Carolina, Georgia, and South Dakota one each. Nonfatal tornadoes occurred in Kansas, Iowa, Missouri, Illinois, Indiana, Pennsylvania, and New Jersey.

Michigan had the greatest tornado damage, with losses estimated at $1,725,000. Minnesota was second with damage amounting to $1,345,000, and Texas third with $543,800. In Virginia, North Carolina, South Carolina, Illinois, Louisiana, Arkansas, and Iowa losses exceeded $100,000, while in South Dakota, Kansas, Oklahoma, Missouri, Indiana, Tennessee, Mississippi, Alabama, Georgia, Florida, Pennsylvania, and New York losses varied from $10,000 for Pennsylvania to $92,050 for Kansas. No estimate of damage was obtained for the single tornado which occurred in New Jersey in April.

The preliminary estimate of total damage is only 67 percent of the preliminary figure for 1938 and is less than half the normal annual tornado damage, the normal being based on a 22-year period, 1916–37, inclusive. The total number of storms, 138, is only 3 less than the usual annual number, but the loss of life was only 55 percent of the 1938 total and about 37 percent of the normal annual death toll from tornadoes.

The most severe storm of the year in respect to fatalities was the one of April 16, which covered a path 15 miles long and 440 yards wide in Arkansas, causing 27 deaths, injuries to 62 persons, but property losses of only $20,000.

A storm in Florida in March caused 4 deaths, one in Louisiana in April caused 8, and one in Minnesota in June resulted in 9 fatalities. North Carolina had 4 deaths from one storm in February, and Oklahoma 7 deaths from one storm in April. Four of the 6 deaths in January resulted from a single storm in Tennessee.

The storms causing the greatest property damage occurred in Michigan and Minnesota. A storm in Kalamazoo, Mich., on August 8 caused losses of $1,050,000 and brought death to two persons. Other tornadoes in the same State on that date caused property damage amounting to $675,000. On June 18, a tornado in Minnesota resulted in 9 deaths and property losses of $1,300,000.

A total of 13 storms with some tornadic characteristics (some of these may have been tornadoes) were experienced during the year. These were mostly confined to February and August, and resulted in 4 deaths and property damage of over $1,435,000. In Illinois 3 deaths and losses of $1,000,000 occurred when tornadic winds visited western and central portions of the State on August 10, and one death and losses of $100,000 were reported in Cattaraugus County, N. Y., on September 29.

TORNADOES AND PROBABLE TORNADOES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Number	4	13	12	42	15	26	7	14	3	2	0	0	138
Deaths	6	7	6	58	5	11	0	4	1	0	0	0	98
Damage [1]	54	287	262	553	377	1,610	70	1,947	6	60	0	0	[2] 5,226

TORNADIC WINDS AND POSSIBLE TORNADOES [3]

Number	0	5	0	0	0	1	1	5	1	0	0	0	13
Deaths	0	0	0	0	0	0	0	3	1	0	0	0	4
Damage [1]	0	310	0	0	0	5	4	1,016	100	0	0	0	[2] 1,435

[1] In thousands of dollars.
[2] Damage occurred in addition to amount shown.
[3] Some of these may not be classed as tornadoes in the final study.

DUSTSTORMS OF 1939 IN THE UNITED STATES

By R. J. MARTIN

[Weather Bureau, Washington, D. C., February 1940]

Duststorms of 1939 were not so widespread or destructive as in several previous years, although occasional storms, particularly in western areas, were locally as severe as any experienced since 1930. A few eastern districts noted dusty conditions, the dust usually being confined to the upper atmosphere, or falling mixed with rain or snow. The 1939 storms were not as numerous as in several recent years.

The storms of 1939 are here discussed by months, the descriptions, in most instances, being based on reports submitted by field officials of the Weather Bureau. At times these reports have been included almost verbatim in this summary.

January.—Despite continued dry conditions in much of the Winter Wheat Belt, with lack of moisture most acute in Oklahoma and Kansas and parts of Texas, Missouri, and Iowa, duststorms were mostly light in character and limited in extent during the month.

Considering the country as a whole, storms were most extensive on the 4th–6th. Geographically the most northern report of dust came from Havre, Mont., where light dust occurred on the 19th, and the farthest eastward was at Sault Ste. Marie, Mich., where light dust mixed with rain, or rain and snow, was reported on the 5th and 15th.

Storms in the central and southern Great Plains were most general between the 4th and 6th and after the 16th. The "Dust Bowl" had 3 to 5 days with pronounced soil blowing. At Dodge City, Kans., thick dust reduced visibility to less than 1 mile on the 27th and 31st, and as far south as Port Arthur, Tex., duststorms with reduced visibility continued for as long as 9 hours. At San Antonio, Tex., the storm on the 5th continued for 14 hours and at Abilene the storm lasted from early in the morning of the 5th to the night of the 6th. At Port Arthur and El Paso minimum visibilities were 2½ miles; at Abilene 1½ miles.

