena, Mont.		
1950	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	131	193	+62	73	113	+40	76	106	+30	71	73	+2
Feb.	134	177	+43	81	116	+35	61	45	−16	88	92	+4
Mar.	130	171	+41	123	116	−7	75	25	−50	100	91	−9
Apr.	117	125	+8	133	87	−46	111	12	−99	106	107	+1
May	111	108	−3	154	117	−37	105	21	−84	102	100	−2
June	119	91	−28	137	107	−30	93	91	−2	123	74	−49
July	149	80	−69	148	162	+14	73	82	+9	139	111	−28
Aug.	155	89	−66	122	114	−8	114	114	0	127	109	−18
Sept.	143	95	−48	104	102	−2	99	85	−14	152	110	−42
Oct.	124	134	+10	114	111	−3	54	81	+27	157	125	−32
Nov.	107	142	+35	135	181	+46	52	41	−11	159	127	−32
Dec.	104	122	+18	109	194	+85	98	23	−75	134	124	−10
1951												
Jan.	92	114	+22	68	165	+97	102	84	−18	63	61	−2
Feb.	102	114	+12	69	114	+45	133	154	+21	66	69	+3
Mar.	92	119	+27	76	139	+63	157	201	+44	59	109	+50
Apr.	79	102	+23	93	150	+57	165	140	−25	87	114	+27
May	62	95	+33	95	144	+49	178	70	−108	121	98	−23
June	49	107	+58	123	132	+9	165	49	−116	110	89	−21
July	78	110	+32	107	149	+42	96	64	−32	148	143	−5
Aug.	89	106	+17	111	159	+48	102	65	−37	152	144	−8
Sept.	96	129	+33	116	135	+19	30	35	+5	174	133	−41
Oct.	86	141	+55	131	139	+8	27	31	+4	173	76	−97
Nov.	78	168	+90	144	159	+15	78	77	−1	104	106	+2
Dec.	64	149	+85	144	200	+56	93	60	−33	151	75	−76
1952												
Jan.	71	125	+54	95	184	+89	150	142	−8	123	92	−31
Feb.	82	119	+37	73	145	+72	211	203	−8	114	97	−17
Mar.	86	113	+27	63	107	+44	204	370	+166	82	104	+22

	Independence, Kans.			Little Rock, Ark.			Madison, Wis.			Montgomery, Ala.		
1950	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	65	81	+16	177	187	+10	120	135	+15	70	67	−3
Feb.	57	58	+1	181	182	+1	146	131	−15	59	65	+6
Mar.	76	75	−1	123	132	+9	118	116	−2	37	79	+42
Apr.	103	92	−11	119	113	−6	106	100	−6	38	86	+50
May	123	108	−15	112	94	−18	104	121	+17	52	84	+32
June	146	157	+11	108	95	−13	109	164	+55	64	102	+38
July	145	164	+19	91	116	+25	110	169	+59	111	87	−24
Aug.	158	154	−4	122	183	+61	96	136	+40	159	166	+7
Sept.	97	77	−20	135	177	+42	82	74	−8	177	133	−44
Oct.	72	31	−41	141	130	−11	103	57	−46	196	124	−72
Nov.	72	9	−63	127	58	−69	93	84	−9	165	56	−109
Dec.	62	29	−33	125	74	−51	87	103	+16	161	67	−94
1951												
Jan.	76	80	+4	108	77	−31	85	130	+45	143	68	−75
Feb.	73	99	+26	87	78	−9	92	120	+28	125	59	−66
Mar.	66	93	+27	79	75	−4	122	145	+23	98	63	−35
Apr.	87	71	−16	68	52	−16	116	128	+12	82	65	−17
May	123	112	−11	69	79	+10	109	113	+4	32	70	+38
June	146	118	−28	93	133	+40	88	82	−6	57	57	0
July	115	121	+6	93	130	+37	67	94	+27	63	65	+2
Aug.	140	108	−32	97	139	+42	93	96	+3	109	124	+15
Sept.	143	123	−20	107	99	−8	125	148	+23	176	129	−47
Oct.	150	144	−6	109	124	+15	145	147	+2	206	134	−72
Nov.	161	134	−27	142	121	−21	129	158	+29	187	77	−100
Dec.	137	94	−43	135	104	−31	93	119	+26	153	75	−78
1952												
Jan.	108	65	−43	129	112	−17	70	102	+32	130	75	−55
Feb.	102	69	−33	113	108	−5	108	114	+6	96	76	−20
Mar.	62	93	+31	93	111	+18	144	88	−56	58	84	+26

May	103	20	−83	81	130	+49	212	312	+100	29	72	+43	49	44	−5	21	60	+39	124	97	−27	91	93	+2
June	167	72	−95	104	121	+17	173	180	+7	71	75	+4	61	39	−22	30	62	+32	106	146	+40	96	75	−21
July	147	70	−77	102	131	+29	130	146	+16	108	65	−43	68	45	−23	50	56	+6	107	164	+57	121	58	−63
Aug.	154	90	−64	101	99	−2	60	61	+1	109	52	−57	48	41	−7	81	88	+7	77	132	+55	122	71	−51
Sept.	143	76	−67	116	105	−11	31	25	−6	124	52	−72	82	21	−61	79	64	−15	64	67	+3	162	77	−85
Oct.	119	90	−29	105	81	−24	3	23	+20	133	75	−58	104	44	−60	93	92	−1	44	59	+15	128	52	−76
Nov.	130	89	−41	126	95	−31	3	31	+28	112	84	−28	121	63	−58	123	107	−16	74	95	+21	119	81	−38
Dec.	112	98	−14	83	110	+27	36	31	−5	71	90	+19	132	70	−102	111	143	+32	87	106	+19	130	91	−39
1953																								
Jan.	92	71	−21	43	136	+93	79	40	−39	61	104	+43	101	58	−43	93	118	+25	93	118	+25	112	125	+13
Feb.	92	77	−15	40	159	+119	107	47	−60	130	100	−30	124	80	−44	153	134	−19	88	118	+30	153	86	−67
Mar.	101	94	−7	35	163	+128	168	149	−19	112	104	−8	104	109	+5	163	141	−22	84	146	+60	166	125	−41
Apr.	93	111	+18	51	131	+80	165	165	0	91	80	−11	88	99	+11	146	157	+11	64	92	+28	145	109	−36
May	92	111	+19	79	101	+22	198	174	−24	109	100	−9	76	91	+15	89	95	+6	71	88	+17	164	124	−40
June	122	93	−29	122	117	−5	187	92	−95	96	79	−17	83	74	−9	42	58	+16	106	95	−11	124	93	−31
July	117	83	−34	165	133	−32	150	57	−93	74	61	−13	109	65	−44	0	40	+40	119	112	−7	144	78	−66
Aug.	119	69	−50	180	144	−36	110	30	−80	70	44	−26	108	68	−40	0	49	+49	95	54	−41	138	121	−17
Sept.	113	50	−63	119	120	+1	97	47	−50	48	44	−4	156	93	−63	0	55	+55	65	57	−8	115	93	−22
Oct.	95	43	−52	77	116	+39	2	37	+35	12	29	+17	107	111	+4	0	43	+43	33	37	+4	105	106	+1
Nov.	85	41	−44	53	121	+68	20	69	+49	46	43	−3	116	94	−22	1	55	+54	41	66	+15	84	99	+15
Dec.	72	62	−10	54	120	+66	19	42	+23	66	107	+41	63	59	−4	105	97	−8	66	80	+14	65	98	+33
1954																								
Jan.	54	106	+52	63	136	+73	35	42	+7	64	102	+38	78	46	−32	147	116	−31	39	85	+46	87	91	+4
Feb.	13	133	+120	39	119	+80	26	23	−3	92	96	+4	17	39	+22	119	107	−12	61	54	−7	47	52	+5
Mar.	0	140	+140	96	138	+42	49	40	−9	75	50	−25	23	69	+46	107	76	−31	78	101	+23	40	61	+21
Apr.	0	97	+97	162	148	−14	141	158	+17	71	62	−9	71	92	+21	118	91	−27	145	120	−25	52	54	+2
May	21	85	+64	222	189	−33	161	156	−5	55	78	+23	84	94	+10	117	84	−33	162	174	+12	61	42	−19
June	48	69	+21	215	172	−43	144	147	+3	79	104	+25	76	70	−6	113	68	−45	173	145	−28	48	54	+6
July	115	82	−33	181	144	−37	189	86	−103	142	144	+2	104	55	−49	54	22	−32	183	141	−42	12	54	+42
Aug.	131	76	−55	149	118	−31	147	105	−42	148	131	−17	140	61	−79	26	32	+6	175	103	−72	0	45	+45
Sept.	134	140	+6	102	136	+34	99	103	+4	137	120	−17	189	119	−70	11	80	+69	125	120	−5	16	39	+23
Oct.	117	134	+17	98	142	+44	47	47	0	89	89	0	166	99	−61	66	89	+23	85	106	+21	71	46	−25
Nov.	95	131	+36	91	154	+63	55	19	−36	86	73	−13	141	110	−31	105	105	0	62	105	+43	66	68	+2
Dec.	73	76	+3	38	113	+75	94	61	−33	58	46	−12	83	75	−8	115	57	−58	42	71	+29	73	81	+8

(*continued*)

TABLE 10.—*continued*

B

	Detroit, Mich.			Eastport, Maine			El Paso, Tex.			Helena, Mont.			Independence, Kans.			Little Rock, Ark.			Madison, Wis.			Montgomery, Ala.		
1955	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	60	95	+35	45	115	+70	62	66	+4	61	32	−29	89	97	+8	158	82	−76	69	91	+22	94	80	−14
Feb.	74	96	+22	35	99	+64	117	90	−27	102	78	−24	37	86	+49	147	81	−66	103	73	−30	108	66	−42
Mar.	122	93	−29	59	119	+60	134	30	−104	106	111	+5	70	53	−17	214	94	−120	97	109	+12	123	77	−46
Apr.	135	64	−71	72	90	+18	131	58	−73	112	116	+4	102	95	−7	199	125	−74	113	94	−19	168	123	−45
May	94	57	−37	99	75	−24	91	46	−45	105	92	−13	123	113	−10	87	126	+39	147	112	−35	99	151	+52
June	103	41	−62	76	60	−16	110	118	+8	96	121	+25	108	113	+5	74	124	+50	145	91	−54	112	137	+25
July	115	74	−41	89	80	−9	116	101	−15	114	113	−1	112	61	−51	97	68	−29	131	77	−54	135	88	−47
Aug.	118	80	−38	103	89	−14	92	92	0	116	90	−26	139	54	−85	101	95	−6	93	53	−40	127	57	−70
Sept.	114	129	+15	110	87	−23	118	52	−66	156	27	−129	160	130	−30	144	85	−59	86	60	−26	121	45	−76
Oct.	129	117	−12	99	87	−12	93	56	−37	152	78	−74	150	113	−37	138	87	−51	85	62	−23	118	46	−72
Nov.	122	115	−7	66	65	−1	105	45	−60	147	127	−20	111	97	−14	136	44	−92	80	67	−13	117	48	−69
Dec.	108	71	−37	90	113	+23	91	38	−53	132	146	+14	122	27	−95	112	71	−41	76	29	−47	76	41	−35
1956																								
Jan.	76	73	−3	95	102	+7	109	111	+2	92	89	−3	34	44	+10	140	127	−13	76	46	−30	74	55	−19
Feb.	56	103	+57	99	126	+27	122	111	−11	56	53	−3	52	36	−16	141	139	−2	63	74	+11	83	93	+10
Mar.	82	132	+50	92	106	+14	146	95	−51	24	49	+25	58	46	−12	124	131	+7	113	110	−3	94	95	+1
Apr.	95	156	+61	99	129	+30	117	108	−9	45	67	+22	78	49	−29	95	82	−13	123	135	+12	52	74	+22
May	80	120	+40	112	119	+7	122	98	−24	71	73	+2	88	63	−25	98	97	−1	132	119	−13	57	57	0
June	87	88	+1	127	113	−14	122	112	−10	66	76	+10	77	67	−10	63	123	+60	100	118	+18	39	103	+64
July	112	106	−6	97	89	−8	115	125	+10	98	118	+20	79	55	−24	59	124	+65	102	128	+26	109	121	+12
Aug.	146	99	−47	94	95	+1	79	48	−31	136	98	−38	63	45	−18	67	85	+18	88	116	+28	163	169	+6
Sept.	147	94	−53	79	88	+9	58	26	−32	157	119	−38	95	35	−60	72	59	−13	89	78	−11	200	207	+7
Oct.	142	62	−80	83	93	+10	81	14	−67	133	59	−74	104	65	−39	76	77	+1	74	69	−5	208	188	−20
Nov.	113	88	−25	93	101	+8	75	45	−30	127	77	−50	136	90	−36	82	96	+14	102	78	−24	198	173	−25
Dec.	96	109	+13	133	91	−42	57	62	+5	155	71	−84	151	84	−67	129	105	−24	125	81	−44	171	95	−76

1957																								
Jan.	109	91	—18	118	92	—26	45	106	+61	135	82	—53	113	89	—24	130	108	—22	84	39	—45	167	99	—68
Feb.	90	79	—11	70	74	+4	74	100	+26	121	113	—8	94	88	—6	122	123	+1	56	36	—20	146	65	—81
Mar.	87	103	+16	44	88	+44	94	97	+3	98	96	—2	62	116	+54	95	160	+65	65	59	—6	99	100	+1
Apr.	75	104	+29	57	85	+28	87	66	—21	81	138	+57	64	150	+86	88	195	+107	70	106	+36	59	162	+103
May	90	114	+24	77	84	+7	126	29	—97	85	115	+30	105	175	+70	79	186	+107	74	137	+63	44	178	+134
June	80	125	+45	82	81	—1	133	66	—67	70	112	+42	128	163	+35	61	138	+77	99	145	+46	17	141	+124
July	113	119	+6	115	110	—5	100	140	+40	70	108	+39	163	99	—64	53	103	+50	128	140	+12	49	82	+33
Aug.	132	126	—6	127	102	—25	84	142	+60	90	130	+40	178	71	—107	82	99	+17	144	98	—46	89	147	+58
Sept.	136	126	—10	134	85	—49	93	192	+99	109	169	+60	171	83	—88	106	128	+22	141	92	—49	94	140	+46
Oct.	117	149	+32	153	79	—74	59	171	+112	127	143	+16	139	111	—28	144	159	+15	125	94	—31	140	182	+42
Nov.	96	180	+84	130	117	—13	38	170	+132	126	107	—19	133	102	—31	161	168	+7	112	116	—4	139	101	—38
Dec.	91	127	+36	105	189	+84	35	119	+84	132	54	—78	109	79	—30	163	139	—24	97	94	—3	169	104	—65
1958																								
Jan.	90	91	+1	74	169	+95	77	160	+83	73	78	+5	98	52	—46	161	80	—81	94	43	—57	121	73	—48
Feb.	111	29	—82	69	137	+68	106	426	+320	69	114	+45	75	94	+19	135	78	—57	72	18	—54	118	107	—11
Mar.	103	37	—66	64	103	+39	120	375	+255	90	137	+47	101	107	+6	130	103	—27	89	42	—47	79	117	+38
Apr.	109	38	—71	84	129	+45	104	273	+169	87	106	+19	87	123	+36	132	141	+9	115	89	—26	75	121	+46
May	90	60	—30	91	138	+47	113	133	+20	130	117	—13	94	87	—7	111	171	+60	117	89	—28	88	90	+2
June	91	72	—19	98	149	+51	179	159	—20	124	117	—7	94	147	+53	119	153	+34	119	71	—48	98	112	+14
July	98	88	—10	115	124	+9	126	178	+52	122	119	—3	132	120	—12	74	138	+64	82	55	—27	138	86	—52
Aug.	89	110	+21	126	123	—3	97	243	+146	149	72	—77	179	189	+10	65	167	+102	93	61	—32	132	112	—20
Sept.	105	92	—13	122	109	—13	127	303	+176	131	48	—83	133	59	—74	77	132	+55	115	82	—33	160	72	—88
Oct.	114	109	—5	134	122	—12	107	296	+189	119	58	—61	93	59	—34	89	136	+47	116	102	—14	170	91	—79
Nov.	105	68	—37	126	111	—15	96	104	+8	107	97	—10	67	30	—37	106	57	—49	104	86	—18	138	56	—82
Dec.	88	88	0	121	117	—4	120	32	—88	95	106	+11	21	39	+18	96	59	—37	72	75	+3	113	69	—44

(continued)

TABLE 10.—*continued*

C

	Nasbville, Tenn.			Natural Bridge, Ariz.			Omaha, Nebr.			Peoria, Ill.			Port Gibson, Miss.			Rochester, N. Y.			Sacramento, Calif.			Salisbury, N. C.		
1950	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	165	189	+24	159	107	−52	109	97	−12	148	228	+80	135	125	−10	124	142	+18	120	95	−25	68	52	−16
Feb.	135	161	+26	139	76	−63	97	107	+10	159	137	−22	163	135	−28	112	166	+54	168	103	−65	79	66	−13
Mar.	63	102	+39	94	48	−46	88	90	+2	109	147	+38	117	120	+3	94	144	+50	184	91	−93	56	61	+5
Apr.	41	75	+34	67	28	−39	95	86	−9	64	109	+45	109	134	+25	74	109	+35	177	75	−102	73	102	+29
May	56	91	+35	53	23	−30	104	81	−25	60	135	+75	97	132	+35	68	105	+37	114	71	−43	60	98	+38
June	85	144	+59	40	80	+40	95	122	+27	69	97	+28	106	172	+66	91	117	+26	109	43	−66	75	115	+40
July	108	180	+72	100	84	−16	106	141	+35	73	104	+31	128	142	+14	119	113	−6	69	23	−46	98	71	−27
Aug.	134	179	+45	135	79	−56	72	133	+61	107	90	−17	152	157	+5	111	90	−21	80	104	+24	103	76	−27
Sept.	129	134	+5	110	21	−89	74	115	+41	124	60	−64	125	109	−16	130	98	−32	101	181	+80	115	74	−41
Oct.	113	121	+8	8	23	+15	54	62	+8	117	70	−47	116	94	−22	155	145	−10	119	271	+152	117	86	−31
Nov.	104	102	−2	0	12	+12	50	64	+14	152	53	−99	120	79	−41	176	148	−28	177	212	+35	103	76	−27
Dec.	130	150	+20	24	56	+32	55	47	−8	163	70	−93	152	87	−65	141	139	−2	190	157	−33	96	62	−34
1951																								
Jan.	128	114	−14	0	61	+61	107	108	+1	154	104	−50	167	108	−59	108	106	−2	155	85	−70	107	57	−50
Feb.	135	128	−7	15	84	+69	157	194	+37	139	128	−11	173	129	−44	98	133	+35	144	51	−93	128	67	−61
Mar.	97	98	+1	47	119	+72	166	241	+75	142	139	+3	131	117	−14	94	144	+50	100	52	−48	133	100	−33
Apr.	79	82	+3	84	157	+73	175	234	+59	161	98	−63	85	81	−4	94	129	+35	86	69	−17	110	87	−23
May	120	113	−7	154	134	−20	130	179	+49	150	87	−63	69	104	+35	78	122	+44	41	58	+17	97	95	−2
June	140	104	−36	110	61	−39	144	143	−1	118	107	−11	65	122	+57	63	117	+54	0	35	+35	71	74	+3
July	128	107	−21	124	94	−30	114	153	+39	79	123	+44	60	122	+62	86	105	+19	0	0	0	71	75	+4
Aug.	115	75	−40	125	99	−26	122	147	+25	81	114	+33	61	120	+59	92	83	−9	15	42	+27	84	58	−26
Sept.	111	99	−12	116	132	+16	114	124	+10	98	102	+4	55	76	+21	116	62	−54	74	99	+25	92	32	−60
Oct.	105	127	+22	57	100	+43	75	61	−14	132	99	−33	88	93	+5	125	104	−21	141	167	+26	131	68	−63
Nov.	121	178	+57	102	163	+61	106	68	−38	135	95	−40	117	81	−36	141	117	−24	96	174	+78	168	101	−67
Dec.	113	155	+42	106	163	+57	130	82	−48	122	78	−44	105	96	−9	118	126	+8	132	195	+63	172	130	−42
1952																								
Jan.	132	150	+18	134	118	−16	160	93	−67	81	73	−8	56	103	+47	70	109	+39	126	146	+20	159	123	−36
Feb.	131	133	+2	128	126	−2	141	123	−18	106	103	−3	83	68	−15	64	98	+34	153	156	+3	167	160	−7

