MEAN TEMPERATURES AND THEIR CORRECTIONS IN THE UNITED STATES

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Mean Temperatures and Their Corrections in the United States by Alexander McAdie

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ALEXANDER MCADIE

MEAN TEMPERATURES AND THEIR CORRECTIONS IN THE UNITED STATES

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UNITED STATES OF AMERICA:
WAR DEPARTMENT.

MEAN TEMPERATURES AND THEIR CORRECTIONS

IN THE

UNITED STATES.

PREPARED UNDER THE DIRECTION OF
BRIGADIER GENERAL A. W. GREELY,
CHIEF SIGNAL OFFICER OF THE ARMY,

BY

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DAILY MEAN TEMPERATURE.

In his comprehensive survey of the temperature distribution in the Russian Empire, Wild* gives a few general deductions, about as follows, concerning the daily march of the temperature of the air in the middle latitudes:

A. The amplitude of the daily curve is determined essentially by the nature of the locality, the amplitude being greatest over dry and arid regions and least over marine localities.

The least mean amplitude observed on the ocean is from 1° to 2° Cent., and the greatest observed in deserts 17° Cent.

For the United States the mean amplitudes of various stations for the different months of the year are:

		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Albany, N. Y	Fahr.	7.0	8.0	8.4	12.2	14.2	13.6	14.6	14.4	14.4	11.2	7.1	5.5
	Cent.	3.9	4.4	4.7	6.8	7.9	7.6	8.1	8.0	8.0	6.2	3.9	3.1
Alpena, Mich	Fahr.	7.8	8.1	10.0	9.4	10.2	9.6	9.8	10.2	9.2	8.8	6.1	4.3
	Cent.	4.3	4.5	5.6	5.2	5.7	5.3	5.4	5.8	5.1	4.9	3.4	2.4
Assinniboine, Mich	Fahr.	8.4	10.4	14.0	18.6	19.8	19.0	20.2	21.4	20.2	16.3	11.5	7.0
	Cent.	4.7	5.8	7.8	10.3	11.0	10.6	11.2	11.9	11.2	9.1	6.4	3.9
Atlanta, Ga	Fahr.	9.6	10.8	12.6	14.4	12.8	12.1	12.2	12.7	13.4	13.6	12.4	10.6
	Cent.	5.3	6.0	7.0	8.0	7.1	6.7	6.8	7.1	7.4	7.6	6.9	5.9
Bismarck, N. Dak	Fahr.	11.0	11.5	13.0	17.0	16.9	17.0	19.2	19.1	21.0	17.1	13.0	9.4
	Cent.	6.1	6.4	7.2	9.4	9.4	9.4	10.7	10.6	11.7	9.5	7.2	5.2
Boston, Mass	Fahr.	8.8	9.1	9.5	10.2	10.6	11.0	12.0	12.0	12.0	10.9	8.9	7.3
	Cent.	4.9	5.1	5.3	5.7	5.9	6.1	6.7	6.7	6.7	6.1	4.9	4.1
Buffalo, N. Y	Fahr.	3.8	4.8	5.8	7.9	9.0	8.1	8.0	10.3	9.9	7.3	5.4	3.7
	Cent.	2.1	2.7	3.2	4.4	5.0	4.5	4.4	5.7	5.5	4.1	3.0	2.1
Charlotte, N. C	Fahr.	10.3	11.1	12.2	13.3	15.0	15.9	13.2	13.7	14.1	14.3	12.7	11.1
	Cent.	5.7	6.2	6.8	7.4	8.3	8.8	7.3	7.6	7.8	7.9	7.1	6.2
Cheyenne, Wyo	Fahr.	12.6	13.4	16.8	17.9	20.7	23.8	24.8	23.6	21.3	19.2	15.6	12.1
	Cent.	7.0	7.4	9.3	9.9	11.5	13.2	13.8	13.1	11.8	10.7	8.7	6.7
Chicago, Ill	Fahr.	6.8	7.8	7.7	7.5	7.4	7.6	8.8	9.0	10.2	8.8	7.2	5.6
	Cent.	3.8	4.3	4.3	4.2	4.1	4.2	4.9	5.0	5.7	4.9	4.0	3.1
Cincinnati, Ohio	Fahr.	7.6	8.5	10.6	12.5	14.0	11.8	13.1	14.0	14.4	12.7	10.2	7.8
	Cent.	4.2	4.7	5.9	6.9	7.8	6.6	7.3	7.8	8.0	7.1	5.7	4.3
Denver, Colo	Fahr.	16.0	16.8	18.8	18.8	19.6	22.8	22.8	22.1	24.2	20.6	18.2	14.5
	Cent.	8.9	9.3	10.4	10.4	10.9	12.7	12.7	12.3	13.4	11.4	10.1	8.1
Dodge City, Kans	Fahr.	16.0	19.0	22.0	21.2	20.2	20.4	20.7	21.0	20.7	20.6	18.8	17.0
	Cent.	8.9	10.6	12.2	11.8	11.2	11.3	11.5	11.7	11.5	11.4	10.4	9.4
Eastport, Me	Fahr.	6.3	6.5	7.5	8.3	9.7	11.1	11.7	11.8	10.1	6.9	5.5	4.7
	Cent.	3.5	3.6	4.2	4.6	5.4	6.2	6.5	6.6	5.6	3.8	3.1	2.6
Galveston, Tex	Fahr.	5.6	6.2	6.7	7.3	6.8	6.4	6.6	6.5	6.3	5.9	5.6	5.4
	Cent.	3.1	3.4	3.7	4.1	3.9	3.6	3.7	3.6	3.5	3.3	3.1	3.0
Lynchburgh, Va	Fahr.	10.4	10.7	12.0	13.1	14.5	15.7	15.6	15.9	16.0	15.6	13.5	11.4
	Cent.	5.8	5.9	6.7	7.3	8.1	8.7	8.7	8.8	8.9	8.7	8.6	6.3
Memphis, Tenn	Fahr.	8.9	10.0	11.8	12.4	14.2	12.6	13.6	13.8	14.0	14.3	11.7	9.2
	Cent.	4.9	5.6	6.6	6.9	7.9	7.0	7.6	7.7	7.8	7.9	6.5	5.1

