TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during December 1939, classified according to the potential temperatures (10-degree intervals between 290° and 409° A.) with which they are identified. (Based on radiosonde observations)*—Continued

Potential temperatures, °A.	Phoenix, Ariz.			St. Louis, Mo.			San Antonio, Tex.			Sault Ste. Marie, Mich.			Spokane, Wash.		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290-299				2	6.6	−41.5				8	6.3	−40.5	4	5.8	−36.0
300-309	1	7.7	−44.0	6	7.9	−49.2				20	7.9	−48.6	9	7.2	−41.4
310-319	7	9.1	−48.0	13	9.1	−50.2	2	8.0	−33.5	22	9.2	−53.4	18	9.0	−49.4
320-329	19	10.2	−51.5	17	10.3	−54.1	10	10.0	−49.9	15	10.2	−56.1	26	10.4	−55.1
330-339	18	11.2	−55.3	10	11.7	−60.5	20	11.1	−53.4	6	11.2	−59.5	9	11.1	−56.8
340-349	10	12.5	−60.1	6	11.7	−56.5	14	12.5	−59.9	2	11.0	−53.5	1	12.3	−63.0
350-359	3	13.5	−65.3	1	13.1	−61.0	5	13.1	−61.4						
360-369	9	14.6	−68.4	2	13.6	−55.5	5	14.0	−63.6				1	13.5	−63.0
370-379	2	15.4	−70.5	3	14.7	−66.3	7	15.3	−68.6				3	14.2	−63.3
380-389	10	16.1	−72.6	2	14.4	−60.0	10	15.7	−68.3	1	14.0	−59.0			
390-399	5	16.3	−70.8				4	16.8	−72.8						
400-409	3	16.9	−71.3	6	15.9	−62.7	7	16.9	−70.6				1	15.2	−54.0
Weighted means		12.5	−59.8		11.0	−55.3		13.0	−60.2		9.0	−51.8		9.8	−51.7
Mean potential temperature °A. (weighted)	347.5			336.1			355.0			315.0			323.2		

LATE REPORTS FOR SAN ANTONIO, TEX.

Potential temperatures, °A.	July 1939			Aug. 1939			Sept. 1939			Oct. 1939		
	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
320-329										3	9.0	−38.0
330-339				2	11.2	−49.0	1	10.4	−41.0	10	11.0	−49.6
340-349	3	11.4	−46.0	6	12.3	−53.3	8	11.9	−53.4	14	12.1	−53.7
350-359	11	13.7	−62.0	12	13.8	−64.3	17	13.6	−62.1	9	13.9	−64.1
360-369	10	14.8	−66.3	15	14.9	−66.1	12	14.7	−67.3	11	14.6	−66.4
370-379	14	15.6	−68.4	8	15.6	−69.1	7	15.5	−70.3	16	15.6	−70.5
380-389	11	16.4	−70.9	15	16.3	−70.9	12	16.0	−70.9	7	16.2	−70.8
390-399	6	17.1	−72.5	4	17.1	−72.0	5	16.9	−72.4	5	17.1	−72.8
400-409	4	17.6	−70.2	3	17.3	−70.3	7	17.4	−72.0	3	17.2	−72.0
Weighted means		15.3	−66.8		15.0	−66.1		14.8	−65.8		14.0	−62.5
Mean potential temperature °A. (weighted)	372.9			369.3			368.9			361.5		

AEROLOGICAL OBSERVATIONS FOR THE YEAR 1939

[Aerological Division, D. M. LITTLE in charge]

By B. FRANCIS DASHIELL

An increase in the use of radiosondes for obtaining observations of pressure, temperature and humidity in the upper air was one of the outstanding features of the aerological work of the Weather Bureau during 1939. At the close of the year radiosonde observations were being made daily at 25 stations of the Weather Bureau, 3 of the United States Navy, and 1 of the Army. Airplane meteorological flights were conducted by the Navy at 6 stations. Valuable radiosonde data were obtained during the 1939 hurricane season at San Juan, P. R., and Swan Island. Special observations were also made by radiosonde at Boston, Mass., and St. Georges, Bermuda, under the direction of the Massachusetts Institute of Technology, and by the United States Coast Guard when on duty at Halifax, Nova Scotia, and at sea in a patrol area extending from latitudes 40° to 44° N. and longitudes 47° to 53° W. Mean pressures, temperatures and humidities, computed from the above data, have been published regularly in the MONTHLY WEATHER REVIEW.