May	62	49	−13	74	83	+9	87	112	+25	78	111	+33	82	67	−15	97	85	−12	157	246	+89	115	66	−49
June	55	43	−12	34	40	+6	74	103	+29	95	99	+4	57	57	0	105	78	−27	141	445	+304	111	58	−53
July	73	63	−10	125	63	−62	69	138	+69	88	120	+32	18	43	+25	105	55	−50	71	442	+371	130	92	−38
Aug.	97	97	0	190	99	−91	84	119	+35	94	91	−3	39	49	+10	123	86	−37	73	246	+173	114	90	−24
Sept.	104	103	−1	184	61	−123	88	93	+5	64	80	+16	68	35	−33	120	74	−46	103	8	−95	104	79	−25
Oct.	98	79	−19	138	133	−5	95	86	−9	51	71	+20	90	35	−55	102	89	−13	106	52	−54	111	59	−52
Nov.	102	61	−41	101	134	+33	115	109	−6	51	87	+36	105	75	−30	86	75	−11	133	114	−19	120	83	−37
Dec.	114	90	−24	134	146	+12	112	127	+15	68	96	+28	105	95	−10	66	89	+23	148	145	−3	92	101	+9
1953																								
Jan.	118	95	−23	77	62	−15	68	92	+24	58	68	+10	119	122	+3	57	80	+23	109	105	−4	93	121	+29
Feb.	150	106	−44	90	53	−37	131	87	−44	77	89	+12	89	108	+19	58	91	+33	158	56	−102	113	114	+1
Mar.	81	94	+13	110	65	−45	126	111	−15	99	98	−1	149	149	0	83	78	−5	172	98	−74	72	100	+28
Apr.	115	118	+3	132	61	−71	123	99	−24	115	104	−11	143	172	+29	105	109	+4	131	129	−2	31	60	+29
May	80	102	+22	158	39	−119	120	90	−30	145	81	−64	199	160	−39	117	95	−22	108	173	+65	16	67	+51
June	81	122	+41	131	48	−83	87	59	−28	141	107	−34	127	117	−10	127	98	−29	23	99	+76	35	74	+39
July	35	83	+48	33	69	+36	37	53	+16	133	105	−28	74	76	+2	132	92	−40	4	66	+62	55	90	+35
Aug.	0	75	+75	66	61	−5	10	30	+20	117	91	−26	16	65	+49	129	114	−15	0	0	0	92	95	+3
Sept.	0	26	+26	53	30	−23	0	35	+35	93	45	−48	51	59	+8	104	112	+8	0	8	+8	119	71	−48
Oct.	0	24	+24	50	13	−37	2	93	+91	55	33	−22	70	48	−22	78	99	+21	47	41	−6	116	55	−61
Nov.	23	40	+17	71	23	−48	42	130	+88	53	59	+6	60	61	+1	71	81	+10	119	47	−72	128	58	−70
Dec.	94	90	−4	129	73	−56	38	126	+88	55	70	+15	39	56	+17	46	80	+34	167	72	−95	163	121	−42
1954																								
Jan.	102	113	+11	78	80	+2	100	135	+35	67	112	+45	17	79	+62	78	76	−2	166	84	−82	172	128	−44
Feb.	97	113	+16	121	133	+12	121	108	−13	73	107	+34	44	84	+40	83	94	+11	242	127	−115	112	107	−5
Mar.	95	90	−5	144	80	−64	133	142	+9	91	146	+55	53	53	0	118	110	−8	228	146	−82	81	76	−5
Apr.	135	93	−42	106	158	+52	99	94	−5	109	121	+12	109	127	+18	91	98	+7	156	114	−42	78	87	+9
May	116	90	−26	86	146	+60	122	103	−19	132	140	+8	76	110	+34	84	80	−4	91	65	−20	47	92	+45
June	78	62	−16	83	197	+114	120	65	−55	118	114	−4	80	111	+31	68	65	−3	62	14	−48	48	94	+46
July	49	42	−7	67	144	+77	167	100	−67	98	188	+90	83	72	−11	96	88	−8	26	0	−26	42	88	+46
Aug.	95	61	−34	14	137	+123	180	91	−89	76	138	+62	181	124	−57	133	88	−45	23	0	−23	43	64	+21
Sept.	133	101	−32	70	104	+34	199	148	−51	91	146	+55	176	133	−43	173	131	−42	51	1	−50	118	106	−12
Oct.	124	100	−24	80	74	−6	157	80	−77	99	82	−17	131	118	−13	207	119	−88	99	62	−37	144	132	−12
Nov.	111	100	−11	156	28	−128	87	68	−19	99	108	+9	72	72	0	206	136	−70	138	118	−20	151	158	+7
Dec.	92	64	−28	140	66	−74	77	40	−37	99	125	+26	49	71	+22	135	87	−48	200	148	−52	104	104	0

(continued)

TABLE 10.—*continued*

C

	Nashville, Tenn.			Natural Bridge, Ariz.			Omaha, Nebr.			Peoria, Ill.		
	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
1955												
Jan.	130	104	−26	16	82	+66	107	83	−24	93	135	+42
Feb.	168	121	−47	32	82	+50	126	96	−30	97	122	+25
Mar.	169	147	−22	123	49	−74	105	114	+9	94	104	+10
Apr.	128	121	−7	176	32	−144	124	82	−42	111	88	−23
May	74	87	+13	83	150	+67	130	100	−30	118	94	−24
June	81	67	−14	71	185	+114	73	83	+10	80	60	−20
July	99	85	−14	160	239	+79	99	86	−13	67	83	+17
Aug.	121	106	−15	196	119	−77	82	95	+13	58	82	+24
Sept.	145	118	−27	154	61	−93	106	64	−42	90	129	+39
Oct.	127	108	−19	58	37	−21	62	50	−12	76	87	+11
Nov.	122	72	−50	20	83	+63	48	16	−32	86	69	−17
Dec.	108	83	−25	74	91	+17	62	38	−24	96	20	−76
1956												
Jan.	129	126	−3	49	81	+32	117	49	−68	120	30	−90
Feb.	126	142	+16	42	35	−7	88	42	−46	121	31	−90
Mar.	109	140	+31	38	55	+17	104	28	−76	99	55	−44
Apr.	81	89	+8	78	35	−43	73	29	−44	80	76	−4
May	85	83	−2	69	55	−14	67	48	−19	76	77	+1
June	54	63	+9	94	46	−48	27	88	+61	71	93	+22
July	65	58	−7	86	60	−26	61	116	+55	51	100	+49
Aug.	67	40	−27	87	43	−44	99	118	+19	37	96	+59
Sept.	87	50	−37	87	44	−43	91	91	0	74	62	−12
Oct.	89	45	−44	84	27	−57	91	100	+9	89	45	−44
Nov.	112	102	−10	61	31	−30	79	85	+6	75	74	−1
Dec.	97	138	+41	90	67	−23	75	71	−4	52	92	+40

	Port Gibson, Miss.			Rochester, N. Y.			Sacramento, Calif.			Salisbury, N. C.		
	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
1955												
Jan.	47	78	+31	98	77	−21	159	104	−55	67	85	−18
Feb.	63	69	+6	76	80	+4	147	53	−94	49	72	−23
Mar.	77	85	+8	115	105	−10	126	97	−29	44	88	−44
Apr.	132	101	+31	111	101	−10	110	117	+7	65	87	−22
May	107	97	−10	92	69	−23	78	117	+39	110	96	−14
June	109	119	+10	63	41	−22	9	41	+32	116	87	−29
July	118	99	−19	85	87	+2	0	5	+5	107	93	−14
Aug.	105	115	+10	119	97	−22	0	101	+101	106	87	−19
Sept.	128	76	−52	130	173	+43	19	125	+106	99	108	+9
Oct.	117	76	−41	138	135	−3	111	150	+39	106	99	−7
Nov.	84	76	−8	112	137	+25	147	131	−16	79	79	0
Dec.	109	61	−48	107	77	−30	189	175	−14	58	42	−16
1956												
Jan.	132	87	−45	90	94	+4	177	178	+1	66	67	+1
Feb.	135	119	−16	93	110	+17	165	96	−69	76	92	+16
Mar.	145	124	−21	101	140	+39	154	78	−76	61	112	+51
Apr.	116	101	−15	117	142	+25	159	104	−55	52	99	+47
May	104	88	−16	122	112	−10	96	103	+7	64	84	+20
June	53	81	+28	94	87	−7	53	52	−1	73	102	+29
July	25	76	+51	102	111	+9	38	0	−38	68	76	+8
Aug.	35	52	+17	136	149	+13	31	101	+70	122	150	+28
Sept.	80	92	+12	124	129	+5	26	158	+132	140	133	−7
Oct.	110	92	−18	95	81	−14	67	159	+92	146	148	+2
Nov.	137	125	−12	80	61	−19	79	60	−19	139	92	−47
Dec.	127	93	−34	93	83	−10	26	26	0	141	88	−53

1957																								
Jan.	125	165	+40	92	88	−4	107	27	−80	86	76	−10	146	97	−49	96	84	−12	92	71	−21	116	126	+10
Feb.	136	124	−12	90	95	+5	145	92	−53	99	75	−24	142	94	−48	60	75	+15	135	99	−36	123	125	+2
Mar.	144	85	−59	90	37	−57	168	106	−62	120	94	−26	127	120	−7	80	79	−1	186	122	−64	116	128	+12
Apr.	101	117	+16	67	72	+5	141	149	+8	154	146	−8	87	112	+25	89	94	+5	196	172	−24	119	97	−22
May	83	160	+77	93	128	+35	119	125	+6	163	138	−25	46	137	+91	117	115	−2	180	142	−38	110	125	+15
June	63	152	+89	126	159	+33	42	113	+71	167	106	−61	57	105	+48	98	101	+3	106	97	−9	126	115	−11
July	90	106	+16	118	143	+25	78	144	+66	133	66	−67	86	86	0	87	78	−9	44	0	−44	104	100	−4
Aug.	108	89	−19	114	81	−33	128	124	−4	132	47	−85	77	67	−10	80	69	−11	23	23	0	111	105	−6
Sept.	112	124	+12	99	111	+12	128	164	+36	130	90	−40	108	81	−27	84	57	−27	31	80	+49	88	104	+16
Oct.	122	154	+32	133	120	−13	49	144	+95	97	108	+11	102	160	+58	108	70	−38	69	87	+18	98	175	+77
Nov.	128	162	+34	113	134	+21	96	132	+36	79	158	+79	149	147	−2	82	63	−19	83	94	+11	88	138	+50
Dec.	122	129	+7	101	69	−32	91	123	+32	91	118	+27	187	146	−41	96	89	−7	118	85	−33	101	157	+56
1958																								
Jan.	100	84	−16	111	64	−47	119	95	−24	133	93	−40	184	79	−105	87	120	+33	182	180	−2	100	95	−5
Feb.	99	56	−43	111	102	−9	147	102	−45	130	36	−94	154	86	−68	81	150	+69	193	229	+36	77	96	+19
Mar.	89	93	+4	87	137	+50	136	107	−29	151	39	−112	90	97	+7	87	155	+68	178	301	+123	68	132	+64
Apr.	83	104	+21	121	137	+16	94	93	−1	115	55	−60	87	104	+17	86	121	+35	153	238	+85	73	134	+61
May	68	107	+39	153	155	+2	62	79	+17	107	89	−18	60	131	+71	76	118	+42	86	282	+96	99	156	+57
June	67	106	+39	133	121	−12	62	117	+55	101	144	+43	62	126	+64	80	120	+40	21	162	+141	88	108	+20
July	98	137	+39	74	92	+18	73	133	+60	102	154	+52	82	132	+50	106	129	+23	36	156	+120	96	105	+9
Aug.	110	142	+32	94	120	+26	89	172	+83	82	145	+63	88	131	+43	122	124	+2	69	54	−15	113	96	−17
Sept.	118	106	−12	123	133	+10	89	84	−5	103	79	−24	104	104	0	133	141	+8	108	72	−36	144	85	−59
Oct.	115	80	−35	135	135	0	106	80	−26	95	71	−24	110	107	−3	146	148	+2	148	42	−106	165	68	−97
Nov.	127	60	−67	131	32	−99	92	31	−61	83	49	−34	131	55	−76	154	108	−46	169	28	−141	151	87	−64
Dec.	124	68	−56	85	29	−56	69	51	−18	67	79	+12	108	70	−38	126	97	−29	167	58	−109	32	79	+47

(*continued*)

TABLE 10.—*continued*

D

	Salt Lake, Utah			San Bernardino, Calif.			Santa Fe, N. Mex.			Spokane, Wash.			St. Louis, Mo.			St. Paul, Minn.			Thomasville, Ga.			Washington, D. C.		
1950	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
Jan.	103	107	+4	88	81	—7	106	100	—6	107	127	+20	108	204	+96	125	93	—32	62	30	—32	85	67	—18
Feb.	66	90	+24	104	65	—39	149	63	—86	111	198	+87	132	184	+52	137	106	—31	95	71	—24	65	38	—27
Mar.	51	69	+18	89	61	—28	168	37	—131	120	145	+25	115	113	—2	120	104	—16	107	112	+5	54	89	+35
Apr.	73	80	+7	81	46	—35	153	12	—141	120	126	+6	117	98	—19	108	83	—25	128	131	+3	71	119	+48
May	69	69	0	37	50	+13	144	49	—95	142	106	—36	138	96	—42	143	93	—50	80	91	+11	79	100	+21
June	96	114	+18	58	28	—30	149	99	—50	147	127	—20	142	74	—78	138	77	—61	73	81	+8	93	113	+20
July	113	75	—38	99	17	—82	107	110	+3	123	137	+14	141	119	—22	116	67	—49	68	72	+4	43	104	+61
Aug.	145	130	—15	83	0	—83	104	98	—6	70	66	—4	124	117	—7	121	62	—59	83	66	—17	18	148	+130
Sept.	149	76	—73	118	2	—116	73	38	—35	84	112	+28	100	113	+13	106	68	—38	95	69	—26	36	155	+119
Oct.	139	123	—16	114	68	—46	101	29	—72	109	118	+9	84	73	—11	105	83	—22	89	58	—31	87	149	+62
Nov.	127	74	—53	76	68	—8	65	4	—61	131	148	+17	50	56	+6	103	81	—22	101	75	—26	79	115	+36
Dec.	114	100	—14	55	100	+45	54	12	—42	132	119	—13	99	76	—23	94	106	+12	100	48	—52	84	102	+18
1951																								
Jan.	83	68	—15	41	42	+1	70	24	—46	95	115	+20	102	119	+17	83	133	+50	143	54	—89	94	95	+1
Feb.	68	79	+11	39	49	+10	75	40	—35	71	126	+55	115	132	+17	94	137	+43	181	98	—83	80	85	+5
Mar.	55	84	+29	14	60	+46	71	49	—22	59	86	+27	106	120	+24	108	122	+14	180	110	—70	94	100	+6
Apr.	60	84	+24	13	119	+106	64	66	+2	54	72	+18	132	55	—77	124	139	+15	198	109	—89	93	98	+5
May	30	65	+35	31	112	+81	87	59	—28	26	56	+30	122	81	—41	122	138	+16	161	93	—68	58	148	+90
June	36	90	+54	20	100	+80	118	54	—64	33	67	+34	122	98	—24	109	112	+3	122	96	—26	45	127	+82
July	69	147	+78	47	48	+1	116	90	—26	66	78	+12	120	107	—13	116	134	+18	92	96	+4	94	115	+21
Aug.	107	143	+36	120	102	—18	49	86	+37	59	71	+12	128	96	—32	127	123	—4	65	76	+11	94	55	—39
Sept.	146	120	—26	121	107	—14	44	87	+43	81	129	+48	130	94	—36	109	127	+18	69	66	+3	87	55	—32
Oct.	145	84	—61	155	144	—11	48	32	—16	114	134	+20	123	109	—14	103	116	+13	120	129	+9	112	102	—10
Nov.	173	156	—17	158	164	+6	59	43	—16	161	180	+19	88	104	+16	105	126	+21	114	141	+27	96	135	+39
Dec.	151	163	+12	195	195	0	67	53	—14	159	138	—21	70	89	+19	92	112	+20	107	136	+29	111	163	+52
1952																								
Jan.	132	170	+38	157	148	—9	48	42	—6	108	181	+73	51	80	+29	84	138	+54	109	109	0	118	122	+4
Feb.	97	162	+65	121	138	+17	62	57	—5	62	94	+32	60	81	+21	84	114	+30	114	105	—9	136	114	—22
Mar.	71	141	+70	85	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

May	51	99	+48	77	50	−27	113	69	−44	85	89	+4	117	69	−48	83	115	+32	133	111	−22	122	146	+24
June	77	136	+59	81	64	−17	117	62	−55	92	83	−9	136	69	−67	99	101	+2	123	105	−18	127	101	−26
July	82	124	+42	92	64	−28	131	65	−66	76	79	+3	153	86	−67	142	98	−44	103	105	+2	142	110	−32
Aug.	90	78	−12	130	189	+59	104	76	−28	65	38	−27	138	70	−68	132	75	−57	90	119	+29	125	124	−1
Sept.	91	8	−83	130	124	−6	111	55	−56	76	38	−38	139	43	−96	115	75	−40	89	109	+20	77	104	+27
Oct.	101	26	−75	161	235	+74	100	40	−60	109	40	−69	104	46	−58	89	54	−35	71	62	−9	65	136	+71
Nov.	133	55	−78	127	155	+28	109	42	−67	140	64	−76	74	62	−12	89	40	−49	55	45	−10	80	135	+55
Dec.	140	120	−20	122	175	+53	93	58	−35	149	131	−18	79	83	+4	85	64	−21	78	59	−19	125	164	+39
1953																								
Jan.	134	104	−30	142	67	−75	59	59	0	160	143	−17	73	74	+1	80	104	+24	109	103	−6	108	100	−8
Feb.	88	91	+3	112	43	−69	72	73	+1	125	145	+20	107	89	−18	99	105	+6	99	95	−4	139	120	−19
Mar.	88	73	−15	110	80	−30	47	67	+20	119	124	+5	42	97	+55	79	109	+30	108	146	+38	110	125	−15
Apr.	90	85	−5	63	102	+39	76	72	−4	94	143	+49	66	101	+35	74	133	+29	177	94	−83	108	154	+46
May	47	92	+45	20	82	+62	118	48	−70	65	119	+54	53	77	+24	67	150	+83	181	133	−48	77	119	+42
June	57	99	+42	0	26	+26	138	110	−28	47	69	+22	28	52	+24	83	128	+45	143	86	−57	75	103	+28
July	43	119	+76	0	19	+19	127	99	−28	112	97	−15	34	33	−1	82	113	+31	119	136	+17	81	65	−16
Aug.	46	104	+58	0	19	+19	86	112	+26	136	92	−44	39	21	−18	72	102	+30	129	136	+7	97	80	−17
Sept.	18	56	+38	73	22	−51	104	58	−46	123	97	−26	100	52	−48	47	90	+43	107	117	+10	91	84	−7
Oct.	10	40	+30	99	25	−74	105	106	+1	100	62	−38	108	54	−54	3	85	+82	58	96	+38	139	89	−50
Nov.	14	56	+42	115	29	−86	76	121	+45	76	72	−4	127	55	−72	3	73	+70	71	120	+49	85	87	+2
Dec.	30	73	+43	178	99	−79	96	127	+31	170	135	−35	82	43	−39	42	78	+36	86	127	+41	108	189	+81
1954																								
Jan.	35	68	+33	202	106	−96	71	70	−1	144	127	−17	27	41	+14	73	110	+37	52	98	+46	108	76	−32
Feb.	50	72	+22	251	169	−82	55	96	+41	101	119	+18	16	45	+29	69	119	+50	11	45	+34	70	71	+1
Mar.	97	59	−38	224	103	−121	94	72	−22	23	70	+47	39	48	+9	87	97	+10	0	58	+58	42	71	+29
Apr.	135	51	−84	178	76	−102	186	126	−60	3	62	+59	82	62	−20	89	115	+26	54	75	+21	50	90	+40
May	187	103	−84	183	74	−109	220	101	−119	32	62	+30	106	73	−33	107	115	+8	53	68	+15	19	78	+59
June	225	154	−71	187	129	−58	264	149	−115	82	101	+19	106	67	−39	121	101	−20	87	58	−29	86	50	−36
July	242	225	−17	219	128	−91	220	146	−74	183	146	−37	106	84	−22	147	91	−56	64	48	−16	36	60	+24
Aug.	234	179	−55	139	63	−76	180	129	−51	148	185	+37	142	106	−36	171	87	−84	47	40	−7	23	48	+25
Sept.	171	129	−42	135	0	−135	82	105	+23	128	148	+20	186	134	−52	176	73	−103	38	33	−5	102	77	−25
Oct.	101	88	−13	175	73	−102	40	54	+14	127	108	−19	171	112	−59	138	71	−67	26	66	+40	119	73	−46
Nov.	54	73	+19	201	90	−111	51	48	−3	103	69	−34	129	99	−30	128	62	−66	44	90	+46	141	95	−46
Dec.	51	98	+47	221	137	−84	50	80	+30	81	71	−10	84	76	−8	101	79	−22	61	120	+59	93	56	−37

(continued)