*See "Die Temperatur—Verhältnisse des Russischen Reiches," page 90, *et seq.*

Mean amplitudes of various stations—Continued.

		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Montgomery, Ala	Fahr.	11.8	12.7	14.5	16.3	15.4	14.7	14.4	14.9	15.1	15.9	14.4	12.6
	Cent.	6.6	7.1	8.1	9.1	8.6	8.2	8.0	8.3	8.4	8.8	8.0	7.0
New Orleans, La	Fahr.	9.0	9.6	11.2	10.8	10.8	8.4	9.0	7.3	9.2	9.6	9.3	8.6
	Cent.	5.0	5.3	6.1	6.0	6.0	4.7	5.0	4.1	5.1	5.3	5.2	4.8
New York City, N. Y	Fahr.	6.8	7.5	9.5	11.0	11.2	11.5	11.0	10.2	10.0	9.8	8.2	6.7
	Cent.	3.8	4.2	5.3	6.1	6.2	6.4	6.1	5.7	5.6	5.4	4.6	3.7
Omaha, Nebr	Fahr.	10.6	12.0	14.2	15.0	14.1	14.8	14.5	15.4	15.5	14.6	12.0	10.0
	Cent.	5.9	6.7	7.9	8.3	7.8	8.2	8.1	8.6	8.6	8.1	6.7	5.6
Philadelphia, Pa	Fahr.	6.6	7.9	10.0	12.8	13.2	13.0	12.8	12.1	12.0	11.2	8.4	6.9
	Cent.	3.7	4.4	5.6	7.1	7.3	7.2	7.1	6.7	6.7	6.2	4.7	3.8
Pittsburgh, Pa	Fahr.	6.6	7.4	8.5	10.1	12.0	13.9	14.1	14.3	14.4	14.6	10.7	6.9
	Cent.	3.7	4.1	4.7	5.6	6.7	7.7	7.8	7.9	8.0	8.1	5.9	3.8
Portland, Oregon	Fahr.	6.2	7.3	12.8	14.5	15.1	15.8	14.5	13.3	12.5	11.9	8.6	5.5
	Cent.	3.4	4.1	7.1	8.1	8.4	8.8	8.1	7.4	7.1	6.6	4.8	3.1
Rochester, N. Y	Fahr.	4.4	5.4	6.3	10.0	11.6	12.5	12.0	11.4	11.2	9.5	6.8	4.0
	Cent.	2.4	3.0	3.5	5.6	6.4	6.9	6.7	6.3	6.3	5.3	3.8	2.2
Roseburgh, Oregon	Fahr.	8.4	12.1	16.6	17.7	19.9	19.9	22.4	24.9	23.1	16.6	11.9	7.2
	Cent.	4.7	6.7	9.2	9.8	11.1	11.1	12.4	13.8	12.8	9.2	6.6	4.0
Saint Louis, Mo	Fahr.	8.2	9.8	11.6	13.4	13.2	13.0	14.1	14.0	14.8	13.2	9.6	7.4
	Cent.	4.6	5.4	6.4	7.4	7.3	7.2	7.8	7.8	8.2	7.3	5.3	4.1
Saint Paul, Minn	Fahr.	9.8	11.7	12.4	15.9	15.0	15.0	15.8	16.4	15.0	12.4	9.8	7.4
	Cent.	5.4	6.5	6.9	8.8	8.3	8.3	8.8	9.1	8.3	6.9	5.4	4.1
Salt Lake City, Utah	Fahr.	9.3	10.1	13.4	13.8	15.6	17.7	19.6	18.4	18.4	14.0	11.5	8.4
	Cent.	5.2	5.6	7.4	7.7	8.7	9.8	10.9	10.2	10.2	7.8	6.4	4.7