Pilot-balloon observations of wind directions and velocities were being made 4 times daily at 98 Weather Bureau stations in the United States proper, at 4 in Alaska, and 1 in Puerto Rico. All of the above stations, with the exception of 2 in Alaska, substituted helium gas for hydrogen on July 1, 1939. A selected group of 27 stations, where afternoon visibilities were unusually favorable, have been using 100-gram pilot balloons for the 5 p. m., 75th meridian time, observations. This was an increase of 12 stations over those in operation at the beginning of the year. During 1939 pilot-balloon observations formerly made at Cleveland were transferred to Akron, Ohio; Vicksburg to Jackson, Miss.; Fort Worth to Dallas, Tex.; and Floyd Bennett Field to the New York City airport. New pilot-balloon stations were opened during 1939 at Birmingham, Ala.; Butte, Mont.; Camden, N. J.; Des Moines, Iowa; Elkins, W. Va.; Elmira, N. Y.; Hartford, Conn.; Little Rock, Ark.; Louisville, Ky.; Milwaukee, Wis.; Mobile, Ala.; Pueblo, Colo.; Rapid City, S. Dak.; San Antonio, Tex.; Springfield, Mo.; and Toledo, Ohio.

A monthly series of flights by sounding balloons carrying recording meteorographs, checked by two theodolite observations, was conducted at Omaha, Nebr., during the month of April in accordance with the international program.

The work of reducing all existing Weather Bureau pilot-balloon observations to punch cards was completed by the Works Progress Administration at its special cooperative Weather Bureau project in New Orleans, La. At the close of the year approximately one million individual flights had been reduced to cards, and the data are being summarized and combined in quickly available forms.

In the upper air, at 1.5, 3, 4, and 5 kilometers, where observations were made both by airplanes and radiosondes,

the lowest annual mean barometric pressure in the United States prevailed throughout the year over Sault Ste. Marie, Mich. This also occurred at all higher levels. Highest pressure occurred generally throughout the South, but particularly over Pensacola and Miami, Fla. These annual means are shown in table 1.

Mean relative humidity was highest over Sault Ste. Marie, Mich., at all levels; and lowest over El Paso, Tex., up to 2.5 kilometers; over San Diego, Calif., to 5 kilometers; and over Oakland, Calif., up to 7 kilometers.

The lowest annual mean temperatures for the year were recorded over Sault Ste. Marie, Mich., at 1.5, 3, 4, and 5 kilometers, while the highest were over El Paso, Tex., at 1.5 and 3 kilometers, and Pensacola, Fla., at 4 and 5 kilometers. In the levels above 5 kilometers, Sault Ste. Marine, Mich., continued to be the coldest station up to 11 kilometers, then Nashville, Tenn., became colder at all subsequent levels. Sault Ste. Marie, Mich., which was the coldest below 11 kilometers, became the warmest above 12 kilometers. The lowest annual mean temperature for 1939 was −65.7° C. over Nashville, Tenn., at 17 kilometers.

At stations having one year of radiosonde records it was found that the individual minimum temperatures noted in the higher levels occurred during different months. However, many low temperatures of interest were observed over several of the newer radiosonde stations. The lowest individual minimum temperatures recorded by radiosonde were −85.1° C. in October and −83.3° C. in August over Swan Island. Other extremely low tempertures occurred in October over San Juan, P. R. (−81.3° C.) Atlanta, Ga. (−80.6° C.), and Charleston, S. C. (−80.5° C.).

With the expansion of radiosonde activities it has been possible to make a comprehensive survey of the upper-air levels at which mean freezing temperatures (0° C.) occurred during 1939. This level reached its maximum altitude during the summer (July) sloping upward from 3,550 meters at Seattle, Wash., to 5,140 meters over San Antonio, Tex., and 5,120 meters over Pensacola, Fla. During winter (January) freezing temperatures or lower occurred at the surface at most northern stations, but in the South (Pensacola, Fla.) the monthly mean freezing level was located at 3,440 meters. A compilation of these monthly levels for all stations is shown in table 4.

During each month of the year resultant wind directions and velocities were computed for all stations in the United States at 1.5 and 3 kilometers (5 a. m.), and 4 and 5 kilometers (5 p. m.). These have been shown on charts which were published monthly. In addition, monthly wind resultants (based on 5 p. m., 75th meridian time observations) have been computed and published for all levels at 39 stations.