TABLE 10.—*continued*

D

	Salt Lake, Utah			San Bernardino, Calif.			Santa Fe, N. Mex.			Spokane, Wash.		
	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
1955												
Jan.	110	87	−23	127	82	−45	61	87	+26	130	77	−53
Feb.	131	74	−57	72	71	−1	100	77	−23	80	75	−5
Mar.	155	73	−82	43	43	0	109	59	−50	87	115	+28
Apr.	181	64	−117	0	111	+111	153	78	−85	61	101	+40
May	88	102	+14	94	127	+33	158	78	−80	100	100	0
June	75	117	+42	78	184	+106	146	70	−76	125	118	−7
July	89	110	+21	79	98	+19	132	79	−53	117	100	−17
Aug.	97	103	+6	80	78	−2	143	98	−45	140	127	−13
Sept.	113	74	−39	76	2	−74	95	77	−18	136	130	−6
Oct.	145	110	−35	86	66	−20	81	37	−44	160	184	+24
Nov.	166	102	−64	94	84	−10	47	64	+17	161	193	+32
Dec.	183	138	−45	105	161	+56	28	98	+70	180	158	−22
1956												
Jan.	146	111	−36	136	102	−34	80	108	+28	153	132	−21
Feb.	97	86	−11	133	82	−51	90	53	−37	92	107	+15
Mar.	64	55	−9	93	48	−49	79	12	−67	68	63	−5
Apr.	59	71	+12	88	75	−13	60	31	−29	41	50	+9
May	62	97	+35	116	75	−41	82	53	−29	32	49	+17
June	43	75	+32	126	257	+131	112	80	−32	55	77	+22
July	42	34	−8	115	225	+110	95	71	−24	127	161	+34
Aug.	76	11	−65	121	225	+104	95	50	−25	135	134	−1
Sept.	91	51	−40	134	28	−106	92	30	−62	151	157	+6
Oct.	93	64	−29	95	28	−67	73	14	−59	150	64	−86
Nov.	109	100	−9	53	34	−19	114	28	−86	153	78	−75
Dec.	113	88	−25	51	73	+22	151	70	−81	156	46	−110

	St. Louis, Mo.			St. Paul, Minn.			Thomasville, Ga.			Washington, D. C.		
	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ	Fore-cast	Ob-served	Δ
1955												
Jan.	117	100	−17	99	75	−24	78	87	+9	59	75	+16
Feb.	123	91	−32	109	74	−35	141	62	−79	70	176	+106
Mar.	137	91	−46	81	71	−10	165	72	−93	69	100	+31
Apr.	104	64	−40	77	68	−9	235	92	−143	42	82	+40
May	117	63	−54	137	73	−60	131	104	−27	96	86	−10
June	149	93	−56	139	82	−57	106	107	+1	161	104	−57
July	158	99	−59	127	80	−47	100	76	−24	187	192	+5
Aug.	123	120	−3	109	96	−13	96	82	−14	154	165	+11
Sept.	104	112	+8	114	104	−10	86	68	−18	134	181	+47
Oct.	81	119	+38	105	83	−22	97	72	−25	77	91	+14
Nov.	75	77	+2	88	76	−12	109	61	−48	87	87	0
Dec.	54	38	−16	85	73	−12	120	69	−51	81	47	−34
1956												
Jan.	48	58	+10	92	73	−19	146	109	−37	134	69	−65
Feb.	70	69	−1	102	65	−37	134	124	−10	130	100	−30
Mar.	125	86	−39	120	54	−66	150	107	−43	125	96	−29
Apr.	113	74	−39	97	75	−22	126	104	−22	89	82	−7
May	95	81	−14	83	104	+21	129	126	−3	100	76	−24
June	70	131	+61	100	115	+15	105	128	+23	123	97	−26
July	82	116	+34	90	115	+25	108	97	−11	109	92	−17
Aug.	85	109	+24	78	119	+41	116	116	0	78	99	+21
Sept.	76	40	−36	92	106	+14	98	126	+28	96	91	−5
Oct.	62	49	−13	100	76	−24	112	120	+8	106	108	+2
Nov.	82	92	+10	99	51	−48	86	62	−24	119	102	−17
Dec.	67	99	+32	106	63	−43	69	23	−46	85	92	+7

1957																								
Jan.	118	92	—26	84	91	+7	102	105	+3	144	69	—75	98	129	+31	106	61	—45	90	26	—64	99	94	—5
Feb.	155	90	—65	103	97	—6	67	158	+91	125	96	—29	92	99	+7	91	55	—36	97	56	—41	104	83	—21
Mar.	123	113	—10	84	58	—26	36	149	+113	107	98	—9	90	148	+58	71	69	—2	113	84	—29	121	88	—33
Apr.	90	157	+67	82	98	+16	36	148	+112	94	161	+67	100	154	+54	76	81	+5	107	121	+14	113	83	—30
May	62	183	+121	58	244	+186	53	92	+39	42	182	+140	108	241	+133	86	104	+18	101	131	+30	98	86	—12
June	69	146	+77	76	216	+140	117	88	+29	42	160	+118	125	205	+80	114	123	+9	96	118	+22	67	61	—6
July	78	153	+75	103	157	+54	128	105	+23	64	71	+7	128	162	+34	112	123	+11	68	91	+23	106	50	—56
Aug.	108	101	—7	117	0	—117	147	98	—48	93	30	—63	133	58	—85	135	118	—17	54	127	+73	95	62	—33
Sept.	98	100	+2	100	134	+34	153	167	+14	100	17	—83	134	64	—70	161	120	—41	51	135	+84	109	81	—28
Oct.	94	63	—31	97	162	+65	136	193	+57	99	99	0	128	86	—42	150	85	—65	51	184	+133	98	106	+8
Nov.	90	92	+2	100	220	+120	88	202	+114	103	101	—2	110	118	+8	121	54	—67	59	114	+55	118	137	+19
Dec.	147	94	—53	127	105	—22	94	134	+40	125	101	—24	105	115	+10	111	48	—63	54	119	+65	109	143	+34
1958																								
Jan.	128	115	—13	131	144	+13	53	96	+43	122	149	+27	122	77	—45	91	37	—54	83	75	—8	131	142	+11
Feb.	92	114	+22	154	164	+10	53	155	+102	110	140	+30	122	75	—47	87	35	—52	101	88	—13	106	151	+45
Mar.	46	144	+78	152	243	+91	53	166	+113	79	134	+55	96	71	—25	124	39	—85	140	122	—18	103	165	+62
Apr.	51	96	+45	97	206	+109	102	125	+23	63	91	+28	76	87	+11	118	44	—74	153	134	—19	63	146	+83
May	69	50	—19	72	128	+56	112	77	—35	86	110	+24	59	76	+17	103	59	—44	117	152	+35	86	96	+10
June	72	10	—62	85	30	—55	129	38	—91	94	125	+31	92	131	+39	108	73	—35	106	128	+22	125	108	—17
July	94	6	—88	92	178	+86	165	94	—71	101	117	+16	109	139	+30	111	63	—48	94	110	+16	144	142	—2
Aug.	116	5	—111	91	396	+305	173	118	—55	138	95	—43	112	153	+41	90	69	—21	106	85	—21	125	130	+5
Sept.	127	2	—125	89	404	+415	190	150	—40	124	47	—77	126	91	—35	101	74	—27	135	62	—73	115	96	—19
Oct.	139	28	—111	131	232	+101	171	128	—43	106	99	—7	104	106	+2	100	58	—42	147	60	—87	122	63	—59
Nov.	135	40	—95	143	13	—130	107	95	—12	121	126	+5	71	66	—5	92	42	—50	134	56	—78	141	64	—77
Dec.	135	52	—83	161	20	—141	63	70	+7	109	187	+78	65	68	+3	68	47	—21	98	49	—49	140	65	—75

of discrepancies from pages 2-3 of my paper cited in footnote 1, d, above:

8. Of 100 years of St. Louis precipitation forecasted, 70 seem fairly satisfactory and yield high correlation coefficients with the events. The failure of the other 30 is reasonably explained.

9. As shown by Dr. W. J. Humphreys in his "Physics of the Air," figure 227, great volcanic eruptions, which throw high columns of vapor and dust, profoundly modify weather. He cites the first four cases in the following list [here my table 11], and I add several more.

TABLE 11.—*Great atmospheric disturbing causes*

Approximate dates	Volcanic eruptions
1856	Cotopaxi and others.
1883-1890	Krakatoa and others.
1901-1904	Pele, Santa Maria, Colima, and others.
1912	Katmai.
1924 and 1928	Many great eruptions.
1930	Great eruptions.
1947	Niuafoo Island.

10. Of 30 unsatisfactory years, in 100 years of synthesis of St. Louis precipitation, these lie in groups as follows: 1854 first half; 1856 to 1860; 1887 to 1889; 1900; 1901; 1905 to 1907; 1912 last half; 1913 first half; 1915 to 1917; 1920; 1923 to 1926; 1930; 1940 to 1950. It will be seen that many of these unsatisfactory intervals fall either soon after tremendous volcanic eruptions occurred or there was tremendous use of explosives in war or explosions of atomic bombs. As has been pointed out, atmospheric changes alter the lags in the weather effects of all solar impulses, and of course unequal periods have unequal lags. These unusual atmospheric disturbances may very well have mixed up the timing of terrestrial responses to the 23 periods so as to cause the events to differ from the predictions.

At some future time it may be possible to connect theoretically the displacements found in my forecasts with causes producing atmospheric alterations of importance in weather. As yet I have been unable to name with certainty causes operative to produce these occasional displacements. For the practical inquiries of farmers, however, it is of importance to estimate the *magnitude* of forecasting *error* rather than the *cause* attending such discrepancies.

As a step toward that, I cite the case of Spokane, Wash., figure 11. A computation made in 1957 derived a "correlation coefficient" of 59 ± 5 percent over the interval March 1950 through October 1956 between forecast and event in Spokane precipitation. In simple language this means that my forecast represented the observed precipitation 59 percent perfectly for almost 7 years.

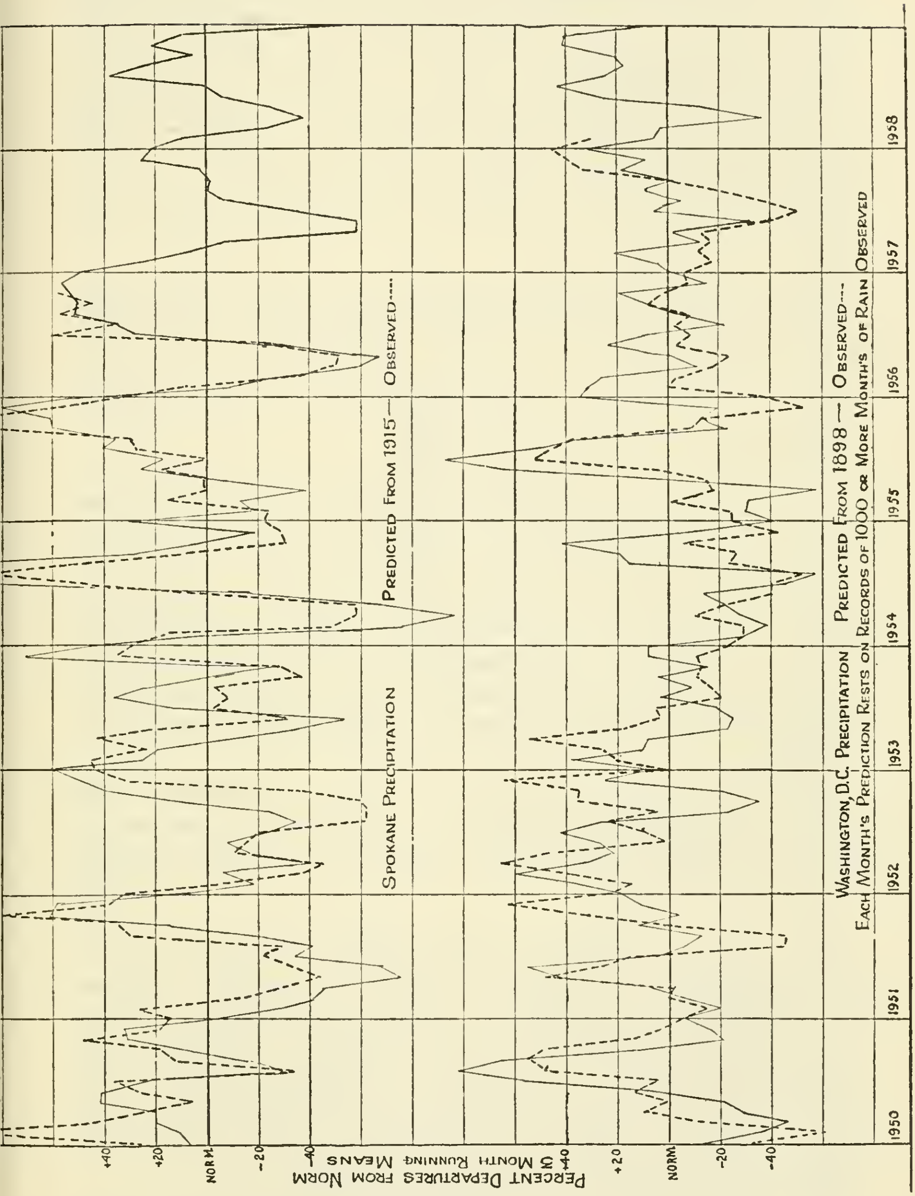


FIG. 11.—Comparison of forecasts and events, 1950-1958. Upper curves, Spokane, Wash.; lower curves, Washington, D. C. Forecasts, full curves; events, dotted curves.

When records through 1958 became available two considerable discrepancies between forecast and event were noted. In the months January and March 1950 heavy precipitation (over twice the normal even in 3-month running means) raised the February observed curve far above the predicted curve. Both curves, as has been said, are smoothed by using 3-month running means in all computations, hence the February effect. Not until April did the two curves come close together. Yet there was a difference of only 6 percent of normal precipitation between the averages of their heights, January-April, 1950.

Beginning October 1956, and extending through August 1957, there was a shift of 5 months, leaving the predicted curve in the rear, and exposing opposed high and low values of the prediction and event. When the two curves were averaged over this interval of 11 months, the predicted curve was 116 percent of the normal and the observed curve 96 percent of the normal.

To sum up: At Spokane, in the 9-year interval, my forecast gives for over 7 years a correlation with observations of 59 percent. Two intervals of marked discrepancy occurred. The first, of 4 months, culminating with February 1950, was obviously caused by extraordinary precipitation in two almost adjacent months. It produced a difference of only 6 percent between the averages over these 4 months. The second discrepancy, extending 11 months, was of unknown cause. It involved a 5-month shift of phases and produced 20 percent difference between forecast and event in average precipitation over those 11 months.

Having set forth those discrepancies I remark that this is in the infancy of my method of forecasting, before any help has come to me from theoretical meteorologists. It may be that some of them will discover the causes of occasional displacements of features between forecast and event. If so, it may reduce error of forecasts greatly. Then, too, my method assumes that the average behavior of periods in weather in a thousand months that are past will be followed in the months to come. It perforce neglects changed conditions which may arise from unpredictable storms, volcanoes, or even from man's interposition, as from forest destruction, invention of new powerful devices, wars and the like. Even a minor atmospheric change may alter the *time* of a feature in precipitation by a month. All these factors tend to lower the coefficient of correlation.

The 273-month period in weather features.—It will have occurred to some readers that if one were backcasting from April 1927 or from July 1904 he would employ the same tabular data that I have used in forecasting from January 1950. Hence one might infer that the precipitation following these earlier dates should parallel that following January 1950.

There is indeed a partial similarity, as I pointed out many years ago, between the march of weather at successive intervals of 273 months. But the correspondence is very imperfect. This appears in figure 2, where the precipitation at Nashville following July 1904 is compared to that following January 1950. However, I call attention to the close agreement of the two curves for the last three years of the comparison. I have computed for several cities, including Nashville, the coefficients of correlation of the observed precipitation following April 1927 and July 1904, and compared with the forecast made to follow January 1950. These coefficients have fallen between 18 and 22 percent, while, as stated in my foreword, the correlation following January 1950 ranges from 52 to 59 percent.

This difference is easily explained. Over 40 percent of perfect 100 percent correlation is unpredictable as yet. There are several causes. (a) There is occasional unusual precipitation, as occurred in January and March 1950 at Spokane. (b) There are displacements of features as yet unexplainable. (c) The graphs I have published show large discrepancies in *amplitude* between forecast and event of obviously identical features. (d) Unpredictable events occur to alter weather from the averages of 1,000 months.

In the march of precipitation from April 1927 and from July 1904, the vicissitudes of the *later* years up to January 1950 cannot have affected the observed precipitation of the earlier times as they have done that following 1950. As such vicissitudes account for 40 percent and more in coefficients of correlation, the tabulation suited to January 1950 can only roughly forecast what follows these earlier dates.

FORECASTS, 1959 TO 1967

Table 12 gives for 32 stations for the interval 1959-1967 the expected monthly mean percentages of the normal precipitation tabulated in table 9. The reader will recall that all forecasts are made from 3-month running means taken from published monthly mean values, and expressed in percentages of the normal values of table 9.

Expressing these forecasts in a more usable form, table 13 gives average percentages of the normal for the intervals January-April, May-August, September-December, of each year, 1959 to 1967, inclusive.

TABLE 12.—*Forecast precipitation*

Percentage departures from columns A and B, Table 9

Months	Abilene, Tex.		Albany, N. Y.		Albany, Oreg.		Augusta, Ga.		Bismarck, N. Dak.		Charleston, S. C.		Cincinnati, Ohio		Denver, Colo.	
	1959	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*
Jan.	+14	−41	−20	+ 3	−17	+42	−36	−15	+ 2	+22	−52	−24	−18	−26	+39	−29
Feb.	−22	+ 4	−31	−14	− 2	+41	−44	−27	−36	+26	−44	− 5	−35	−15	+81	+ 1
Mar.	− 7	+ 3	−31	+ 3	−25	+66	−36	−25	−32	+63	−29	+ 1	−48	−25	+68	+37
Apr.	−32	+47	−18	−12	−62	+64	−14	−25	−48	+68	−32	− 2	−66	−31	+58	+48
May	−15	+66	−11	−38	−71	−11	+31	+ 5	−65	+22	−27	−36	−14	−46	+53	+27
June	− 5	+59	+22	−44	−46	−57	+28	+15	−28	−33	+ 8	+22	+35	−54	−12	+10
July	+ 9	− 1	+ 5	−37	− 1	−10	+19	+ 2	+ 2	−66	+32	+41	+39	−23	− 5	+60
Aug.	−49	−57	− 9	−22	+ 9	−37	+12	−14	+47	−54	+33	+23	+37	−29	−32	+60
Sept.	−29	−97	+ 7	−16	+49	− 8	+38	−36	+22	−26	+14	− 5	+30	−42	+ 2	+28
Oct.	−23	−59	+ 6	+17	+49	−13	+28	−15	+47	+17	+25	− 4	− 1	+ 1	+25	0
Nov.	−20	−37	− 5	− 1	+36	+ 8	+33	−20	+20	+20	+ 1	0	−21	+ 7	+49	+ 3
Dec.	+ 2	+ 6	−15	− 5	+30	+24	− 6	−22	+18	+11	+ 9	+14	−32	+32	+37	+ 6
	1960	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*
Jan.	− 4	+42	+16	− 2	− 6	− 5	0	+40	− 1	+18	+11	+10	−60	+27	+42	+31
Feb.	−15	+89	+26	+ 3	−14	+12	−14	+48	+28	+41	+27	+31	−68	+71	+23	+43
Mar.	−36	+106	+24	+22	+ 6	−25	− 2	+72	− 3	+26	+41	+23	−46	+64	− 1	+56
Apr.	−20	+106	+19	+20	+27	−51	− 4	+91	+29	−26	+45	+30	−22	+79	−33	+47
May	0	+46	− 2	+ 3	+19	−21	+ 7	+40	− 2	−11	+38	−17	+21	+58	−23	+61
June	−16	+55	+15	− 6	+50	−15	−24	+28	+ 2	+ 7	+20	−15	+53	+54	−19	+29
July	− 2	+36	+ 7	− 1	+66	+21	−42	+ 7	−15	+21	+ 1	− 7	+73	+30	−35	+ 8
Aug.	+ 5	+ 2	+21	− 3	+58	+27	−42	−19	−27	+24	+15	+10	+64	+42	− 9	−50
Sept.	+56	−49	−20	+23	+50	+67	−26	−36	−10	− 6	− 7	− 9	+25	+23	− 4	−75
Oct.	+60	−42	− 9	+39	+35	+77	−29	−37	+14	+64	−45	+21	−20	−29	+15	−94
Nov.	+40	−19	+34	+20	+18	+111	−21	− 7	− 6	+46	−48	+52	−41	−12	+31	−54
Dec.	+16	+19	+32	+11	+19	+17	+ 1	+ 3	− 8	+13	−37	+66	−44	+14	+42	+14
	1961	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*
Jan.	+42	+30	+22	+24	+32	+43	+20	+52	−13	+ 2	−15	+67	−32	+74	+43	+46
Feb.	+47	+66	− 4	+15	+ 5	+ 2	+38	+70	+ 7	− 8	+19	+58	−23	+79	− 1	+39
Mar.	+86	+38	+ 6	+ 4	− 9	+17	+11	+80	+17	−15	+37	+37	0	+81	+ 5	+ 5

