It will be noted that at Delaware the estimated minimum by the hygrometric method was within 3 degrees of the actual 22 times out of the 28 cases, and was 5 degrees too low twice and 5 degrees too high once. Using the temperature-range method, the estimate was within 3 degrees of the actual 13 times out of the 28 cases, was once 9 degrees too low, and once 7 degrees too high. In 26 cases using the median-temperature method, 18 times the estimated was within 3 degrees of the actual, twice being 6 degrees too high, and once 3 degrees too low. By using the mean of these three computations we find that in the 28 cases considered the computed was within 3 degrees of the actual 26 times, and that it was once 5 degrees too low and once 4 degrees too high.

CONCLUSIONS.

It seems probable that formulæ may be prepared by two years' thermograph records and whirled psychrometer observations that will permit the making of very accurate minimum temperature forecasts under radiation conditions at any specified point, and further that longer carefully made records will permit of establishing rules that will be widely applicable to places under similar topographic and atmospheric surroundings. The method of hygrometric equation has an advantage in the fact that the dewpoint and relative humidity observations may apparently be made at any convenient hour in the late afternoon or early evening. After the observations have been reduced, and the values of a and b determined, it is then very easy to determine the variation of the minimum temperature from the evening dewpoint by the formula

$$Y = a + bR$$

in which R is the relative humidity at the evening observation and Y the probable variation of the minimum temperature from the evening dewpoint.

HISTORICAL NOTE.

By CHARLES F. MARVIN, Chief of Bureau.

The subject matter of this paper, as regards the prediction of minimum temperatures by means of the so-called median temperature and also the method based on the evening dewpoint and relative humidity, was fully presented by Prof. Smith in a paper submitted August 14, 1915. Publication was deferred at that time because of scantiness of certain data bearing on the question of the change in dewpoint throughout the night, and from other considerations. This lack of data has since been removed and the conclusions of the original paper are herein now seen to be fully confirmed.

Attention is called to the circumstance that as early as 1910 Charles A. Donnel, in analyzing certain special observations made at Boise under the direction of Edward L. Wells, for the purpose of predicting minimum temperatures, noticed that when the evening relative humidity was about 55 per cent, the minimum temperature was about the same as the evening dewpoint. Subsequently, Mr. Wells in a personal report to Mr. Beals, at Portland, Oreg., dated August 9, 1912, stated the relation Donnel had pointed out in the following equation:

M = expected minimum temperature, at orchard level.
D = dewpoint at 8 p. m., at orchard level.
R = relative humidity, at 8 p. m., at orchard level.

Then,

$$M = D - \frac{R-45}{5}$$

This matter was briefly alluded to by Mr. Beals in his bulletin "Forecasting Frost in the North Pacific States," page 17.[4]

During 1917 Floyd D. Young, detailed from the Portland, Oreg., station to manage the spring frost warning service at Medford, Oreg., reported at some length on his utilization of the Donnel relation in that work. Mr. W. G. Reed, also engaged in frost protection investigations at Medford, Oreg., and familiar in a general way with Prof. Smith's investigations, has also studied the utility and application of this relation between the evening hygrometric state and the minimum temperature of the following morning.

It is interesting to observe the close similarity between the entirely independent investigations of Donnel and Wells on the one hand and Prof. Smith on the other. The mathematical identity of the two equations employed is easily shown.

Let M = morning minimum temperature.
Let D = evening dewpoint and R = relative humidity.

DONNEL.	SMITH.
$M = D - \frac{R-n_1}{n_2}$	Y = difference between minimum and dewpoint = $M-D$.
in which n_1, n_2 are two numbers deduced from study of data.	R = evening rel. humidity. a and b are two constants depending on the data.
$M - D = \frac{n_1}{n_2} - \frac{1}{n_2}R$	$Y = a - bR$.
Let $M - D = Y$, $\frac{n_1}{n_2} = a$, $\frac{1}{n_2} = b$.	The computations show that the values of b are negative.
$\therefore Y = a - bR$	

.551.524 (47+57)

THE LOWEST AIR TEMPERATURE AT A METEOROLOGICAL STATION.

While works on meteorology generally agree in stating that the lowest temperature ever observed at a meteorological station (not including upper-air observations) was recorded at Verkhoyansk, Siberia, the value of the reading and the date of occurrence have been variously stated. The following letter on this subject is in reply to one addressed to the late Prince Boris Galitzin (Russian, Golitsyn), director of the Nicholas Central Physical Observatory, Petrograd. The reference in the last paragraph is to Prof. A. Voeikov's "Meteorologia," St. Petersburg, 1910, p. 73, where the absolute minimum at Verkhoyansk is given as −72°C.—*C. F. Talman, Librarian.*

OBSERVATOIRE PHYSIQUE CENTRAL NICOLAS,
Petrograd, Dec. 2, 1915.

Prof. C. F. MARVIN,
Chief Weather Bureau,
Washington, D. C.

DEAR SIR: In answer to your letter [of] October 4, 1915, about the lowest temperature of air in Verkhoyansk, I can refer you to what follows:

The lowest temperature was noticed by the observer at Verkhoyansk the 5th and 7th of February, 1892. The observations were made by means of the alcohol thermometer Müller No. 81*: the direct reading on this thermometer was −68° C. [= −90.4° F.]. This thermometer, No. 81*, was verified in the Central Physical Observatory, but only

[4] *Beals, E. A.* Forecasting frost in the North Pacific States. Washington, 1912. [12 figs.], 49 p. 8°. (Weather Bureau Bull. 41.) (W. B. No. 473.)

between the limits +20° and −20°, so that we don't possess its corrections for lower temperatures.