San Diego, Cal	Fahr.	13.6	12.4	11.2	10.4	9.8	9.4	9.5	9.9	10.5	11.2	11.9	12.5
	Cent.	7.7	6.9	6.2	5.8	5.4	5.2	5.3	5.5	5.8	6.2	6.6	6.9
San Francisco, Cal	Fahr.	7.0	7.2	8.0	8.6	9.4	9.5	10.5	10.4	10.3	10.2	8.0	6.0
	Cent.	3.9	4.0	4.4	4.8	5.2	5.3	5.8	5.8	5.7	5.7	4.4	3.3
Santa Fé, N. Mex	Fahr.	15.4	17.3	19.4	17.4	21.6	22.0	20.2	18.2	21.4	18.8	16.9	14.8
	Cent.	8.6	9.6	10.8	9.7	12.0	12.3	11.2	10.1	11.9	10.4	9.4	8.2
Savannah, Ga	Fahr.	11.1	12.1	13.2	11.9	11.4	11.2	10.8	9.8	11.3	12.0	12.2	12.6
	Cent.	6.2	6.7	7.3	6.6	6.3	6.2	6.0	5.4	6.3	6.7	6.8	7.0
Toledo, Ohio	Fahr.	6.8	8.0	9.2	10.8	11.2	11.4	12.0	12.6	12.4	10.2	7.4	5.2
	Cent.	3.8	4.4	5.1	6.0	6.2	6.3	6.7	7.0	6.9	5.7	4.1	2.9
Washington City	Fahr.	8.9	10.8	11.6	14.8	15.2	14.7	14.4	14.8	14.8	15.0	11.6	9.6
	Cent.	4.9	5.9	6.4	8.2	8.4	8.2	8.0	8.2	8.2	8.3	6.4	5.3
Wilmington, N. C	Fahr.	10.8	12.0	12.0	12.4	11.8	10.7	11.0	10.7	11.4	13.2	12.8	12.7
	Cent.	6.0	6.7	6.7	6.9	6.6	5.9	6.1	5.9	6.3	7.3	7.1	7.1
Winnemucca, Nev	Fahr.	15.1	16.8	20.6	21.0	25.1	25.8	29.3	33.8	31.2	27.2	22.8	16.6
	Cent.	8.4	9.3	11.4	11.7	14.1	14.3	16.3	18.8	17.3	15.1	12.7	9.2
Yuma, Ariz	Fahr.	19.3	20.0	23.6	28.2	27.6	28.3	24.0	24.2	24.8	24.6	20.4	16.8
	Cent.	10.7	11.1	13.1	15.7	15.3	15.7	13.3	13.4	13.8	13.7	11.3	9.3

It is evident from the table that the amplitude is greatest over arid dry regions and least in marine localities. At Winnemucca in August the amplitude is 33°.8, while for the same month at Galveston it is only 6°.5 Fahr., or somewhat less than one-fifth of the value at Winnemucca. Galveston is also a place where the amplitude varies but slightly, from month to month, there being but 1° Fahr. difference between the value for July (6°.6) and that of January (5°.6). At Winnemucca the value for July (29°.3) is nearly twice that of January (15°.1), the difference amounting to 14°.2.

