AEROLOGICAL OBSERVATIONS

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During September radiosonde observations were inaugurated in the United States proper at Buffalo, N. Y.; Minneapolis, Minn.; St. Louis, Mo.; Medford, Oreg.; Billings, Mont.; and Spokane, Wash. The airplane flights at the two latter stations were discontinued with the termination of August and replaced by radiosonde observations. Upper-air reports made during the hurricane season at Swan Island, in the western Caribbean Sea, are included for the first time. Airplane observations taken at 8 United States naval stations are shown in table 1, while the radiosonde data from 24 stations are given in table 1a. Tables 2 and 3 contain upper-air wind directions and velocities, and table 4 gives the heights of the tropopauses. Charts VIII, IX, X, and XI, show the mean pressures, temperatures, and resultant winds at 1.5, 3, 4, and 5 kilometers, respectively, and chart XII gives the September isentropic data. A detailed description of the above charts and tables will be found in the January 1939 MONTHLY WEATHER REVIEW.

An area of mean low barometric pressure extended north and northeast of the United States at 5,000 feet (chart VIII), while mean high pressure prevailed over the Southeast. However, a falling pressure tendency again appeared south of this high-pressure area, being indicated by the observations made at Swan Island. At 3, 4, and 5 kilometers (charts IX, X, and XI) the lowest mean pressures occurred over Sault Ste. Marie, Mich., and the highest over Pensacola, Fla. But above 5 kilometers, at all levels given in table 1a, mean pressure was high over the Southwest, and also from southern Florida to Puerto Rico. The lowest pressure existed along the northern border of the country, and falling pressure southward over the western Caribbean. The pressure gradient, or difference between the mean pressures recorded over the low and high areas in the North and South, respectively, at each level from the surface to the maximum altitude reached, shows that this gradient difference increased steadily with altitude to 14 millibars at 10 kilometers. Above that altitude the gradient difference steadily decreased from 14 millibars to 2 millibars at 19 kilometers.

Mean relative humidity at 1.5 kilometers was high over the Northeast and Southeast and low over the western half of the country. The humidity at 3 kilometers was high over the Great Lakes and Florida, and low over the middle Atlantic coast and California, and moderately low west of the Mississippi. At 4 kilometers humidity was highest over Florida and moderately high over the Rocky Mountains and Great Lakes region while the lowest humidity occurred over the Pacific coast. Similar conditions prevailed at 5 kilometers. However, there was some increase over the Rocky Mountains and a decrease over the middle Atlantic and Pacific coasts. At all levels above 5 kilometers humidity was low over the Pacific coast and the central portion of the United States, while high humidities prevailed along the northern border, over Florida, and thence southwestward over the Caribbean.

Mean free-air temperatures were seasonally lower in September than during the preceding month. In all cases below-zero temperatures occurred beneath the 5-kilometer level, while slightly north of the 40th parallel similar temperatures existed under 4 kilometers. At all levels, from the surface up to 5 kilometers, where observations are made both by airplanes and radiosonde, mean temperatures were lowest over Sault Ste. Marie, Mich. Highest temperatures were noted over Phoenix, Ariz., up to 1 kilometer; over El Paso, Tex., up to 3 kilometers; over San Diego, Calif., at 4 kilometers; and over Miami, Fla., at 5 kilometers.

Above 5 kilometers, where all observations are made by radiosonde, lowest temperatures occurred over Spokane, Wash., up to 11 kilometers; Buffalo, N. Y., at 12 and 13 kilometers; Charleston, S. C., at 14 and 15 kilometers; and El Paso, Tex., at 16, 17, and 18 kilometers. Highest mean temperatures occurred over Phoenix, Ariz., Albuquerque, N. Mex., El Paso, Tex., and Miami, Fla., at 6, 7, 8, 9, and 10 kilometers; over Phoenix, Ariz., at 11, 12, and 13 kilometers; and Spokane, Wash., from 14 to 18 kilometers. Stations which were warmest in the lower levels became coldest in the upper levels, and vice versa. Above 13 kilometers the mean temperatures at Swan Island became colder than those recorded elsewhere, while the temperatures over San Juan, P. R., above 16 kilometers, were nearly as low as those recorded over Swan Island, but colder than elsewhere.

Of all the 704 radiosonde flights made during September at the 24 stations listed in table 1a, 99, 95, 87, 41, and 11 percent reached altitudes of 5, 10, 15, 20, and 22 kilometers, respectively. At most stations individual flights reached 22 and 23 kilometers, and one radiosonde ascension over Nashville, Tenn., rose to 28 kilometers, a height equalled but once before, at Miami, Fla., during the preceding month. The lowest individual temperatures reported from the upper air occurred over Swan Island (−80.8° C.) at 17 kilometers, and in the United States proper over Albuquerque, N. Mex. (−77.2° C.) at 18 kilometers, and Charleston, S. C. (−77.0° C.) at 16 kilometers. Individual temperatures over the more northern stations were not so low, such as that of −64.2° C. over Spokane, Wash., and −67.4° C. over Minneapolis, Minn., both at 16 kilometers.

During the month the lowest minimum mean temperatures were recorded in the South over Swan Island (−75.8° C.), San Juan, P. R. (−72.9° C.), El Paso, Tex. (−72.6° C.), Albuquerque, N. Mex. (−72.0° C.), Charleston, S. C. (−71.0° C.), and Miami, Fla. (−70.3° C.). The highest minimum mean temperatures were noted in the North over Spokane, Wash. (−59.5° C.), Minneapolis, Minn. (−61.4° C.), Sault Ste. Marie, Mich. (−61.5° C.), Bismarck, N. Dak. (−61.8° C.), and Billings, Mont. (−62.3° C.).

September pilot-balloon observations were made at 97 Weather Bureau stations in the United States proper, and the resultant wind directions and forces based on these flights as well as others made in Canada, Mexico, and Cuba, are shown on charts VIII, IX, X, and XI, for 1.5, 3, 4, and 5 kilometers, respectively. During the month 79 percent of these stations reached a maximum altitude of 10 kilometers; 17 percent exceeded 15 kilometers; and 5 percent ascended to 20 kilometers or more. High altitudes were reached at Tampa, Fla., Las Vegas, Nev., Redding, Calif., Wichita, Kans., Omaha, Nebr., Denver, Colo., and San Juan, P. R., particularly on the 15th, 16th, 17th, and 18th, east of the Mississippi and north of the Ohio, and in the Rocky Mountain region.

At 1.5 kilometers (chart VIII) the resultant wind directions for the current month, based on 5 a. m., 75th

meridian time observations, showed a well defined anticyclonic circulation around a cell of high pressure over Alabama. At its center (Birmingham, Ala.) a rare occurrence of a resultant calm was noted. Very light resultant velocities occurred over Atlanta, Ga., Jacksonville, Fla., Spartanburg, S. C., and Jackson, Miss. Light velocities also existed over the middle Pacific coast. Southeasterly winds over Cuba, Mexico, and the Gulf States became southwesterly over the South Central States and westerly and northwesterly over the Northern and Eastern States. Southerly winds prevailed over the far West. Resultant velocities were unusually low over the Southeast, but were moderately high over the Central, Northern, and Northeastern States.

The anticyclonic circulation over the Southeast at 1.5 kilometers continued at 3 kilometers (chart IX) and maintained its same central position over Alabama. At 3 kilometers the easterly winds over the Gulf area turned clockwise so that southerly and southwesterly directions over the far Southwest became westerly and northwesterly over the northern and northeastern portions of the country. Resultant velocities at 3 kilometers remained low over the Southeast and high over the northern half of the United States, becoming outstanding at Havre, Mont. (9.6 m. p. s.), Kylertown, Pa. (9.9 m. p. s.), and Burlington, Vt. (10.6 m. p. s.).

