LIGHTNING FIRE FREQUENCY AT DIFFERENT ALTITUDES

It has been a common belief that zones of great lightning fire risk exist at high altitudes more frequently than at low altitudes because the highest mountains seem more exposed to lightning flashes; but analysis of the altitudinal distribution of lightning fires in the mountains of Oregon and Washington shows that on a given national forest the number of lightning fires per acre at low altitudes is as great as the number per acre at high altitudes if approximately the same number of lightning storms occur over the two areas and if there is sufficient kindling material. The greater number of lightning fires simply occur at the level containing the greater part of the land surface. To determine this relationship precisely, the area of forest land between 0 and 2,000 feet altitude, 2,000 and 4,000 feet, etc., was planimetered from United States Geological Survey topographic maps of three national forests in different parts of Oregon and Washington. (Complete topographic maps were not available for additional national forests having a sufficient number of lightning fires for analysis.) In each case, the number of lightning fires which have occurred at each altitude during a 6-year period was directly proportional to the area of forest land at each altitude.

LIGHTNING FIRE ZONES

An attempt was made to construct a map showing comparative horizontal zones of lightning fire frequency. The starting points for 5,500 lightning fires which occurred on the national forests of Oregon and Washington from 1925 to 1931 were plotted on a single map. At first there appeared to be a few fairly well-defined groupings of these fires, but further analysis showed that there are no zones of consistently repeated fire occurrence.

Detailed study of lightning fire maps for individual days indicates why there is little or no consistent zonation of lightning fire occurrence. Usually, the fires set on any 1 day are widely scattered throughout the area covered by the storms, which is often 7,500 square miles; but occasionally the storms of a single day set many fires within a small area, giving to that area the appearance of a dangerous fire zone. Several years often elapse before another fire is set in the same locality, even though storms occur over it.

THE EFFECT OF TIME OF OBSERVATION ON MEAN TEMPERATURE[1]

By W. F. RUMBAUGH

[Weather Bureau, Boise, Idaho, October 1934]

In meteorological records made at cooperative stations, the writer has frequently observed differences in mean temperature at adjacent stations which could not be satisfactorily explained by topographical influences, but the observations at these stations were taken at differing times of the day, so this investigation was pursued to determine what effect the *time of observation* has on the computed mean temperature. For the benefit of readers not familiar with the climatological work done by the Weather Bureau, it may be stated that mean monthly temperatures at all stations, whether regular Weather Bureau or cooperative, are computed from daily maximum and minimum temperatures for a definite 24-hour period ending at the same time each day for a particular station. At regular Weather Bureau stations, this period ends at midnight. As a midnight-to-midnight standard has been adopted for regular Weather Bureau stations, means obtained by using 24-hour periods ending at other times of the day were compared with those obtained by using the midnight-to-midnight basis.

Effort usually is made to have the observers at cooperative stations read their maximum and minimum thermometers at as near sunset as practicable. Comparable values would be obtained if all cooperative observers could be induced to take their readings at that hour. In numerous cases, however, it is impossible to obtain an observer who is willing to take the readings outside of regular business or office hours, especially if his employers require him to act as observer as a part of his work. These observers usually desire to take the readings either when they begin work, at about 8 a. m., or just before leaving, at about 5 p. m., in most cases. Practically all cooperative observers take their readings at one of the hours mentioned above, namely, sunset, 8 a. m., or 5 p. m. For this reason, means from extremes for 24-hour periods ending with these hours, together with the midnight standard adopted by the Weather Bureau for comparison with records made at regular Weather Bureau stations, are compared in this study.

In order to pursue this investigation, it was necessary to have four sets of thermometers in a ground shelter, and read each set at one of the times named above for a period of several years; or to obtain thermograph records made in a ground shelter for a like period of time. Records made in a roof shelter are not comparable with those made in a ground shelter, hence the use of regular station records was precluded. When, however, it was discovered that the United States Bureau of Entomology at Twin Falls had been making thermograph records in a ground shelter for a period of over 6 years, the second method was adopted, and the original record sheets here referred to borrowed in order to extract the necessary data.

Twin Falls is situated near the center of a large irrigated tract, surrounded by mostly level country. The nearest mountains are about 20 miles to the southeast. As there are no mountains nearer than 100 miles in the direction from which the prevailing winds blow, and none nearer than 20 miles in any direction, air-drainage and inversion effects are largely eliminated. The climatic conditions are representative of a large part of the intermountain region. There usually is little wind during the night and early morning, especially if the sky is clear, but frequently considerable air movement during the warmer part of the day.

In the intermountain region, the maximum temperature occurs much later in the afternoon than in the moister regions of the country. At Twin Falls, it usually occurs between 4 and 6 p. m. from March through September, and only about an hour earlier during the other months,

[1] This study of the effect of time of observation on the *mean* monthly temperature as determined from the daily maxima and minima may be compared with the investigation by E. S. Nichols, of the effect of time of observation on the minima and maxima themselves, MONTHLY WEATHER REVIEW, September 1934. The primary question considered in these papers is that of the *comparability* of records; on the closely related problem of the discrepancy between temperature means as determined by different conventional observing procedures and the true mathematical mean, reference may be made to: Hartzell, Comparison of Methods for Computing Daily Mean Temperatures, MONTHLY WEATHER REVIEW, November 1919; McAdie, Mean Temperatures and their Corrections in the United States, Washington, 1891; Hann, Lehrbuch der Meteorologie, 4 aufl., pp. 93-96.—EDITOR.

and the temperature usually does not fall appreciably during the first hour or two after that time. Minimum temperatures generally occur at sunrise or a few minutes afterward, and on clear mornings a rapid rise begins about half an hour after that time.