In South Dakota fresh to brisk winds were reported in all sections on the 14th and from the 21st to the 25th, with local dust blowing noted from McPherson westward to Carson County and from Dewey and Stanley Counties westward to Butte and Mead Counties from the 21st to the 25th.

In Colorado northwesterly winds on the 4th raised considerable dust in extreme eastern counties south of the Arkansas-Platte Divide, especially south of the Arkansas River. Shallow-rooted weeds were loosened and blown away, exposing loose and friable soil to erosion over large areas. In northeastern Baca County the visibility was reduced to zero for several hours in the lee of blowing fields. Strong northerly winds on the 22nd, 23rd, 25th, and 27th did slight damage to fields in Baca County. Dust reduced visibility to from 2,000 to 5,000 feet.

On the 31st, strong winds which continued for about 7 hours caused light to moderate dust in Lincoln, Kit Carson, Cheyenne, Kiowa, and Prowers Counties and considerable erosion occurred in Baca County where new areas began to blow. Thin stands of sorghum stalks failed to prevent blowing, and wheat, unprotected by strips of heavy sorghum growth, was generally blown out,

In parts of Baca County the visibility was reduced to from zero to 100 feet for a period of from 5 to 7 hours. This was the most destructive duststorm to date for the winter of 1938–39 in Colorado.

Heavy dust was noted over much of northwestern and extreme southwestern Oklahoma on the 4th with a visibility of ⅛ mile reported at Hollis, 200 yards at Canton for a short period, and ¼ mile at Goodwell.

Another heavy duststorm covered much of northwestern Oklahoma on the 27th with visibilities of less than one mile at Alta, Goodwell, Waynoka, Hooker, and Mutual; at Goodwell the visibility was less than ¾ of a mile for over 4 hours. Goodwell and Hooker, both in the panhandle, had heavy dust on the 31st with a minimum visibility of 200 yards at 3:30 p. m.

February.—Duststorms were more widespread in February than during the preceding month and were reported on the 28th as far east as central Tennessee and central Indiana, northward to southwestern Minnesota and portions of South Dakota, and southward to the Texas coast. The most easterly occurrence of dust was at Scranton, Pa., on the 20th.

In the Great Plains, duststorms were most frequent during the first decade and the last 3 or 4 days of the month. A few reports of moderate to heavy dust were received, chiefly from the central and southern Great Plains.

A Soil Conservation Service report from Amarillo, Tex., stated that the "Dust Bowl" had shrunk to less than ⅛ of its original size, with portions of Texas, New Mexico, Kansas, Colorado, and Oklahoma in the best condition since 1932. The "Bowl" had been reduced from an area of approximately 50,000,000 acres at its worst in the winter of 1935–36 to only 9,500,000 acres on February 1st, according to H. H. Finnell, Regional Conservator; in parts of the "Bowl" area the soil was wet to a depth of 48 inches.

At Goodwell, Okla., light storms were reported on the 4th, 9th, 12th, 13th, 15th, 16th, and 18th. At times visibility was reduced to less than 1 mile; this was the case on the 9th with a minimum visibility of one-fourth mile and on the 16th of one-half mile. At Cheyenne a visibility of 200 yards was reported on the 7th and at Elk City and Goodwell on the 9th it was reduced to one-fourth mile. Heavy dust was also noticed at Tipton on the 16th, while on the 27th heavy dust covered the central and southern portions of the State, reducing visibility at times to three-fourths mile at Pauls Valley and Altus, one-fourth mile at Tipton, and one-fourth mile at Duncan. Light dust was reported at one or more Oklahoma stations on 15 days, though no damage was reported, except for a small amount of wheat blown out in northwestern sections.

Four to six duststorms occurred in extreme southwestern counties of Kansas. On the 18th they were reported in a number of localities scattered over the western third of the State, and on the 19th were general over the western third and extended to some central counties. Light to moderate dust was carried in the upper air into eastern counties on several days, including the 7th, 8th, and 19th.

Southeastern Nebraska had a duststorm on the 7th which began before noon in Hall County, about 1 p. m. in Nuckolls, and at 2:30 p. m. in Lancaster County; the lowest visibility at Lincoln was 500 feet, but the storm was of short duration.

High northerly and northwesterly winds raised considerable dust in Baca County, Colo., on the 16th, resulting in moderate damage to fields, and reducing visibility to 50 feet in the lee of fields for several hours. On the 18th and 19th strong southwesterly winds were erosive in Baca County with visibilities of 50 to 500 feet for periods of from 5 to 8 hours on each of the 2 days. These were the most destructive storms reported in the State. Light to moderate dust was noted on the 18th as far north as Prowers, Cheyenne, Kit Carson, and Elbert Counties.

Light to moderate storms were reported in Texas, particularly in the Panhandle, on from 1 to 6 days. The storms were heavy at Amarillo on the 9th and 16th with minimum visibility of one-half mile for 3 hours; the maximum wind velocity during the storm of the 9th was 56 miles per hour. Dust reduced visibility to less than 1 mile in Houston for several hours on the 10–11th.