A continuation of the anticyclonic circulation at 1.5 and 3 kilometers was indicated at 4 kilometers (chart X). These observations were made at 5 p. m., 75th meridian time. At this altitude the high-pressure cell tilted toward the west so as to be centered approximately over Jackson, Miss. Wind directions elsewhere were mostly southwesterly, becoming northwesterly in the north and northeastern States. High resultant velocities occurred over all sections except in the South and Southeast, being highest over Detroit, Mich. (13.5 m. p. s.) and Minneapolis, Minn. (13.2 m. p. s.).

Resultant wind directions at 5 kilometers (chart XI) showed the center of the southern cell to be over extreme eastern Texas. The anticyclonic circulation over the South still was pronounced at this altitude. Southwesterly winds prevailed generally over the Southwest and southern Pacific coast, while westerly and northwesterly winds were general over the northern and eastern portions of the country. Resultant velocities were rather high over the entire northern half of the United States, with extremes centered over the north-Central States (Minneapolis, Minn., 15.0 m. p. s., and Fargo, N. Dak., 14.5 m. p. s.). Velocities throughout the South, with the exception of southern Florida and southern California, were unusually low.

The current resultant-wind directions at 24 well-distributed stations showed they departed from the normal direction at 1.5 kilometers by assuming counterclockwise rotations. This was true for all of the country except the extreme Southeast and the far Northwest. There the current winds were oriented by clockwise rotations from normal directions. Outstanding departure differences between the current and normal directions, were noted at Medford, Oreg. (69° counterclockwise), Oakland, Calif. (160° clockwise), Seattle, Wash. (47° clockwise), and Atlanta, Ga. (43° clockwise). At 1.5 kilometers resultant velocities were less than normal over the Pacific coast as well as in the East, but elsewhere velocities were greater than normal. Moderate velocity departures occurred over Billings, Mont., San Diego, Calif., Oklahoma City, Okla., and Washington, D. C.

At 3 kilometers the September wind directions were oriented from normal by turning in counterclockwise rotations over all but the eastern portion of the country. Large differences in departure occurred over Nashville, Tenn. (147° clockwise), Atlanta, Ga., Oklahoma City, Okla., Cheyenne, Wyo., Seattle, Wash., and Oakland, Calif. (86°, 64°, 36°, 46°, and 47°, respectively—all counterclockwise). Velocities at the 3-kilometer level were greater than normal over the sections of the country where directions departed by counterclockwise rotations. Elsewhere the velocities were less than normal. Large resultant-velocity departures from normal were noted over Omaha, Nebr. (+2.9 m. p. s.), Houston, Tex. (+3.6 m. p. s.), Boston, Mass. (−4.0 m. p. s.), Washington, D. C. (−3.1 m. p. s.) and Detroit, Mich. (−2.4 m. p. s.).

Table 2 gives resultant winds based on observations made at 5 p. m. (E. S. T.). Southwesterly winds in the lower levels turned gradually with altitude until they became northwesterly in the upper levels over Buffalo, N. Y., Cincinnati, Ohio, Fargo, N. Dak., Huron, S. Dak., Minneapolis, Minn., Oklahoma City, Okla., Omaha, Nebr., Nashville, Tenn., St. Louis, Mo., Spokane, Wash., and Washington, D. C. However, at Medford, Oreg., and Boise, Idaho, northwesterly winds at the surface backed gradually through the higher levels to become southwesterly.

Comparing these 5 p. m. observations with 5 a. m. normals for all levels up to 5 kilometers at 20 selected stations, it was noted that the current afternoon directions departed from normal by small counterclockwise rotations. At Nashville, Tenn., and Atlanta, Ga., the current departures from normal at all levels were by large clockwise rotations, and outstanding departures having counterclockwise rotations from normal were noted over Oklahoma City, Okla., Houston, Tex., and Albuquerque. N. Mex. Current velocities at Omaha, Nebr., Oklahoma City, Okla., Billings, Mont., Houston, Tex,, and Cincinnati, Ohio, were considerably greater than normal.

When the 5 a. m. winds at 1.5 and 3 kilometers (charts VIII and IX) were compared with the 5 p. m. winds for the same levels (table 2) it was noted that definite diurnal changes of direction occurred. At 1.5 kilometers the September 5 p. m. resultant-wind directions differed from the 5 a. m. directions by departing from the latter in counterclockwise rotations over most of the country, except the middle Atlantic coast, far Southwest, and southern California, where the 5 p. m. diurnal changes were by clockwise rotations. At 3 kilometers the 5 p. m. winds differed from those at 5 a. m. by showing counterclockwise diurnal departures over the entire country, except the Southeast and the Pacific States. Resultant-wind velocities at 5 p. m. were lower than those for 5 a. m. at 1.5 kilometers, except in the Northeast and far Northwest. But at 3 kilometers 5 p. m. velocities were higher than at 5 a. m. over most of the country, except the West Gulf and southern Rocky Mountain States.

Table 3 shows the individual maximum wind velocities recorded during September over the United States. None of the velocities recorded were unusual, most of them being lower than any recorded during the past several months.

MONTHLY MEAN ISENTROPIC CHART

The mean isentropic chart, $\theta=312°$ (chart XII), for September 1939, is dominated by a single large anticyclonic eddy over the southern part of the United States, with its center near Fort Smith, Ark. A broad band of

westerly winds prevails over the northern half of the country.

Except in the far Southwest and the east Gulf States the entire pattern suggests prevailing downslope (subsiding) motion, a fact which helps account for the deficiency of precipitation over most of the country. The dry tongue extending from Illinois into eastern Texas corresponds closely with the belt of maximum precipitation deficiencies, while marked excesses are confined to the region to the left of an observer travelling with the moist current in the Southwest. Much of the precipitation in southern California occurred in connection with a tropical storm which moved inland September 25, but elsewhere in the Southwest abnormal shower activity prevailed throughout the month. There is a relatively inactive moist tongue extending northeastward over the eastern Gulf of Mexico, which may be associated with the increased shower activity on its northern, upslope side, where excesses in precipitation, or smaller deficiencies than elsewhere, prevail.

In drawing chart XII it was found impossible to reconcile in a logical manner the data for Washington, Norfolk, and Lakehurst. It was decided to draw only for the Washington averages, rather than force the pattern into consistency with all the data. The difficulty may be attributed to the fact that at each of these stations soundings were not made on several days, the dates differing for the various stations. The data for Seattle, being based on but 17 observations, were also disregarded.

