

TABLE 2.—Free-air resultant winds (m. p. s.) during June, 1922.

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)				Drexel, Nebr. (396m.)				Due west, S. C. (217m.)				Ellendale, N. Dak. (444m.)				Groesbeck, Tex. (141m.)				Royal Center, Ind. (225m.)			
	Mean.		Average.		Mean.		Average.		Mean.		Average.		Mean.		Average.		Mean.		Average.		Mean.		Average.	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface.....	S. 19° W.	3.9	S. 4° W.	3.8	S. 2° E.	3.0	S. 8° W.	1.5	S. 85° W.	1.9	N. 24° W.	0.7	N. 65° W.	2.0	S. 45° E.	0.1	S. 7° W.	1.7	S. 15° E.	2.7	N. 81° W.	1.4	S. 48° W.	0.8
250.....	S. 19° W.	3.9	S. 4° W.	3.7	S. 2° E.	3.0	S. 8° W.	1.5	S. 85° W.	1.9	N. 24° W.	0.7	N. 65° W.	2.0	S. 45° E.	0.1	S. 7° W.	1.7	S. 15° E.	2.7	N. 81° W.	1.4	S. 48° W.	0.8
500.....	S. 23° W.	5.5	S. 12° W.	4.9	S. 2° E.	3.9	S. 7° W.	2.0	S. 85° W.	2.0	N. 34° W.	0.7	N. 58° W.	2.9	S. 11° W.	0.3	S. 11° W.	3.9	S. 5° E.	4.3	N. 83° W.	1.5	S. 47° W.	0.8
750.....	S. 23° W.	6.4	S. 15° W.	5.7	S. 8° W.	5.8	S. 19° W.	3.0	S. 85° W.	3.1	N. 30° W.	1.1	N. 71° W.	2.2	S. 13° E.	0.3	S. 11° W.	3.9	S. 5° E.	4.3	N. 79° W.	2.5	S. 42° W.	1.8
1,000.....	S. 21° W.	6.3	S. 20° W.	5.9	S. 19° W.	6.6	S. 34° W.	3.6	N. 81° W.	3.1	N. 60° W.	1.7	N. 85° W.	2.3	S. 8° W.	0.9	S. 9° W.	4.4	S. 3° E.	4.6	S. 84° W.	3.4	S. 51° W.	2.3
1,250.....	S. 21° W.	6.4	S. 23° W.	6.2	S. 24° W.	6.7	S. 45° W.	4.0	N. 71° W.	3.4	N. 59° W.	1.3	N. 87° W.	2.6	S. 20° W.	1.3	S. 3° W.	4.8	S. 3° E.	4.9	N. 84° W.	4.6	S. 71° W.	2.9
1,500.....	S. 24° W.	6.5	S. 27° W.	6.3	S. 34° W.	6.6	S. 37° W.	4.5	N. 71° W.	3.4	N. 59° W.	1.4	N. 89° W.	3.1	S. 50° W.	2.0	S. 3° E.	5.4	S. 3° W.	5.5	N. 84° W.	5.1	S. 79° W.	3.3
2,000.....	S. 33° W.	6.0	S. 32° W.	6.5	S. 46° W.	6.7	S. 62° W.	4.9	N. 69° W.	3.4	N. 69° W.	1.7	S. 86° W.	3.4	S. 51° W.	2.3	S. 1° W.	5.6	S. 2° W.	4.9	N. 78° W.	6.2	N. 86° W.	3.8
2,500.....	S. 31° W.	5.4	S. 29° W.	6.5	S. 52° W.	6.7	S. 72° W.	6.7	N. 83° W.	4.2	N. 81° W.	3.0	W.	5.0	S. 63° W.	3.5	S. 1° E.	6.1	S. 2° W.	4.7	N. 83° W.	11.1	S. 89° W.	5.9
3,000.....	S. 35° W.	5.2	S. 19° W.	6.7	S. 53° W.	11.6	S. 78° W.	8.5	N. 88° W.	7.0	N. 86° W.	4.0	S. 87° W.	8.4	S. 72° W.	5.3	S. 7° W.	6.4	S. 9° W.	4.5	N. 82° W.	13.1	S. 88° W.	8.1
3,500.....	S. 49° W.	5.2	S. 22° W.	7.9	S. 61° W.	11.6	S. 80° W.	9.2	S. 73° W.	7.3	S. 72° W.	5.4	S. 80° W.	12.2	S. 75° W.	7.2	S. 4° W.	7.2	S. 15° W.	5.0	N. 79° W.	16.0	W.	10.9
4,000.....	S. 64° W.	6.1	S. 37° W.	7.0	N. 79° W.	13.7	N. 81° W.	8.7	S. 76° W.	7.6	S. 73° W.	8.7	N. 82° W.	15.6	N. 85° W.	10.1	S. 12° E.	10.4	S. 4° E.	6.4	N. 78° W.	15.9	N. 89° W.	12.3
4,500.....	N. 35° W.	4.9						8.7	S. 76° W.	7.6	S. 73° W.	8.7	N. 82° W.	13.3	N. 70° W.	14.0	S. 22° E.	15.0	S. 29° E.	12.2				
5,000.....								8.8	N. 56° W.	10.4			N. 82° W.	13.7	N. 73° W.	17.5								

