posed to have come from the desert or semidesert regions. Similar fogs have also been observed along the Niger River, in Zinder, and around Lake Chad. While in the Borku Oasis (northeast of Lake Chad) the fogs observed were remarkable for their extreme dryness, as is attested by the following table:

Date of fog and hour of observation.	Temperature.		Relative Humidity.	Wind.	
	Dry-bulb.	Wet-bulb.		Direction.	Speed.
	° C.	° C.	Per cent.		Meters per second.
Dec. 4, 1914:					
6 a. m.	18.9	9.1	17	NE.	12
12 m.	25.8	12.4	12	NE.	15
9 p. m.	21.5	11.8	24	NE.	12
Dec. 5, 1914:					
6 a. m.	15.3	6.9	19	NE.	18
12 m.	21.0	9.8	13	NE.	22
9 p. m.	18.0	8.9	20	NE.	16

State of the atmosphere: Heavy fog with visibility limited to about 300 to 400 meters.

Owing to the frequence and duration of these dry fogs of the Sahara, they are of importance to aviation. Observations were carefully made from May, 1914, to April, 1917, at Borku, three times a day. The following scale was used in estimating the intensity of fogs:

Heavy fog.......................... Visibility limited to 0.5 km.
Moderate fog....................... Visibility limited to 3 km.
Light fog.......................... Visibility greater than 3 km.

Distances were estimated in the daytime by certain known groups of palm trees, rocks, etc., while at night they were indirectly estimated by observing the various magnitudes of visible stars. The number of fogs so observed were as follows:

Year and month.	Number of fogs observed.			Total number of observations.	Per cent.
	Heavy.	Moderate.	Light.		
1915, 1916, 1917:					
January	10	32	42	273	15.4
February	29	20	49	257	19.0
March	13	21	34	279	12.2
April	24	21	45	245	18.4
1915, 1916:					
May	5	13	18	181	10.0
1914, 1915, 1916:					
June	22	26	48	269	18.0
July	21	17	38	275	13.8
August	13	12	25	177	9.0
September	1	10	11	261	4.2
October	4	2	6	263	2.3
November	0	8	8	265	3.0
December	16	37	53	276	19.2

It appears from the table that the time of greatest fog frequency is that between the winter and summer solstices, while the northeast winds dominate the region. From August to November, when the west and southwest winds are dominant, there are fewer fogs. The northeast fog-producing winds are persistent and blow with great violence for many days at a time, and generally reach maximum about 10 a. m. and a minimum about sundown.

While it is difficult to estimate the depth of these fogs, it is certain that they are often deeper than the highest rocks at Borku, which extend upward 250 to 300 meters.

As the speed of the wind increases it is observed that the intensity of the fog increases. With winds above 8 or 10 meters per second the fog recorded is usually heavy; below that speed, it is light. As the wind dies down, the dust particles settle out of the air to the ground, and the visibility becomes equal to that in France on the best days, and it is often possible to see from 100 to 120 kilometers.

Sand storms.—These storms are frequently observed with such violence as to quickly bury small objects, such as boxes, camp equipment, etc. Pebbles the size of a hazelnut and minute crystal of quartz serve to make exposure to such a storm very uncomfortable. Static electrical phenomena are frequently observed under such conditions.—*C. L. M.*

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ON THE DIFFERENCES BETWEEN SUMMER DAYTIME AND NIGHTTIME PRECIPITATION IN THE UNITED STATES.

By W. J. HUMPHREYS.

[Weather Bureau, Washington, D. C., July 10, 1921.]

Several studies have been made of the hourly distribution of the amount of precipitation in many parts of the world, and the results of most of these have been given in Hann's *Lehrbuch der Meteorologie* (3d edition, pp. 338–346). A later paper [1] shows both in tables and by chart (reproduced here as fig. 1) the various percentages of the 24-hour rainfall in different portions of the United States that occur at night during the summer. The inequalities between the day and night precipitations here shown are both interesting and important, and hence need to be explained.