TABLE 1.—*Mean free-air barometric pressures (P.) in mb., temperatures (T.) in ° C., and relative humidities (R. H.) in percent obtained by airplanes during September 1939*

Stations and elevations in meters above sealevel	Altitude (meters) m. s. l.																													
	Surface				500			1,000			1,500			2,000			2,500			3,000			4,000			5,000		
	Number of observations	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity	Pressure	Temperature	Relative humidity
Coco Solo, C. Z. (15 m.)	25	1,011	25.1	95	957	24.2	83	904	21.9	82	854	19.8	78	806	17.6	77	759	15.6	70	716	13.3	67	636	7.7	73	----	----	----
Lakehurst, N. J. (39 m.)	24	1,013	15.8	88	959	17.7	66	905	15.3	59	853	13.5	56	804	11.2	51	757	8.9	50	713	6.8	47	630	2.1	43	555	−2.5	42
Norfolk, Va. (10 m.)	26	1,018	20.9	86	963	20.0	71	908	17.2	67	856	14.3	65	807	12.0	58	760	10.0	52	715	7.0	49	633	0.9	46	558	−5.5	44
Pearl Harbor, T. H. (6 m.)	30	1,014	22.6	82	959	20.7	76	905	17.0	75	854	14.0	72	804	11.5	65	757	11.2	43	714	9.1	30	631	2.6	24	----	----	----
Pensacola, Fla. (13 m.)	27	1,016	22.8	90	960	24.0	73	907	21.2	69	856	18.0	73	807	15.5	63	761	12.9	58	717	10.4	50	635	4.4	48	561	−3.2	48
St. Thomas, V. I. (8 m.)	28	1,016	28.9	72	962	25.0	90	909	22.0	84	857	19.4	76	809	16.9	71	762	14.8	60	718	12.3	51	637	6.8	46	----	----	----
San Diego, Calif. (10 m.)	29	1,011	20.8	80	955	21.6	70	901	21.6	56	850	19.0	51	802	16.7	47	756	14.0	44	712	11.0	42	631	4.5	41	558	−2.2	38
Seattle, Wash. (10 m.)	23	1,016	15.6	76	960	13.4	74	904	13.5	62	852	11.8	56	803	9.9	46	756	7.6	47	711	5.2	48	628	−0.2	48	----	----	----

Observations made by U. S. Navy, and taken at 4 a. m., 75th meridian time, except along the Pacific coast and Hawaii where they are made at dawn.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

TABLE 1a.—*Mean free-air barometric pressures (P.) in mb., temperatures (T.) in °C., and relative humidities (R. H.) in percent obtained by radiosondes during September 1939*

Altitude (meters) m. s. l	Stations and elevations in meters above sea level																															
	Albuquerque, N. Mex. (1,621 m.)				Atlanta, Ga. (298 m.)				Billings, Mont. (1,089 m.)				Bismarck, N. Dak. (508 m.)				Buffalo, N. Y. (219 m.)				Charleston, S. C. (14 m.)				Denver, Colo. (1,616 m.)				El Paso, Tex. (1,194 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	30	841	18.1	55	28	983	20.2	86	30	892	12.9	54	30	955	10.8	69	29	991	14.2	83	29	1,015	21.8	93	29	840	14.2	58	30	883	21.1	49
500	----	----	----	----	28	961	22.1	75	----	----	----	----	----	----	----	----	29	959	14.8	77	29	960	22.2	78	----	----	----	----	----	----	----	----
1,000	----	----	----	----	28	907	20.0	75	----	----	----	----	30	901	15.6	52	29	904	13.0	75	29	906	19.7	76	----	----	----	----	----	----	----	----
1,500	----	----	----	----	28	855	16.7	79	30	850	14.7	49	30	849	13.3	49	29	852	11.1	71	29	855	16.4	79	----	----	----	----	30	852	22.4	45
2,000	30	804	18.3	52	28	806	13.7	79	30	800	12.3	47	30	800	10.5	50	29	802	8.8	69	29	806	13.5	75	29	803	16.7	52	30	804	19.7	44
2,500	30	758	15.4	50	28	760	11.2	70	30	753	9.2	46	30	752	7.4	48	29	755	6.4	65	29	759	11.1	65	29	757	14.1	50	30	759	16.1	45
3,000	30	715	11.7	53	28	715	8.9	60	30	709	5.7	48	30	708	4.3	45	28	710	4.2	61	29	715	8.6	59	29	713	10.7	51	30	715	12.0	49
4,000	30	633	3.9	63	28	633	2.7	53	30	627	−1.6	53	30	626	−1.6	42	28	627	−1.7	56	29	633	2.9	54	29	632	3.2	55	30	634	4.2	59
5,000	30	560	−2.5	68	28	560	−2.9	50	30	552	−8.3	50	29	551	−7.9	41	28	552	−7.7	51	29	559	−3.2	50	29	558	−3.7	57	30	560	−1.8	57
6,000	30	493	−7.8	58	28	492	−8.9	46	30	484	−14.9	46	29	484	−14.5	41	28	485	−14.1	49	29	492	−8.7	45	28	490	−9.7	54	30	493	−7.1	46
7,000	29	433	−14.2	51	28	432	−15.5	44	29	424	−21.7	43	29	423	−21.9	42	28	425	−20.9	45	29	432	−15.1	43	27	431	−16.4	50	29	434	−13.3	41
8,000	29	378	−21.5	48	28	378	−22.3	41	29	369	−29.1	42	29	369	−29.5	42	28	370	−28.2	43	27	378	−22.2	43	27	376	−23.6	48	29	380	−20.3	39
9,000	27	329	−29.3	47	28	329	−30.0	41	29	320	−36.9	----	29	320	−37.3	40	27	321	−36.3	42	27	329	−29.9	43	27	327	−31.4	48	29	331	−27.6	38
10,000	27	286	−37.2	47	28	285	−37.8	40	29	277	−44.2	----	29	276	−45.1	----	27	277	−44.1	40	27	285	−37.6	41	27	284	−38.6	48	29	287	−35.6	38
11,000	27	247	−44.7	----	28	246	−45.6	----	29	238	−50.2	----	29	237	−51.5	----	26	238	−51.2	----	26	246	−45.4	----	26	244	−46.4	----	28	248	−43.4	----
12,000	27	212	−51.5	----	28	211	−52.6	----	29	204	−54.7	----	29	203	−55.8	----	26	204	−56.6	----	25	212	−52.9	----	25	211	−53.0	----	28	213	−50.4	----
13,000	26	181	−57.7	----	28	181	−58.7	----	28	174	−58.0	----	29	173	−58.0	----	26	174	−59.7	----	23	181	−59.6	----	25	180	−58.2	----	28	182	−57.4	----
14,000	24	154	−63.1	----	28	154	−63.7	----	28	148	−59.5	----	27	148	−60.0	----	25	148	−62.0	----	20	154	−65.1	----	24	153	−62.3	----	28	155	−64.0	----
15,000	23	131	−67.7	----	28	130	−67.2	----	28	126	−61.0	----	27	126	−61.3	----	23	126	−63.9	----	18	130	−68.8	----	24	130	−66.2	----	27	132	−69.2	----
16,000	21	111	−70.9	----	28	110	−69.3	----	27	108	−62.0	----	24	107	−61.8	----	23	107	−64.5	----	18	110	−70.2	----	24	110	−68.2	----	27	111	−72.2	----
17,000	20	93	−72.0	----	26	93	−69.9	----	25	91	−62.3	----	21	91	−61.4	----	21	91	−64.2	----	17	93	−71.0	----	22	93	−68.1	----	27	94	−72.6	----
18,000	19	79	−69.5	----	24	79	−68.0	----	25	78	−61.5	----	17	78	−60.1	----	18	77	−62.5	----	17	78	−69.6	----	22	79	−66.5	----	25	79	−70.2	----
19,000	9	67	−66.0	----	20	67	−65.3	----	22	66	−60.7	----	15	66	−58.9	----	12	66	−60.7	----	14	66	−67.5	----	19	67	−63.3	----	21	67	−66.2	----
20,000	5	56	−62.8	----	19	57	−62.8	----	17	56	−59.7	----	6	57	−58.0	----	8	56	−59.6	----	13	56	−64.4	----	15	57	−60.8	----	18	57	−62.2	----
21,000	----	----	----	----	9	48	−60.2	----	10	48	−58.2	----	----	----	----	----	----	----	----	----	8	48	−61.7	----	8	48	−58.6	----	6	49	−58.8	----
22,000	----	----	----	----	5	41	−57.8	----	5	----	−57.0	----	----	----	----	----	----	----	----	----	6	40	−60.6	----	6	42	−56.8	----	----	----	----	----

Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels; also, the humidity data are not used in daily observations when the temperature is below −40.0° C.

