SHORTER CONTRIBUTIONS

A New Approach to Weather Broadcasting

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THE Weather Bureau has long been faced with the problem of delivering more and more weather information to the public. Radio and television offer the most rapid means of mass dissemination. The preparation and presentation of extensive information, based primarily on tabular data, pose a difficult problem. Many suggestions have been made and numerous solutions have been tried. To get to the general public all of the weather information that any individual may want without burdening others of the listening audience, has been the main stumbling block in the path of development. The reading of lists of data or the reporting of synoptic situations in strictly meteorological terms will not accomplish the task.

On Weather Bureau broadcasts over the country, the general practice is to endeavor to provide a listenable program by presenting the synoptic picture, a general summary, and the forecasts, in a narrative fashion. Unless the meteorologist is interested in broadcasting and is enthusiastic in his presentation, the best copy will be most uninteresting and hardly listenable even if the listener himself is vitally and intensely interested in weather.

A new approach has been tried in the past few months in the Broadcast Television Unit of the Weather Bureau in Washington. This new technique brings to the listener a complete resume of the weather over a wide area of the country in terms that are commonplace. To be sure, fronts are mentioned, but only as, "the leading edge of the cold air," or "where the winds shift from southwest to northwest," etc. The picture is usually presented in such terms as: "It's been cloudy today over most of the eastern United States, with the clouds quite low from Hatteras to Cape Cod"; or, "Rain has fallen throughout the Ohio Valley from Pittsburgh to Evansville, Indiana." Similarly, the winds and the general situation are described in sufficient detail to convey the picture to either the experienced meteorologist or the layman.

In addition to the very plain language used, there is much emphasis placed upon the current and last minute reports. Thus, teletype reports are spotted as fast as they come in—right up to air time. Full use is also made of radar and pilot reports to convey to the listener the movement and change in the weather.

One of the advantages of the technique now being developed is that the program is presented on a network basis and does not itself include any forecasts. The Broadcast Television Unit utilizes the extensive material from all of the units of the central office of the Weather Bureau. These reports and data are then correlated with the regional, state, and airways forecasts, before being broadcast, so that when the program ends with "and now for the forecast for your own vicinity—here is your local announcer," the forecast that follows sounds like a continuation of the general weather picture brought down to the local area of the listener.

In practice, the average radio listener may use the service for months before he realizes that the voice which he hears over his local radio station is really coming from Washington while the forecast that covers his own vicinity may have been prepared in Boston or some other forecast center. This is accomplished by introducing the program: "This is the United States Weather Bureau." The absence of personalities in the presentation is offset to a very great extent by a very informal and pleasant delivery, with trained voice and a newsy air.

The program has an additional and interesting feature in that it has utilized, basically, FM radio which has the advantage of being heard with clear reception—even in times of severe static.

This new program originates at 6 p.m., E.D.T., daily, from the Weather Bureau's own studio in Washington and is fed to the Continental FM Network through the facilities of station WASH (FM) of Washington. The following stations have carried the service: Baltimore, Md., WMAR; Martinsburg, W. Va., WEPM; Sunbury, Pa., WKOK; Scranton, Pa., WQAN; Springfield, Mass., WACE; Cambridge, Mass., WXHR; and the high powered Armstrong stations, W2XMN and W2XEA in New York.

Atmospheric Contamination Over Boston, Massachusetts

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OBSERVING SITES

ON January 1, 1944, radiation equipment was installed on the 19th floor and on the roof of the Post Office Building in Boston [1] to measure the total solar and sky radiation received on a horizontal surface and also direct solar radiation on a surface normal to the solar rays., Similar measurements had been made by the Harvard Blue Hill Observatory in cooperation with the Weather Bureau for a number of years prior to the Boston installation.[2]

The Post Office Building is in the business section of Boston about one-third of a mile west of the harbor. The atmosphere at the observing site is comparatively free of man-made vitiation when there is an easterly component of wind. The two largest railway yards, about one-half mile south and northwest, create the usual smoke-contamination customarily produced when electric locomotives are not substituted for locomotives burning soft-coal. Winds from all directions except east bring smoke-laden air over the business area.

Blue Hill Observatory is at an elevation of 640 feet on top of the highest point of the Blue Hills Reservation and ten miles south-southwest of the Boston Post Office.[2] With the exception of slight atmospheric contamination produced in railway yards two miles to the northwest the atmosphere is comparatively clear except with winds having a northerly component, at which time smoke is brought over the Observatory from Boston.