In order to reduce the alcohol thermometers to the terms of the international hydrogen thermometer, to all readings made on alcohol thermometers, before their being published in the Annals for 1892, corrections were applied, as they were obtained by Mr. Hlasek from comparisons of the thermometer, Geissler No. A, belonging to the Observatory, with the normal thermometer Tonnelot, purchased by the Observatory and verified in the International Bureau of Weights and Measures. The corrections were—

At	−20° C.	−30° C.	−40° C.	−50° C.	−60°C.
Correction	0.0°	−0.6°	−1.1°	−1.6°	−2.0°

From direct comparisons of the readings of the alcohol thermometers with those of the mercury ones, made at several stations in the district of the Observatory in the interval −30° to −40° it follows, that these corrections ought not have been applied to the alcohol thermometers on most stations, for the readings of the alcohol thermometers differ in the above-mentioned interval in general very little from the readings of the mercury thermometers.

Therefore since 1893 the above-stated corrections were no more applied to the readings of the alcohol thermometers and for low temperatures only additional corrections were used, obtained from direct comparisons of the alcohol thermometers with the mercury ones, belonging to the stations.

Owing to these reasons I suppose, that the correction −2.0° C. should not have been applied to the readings of the alcohol thermometer No. 81*, in Verkhoyansk in 1892; as we do not know the true corrections for the thermometer No. 81* in the interval −30° to −70°, it would be more appropriate to use its direct readings without any additional correction. *The lowest temperature of air in Verkhoyansk ought therefore to be considered as* −68° C [−90.4° F.], *it is also the lowest temperature which has ever been observed on the stations of our meteorological net.*

As for the value −72°, which Prof. Voeikov gives in his work, it is most probably due to a misunderstanding; it seems, that he added the correction −2.0° once more to the already-corrected reading of the alcohol thermometers, published in the Annals of the Observatory for the year 1892.

Yours truly,

[Signed] B. Galitzin.

551.524 (794)

NOTES ON THE HOT WAVE IN SOUTHERN CALIFORNIA, JUNE 14–17, 1917.

By Ford Ashman Carpenter, Meteorologist.

[Dated: Weather Bureau, Los Angeles, July 12, 1917.]

Record June temperatures were experienced generally in southern California during the four days ending June 17, 1917. As this heat wave was unique in the meteorological history of this section of the United States, both in its distribution and effects, some notes have been collected on the subject and are here presented for future reference and study.

Contributing causes of hot waves in southern California—Mr. G. H. Willson gives the following explanation of hot waves in California.[1]

> In the late spring, summer, and early fall, when HIGHS cover the North Pacific States and Plateau region, light to moderate, north to east winds prevail over California, and the cool ocean influences are checked or held back. The sky is clear and insolation is great, and the air is heated dynamically in moving down the mountain slopes, causing very high temperatures in the valleys and coast sections. When these conditions are very marked they produce hot waves.

[1] Weather Forecasting in the United States, Washington 1916. p. 338. (W. B. No. 583.)

And the present writer, in discussing a hot wave which occurred at Los Angeles on September 17, 1913, gave the following explanation:[2]

> The cause of this hot spell, like all instances of temperatures above 90° in this portion of southern California, was a well-defined "norther" condition brought about by pressure distribution typical of such phenomena.
>
> On September 15 the barometric pressure was high over the Northwest and low in the Southwest. While the low area remained stationary for many days, the high area progressed in a southeasterly direction. The greatest difference in pressure was coincident with the warmest day, when the weather map showed a gradient of a tenth of an inch in barometric pressure to the hundred miles on an east-and-west line.

General weather conditions accompanying the hot wave.—The hot wave of June, 1917, extended over a period of four days; the first indication that a period of warm weather was imminent occurred with the weather map of the 11th, which showed the arrangement of high and low areas typical to such conditions. Up to this date the season had been backward, the weather being cool and cloudy. The ensuing week brought a rapid balancing of the temperature deficiency which was of long standing. At Los Angeles the temperature reached 100° twice in the four days June 14–17, with the maximum of 105° on the 17th. (See fig. 1.) The highest temperature of which we have data, 124° F., was registered at Mecca, Riverside County, on the 15th, and the lowest maximum, 87°, occurred at San Diego. Except along the immediate coast section the mean maximum temperature for southern California for the four days approximated 100°.

Southern California is specially fortunate in having a number of stations equipped with thermographs. In perusing the thermograms from 16 stations it is found that they fall into two general classes: one (illustrated by fig. 2) where the crest of the hot wave was reached on the fourth day; and the other (see fig. 3) where the temperature suddenly touched the highest point on the first day and thereafter steadily diminished. Among stations falling in the first class belong Los Angeles, Pasadena, Mount Wilson, Redlands, Riverside, Corona, Upland, Pomona, San Bernardino, and Santa Barbara. The second class includes San Diego, Escondido, El Cajon, Bonita, Tustin, and Whittier.

Incidental phenomena were associated with the hot wave. The influence of the hot wind at midnight of the 16–17th (see fig. 4), which traversed the seaward side of the mountain range and caused the temperature to rise 15 degrees, is shown at El Cajon, San Bernardino, and Redlands. This hot wind was also felt at many of the desert stations farther south. Another accompanying phenomenon was the effect of the neighboring forest fires on the otherwise equable littoral weather of Santa Barbara (see fig. 5). Special meteorological observer G. W. Russell at that station is probably correct in attributing the abnormal temperatures there to the forest fire. Concerning this phase of the hot wave Mr. Russell says:

[2] The September hot wave in Los Angeles, Cal. Monthly Weather Review, Washington, Sept., 1913, 41:1404.