Form No. 1024.

U. S. DEPARTMENT OF AGRICULTURE, WEATHER BUREAU.

Record of evaporation and meteorological conditions during the month of July, 1915;
Station, Amer. Univ'y, D. C.; *Latitude,* 38° 54'; *Longitude,* 77° 03'; *Meridian time used,* 75th;
Evaporation tank .... *inches deep,* .... *inches diameter, filled to approximate depth of* 8 *inches; description of station filed,* at Office of the Weather Bureau, Washington, D.C.

DATE.	Exact time of observation.	Number of hours since last observation.	Meteorological conditions. Air temperature. Max.	Min.	Set Max.	Mean.	Precipitation.* Character.	Began.	Ended.	Amount.	Wind. Anemometer dial reading.	Since last observation. Total movement.	Prevailing direction.	Evaporation. Gage reading.	Gage reading when tank filled.	Actual amount, (†)
			F°.	F°.	F°.	F°.				In.	Mi.	Mi.		In.	In.	In.
1	7:00 a	24	82.1	65.6	70.6	72.6	R	DN	DN	0.550	362	48		2.920	*	0.286
2	7:00 a	24	85.1	66.2	74.4	75.2	R	DN	DN	0.035	403	41		2.726		0.229
3	7:00 a	24	84.3	64.9	70.8	73.3	R	DNp	DNp		475	72		2.420		0.306
4	7:00 a	24	84.5	62.6	68.2	71.8				0.050	501	26		2.301		0.169
5	7:00 a	24	82.3	68.2	68.8	73.1	R	DNa	9:00 a	0.200	562	61		2.327		0.174
30																
31																
Sums	(a)	(a)					(a)	(a)	(a)		(a)		(a)	(a)	(a)	
Means	(a)	(a)					(a)	(a)	(a)	(a)	(a)			(a)	(a)	

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(a) No data required. *Including rain, hail, sleet, and melted snow. †Last gage reading plus precipitation minus present

(IN TRIPLICATE.)

Observer, George H. Hand *Address,*

FIG. 7.—Illustration of entries on form used by Class A evaporation stations.

moval of a sufficient amount of water, making hook-gage readings before and after such removal. The pan is emptied and stored during the season of freezing temperatures.

The anemometer is read once daily at the observation hour, and the total wind movement of the past 24 hours is recorded.

The prevailing direction of the wind is determined by means of frequent eye observations on the movement of smoke, bending of tree twigs, etc., and the entry made at the time of the evaporation observation refers to the prevailing direction since the last entry. When the wind has blown from various directions the entry "variable" (var.) is made.

The temperature observations are made in the usual Weather Bureau manner, by means of the maximum and minimum thermometers exposed in the shelter shown in figure 1. Readings are made and entered at the regular observation hour (about 7 a. m.) and obviously give the air temperature only.

The recording form supplied and used is best understood by the sample extract shown in figure 7.

PUBLICATION OF OBSERVATIONS.

As remarked in the introduction, the Weather Bureau has been engaged in these installations during the past two years; indeed, the first observations according to this system were made at the Weather Bureau station on the American University campus, District of Columbia, beginning April 18, 1915. On December 12, 1916, the Chief of Bureau issued a circular announcing that the evaporation data now being collected will, thereafter, be published in the monthly State Section Reports, i. e., "Climatological data by [State] sections" (not the same as another publication of data by sections bearing the same title but also known as Weather Bureau Bulletin "W"). All evaporation observations of this current series made under the direct supervision of the Weather Bureau during 1915 and 1916 will be published in the Annual Summary for 1916 of the "Climatological Data by [State] Sections" for the appropriate State.

A detailed description of each station will be published in the respective issues which contain the first data for the station. These descriptions will not be repeated in subsequent issues unless changes in a station occur. The temperature, cloudiness, and wind direction will appear in the regular tables of climatological data as now published in these section reports, but the daily evaporation measurements and wind movements, together with any other special data will be placed in a separate table of a form similar to that now used for the daily temperature extremes.