July	−50	−42	+15	− 3	−20	+10	+29	−17	−13	−18	+27	−52	+52	−15	+42	−29
Aug.	−33	−30	+19	−12	+20	+46	+10	−28	− 7	−11	− 3	−55	+42	−22	+27	−46
Sept.	−19	+45	+13	−18	− 1	+53	0	−62	− 5	−30	−12	−36	+52	−40	+23	−34
Oct.	−30	−40	+10	−32	− 9	+13	+13	−14	+10	−32	−17	+ 8	+18	−11	+ 9	+41
Nov.	+16	−21	−20	−40	− 7	+19	+24	+ 2	+ 8	−24	− 8	+ 3	−16	− 8	+11	+74
Dec.	+31	+19	−30	+ 3	+ 4	− 2	+ 7	+13	− 5	0	− 6	− 5	−21	−33	−34	+66
	1962	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*
Jan.	+33	+17	−31	− 5	+ 1	−46	−33	+ 9	−23	+ 4	−26	−10	−45	−63	−75	+26
Feb.	+25	+43	− 9	−26	0	−36	−64	−18	−19	+ 4	−17	− 7	−23	−56	−74	+15
Mar.	+ 5	+40	+28	− 3	− 1	−38	−47	+ 1	+ 8	+ 3	− 7	0	−11	−47	−79	−12
Apr.	−30	+14	+31	+21	+27	−20	−27	+ 8	−26	+10	+ 2	+18	+ 3	−11	−91	−18
May	−25	+24	+33	+10	+14	−26	−16	+14	−48	− 5	− 6	+35	+23	−12	−72	+ 7
June	−42	+15	−28	+28	+ 1	− 6	−46	− 3	−14	+17	−50	+44	+ 4	−22	−23	+13
July	−28	+11	−24	+24	+16	−27	−41	+15	+ 9	+27	−54	+63	−14	−26	−19	+32
Aug.	+15	−27	− 7	+ 9	+ 1	−19	−18	+22	+11	+30	−24	− 8	+ 3	+ 9	−34	+30
Sept.	+24	+ 4	+ 4	+12	+ 7	−24	−28	+25	+23	+35	+10	+18	− 5	+38	−33	+24
Oct.	−42	−13	− 1	+10	+32	0	−50	+ 3	+41	+18	− 5	+ 8	−27	+16	−25	+ 8
Nov.	−17	− 1	− 8	+ 7	+17	−24	−45	− 3	+16	+38	+18	0	−14	+ 4	− 1	+12
Dec.	+ 1	−11	−12	0	+19	−14	−51	− 1	−20	+14	0	− 9	+18	−31	0	+12
	1963		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*	
Jan.	+49		+ 4		− 1		− 8		−53		− 1		+37		− 2	
Feb.	+89		+ 9		−10		+21		−58		−35		+66		− 5	
Mar.	+31		0		+13		+17		−41		−33		+75		−25	
Apr.	+19		−17		+ 4		+18		+ 3		−51		+35		−13	
May	− 4		−15		−19		+30		+41		−43		+ 8		−12	
June	−15		− 5		+19		−19		+41		+ 3		+38		−30	
July	+ 1		+ 8		−29		−19		+12		−25		+27		−11	
Aug.	+21		−17		−48		−34		−10		−20		+18		−10	
Sept.	+10		+17		−38		−23		+ 5		−12		−17		+24	
Oct.	+ 4		−18		−22		− 4		+16		−20		+ 1		− 3	
Nov.	−40		−16		+14		+16		+22		− 8		−32		−10	
Dec.	−44		−16		+ 2		− 8		+25		−15		−27		−41	

(continued)

TABLE 12—*continued*

Months	Detroit, Mich.		Eastport, Maine		El Paso, Texas		Helena, Mont.		Independence, Kans.		Little Rock, Ark.		Madison, Wis.		Montgomery, Ala.	
	1959	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*
Jan.	−24	−49	−17	−20	+48	+ 3	−14	−41	−77	−40	− 1	− 5	−58	−12	−32	+12
Feb.	−13	−25	−20	− 7	+59	+ 9	−31	−52	−75	−24	+14	+ 5	−36	+ 7	−37	+57
Mar.	−17	− 6	− 7	− 8	+27	− 9	−62	−53	−56	− 3	−19	+46	−19	−16	−73	+37
Apr.	− 2	+34	− 9	+ 4	−13	−18	−61	−19	−16	+ 9	−24	+67	− 6	−30	−64	+16
May	− 8	+54	+10	+16	+25	−36	−16	+44	+12	+14	−17	+42	+18	−35	−24	− 2
June	−13	+53	+10	+25	+63	+24	+23	+47	+40	+ 8	−14	+26	+28	−14	+ 9	−16
July	−11	+ 7	+28	+13	+73	+79	+20	+ 7	+55	+14	+ 8	+16	+40	+ 8	+40	+ 2
Aug.	+17	+17	+40	+37	+53	+76	+63	+14	+42	+33	− 5	−56	+47	+ 5	+62	−24
Sept.	+24	−13	+16	+36	−15	+92	+88	+15	+70	+27	+ 4	−46	+35	− 2	+76	−30
Oct.	+17	−53	− 8	+33	−16	+75	+54	+ 2	+26	− 8	+29	−80	+45	+ 2	+24	−16
Nov.	+44	−68	−22	+10	+ 4	+39	+ 2	−14	+16	−41	+24	−48	+24	+ 7	+24	− 5
Dec.	+55	−58	−28	−25	+ 5	+47	−20	+ 9	− 9	−53	−18	−25	−14	+24	−11	− 6
	1960	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*
Jan.	+32	−23	−54	−69	+37	+50	−51	− 7	−28	−17	−16	+24	−47	+18	−30	+ 8
Feb.	− 2	−39	−33	−81	+41	+22	−62	− 7	−33	+10	− 5	+86	−35	+33	−14	+60
Mar.	−19	−43	−20	−63	+30	+37	−53	−27	−23	−16	+14	+69	−36	− 5	+ 6	+80
Apr.	−21	−39	−10	−38	+78	+96	−11	+23	+ 9	+29	+10	+64	−38	−11	+13	+69
May	− 7	−27	+14	−16	+104	+95	0	+50	+40	+34	+28	+48	−18	− 7	+24	+35
June	−10	+ 3	+33	− 8	+69	+94	− 4	+86	+39	+70	+26	− 7	− 4	−13	+ 5	+40
July	+ 6	+33	+20	− 4	−12	+106	+13	+76	+61	+37	+16	−43	+23	− 3	+ 4	+22
Aug.	+36	−15	− 4	+16	−51	+104	+41	+56	+39	+26	+ 5	−83	+ 8	+27	− 2	+12
Sept.	+54	+ 1	−13	+30	−11	+48	+69	+34	+44	+30	+47	−94	+16	+66	+ 6	− 9
Oct.	+48	+28	−34	+48	−23	−24	+60	+39	+46	+ 2	+32	−64	− 6	+31	−18	−23
Nov.	+28	+30	−64	+49	− 8	−149	+13	+42	+46	+11	+37	−30	−11	− 6	−16	− 5
Dec.	− 3	+31	−49	+ 9	−10	−111	+10	− 2	+ 3	+ 8	+19	+13	+ 2	−28	+ 8	− 1
	1961	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*
Jan.	−15	+17	− 9	−45	−25	−82	+37	+23	−14	+22	−30	+40	+ 6	−32	+52	+40
Feb.	−28	+ 5	+ 1	−32	+35	−45	+62	−19	−21	+25	−35	+86	+ 8	−42	+52	+34
Mar.	−34	−30	+20	−14	+43	−58	+54	− 4	− 5	+28	−15	+27	+ 3	−48	+36	+36
Apr.	−41	− 1	+16	−10	+28	−97	0	−37	+16	−14	− 3	+29	+21	−61	+ 5	− 4

July	+26	+82	+14	+102	−28	+10	+ 3	− 3	+15	−82	−28	−27	+20	+ 7	−43	+11
Aug.	+26	+99	− 8	+100	−24	+32	− 9	+ 1	+14	−11	− 6	−28	+13	+ 3	+26	+12
Sept.	+20	+112	+ 1	+66	−48	+85	− 9	−17	− 3	+ 1	+30	−63	+20	+11	+20	−18
Oct.	+27	+27	+12	+ 1	−22	−78	+ 9	+32	+ 5	+15	+42	+13	+25	+11	+40	+20
Nov.	+18	+30	+52	−36	−24	−41	+21	+52	−11	+ 2	+38	+31	+28	+15	+15	+38
Dec.	+29	+26	+12	−56	−13	−19	−10	+42	−21	+ 9	+15	+18	+ 7	+ 9	+13	+20
	1962	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*
Jan.	− 4	+ 3	+ 3	−51	−55	−29	−46	+22	−37	+14	− 8	−22	−19	+27	− 9	−10
Feb.	− 8	−13	−15	−37	−49	−13	−48	+17	−52	+ 7	− 7	+ 8	− 1	+39	− 8	+ 6
Mar.	−17	−13	− 7	−19	−39	+ 3	−13	+10	−63	− 1	−23	− 3	+ 3	+22	+ 2	−14
Apr.	−17	− 3	− 7	− 9	−40	+41	−15	+31	−49	+19	−27	−18	+ 2	+34	+ 3	−22
May	+ 8	− 8	− 5	−16	−49	+38	−35	+15	− 5	− 5	−46	−45	−47	+19	+ 4	−47
June	+ 7	− 5	+ 6	−30	+34	− 6	+30	+ 7	+26	0	−32	−50	+ 1	+23	−22	−25
July	+ 2	+16	+50	−47	+40	−29	+32	−20	−16	−18	− 8	−29	+20	+15	− 1	−21
Aug.	−12	+23	+ 6	−33	+26	−27	+11	+ 8	+ 7	+23	+ 1	−28	+44	+27	−22	+42
Sept.	−24	+12	+12	0	+19	−40	+45	+49	−41	+64	− 3	+17	+27	+10	−48	+71
Oct.	−12	− 8	+12	+ 7	−34	−21	+23	+47	−18	+21	− 7	+55	+ 9	− 3	−30	+53
Nov.	−15	−15	− 4	+15	−83	+ 6	−18	+72	−31	+23	+12	+41	−16	0	−21	+37
Dec.	−20	−19	−19	−16	−82	+ 1	−40	+57	− 5	+22	+76	+28	−30	+ 8	0	+32
	1963		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*	
Jan.	−46		−42		−55		+ 1		−55		+67		− 9		+ 3	
Feb.	−48		−58		−11		− 7		−41		+46		−40		+25	
Mar.	−68		−50		+29		+ 4		−55		+24		−35		+ 9	
Apr.	−34		−27		+12		−21		−13		− 3		−27		+ 5	
May	− 8		0		+34		+34		−18		−10		+13		−11	
June	+26		− 7		+ 1		+ 6		−24		−12		− 4		−23	
July	+45		+20		+16		+17		−36		−57		+34		+18	
Aug.	+58		+31		−40		+ 4		+27		−77		+39		+16	
Sept.	− 3		+29		−80		−24		+24		−43		− 2		− 6	
Oct.	−11		+ 7		−54		−51		+45		−45		+24		−47	
Nov.	−33		+ 4		−75		−58		+14		−23		+10		−65	
Dec.	−52		− 1		−63		−24		+18		−30		−12		− 3	

(*continued*)

TABLE 12—*continued*

Months	Nashville, Tenn.		Natural Bridge, Ariz.		Omaha, Nebr.		Peoria, Ill.		Port Gibson, Miss.		Rochester, N. Y.		Sacramento, Calif.		Salisbury, N. C.	
	1959	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*
Jan.	− 4	+22	−45	+64	− 7	+ 4	−23	+37	+ 1	+17	+ 9	−72	+51	+88	−13	−24
Feb.	−22	−25	−45	+88	+ 5	0	−46	+14	+22	−52	−20	−59	+28	+54	−22	− 9
Mar.	−80	−49	+23	+97	+26	− 9	−44	+ 6	−17	−77	−33	−28	− 4	+40	−33	−21
Apr.	−42	−25	+46	+97	+15	+ 8	−31	+21	−12	−65	−47	−30	−25	+28	−21	−22
May	−35	− 2	+47	+14	+21	− 8	+29	+34	−24	− 5	−42	−13	−49	−28	+24	−29
June	+ 4	+29	+10	− 8	+34	+32	+30	+43	−49	+20	−56	−16	−70	−84	+23	−12
July	− 6	+18	−27	+ 4	+27	+33	+20	+35	−53	−45	+ 8	−13	−124	−48	+31	0
Aug.	+20	−35	+36	+ 6	+19	+12	−21	+24	−42	−44	+59	−16	−97	−93	+70	−15
Sept.	+34	−22	+45	+52	+39	−19	−21	+ 1	−12	−14	+56	− 9	−44	−108	+61	−34
Oct.	+63	−21	+53	+48	+26	+31	− 4	−19	− 6	+25	+19	− 5	+22	+ 2	+53	−27
Nov.	+38	− 4	+35	+15	+ 4	+55	+ 9	−12	− 6	−35	+10	− 7	+ 9	+59	+23	− 4
Dec.	+ 4	−23	+16	−21	−41	+40	− 4	+10	− 6	− 5	+13	+ 2	+53	+122	+ 4	+22
	1960	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*
Jan.	+24	+ 8	+ 3	+13	−23	+18	−39	+13	+17	−30	− 8	−21	+46	+149	+11	+17
Feb.	+13	+ 9	−23	+71	+25	+28	−14	+ 4	+31	− 2	−15	+18	+43	+116	+10	+50
Mar.	+ 6	+33	−59	+83	+26	+32	+16	0	+29	+ 9	− 1	+19	+29	+62	+15	+61
Apr.	−24	+72	−16	+30	+ 7	0	−12	− 1	−21	+16	+28	+31	+32	− 1	+ 6	+48
May	−12	+27	−37	−32	+16	−18	+ 1	−18	−14	−40	+ 9	+18	+ 2	− 1	+ 5	+28
June	−14	+18	+43	−77	− 8	− 4	−16	−14	−38	+21	+11	+21	−57	−43	−13	− 3
July	0	+11	− 1	−88	0	−32	−21	−21	−41	+54	+26	− 6	−47	−51	−24	+ 8
Aug.	+ 2	+ 4	+29	−73	+17	−53	−33	−19	−95	+34	+65	+ 2	−24	−27	−20	− 5
Sept.	+ 8	− 6	+49	−72	+45	−63	+18	−27	−40	+ 3	+45	+ 1	+26	− 8	− 8	+ 3
Oct.	− 1	−23	+62	−52	+37	−94	+62	+ 6	−15	− 2	+24	+11	+63	+77	−14	−28
Nov.	−16	−38	+36	−10	+ 1	−62	+66	+ 3	−14	−37	−25	+17	+90	+121	−33	−22
Dec.	−22	0	−63	− 5	0	+27	+37	−15	+ 5	+ 2	−38	+47	+99	+93	−36	−12
	1961	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*
Jan.	+23	+49	−88	+16	+17	+18	+57	−22	+14	+ 9	−28	+48	+114	+117	0	+22
Feb.	+39	+59	−62	− 2	+12	+45	+68	−26	− 3	+12	−27	+66	+114	+90	−15	+66
Mar.	+21	+14	−19	+14	+31	+ 7	+75	−18	+26	+30	− 7	+51	+75	+39	−13	+62
Apr.	+22	− 7	−42	+16	+38	−16	+40	− 5	+25	−16	− 7	+48	+42	+ 7	− 9	+10
May	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

June	0	+23	+ 2	−65	−27	−32	− 3	+26	−27	−80	−10	+18	−53	−142	+ 4	−28
July	− 7	+14	+56	−62	−27	−28	−25	+24	−13	−78	−17	− 4	−73	−141	+27	−52
Aug.	−23	−39	+78	−28	0	+ 3	−18	+19	+49	−123	−10	−11	−76	−122	+26	−56
Sept.	+ 8	−81	+56	+12	+ 5	− 1	−40	+ 5	+47	−108	+41	−42	−70	−94	+48	−84
Oct.	+17	−18	+10	+18	+10	+32	−25	−72	+42	−13	+37	+18	−37	−24	+60	+29
Nov.	+26	−15	−46	+ 9	+ 7	+30	+ 8	+11	+18	−32	+18	+16	− 6	+26	+52	+23
Dec.	+30	− 7	−30	−14	−15	−27	+14	+71	+22	+14	− 6	− 8	+26	+78	−16	+35
	1962	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*
Jan.	−23	−20	−24	+ 2	−51	+ 3	+41	+52	+29	+15	+ 6	−10	+67	+75	−46	+58
Feb.	−18	−15	−14	+31	−21	+22	+ 5	+45	+26	−12	+10	−24	+74	+79	−63	+35
Mar.	− 1	−41	−66	−24	0	+36	− 6	+32	+10	−27	−16	−51	+ 3	+34	−36	+ 5
Apr.	−21	−37	−85	+ 4	− 2	+43	− 2	+50	−14	−47	−28	−55	−65	+17	−19	+30
May	−32	− 3	−36	− 2	+27	+ 5	+ 1	+43	−34	−33	−29	−48	−92	+ 3	−13	+35
June	−17	−30	−119	−28	− 4	−28	−19	+32	+17	−25	− 6	−58	− 8	−13	−50	+ 9
July	−50	−30	−88	+20	−34	−31	−26	+15	+ 3	−33	−12	−12	−35	−31	−21	−10
Aug.	−33	− 6	−84	− 7	−28	− 6	−42	+30	−15	+13	0	−10	−21	−14	−33	− 3
Sept.	−11	+ 5	−99	+16	−16	+10	−35	+38	+ 5	− 8	+11	+23	+ 2	−34	−43	+19
Oct.	+ 9	+54	−95	+11	+ 7	− 8	−29	+46	+19	+ 7	+ 5	+25	+52	−38	−28	+23
Nov.	+ 3	+63	−30	+43	+35	+28	− 2	+29	+23	−35	−10	+41	+43	−44	+ 5	+19
Dec.	+35	+71	− 2	+ 7	+58	+29	+17	− 6	+17	−20	− 5	+ 4	+66	−25	+22	+11
	1963		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*	
Jan.	+22		+15		−10		− 3		+27		−22		+51		+ 3	
Feb.	+22		+26		−65		− 7		+20		0		+76		−11	
Mar.	−12		+25		−89		−16		− 5		+21		+37		+ 6	
Apr.	−49		+19		−73		−35		− 3		+ 6		−31		+14	
May	−47		−55		−24		−27		+17		+ 2		−53		− 3	
June	0		−55		+36		−14		− 6		+40		−72		−38	
July	− 3		−20		+62		+ 3		+48		+50		−99		−19	
Aug.	+ 6		−51		+13		− 2		+51		+39		−128		+ 6	
Sept.	−31		+ 5		−33		+ 9		+66		0		−88		+27	
Oct.	−46		−52		−37		+23		+ 9		−14		−35		+23	
Nov.	−17		+ 7		−46		+49		+ 5		− 2		+56		+ 1	
Dec.	+10		+22		+19		+39		+ 2		−23		+92		−18	

(*continued*)

TABLE 12—*concluded*

Months	Salt Lake, Utah		Santa Fe, N. Mex.		San Bernardino, Calif.		Spokane, Wash.		St. Louis, Mo.		St. Paul, Minn.		Thomasville, Ga.		Washington, D. C.	
	1959	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*	*1959*	*1964*
Jan.	−1	−9	−50	−40	+41	+63	−51	+79	−18	−84	−37	−3	−21	−9	+12	−8
Feb.	−4	−27	−43	−24	−34	+48	−70	+92	+8	−48	−26	+18	−8	+15	−36	−22
Mar.	−39	+3	−25	−10	−36	+18	−51	+69	+37	−58	−23	+16	+15	−10	−44	−74
Apr.	−33	+11	−23	−27	−35	−18	−26	+76	+12	+1	−14	−10	+27	+3	−35	−81
May	−30	+38	−15	−10	−26	−23	−38	+32	+6	−1	+24	+3	+28	+48	−22	−65
June	+1	+49	+17	+19	+7	−33	+5	+12	+4	−12	+35	+29	+35	+64	−14	+17
July	+4	+34	+13	+47	+47	−55	−9	−6	+14	−43	+30	+42	+8	+87	−18	+37
Aug.	+58	+6	+25	+37	+52	−47	−9	+21	−7	−39	+37	+24	−31	+56	−3	+58
Sept.	+79	−16	+40	−7	+37	−64	+42	+48	−19	+15	−4	+35	−57	+12	+38	−3
Oct.	+82	−39	+33	−55	+13	−40	+83	+72	−10	+61	−55	+19	−43	+7	+55	−11
Nov.	+43	−11	+59	−99	+26	+14	+90	+64	0	+43	−31	−1	−14	−24	−21	+1
Dec.	+30	+2	+30	−33	+26	+46	+46	+62	−6	+14	−14	+10	+8	−19	+18	+43
	1960	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*	*1960*	*1965*
Jan.	+12	+65	−27	−53	−19	+98	+16	+60	+8	−25	−26	+32	+20	−15	+24	+6
Feb.	+31	+49	−40	−42	−75	+98	+35	+66	−14	−38	−22	+68	+48	+13	−15	+6
Mar.	−58	+6	−54	−28	−89	+57	+15	+16	+3	−24	+3	+57	+74	+30	−17	+34
Apr.	−39	−22	−44	+21	−87	+49	+28	−34	+10	+49	+2	+30	+66	+79	+2	+35
May	−13	−35	−27	+40	−73	+17	+47	−64	+14	+60	+2	0	+104	+91	+27	+58
June	+19	−44	−28	+111	−39	+7	+42	−53	+3	+29	+26	−17	+41	+73	+47	+31
July	+32	+7	−4	+73	−3	−37	+52	−30	+7	−39	+30	−19	+19	+39	+34	+22
Aug.	+49	+16	−26	+11	+41	−18	+45	−24	+4	−29	+26	−25	−12	−4	−5	+38
Sept.	+30	+53	−32	−24	+82	−23	−1	+17	+15	−20	+16	−46	−18	−22	−59	+9
Oct.	+15	+64	−34	−22	−91	+45	+5	+35	+8	−33	+11	−51	−50	−46	−44	−16
Nov.	+29	+51	−18	−39	+58	+82	+7	+64	+23	−23	+3	−34	−50	−73	+3	−18
Dec.	+14	+10	−36	−71	+35	+79	+3	+52	0	+1	−6	−17	−22	−58	+10	−12
	1961	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*	*1961*	*1966*
Jan.	+1	−11	−19	−110	+21	+16	+21	+45	−28	+31	−16	+18	+10	−33	+13	−7
Feb.	−46	−2	−32	−108	+44	−27	−26	+28	−3	+30	+4	+46	+39	−13	−8	−26
Mar.	−59	0	−5	−37	+33	−78	−80	−15	+21	+72	−5	+48	+51	+35	−32	−6
Apr.	−55	−19	+6	−20	−20	−96	−59	−15	+36	+13	+13	0	+48	+26	−63	−36
May	−30	−32	−7	+18	−31	−103	−17	−18	+46	−11	+33	−7	+1	+20	+37	−43