An annual summary of the 5 p. m. winds is shown in table 2. Individual maximum velocities reported for the different sections of the country during the year are shown in table 3. In several instances these have been very high, and a velocity of 95.5 meters per second (214 miles per hour) recorded at 8.4 kilometers over Albuquerque, N. Mex., on the 14th of January, was the highest ever obtained by pilot balloons in the upper air.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during year 1939*

Altitude (meters) mean sea level	Stations and elevations in meters above sea level																											
	Billings, Mont. (1,089 m.)				El Paso, Tex. (1,193 m.)				Lakehurst, N. J.[1] (39 m.)				Nashville, Tenn. (180 m.)				Norfolk, Va.[1] (10 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
Surface	361	891	6.8	60	364	882	13.8	47	315	1,013	8.7	80	363	996	12.4	80	270	1,019	13.3	82	363	1,017	10.9	84	361	970	12.8	70
500									315	957	9.5	68	363	959	13.5	71	270	961	13.9	64	362	959	11.9	74	360	957	13.9	66
1,000									314	902	7.6	65	363	904	11.6	69	270	906	11.4	60	362	903	13.2	56	360	903	14.2	57
1,500	361	848	8.7	52	364	851	15.9	42	309	848	5.7	63	363	851	9.3	66	270	853	8.9	59	362	851	11.5	48	360	851	12.2	53
2,000	360	798	6.0	52	364	802	13.2	40	306	798	3.6	61	363	801	7.1	63	269	803	6.6	56	363	801	9.1	43	361	801	9.7	51
2,500	359	750	2.8	53	364	755	10.1	40	303	750	1.3	60	363	754	4.8	59	269	755	4.1	53	363	754	6.4	41	361	754	7.0	50
3,000	358	705	−0.7	55	363	711	6.6	41	301	705	−1.2	57	359	708	2.4	56	268	710	1.4	50	363	709	3.5	39	361	709	4.2	48
4,000	358	621	−7.4	57	359	628	−0.3	43	290	621	−6.4	54	355	626	−2.9	51	263	626	−4.2	44	360	626	−2.6	37	358	626	−1.8	46
5,000	354	545	−14.2	56	356	554	−7.2	43					353	551	−8.8	48	202	551	−10.6	41	360	551	−9.0	37	355	552	−8.1	43
6,000													350	483	−14.9	46					358	484	−15.8	35	353	484	−14.7	40
7,000													347	423	−21.7	44					356	423	−23.0	34	351	424	−21.5	38
8,000													340	368	−28.7	43					349	368	−30.6	34	344	369	−28.6	37
9,000													337	320	−35.9						345	319	−38.2	33	338	320	−35.8	
10,000													335	276	−43.1						339	275	−45.4		333	277	−43.0	
11,000													327	238	−49.6						331	236	−51.7		322	238	−49.6	
12,000													314	204	−55.0						321	202	−56.3		311	204	−54.6	
13,000													304	174	−58.7						314	173	−58.7		296	174	−58.2	
14,000													300	148	−61.4						301	147	−60.3					
15,000													275	126	−63.8						282	125	−62.0					
16,000													259	107	−65.2						261	106	−63.4					
17,000													221	90	−65.7						234	90	−63.8					
18,000																					199	76	−63.1					