SLOPE AND VALLEY AIR TEMPERATURES.

By WILLIAM R. BLAIR, Professor of Meteorology.

[A short time ago the Weather Bureau received a communication asking for information that will help orchardists to avoid the known cold valley floors, to seek out the warmer zones along the valley slopes, to find the spots that are warmest just before sunrise, etc. The following reply was prepared and is here reprinted[1] for the readers of the REVIEW.—C. A., jr.]

The more important factors entering into the temperature conditions experienced in a given locality are:

[1] See U. S. Reclamation service. Reclamation Record, January, 1917, 8:40-41.

(1) The effect of the earth's surface in heating or cooling the air in contact with it; (2) the heating or cooling of air adiabatically when there is a downward or upward component in the air's motion; (3) the heating or cooling of the air itself by its absorption and reradiation of heat radiated to it, mostly from the earth's surface; and (4) the carrying in of colder or warmer air from other locations by whatever wind may be blowing at the time these temperature conditions are being considered.

During insolation the earth's surface in the valley, on the slopes and on the mountain tops is being heated by the absorption of the sun's rays. During day and night the earth's surface is being cooled by the radiation of its heat to the air above it and to space. The air near the earth's surface is clearer, i. e., freer from dust and moisture, at night than during the day and consequently absorbs less terrestrial radiation at night than during the day. The earth's surface and the air in contact with it, i. e., the air in which we live and in which trees and plants live, is warmest at 3 to 4 p. m. and coldest just before sunrise, as a rule, markedly so in clear, calm weather.

In cloudy weather the clouds screen the earth's surface from the sun's radiated heat to a greater or less extent, depending on the cloudiness, and prevent, more or less, the escape of the earth's radiated heat to the air above them and to space. Diurnal extremes of temperature are not pronounced in cloudy weather, and therefore any discussion of valley, slope, and summit temperatures with reference to late spring and early autumn frosts need concern itself with clear weather only.

When the wind prevailing on a given occasion is blowing in such direction and at such rate as to keep the air moving fairly rapidly over the earth's surface in the location in question, there is less likelihood of very low minimum or very high maximum temperatures during the day than if the air were allowed to remain for a longer time under the cooling or heating influence of the earth's surface. It is in clear, calm weather conditions that frosts are most likely to occur. It often happens that winds are directed at, or nearly at, right angles to ranges of mountains or hills. At such times wind velocities may be high on the mountain tops but comparatively low in the valleys, especially if the latter are narrow. This is one reason why valleys are more subject to frosts than are nearby plain areas at approximately the same level.

At 3 to 4 p. m. the temperature of the air next the earth's surface is, as a rule, at a maximum in the valley, on the slope, and on the mountain top, and the maximum is the more pronounced in clear, quiet weather conditions. Under the heating influence of the earth's surface at this time of day the air on the slopes and on the mountain tops is warmer than the free air over the valley at the same level. The circulation attending this distribution of temperature will be a nearly vertical interchange of the air on the valley floor with that just above it and a nearly horizontal interchange of the air on the slopes with the free air over the valley, the initiative in this circulation being with the cooler free air over the valley. The initial vertical component of the circulation thus set up is downward, but it changes to upward as it nears the heating surface of the slopes. It is readily seen that the path of this circulation will always be tangent to the earth's surface and will, to an observer on the surface, have the appearance of a breeze blowing from the valley up the slopes to the mountain top; hence the term "valley breeze." While it continues this circulation tends to keep the temperature of the air near the earth's surface down and to increase the temperature of the free air over the valley.