June	−14	−27	+44	+34	−18	−111	+ 6	−14	+37	−81	+51	+ 1	+ 5	+37	+ 6	−19
July	−30	−29	+34	− 2	− 6	−75	− 5	−20	+62	−62	+29	−41	−15	−29	−24	0
Aug.	−31	0	+42	+16	−11	−47	− 6	−22	+51	+ 3	+ 2	−63	−38	−24	−62	−17
Sept.	− 2	−12	+60	+16	+27	−23	+ 6	−69	+43	+62	−19	−73	−47	−53	−28	−13
Oct.	+31	+56	+57	− 6	+32	− 5	+16	+62	+36	+60	−21	− 3	−48	−58	− 6	−25
Nov.	+23	+47	+86	+ 4	+ 3	− 5	− 1	+19	0	+26	−47	−14	−30	−53	+27	−22
Dec.	− 3	+25	+ 8	− 1	−22	−19	+ 9	− 6	−12	− 5	+50	−30	−23	−16	+16	+19
	1962	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*	*1962*	*1967*
Jan.	−19	−15	−19	− 2	− 4	0	−29	+ 2	−41	−31	− 9	− 5	−12	+19	+52	+14
Feb.	−16	−25	−31	−28	−13	−12	−81	+ 8	−15	−20	−10	− 8	+11	+54	+48	−10
Mar.	−34	−39	−68	−25	−23	+ 5	−63	+ 2	−30	+ 2	+ 5	−11	+38	+61	+23	−32
Apr.	−73	−42	−57	− 4	−20	+22	−51	−37	0	+ 6	+15	−18	+63	+41	−39	−20
May	−56	−47	−26	+55	− 9	+19	−21	−28	−25	+ 9	+ 9	− 1	+56	+23	−30	− 8
June	+53	−31	+30	+17	−76	+ 7	0	− 9	−28	+10	−24	+12	+16	− 1	−27	+22
July	+50	−45	− 1	+37	−38	+36	+49	+15	−13	+29	−53	+23	−30	+ 3	−39	+54
Aug.	+78	−12	+38	+38	+ 2	+32	+46	+13	−17	+57	−27	+16	−21	+ 1	−48	+62
Sept.	+37	+ 5	+ 5	+54	+25	+14	+48	+17	−28	+45	−54	− 3	−44	+ 5	−22	+33
Oct.	+10	+ 6	0	+45	+27	+ 9	+26	−19	−21	+41	−41	+13	−23	−41	+12	+12
Nov.	+23	+43	+34	+28	+25	− 2	+19	+15	−45	+17	−12	−25	− 8	−54	+ 1	− 5
Dec.	+12	+17	+22	+22	+10	−15	−51	+15	−59	+ 3	+23	−39	−24	−63	−22	−14
	1963		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*		*1963*	
Jan.	−20		+27		− 2		−21		−81		+ 8		−23		+69	
Feb.	−25		+ 9		+19		+ 7		−86		+15		+12		−34	
Mar.	−28		+15		+19		−16		−61		+31		− 8		−29	
Apr.	+11		+26		+12		−32		−27		+ 4		−12		− 6	
May	+42		+39		+22		−52		−26		− 5		+ 5		−44	
June	+20		+ 9		0		−32		−20		− 2		+ 8		− 2	
July	−10		+32		+ 3		−32		+19		− 4		+13		+31	
Aug.	+10		−10		+28		−15		+51		− 6		−13		+53	
Sept.	−11		−18		− 7		− 2		+76		−27		+ 7		+53	
Oct.	−20		−51		−17		+30		+41		− 2		+11		+16	
Nov.	−44		−25		−37		+33		−10		−20		−20		− 6	
Dec.	−40		−55		− 8		+38		−36		−16		−30		+32	

At the end of text are 27 maps of the United States with the 32 cities as listed above, and each accompanied above the circle by a number identical with the appropriate number in the column headings in table 13. Below is the predicted departure from normal. Each group of three maps covers the three intervals per year of four months each named with table 13. Large areas of approximately equal departures from normal precipitation are clearly noticeable on the maps. These area similarities may aid farmers remote from the 32 cities to estimate the precipitation probable in their locations.

APPLICATIONS

Periods control long-range weather.—I have sought to present to meteorologists evidence of two important propositions. First, that there exists in weather a family of periods, all exact submultiples of 273 months. These periods are hidden from immediate recognition because their phases are shifted according to the state of the atmosphere. When, however, the long monthly records are grouped and reduced with reference to time of the year, sunspot activity, and march of population, the family of periods is clearly disclosed with constant length, and with approximate sine-curve forms.

Second, long-range precipitation is to nearly 60 percent governed by this family of periods. By evaluating the average forms and amplitudes of these periods from thousand-month records, precipitation and temperature may be forecasted for years in advance, with considerable approximation to the event.

Whether these forecasts will appear to interested parties as trustworthy guides to help in planning their future operations must depend on the agreement attained between forecasts and events, 1950-1958. I therefore prepared table 14 which gives for 32 cities the 4-month forecasts and observations, 1950-1958, and the differences in percentages of normal precipitation, Δ, in the sense observed minus forecasted. Their means are given disregarding signs.

Agricultural requirements.—For agricultural purposes a foreknowledge of *seasons* rather than of individual months is most desired. Hence I give in table 14 4-month mean values computed from table 10. But it is the *difference* between forecast and event which would be the controlling factor in estimating the value of the forecasts.[5] The average differences, Δ (observed minus scale-corrected forecasts) are

[5] As differences in *level* of *observed* precipitation, 1950-1958, from the averages of 1,000 months, are disclosed in table 9a, I refer to that table for possible corrections of level which might be applied to values for some stations in table 14.

entered at the bottom of the columns of Δ in table 14. These averages will be needful to the use of table 15 which is to follow.

Assuming that the degree of success attained in the forecasts from 1950 through 1958 will be attained from 1959 through 1967, I have prepared table 15 from which the probable sizes and numbers of discrepancies between forecasts and events in 4-month mean values over the entire interval of 9 years, 1959-1967, may be estimated. Selected from table 14, four groups of cities, 25 in all, are tabulated in table 15. The first group of 11 cities have average 4-month mean discrepancies, 1950-1958, of about 20 percent between forecasts and events.

The second group of six cities have mean 4-month discrepancies of about 26 percent, the third group of five cities, 30 percent, and the fourth group of three cities, 40 percent. All the percentages relate to normal precipitation given in table 9, with the scale corrections from table 9a used in table 14.

The six columns of table 15 give, respectively, the numbers of cases in table 14 when the discrepancies between forecast and event, 1950-1958, are (a) less than one-fourth, (b) one-fourth to one-half, (c) one-half to one times, (d) one to one and one-half, (e) one and one-half to two, and (f) over two times the average discrepancy of the group.

If the same degree of success is reached 1959-1967 as was reached 1950-1958, the interested person of a city in Group 1 would expect the numbers of discrepancies (O-F) among the 4-month means stated in the mean values at the bottom of the columns of table 15 to occur in the entire interval of 9 years with magnitudes in percent of the normals as stated at the top of the columns of the first group. If he were located at a city of Group 4, the percentages would be twice as large, because the numbers heading Group 4 are twice those heading Group 1. But the numbers of cases would be the same.

Stated numerically, a person residing where the mean departure of forecast from observation, given in table 14 for 4-month intervals from 1950 through 1958, was about 20 percent of normal precipitation, may expect the following numbers and magnitudes of departure from the forecast of 4-month means during the entire 9 years, 1959-1967, given in table 14.

Numbers of departures.....	4.6	4.5	6.1	6.0	2.8	3.0
Magnitudes in percent......	0-5	6-10	11-20	21-30	31-40	>40

If he resided where the mean departure given in table 14 was greater, the numbers of departures as just given would be unchanged, but †

† Text continued on page 67.

TABLE 13.—*Predicted departures from normal precipitation* 1959-1967

Four-month mean

		1 Abilene Tex.	2 Albany, N. Y.	3 Albany, Oreg.	4 Augusta, Ga.	5 Bismarck, N. Dak.	6 Charleston, S. C.	7 Cincinnati, Ohio	8 Denver, Colo.
1959	A	−15	−25	−26	−32	−28	−39	−42	+61
	B	−15	+2	−27	+22	−11	+25	+24	+1
	C	−17	−2	+41	+23	+27	+12	−6	+18
1960	A	−19	+21	+3	−5	+13	+31	−49	+8
	B	−3	+10	+48	−25	−10	+18	+53	−21
	C	+43	+9	+30	−19	−2	−34	−20	+21
1961	A	+52	+3	+8	+18	+2	+27	−5	+13
	B	−28	+19	−4	+12	−1	+30	+55	+18
	C	0	−7	−3	+11	+2	−11	+8	+2
1962	A	+8	+5	+7	−43	−15	−12	−19	−80
	B	−20	−4	+8	−30	−10	−33	+4	−37
	C	−8	−4	+19	−43	+15	+6	−7	−15
1963	A	+47	−1	+1	+12	−37	−30	+53	−11
	B	+1	−7	−19	−10	+21	−21	+23	−16
	C	−17	−16	−11	−5	+17	−14	−19	−7
1964	A	+3	−5	+53	−23	+45	−7	−24	+14
	B	+14	−35	−29	+2	−33	+12	−38	+39
	C	−47	−1	+3	−23	+5	+1	0	+9
1965	A	+26	+11	−17	+63	+15	+23	+60	+44
	B	+35	−2	+3	+14	+10	−42	+46	+12
	C	−23	+23	+83	−19	+29	−7	−1	−52
1966	A	+37	+12	+15	+66	−5	+39	+61	+16
	B	−40	+2	+11	−6	−23	−42	−22	−32
	C	+1	−22	+21	−15	−21	−7	−23	+37
1967	A	+28	−15	−35	0	+5	0	−44	+3
	B	+6	+18	−19	+12	+17	+33	−13	+20
	C	−5	+7	−15	+6	+26	+4	+7	+14

		9 Detroit, Mich.	10 Eastport, Maine	11 El Paso, Tex.	12 Helena, Mont.	13 Independence, Kans.	14 Little Rock, Ark.	15 Madison, Wis.	16 Montgomery, Ala.
1959	A	—14	—13	—30	—42	—56	—8	—30	—51
	B	—4	+22	+53	—22	+37	—7	+33	+22
	C	+35	—10	—5	+31	+26	+10	+22	+28
1960	A	—2	—29	+46	—44	—19	+1	—39	—6
	B	+6	+16	+27	+12	+45	+19	+2	+8
	C	+32	—40	—13	+38	+35	+34	0	—5
1961	A	—29	+7	+20	+38	—6	—21	+9	+38
	B	+14	+16	—12	—5	+20	—16	+26	—22
	C	+23	+19	—27	+3	—7	+31	+20	+22
1962	A	—11	—6	—46	—30	—50	—16	—4	—3
	B	+1	+14	+13	+9	+3	—21	+4	—10
	C	—18	0	—45	+2	—24	+19	—2	—25
1963	A	—49	—44	—6	—1	—41	+33	—28	+10
	B	+30	+11	+3	+15	—13	—39	+20	0
	C	—25	+10	—68	—39	+25	—35	+5	—30
1964	A	—11	—8	—4	—41	—14	+28	—13	+30
	B	+33	+23	+36	+28	+17	+7	—9	—10
	C	—48	+13	+63	+3	—19	—50	+8	—14
1965	A	—36	—63	+51	—4	+1	+61	+9	+54
	B	—1	—3	+100	+67	+42	—21	+1	+27
	C	+22	+34	—59	+28	+13	—44	+16	—9
1966	A	—2	—25	—70	—9	+15	+45	—46	+26
	B	+61	+68	—28	—7	—42	—8	—29	—3
	C	+49	—6	—13	+27	+7	0	+11	+15
1967	A	—6	—29	0	+20	+10	—9	+30	—10
	B	+6	—31	—6	+2	0	—38	+21	—13
	C	—7	+1	—13	+56	+32	+35	+4	+48

(*continued*)

TABLE 13.—*continued*

Year		17 Nashville, Tenn.	18 Natural Bridge, Ariz.	19 Omaha, Nebr.	20 Peoria, Ill.	21 Port Gibson, Miss.	22 Rochester, N. Y.	23 Sacramento, Calif.	24 Salisbury, N. C.
1959	A	—37	—5	+10	—36	—2	—23	+12	—22
	B	—4	+16	+25	+14	—42	—8	—85	+37
	C	+35	+37	+7	—5	—7	+24	+10	+35
1960	A	+5	—24	+9	—12	+14	+1	+38	+10
	B	—6	+8	+6	—17	—47	+28	—31	—13
	C	—8	+21	+21	+46	—16	+4	+69	—23
1961	A	+26	—53	+24	+60	+15	—17	+86	—9
	B	—10	+21	—4	—15	0	—4	—58	+14
	C	+20	—2	+1	—11	+32	+22	—22	+36
1962	A	—16	—47	—18	+9	+13	—7	+20	—41
	B	—33	—82	—10	—21	—7	—12	—39	—29
	C	+9	—56	+21	—12	+16	0	+41	—11
1963	A	—4	+21	—59	—15	+10	+1	+33	+3
	B	—11	—45	+22	—10	+27	+33	—88	—13
	C	+21	—4	—25	+30	+20	—10	+6	+8
1964	A	—19	+86	+1	+19	—44	—47	+52	—19
	B	+2	+4	+17	+34	—18	—14	—63	—14
	C	—17	+23	+27	—5	—7	—5	+19	—11
1965	A	+30	+49	+20	+4	—2	+12	+82	+44
	B	+15	—68	—27	—18	+17	+13	—30	+7
	C	—17	—35	—48	—8	—6	+19	+71	—15
1966	A	+29	+11	+13	—18	+9	+52	+63	+40
	B	—4	—42	—15	+25	—80	+6	—116	—38
	C	—30	+6	+8	+4	—35	—4	—3	+1
1967	A	—28	+3	+26	+45	—18	—35	+51	+32
	B	—17	—4	—15	+30	—19	—32	—14	+8
	C	+48	+19	+15	+27	—14	+23	—38	+18

		25 Salt Lake, Utah	26 San Bernardino, Calif.	27 Santa Fe, N. Mex.	28 Spokane, Wash.	29 St. Louis, Mo.	30 St. Paul, Minn.	31 Thomasville, Ga.	32 Washington, D. C.
1959	A	−19	−16	−35	−49	+10	−25	+3	−25
	B	+10	+20	+10	−13	+4	+31	+10	−14
	C	+58	+25	+40	+65	−9	−26	−26	+32
1960	A	−13	−67	−41	+23	+2	−11	+52	−1
	B	+22	−18	−21	+46	+7	+21	+38	+26
	C	+22	+66	−30	+3	+11	+6	−35	−23
1961	A	−40	+19	−12	−36	+6	−1	+37	−22
	B	−26	−16	+28	−5	+49	+29	−12	−11
	C	+12	+10	+53	+7	+17	−9	−37	+2
1962	A	−35	−15	−44	−56	−41	0	+25	+21
	B	+31	−30	+11	+18	−21	−24	+5	−36
	C	+20	+22	+15	+10	−38	−21	−25	−8
1963	A	−15	+12	+19	−15	−64	+14	−8	−54
	B	+15	+13	+17	−33	+6	−4	+3	+9
	C	−29	−17	−37	+25	+18	−16	−8	+24
1964	A	−5	+28	−25	+49	−47	+5	0	+46
	B	+32	−39	+23	+15	−24	+24	+64	+12
	C	−16	−11	−48	+61	+33	+16	−6	+7
1965	A	+24	+75	−25	+27	−10	+47	+27	+20
	B	−14	−8	+59	−43	+5	−15	+50	+37
	C	+44	+46	−24	+47	−39	−37	−40	−9
1966	A	−8	−46	−69	+11	+36	+18	+4	−19
	B	−22	−84	+16	−18	−38	−28	+1	−10
	C	+29	−13	+3	+2	+36	−30	−45	−20
1967	A	−30	+4	−15	−6	−11	−10	+44	−12
	B	−34	+23	+37	−2	+26	+12	+6	+32
	C	+18	+1	+37	+7	+26	−14	−38	+6

TABLE 14.—*Forecast and observation, 1950-1958* *

Four-month mean values

		Abilene, Tex.			Albany, N. Y.			Albany, Oreg.			Augusta, Ga.		
		Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ
1950	A	73	85	−12	110	133	−23	120	77	+47	64	22	+42
	B	169	67	+102	67	118	−51	94	111	−17	111	72	+35
	C	46	58	−12	107	108	−1	70	151	−81	95	120	−35
1951	A	62	117	−55	129	128	+1	97	76	+21	70	80	−10
	B	75	110	−35	114	131	−17	35	58	−23	68	78	−10
	C	38	41	−3	142	102	+40	126	102	+24	91	117	−26
1952	A	71	60	+11	104	102	+2	81	67	+14	99	90	+9
	B	36	32	+4	100	93	+7	83	87	−4	91	117	−26
	C	118	82	+36	99	74	+25	54	124	−70	69	88	−19
1953	A	60	96	−36	159	112	+47	124	85	+39	111	114	−3
	B	123	108	+15	110	77	+33	114	59	+55	97	95	+2
	C	69	49	+20	91	92	−1	119	143	−24	84	96	−12
1954	A	61	65	−4	111	120	−9	111	69	+42	84	63	+21
	B	45	121	−76	101	71	+30	170	140	+30	84	43	+41
	C	75	143	−68	97	96	+1	107	121	−14	68	53	+15
1955	A	74	135	−61	96	99	−3	98	104	−6	89	176	−87
	B	117	99	+18	68	90	−22	119	121	−2	77	101	−24
	C	57	86	−29	148	89	+59	150	149	+1	70	58	+12
1956	A	85	121	−36	124	113	+11	121	113	+8	90	61	+29
	B	27	66	−39	80	129	−49	65	54	+11	59	69	−10
	C	55	53	+2	90	98	−8	86	125	−39	67	122	−55
1957	A	154	91	+63	70	117	−47	111	109	+2	71	85	−14
	B	124	81	+43	79	109	−30	108	81	+27	86	74	+12
	C	153	94	+59	94	108	−14	91	134	−43	153	82	+71
1958	A	149	140	+9	115	110	+5	112	86	+26	98	75	+23
	B	120	68	+52	82	110	−28	73	108	−35	89	85	+4
	C	121	83	+38	87	72	+15	94	93	+1	34	96	−62
Mean				34.7			21.5			26.0			26.3

		Bismarck, N. Dak.			Charleston, S. C.			Cincinnati, Ohio			Denver, Colo.		
		Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ
1950	A	179	118	+61	57	83	−26	130	79	+51	73	113	−40
	B	72	85	−13	101	112	−11	120	115	+5	109	58	+51
	C	87	78	+9	87	100	−13	135	147	−12	86	102	−16
1951	A	87	94	−7	71	82	−11	105	80	+15	131	115	+16
	B	122	68	+54	81	93	−22	66	91	−25	120	134	−14
	C	104	125	−21	90	70	+20	126	139	−13	160	160	0
1952	A	125	107	+18	111	141	−30	124	121	+3	129	140	−11
	B	55	72	−17	99	123	−24	103	144	−41	71	99	−28
	C	28	54	−26	84	42	+42	97	106	−9	86	91	−5
1953	A	135	143	−8	83	78	+5	89	109	−20	121	148	−27
	B	105	108	−3	87	70	+17	79	52	+27	107	82	+25
	C	84	72	+12	76	95	−19	48	10	+38	104	132	−28
1954	A	75	48	+27	62	88	−22	72	73	−1	49	79	−25
	B	128	126	+2	79	110	−31	110	158	−48	69	72	−3
	C	41	107	−66	112	38	+74	120	141	−21	73	40	+33
1955	A	90	94	−4	84	71	+13	138	162	−24	103	111	−8
	B	117	98	+19	82	106	−24	121	166	−45	132	107	+25
	C	124	120	+4	83	77	+6	139	128	+11	99	139	−40
1956	A	99	85	+14	79	87	−8	117	104	+13	89	68	+21
	B	110	88	+22	86	91	−5	108	117	−9	110	82	+28
	C	107	95	+12	62	95	−33	74	100	−26	92	107	−15
1957	A	66	101	−35	86	56	+30	105	70	+35	141	93	+48
	B	88	73	+15	126	112	+14	160	108	+52	119	105	+14
	C	105	131	−26	126	81	+45	143	114	+29	114	132	−18
1958	A	98	101	−3	136	113	+23	72	75	−3	140	80	+60
	B	69	125	−56	93	114	−21	153	142	+11	127	86	+41
	C	106	104	+2	82	72	+10	91	109	−18	107	152	−45
Mean				20.6			22.2			18.7			26.6