March.—Duststorms became more serious during March with parts of Oklahoma, the Texas Panhandle, and Kansas again seriously affected. The worst duststorm in 2 years brought heavy clouds of red dust to an area of about 100,000 square miles in six States, including portions of New Mexico, Arkansas, Missouri, Kansas, Oklahoma, and Texas. Light dust was reported from Montana eastward to Sault Ste. Marie, Mich., and from New Mexico eastward to Alabama.

Storms were most frequent from the 11th to the 19th, though a few were reported, especially in the northern Great Plains and upper Mississippi Valley, during the last decade. The number of days with dusty conditions varied from 2 or 3 in the extreme northern Great Plains to as many as 9 in portions of Texas. Dense or heavy dust occurred on 1 to 2 days in portions of southern Missouri, western Oklahoma, and the Texas Panhandle.

At El Paso, Tex., dust was reported at elevations exceeding 8,000 feet and continued in the upper atmosphere from the 15th through the 19th. The minimum visibility noted at Abilene was one-fourth mile on the 11th, but at Springfield, Mo., the worst duststorm in 3 years reduced horizontal visibility to one-fifth mile and ceiling to zero for about 1½ hours. At Amarillo, Tex., the visibility was zero for 1 hour on the 4th and for 5 hours on the 11th. On the 5th and 14th visibility was reduced to one-half mile for from 1 to 2 hours; the maximum wind velocity reported during the storms was 60 miles per hour on the 11th.

At Oklahoma City, Okla., the heaviest storm of local record reduced visibility to 400 feet and deposited heavy coatings of fine dust even in weather-stripped houses. At the Oklahoma City airport the visibility was reduced to zero. Light dust was noted in some parts of the State from the 3rd to the 11th, inclusive, and on the 18–19th, and heavy dust at one or more stations on the 4th, 11th, 14th, and 23d. The storm of the 11th covered practically the entire State, reducing visibility to from 10 to 30 yards at some stations. Some wheat was blown out on sandy lands, but the aggregate damage was not large.

In New Mexico strong winds on the 4th and 5th caused heavy blowing dust in east-central and southwestern counties, and on the 10th visibility was zero most of the day over south-central and southwestern districts. On the 11th visibility ranged from zero to 3 miles in much of the eastern part of the State, and on the 14th and 15th dust was noted from the Rio Grande Valley to the eastern border. The top of the dust cloud was reported at 12,000 feet.

Duststorms were reported in extreme southwestern Kansas on the 11th, 14th, 18th, and 23d; on the 11th the dust reached as far east and north as Dodge City. Only light dust was reported in Montana, principally on the 11th, 25th, and 31st in Hill, Liberty, Chouteau, and Fergus Counties. Light dust was reported in various

parts of Illinois on 4 days, and at some widely scattered points in Indiana on 7 days.

April.—Dusty conditions were reported at only a few stations east of the Mississippi River during April. There were four occurrences of light dust in southwestern Illinois, on the 1st, 9th, 18th, and 22d, and dust was reported at two stations in Indiana on the 10th and in Tennessee on the 18th.

Extreme western Minnesota noted dusty conditions on the 4th, 11th, 20th, 25th, and 26th, and dust was noted aloft at Kansas City, Mo., on the 11th.

In the tiers of States reaching from Montana and the Dakotas southward to Texas and Oklahoma dusty conditions were rather frequent, although no real duststorms were reported in several of these States. Light local dust was noted in eastern Nebraska on the 10th, and in the western part of the State on the 16th, and dusty conditions prevailed in southwestern New Mexico on 5 days between the 10th and 21st. In Kansas, Oklahoma, and Texas storms were rather frequent, though they were mostly light. As many as 16 days with dusty conditions were reported in southwestern Kansas, 9 or 10 days in northern and central Texas, and 8 in Oklahoma.

A duststorm was general throughout northern and western North Dakota on the 17th with visibility as low as 1½ miles during part of the afternoon. In South Dakota wind velocities ranging from 27 to 43 miles per hour resulted in local soil blowing, in some instances the worst since 1935, in the eastern two-thirds of the State from the 3d to the 10th, on the 16th–17th, and the 24th–26th. On April 24 the visibility at Huron was reduced to one-tenth mile.

Duststorms in Kansas were confined to the western third of the State, except on the 10th when storms were reported in Edwards and Sumner Counties. In the extreme southwest county, Morton, duststorms occurred on 16 days. Storms were reported at several localities in the southwest quarter on the 9th, 10th, 16th, 17th, 22d, 23d, and 24th. Dusty conditions occurred on several days in the northwestern part of the State with storms noted in Decatur County on the 23d and 24th.