Galveston, Alpena, Boston, Buffalo, Chicago, New Orleans, and Toledo may be taken as types of the marine locality in which the amplitude is relatively small; and Winnemucca, Roseburgh, Yuma, and Santa Fé may be taken as types of the inland or continental locality, in which the amplitude is great.

It will also be seen that in all places, except San Diego, the least amplitude occurs in the winter months and the greatest in the summer months. San Diego is a striking exception to this general law. The climatic conditions in the vicinity of San Diego are remarkable in this, that during the winter months the isocheimals have a value equaling those of the country closely surrounding the northern portion of the Gulf of California, whereas the isotheral curves, showing the mean summer temperature distribution, are of a very different character from those on the eastern slope of the San Jacinto Mountains.

B. The time of occurrence of the maximum depends upon locality. In the diurnal fluctuations it will be seen from the following table, showing the corrections to be applied at any hour to reduce to the true mean temperature, that this second of Wild's deductions also holds, and that making allowance for the time of the sun's reching the zenith and the seasonal influence, the time of occurrence of the maximum temperature depends upon the locality. The maximum occurs earliest in the purely marine climate and latest in dry and arid regions. Over the ocean and on the coast the highest temperature of the day occurs between midday and 1 o'clock p. m. (in summer a little earlier than in winter), while in the interior of continents and particularly in deserts the maximum occurs between 2 and 3 p. m. (in summer somewhat later than in winter), as follows:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Alpena	2.00	2.00	2.00	2.00	1.30	1.30	1.00	1.00	1.30	2.00	2.30	2.30
Buffalo	3.00	3.00	2.30	3.00	3.00	3.00	3.30	3.00	2.30	3.00	2.30	2.30
Chicago	3.00	3.00	3.00	2.30	2.30	3.00	3.30	3.30	3.00	2.30	2.00	2.00
Galveston	3.00	3.00	3.00	3.00	2.30	2.30	3.00	3.00	3.00	2.30	2.00	2.00
New Orleans	3.00	3.00	3.00	3.00	2.30	2.00	2.00	1.00	1.45	2.00	2.30	2.30
Roseburgh	3.00	3.30	4.00	4.00	4.00	4.00	4.00	4.00	3.30	3.00	3.00	3.00
Salt Lake City	2.00	3.00	3.00	3.00	3.00	3.00	3.00	2.30	2.30	2.00	2.00	2.00
Santa Fé	2.30	3.00	3.00	3.00	3.30	3.00	3.00	3.00	3.00	2.30	2.00	2.00
Winnemucca	2.30	3.00	3.00	3.00	3.00	3.00	3.30	3.00	3.00	3.00	2.30	2.00
Yuma	3.00	3.00	3.00	3.00	3.00	3.00	2.30	3.00	2.30	3.00	2.30	2.00

C. The time of the occurrence of the minimum temperature, making allowance for the season and the time of sunrise, is also determined by the nature of the locality. Over a purely marine locality the minimum occurs always a certain time (from 1 to 2 hours) before sunrise, and over dry and arid regions, in the interior of continents, and especially in deserts, almost exactly at the time of sunrise or a little (15 minutes) later. In the winter months, however, the time of the occurrence of the minimum is always much earlier than sunrise, and so it is only in localities with continental climates that the minimum occurs in winter about the time of sunrise, as follows:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Alpena—												
Minimum	6.00	5.30	5.00	4.00	4.00	4.00	4.00	4.00	4.30	5.00	6.00	6.00
Sunrise	7.36	7.07	6.19	5.23	4.36	4.12	4.23	4.55	5.34	6.11	6.52	7.29
Buffalo—												
Minimum	5.30	5.30	5.30	5.00	5.00	4.30	5.00	5.00	5.00	5.30	5.30	5.30
Sunrise	7.30	7.03	6.18	5.25	4.41	4.19	4.30	5.00	5.35	6.09	6.48	7.22
Chicago—												
Minimum	6.00	6.00	6.00	6.00	5.30	5.00	5.00	5.00	5.30	5.30	6.00	6.00
Sunrise	7.27	7.01	6.18	5.26	4.43	4.23	4.34	5.02	5.35	6.08	6.45	7.18
Galveston—												
Minimum	5.30	5.30	5.30	5.00	4.45	4.30	4.30	4.45	5.00	5.30	6.00	6.00
Sunrise	6.55	6.42	6.13	5.38	5.10	5.01	5.09	5.26	5.42	5.59	6.20	6.44