		Detroit, Mich.			Eastport, Maine			El Paso, Tex.			Helena, Mont.			Independence, Kans.			Little Rock, Ark.			Madison, Wis.			Montgomery, Ala.		
		Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ
1950	A	166	114	+52	108	125	—17	47	81	—34	91	80	+11	76	58	+18	154	154	0	120	122	—2	74	51	+23
	B	92	129	—37	125	163	—33	77	96	—19	98	112	—14	146	126	+20	122	112	+10	147	104	+43	110	97	+13
	C	123	115	+8	147	138	+9	57	76	—19	121	139	—18	36	59	—23	110	136	—26	80	93	—13	95	175	—80
1951	A	112	87	+25	142	100	+42	145	139	+6	88	58	+30	86	59	+27	70	90	—20	131	104	+27	64	112	—48
	B	104	66	+38	146	132	+14	62	135	—73	118	122	—4	115	114	+1	120	92	+28	96	89	+7	79	65	+14
	C	147	77	+70	158	157	+1	51	57	—6	97	164	—67	124	131	—7	112	127	+15	143	123	+20	104	180	+76
1952	A	118	87	+31	133	98	+35	262	196	+66	101	85	+16	77	69	+8	108	104	+4	103	112	—9	87	83	+4
	B	78	154	—76	120	120	0	175	144	+31	66	68	—2	42	40	+2	66	50	+16	135	103	+32	74	106	—32
	C	88	122	—36	98	130	—32	28	18	+10	75	99	—24	49	93	—44	101	105	—4	87	67	+20	75	135	—60
1953	A	88	91	—3	147	135	+12	100	130	—30	97	88	+9	86	87	—1	137	143	—6	118	82	+36	111	144	—33
	B	89	108	—19	124	159	—35	88	161	—73	71	76	—5	74	77	—3	60	29	+31	87	98	—11	104	142	—38
	C	49	87	—38	119	99	+20	49	15	+34	56	32	+24	89	93	—4	62	6	+56	60	51	+9	99	92	+7
1954	A	119	8	+111	135	113	+22	66	137	—71	77	65	+12	61	30	+31	97	116	—19	90	81	+9	64	57	+7
	B	78	75	+3	156	215	—59	123	160	—37	114	90	+24	70	84	—14	51	82	—31	141	173	—32	49	30	+19
	C	120	101	+19	136	105	+31	70	74	—4	82	82	0	101	128	—27	83	78	+5	100	79	+21	58	57	+1
1955	A	87	94	—7	106	76	+30	61	111	—50	84	84	0	83	58	+25	95	183	—88	92	96	—4	86	123	—37
	B	63	104	—41	76	85	—9	89	102	—13	104	97	+7	85	103	—18	103	94	+9	83	129	—46	108	118	—10
	C	108	114	—6	88	86	+2	48	102	—54	94	136	—42	92	108	—16	72	136	—64	54	82	—28	45	108	—63
1956	A	116	78	+43	116	119	—3	106	123	—17	64	43	+21	44	39	+5	120	121	—1	91	94	—3	79	76	+3
	B	103	102	+1	104	130	—26	96	109	—13	91	82	+9	57	60	—3	108	76	+32	120	105	+15	112	92	+20
	C	88	120	—32	93	120	—27	37	68	—31	81	132	—51	68	104	—36	84	94	—10	76	98	+22	166	194	—28
1957	A	94	86	+8	85	95	—10	92	75	+17	107	98	+9	111	66	+45	146	113	+33	60	69	—9	106	118	—12
	B	121	100	+21	94	123	—29	94	111	—17	116	68	+48	127	126	+1	131	73	+58	130	111	+19	137	50	+87
	C	145	104	+41	118	153	—35	163	56	+107	118	112	+6	94	121	—27	148	147	+1	99	119	—20	132	135	—3
1958	A	49	99	—50	134	96	+38	208	102	+106	109	69	+40	94	73	+21	100	143	—43	48	93	—45	104	98	+6
	B	82	86	—4	133	130	+3	178	129	+49	106	121	—15	138	108	+30	157	96	+61	69	103	—34	100	114	—14
	C	90	99	—9	114	149	—35	209	112	+87	77	102	—25	47	62	—15	96	96	0	86	102	—16	72	145	—73
Mean				30.7			22.4			39.0			19.7			17.5			24.8			20.3			30.0

(continued)

TABLE 14.—*continued*

	Nashville, Tenn.			Natural Bridge, Ariz.			Omaha, Nebr.			Peoria, Ill.		
	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ
1950 A	132	101	+31	65	108	−43	95	97	−2	154	174	−20
B	148	96	+52	66	75	−9	113	94	+25	106	71	+35
C	127	119	+8	28	20	+8	72	58	+14	63	133	−70
1951 A	105	114	−9	105	26	+79	194	151	+43	117	143	−26
B	100	126	−26	97	135	−38	155	127	+28	108	101	+7
C	140	112	+28	189	102	+87	84	106	−22	93	116	−23
1952 A	127	120	+7	142	118	+24	122	136	−14	101	99	+2
B	63	72	−9	71	111	−40	118	79	+39	105	83	+22
C	83	104	−21	118	146	−28	104	102	+2	83	53	+30
1953 A	103	141	−38	60	109	−49	97	112	−15	90	80	+10
B	95	46	+49	54	104	−50	58	64	−6	96	128	−32
C	45	5	+40	35	69	−64	96	20	+76	52	58	−6
1954 A	102	107	−5	111	119	−8	120	113	+7	121	79	+42
B	64	85	−21	156	56	+100	90	147	−57	145	100	+45
C	91	115	−24	69	104	−35	84	130	−46	115	91	+24
1955 A	123	149	−26	61	79	−18	94	115	−21	112	93	+19
B	86	94	−8	173	134	+39	91	96	−5	80	74	+6
C	95	125	−30	69	70	−1	42	70	−28	76	81	−5
1956 A	124	111	+13	51	45	+6	37	96	−59	48	99	−41
B	61	68	−7	52	107	−55	92	64	+28	91	54	+37
C	84	96	−12	42	76	−34	87	84	+3	68	67	+1
1957 A	123	126	−3	73	78	−5	93	140	−47	98	122	−24
B	127	86	+41	128	120	+8	126	92	+34	89	155	−66
C	142	121	+21	108	118	−10	141	116	+25	118	93	+25
1958 A	84	93	−9	110	114	−4	99	124	−25	56	126	−70
B	123	86	+37	122	120	+2	125	72	+53	133	92	+41
C	79	121	−42	82	125	−43	62	89	−27	70	81	−11
Mean			22.7			32.5			28.8			27.4

	Port Gibson, Miss.			Rochester, N. Y.			Sacramento, Calif.			Salisbury, N. C.		
	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ	Observed	Forecast	O-F Δ
1950 A	129	131	−2	140	101	+39	91	158	−67	70	64	+6
B	141	121	+20	106	97	+9	60	89	−29	90	79	+11
C	92	128	−36	132	150	−18	205	143	+62	74	103	−29
1951 A	109	139	−30	128	94	+34	64	117	−53	78	114	−36
B	117	64	+53	107	80	+27	34	10	+24	75	76	−1
C	86	91	−5	102	125	−23	159	107	+52	83	136	−53
1952 A	84	81	+3	104	74	+30	130	154	−24	146	157	−11
B	54	49	+5	76	107	−31	223	104	+119	76	114	−38
C	60	92	−32	82	94	−12	80	118	−38	80	103	−23
1953 A	138	125	+13	89	76	+3	97	138	−41	99	73	+26
B	104	104	0	100	126	−26	84	23	+61	81	46	+35
C	66	55	+11	93	75	+18	42	70	−28	76	127	−51
1954 A	86	56	+30	94	93	+1	118	94	+24	99	107	−8
B	104	113	−9	80	95	−15	20	47	−27	84	41	+43
C	98	107	−9	118	180	−62	82	118	−36	125	125	0
1955 A	83	80	+3	91	100	−9	93	131	−38	83	52	+31
B	107	110	−3	73	90	−17	66	7	+59	91	106	−15
C	72	109	−37	130	122	+8	145	112	+33	82	82	0
1956 A	108	132	−24	121	117	+4	114	160	−46	92	60	+32
B	74	54	+20	115	136	−21	64	51	+13	103	78	+25
C	100	113	−13	88	98	−10	101	46	+55	115	137	−22
1957 A	106	125	−19	83	81	+2	116	148	−32	119	114	+5
B	97	67	+30	91	96	−5	65	85	−20	111	109	+2
C	134	136	−2	70	93	−23	86	71	+15	143	90	+53
1958 A	91	129	−38	136	85	+51	187	172	+15	114	76	+38
B	130	73	+57	123	96	+27	163	49	+114	116	95	+21
C	84	113	−29	124	140	−16	50	144	−94	80	144	−64
Mean			19.6			19.4			38.4			25.1

		Salt Lake, Utah			San Bernardino, Calif.			Santa Fe, N. Mex.			Spokane, Wash.			St. Louis, Mo.			St. Paul, Minn.			Thomasville, Ga.			Washington, D. C.		
		Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ	Ob-served	Fore-cast	O-F Δ
1950	A	86	66	+2	63	101	−38	53	127	−74	149	114	+35	150	110	+40	96	111	−15	86	89	−3	76	69	+7
	B	97	99	−2	24	79	−55	89	105	−16	109	120	−11	101	128	−27	75	118	−43	78	67	+11	116	131	−15
	C	93	126	−33	59	101	−42	21	56	−35	124	114	+10	80	75	+5	84	91	−7	62	87	−25	130	110	+20
1951	A	79	60	+19	67	37	+30	45	53	−8	100	70	+30	106	106	0	133	91	+42	91	166	−75	94	94	0
	B	111	53	+58	90	64	+25	72	76	−4	68	46	+22	95	115	−20	127	107	+20	90	101	−11	111	124	−13
	C	131	147	−16	152	147	+5	54	38	+16	145	129	+16	99	95	+4	120	91	+29	118	93	+25	114	101	+13
1952	A	145	87	+58	130	120	+10	63	64	−1	85	74	+11	84	66	+18	119	67	+52	116	121	−5	135	136	−1
	B	109	68	+41	92	105	−13	68	99	−31	72	79	−7	74	128	−54	97	103	−6	110	103	+7	120	129	−9
	C	52	109	−57	172	145	+27	49	86	−37	68	118	−50	58	91	−33	58	84	−26	69	64	+5	135	113	+22
1953	A	88	93	−5	73	117	−44	68	47	+21	139	124	+15	90	67	+23	113	72	+41	109	114	−5	125	121	+4
	B	104	41	+65	36	6	+30	92	100	−8	94	90	+4	46	37	+9	123	65	+58	123	134	+11	102	83	+19
	C	56	11	+45	44	126	−82	103	88	+15	91	117	−26	51	86	−35	81	13	+68	115	72	+43	87	106	−19
1954	A	62	72	−10	113	224	−111	91	84	+7	94	68	+26	49	33	+16	110	69	+41	69	19	+50	77	68	+9
	B	160	113	+47	98	28	+70	131	104	+27	123	145	−22	82	92	−10	98	125	−27	53	54	−1	61	56	+5
	C	120	87	+33	75	193	+118	72	39	+33	99	133	−34	105	151	−46	71	125	−54	77	33	+44	80	113	−33
1955	A	74	137	−63	77	70	+7	75	89	−14	92	90	+2	86	107	−21	72	87	−15	78	146	−68	83	60	+23
	B	108	80	+28	122	93	+29	81	128	−47	111	120	−9	94	124	−30	83	107	−24	92	99	−7	137	150	−13
	C	106	145	−39	78	100	−22	69	46	+23	166	159	+7	86	88	−2	84	91	−7	67	95	−28	103	95	+8
1956	A	81	85	−4	77	122	−45	51	60	−9	88	89	−1	72	66	+6	67	92	−25	111	130	−19	85	119	−34
	B	54	49	+5	195	129	+66	63	79	−16	105	87	+18	109	80	+29	113	77	+36	117	105	+12	91	102	−11
	C	76	94	−18	41	93	−52	35	90	−55	86	152	−66	70	68	+2	74	90	−16	83	82	+1	98	101	−3
1957	A	113	114	−1	86	98	−12	140	43	+97	106	117	−11	132	79	+53	66	75	−11	72	93	−21	87	109	−22
	B	146	72	+74	154	99	+55	96	94	+2	111	60	+51	166	107	+59	117	101	+16	117	71	+46	65	92	−27
	C	87	100	−13	155	116	+39	174	101	+73	97	107	−10	96	118	−22	77	125	−45	138	45	+83	117	108	+9
1958	A	117	72	+45	189	143	+46	135	48	+87	130	94	+36	78	92	−14	39	94	−55	105	110	−5	151	101	+50
	B	18	81	−63	183	95	+88	82	128	−46	112	105	+7	125	85	+40	66	92	−26	119	97	+22	119	122	−3
	C	31	127	−96	167	141	+26	111	116	−5	115	115	0	83	84	−1	58	79	−21	57	119	−62	72	130	−58
Mean				31.3			43.9			29.9			19.9			22.9			30.9			25.7			16.7

TABLE 15.—*Expected numbers of discrepancies of forecasts between assigned limits*

Numbers expected of 4-month intervals in 9 years, 1959-1967, when (O-F) has certain values

Group 1. Mean (O-F) = 20 percent

	<5	6-10	10-20	20-30	30-40	>40
Bismarck	6	3	8	5	1	4
Charleston	4	0	10	8	1	4
Cincinnati	4	4	7	3	4	5
Independence	4	5	4	8	2	4
Madison	3	5	8	4	4	3
Nashville	2	7	2	8	5	3
Port Gibson	8	2	6	5	4	2
Rochester	5	5	5	7	3	2
Spokane	3	6	7	6	2	3
St. Louis	6	4	3	6	4	4
Washington	6	5	8	4	2	2

Group 2. Mean (O-F) = 26 percent

	<6	7-13	14-26	27-40	41-52	>52
Albany, Oreg.	4	5	7	5	4	2
Augusta	1	7	9	6	1	3
Denver	3	2	10	7	3	2
Little Rock	5	6	4	6	1	5
Peoria	4	3	6	7	4	3
Salisbury	5	5	3	8	3	3

Group 3. Mean (O-F) = 30 percent

	<7	8-15	16-31	32-46	47-62	>62
Detroit	5	5	4	8	2	3
Natural Bridge, Ariz.	6	4	4	9	2	2
Salt Lake	6	2	4	6	4	5
Santa Fe	5	5	7	4	2	4
St. Paul	3	5	8	6	4	1

Group 4. Mean (O-F) = 40 percent

	<10	11-20	21-40	41-60	61-80	>80
El Paso	3	5	5	3	7	4
Sacramento	0	4	11	6	3	3
San Bernardino	3	2	9	7	2	4
Sums of 25	104	106	159	152	74	80
Means	4.2	4.2	6.4	6.1	3.0	3.2
Limits	<¼	¼-½	½-1	1-3/2	3/2-2	>2

their magnitudes would be greater in proportion as the mean departure of his place bears to 20 percent.

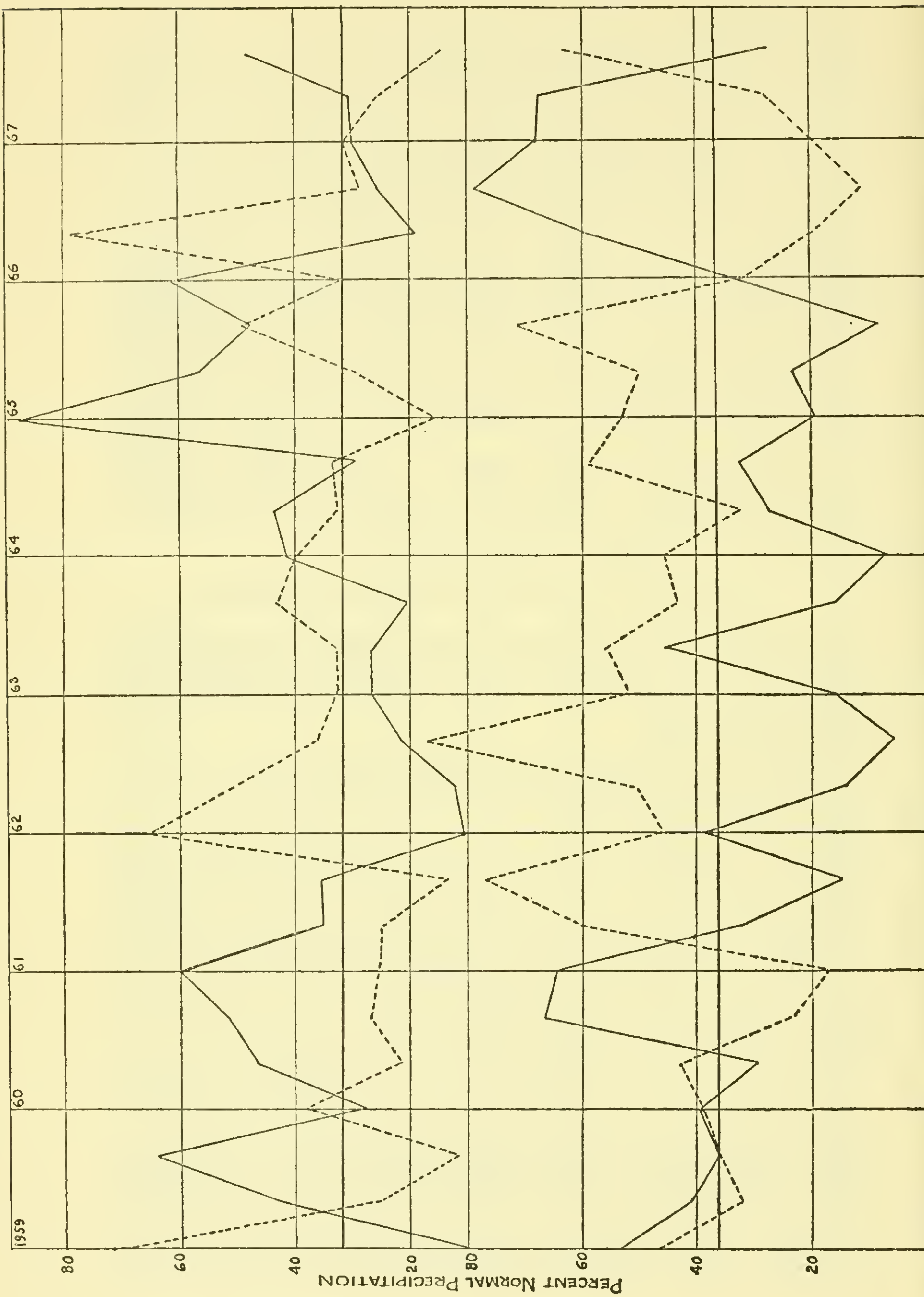
As actual cases, farmers living near Albany, Oreg., or Augusta, Ga., both by table 14 lying in the 26-percent class of table 15, may expect, according to table 15, during the 9 years 1959-1967, the numbers of 4-month averages found in table 14 to differ as follows from the 27 mean 4-month departures from normal precipitation they will actually experience: Four cases less than 7 percent; four cases between 7 and 13 percent; six cases between 14 and 26 percent; six cases between 26 and 39 percent; three cases between 39 and 52 percent; and four cases over 52 percent. Farmers living near one of the cities of the 20-percent class might expect this same division of the 27 cases for the 4-month mean departures from normal precipitation, but these departures would be smaller in percentages in the ratio $\frac{20}{26}$. It will be for their judgment to dictate whether it is worth while to procure from the Smithsonian Institution, and make use of this paper, "A Long-range Forecast of U. S. Precipitation."

COUNTRY-WIDE TRENDS IN PRECIPITATION

The maps of the United States presented below show large areas over which similar forecasts prevail. This should be helpful to interested persons who reside at a distance from the 32 cities for which forecasts were made.

I have been interested to search further to see if similar trends of precipitation sometimes prevail over the whole United States. Table 14 gives the actual departures of 3-month consecutive means of precipitation as averaged over three 4-month intervals per year, 1950-1958. A working table of these results was prepared, giving the 32 departures from normal of the cities employed in each line of a table of 27 lines, 3 lines per year for 9 years. Recording separately plus and minus departures, sums were taken for each line. These plus and minus departure-sums were plotted in figure 12, lower two curves. Plus sums are given in full lines, minus sums in dotted lines.

The plus and minus departure curves run generally in opposite directions, and in some 4-month intervals are widely separated. In such cases of wide separation the 4-month intervals were strongly heavy in precipitation if the high points are on full lines, and strongly drought-prevailing if dotted. With this explanation it is seen that the autumn of 1951 and winter of 1952 were wet periods generally for the whole United States, and similarly from the summer of 1957


PERCENT NORMAL PRECIPITATION
80
60
40
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80
60
40
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1959
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67
1950
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58

through the summer of 1958. On the other hand from the summer of 1952 through the autumn of 1956 the country was generally dry.

This interpretation of generality over the country is justified by the fact that the high points of figure 12 depend on observations of identity of signs for more than 20 out of 32 cities, in 15 cases. Some peaks are supported by 28 cities out of 32.