As the sun continues its descent the amount of heat radiated to the air and to space by the earth's surface becomes large compared with the amount of the sun's heat absorbed, and the air in contact with the cooling surface of the earth in the valley floor, the slopes, and the mountain tops becomes cool relative to the free air above the valley. This cooling takes place nearly simultaneously on the valley floor and on the slopes and top of the mountain. Depending on the slope of the valley floor, air resting upon it moves slowly, if at all. Since this air is denser than the warmer air immediately above it, it remains on the valley floor and becomes colder during the night. The warmest part of the air mass contained in the valley at 3 to 4 p. m. was that in contact with the valley floor. As the air in contact with the cooling earth's surface takes up the temperature of that surface the maximum temperature of the air mass over the valley rises gradually during the night. The circulation attending this distribution of temperature will be an interchange of the cool air on the slopes and top of the mountains with the warm mass of free air which we have seen building over the valley earlier in the day and which terrestrial radiation tends to maintain during the night. The initiative in this circulation will be with the cool air of the slopes and mountain tops. This cool air will flow toward the point of maximum temperature in the air mass over the valley provided the maximum temperature is at the same or a slightly lower level, i. e., air of high specific gravity can not displace air of lower specific gravity unless the air of lower specific gravity is at the same or a lower level than the air of higher specific gravity. The vertical component of this circulation will be downward as the cool air leaves the slopes, but upward as the warm free air over the valley is being displaced. It is readily seen that the path of this circulation is tangent to the earth's surface on the slopes and that it will, to an observer on the slope, have the appearance of a breeze blowing down the side of the mountain, hence the term "mountain breeze." While it continues this circulation tends to build up a deeper and deeper mass of cold air in the valley and to keep warmer the air on the slopes above the cold air mass. The depth to which this cold air mass in the valley can build up depends on (1) the width of the valley compared with the height of the mountain on either side; (2) the lengthwise slope of the valley floor; and (3) the relative lengths of day and night. In a relatively narrow valley the cold air mass will be deeper than in a relatively wide valley. The cold air mass will flow down the valley with greater or less velocity, depending on the lengthwise slope of the valley floor. The faster it moves, i. e., the faster the cold air resting on the valley floor drains away, the less deep will be the cold air mass built up in the valley during a clear, quiet night by the process described above.

A little observation on the slopes of a given valley at the time of injurious frosts in the late spring and in the early autumn should therefore serve to determine with sufficient exactness the height on the slopes above which, for some distance at least, the greatest freedom from such frosts will be experienced. The easiest and most direct way of making these observations is to expose thermographs at different altitudes on the slopes. The balloon is not needed because the upper surface of the cold-air mass in the valley is nearly level, possibly a few meters lower over the middle than at the sides of the valley. This upper surface has been found at 100 to

300 meters above the valley floor at different times of the night and in different localities.

It would be an uncertain procedure to apply the observations made in one valley to the conditions in another, except in a general way. The general remarks above are based (1) on three or four years' observations of mountain and valley temperatures in the vicinity of Mount Weather, Va., and (2) on a number of observations by means of captive balloons at Lone Pine and Mount Whitney, Cal. The observations in the vicinity of Mount Weather were summarized with reference to late and early frosts in the Bulletin of the Mount Weather Observatory, volume 5, page 118. This number of the Bulletin was issued in February, 1914. The captive balloon observations at Lone Pine and Mount Whitney, Cal., were published in the MONTHLY WEATHER REVIEW, July, 1914. Another helpful article on this subject, based on the above data, was published in the MONTHLY WEATHER REVIEW for October, 1914, under the title "Air drainage explained." Other observations in the mountain regions of North Carolina have been made by the Weather Bureau in the further study of this subject, but these observations have not yet been published.

LOW PRESSURE AT PARIS, NOVEMBER 18, 1916.[1]

By [CHARLES] ALFRED ANGOT, Director.

[Dated: Bureau Central Météorologique de France.]

On November 18, 1916, there occurred a meterological phenomenon really exceptional in this region. After a period of low pressure which lasted nearly 48 hours, the barometer at Paris fell to a point almost unprecedented. The pressure reduced to sealevel was 722.5 mm. (28.44 inches) at $22^h 25^m$ (10:25 p. m.), which corresponds to less than 720 mm. (28.35 inches) in the lowest parts of the city. The extreme minimum observed at Paris, 719.4 mm. (28.32 inches) at sealevel, occurred on December 24, 1821.