In most, if not all, parts of this country, as also nearly everywhere else, the day and night distribution of summer rainfall is substantially the same as, and owing to, the corresponding distribution of the thunderstorm. And, since this type of storm is caused by a strong vertical convection of air containing a considerable amount of water vapor, it follows that summer precipitation is divided between day and night in substantially the same proportion as is the strong vertical convection of tolerably humid air.

In the southeastern portion of the United States where the prevailing summer winds are southerly (hence humid) and gentle most of the rainfall of this season is due to heat thunderstorms—that is, local thunderstorms resulting from convection induced by strong surface heating. Hence in this section summer rains are most frequent about mid afternoon.

Similarly, throughout much of the Rocky Mountain and Plateau regions, especially about the chimney-acting peaks and other places favorable to strong updrafts, cumuli and the resulting precipitation are most frequent during summer, in the afternoon, and least frequent at night.

Through the northeastern portion of the United States the typical heat thunderstorm is of secondary importance. Nevertheless, its occurrence there appears still to be often enough to account for the slight excess in that region of the daytime over the nighttime precipitation.

There remain for consideration the regions in which the summer rain is most abundant by night.

One of these regions is the lower Michigan peninsula. Here, as elsewhere, rain at any given place and time is due to clouds that had their inception to the windward. In general, therefore, the rains over the lower Michigan peninsula are from clouds that either originated above or crossed over Lake Michigan. Now, during summer the land areas about this lake, as, in general, about all lakes, commonly are warmer through the day than the surface of the water and cooler at night. Hence, convection over the lake and, consequently, the cloudiness and precipitation to the near leeward—that is, over the lower peninsula—are greatest at night.

[1] Kincer, J. B., MONTHLY WEATHER REV., Nov., 1916, 44; 628-632.

The extreme southwestern portion of the United States appears also to get most of its summer precipitation at night. Here the air that rises during the day, being over hot desert regions, is too dry, except rarely, to yield any considerable precipitation. Furthermore, any daytime rain that may fall as the result of a local convection must be from a high cumulus and through more or less dry air. Hence the daytime catch in this region is reduced, often greatly reduced, by the evaporation in mid-air.

The nighttime catch presumably is greater than that of the daytime, as indicated by the rather scanty data, because (*a*) when the wind at the cumulus level is from the general direction of the Gulf of California the night rain obviously must predominate, owing to the fact that the ascending night air, being over the Gulf, is humid in comparison with the daytime convective columns that rise from the desert; and (*b*) the percentage of the rain lost by evaporation while falling is less at night than through the day, owing to the lower level of the night clouds, and the greater relative humidity of the air at that time.