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

PRESSURE AND WINDS.

As is usual in June, pressure diminished from the May values over the northeastern districts and from the Rocky Mountains westward, the decreases over the far Northwest being much greater than usual. In the central and northern interior districts where the pressure is usually distinctly less in June than in May, there was a rise of considerable importance, while in the southern districts from Texas and Oklahoma eastward, where the normal pressure in June is only slightly higher than in May, the increases during June were quite marked. As a result the pressure gradients for the different portions of the country were unusually small and the flattened system of isobars, common to the summer season, was more pronounced than usual.

While the cyclones and anticyclones formed in somewhat more rapid succession than usual, they were mainly of small dimensions and pursued rather indefinite courses.

The cyclones usually reached their greatest development over the more eastern districts, with a resultant excess of rainfall in those regions. On the other hand, the anticyclones moving southward from the Canadian Northwest attained their maximum intensity over the central valleys and Lake region, with accompanying dry weather in those localities.

For the month as a whole the atmospheric pressure was below normal over the northeastern districts and in parts of the far Northwest. In other districts the pressure was above normal and to a considerable degree in the Rocky Mountain and adjacent regions.

While the barometric gradients were weak the main slope was toward the north over the districts from the Rocky Mountains eastward, and the atmospheric circulation responded accordingly and southerly winds were general over all that region.

From the Rocky Mountains westward to the Pacific, there was some movement toward the low-pressure area over the far Southwest, but in most districts there was the usual diversity of directions, due mainly to varying topography.

No extensive areas had high winds on the same dates save about the 11th and 12th, when thunderstorms prevailed over much of the country from the Great Lakes and Ohio Valley eastward to the Atlantic coast. In some of the more eastern districts severe thunderstorms

occurred on the afternoon of the 11th, attended by high winds, heavy rains, considerable loss of life, and much damage to property. A more detailed account of these storms will be found at the end of this section.

TEMPERATURE.

No unusual heat or cold occurred during the month over extensive areas or periods, and the ranges from day to day were usually small.

The first week of the month was moderately cool over the interior valleys and southern States, and generally warm from the Ohio Valley eastward, along the northern border, and over most of the Plateau and Pacific Coast States, though it was cooler than normal in portions of California.

Conditions were partially reversed during the second week when there was a decided rise in temperature over all interior and eastern districts, and a general lowering along the northern border from the Great Lakes westward. Cool weather prevailed in the Great Valley of California, and it continued cool in the West Gulf section.

The third week of the month continued warm over the central valleys and Northwest, but a change to decidedly cooler overspread the Northeastern States, and temperatures below normal continued in western Texas, and extended into New Mexico and eastern Arizona.

The final week of the month continued warmer than normal over most districts from the Mississippi and Missouri Rivers westward, the warmth extending into the Southwest where temperatures below normal had persisted during much of the preceding portion of the month. This week continued warm over the Southern States, but like the preceding week it remained cooler than normal over the Northeast, the coolness extending into the Ohio Valley and Lake region.

For the month as a whole temperature averaged above normal over nearly all portions of the country, the only exceptions being small areas in central and western Texas and the adjoining portion of New Mexico, and locally in the northern portions of New York and Vermont.