INSTRUMENTAL EQUIPMENT

Eppley thermoelectric pyrheliometers are used for measuring total solar and sky radiation received on a horizontal surface at Blue Hill [2] and Boston.[1] Leeds and Northrup micromax potentiometers serve as recorders. Two Eppley thermoelectric normal-incidence pyrheliometers recording on micromax potentiometers [3] furnish the graphical record of normal-incidence radiation at Blue Hill. An eye-read Clark pyrheliometer [4] is used in Boston for measuring normal-incidence radiation. A Smithsonian silver-disk pyrheliometer is employed as the check instrument for all the other pyrheliometers.[5]

DEPLETION OF SOLAR RADIATION

TABLE 1 gives the seasonal variation of the ratios as percentages of total solar and sky radiation received on a horizontal surface at Boston to that received at Blue Hill during the colder half of the year. The maximum ratio occurred on February 14, 1946, owing to rain at Blue Hill while Boston received no precipitation until 4:20 p.m. Visibility at Boston was above average on this day while that at Blue Hill was low. The minimum ratio on December 6, 1946, was owing partially to smoke over Boston while Blue Hill was smoke-free. In general the ratios are highest during March.

TABLE 1. TOTAL SOLAR AND SKY RADIATION RECEIVED ON A HORIZONTAL SURFACE AT BOSTON AS A PERCENTAGE OF THAT RECEIVED AT BLUE HILL. Based on means for four-year period, 1944–1948.

Week beginning	%	Week beginning	%	Week beginning	%
October 1	84	December 3	74	January 29	82
8	81	10	81	February 5	80
15	81	17	79	12	84
22	77	24	83	19	83
29	80	January 1	83	26	88
November 5	80	8	81	March 5	95
12	82	15	77	12	93
19	74	22	81	19	90
26	73			26	90

Maximum of 173.6% on February 14, 1946.
Minimum of 6.0% on December 6, 1946.
Mean of all during the period, 82%.

The first part of TABLE 2 shows the diurnal and seasonal variation of the ratio of sky radiation received on a horizontal surface at Boston to similar values at Blue Hill, all cases for the colder half of the year being considered. The second part of the table gives comparative data for cloudless days only. The lowest ratios occur with low sun when the rays pass through a thicker air mass. Without question, the ratios would be still lower if the pyrheliometer were located at ground-level instead of on the roof of the 23-story Post Office Building.

[1] *Mo. Wea. Rev.*, p. 43, Jan. 1944.
[2] *Mo. Wea. Rev.*, pp. 230–231, Aug. 1933.
[3] *Mo. Wea. Rev.*, pp. 419–420, Dec. 1937. *Pyrheliometers and Pyrheliometric Measurements*, U. S. Department of Commerce, Weather Bureau, Washington, D. C., 1946.
[4] *Mo. Wea. Rev.*, pp. 339–344, Dec. 1940.
[5] *The Silver-Disk Pyrheliometer*, C. G. Abbot, Smithsonian Pub. No. 2008, Washington, D. C., 1911.

TABLE 2. RELATIONSHIP BETWEEN TOTAL SOLAR AND SKY RADIATION RECEIVED ON A HORIZONTAL SURFACE AT BOSTON AND BLUE HILL, MASS.; BOSTON/BLUE HILL. (Figures are percentages.)

	A.M.				(Solar Time)		P.M.			
Hour Ending	8	9	10	11	12	1	2	3	4	5
All Cases										
October (1944–47)	66	79	80	79	83	84	84	82	80	70
November (1944–47)	39	64	74	79	83	83	81	83	66	52
December (1944–47)	26	60	73	76	79	82	80	80	75	65
January (1945–48)	36	65	72	80	82	85	86	84	78	67
February (1945–48)	62	79	82	84	85	86	77	83	80	70
March (1945–48)	79	84	88	87	91	93	92	91	91	96
Means	52	72	78	81	84	86	84	84	78	70
Cloudless Days Only										
October (1944–46)		74	78	81	83	83	85	82	78	
November (1944–46)		82	83	85	86	85	85	78	68	
December (1944–46)		74	82	83	82	81	79	77	67	
January (1945–47)		70	81	84	84	87	87	88	89	
February (1945–47)		84	85	84	84	85	85	85	81	
March (1945–47)		83	86	88	90	89	90	92	91	
Means		78	82	84	85	85	85	84	79	

TABLE 3 gives the ratios between normal-incidence values at the two stations through air masses 2.0, 3.0, 4.0 and 5.0, both morning and afternoon. As might be expected, the lowest ratios occur in the early morning before convection has started, with a secondary minimum in late afternoon. (See FIGURE 1.) At these times the solar rays are closer to horizontal and pass through a much thicker layer of atmosphere than when the sun is high in the heavens. The lowest ratio occurred at 9:00 a.m. on January 18, 1944, when the depletion of solar radiation in Boston was more than 90 percent, owing almost exclusively to a dense smoke-pall.