Time of minimum and sunrise—Continued.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
New Orleans—												
Minimum	6.00	6.00	6.00	5.30	5.00	4.30	4.30	5.00	5.00	5.30	6.00	6.00
Sunrise	6.57	6.44	6.14	5.37	5.09	4.58	5.06	5.25	5.42	6.00	6.22	6.46
Roseburgh—												
Minimum	6.00	6.00	6.00	5.00	4.00	4.00	4.00	4.30	5.00	5.30	5.30	6.00
Sunrise	7.30	7.03	6.18	5.25	4.41	4.19	4.30	5.00	5.35	6.09	6.48	7.22
Salt Lake City—												
Minimum	6.00	6.00	5.30	5.30	5.00	4.00	5.00	5.00	5.30	5.30	6.00	6.00
Sunrise	7.25	7.00	6.17	5.28	4.45	4.27	4.37	5.04	5.36	6.07	6.43	7.15
Santa Fé—												
Minimum	5.30	5.30	6.00	6.00	5.00	5.00	5.00	5.00	5.08	6.00	6.00	6.00
Sunrise	7.10	6.52	6.16	5.33	4.57	4.41	4.51	5.14	5.39	6.03	6.33	7.01
Winnemucca—												
Minimum	6.15	6.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	6.00	6.15
Sunrise	7.27	7.01	6.18	5.26	4.43	4.23	4.34	5.02	5.35	6.08	6.45	7.18
Yuma—												
Minimum	6.30	6.00	6.00	5.00	5.00	5.00	5.00	5.00	6.00	6.00	6.00	6.00
Sunrise	7.04	6.49	6.15	5.53	5.03	4.49	4.59	5.19	5.41	6.02	6.27	6.53

At Winnemucca during the winter months the minimum occurs an hour before sunrise and in the summer months about half an hour after sunrise, whereas at Galveston or Alpena the minimum occurs in summer as well as winter before sunrise.

D. The amplitude of the daily oscillation and the times of maximum and minimum temperatures are influenced by the environment of the locality and in particular by the elevation. Just as the amplitude varies in passing from land to sea, so will it vary in passing from the surface of the earth to high atmospheric strata, and we will find the maximum coming earlier and nearer the time of the sun's reaching the zenith, while the minimum (but not always, however) appears to move back from the time of sunrise toward midnight.

E. The amplitude of the daily oscillation, other influence being allowed for, varies somewhat with the latitude of the place, seeming to be less in high latitudes than in low. This influence would be opposed to those mentioned above, and again it is essentially modified of course by the day's length, *i. e.*, the time the sun is above the horizon.

F. The amplitude is greatly modified by the condition of cloudiness. Lamont* has shown for Munich, E. Quételet† for Brussels, Rykatscheff‡ for St. Petersburg, Jesse for Hamburg, and Angot§ for Paris that the amplitude on clear days is much greater than on cloudy days. This influence may be so effective that the influence of the day's length may be entirely masked.

Owing to the lack of adequate cloud observations (for only an extended and continuous series from self-recording instruments would be really valuable in a comparison of this nature) the relation between the degree of cloudiness and the variation in the daily amplitude cannot be given with any degree of accuracy. These few conditions seem evident:

1st. The times of the maximum and minimum temperatures vary in the course of the year much more on clear than on cloudy days. For example, if the maximum temperature occur at a given place in January, at 2.30 p. m., in July on clear days the times of maximum may vary as much as two hours from this time, whereas on cloudy days the tendency is to approach closely this time.

2d. In the United States the greatest amplitudes are found with the least cloudiness, *e. g.*, Win-

* "Darstellung der Temp-Verhältnisse an der Oberfläche der Erde." Abhandl'g d. Math-Phys. Classe der Bayer Acad.

† "Mémoire sur la Température, etc., à Bruxelles," 1867.