At a few points the month as a whole was warmer than any preceding June, notably in western Montana, northern Idaho, and eastern Washington. In portions of the last-named State, June, 1922, is the first month since November, 1921, with average temperature above the normal.

No particular period of the month had notably high temperatures over large areas, but about the 14th to 15th

the maxima for the month were recorded in most of the Ohio Valley and cotton-region States; about the 19th to 21st over the far Southwest; and from the 20th to 24th over the northern sections from the Rocky Mountains eastward.

The lowest temperatures were observed from the 1st to 3d over nearly all portions of the region from the Plateau to the Mississippi Valley; on the 13th to 14th over the North Atlantic States; and about the 23d to 26th from the Great Lakes to the South Atlantic States.

Temperatures below freezing were observed at exposed points in all the Mountain States of the West, the lowest reported,  $12^{\circ}$ , occurring at a point in Colorado. Temperatures of  $32^{\circ}$  or only slightly higher occurred along the northern border extending southward as far as Nebraska and Pennsylvania.

Frosts were observed in Colorado and New Mexico on the 1st, but without material damage, and on the 26th they were severe in northern Michigan, causing much damage to garden truck.

#### PRECIPITATION.

The rainfall during June, as is usual for a summer month, was mainly the result of thunderstorm activity, and exhibited to an unusual extent the variations in amounts received at near-by stations when thunderstorms prevail.

In the main, precipitation was frequent and usually heavy over most eastern districts, in fact portions of New York and New England had more rain than ever previously recorded in June. On the other hand, the month was distinctly dry in the great central valleys and portions of the far Northwest. In portions of Illinois, Indiana, Iowa, and locally in adjacent States, the total fall for the month was less than 1 inch, in some instances less than half an inch, while at Chicago, Ill., it was but one-tenth of an inch, the least recorded in June for over 50 years, and similar conditions existed at other points in the Middle West. Also in the far Northwest precipitation was in some cases the least of record for June. In fact, save over most of the Atlantic Coast States, and in portions of Texas, the upper Lake region, western Montana, and a few small areas in Arizona and Nevada, June was a distinctly dry month, particularly in the middle Mississippi Valley and central Plains where the deficiencies by States averaged from 1 to nearly 3 inches. Due to the very general and copious rains of the preceding months, however, the soil had been well saturated with moisture, so that no serious drought existed over any extensive area at the close of the month.

#### SNOWFALL.

In the high Sierra of California snow fell from the 9th to 11th, amounting to as much as 6 inches locally. In other mountain districts of the West snow was reported from a few points only.

The stored snow in the mountain sections furnishing the summer supply of water for irrigation and other purposes in the far West, continued to melt slowly due to continued cool weather up to the middle of the month, after which time melting was more rapid.

At Reno, Nev., the observer reports that more snow was visible in the surrounding mountains at the end of the month than had been observed before in the memory of the oldest inhabitants. In California, the melting snow increased the discharge of Kings River to such a degree that the surplus water overflowed into the dry

bed of Lake Tulare, previously plowed and sowed to grain, which was nearly ready for harvest, causing a loss estimated to exceed half a million dollars.

#### RELATIVE HUMIDITY.

The moisture in the atmosphere as disclosed by the average relative humidity, was in excess of the normal for June over all Atlantic and Gulf Coast States, although the amount of such excess was distinctly less than would be expected from the number of rainy days, marked lack of sunshine, and the generally wet condition of the soil, and other objects.

In the central valleys, where there were long periods without rain, the relative humidity was mainly less than normal, and here too the amount of the deficiency was much less than would be expected considering the marked lack of rain and dry condition of the surface soil.

In the far Northwest and adjoining portions of the Mountain and Plateau regions the relative humidity was less than normal, the deficiencies being as a rule greater than in the central valleys. In other districts the humidity conditions were not materially different from normal.

#### SEVERE STORMS OF JUNE 11.

A number of severe storms, with violent winds, heavy rains, and sometimes heavy hail, visited large portions of the middle Ohio Valley and the Middle and North Atlantic States on Sunday, the 11th.