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during year 1939*—Continued

Altitude (meters) mean sea level	Omaha, Nebr. (301 m.)				Pearl Harbor, T. H. (6 m.) [1]				Pensacola, Fla. (24 m.) [1]				San Diego, Calif. (19 m.) [1]				S. Ste. Marie, Mich. (221 m.)				Spokane, Wash. (598 m.)				Washington, 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
Surface	365	980	8.6	73	365	1,016	21.6	81	318	1,018	16.8	87	344	1,014	15.0	80	363	988	1.7	89	358	947	6.8	73	339	1,017	10.8	80
500	365	957	9.9	66	365	960	19.8	77	318	962	17.7	70	344	958	15.0	74	363	954	2.4	85					339	959	10.3	69
1,000	365	901	9.7	59	365	906	16.3	80	318	907	15.6	65	344	903	15.6	58	363	897	1.5	81	358	902	9.1	61	339	903	8.6	66
1,500	365	848	8.1	55	365	854	13.6	77	318	855	13.3	61	344	851	14.4	48	363	843	−0.1	78	357	848	6.8	57	339	850	6.5	64
2,000	365	798	5.7	53	365	804	12.0	63	318	805	11.2	55	344	802	12.3	42	363	792	−2.1	75	357	798	3.5	58	339	799	4.6	62
2,500	365	750	3.0	52	365	757	10.6	46	318	758	8.9	50	344	755	9.5	39	363	743	−4.2	71	354	750	0.2	59	338	751	2.2	60
3,000	365	705	0.2	51	365	713	8.4	37	318	714	6.5	46	344	710	6.5	36	363	697	−6.4	68	353	704	−3.0	59	336	706	−0.3	58
4,000	360	622	−5.8	50	363	631	2.9	28	316	631	0.7	42	333	628	0.0	34	358	613	−11.9	64	347	620	−9.0	56	335	622	−5.3	55
5,000	357	547	−12.2	49					252	556	−5.3	42					355	537	−17.8	61	319	544	−15.3	54	334	547	−10.9	52
6,000	353	479	−18.9	46													351	469	−24.2	59					331	480	−17.0	50
7,000	350	418	−26.0	44													349	408	−31.2	57					323	419	−23.5	49
8,000	349	363	−33.4														343	354	−38.1						303	365	−30.4	
9,000	348	314	−40.5														337	305	−44.6						290	316	−37.3	
10,000	343	271	−46.7														324	262	−49.6						277	273	−43.9	
11,000	339	233	−51.8														311	225	−53.1						257	235	−50.0	
12,000	332	199	−55.4														293	192	−55.1						239	201	−54.9	
13,000	322	170	−57.8														276	164	−56.0						218	172	−58.2	
14,000	309	145	−59.4														252	140	−56.6									
15,000	290	123	−61.0														225	120	−57.6									
16,000	265	105	−62.2														192	102	−58.4									
17,000	222	89	−62.3																									

Altitude (meters) mean sea level	Stations and elevations in meters above sea level: Coao Solo, C. Z.[1 2] (15 m.)				Seattle, Wash.[1 2] (10 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	296	1,011	25.6	88	244	1,018	11.8	74
500	296	957	23.3	88	244	960	9.2	73
1,000	295	904	20.7	86	244	904	7.6	66
1,500	291	853	18.3	82	219	850	5.6	61

Altitude (meters) mean sea level	Stations and elevations in meters above sea level: Coco Solo, C. Z.[1 2] (15 m.)				Seattle, Wash.[1 2] (10 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
2,000	284	804	16.1	75	211	800	3.1	56
2,500	276	758	14.4	62	196	751	0.7	52
3,000	272	715	12.3	54	190	706	−1.8	47
4,000	246	634	6.8	52	174	621	−7.7	45

[1] Navy.
[2] Yearly means based on 11 months. Month of December not included due to insufficient number of observations.

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

[Directions given in degrees from north (N=360°, E=90°, S=180°, W=270°)—velocities in meters per second]

Altitude (meters) m. s. l.	Abilene, Tex. (637 m.)		Albuquerque, N. Mex. (1,554 m.)		Atlanta, Ga. (302 m.)		Billings, Mont. (1,095 m.)		Boise, Idaho (850 m.)		New York, 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	189^{352}	1.9	250^{364}	1.5	269^{346}	1.6	281^{362}	2.0	296^{353}	2.0	247^{336}	2.2	125^{349}	3.8	254^{347}	3.2	246^{334}	1.0	190^{363}	1.2	275^{344}	2.7	246^{363}	1.5	248^{353}	1.7
500					270^{346}	2.0					267^{334}	4.3	138^{349}	4.9	252^{347}	4.8	245^{332}	2.8	209^{357}	2.8			245^{344}	3.0	294^{353}	3.6
1,000	189^{361}	2.7			263^{341}	2.6			298^{353}	2.2	279^{313}	6.4	150^{300}	3.2	252^{308}	7.2	263^{316}	4.9	239^{333}	3.7			254^{317}	4.9	247^{327}	4.6
1,500	203^{350}	2.9			267^{327}	3.5	274^{358}	3.5	298^{328}	1.9	285^{290}	8.1	183^{276}	1.9	260^{268}	7.6	270^{289}	6.4	284^{307}	5.3			268^{285}	6.4	259^{299}	5.9
2,000	227^{333}	3.6	294^{363}	2.3	273^{299}	4.9	279^{347}	4.9	291^{349}	2.5	288^{285}	9.4	219^{239}	1.7	270^{233}	8.4	281^{224}	7.6	274^{273}	6.5	276^{344}	3.2	275^{252}	7.7	271^{272}	7.4
2,500	244^{317}	4.4	283^{361}	2.9	278^{276}	6.2	279^{338}	6.3	279^{332}	3.7	289^{236}	11.1	236^{213}	2.2	277^{180}	8.1	286^{177}	8.5	272^{255}	7.7	284^{344}	4.5	282^{232}	8.8	280^{240}	8.1
3,000	252^{304}	5.4	271^{352}	3.9	282^{252}	7.1	277^{312}	7.9	273^{315}	4.6	288^{194}	11.9	251^{181}	2.5					271^{224}	7.7	285^{340}	5.8	288^{200}	9.6		
4,000	265^{279}	6.9	280^{326}	6.4	283^{218}	8.7	282^{262}	10.5	274^{255}	6.2									273^{170}	8.9	286^{314}	8.1				
5,000	272^{244}	8.7	283^{294}	8.7			286^{227}	12.3	265^{183}	7.8											283^{267}	10.0				
6,000	272^{207}	9.9	283^{265}	10.5			288^{202}	12.8													285^{210}	11.9				
8,000			276^{212}	11.7																						
10,000			279^{167}	15.2																						