‡ "La marche diurne de la Temp., etc." Repertorium für Meteor. Bd. III, 1873.

§ "Influence de la Nébulosité sur la variation diurne de la Temp., etc." Ann. du Bureau Central Météor., 1888, I, B. 188.

nemucca, El Paso, Yuma, where the mean annual cloudiness is .3 or less and the mean amplitude or difference between the highest and lowest points of the curve of diurnal variation approaches 25° Fahr., while at Toledo, Cleveland, and Eastport, where the mean annual cloudiness is $\frac{55}{100}$ or slightly over, the mean amplitude is about one-half or less that of the first-named places.

The following table gives the amplitude and degree of cloudiness for the different months of the year at different places, the cloudiness being given in tenths; thus, Cleveland, 7.35 means 7 tenths and over of sky covered with clouds:

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Winnemucca—												
Amplitude, ° F.	15.1	17.8	20.6	21.0	23.4	25.8	29.8	33.8	31.2	27.2	22.8	16.6
Clouds, 0–10	4.6	4.6	3.8	4.2	3.9	3.2	1.7	1.4	1.9	2.6	3.6	4.6
Yuma—												
Amplitude	19.3	20.0	23.6	28.2	27.6	28.3	24.0	24.2	24.8	24.6	20.4	16.8
Clouds	2.4	2.2	2.2	1.6	1.2	0.8	1.7	2.2	1.0	1.2	1.9	2.0
Washington—												
Amplitude	8.9	10.8	11.7	14.7	15.2	14.7	14.4	14.8	14.8	15.1	11.6	9.6
Clouds	5.9	5.6	5.4	5.3	5.0	4.9	4.6	4.9	4.7	4.7	5.1	5.6
Philadelphia—												
Amplitude	6.8	8.0	10.0	12.6	13.6	13.0	12.8	12.1	12.0	11.2	8.4	6.9
Clouds	5.6	5.2	5.5	5.3	4.8	4.7	4.8	4.7	4.6	4.6	5.0	5.8
Salt Lake City—												
Amplitude	9.3	10.1	13.4	14.0	15.6	17.7	19.6	18.4	18.4	14.0	11.5	8.4
Clouds	5.4	5.4	5.0	5.2	4.5	3.2	3.0	3.1	2.5	3.7	4.5	5.5
Saint Louis—												
Amplitude	8.2	9.8	11.6	13.4	13.2	13.0	14.1	14.0	14.8	13.2	9.6	7.4
Clouds	5.3	5.3	5.4	5.0	4.9	5.0	4.2	3.8	3.7	3.8	5.2	5.8
New Orleans—												
Amplitude	9.0	9.6	11.2	10.4	10.8	8.4	9.0	7.6	9.2	9.6	9.3	8.6
Clouds	5.3	5.0	4.9	4.8	4.5	4.6	4.8	4.6	4.5	3.9	4.7	5.3
Memphis—												
Amplitude	8.9	10.0	11.8	12.4	14.2	12.6	13.6	13.8	14.2	14.2	11.7	9.2
Clouds	5.8	5.7	5.1	4.7	4.6	4.5	4.2	4.0	4.0	3.8	5.1	5.6
Santa Fé—												
Amplitude	15.4	17.0	19.4	17.4	19.5	22.0	20.0	18.2	18.7	19.0	16.5	14.8
Clouds	3.3	3.7	3.6	4.1	3.8	3.3	4.8	4.7	3.0	2.4	3.1	3.1
Buffalo—												
Amplitude	3.8	4.8	5.7	7.9	9.0	8.1	8.2	10.3	9.9	7.3	5.4	3.3
Clouds	7.7	6.6	6.4	5.5	5.2	4.8	3.6	4.4	5.0	6.0	7.4	8.1

G. Topographical features have also a marked influence on the daily amplitude, and Woeikof* has summarized these effects as follows:

a. A convex land surface (such as a hill or mountain) has the effect of diminishing the daily amplitude, and the greater the ratio of the vertical to the horizontal dimensions the greater the diminution.

b. A concave land surface (such as a valley or pass) increases the daily amplitude, but only increases up to a certain ratio between the vertical and horizontal dimensions.

c. Only a perfectly level land surface can give a normal daily amplitude.

TRUE DAILY MEAN.