With the thermograph record-sheets for the entire 6½ years available, daily maximum and minimum temperatures were extracted for 24-hour periods ending at the four times mentioned above, and monthly means were computed from these data. The maxima obtained for the period ending at 8 a. m. were in all cases charged to the preceding day. These extremes were considered to be observation readings of maximum and minimum thermometers made at these times. No instrumental corrections were applied, as instrumental error would have the same effect on all values, and therefore not affect the differences. The rapid rise in temperature, which on clear mornings begins about half an hour after sunrise, made an excellent time check, as practically all sheets showed at least two or three such mornings, and most of them more than that. Most of the time, however, the thermograph was found to be running on time, or very close to it. After the monthly means were computed, means for all months of the same name and time of observation were computed, and then the differences between the mean obtained by observations taken at each of the three times during the day and the midnight standard. As sunset occurs close to 5 p. m. during the months of November, December, and January, the 5-p. m. values were used for sunset also during these months.

Table 1 shows the variation in mean temperature from the midnight-to-midnight standard produced by taking the observations at the other three times named above. All available data were used in its preparation, and it is believed that if longer records had been available, the results would not have been materially different.

Because the maximum temperature occurs so late in the afternoon in Idaho, observers who take their readings at 5 p. m., do so at approximately the same time that the maximum occurs during 7 months of the year; and during the other 5 months, the temperature has fallen only a little from the maximum by that hour. Therefore 1 warm day would result in 2 high maximum readings, one on the warm day, and the other on the next; while 1 cold night would result in only 1 low minimum reading being recorded. The sunset reading gives better results, but still shows a considerable number of carry-over maxima, and gives a mean temperature considerably higher than the midnight standard for all months of the year. The 8 a. m. and midnight values are very near the same for all months except February. In most cases, the carry-over minimum readings obtained by taking observations at 8 a. m. are offset by minimum temperatures occurring at midnight, each instance resulting in 2 low readings for 1 cold night; and 1 warm day in either case would give only 1 high maximum reading. Except in the winter, the temperature usually rises so much by 8 a. m. that there are few carry-over minima.

TABLE 1.—*Departure from midnight-to-midnight mean temperature obtained by taking observations at other times of the day (degrees Fahrenheit)*

Time of observation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
5 p.m.	+1.0	+1.0	+1.1	+1.5	+1.3	+1.4	+1.2	+1.1	+1.4	+1.2	+1.0	+0.9	+1.2
Sunset	+1.0	+.4	+.5	+.6	+.5	+.4	+.3	+.3	+.4	+.6	+1.0	+.9	+.6
8 a.m.	-.3	-.6	-.2	+.2	0	+.2	+.3	+.1	-.1	-.2	-.3	0	-.1

From this table of differences between the midnight-to-midnight standard and mean temperatures obtained by taking readings at the other times of the day, it is evident that mean temperatures based on afternoon observations, especially if taken as early as 5 p. m., are considerably too high to be comparable with those based on the Weather Bureau standard of midnight-to-midnight, or the 8 a. m. readings; and that if it is desired to have cooperative readings that are comparable to regular Weather Bureau station records, observations taken at 8 a. m. will give the best results of any practicable time. It is impossible, of course, to obtain records based on the midnight-to-midnight period except at regular Weather Bureau stations. If for any reason it is necessary for a cooperative observer to take his readings during regular working hours (from 8 a. m. to 5 p. m.) the early morning hour will result in mean temperatures much more comparable with those recorded at a regular Weather Bureau station than if the observation is taken in the afternoon. It is recognized that difficulty is frequently experienced in determining the date on which maximum temperatures occur when based on morning observations, as some observers set them back 1 day and others do not; but it is believed that the advantages in obtaining records which are more nearly comparable with those made at regular Weather Bureau stations will more than offset this minor difficulty.

THE USE OF FREE-AIR SOUNDINGS IN GENERAL FORECASTING

By HORACE R. BYERS

The use of free-air soundings in general forecasting practice presents several difficulties, chief of which is the limited time allowed for analysis of the data. With a score or more of aeroplane sounding stations dotting the country, enough information should be available for approximating mathematical treatment of the forecast problem; but to utilize in this manner all of the data to their fullest extent is a task left to the research worker, who calculates the atmospheric conditions after the weather events have taken place. In the office of a weather service such as the United States Weather Bureau, less than 2 hours are allowed between the time the data of upper air soundings are received and the general forecasts are issued, so that no time is available for detailed analysis.

However, in this limited time much can be accomplished through the use of rapid graphical methods for determining the state of the atmosphere. Recent advances in the graphical representation of air-mass properties and new knowledge concerning the behavior of the upper air have been helpful. In the course of nearly a year's work in practical forecasting with the use of these data for most of the United States, the writer has found a highly satisfactory degree of success possible without the expenditure of a great deal of time.

Since superadiabatic lapse rates are rare and of little consequence in the free atmosphere, we need consider only instability with respect to saturated air in forecasting rain and storms. This, of course, assumes that we accept the principles of modern synoptic meteorology that heavy clouds and precipitation are formed almost exclusively by adiabatic cooling of moist air during upward motions; and that departures from equilibrium conditions in the vertical temperature distribution, to