In Oklahoma light dust was noted at one or more stations on the 9th, 10th, 14th, and 16th–24th; heavy dust was confined to the panhandle and extreme western tier of counties. At Goodwell the visibility was 100 yards at 1 p. m. on the 17th, one-fourth to one-half mile for 4 hours on the 18th, and 1 mile on the 20th. On the 20th, 24th, and 30th visibility at that station was again cut to one-fourth mile. A heavy duststorm on the 10th reduced visibility decidedly.

In Colorado winds of moderate to gale force were frequent during the month and considerable dust was carried aloft in extreme southeastern counties on the 9th, 10th, 12th, 13th, 14th, 16th, 17th, 20th, and 23d. The duration of dust movement averaged about 7 hours on these days with visibility reduced to from 200 feet to zero at times in the lee of blowing fields. Moderate to severe erosion occurred in Baca County on all these dates, except the 12th and 20th; the storm of the 16th continued until the 17th, causing much erosion locally and killing or damaging young seeds in all blowing areas.

Duststorms were reported in various portions of Montana on 13 days; they were particularly widespread on the 15th and 19th, especially in northern portions of the State.

May.—Dust was reported in May as far east as Massachusetts where Harvard's Blue Hill Observatory recorded the most intense duststorm in 5 years over Massachusetts and New Hamsphire. Visibility was diminished to 5 miles at the observatory and sunshine was reduced by 50 percent.

Light to moderately heavy dust was observed in most sections of Michigan on the 10th, though horizontal visibility was not greatly reduced. Most of the stations reporting dust were located in the north-central portion of the Lower Peninsula; the minimum visibility was 2 miles at Milford.

In Wisconsin light dust appeared in the northwest on the afternoon of the 9th and spread over the remainder of the State during the night so that dust was quite generally reported in the morning of the 10th. The dust disappeared in the northern portions during the forenoon, but persisted until late afternoon of the 10th in the southeast.

Northern and west-central Illinois reported dusty conditions on the 10th and 22nd; dense dust was noted at Mount Carroll on the 10th. Light dust was reported on as many as 9 days, well scattered throughout the month, in western Minnesota, and light dust was observed in western Missouri on the 6th and 10th.

In the States from Montana and the Dakotas southward dusty conditions were reported on from 1 to as many as 16 days. In North Dakota duststorms were reported at many stations on the 5th, 7th, 8th, 9th, 17th, 19th, and 20th. At Bismarck a storm on the 9th reduced visibility to one half mile from 10 to 11:30 p. m., while on the 19th–20th visibility was less than 1 mile from 9:30 p. m. of the 19th to 12:30 a. m. of the 20th. In South Dakota dust was noted throughout the State from the 5th to 10th and in the western two-thirds on the 17th and 20th.

Strong winds, with local dust blowing, were reported at a number of stations in the eastern half of Nebraska on the 6th and light dust was noted in the upper air in all but the extreme western part of the State on the 10th; at times in many localities the dust was thick enough to justify the term "duststorm." On the 24th local dust blowing was reported at a few stations in south-central and southwestern portions of the State. At Valentine visibility on the 9th was cut to one-half mile or less.

In Kansas duststorms were general in southwestern counties on the 5th, 6th, and 24th. In Morton, the extreme southwest county, duststorms occurred on 16 days and in Grant County on 6. Dust of more or less intensity was raised in most parts of the State on 1 or more days, but the only storms reported outside the southwestern counties were at Plainville on the 5th and Oberlin on the 6th.

Heavy dust was noted at Kenton, Cimarron County, Okla., on the 6th, 20th, and 24th. Visibility was about 100 yards for a time on the 6th while on the other 2 dates the minimum was about 1 mile. At Coalgate a 50-yard visibility prevailed for a time on the 19th. Light dust was noted at one or more stations on the 5th, 6th, 10th, 11th, 17th, 22d, and 23d; the storm on the 6th was the most extensive and was felt from Erick and Waynoka eastward to Bartlesville and Tulsa and southward to Duncan.

In northwestern Texas duststorms occurred on the 18th and 20th. In Amarillo the storm of the 10th resulted in a visibility of one-half mile for a period of 2 hours, while the one on the 20th cut visibility to three-fourths mile for 1 hour.

On the 9th a heavy pall of dust hanging over Montana limited visibility in several cities. Air transportation was not seriously affected, for although horizontal visibility was poor near the ground, planes topped the dust cloud at from 8,000 to 9,000 feet above sea level, airline officials said.

Other duststorms prevailed in Montana on the 5th and 19th; at Miles City in both these storms visibility was 100 feet for short periods of time. At Havre dusty conditions, at times approaching the intensity of a duststorm, were reported on the 3rd, 4th, 6th, 8th, 9th, and 20th. On the 8th–11th dense clouds of dust which had been whipped into the air by strong winds in extreme north-central Montana overspread the northern tier of counties east of the Continental Divide to Blaine County and southward to Cascade. The dust had overspread and settled in all sections of Montana east of the Divide by the evening of the 9th with horizontal visibility generally as low as 1 mile. On the afternoon of the 19th severe duststorms occurred in Yellowstone, Beacon, Rosebud, Custer, Garfield, McCone, and Valley Counties.