When both curves are near the heavy horizontal line the precipitation of the country as a whole was nearly normal. That is, through 1950 and the first four months of 1951, and for portions of the years 1953, 1954, and 1957 precipitation generally averaged nearly normal. The curves of figure 12 show plainly that the entire country is subject to nearly simultaneous trends of precipitation, depending, as they do, on nearly universal agreement of observations of departures in 32 cities over an interval of 9 years.

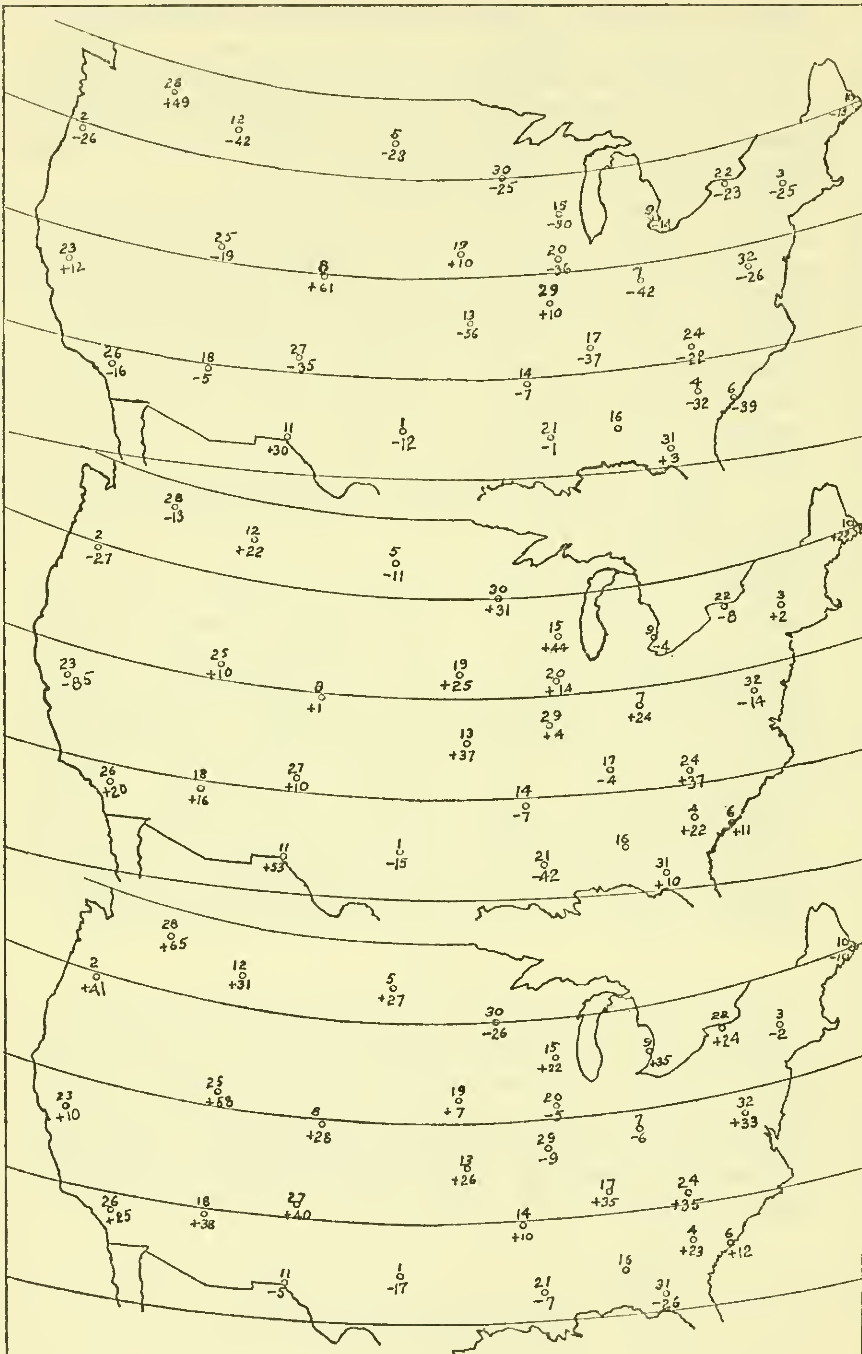
With this result established, turn to the two upper curves on figure 12. These are plotted similarly to those below, but are from table 13 which gives the 4-month mean departures from normal precipitation forecasted 1959-1967.

Reading these upper curves: After the dry winter of 1959 there should follow a short well-watered interval, and an interval of nearly normal precipitation before a rather well-watered period in 1960. Then, following normal precipitation in 1961, should come pretty dry conditions in the winter and early summer of 1962. A long period of normal rainfall follows from the autumn of 1962 through the summer and autumn of 1964. A very wet winter of 1965 follows, and fairly normal precipitation thereafter, except for the dry summer of 1966.

The last preceding paragraph concerns the country as a whole. For details of forecasts for individual stations, the predictions may be found in tables 12 and 13, and in the 27 maps of the United States.

MAPS

Twenty-seven maps of the United States follow, with circles showing location of 32 cities. Numbers above the circles refer to the cities given in table 13, which are numbered correspondingly. Numbers below the circles give percentage departures from normal precipitation as forecasted as means for 4-month intervals in table 13, 1959-1967, A, B, and C, for each year. Three maps form one chart. The nine charts are dated from 1959 to 1967.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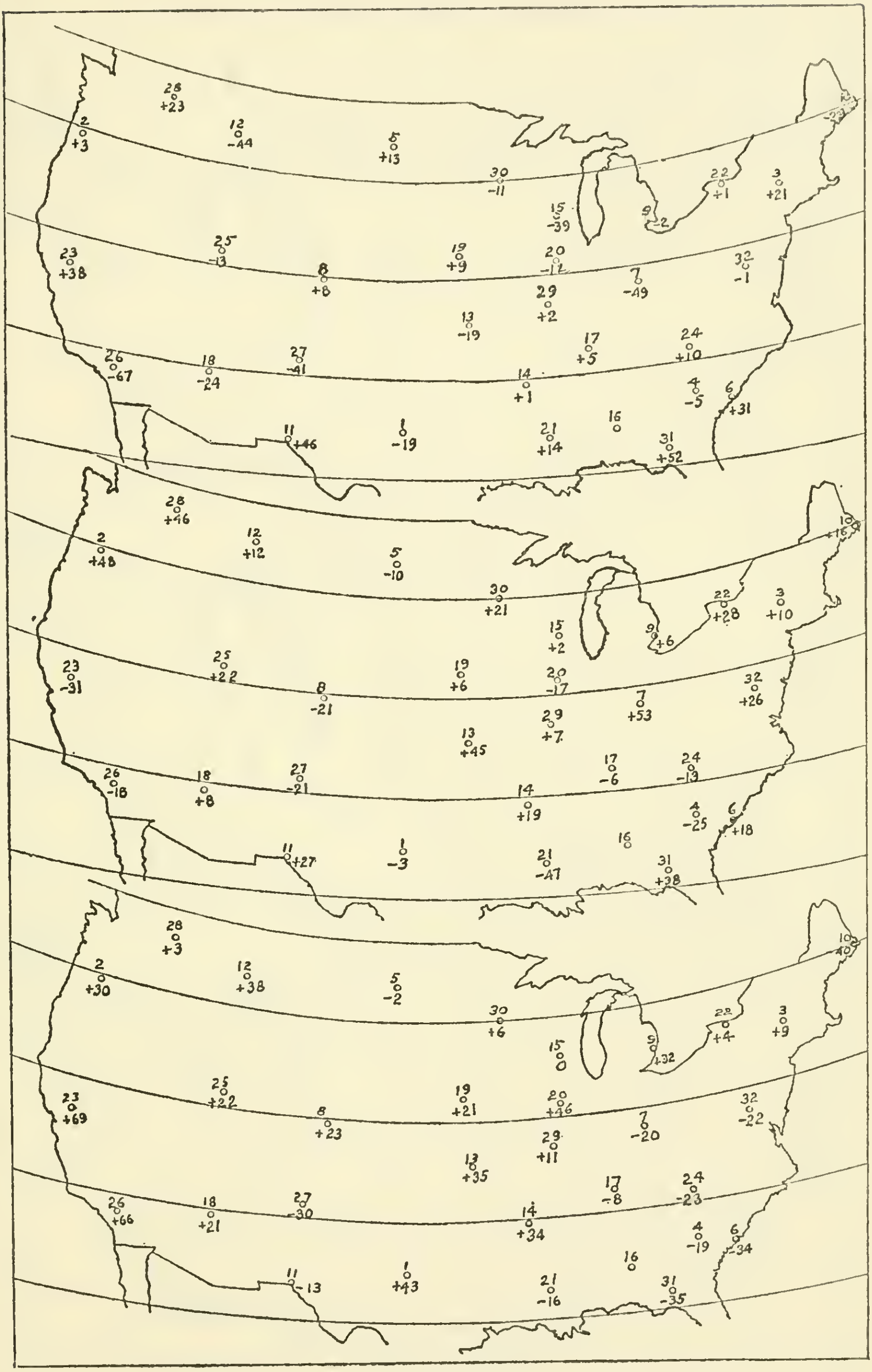
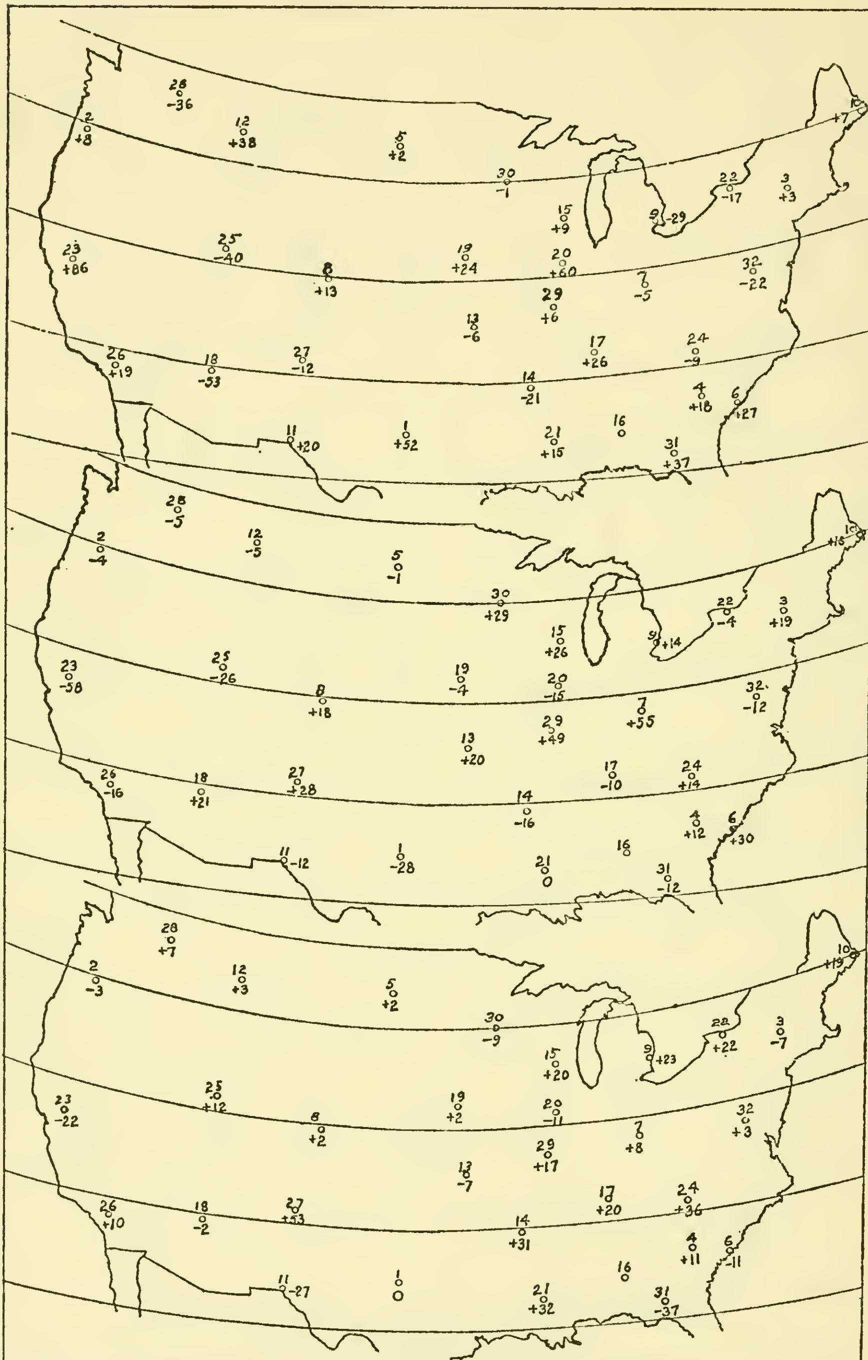
15 −30
9 −14
22 −23
3 −25
10 −13
23 +12
25 −19
8 +61
19 +10
20 −36
7 −42
32 −26
29 +10
13 −56
17 −37
24 −22
26 −16
18 −5
27 −35
14 −7
4 −32
6 −39
11 +30
1 −12
21 −1
16
31 +3
28 −13
2 −27
12 +22
5 −11
30 +31
15 +44
9 −4
22 −8
3 +2
10 +23
23 −85
25 +10
8 +1
19 +25
20 +14
7 +24
32 −14
29 +4
13 +37
17 −4
24 +37
26 +20
18 +16
27 +10
14 −7
4 +22
6 +11
11 +53
1 −15
21 −42
16
31 +10
28 +65
2 +41
12 +31
5 +27
30 −26
15 +22
9 +35
22 +24
3 −2
10
23 +10
25 +58
8 +28
19 +7
20 −5
7 −6
32 +33
29 −9
13 +26
17 +35
24 +35
26 +25
18 +38
27 +40
14 +10
4 +23
6 +12
11 −5
1 −17
21 −7
16
31 −26

1959



1960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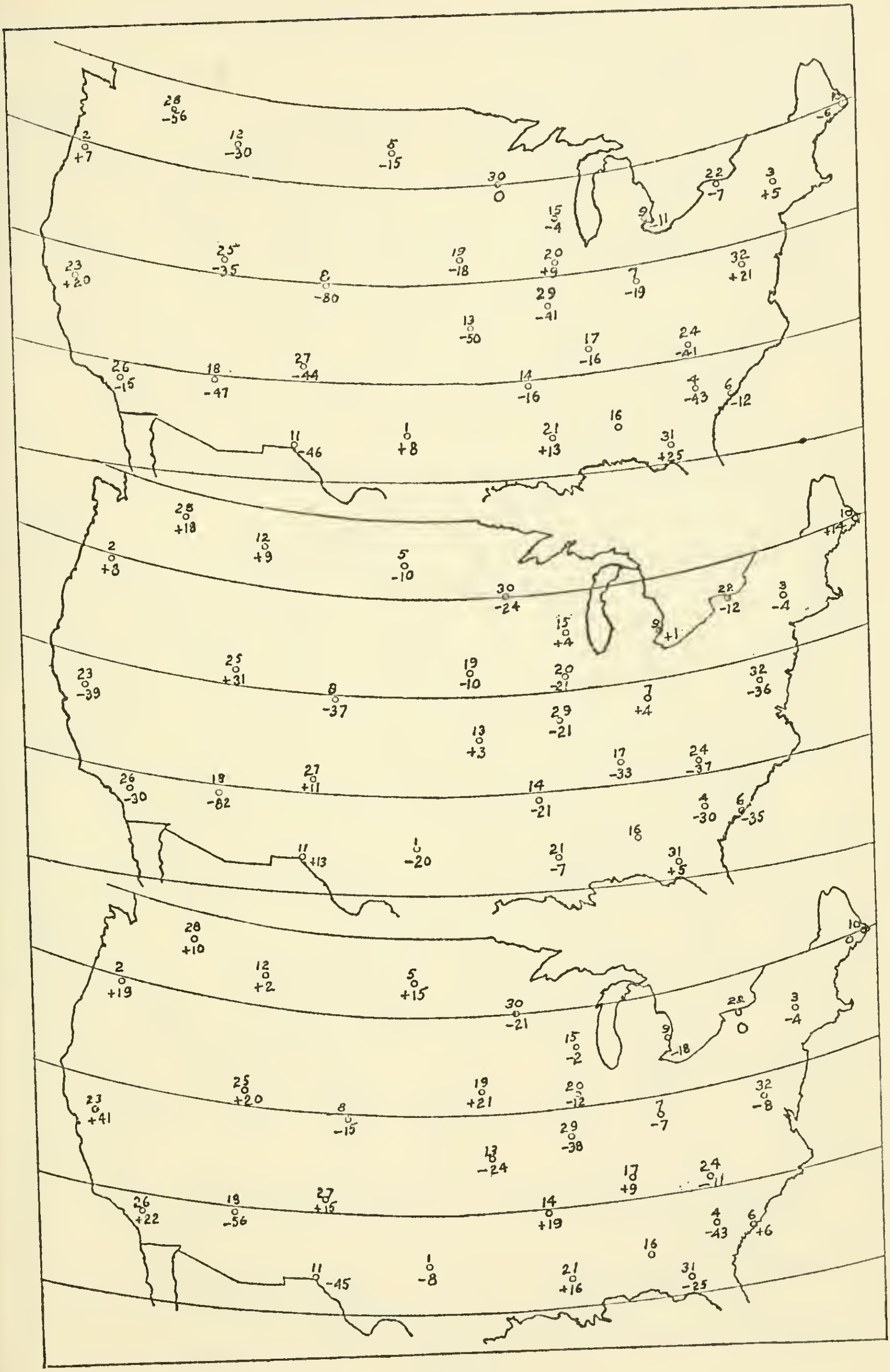
5 +2
30 -1
10 +7
22 -17
3 +3
15 +9
9 -29
23 +86
25 -40
8 +13
19 +24
20 +60
29 +6
7 -5
32 -22
13 -6
17 +26
24 -9
26 +19
18 -53
27 -12
14 -21
4 +18
6 +27
11 +20
1 +52
21 +15
16
31 +37
28 -5
2 -4
12 -5
5 -1
30 +29
10 +16
22 -4
3 +19
15 +26
9 +14
23 -58
25 -26
19 -4
20 -15
8 +18
32 -12
7 +55
29 +49
13 +20
26 -16
18 +21
27 +28
17 -10
24 +14
14 -16
4 +12
6 +30
11 -12
1 -28
21 0
16
31 -12
28 +7
2 -3
12 +3
5 +2
30 -9
10 +19
22 +22
3 -7
15 +20
9 +23
23 -22
25 +12
19 +2
20 -11
8 +2
32 +3
7 +8
29 +17
13 -7
26 +10
18 -2
27 +53
17 +20
24 +36
14 +31
4 +11
6 -11
11 -27
1 0
21 +32
16
31 -37

1961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15 -4
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22 -7
3 +5
-6
23 +20
25 -35
8 -80
19 -18
20 +9
29 -41
7 -19
32 +21
13 -50
17 -16
24 -41
26 -15
18 -47
27 -44
14 -16
4 -43
6 -12
11 -46
1 +8
21 +13
16
31 +25
28 +18
2 +3
12 +9
5 -10
10 +14
30 -24
22 -12
3 -4
15 +4
9 +1
23 -39
25 +31
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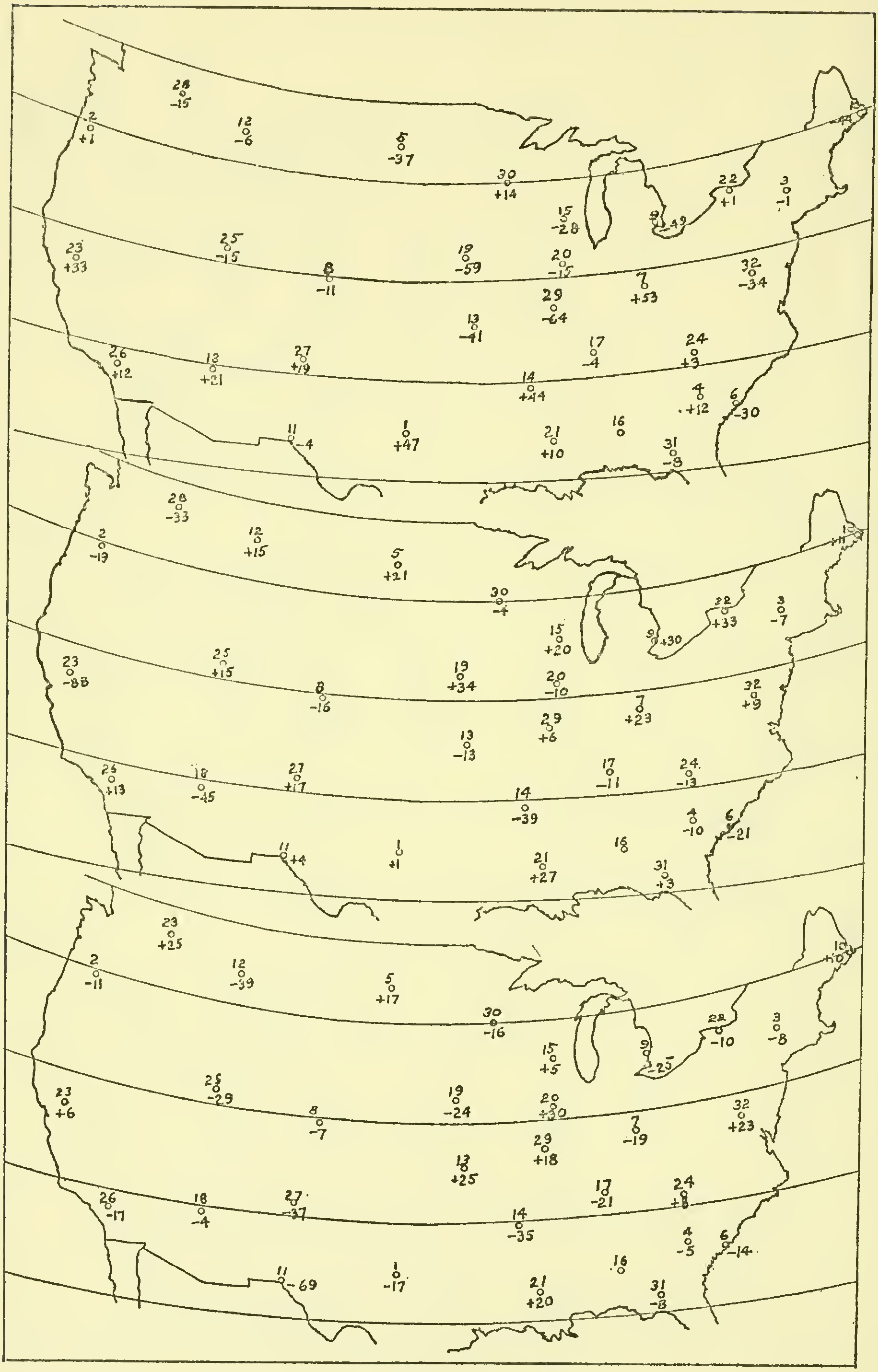
19 -10
20 -21
32 -36
7 +4
29 -21
13 +3
17 -33
24 -37
26 -30
18 -82
27 +11
14 -21
4 -30
6 -35
16
11 +13
1 -20
21 -7
31 +5
28 +10
2 +19
12 +2
5 +15
10
30 -21
22 0
3 -4
15 -2
9 -18
23 +41
25 +20
8 -15
19 +21
20 -12
32 -8
7 -7
29 -38
13 -24
17 +9
24 -11
26 +22
18 -56
27 +15
14 +19
4 -43
6 +6
16
11 -45
1 -8
21 +16
31 -25