TABLE 1a.—*Mean free-air barometric pressures (P.) in mb., temperatures (T.) in °C., and relative humidities (R. H.) in percent obtained by radiosondes during September 1939*—Continued

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Ely, Nev. (1909 m)				Joliet, Ill. (178 m)				Medford, Oreg. (401 m)				Miami, Fla. (4 m)				Minneapolis, Minn. (263 m)				Nashville, Tenn. (180 m)				Oakland, Calif. (2 m)				Oklahoma City, Okla. (391 m)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	30	812	9.6	69	28	995	15.8	80	30	968	14.8	61	29	1015	23.4	95	30	984	14.9	73	30	996	20.2	75	30	1013	15.3	82	29	970	21.7	55
500					28	958	20.2	62	30	956	15.9	60	29	959	23.5	82	30	957	15.6	65	30	960	22.3	65	30	957	18.0	68	29	957	23.3	51
1,000					28	904	18.2	59	30	902	15.9	56	29	906	20.6	78	30	903	14.4	60	30	906	20.1	63	30	902	18.5	50	29	905	23.3	45
1,500					28	853	15.9	53	30	850	12.8	55	29	855	17.7	75	30	850	12.1	58	30	855	17.2	63	30	851	16.4	45	29	854	20.5	46
2,000	30	803	11.7	64	28	804	13.0	50	30	800	10.5	55	29	806	14.9	72	30	801	9.7	54	30	806	14.3	62	30	802	13.2	44	29	805	17.3	46
2,500	30	756	11.6	56	28	756	10.2	50	30	753	8.0	51	29	760	12.1	70	30	754	7.0	51	30	760	12.0	56	30	755	10.1	43	29	759	13.7	50
3,000	30	712	8.3	55	28	712	7.5	50	30	708	5.0	45	29	715	9.2	68	30	709	4.1	50	30	716	9.2	53	30	711	7.1	41	29	715	10.7	48
4,000	29	630	0.9	58	28	630	1.3	52	30	626	−1.5	40	29	634	3.9	61	30	626	−1.7	50	30	634	2.8	49	30	629	0.9	40	29	634	4.0	47
5,000	28	556	−5.8	57	28	556	−5.4	52	30	552	−7.8	38	29	560	−1.7	57	30	552	−7.7	47	30	559	−2.9	44	30	555	−6.1	38	29	560	−2.0	47
6,000	27	488	−11.3	50	28	489	−11.5	46	30	484	−14.9	36	28	493	−7.9	56	29	484	−14.2	45	30	492	−8.8	42	30	487	−13.0	37	29	493	−8.0	41
7,000	27	428	−17.6	42	28	428	−18.3	40	30	424	−22.3	35	28	433	−14.2	53	29	424	−21.4	43	30	432	−15.5	39	30	427	−19.9	35	29	433	−14.6	38
8,000	26	374	−25.3	41	28	374	−25.7	39	30	369	−29.7	35	27	379	−20.8	52	28	370	−28.8	42	30	378	−22.6	37	30	372	−27.7	34	29	379	−22.5	37
9,000	26	325	−33.0	40	28	325	−33.6	39	30	320	−37.1	34	27	330	−27.8	49	27	320	−36.4	40	30	329	−30.3	37	29	323	−35.2	34	29	330	−30.5	35
10,000	27	282	−40.3	38	28	281	−41.4	38	30	276	−44.5		27	287	−35.7	46	26	277	−43.6		30	285	−37.9	37	29	280	−42.4		29	286	−38.0	33
11,000	26	243	−47.2		28	242	−48.6		30	237	−50.4		27	248	−43.5		26	238	−50.0		30	246	−45.3		29	241	−48.5		29	246	−44.9	
12,000	26	208	−52.9		28	208	−54.2		30	203	−55.0		27	213	−51.0		23	204	−55.0		30	212	−52.2		28	206	−53.6		29	212	−51.2	
13,000	26	178	−57.3		28	177	−58.9		30	174	−57.5		27	182	−58.4		23	174	−57.8		30	181	−57.8		28	176	−56.4		29	182	−57.2	
14,000	26	152	−60.6		28	151	−62.4		30	148	−58.8		27	155	−64.5		22	149	−59.8		29	154	−62.3		27	150	−59.3		28	154	−62.4	
15,000	26	129	−63.4		28	128	−65.0		28	126	−60.9		27	132	−68.3		20	127	−61.0		29	131	−66.4		27	128	−62.0		27	131	−66.6	
16,000	26	110	−65.0		26	109	−66.5		28	108	−62.1		27	112	−69.9		19	108	−61.4		29	111	−69.2		27	109	−64.1		26	111	−68.9	
17,000	25	93	−64.9		24	92	−66.4		25	91	−62.5		25	94	−70.3		17	91	−61.4		27	94	−69.8		27	93	−64.6		22	94	−69.6	
18,000	23	79	−64.3		23	78	−64.2		24	78	−61.8		22	79	−69.1		16	78	−60.0		27	79	−68.8		26	78	−64.0		21	79	−69.1	
19,000	14	67	−62.5		21	66	−61.9		20	66	−60.7		21	67	−67.2		13	66	−58.4		24	67	−66.3		23	67	−62.4		20	67	−66.0	
20,000	7	57	−60.5		13	56	−59.2		11	57	−59.5		17	57	−64.0		9	56	−56.8		20	57	−63.6		17	57	−60.8		18	56	−62.4	
21,000					9	47	−57.3						10	48	−61.2						16	48	−60.9		11	48	−59.4		12	48	−59.8	
22,000					5	40	−55.4						6	41	−58.9						12	41	−58.6		5	41	−58.6		8	41	−57.1	
23,000																					8	35	−56.3									