On the morning of the 11th, at the hour of regular observation, there was a low-pressure center of unusual energy for the warm season located to north of the upper St. Lawrence Valley, the sea-level pressure at Montreal and at White River being 29.38 inches. By the morning of the 12th the low-pressure area was centered over the western portion of the Gulf of St. Lawrence, readings as low as 29.16 inches being reported from Father Point and Quebec. The high temperatures which had prevailed on the 11th from New York southward to Maryland and southwestward to Ohio and southern Michigan had given way to considerably cooler weather, several places reporting 24-hour drops in temperature of from  $10^{\circ}$  to  $16^{\circ}$ .

In the Ohio Valley, while rather high winds occurred practically everywhere, the violent storms seem to have affected mainly some small, scattered areas in three different States. Loss of life occurred in each of these three States. In central Ohio, late in the afternoon, a violent wind struck the region of Buckeye Lake, near Newark. The collapse of several buildings here suggests that a tornado may have occurred, but no evidence of whirling winds or of a funnel cloud is at hand. In the vicinity of Parkersburg, W. Va., the storm was at its height about 7 p. m., 75th meridian time. Some distance to the southwestward, about four hours later, north-central Kentucky was visited. Owen and Henry Counties suffered particularly, but there was considerable damage within the city of Lexington, to southeastward of these counties.

A number of hours earlier, chiefly between midnight and 8 a. m., western and central New York experienced severe storms, the heavy rainfall being here the marked feature. There was, however, considerable wind damage in several counties. A district lying about midway between a line joining Buffalo and Rochester and the Pennsylvania border was visited by unusually high winds. At Delevan, Cattaraugus County, the reports of devastation by the wind during the early morning hours suggest a tornado, but the evidence is not conclusive. At Cort-

land, about 7 a. m., there was great damage by a brief, violent wind, which was probably not a tornado. At that place, and at Syracuse, Oneida, and Salamanca, the rapid rise in small streams due to the heavy rains led to vast damage, chiefly during the forenoon hours.

In the afternoon of the day damage by wind, rain, or occasionally by hail was experienced from northern New Hampshire southward in practically every one of the coast States to Virginia, the time being earliest, as a rule, to northward and northeastward. In Berlin, N. H., the hour of wind damage was 4 p. m. For the New England States, as a whole, the greatest damage seems to have been experienced in a belt crossing in an east-southeastward direction from northwestern Massachusetts and extreme southern Vermont to the Cape Cod district, and here the greatest rainfalls in New England were generally recorded. Considerable wind harm was reported from Pittsfield, Worcester, and from a few miles north of Boston to the vicinity of Brockton; but the greatest wind damage in the State was apparently in Weymouth, Quincy, and vicinity. The places of chief hail damage, however, were well to northward of the places of most wind damage, the hail being felt most in Everett, Malden, and Melrose. The height of the storm, in and near Boston, was between 3 and 4 p. m.

In New York City and vicinity the storm damage was chiefly between 5:30 and 6 p. m. Here the loss of life, and probably of property also, was greatest. While a

considerable number of deaths occurred as a result of the storm in various ways and in various localities, yet the large majority came from the effects of a brief, violent thundersquall, that came very suddenly to part of the Bronx section and to the waters of Long Island Sound to southeastward. A Ferris wheel, in operation near the shore, was blown off its bearings and partly demolished, some of the wreckage falling into the water; 7 deaths resulted from this accident. About 50 were drowned by the upsetting of small craft in the squall-swept area.

At Washington, D. C., the violent winds and thunderstorm came about 8 p. m. Many trees were uprooted or broken off, and some persons were injured by accidents due to the wind.

About 10:30 p. m., Sullivan County, in northeastern Pennsylvania, was visited by a small tornado, which traveled about 8 miles southeastward, resulting in one death and much property loss.

Later information indicates that two small tornadoes did occur in New York State, but not at places mentioned above. The first was at Prattsburg, Steuben County, about 6 p. m. on the 10th. The second was in Greene and Columbia counties, about 4 p. m. on the 11th; this storm traveled 20 miles, crossing the Hudson River north of Athens. These storms damaged farm property but caused no deaths.

These storms are mentioned in the table following this section.

SEVERE LOCAL STORMS.

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the annual report of the chief of bureau.]