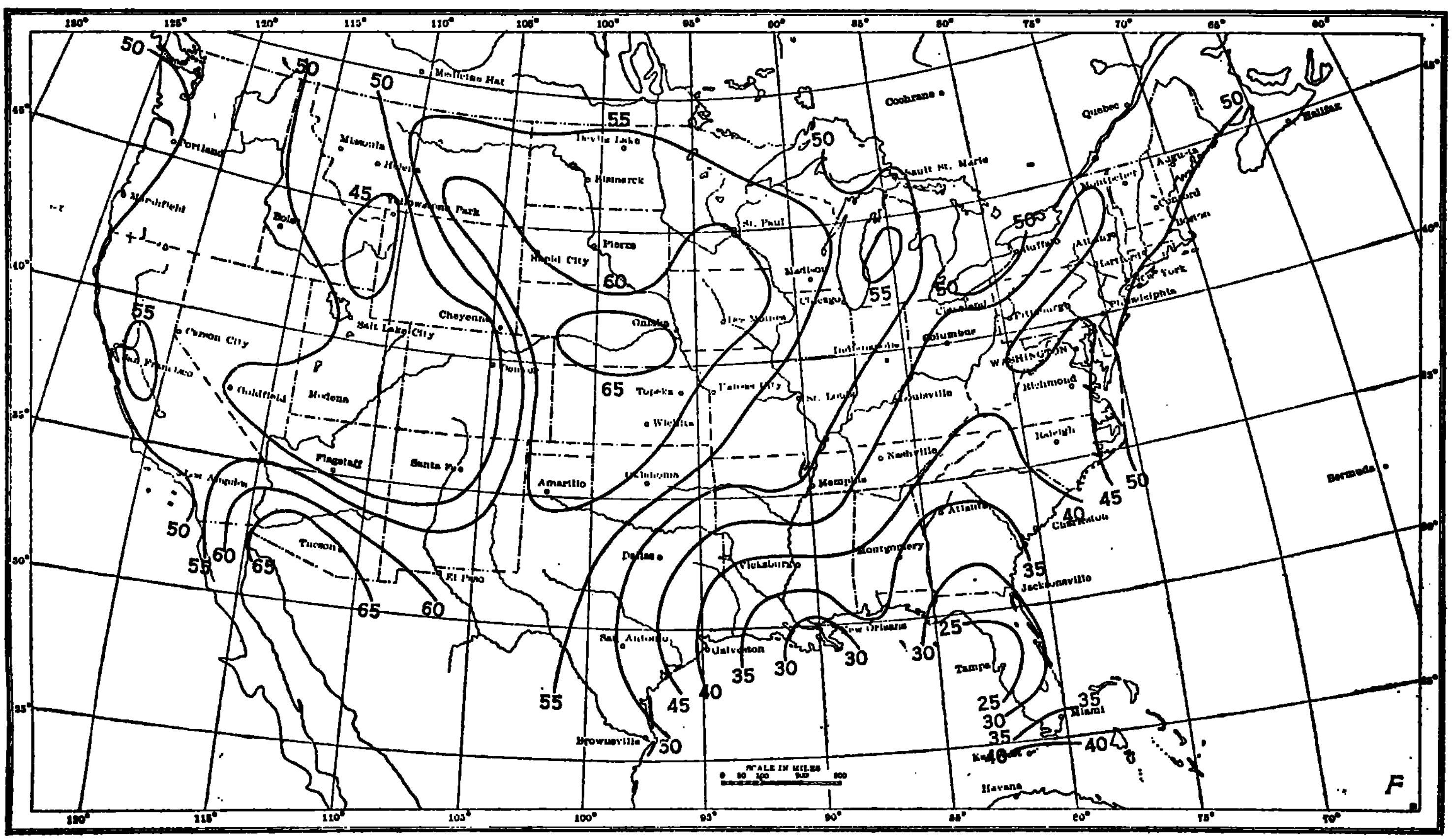

FIG. 1.—Percentage of average precipitation for the season, April to September, inclusive, 1895–1914, that occurs at night (8 p. m. to 8 a. m.). Based on about 175 Weather Bureau stations. Seventy-fifth meridian time.

Finally, summer precipitation is greater at night than during the day over a large area that is centered, roughly, in eastern Nebraska.

Cold anticyclones, cold because of considerable southward travel over land, frequently enter the United States by way of Montana, or anywhere east to and including the Great Lakes. It is these cool anticyclones that "break" the "hot waves" of the Mississippi, Missouri, and Ohio Valleys. On such occasions thunderstorms are frequent in the region under consideration (*a*) when, in conjunction with an anticyclone over Montana, say, the pressure is high also over the eastern and southeastern portions of the United States, and, consequently, a north-south or northeast-southwest "trough" of low pressure lies over eastern Nebraska and adjacent regions; (*b*) when there is a LOW, or cyclone, in the Southwest, over New Mexico, for instance, and a cold anticyclone centered just north of the Great Lakes.

Under each of these, and similar, conditions, eastern Nebraska and the adjacent regions are likely, during summer, to be quite warm, and the surface pressure more or less below normal. At a kilometer elevation, however, and for some distance above that level, the pressure over the heated region may, during the daytime, be approximately equal (owing to expansion of the air below) to that over the anticyclone, and hence the winds at that level correspondingly gentle.

At night the warmer region normally loses heat more rapidly than the cooler, and hence the pressure at any considerable elevation above the former tends to fall below that of the latter at the same level. This in turn allows the cooler air here and there to overflow the warmer and thereby establish that convectional instability essential to the genesis of the thunderstorm.

Hence, in part at least, in the central portion of the United States the thunderstorm is more frequent and the summer precipitation more abundant during the night than in the daytime.