In Colorado considerable damage was suffered as a result of frequent "dusters" in southeastern counties. On the 5th, 6th, 10th, 11th, 15th, 19th, 20th, and 24th duststorms were general in eastern counties. Heavy erosion was confined mostly to barren ground, except where soil from such ground was carried to adjoining fields of small and tender plants which were either cut off by sabulous winds or completely covered by the blowing sand and soil. A storm on the 23d covered almost the entire State; it continued throughout most of the day and dust was so thick at times that visibility was only 100 feet.

June.—During June light dust was noted as far east as portions of Michigan where south-central stations experienced dusty conditions on the 16th. In southwestern Illinois light dust was observed on the 5th, and two stations recorded dusty conditions in the northern part of the State on the 7th, and in south-central Illinois on the 11th.

Thick dust was reported on the 4th at Tracy, Lyon County, Minn. Many cornfields were damaged, some being stripped completely. Light dust was reported in extreme western portions of the State on the 4th and 7th.

In the tiers of States from Montana and South Dakota southward duststorms were rather frequent. In portions of Kansas dusty conditions were reported on from 10 to as many as 18 days. In South Dakota local dust blowing was experienced in the southern half on the 4th and 5th, in south-central sections on the 14th, in the southeast quarter on the 17th, and in a large part of the western half of the State on the 27th. In Nebraska dust blowing was reported in Antelope, Pierce, and Knox Counties on the 4th of the month.

At Dodge City, Kans., light dust, with visibility ranging from five-eighths to 6 miles, occurred on the 9th, 14th–18th, 20th–21st, 25th, 26th, and 29th, a total of 11 days; on the 21st visibility was cut to less than five-eighths of a mile. In southwestern counties of the State the most general storms were experienced on the 9th–10th, 14th–17th, 20th, 28th, and 29th. In northwestern counties the storms were less frequent and more limited in extent; they were reported in this area on the 11th, 16th, 19th, and 20th. A few storms occurred in central parts of the State, and moderate dust was reported in the middle third and some eastern counties on one or two dates.

Heavy dust was confined to the extreme northwestern portion of Oklahoma. At Kenton a severe "black blizzard" arrived at 8 p. m. on the 9th and continued until after midnight; visibility was nearly zero at times during this storm, and some crop deterioration resulted. Waynoka reported heavy dust on the 17th–18th, and light dust was noted at one or more stations on the 3d, 4th, 6th, 9th–11th, 13th–18th, and 21st. Dust was confined to the western third of the State.

In the south Plains sections light dust was most frequent in western portions of Texas; at El Paso light dust was noted on 9 days, although visibility was only slightly affected. At Abilene dusty conditions obtained on the 10th, and at Amarillo dust reduced visibility to zero for 1 hour on the 10th and to one-half mile for an hour on the 19th.

Moving northward to Montana we find that local dust blowing occurred in portions of Flathead County on the 22d, in Stillwater, Yellowstone, and Big Horn Counties on the 23d, and in Chouteau and Gallatin Counties on the 30th.

Following 2 months of deficient precipitation, strong dessicating winds in June resulted in destruction of many crops and damaged the topsoil over large areas in Colorado. Duststorms were more frequent and damaging than at any other time during the year. A report from H. F. Choun describes the duststorms during June and is appended herewith:

Moderate to severe dust began in Baca County on the 3d and southerly winds spread the dust throughout extreme eastern counties east of the one hundred and third meridian on the 4th and 5th. In this region, brisk winds distributed considerable dust from 6 a. m. to 6 p. m., reducing the visibility to 100 feet for 12 hours in Baca County and to 2 to 3 miles as far north as Kit Carson County.

Slight damage was caused to fields by a moderate intermittent duster in Baca County on the 6th.

During the late afternoon of the 9th, strong northerly winds disturbed the topsoil throughout eastern counties, reducing the visibility to a quarter mile in Arapahoe and Kit Carson Counties, to one-half mile in Elbert and Lincoln Counties, and to zero in Baca County where a very severe black duster continued through the night. The duster moved into Pueblo with a northwest wind of 34 miles per hour velocity about 6 p. m. At the height of the storm, visibility was reduced to 1 mile on the prairies adjacent to the city. All travel by air was grounded for a short time and highway travel was much impeded due to poor visibility. The only damage reported in the Pueblo area was to small trees and shrubbery. Young corn, sugar beets, and bean plants in the Greeley area were cut off at the ground by blowing sand, and dust darkened the sky during most of the afternoon. Heavy dust sifted over Denver and reduced the visibility to zero at the Municipal Airport where the wind attained a velocity of 56 miles per hour.

Strong northerly and northwesterly winds caused violent dust clouds in Prowers and Baca Counties during the early evening and night of the 10th, reducing the visibility to 50 feet at times and causing some damage to vegetation.