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

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.)		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
	°		°		°		°		°		°		°		°		°		°		°		°	
Surface	242^{365}	1.5	290^{352}	1.2	243^{337}	1.5	267^{340}	2.5	32^{354}	2.0	285^{362}	1.3	156^{362}	8.1	310^{349}	1.5	107^{362}	2.7	260^{344}	1.6	245^{341}	1.3	103^{358}	0.1
500	----	----	282^{336}	1.7	243^{337}	2.6	----	----	17^{349}	2.9	290^{362}	1.6	----	----	314^{336}	1.8	111^{362}	3.0	256^{344}	2.2	236^{341}	2.2	185^{356}	1.5
1,000	----	----	276^{315}	3.2	250^{332}	4.2	261^{340}	4.7	186^{330}	1.8	283^{350}	2.5	144^{362}	7.0	296^{328}	1.2	59^{349}	1.6	259^{323}	3.5	240^{330}	3.1	224^{336}	1.3
1,500	245^{365}	1.8	284^{305}	4.9	264^{328}	5.3	268^{340}	6.8	248^{310}	1.6	282^{325}	4.2	204^{362}	8.8	246^{326}	1.5	191^{325}	5.5	260^{310}	5.1	255^{321}	4.2	271^{307}	1.8
2,000	247^{365}	2.2	288^{282}	6.5	273^{314}	7.2	275^{328}	8.0	274^{288}	2.4	283^{314}	6.0	239^{362}	1.8	259^{318}	2.0	213^{305}	1.1	276^{279}	7.1	268^{299}	5.6	288^{276}	3.0
2,500	257^{357}	2.7	285^{259}	8.1	279^{282}	8.8	277^{308}	9.2	268^{261}	3.2	285^{303}	7.6	256^{357}	2.5	240^{297}	3.1	251^{273}	1.7	284^{246}	8.4	274^{282}	6.5	289^{259}	3.6
3,000	262^{348}	3.6	287^{237}	9.7	280^{270}	10.3	276^{262}	9.3	273^{235}	3.8	287^{293}	9.1	261^{352}	3.0	249^{275}	3.6	250^{250}	2.1	289^{216}	8.6	283^{246}	7.5	294^{236}	4.4
4,000	266^{313}	5.6	288^{211}	12.3	281^{203}	12.7	281^{185}	10.0	279^{204}	5.4	288^{261}	11.3	265^{339}	4.7	254^{237}	5.0	238^{228}	2.8	290^{168}	11.4	290^{197}	9.4	291^{190}	5.0
5,000	266^{271}	7.4	----	----	287^{160}	14.6	283^{137}	11.5	280^{165}	5.9	292^{256}	13.5	270^{315}	5.7	260^{224}	6.5	244^{105}	3.4	----	----	----	----	----	----
6,000	270^{238}	8.9	----	----	----	----	----	----	----	----	294^{206}	14.7	277^{302}	6.9	----	----	----	----	----	----	----	----	----	----
8,000	----	----	----	----	----	----	----	----	----	----	292^{174}	16.3	285^{254}	8.9	----	----	----	----	----	----	----	----	----	----
10,000	----	----	----	----	----	----	----	----	----	----	----	----	283^{210}	11.5	----	----	----	----	----	----	----	----	----	----
12,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