The true daily mean temperature is the sum of the observations made each hour of the twenty-four divided by 24. There are but few stations, however, where such a series of observations can be maintained for any length of time. Recourse has, therefore, been had to combination hours, from

* "Lehrbuch der Meteor." Van Bebber. Page 80.

which a mean very close to that of the true mean is obtained. The corrections to the various "combination hour" methods are given further on. The best known of these means are—

6 a. m., 2 p. m., 10 p. m., divided by 3. (Dove's system.)
7 a. m., 2 p. m., 9 p. m., divided by 3. (Mannheimer system; in use in Austria.)
7 a. m., 1 p. m., 9 p. m., divided by 3. (In use in Switzerland and Russia.)
7 a. m., 2 p. m., 9 p. m., 9 p. m., divided by 4.
Maximum and minimum divided by 2.
8 a. m., 2 p. m., 8 p. m., divided by 3.
8 a. m., 8 p. m., divided by 2.

The first and fourth of these give means very close to the true means. The 8 a. m. and 8 p. m., on the ground of convenience to observers, has been discussed and the corrections given in detail, with also a table giving the corrections for the mean obtained from observations taken at local times corresponding to 8 a. m. and 8 p. m., 75th meridian time.

MEAN TEMPERATURES.

Twice during the twenty-four hours occurs a mean temperature of the day. The forenoon mean over water surfaces occurs about 8 o'clock, and over dry and arid localities nearly an hour later. The evening mean, in general, occurs after sunset, and comes earlier over water surfaces than over dry and arid regions, and varies less in the course of the year than the morning mean.

KOPPEN'S METHOD OF DETERMINING THE TRUE DAILY MEAN TEMPERATURE.

In the "Ann. der Hydrog.," 1888, p. 341, and in Von Bebber's "Lehrbuch der Meteorologie," p. 34, is described a method for obtaining the true daily mean temperature from the mean of the 8 a. m., 2 p. m., and 8 p. m. observations in connection with the minimum. This last is not given equal weight with the others, but has a value varying with the month.

Let n = mean of 8 a. m., 2 p. m., 8 p. m. b = minimum. m = true daily mean.

Then $m = n - k(n - b)$ and $k = \frac{n-m}{n-b}$. The correction to be applied to $\frac{8\ 2\ 8}{3}$ is propotional to the distance of the minimum temperature from the mean.

The formula is $\frac{8\text{ a.}, 2\text{ p.}, 8\text{ p.}}{3} - k\left\{\frac{8\text{ a.}, 2\text{ p.}, 8\text{ p.}}{3} - \text{minimum}\right\} = \text{true mean.}$ A determination of the value of this factor k shows that it varies from a mean value of 0°.175 Fahr. [0°.1 Cent.] in January to 0°.22 Fahr. [0.12 Cent.] in June.

Table I on page ix gives the values of k, and shows also very clearly the variation in this value with the season as well as with locality.

This method is open to criticism, however, in this that for general use it requires the nicest determination of the minimum temperature, and in the absence of self-registering instruments this necessitates an observation at what is apt to be an inconvenient hour. Conversely the formula suggests an interesting method of determining the true minimum when the true mean and the various other observations are given.

Let $1° - k = h$ and $\frac{1}{k} = l$ Minimum temperature $= \frac{8\ 2\ 8}{3}h - \frac{\text{true mean}}{k} = l\left(\frac{8\ 2\ 8}{3}\right)h - \text{true mean.}$

TO DETERMINE THE TRUE DAILY MEAN TEMPERATURE FROM THE MAXIMUM AND OTHER TEMPERATURES.

Koppen's method, given just above, suggested the following method of getting the mean, making use of the maximum instead of the minimum temperatures and using the 8 a. m. and 8 p. m. (local time) observations. The maximum temperature occurs at a time of day when, in the ordinary routine of life, an observer is able to note with convenience to himself the temperature, and in this respect, therefore, this method is more advantageous.

The formula is, if we let $\frac{8\text{ a.} + 8\text{ p.}}{2} = b$, maximum $= c$, true daily mean $= d$, 1° Fahr. $= k' = h$.

$b - k'(b - c) = d$, $b + k'(c - b) = d$, $bh = d - k'c$, and $d = bh + k'c$.

Table II on page ix gives the values of k' and h for different places in the United States, and it