On the 11th, northerly and northwesterly winds reduced the visibility to one-half mile to 1 mile in Douglas, Elbert, and northern El Paso Counties, and strong southerly winds caused a severe duststorm of short duration in Baca and parts of Prowers Counties.

On the 15th, southerly winds of gale force extended throughout the State and dust of varying intensity was reported from all sections. In extreme southeastern counties the storm was intense for 4 hours, reducing the visibility to 50 feet. In east-central counties severe dust prevailed from 4 p. m. to 8 p. m. while high dust clouds were seen or dust settled over practically every county in the State. In the Dolores Valley and the San Juan Mountain region, southerly winds arising on the Navajo Indian Reservation and adjoining localities in Utah, Arizona, and New Mexico, brought the most severe duststorms that that section ever experienced. Visibility was reduced in places to a quarter mile and crops were damaged considerably.

Scattered showers, after the middle of the month, relieved appreciably the drought situation, and duststorms were confined to extreme southeastern counties on the 16th, 17th, 20th, 21st, 24th, and 25th. The visibility was reduced to 50 feet to 500 feet on each of these days and living conditions were rendered uncomfortable for an average of 5 hours each day.

July.—During July duststorms were noted as far east as New York State. On Staten Island parching heat for 27 days baked the moisture from the soil on truck farms and tons of dust were swept over residential areas. No other reports of dusty conditions were received during the month from stations east of the Mississippi River.

In western districts duststorms were mostly confined to Plains sections from Oklahoma northward to South Dakota, and to portions of Colorado and Montana. In

Colorado hot, drying winds were frequent in eastern Plains districts and in extreme southeastern counties duststorms of damaging intensity occurred on the 8th, 15th, 17th, 22d, and 24th. Soil erosion on these dates was mostly caused by southerly winds, and visibility was reduced from 200 to 500 feet for 1 to 4 hours. Light to moderate storms causing no material damage or discomfort were reported from northeastern counties of the State on numerous dates.

Dusty conditions were reported at Kansas City, Mo., on the 11th, 12th, and 18th; the storm of the 18th, of very short duration, reduced visibility to about one-half mile.

At Huron, S. Dak., dusty conditions were reported on the 2d, 19th–21st, and 31st, and local dust blowing was noted in all sections of the State on the 4th, in the western third on the 15th, and again in all sections of the State on the 20th, 27th, 29th, and 30th. Nebraska enjoyed an almost dustless month, although at Valentine storms of short duration were experienced on the 16th and 18th. In both of these storms visibilities were limited for short periods of time, although the dust in both instances was of purely local origin.

In Kansas two snow plows were kept available for clearing dust from the tracks of the Santa Fe line between Dodge City and Boise, Okla. At Dodge City duststorms sufficiently heavy materially to limit visibility were reported on the 1st, 4th, 7th, 16th, 17th, 19th, 22d, 24th, and 26th, while for the State as a whole duststorms, mostly of local origin, were rather frequent on from 4 to 9 days. No severe storms were reported in the middle or eastern third of the State, though light dust occurred there on several days.

The only heavy dust reported in Oklahoma was at Waynoka on the 22d, with visibility reduced to three-fourths of a mile for a short period. Light dust was noted at Goodwell on the 6th and 31st, and at Kenton on the 7th, 15th, and 21st.

In the northern Great Plains, Montana experienced dusty conditions on about 4 days, mostly during the first half of the month. Minimum visibilities were one-half mile at Havre on the 2d, and one-fifth mile at the same station on the 10th. In Hill, McCone, Lewis and Clark, Custer, and Gallatin Counties the dust was mostly of local origin.

August.—During August duststorms were confined to portions of the Great Plains and southern Rocky Mountain region. In Oklahoma heavy dust was noted at Clinton, Garber, and Hennessey on the 7th, with a 10-yard visibility reported at Hennessey and 100 yards at Garber. Light dust was noted at Enid on the 4th and 7th, at Waukomis on the 22d, and Clinton on the 14th, while Kenton reported dust on the 7th, Okeene on the 11th, and Waynoka on the 22d and 31st.

Local dust blowing was noted in Harding County, S. Dak., on the 18th of the month and in the eastern third of the State on the following date. Light dust was reported at Huron on the 19th, 21st, and 27th.

In Kansas 6 to 9 duststorms occurred in extreme southwestern districts and a few storms of rather local nature occurred elsewhere in the western part of the State on 1 or 2 days, mostly the 22d and 30th.

In northwestern Texas and eastern New Mexico a few duststorms were reported near the end of the month with the lowest visibility at Amarillo, Tex., 1½ miles on the 22d. In Montana storms, mostly light and local in character, were reported on as many as 11 days. The storm at Trident, Gallatin County, on the 4th, was classed as severe, while the storm of the 3d at Helena diminished surface visibility at times to about one city block.

September.—During September duststorms were again reported in several States east of the Mississippi River. Dusty conditions prevailed in Indiana and Tennessee on the 29th, but in the latter State the storm was of very short duration.