1962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15 -28
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23 +33
25 -15
8 -11
19 -59
20 -15
7 +53
32 -34
29 -64
13 -41
17 -4
24 +3
26 +12
13 +21
27 +19
14 +44
4 +12
6 -30
11 -4
1 +47
21 +10
16
31 -8
28 -33
2 -19
12 +15
5 +21
10 +11
30 -4
22 +33
3 -7
15 +20
9 +30
23 -88
25 +15
19 +34
20 -10
32 +9
8 -16
7 +23
29 +6
13 -13
26 +13
18 -45
27 +17
17 -11
24 -13
14 -39
4 -10
6 -21
11 +4
1 +1
16
21 +27
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23 +25
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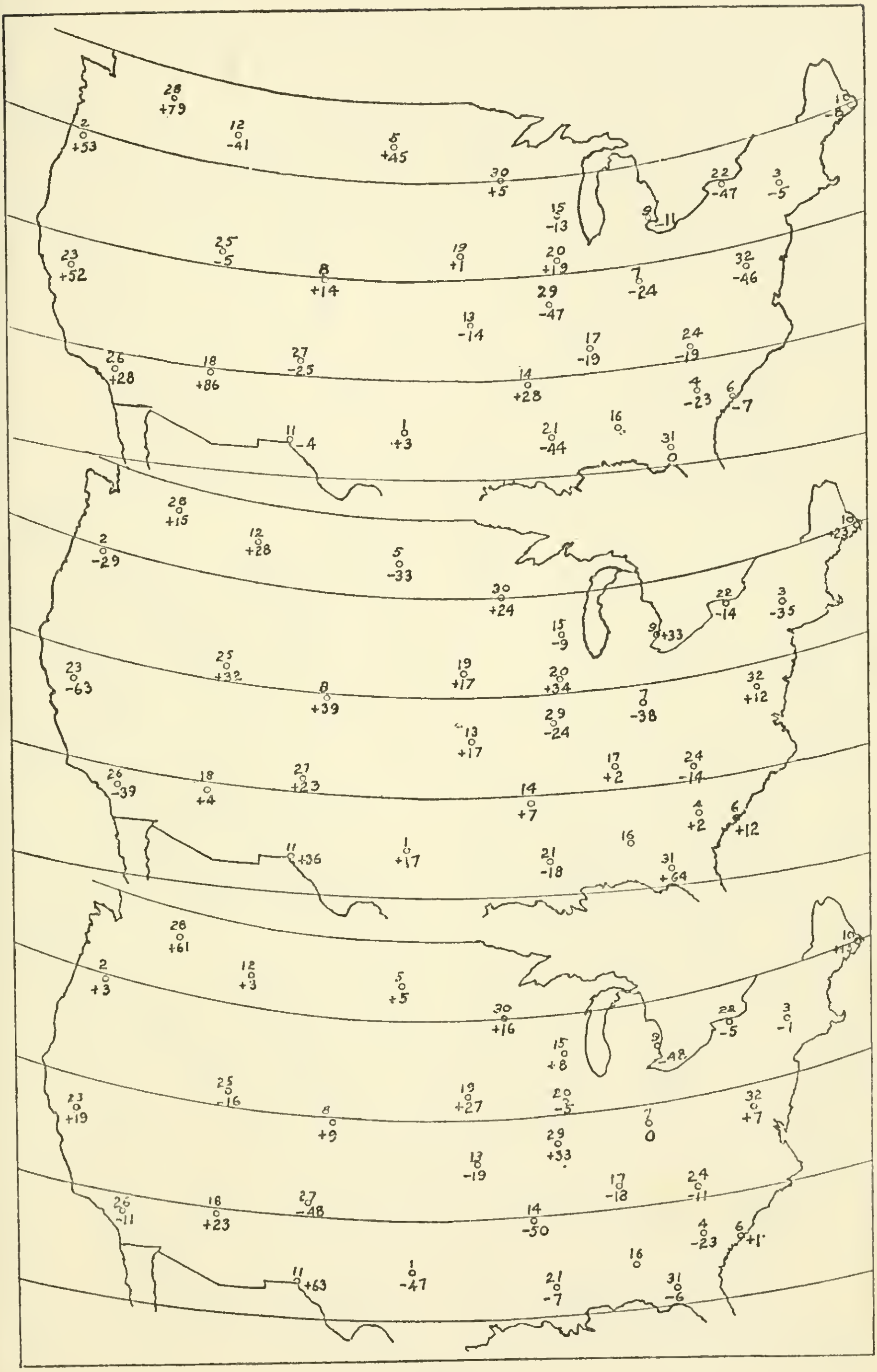
13 +25
26 -17
18 -4
27 -37
17 -21
24 +8
14 -35
4 -5
6 -14
11 -69
1 -17
16
21 +20
31 -8

1963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19 +1
20 +19
7 -24
32 -46
29 -47
13 -14
17 -19
24 -19
26 +28
18 +86
27 -25
14 +28
4 -23
6 -7
11 -4
1 +3
21 -44
16
31 0
28 +15
2 -29
12 +28
5 -33
30 +24
15 -9
9 +33
22 -14
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29 -24
13 +17
17 +2
24 -14
26 -39
18 +4
27 +23
14 +7
4 +2
6 +12
11 +36
1 +17
21 -18
16
31 +64
28 +61
2 +3
12 +3
5 +5
30 +16
15 +8
9 -48
22 -5
3 -1
10 +13
23 +19
25 -16
8 +9
19 +27
20 -5
7 0
32 +7
29 +33
13 -19
17 -18
24 -11
26 -11
18 +23
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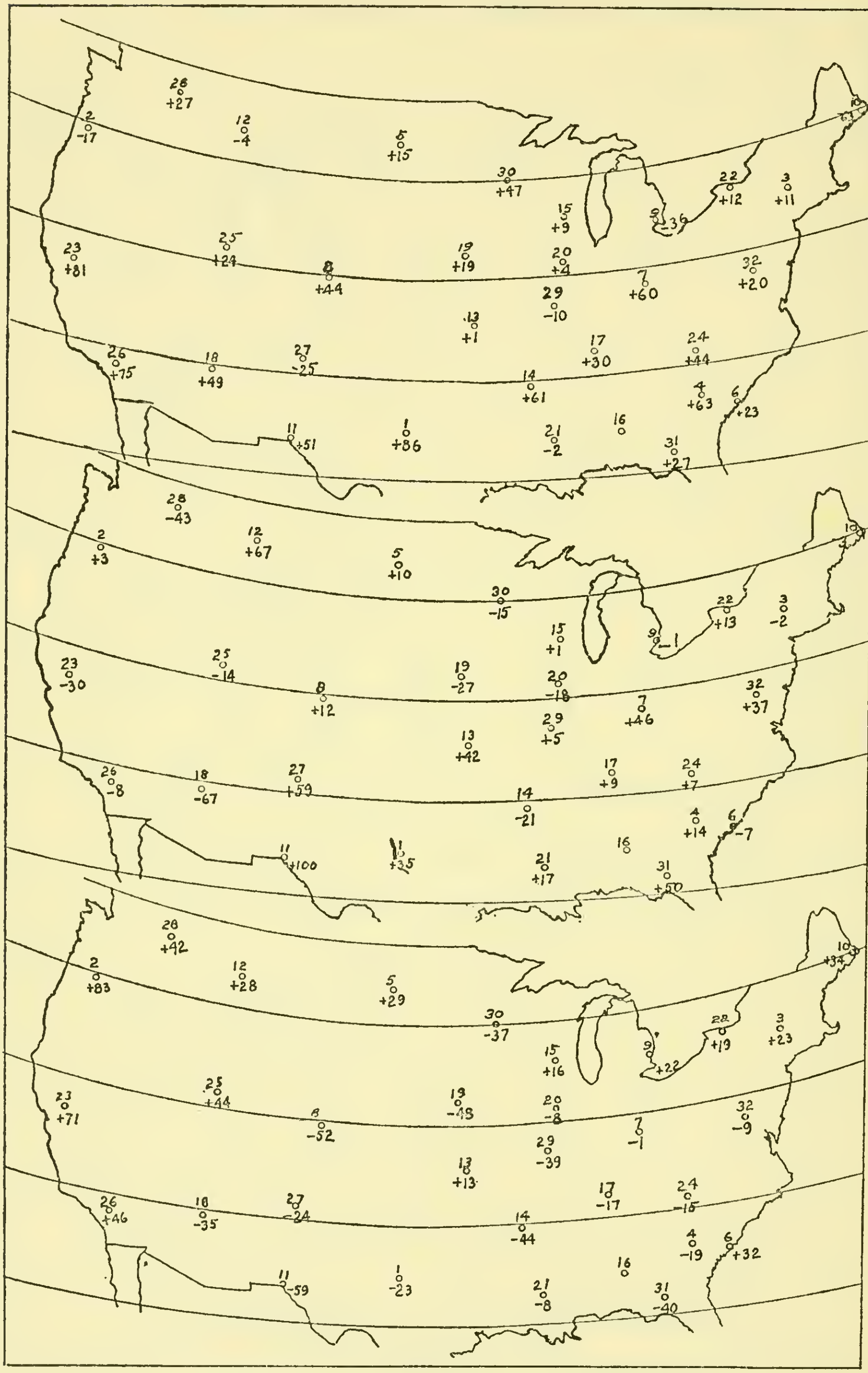
14 -50
4 -23
6 +1
11 +63
1 -47
21 -7
16
31 -6

1964



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5 +15
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30 +47
22 +12
3 +11
15 +9
9 -36
23 +81
25 +24
19 +19
20 +4
8 +44
32 +20
29 -10
7 +60
13 +1
17 +30
24 +44
26 +75
18 +49
27 -25
14 +61
4 +63
6 +23
11 +51
1 +86
21 -2
16
31 +27
28 -43
2 +3
12 +67
5 +10
10
30 -15
22 +13
3 -2
15 +1
9 -1
23 -30
25 -14
19 -27
20 -18
8 +12
32 +37
7 +46
29 +5
13 +42
17 +9
24 +7
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27 +59
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4 +14
6 -7
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7 -1
13 +13
17 -17
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4 -19
6 +32
16
11 -59
1 -23
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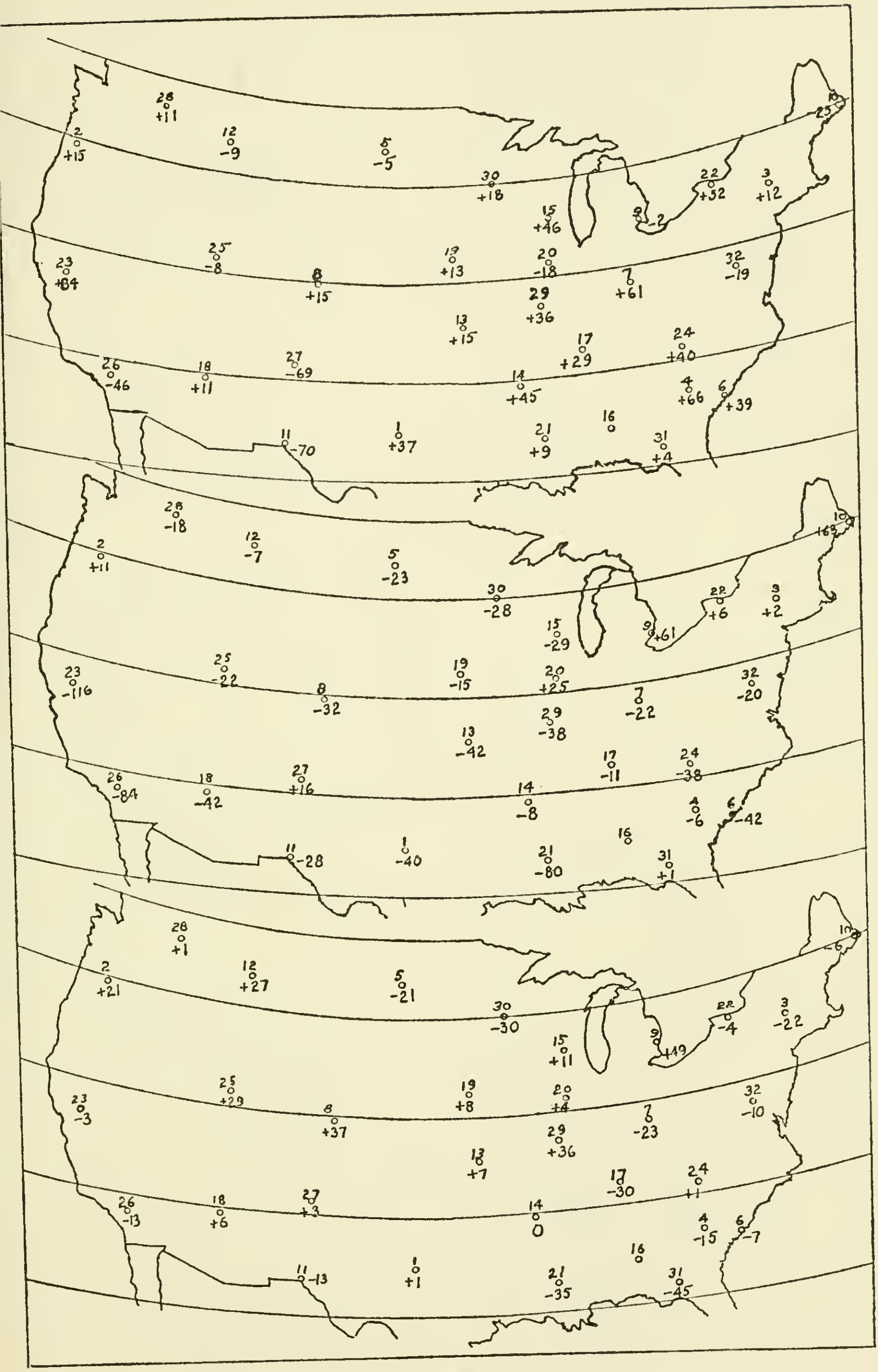
31 -40

1965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8 +15
19 +13
20 -18
7 +61
32 -19
29 +36
13 +15
17 +29
24 +40
26 -46
18 +11
27 -69
14 +45
4 +66
6 +39
16
11 -70
1 +37
21 +9
31 +4
28 -18
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12 -7
5 -23
30 -28
10
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22 +6
3 +2
15 -29
9 +61
23 -116
25 -22
8 -32
19 -15
20 +25
7 -22
32 -20
29 -38
13 -42
17 -11
24 -38
26 -84
18 -42
27 +16
14 -8
4 -6
6 -42
16
11 -28
1 -40
21 -80
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28 +1
2 +21
12 +27
5 -21
30 -30
10 -6
22 -4
3 -22
15 +11
9 +19
25 +29
23 -3
8 +37
19 +8
20 +4
7 -23
32 -10
29 +36
13 +7
17 -30
24 +1
26 -13
18 +6
27 +3
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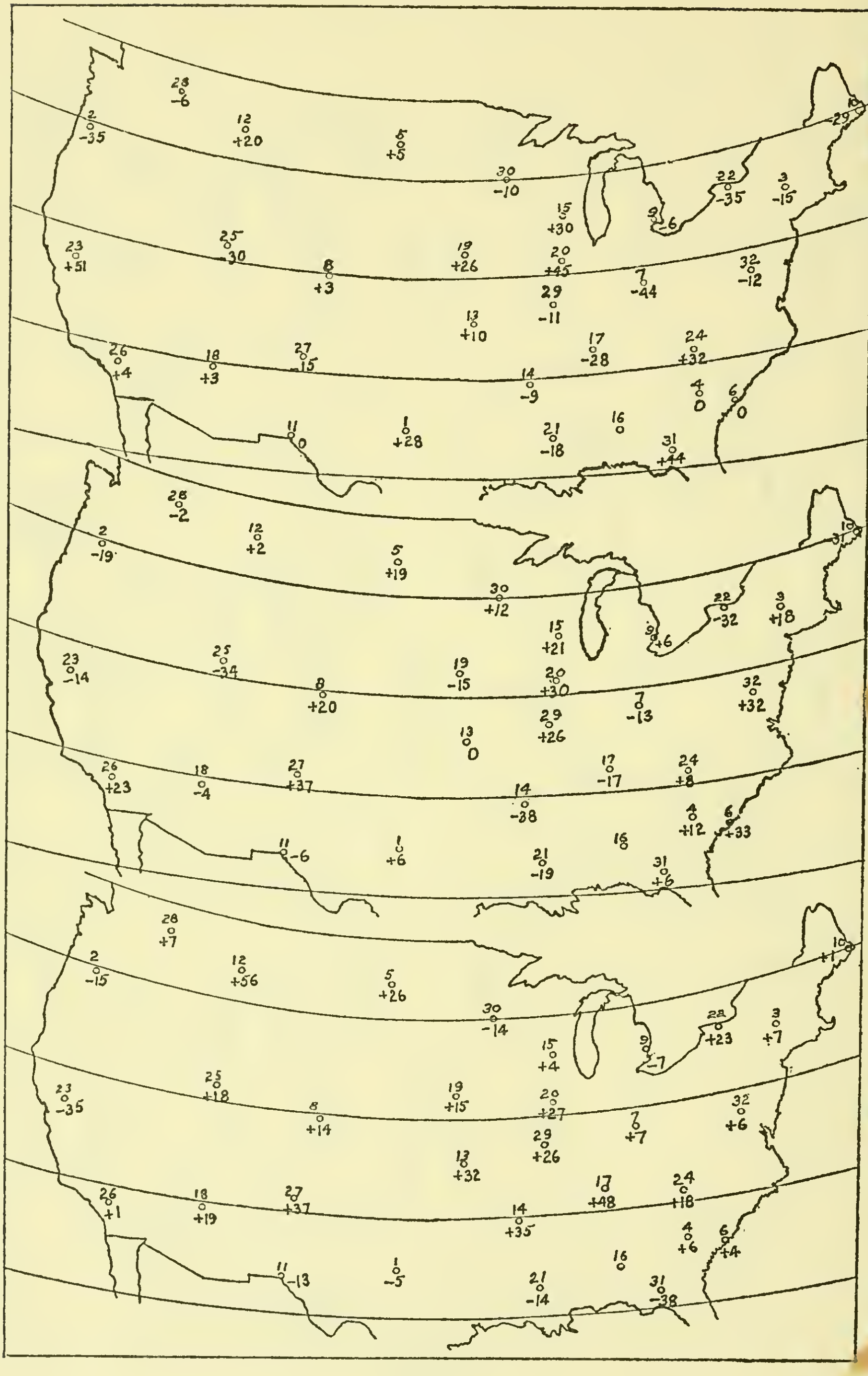
6 -7
16
11 -13
1 +1
21 -35
31 -45

1966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19 +26
20 +45
7 -44
32 -12
29 -11
13 +10
17 -28
24 +32
26 +4
18 +3
27 -15
14 -9
4 0
6 0
11 0
1 +28
21 -18
16
31 +44
28 -2
2 -19
12 +2
5 +19
30 +12
10 31
22 -32
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15 +21
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20 +30
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32 +6
29 +26
13 +32
26 +1
18 +19
27 +37
14 +35
17 +48
24 +18
4 +6
6 +4
11 -13
1 -5
16
21 -14
31 -38

1967