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Omaha, Nebr. (300 m)				Phoenix, Ariz. (339 m)				St. Louis, Mo. (176 m)				San Juan, P. R. (18 m)				Sault Ste. Marie, Mich. (221 m.)				Spokane, Wash. (597 m.)				Swan Island, W. I. (10 m.)				Washington,[1] D. C. (7 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	30	980	17.7	60	29	972	24.0	68	30	996	20.5	69	30	1012	24.9	89	30	989	10.5	93	29	946	11.8	63	29	1010	26.3	87	26	1017	17.7	86
500	30	958	19.4	55	29	955	26.8	57	30	959	22.9	55	30	958	23.2	87	30	957	11.7	86					29	956	22.7	88	26	960	17.9	76
1,000	30	904	19.2	50	29	902	25.1	50	30	906	20.8	52	30	905	20.3	84	30	901	10.0	79	29	901	14.6	50	29	903	19.4	82	26	905	16.0	66
1,500	30	853	17.5	48	29	852	21.5	51	30	855	18.2	51	30	854	17.4	77	30	848	7.5	74	29	850	12.0	50	29	852	16.5	79	26	854	13.8	58
2,000	30	804	14.9	49	29	804	18.1	53	30	806	15.1	51	30	805	14.9	70	30	798	5.6	68	29	800	8.6	54	29	803	13.5	74	26	805	12.4	52
2,500	30	757	12.0	50	29	758	14.7	53	30	759	12.0	48	30	759	12.7	64	30	750	3.4	65	29	753	5.1	59	29	756	10.5	70	25	758	10.0	50
3,000	30	713	8.9	50	29	714	11.3	53	30	715	8.8	48	30	715	10.0	61	30	705	1.4	61	29	708	2.0	62	29	712	7.5	68	25	713	7.2	48
4,000	30	631	2.6	48	29	633	4.3	57	30	633	2.2	51	29	633	4.5	56	28	622	−4.3	58	29	625	−3.4	55	28	630	2.0	65	25	631	1.6	44
5,000	30	558	−3.8	44	29	559	−1.8	54	30	559	−4.3	49	28	560	−1.2	53	28	548	−10.0	56	28	550	−10.0	51	27	556	−3.4	64	25	556	−4.0	38
6,000	30	490	−10.0	39	29	492	−7.5	46	30	491	−10.4	45	28	493	−7.3	50	28	480	−16.1	54	28	482	−16.8	49	27	490	−8.9	61	21	489	−9.8	38
7,000	30	430	−16.6	36	28	433	−13.8	40	30	431	−17.4	45	28	433	−13.7	48	28	420	−23.1	53	28	421	−23.8	50	27	430	−14.7	60	23	429	−16.2	41
8,000	30	376	−24.1	34	28	378	−20.5	38	30	376	−25.2	41	28	379	−20.5	46	28	366	−30.5	52	28	366	−31.0	50	27	376	−21.1	57	22	375	−22.7	42
9,000	30	327	−32.1	33	28	330	−27.9	37	30	327	−33.0	40	27	330	−27.5	44	28	317	−38.2	52	28	318	−38.8	50	27	327	−28.2	55	21	327	−30.0	43
10,000	30	284	−39.7	33	28	287	−35.7	36	30	283	−40.8	40	27	287	−34.9	44	28	273	−45.7	50	28	274	−46.4		27	284	−35.7	54	20	284	−37.4	39
11,000	30	244	−46.6		28	248	−43.1		30	244	−48.1		27	248	−42.4		28	235	−52.3		28	235	−52.6		27	246	−43.6		17	245	−44.8	
12,000	30	210	−52.7		28	213	−50.2		29	209	−54.5		27	213	−49.7		26	201	−56.0		28	201	−56.2		27	211	−51.4		17	210	−51.9	
13,000	30	179	−57.4		28	182	−56.6		28	178	−59.7		27	183	−56.6		25	172	−58.0		27	172	−57.7		27	180	−59.1		16	180	−57.9	
14,000	29	153	−61.1		28	155	−62.2		28	152	−63.9		27	156	−62.4		25	146	−59.7		27	146	−58.4		27	153	−66.4		12	153	−62.1	
15,000	29	130	−64.0		28	132	−66.7		27	128	−67.4		27	132	−67.1		24	124	−60.9		27	124	−59.4		27	130	−72.2		11	130	−65.1	
16,000	28	110	−66.0		28	112	−69.5		25	109	−69.1		27	112	−70.4		22	106	−61.5		27	106	−59.5		27	109	−75.1		6	110	−67.7	
17,000	28	94	−66.1		28	94	−69.4		24	92	−68.8		27	94	−72.3		19	90	−60.8		26	90	−59.3		26	92	−75.8					
18,000	26	79	−64.7		28	80	−68.0		22	78	−66.3		25	79	−72.9		13	76	−59.5		18	77	−58.5		25	77	−75.2					
19,000	19	67	−62.8		22	68	−65.5		18	66	−63.6		24	67	−71.7		7	65	−57.5		6	66	−57.9		24	65	−72.2					
20,000	10	56	−60.5		16	57	−62.7		8	56	−61.0		21	57	−69.9										19	55	−69.6					
21,000	9	48	−58.5		14	49	−60.0						20	48	−66.7										12	46	−67.4					
22,000													13	40	−63.4										6	39	−66.1					
23,000													7	34	−60.3																	

[1] Navy.

Observations taken about 4 a. m., 75th meridian time.

NOTE.—None of the means included in this table are based on less than 15 surface or 5 standard-level observations.

Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels; also, the humidity data are not used in daily observations when the temperature is below −40.0° C.

TABLE 2.—*Free-air resultant winds based on pilot-balloon observations made near 5 p. m. (E. S. T.) during September 1939*

[Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second (superior figures indicate number of observations]