Light dust was observed in extreme western Minnesota on the 5th, 14th, and 24th, and at several Montana stations on the 1st, 11th, and 24th. In Oklahoma, although the month was the driest September of record, duststorms were relatively few and were confined to the western half of the State. These storms were mostly light in character and were most general in extreme northwestern sections on the first 3 days of the month or after the 16th. The worst and most general storm occurred on the 29th; at two stations this storm was classified as heavy and visibility was reduced to 1 mile or less for nearly 2 hours.

In Kansas duststorms were reported in extreme southwestern counties on from 5 to 8 days. On the 3d storms of limited extent were reported in many western counties and locally in the eastern part of the State, while on the 28th and 29th duststorms were rather general in much of western third. At Dodge City light dust was observed on 9 days, mostly during the first half of the month. Visibility was reduced to one-half mile or less during the storm of the 29th.

In Nebraska coarse sand and dust reduced visibility to less than 1 mile for about an hour at Valentine on the 22d. Light to thick dust, but not severe in any locality, was observed over most of the State on the 3d, 12th, and 13th, and over scattered areas on the 5th, 6th, 11th, 14th, 22d, 24th, 27th, and 28th.

In South Dakota local dust blowing was quite prevalent in the eastern third on the 5th, and in the eastern half on the 21st and 24th.

A few storms, mostly light in character, were noted in Texas on the 29th and 30th. Some of these were sufficient to reduce visibility to as little as 1 mile for several hours.

October.—During October dusty conditions were noted in Montana on 5 days, mostly after the 19th, and in extreme southwestern Minnesota on the 3d, 15th, and 31st. In South Dakota local dust blowing was prevalent in the eastern third on the 1st, 2d, and 4th, and in scattered places throughout the State on the 21st, 29th, and 31st. Further south, in Nebraska, light to moderate dust was observed over the entire State, especially in the Panhandle on the 1st and 2d, and locally on other dates.

Kansas reported duststorms in extreme southwestern counties on from 4 to 8 days. They were most common on the 1st, 4th, 7th, and 26–28th. The storms of the 1st and 4th were most general and were observed as far east as Rush County. Texas and New Mexico reported dusty conditions early in the month and again during the closing days, while in Montana storms were most general on the 19th–21st, 24th, and 29th.

Only a few duststorms were reported in Oklahoma and these were generally light in character. The most widespread storm in this State was noted on the 29th.

November.—Duststorms during November were confined to the Great Plains, except for isolated occurrences in extreme northwestern portions of Minnesota on the 9th and 10th, and a few central sections of Wisconsin on the 9th.

In South Dakota soil blowing occurred locally in the eastern third on the 4th and 9th, and quite generally in all sections on the 23d and 27th; at Huron dusty conditions prevailed for comparatively short periods of time on the 4th, 9th, 23d, 27th, and 28th.

No storms were reported in Nebraska, but in southwestern Kansas thick dust of a local nature was reported on 2 or 3 days while on the 9th light dust was felt in many

parts of the State. Oklahoma noted light dust in the Panhandle on the 9th.

In Montana light dust was reported on the 2d, 8th, 22d, 29th, and 30th. The storms of the 22d in north-central counties were the most extensive.

December.—During December duststorms were reported from Montana eastward to portions of Illinois and southward to Texas. In Illinois light dust was observed on the 12th–13th, 14th, and 28th. The storms were all light in character, and of short duration.

In the upper Mississippi Valley light storms were reported in Minnesota on the 11th, 12th, and 16th, while in Iowa a heavy duststorm carried by a 40-mile wind resulted in sharply reduced visibilities and considerable discomfort. Light dust was observed in western Missouri on the 1st, 2d, and 12th.

South Dakota, because of deficient moisture and high winds, experienced soil blowing in all sections on the 1st, 11th–12th, and 15th–16th. In Nebraska a severe duststorm occurred at Valentine on the 12th, with lowest visibility about one-fourth mile for about one-half hour.

In Kansas dusty conditions were observed on the 1st, 11th, 12th, and 18th, and on the same days dust was reported in western Oklahoma with visibility reduced to less than 1 mile in the panhandle sections on 2 or more days. Light dust was reported in Texas on the 1st, 2d, 3d, 12th, 18th, and 19th, and in Montana, particularly in northern districts, on the 6th, 11th, 14th, and 15th.

NORTH ATLANTIC TROPICAL CYCLONES OF 1939

By WILLIS E. HURD

Five tropical cyclones occurred in the North Atlantic Ocean, including the Gulf of Mexico and the Caribbean Sea, during the hurricane season of 1939. A synopsis of some of their more important features is given in the table herewith. Their tracks, numbered I to V chronologically, are shown on the accompanying chart. The average annual number of tropical cyclones occurring during the past 53 years is about 7, 1939 thus showing a deficiency of 2.