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	266^{353}	4.0	349^{352}	1.9	249^{354}	1.0	251^{365}	0.9	228^{346}	1.4	294^{359}	1.3	278^{348}	3.6	80^{366}	6.0	283^{319}	2.1	243^{330}	1.9	221^{332}	2.1	263^{350}	1.1	252^{363}	2.5
500	292^{351}	2.5	191^{348}	2.2	251^{354}	1.4	----	----	236^{346}	2.5	----	----	286^{348}	2.3	87^{365}	7.8	286^{319}	3.1	217^{330}	2.5	----	----	282^{350}	3.1	----	----
1,000	302^{339}	1.7	207^{347}	2.8	254^{343}	2.4	----	----	243^{333}	3.9	----	----	305^{324}	0.7	105^{357}	6.6	274^{288}	4.0	214^{289}	3.4	219^{352}	3.2	263^{325}	5.1	----	----
1,500	294^{322}	1.7	227^{339}	3.7	264^{332}	4.2	252^{363}	.8	261^{298}	5.3	258^{330}	1.2	356^{307}	0.7	107^{328}	5.6	282^{247}	5.2	214^{279}	3.7	227^{326}	4.3	277^{311}	7.5	----	----
2,000	294^{310}	1.4	293^{322}	4.7	265^{309}	6.0	230^{365}	1.4	271^{286}	6.9	243^{325}	1.6	330^{292}	0.7	103^{294}	4.9	286^{222}	6.8	225^{216}	3.8	237^{297}	5.3	283^{287}	9.5	247^{361}	2.2
2,500	283^{303}	1.7	255^{311}	5.6	281^{293}	7.8	241^{359}	2.3	281^{258}	8.2	245^{325}	2.4	298^{283}	1.1	97^{320}	4.7	294^{197}	8.1	235^{196}	4.2	245^{265}	5.8	284^{269}	10.9	252^{361}	2.8
3,000	294^{292}	2.3	263^{295}	6.7	281^{278}	9.2	255^{344}	3.3	286^{218}	9.3	254^{325}	3.3	284^{269}	2.0	94^{321}	4.4	295^{165}	9.8	238^{170}	5.0	253^{256}	6.4	284^{234}	11.5	250^{358}	3.1
4,000	290^{275}	3.2	273^{271}	8.2	287^{248}	11.7	267^{306}	4.5	----	----	269^{289}	5.1	268^{246}	3.2	89^{151}	3.4	----	----	----	----	264^{194}	8.5	286^{150}	12.4	265^{330}	4.6
5,000	274^{238}	1.1	281^{248}	9.6	289^{235}	13.3	276^{255}	5.9	----	----	277^{228}	6.6	265^{210}	5.2	----	----	----	----	----	----	270^{154}	9.8	----	----	273^{301}	5.9
6,000	----	----	284^{219}	11.0	292^{215}	14.9	283^{201}	6.8	----	----	----	----	267^{168}	6.6	----	----	----	----	----	----	----	----	----	----	279^{277}	7.5
8,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	279^{244}	10.4
10,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	278^{201}	13.6
12,000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	273^{183}	16.1

TABLE 3.—*Maximum free air wind velocities (m. p. s.), for different sections of the United States based on pilot-balloon observations during the year of 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	Month	Station	Maximum velocity	Direction	Altitude (m.) (m. s. l.)	Date	Month	Station	Maximum velocity	Direction	Altitude (m.) (m. s. l.)	Date	Month	Station
Northeast [1]	51.6	WNW	2,360	31	Dec.	Harrisburg, Pa.	62.8	NW	4,240	24	Oct.	Hartford, Conn.	61.0	W	9,880	13	Feb.	Cleveland, Ohio.
East-Central [2]	56.6	W	2,480	31	Dec.	Richmond, Va.	63.4	W	4,320	26	Jan.	Greensboro, N. C.	76.0	WNW	9,400	5	Dec.	Greensboro, N. C.
Southeast [3]	42.0	SW	2,440	30	Jan.	Jacksonville, Fla.	50.0	W	4,300	22	Feb.	Spartanburg, S. C.	73.0	N	20,620	8	June	Miami, Fla.
North-Central [4]	43.6	W	1,970	25	Apr.	Minneapolis, Minn.	54.4	NW	4,260	7	Dec.	Milwaukee, Wis.	75.0	NW	10,080	13	Dec.	Huron, S. Dak.
Central [5]	50.2	SW	2,320	9	Jan.	Wichita, Kans.	54.0	WSW	4,680	1	Feb.	Omaha, Nebr.	87.5	WSW	11,960	22	do.	Omaha, Nebr.
South-Central [6]	41.0	SSW	1,390	16	Feb.	Oklahoma City, Okla.	53.2	NNW	3,280	2	do.	Del Rio, Tex.	75.2	WNW	12,750	5	Nov.	Abilene, Tex.
Northwest [7]	47.7	WNW	1,700	19	May	Billings, Mont.	53.5	SW	4,500	1	Jan.	Medford, Oreg.	72.0	NNW	6,580	14	Jan.	Billings, Mont.
West-Central [8]	45.3	SSW	2,500	15	June	Modena, Utah	67.4	SW	3,960	3	June	Reno, Nev.	86.0	ENE	17,760	17	Feb.	Denver, Colo.
Southwest [9]	51.4	N	2,500	5	Apr.	Sandberg, Calif.	59.1	NNW	2,750	26	Feb.	Sandberg, Calif.	95.5	NNW	8,440	14	Jan.	Albuquerque, N. Mex.