Ordinarily barometric depressions pass over the British Isles or farther north, moving almost directly from west to east. The position of the center is usually such that Paris is in the region of violent ocean winds from the south, southwest, and west. This time the center followed an entirely different track. It came from the Gulf of Gascony and at 7^h on the 18th was between Belle Isle and the mouth of the Loire. From there it moved inland across the south of Brittany, turning toward le Mans (Department of Sarthe), where it arrived about 18^h (6 p. m.), then toward le Havre and Dieppe, and finally toward London, where it arrived at 7^h on the 19th. All the coast of the Gulf of Gascony, of Brittany, and the western side of the English Channel experienced violent ocean winds blowing from the west. On the other hand, at Paris, on the right of the track, the wind came from the land; it blew from between the south and southeast and remained relatively moderate. At the top of the Eiffel Tower the wind hardly reached a velocity of 20 meters per second (45 miles per hour) even in squalls at the middle of the night when the barometer first began to rise rapidly, although velocities of 30 to 35 meters per second (67 to 78 miles per hour) are often observed with ocean winds from the west and southwest in the winter storms whose centers pass much farther to the north.

During the time the depression was following an abnormal track its velocity was very slight. From the south of Brittany to London the storm scarcely moved 600 kilometers (373 miles) in 24 hours, or with a mean velocity of 25 kilometers (16 miles per hour). Finally, the period of low pressure was of very long duration, but at the time when the barometer was falling most rapidly the rate of change did not exceed 1.5 mm. (0.06 inch) per hour. All these considerations, and others upon which it is not possible to comment now, explain why at least in the Paris region stronger winds were not observed in spite of a pressure entirely comparable to those often observed in tropical cyclones.

[1] La baisse barométrique du 18 novembre 1916. Comptes rendus, Acad. d'agric. de France, 2:1042-1043. Paris 22 nov. 1916. *Translation* by W. G. Reed.

THUNDER AND HAIL IN THE PARIS REGION.[2]

By [CHARLES] ALFRED ANGOT, Director.

[Dated: Bureau Central Météorologique de France.]

It has been shown that thunderstorms are always a result of atmospheric movements which lead to the formation of cumulo-nimbus clouds. There are often accompanying phenomena such as rain, hail, and electric manifestations, which may be produced simultaneously, but there is no relation of cause and effect between them. The cause of the production of hail can not be seen in the electric manifestations.

In the course of recent investigations there was occasion to tabulate the number of days with thunder and the number of days with hail observed at the Parc Saint-Maur Observatory during the 40 years 1874–1913. Table 1 gives the results.

TABLE 1.—*Number of days with thunder and the number of days with hail, at Parc Saint-Maur, Paris, during (40 years) 1874–1913.*

Months.	Total number of days with—	
	Thunder.	Hail.
January	3	24
February	11	36
March	34	80
April	85	66
May	170	65
June	226	21
July	221	18
August	185	10
September	108	9
October	38	20
November	8	10
December	5	24
Total	1,094	383

In this table only days with true hail have been included, grésil ("soft hail") has been omitted. Part of the decrease in frequency of hail in the summer months appears to be due to the fact that when the hailstones are small they are melted before reaching the ground and are recorded as rain. It is in part for this reason that hail is rare within the Tropics.

In the Paris region hail is more frequent than electric manifestations in Winter; but very much less frequent in Summer. The maximum frequency is in Spring from March to May, specially in March ("April showers"); thunder, on the other hand, is most frequent in June and July.

These data furnish an additional proof of the complete independence of hail and electric phenomena.

[2] *Angot, Charles Alfred.* Le tonnerre et la grêle dans le région de Paris. Comptes rendus, Acad. agric. de France, Paris, Oct. 11, 1916, 2:912-913. *Translation* by W. G. Reed.