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)		Albuquerque, N. Mex. (1,554 m.)		Atlanta, Ga. (302 m.)		Billings, Mont. (1,095 m.)		Boise, Idaho (850 m.)		Brooklyn, N. Y. (15 m.)		Brownsville, Tex. (7 m.)		Buffalo, N. Y. (220 m.)		Burlington, Vt. (132 m.)		Charleston, S. C. (18 m.)		Cheyenne, Wyo. (1,873 m.)		Chicago, Ill. (192 m.)		Cincinnati, Ohio (157 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	154^{30}	1.7	218^{30}	1.8	28^{29}	0.6	291^{29}	0.8	299^{30}	2.3	189^{29}	2.7	106^{28}	3.8	267^{28}	2.0	210^{28}	1.2	41^{30}	0.9	229^{28}	2.8	287^{29}	0.7	256^{29}	1.7
500	----	----	----	----	39^{29}	.8	----	----	----	----	232^{29}	3.3	115^{28}	4.2	261^{28}	3.2	246^{28}	2.4	59^{30}	1.4	----	----	273^{29}	.9	252^{29}	3.2
1,000	148^{30}	3.4	----	----	74^{29}	1.3	----	----	294^{30}	2.0	260^{28}	4.9	124^{28}	2.9	251^{28}	5.4	276^{28}	5.0	92^{5}	1.2	----	----	243^{28}	2.6	248^{29}	4.3
1,500	153^{30}	3.2	----	----	68^{28}	.6	243^{29}	4.3	287^{30}	1.0	282^{28}	5.4	123^{28}	2.4	256^{24}	7.9	285^{27}	6.9	330^{26}	1.6	----	----	258^{27}	5.6	255^{29}	5.0
2,000	154^{30}	3.3	212^{30}	2.4	70^{26}	1.0	257^{29}	2.4	278^{30}	1.5	284^{28}	6.6	126^{21}	2.0	265^{24}	9.4	288^{21}	8.8	337^{21}	2.3	228^{28}	3.0	269^{24}	6.0	263^{29}	5.8
2,500	157^{30}	2.9	202^{30}	2.8	325^{22}	1.0	269^{27}	4.3	264^{29}	2.3	284^{26}	7.6	119^{19}	2.1	278^{21}	9.2	289^{14}	10.4	325^{19}	3.0	252^{28}	3.4	277^{21}	7.4	273^{29}	7.3
3,000	162^{30}	1.9	211^{29}	2.7	343^{18}	1.8	262^{26}	7.0	255^{29}	3.0	276^{19}	7.6	103^{16}	2.5	282^{18}	9.3	302^{12}	10.3	323^{18}	2.3	261^{28}	4.8	277^{18}	8.8	282^{29}	8.2
4,000	158^{29}	2.1	229^{24}	3.3	305^{17}	1.9	268^{25}	10.7	248^{26}	5.4	----	----	71^{12}	3.0	290^{14}	10.0	----	----	288^{14}	3.8	272^{25}	8.6	289^{15}	9.3	289^{25}	8.6
5,000	212^{23}	1.9	233^{22}	4.0	326^{15}	2.4	277^{21}	11.8	249^{19}	7.3	----	----	64^{10}	2.8	----	----	----	----	277^{12}	3.0	266^{23}	10.1	----	----	300^{18}	8.3
6,000	252^{21}	1.9	232^{19}	4.4	326^{15}	3.2	275^{18}	12.9	247^{14}	9.5	----	----	----	----	----	----	----	----	----	----	268^{21}	10.0	----	----	300^{15}	11.3
8,000	294^{19}	4.8	226^{15}	4.4	355^{13}	2.3	272^{14}	16.3	----	----	----	----	----	----	----	----	----	----	----	----	261^{17}	14.2	----	----	303^{10}	13.2
10,000	308^{17}	9.0	257^{10}	5.0	----	----	270^{10}	21.5	----	----	----	----	----	----	----	----	----	----	----	----	280^{13}	18.7	----	----	----	----
12,000	301^{13}	8.8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14,000	312^{11}	7.8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)		Fargo N. Dak. (283 m.)		Greensboro, N. Car. (271 m.)		Havre, Mont. (766 m.)		Houston, Tex. (21 m.)		Huron, S. Dak. (393 m.)		Las Vegas, Nev. (570 m.)		Little Rock, Ark. (82 m.)		Medford, Oreg. (410 m.)		Miami, Fla. (10 m.)		Minneapolis, Minn. (261 m.)		Nashville, Tenn. (194 m.)		New Orleans, La. (19 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	136^{30}	0.8	236^{30}	1.4	173^{29}	0.3	269^{27}	3.3	135^{30}	3.2	220^{30}	2.0	115^{29}	1.8	132^{30}	2.1	306^{29}	1.4	111^{30}	2.2	235^{29}	1.8	281^{29}	0.7	71^{30}	1.4
500	----	----	250^{30}	1.7	177^{29}	.5	----	----	129^{30}	3.5	222^{30}	1.8	----	----	155^{30}	2.7	308^{29}	1.4	119^{30}	2.5	257^{29}	2.4	239^{29}	.7	109^{30}	2.5
1,000	----	----	256^{30}	2.8	243^{29}	.8	264^{27}	4.4	117^{30}	2.7	235^{30}	2.3	118^{29}	1.9	166^{30}	2.1	307^{29}	1.2	112^{30}	1.4	234^{28}	3.8	243^{29}	.8	104^{30}	2.8
1,500	142^{30}	1.3	260^{29}	4.9	264^{29}	.8	264^{27}	6.6	106^{29}	2.2	253^{28}	4.1	153^{29}	1.6	208^{29}	1.3	217^{29}	.6	91^{30}	.7	250^{28}	4.8	240^{28}	.6	83^{28}	2.9
2,000	153^{30}	1.9	271^{26}	7.0	273^{28}	2.0	264^{26}	7.5	93^{28}	2.4	263^{28}	5.1	185^{29}	1.4	264^{29}	1.0	200^{28}	1.8	97^{30}	.5	264^{27}	7.1	263^{27}	.9	69^{25}	3.2
2,500	139^{30}	2.6	281^{25}	8.5	299^{28}	2.9	263^{25}	8.6	96^{24}	2.9	266^{25}	7.4	211^{29}	3.1	307^{27}	.6	212^{27}	2.3	189^{28}	.7	270^{25}	9.2	285^{26}	1.1	76^{23}	3.4
3,000	125^{30}	2.8	283^{24}	11.2	313^{25}	4.2	268^{24}	9.8	84^{23}	2.8	273^{24}	8.2	208^{29}	4.5	319^{27}	1.3	212^{27}	2.6	209^{27}	1.3	269^{23}	10.7	299^{26}	1.9	64^{21}	3.7
4,000	128^{28}	1.6	280^{22}	12.3	311^{24}	5.9	280^{20}	11.2	86^{17}	4.8	274^{23}	11.2	213^{29}	6.9	230^{24}	1.3	214^{25}	1.7	202^{24}	2.4	281^{19}	13.2	352^{20}	3.6	79^{15}	3.6
5,000	204^{23}	1.9	285^{20}	14.5	306^{19}	7.5	283^{15}	13.2	71^{14}	3.9	280^{20}	12.4	219^{25}	7.5	261^{20}	2.6	242^{23}	1.0	189^{20}	3.5	291^{14}	15.0	335^{19}	3.7	----	----
6,000	245^{19}	2.6	283^{17}	16.2	288^{17}	7.8	287^{13}	12.7	68^{13}	3.3	281^{20}	14.6	223^{23}	8.5	269^{20}	3.4	268^{23}	.8	181^{20}	3.6	290^{14}	16.3	330^{17}	5.7	----	----
8,000	278^{17}	4.6	281^{15}	21.0	287^{13}	9.7	----	----	----	----	278^{19}	18.8	225^{20}	13.5	266^{17}	4.0	254^{21}	1.1	159^{11}	4.4	----	----	314^{12}	6.8	----	----
10,000	----	----	----	----	299^{10}	11.1	----	----	----	----	285^{13}	22.6	230^{17}	19.5	347^{10}	1.4	----	----	----	----	----	----	----	----	----	----
12,000	----	----	----	----	----	----	----	----	----	----	285^{12}	25.2	241^{17}	25.6	----	----	----	----	----	----	----	----	----	----	----	----
14,000	----	----	----	----	----	----	----	----	----	----	----	----	237^{15}	20.2	----	----	----	----	----	----	----	----	----	----	----	----
16,000	----	----	----	----	----	----	----	----	----	----	----	----	244^{13}	10.1	----	----	----	----	----	----	----	----	----	----	----	----

Altitude (meters) m. s. l.	Oakland, Calif. (8 m.)		Oklahoma City, Okla. (402 m.)		Omaha, Nebr. (306 m.)		Reno, Nev. (1,346 m.)		St. Louis, Mo. (170 m.)		Salt Lake City, Utah (1,294 m.)		San Diego, Calif. (15 m.)		San Juan, P. R. (16 m.)		Sault Ste. Marie, Mich. (198 m.)		Seattle, Wash. (14 m.)		Spokane, Wash. (603 m.)		Washington, D. C. (10 m.)		Winslow, Ariz. (1,488 m.)	
	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity	Direction	Velocity
	°		°		°		°		°		°		°		°		°		°		°		°		°	
Surface	270^{29}	3.9	193^{30}	3.2	200^{30}	2.5	245^{30}	0.9	200^{29}	1.6	295^{27}	1.1	283^{27}	3.2	83^{30}	4.6	271^{29}	1.6	307^{28}	2.0	216^{30}	2.2	177^{30}	1.1	211^{30}	2.7
500	307^{29}	1.8	193^{30}	3.2	203^{30}	3.7	----	----	214^{29}	1.9	----	----	226^{27}	1.4	99^{30}	6.4	238^{29}	2.4	297^{28}	1.1	----	----	214^{30}	2.1	----	----
1,000	80^{29}	.2	188^{30}	3.5	196^{30}	4.2	----	----	226^{29}	3.0	----	----	147^{26}	2.4	110^{28}	4.9	229^{25}	4.5	275^{24}	1.5	223^{30}	2.8	244^{28}	4.1	----	----
1,500	183^{28}	1.2	200^{29}	4.5	220^{30}	5.3	231^{30}	.7	244^{29}	4.2	278^{27}	1.2	144^{28}	3.6	109^{27}	4.7	254^{21}	5.8	229^{21}	2.4	225^{30}	3.0	275^{27}	5.0	----	----
2,000	162^{29}	2.3	206^{29}	4.6	245^{29}	7.1	159^{30}	1.3	255^{29}	5.3	238^{27}	1.6	154^{23}	2.6	103^{24}	4.7	265^{19}	8.2	243^{19}	2.1	229^{27}	3.8	297^{25}	6.2	204^{30}	2.5
2,500	155^{27}	2.8	208^{29}	4.8	255^{28}	8.3	180^{29}	2.5	263^{28}	6.5	221^{26}	3.2	175^{23}	2.8	97^{23}	4.8	274^{18}	9.1	262^{17}	2.3	247^{26}	4.4	294^{25}	6.8	199^{30}	2.8
3,000	161^{26}	3.4	211^{26}	3.6	263^{27}	9.6	200^{28}	3.6	271^{26}	7.9	222^{26}	3.5	192^{22}	3.7	89^{23}	5.1	274^{16}	10.4	267^{17}	3.8	255^{22}	5.9	292^{24}	7.5	194^{30}	4.1
4,000	172^{26}	3.1	232^{26}	2.3	272^{24}	10.9	213^{26}	4.3	278^{26}	8.3	222^{25}	5.8	199^{18}	5.1	86^{21}	5.0	288^{12}	12.6	290^{17}	4.0	256^{20}	8.3	294^{22}	7.8	205^{28}	4.7
5,000	193^{26}	4.9	256^{20}	3.6	277^{23}	11.6	217^{26}	4.9	292^{17}	7.6	238^{22}	6.3	212^{18}	7.5	91^{20}	5.5	----	----	284^{17}	6.8	272^{18}	9.2	----	----	220^{24}	4.2
6,000	210^{22}	5.4	265^{19}	3.7	279^{21}	12.5	214^{26}	6.3	290^{14}	7.8	257^{20}	7.0	212^{19}	8.8	88^{18}	5.1	----	----	267^{14}	10.0	280^{18}	10.4	----	----	235^{21}	5.9
8,000	219^{19}	7.7	282^{17}	6.7	282^{19}	14.6	219^{23}	8.7	----	----	260^{14}	8.8	----	----	90^{14}	6.1	----	----	----	----	----	----	----	----	239^{20}	9.4
10,000	209^{13}	10.1	290^{14}	7.8	286^{17}	17.4	227^{17}	12.1	----	----	----	----	----	----	71^{12}	7.7	----	----	----	----	----	----	----	----	256^{15}	15.5
12,000	----	----	----	----	289^{10}	16.4	224^{10}	17.4	----	----	----	----	----	----	47^{10}	7.6	----	----	----	----	----	----	----	----	258^{13}	16.9
14,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	266^{11}	13.3
16,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	253^{10}	5.6