[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.—*Monthly mean heights of freezing temperatures (0° C.) during year 1939*

Stations	Elevation in meters (m. s. l.)	January		February		March		April		May		June		July		August		September		October		November		December	
		Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)	Number of observations	Altitude in meters (m. s. l.)
Albuquerque, N. Mex	1,620															31	4,780	30	4,610	27	3,790	29	3,160	31	3,130
Atlanta, Ga	300													26	4,740	31	4,340	28	4,480	29	4,130	30	2,670	31	2,810
Bermuda (St. Georges)	50							24	3,470	26	3,990	29	4,470												
Billings, Mont	1,089	30	(1)	26	(1)	31	1,760	30	2,530	31	3,330	30	3,280	31	4,500	31	4,290	30	3,780	30	2,920	30	2,900	31	2,230
Bismarck, N. Dak	505													23	4,470	30	4,210	30	3,710	30	2,500	30	2,460	31	(1)
Boise, Idaho	824																	29	3,860	30	3,000	30	2,750	30	2,160
Boston, Mass	26							27	1,620	30	2,730														
Buffalo, N. Y	220																	28	3,710	30	2,350	29	590	31	(1)
Charleston, S. C	14													17	4,710	30	4,830	29	4,470	28	4,360	29	3,090	30	3,070
Cheyenne, Wyo	1,873	31	(1)	28	(1)	30	2,410	28	2,900	30	3,780	30	4,160	15	4,870										
Chicago, Ill	187	29	(1)	28	(1)	30	710	30	1,750	31	3,350	30	4,210												
Denver, Colo	1,616													18	4,980	31	4,660	29	4,460	29	3,620	30	3,170	30	2,970
El Paso, Tex	1,193	31	2,820	28	2,330	31	3,480	30	3,840	27	4,210	29	4,680	30	4,870	31	4,800	30	4,690	31	4,080	30	3,310	31	3,460
Ely, Nev	1,908															31	4,680	28	4,130	29	3,380	30	3,200	31	2,650
Fairbanks, Alaska	152																	19	1,260	30	(1)	29	(1)	30	(1)
Fargo, N. Dak	274	31	(1)	28	(1)	31	(1)	30	1,240	31	3,340	27	3,590												
Halifax, Nova Scotia	5									18	1,260	20	3,320												
Joliet, Ill	178													30	4,780	29	4,320	28	4,210	29	2,960	29	1,570	31	(1)
Juneau, Alaska	49																			30	870	30	760	29	770
Lakehurst, N. J	39	22	(1)	23	780	25	650	22	1,620	28	3,200	9	4,510	6	4,320	9	4,780	7	4,460	31	3,170	27	1,360	29	(1)
Medford, Oreg	401																	30	3,770	31	3,430	29	3,090	30	2,470
Miami, Fla	4													20	4,950	31	5,140	29	4,700	29	4,790	29	4,330	31	4,070
Minneapolis, Minn	263																	30	3,710	31	2,460	30	1,630	31	(1)
Nashville, Tenn	180	31	1,960	28	2,180	30	2,720	28	2,780	31	3,740	29	4,640	30	4,700	31	4,580	30	4,510	30	3,650	29	2,300	31	2,120
Norfolk, Va	10	19	2,060	15	1,600	22	2,030	18	2,620	25	3,670	13	4,670	16	4,500	23	4,390	23	4,140	23	3,640	25	2,550	24	1,770
Oakland, Calif	2	31	2,590	28	1,950	31	2,560	30	3,380	31	3,480	30	4,270	31	4,780	31	4,810	30	4,130	30	3,760	29	3,430	31	3,130
Oklahoma City, Okla	391	30	2,260	28	1,860	31	2,920	28	3,280	31	3,930	29	4,480	31	4,820	30	4,730	29	4,660	29	3,820	30	2,870	31	2,910
Omaha, Nebr	301	31	(1)	28	(1)	31	1,840	30	2,280	31	3,670	28	4,310	30	4,650	31	4,410	30	4,420	31	3,290	30	2,230	31	1,880
Pearl Harbor, T. H	6	8	5,000	5	4,850																				
Pensacola, Fla	13	25	3,440	16	3,480	21	3,580	29	3,770	20	4,150	24	5,030	22	5,120	20	4,730	20	4,580	29	4,410	27	3,590	30	3,520
Phoenix, Ariz	339															30	4,830	29	4,710	31	4,030	29	3,530	30	3,610
St. Louis, Mo	171																	30	4,340	30	3,350	30	2,100	31	1,720
Salt Lake City, Utah	1,288	31	(1)	28	(1)	31	2,410	30	3,100	31	3,690	30	4,030	21	4,740										
San Antonio, Tex	174													24	5,140	29	4,950	28	4,860	31	4,620	29	3,720	31	3,710
San Diego, Calif	10	29	2,880	26	2,420	27	3,080	27	3,790	25	4,040	27	4,760	28	4,890	29	4,850	15	4,670	8	4,210	24	3,580	27	3,710
San Juan, P. R	18															31	4,760	28	4,780	29	4,770				
Seattle, Wash	10	12	1,160	18	670	19	1,630	19	2,180	22	2,710	17	2,680	21	3,550			17	3,960	10	3,340	15	2,780		
Shreveport, La	51									18	4,080											18	3,550	20	2,940
Sault St. Marie, Mich	221	31	(1)	28	(1)	31	(1)	30	(1)	31	2,690	29	3,610	30	3,700	30	3,650	28	3,250	31	1,600	30	(1)	31	(1)
Swan Island, West Indies	10															31	4,450	27	4,370	31	4,580				
Spokane, Wash	598	30	920	25	(1)	30	1,680	30	2,390	31	2,810	29	2,800	30	3,940	31	4,210	29	3,370	31	2,450	30	2,540	30	1,520
Washington, D. C	7	29	800	25	1,500	31	1,670	30	2,160	29	3,150	27	4,360	26	4,250	30	4,400	25	4,300	29	3,570	27	2,000	27	1,050
At sea: (Lat. 40°–44° N., Long. 47°–53° W.)	5									30	2,900	25	3,700												