Place.	Date.	Time.	Width of path (yards).	Loss of life.	Value of property destroyed.	Character of storm.	Remarks.	Authority.
Dublin, Ga.....	1					Wind.....	Considerable damage to property, especially to telephone and telegraph lines and shade trees.	Official, U. S. Weather Bureau.
Mexia, Tex. (near).....	2	P. m.....				do.....	About 50 derricks demolished and tents and oil shacks blown down.	Dallas Morning News (Tex.).
Scranton, Pa.....	3					Rain.....	Streets badly washed, sewers blocked, street car traffic interrupted.	Official, U. S. Weather Bureau.
Lansing, Mich., and vicinity..	5	P. m.....				Wind, rain, and hail.....	Hydroelectric plant incapacitated and other minor damage done.	State Journal (Lansing, Mich.).
Missoula, Mont.....	5	P. m.....				do.....	General damage done. Loss estimated at thousands of dollars.	Helena Independent (Mont.).
Dayville, Oreg.....	6	P. m.....	6,000			Electrical and hail.....	Considerable damage to crops and garden truck, roofs, and trees. Small live stock killed.	Official, U. S. Weather Bureau.
Windsor, N. Y.....	6	P. m.....				Cloudburst.....	Heavy damage to crops and railroad tracks.....	The Press (Binghamton, N. Y.).
Middle Tennessee.....	6			4		Electrical.....	Some stock killed.....	Official, U. S. Weather Bureau.
Pulaski and McMinnville, Tenn. (near).	6					Electrical and rain.....	No damage reported.....	Do.
Put-in Bay, Ohio, and vicinity.	9	P. m.....				Wind.....	Damage to buildings, wires, and trees.....	Star-Journal (Sandusky, Ohio).
Western, southern, and eastern Wisconsin.	9-10				\$500,000	Thundersqualls, hail, heavy rain, and wind.	Many buildings demolished and others damaged. Several persons hurt; live stock killed; floods force families to leave homes; interurban and telephone systems crippled.	Official, U. S. Weather Bureau; Green Bay Gazette (Wis.); Star (Washington, D. C.).
Central and western New York.	11	A. m.....		1	1,000,000	Wind and rain.....	Residential and business districts of Syracuse flooded. Pavements, roadways, and bridges washed out. Railway and trolley service stopped; crops devastated.	Official, U. S. Weather Bureau; The Post-Standard (Syracuse, N. Y.); Buffalo Express (N. Y.).
Parkersburg, W. Va.....	11	P. m.....		2		Electrical.....	High winds and excessive rain.....	Official, U. S. Weather Bureau.
Newark, Ohio.....	11	P. m.....		3	100,000	Wind.....	Bathhouse toppled into lake. Eight injured.....	Washington Post (D. C.).
Dnshore, Pa.....	11	10:30 p. m.	160	1	40,000	Tornado.....	House and barns wrecked, stock killed, orchards uprooted, and other property damage.	Official, U. S. Weather Bureau.
Owen and Henry Counties, Ky., and vicinity.	11	P. m.....		2		Wind and hail.....	Heavy property damage, trees and telephone lines down. Several persons hurt.	Official, U. S. Weather Bureau; Lexington Leader (Ky.).
Washington, D. C., and vicinity.	11	8 p. m.....				Thundersquall.....	Trees, houses, automobiles injured; some personal injuries.	Washington Post (D. C.).
New York City, N. Y., and vicinity.	11	P. m.....		70		do.....	Heavy property damage. Many lives lost and 100 persons injured.	Official, U. S. Weather Bureau; Express (Buffalo, N. Y.); Boston Post (Mass.).
North Adams, Mass., and vicinity.	11				100,000	Wind and heavy rain.....	Buildings flooded. Streets and gardens damaged.	Boston Post (Mass.).
Boston, Mass., and vicinity..	11	P. m.....		1		Wind and hail.....	Many persons injured. Houses wrecked, roofs damaged, trees, poles and wires down, cellars flooded. Loss estimated at hundreds of thousands of dollars.	Do.
Portland, Me.....	12					Wind.....	Trees uprooted, overhead wires carried away, and traffic delayed.	Official, U. S. Weather Bureau.
Chattanooga, Tenn., and vicinity.	12	1 p. m.....			15,000	Wind and rain.....	General damage done by flooding.....	Official, U. S. Weather Bureau; Chattanooga News (Tenn.).