TABLE 3.—*Maximum free-air wind velocities (M. P. S.), for different sections of the United States based on pilot balloon observations during September 1939*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	33.1	WNW	1,180	6	Boston, Mass.	38.4	WNW	4,660	10	Cleveland, Ohio	57.6	WSW	12,400	28	Cleveland, Ohio.
East-Central [2]	25.5	WNW	2,260	10	Washington, D. C.	29.0	WSW	2,950	29	Cincinnati, Ohio	36.0	W	9,720	25	Greensboro, N. C.
Southeast [3]	19.7	N	2,090	14	Charleston, S. C.	24.9	NNE	5,000	14	Jacksonville, Fla.	37.0	WSW	10,540	30	Jacksonville, Fla.
North-Central [4]	37.7	NNW	1,970	3	Rapid City, S. Dak.	36.0	NW	4,130	29	Rapid City, S. Dak.	52.8	W	13,890	11	Fargo, N. Dak.
Central [5]	32.3	WSW	790	12	Moline, Ill.	34.0	WNW	4,960	10	Chicago, Ill.	39.0	WSW	13,080	26	Omaha, Nebr.
South-Central [6]	30.2	SW	1,730	3	Amarillo, Tex.	25.6	WSW	2,870	29	Little Rock, Ark.	43.0	SW	11,450	23	New Orleans, La.
Northwest [7]	26.3	WSW	1,770	27	Pocatello, Idaho	35.0	W	4,820	8	Havre, Mont.	49.6	WSW	10,220	4	Billings, Mont.
West-Central [8]	25.4	WNW	2,480	15	Cheyenne, Wyo.	41.8	SW	3,560	1	Modena, Utah	56.0	NW	19,440	19	Denver, Colo.
Southwest [9]	28.6	SSE	816	24	San Diego, Calif.	29.2	SSW	4,940	13	Las Vegas, Nev.	51.2	SSW	9,700	12	Las Vegas, Nev.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during September 1939, classified according to the potential temperatures (10-degree intervals between 300° and 409° A.) with which they are identified. (Based on radiosonde observations)*

Potential temperatures, ° A.	Albuquerque, N. Mex.			Atlanta, Ga.			Billings, Mont.			Bismarck, N. Dak			Charleston, S. C.			Denver, Colo.			El Paso, Tex.		
	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature
300-309										1	7.1	−36.0									
310-319							1	10.1	−55.0	1	7.7	−35.0									
320-329							10	10.2	−50.2	17	10.5	−51.0				2	9.6	−44.0			
330-339	13	10.4	−44.9	3	11.2	−51.0	20	11.1	−49.4	21	11.0	−51.7	5	10.7	−47.0	11	11.0	−50.3	4	10.4	−42.8
340-349	15	12.3	−55.5	24	12.9	−58.4	13	12.3	−58.7	17	11.9	−54.6	17	12.3	−56.1	21	12.1	−52.2	14	11.6	−48.6
350-359	14	13.6	−61.8	16	13.6	−63.4	11	12.8	−57.3	3	13.4	−62.0	15	13.9	−65.2	8	13.5	−60.9	22	13.8	−64.3
360-369	11	14.7	−67.2	17	14.7	−67.2	5	14.0	−61.2	3	13.8	−61.3	9	16.1	−69.9	10	14.6	−66.4	14	15.2	−70.9
370-379	10	15.7	−70.1	14	15.4	−69.1	6	14.5	−61.7	5	14.8	−63.2	4	15.5	−71.2	9	15.3	−68.4	13	16.0	−73.2
380-389	6	16.5	−73.8	7	16.2	−71.1	4	14.9	−61.5	4	14.9	−61.5	5	16.2	−70.8	10	15.9	−69.4	8	16.4	−73.6
390-399	3	17.1	−74.0	8	16.8	−72.1	6	15.8	−63.7	3	16.1	−66.0	5	16.9	−73.2	8	16.6	−70.0	7	17.0	−74.0
400-409	9	17.3	−71.8	5	17.0	−68.0	1	16.4	−63.0	5	16.2	−62.8	3	17.1	−69.3	4	16.8	−68.5	4	17.4	−73.2
Weighted means		14.0	−62.1		14.5	−64.8		12.5	−55.9		12.2	−54.2		14.2	−63.6		13.8	−60.6		14.5	−65.2
Mean potential temperature (weighted), °A.	362.4			368.2			350.7			347.5			360.4			361.6			364.7		

Potential temperatures, ° A.	Ely, Nev.			Joliet, Ill.			Medford, Oreg.			Miami, Fla.			Minneapolis, Minn.			Nashville, Tenn.			Oakland, Cal.		
	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature
300-309																			3	6.3	−28.3
310-319	1	7.9	−34.0				2	8.3	−42.0							1	8.0	−28.0	3	7.7	−35.7
320-329	3	9.6	−43.7	12	10.0	−47.3	14	9.7	−45.5				10	10.1	−49.6	2	9.0	−36.0	8	9.1	−39.1
330-339	17	10.6	−47.2	22	10.9	−49.6	26	11.1	−53.0	1	10.4	−43.0	11	11.1	−52.0	5	11.3	−52.0	22	10.7	−47.9
340-349	19	12.5	−55.5	16	12.1	−55.9	14	12.2	−56.1	10	12.9	−60.2	14	12.0	−56.0	22	12.0	−53.1	13	12.2	−56.4
350-359	9	13.0	−58.8	11	13.3	−59.5	6	13.3	−61.7	25	13.9	−62.2	2	13.2	−61.5	9	13.6	−61.8	5	12.6	−55.2
360-369	8	14.0	−61.4	14	14.6	−66.1	3	13.9	−62.3	18	14.8	−67.4	6	13.8	−62.0	9	14.8	−68.0	7	13.7	−59.9
370-379	9	15.1	−65.6	3	15.4	−69.7	8	14.4	−60.9	9	15.6	−70.9	5	14.5	−63.0	17	15.3	−67.8	5	14.1	−58.2
380-389	10	16.0	−64.6	6	15.7	−67.7	3	15.1	−62.0	7	16.2	−70.6	1	15.8	−68.0	7	16.3	−72.6	7	15.6	−65.3
390-399	8	16.0	−66.2	7	16.3	−67.7	6	15.8	−63.5	3	16.7	−71.3	2	15.7	−64.0	4	16.5	−69.0	10	16.0	−64.2
400-409	4	16.7	−65.8	2	16.9	−67.0	7	16.6	−64.7	4	17.3	−71.8	3	16.2	−63.3	5	17.2	−71.4	7	16.6	−65.1
Weighted means		13.3	−57.6		12.8	−57.6		12.4	−54.9		14.6	−65.5		12.4	−56.4		13.9	−61.7		12.5	−53.7
Mean potential temperature (weighted)	362.7			352.7			351.7			364.5			350.1			362.5			355.2		

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during September 1939, classified according to the potential temperatures (10-degree intervals between 300° and 409° A.) with which they are identified. (Based on radiosonde observations)*—Continued.