[1] Surface.

RIVERS AND FLOODS

[River and Flood Division, MERRILL BERNARD in charge]

By BENNETT SWENSON

The report for December 1939 will appear in the next issue of this REVIEW.

WEATHER ON THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. E. HURD acting in charge]

NORTH ATLANTIC OCEAN, DECEMBER 1939

By H. C. HUNTER

Atmospheric pressure.—The pressure was below normal over most parts of the North Atlantic Ocean. The deficiency was notably large over the waters adjacent to the Canadian Maritime Provinces and to the northeastern United States.

The stations in middle and lower latitudes generally reported pressures averaging lower during the final third of the month than during the preceding portion.

The extremes of pressure found in available vessel reports are 1,038.9 and 955.9 millibars (30.68 and 28.23 inches). The high mark was recorded during the forenoon of the 13th, near latitude 40° N., 35° W., on the American steamship *Yaka*. The low reading was noted in about the same part of the ocean, namely 48° N., 33° W., about midnight of the 29th–30th, on the Dutch liner *Noordam*.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, December 1939*

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Julianehaab, Greenland [1]	999.4	+1.1	1,019	18	985	6, 7
Lisbon, Portugal [2]	1,019.7	+.1	1,032	1	1,003	24
Horta, Azores	1,017.7	−3.0	1,033	14	991	29, 30
Belle Isle, Newfoundland [3]	1,000.5	−6.6	1,028	12	959	9
Halifax, Nova Scotia	1,006.1	−8.1	1,026	16	981	8
Nantucket	1,009.1	−8.5	1,029	15	990	8
Hatteras	1,015.2	−5.1	1,032	15	1,000	27
Turks Island	1,016.7	−0.2	1,020	26	1,011	24
Key West	1,017.6	−1.0	1,024	7	1,009	26
New Orleans	1,018.6	−1.7	1,029	14	998	26

[1] For 24 days. [2] For 27 days. [3] For 26 days.

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.