In 1939 there was only one major hurricane, that of October 12–18 (IV). This expended its energy at sea, but passed so close to Bermuda in its north-northeastward course as to be damaging to the islands. Another storm, that of October 29–November 8 (V), may be classed as a hurricane, although winds of full hurricane force were reported on only 1 day, October 30, while crossing Grand Cayman Island. A week later, in higher latitudes, one ship reported a gale of force 11. The other 3 cyclones had known locally highest winds not in excess of force 9 or 10. In chronological occurrence, there was 1 tropical cyclone each in June, August, September, and October, and 1 in October–November.

The hurricane of October 12–18 was the only one of the 5 disturbances to attain great barometric depth. On the 14th its lowest reported minimum was 941.4 millibars (27.80 inches), but on the 17th and 18th pressures were noted almost down to 948 millibars (28 inches). Two of the cyclones were shallow, and lowest barometers did not fall as low as 999 millibars (29.50 inches).

Of the cyclones, 2 (I and III) were associated almost wholly with the Gulf of Mexico; 1 (V) originated in the Caribbean Sea, where it remained for a week, then crossed eastern Cuba and, so far as can be determined from meager ship's reports in the western Atlantic, held to a northeastward course as far as Newfoundland; 2 (II and IV) originated over or in the vicinity of the Leeward Islands, 1 keeping a northwesterly course across Florida, then recurving up the eastern United States, the other remaining at sea until it crossed southeastern Newfoundland.

Two storms of the year took abnormal directions during a part of their tracks. That of June (I), described a rare left-handed loop in the northern part of the Gulf of Mexico; that of October–November (V) performed an unusual curve from northwesterly through north into easterly then northeasterly while in tropical waters.

Only 5 or 6 lives are known to have been lost directly or indirectly due to these tropical cyclones. Economically, the year's losses from them were comparatively small. No estimates of property losses are available for the three storms (II, IV, and V) that caused some damage. (See under "Remarks" in the table.)

North Atlantic tropical cyclones of 1939

[Synopsis of tropical cyclones of 1939 (number of storm in table corresponds to number of track on accompanying chart)]

Storm	Date	Place where first reported	Coast lines crossed	Maximum wind velocity reported	Lowest barometer reported	Place of dissipation	Intensity	Remarks
I	June 12–16	Gulf of Honduras	Yucatan, Alabama.	Force 9, southeast S. S. *Alabama.*	1,000.3 millibars (29.54 inches) S. S. *Kofresi.*	Tennessee	Not of hurricane intensity.	1 person drowned (A).
II	Aug. 8–20	Northeast of Puerto Rico.	Florida, Alabama.	Force 10, east, S. S. *Pan Amoco;* 62 miles Tampa Airport.	988.5 millibars (29.19 inches) St. Andrews, Fla.	Southeastern New York.	do	1 person drowned. Some damage from wind, heavy rains and floods (B).
III	Sept. 24–26.[1]	Northwest of Yucatan.	Louisiana	Force 9, north-northeast, M. S. *Cubahama.*	1,003.7 millibars (29.64 inches) M. S. *Cubahama.*	Mississippi and Alabama.	do	(C.)
IV	Oct. 12–18[2]	Leeward Islands	None	Force 12, by several ships and by Bermuda.	941.4 millibars (27.80 inches) S. S. *F. W. Abrams.*	East of Newfoundland.	Intense hurricane	Some damage at Bermuda and to ships at sea; 1 life lost at sea (D).
V	Oct. 29–Nov. 8.[3]	Western Caribbean Sea.	Cuba, Newfoundland.	92 miles at Grand Cayman Island.	989.0 millibars (29.21 inches) ship at sea.	East of Labrador	Hurricane on 1 day; of force 11 on 2 others.	Definite loss of 2 lives; property damage in the Cayman Islands Jamaica, and Cuba; 4 schooners lost in the Caymans (E).

Complete reports of these cyclones may be found in the MONTHLY WEATHER REVIEW: (A) June 1939; 67: 175, 176. (B) August 1939; 67: 296, 297. (C) September 1939; 67: 340. (D) October 1939: 67: 382, 383. (E) November 1939; 67: 416.

[1] There was squally weather in the extreme southwestern part of the Gulf of Mexico on the 22d to early 24th, and unsettled weather in the northwestern Caribbean on the 23d, but no definite cyclonic circulation could be charted until 7 p. m. (eastern standard time) of the 24th.

[2] Unsettled weather and slightly depressed barometer occurred to the eastward of the Antilles as early as the 9th, but no cyclonic center could be established prior to the 12th.

[3] Disturbed weather occurred in the southwestern Caribbean on October 27, but no cyclonic circulation was defined until the 29th. The dashed part of track V indicates that the course of the storm is approximated, due to lack of ship reports. Late information received from the meteorological office, Kingston, Jamaica, shows that, on November 2, at 7 a. m., Negril Point had a barometer of 1,000 millibars (29.53 inches), with a west-northwest wind of 60 miles, and heavy sea; at 9 a. m. Kempshot had a barometer of 992.6 millibars (29.31 inches), with a wind velocity of about 70 miles from southwest.