Potential temperatures A.	Oklahoma City, Okla.			Omaha, Nebr.			Phoenix, Ariz.			San Juan, P. R.			Sault Ste. Marie, Mich.			St. Louis, Mo.			Spokane, Wash.			Swan Island, W. I.		
	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature	Number of cases	Mean altitude	Mean temperature
310-319				1	7.7	−34.0							4	7.5	−34.3				2	8.2	−38.0			
320-329	3	9.4	−40.3	8	9.9	−45.8							22	10.2	−52.7	2	10.8	−53.5	18	9.9	−47.6			
330-339	8	10.7	−46.8	16	10.1	−41.9	5	10.8	−46.6	3	11.2	−51.6	19	11.3	−56.2	17	10.9	−49.5	24	11.2	−54.8			
340-349	17	12.1	−53.9	17	12.1	−55.0	15	11.8	−50.5	10	12.3	−55.9	8	11.8	−54.9	17	12.3	−57.2	11	12.3	−58.7	9	12.9	−61.1
350-359	14	13.4	−59.9	12	13.2	−58.2	17	13.5	−61.2	13	13.4	−61.3	5	13.1	−61.0	9	13.8	−64.3	4	13.2	−61.8	25	14.3	−69.7
360-369	13	14.7	−66.5	8	14.2	−62.5	11	14.8	−67.3	14	14.7	−66.5	8	14.0	−62.1	11	14.9	−70.1	3	13.6	−59.3	16	15.4	−73.4
370-379	7	15.7	−70.6	9	15.3	−67.2	13	15.7	−69.9	5	15.6	−71.0	3	14.3	−60.0	9	15.0	−66.3	4	14.6	−61.2	10	16.1	−76.4
380-389	9	15.0	−69.8	7	15.8	−67.4	10	16.4	−71.9	7	16.5	−73.6	3	15.7	−66.3	6	16.1	−71.0	3	15.0	−62.0	6	16.9	−76.3
390-399	5	16.8	−71.4	12	16.3	−67.3	7	16.7	−70.6	6	16.9	−72.0				10	16.2	−68.8	3	15.8	−62.7	1	17.2	−77.0
400-409	3	17.6	−72.7	2	17.2	−70.5	5	17.4	−71.6	2	17.2	−72.5	1	16.3	−63.0	5	16.9	−68.8				5	17.7	−77.4
Weighted means		13.7	−60.9		13.1	−56.9		14.2	−60.7		14.5	−64.8		11.6	−54.6		13.8	−61.9		11.7	−54.7		15.1	−71.6
Mean potential temperature (weighted)	360.5			357.4			362.3			364.6			340.5			360.5			342.5			364.6		

LATE REPORTS FOR AUGUST 1939

Altitude (meters) m. s. l.	Bismarck, N. Dak. (508 m.)				Charleston, S. C. (14 m.)				Sault Ste. Marie, Mich. (221 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	955	15.9	70	30	1,014	22.6	95	30	988	14.3	95
500					30	959	23.1	79	30	956	16.0	82
1,000	31	902	20.4	49	30	905	21.0	75	30	901	14.6	77
1,500	31	851	17.6	48	30	854	18.0	74	30	849	11.6	79
2,000	31	802	14.2	52	30	806	15.3	73	30	800	8.8	78
2,500	31	756	10.8	54	30	760	12.6	71	30	753	6.3	71
3,000	31	711	7.8	53	30	716	10.0	69	30	708	3.6	66
4,000	31	630	1.4	48	30	634	4.5	67	30	625	−2.0	58
5,000	30	555	−5.5	44	30	561	−0.8	61	30	551	−7.5	48
6,000	30	488	−12.6	43	29	494	−6.4	57	29	484	−13.1	44
7,000	30	427	−19.8	41	29	434	−12.3	50	29	423	−20.3	42
8,000	30	373	−27.4	39	28	380	−18.8	46	29	369	−28.2	41
9,000	30	323	−35.6	39	28	332	−25.8	46	29	320	−36.2	40

Altitude (meters) m. s. l.	Bismarck, N. Dak. (508 m.)				Charleston, S. C. (14 m.)				Sault Ste. Marie, Mich. (221 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
10,000	29	279	−43.0		28	288	−33.6	40	29	277	−43.7	
11,000	29	241	−48.9		28	249	−41.3		29	238	−49.6	
12,000	29	206	−53.8		28	215	−48.9		29	204	−53.7	
13,000	29	176	−56.5		27	184	−55.8		29	174	−55.7	
14,000	28	150	−57.8		24	157	−61.6		29	149	−57.2	
15,000	27	128	−58.8		24	133	−65.9		29	127	−58.3	
16,000	23	109	−59.9		24	113	−68.3		27	108	−58.7	
17,000	22	92	−60.0		23	96	−67.4		23	92	−58.3	
18,000	21	79	−58.6		21	81	−65.5		14	78	−57.4	
19,000	19	67	−56.6		19	68	−63.9		9	67	−56.0	
20,000	14	57	−54.9		12	58	−62.2		6	57	−54.9	
21,000	10	48	−52.9		8	49	−60.9					
22,000	5	41	−51.9		8	42	−59.2					

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in charge]

By BENNETT SWENSON

The principal floods during August and September 1939 occurred in the Southeastern States as the result of the passage inland of a tropical disturbance over extreme northwestern Florida on August 12–13. This disturbance remained practically stationary over Alabama until the 17th when it began to move slowly northeastward. Heavy precipitation accompanied the storm, the greatest amounts being recorded in extreme northwestern Florida and central and southern Alabama. Moderately heavy rains over Georgia, North and South Carolina, and portions of southern Virginia accompanied the slow northeastward progress of the disturbance.

An interesting feature of this cyclone of tropical origin was, that after its passage inland, it maintained an intense cyclonic circulation to very high levels for several days, the center of the circulation aloft being almost directly above the center at the surface. Pilot-balloon observations at Birmingham, Ala., on the 13th showed that east-southeast winds prevailed at all levels to and including 14,000 feet. At 12,000 feet the highest velocity, 63 miles per hour, was observed. At the same time, Pensacola, Fla., had west-northwest winds at the same levels with a maximum velocity of 54 miles per hour also at 12,000 feet.

Except for the region mentioned above, rains over the country during August were scattered and resulted mainly in minor flooding in Kansas and some local floods in southern New Mexico.

September was unusually dry over the country except for the extreme Southwestern States, which had considerably more than normal rainfall and resulted in some local flooding, and Louisiana and Mississippi where the rainfall was somewhat above normal.

South Atlantic drainage:—Slight to moderate floods occurred in most of the rivers of the Atlantic slope as far north as the James River Basin. These rises resulted from moderately heavy precipitation from August 17–19 during the slow northeastward progress of the remnants of the tropical disturbance over that region. Damages were generally slight or moderate.