TABLE 3. PERCENTAGES OF NORMAL-INCIDENCE RADIATION AT BOSTON AND AT BLUE HILL. Based on means for four-year period, 1944–1948. Ratios Boston/Blue Hill.

	Air Mass							
	A.M.				P.M.			
	5.0	4.0	3.0	2.0	2.0	3.0	4.0	5.0
October	80	80	86	92	98	88	86	76
November	70	63	79	81	88	85	87	83
December	82	85	87	—	—	87	84	80
January	85	84	84	84	—	92	86	85
February	70	73	77	90	90	89	82	70
March	62	70	75	87	88	86	92	—
Means	75	76	81	87	91	88	86	79

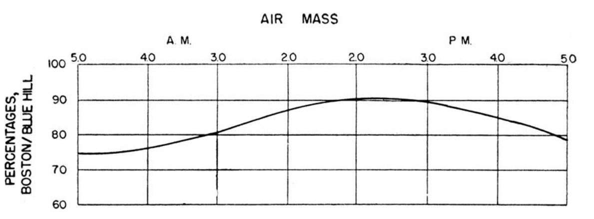

FIG. 1.

The upper two traces on FIGURE 2 represent maximum values of total solar and sky radiation received on a horizontal surface at Blue Hill and Boston. The two lower traces represent four-year means of all values of total solar and sky radiation received on a horizontal surface at the two stations. These mean values were smoothed by the formula $(A + 2B + C)/4$ where A, B and C represent values of the previous, current and following mean weekly radiation. Statistical experience shows that with data from additional observations, these curves will have less irregularity. Planimeter readings of the winter portions of the curves indicate that the total radiation at Boston during the period was 17 percent less than that received at Blue Hill.

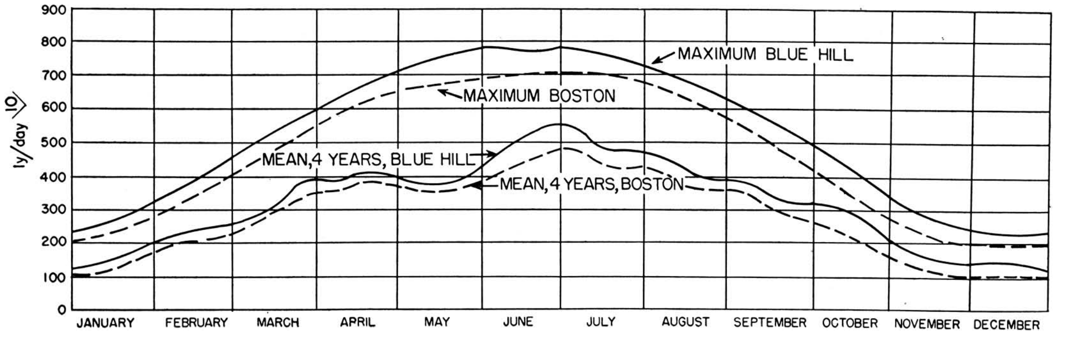

FIG. 2. ([10] ly, or "langley" = 1 gm cal/sq. cm = 3.69 btu/sq. ft. See *Bull. Amer. Met. Soc.*, Nov. 1947, p. 443.)

EFFECT ON HEALTH

In addition to the obvious disadvantages of a smoky atmosphere such as decreased visibility and increased laundry bills, a still greater peril exists through the loss of the ultraviolet, or so-called health-giving radiation.[6, 7, 8, 9] Even a diminution of five percent in the total solar radiation resulting from smoke almost completely robs the radiation of its true-ultraviolet component.[6, 7, 8, 9]

DISCUSSION

Although it is obvious that the smokier Boston is, the less insolation it will get relative to that at Blue Hill, except, as Mr. Hand shows, when the cloudiness is different, it seems worth while to amplify the general statement of meteorological factors given in this paper. The weather affects the amount of smoke produced, and its varying concentration over Boston with the changing horizontal and vertical rates of dispersal.

There is more smoke from house and other building heating units in cold weather than in mild, and on cloudy days than clear at the same temperature, owing to reduced solar heating. Stronger winds also make more heating necessary, but more than compensate for the extra smoke by blowing it away faster.

When the wind is light, Boston not only suffers from slow removal of smoke down wind, but also even has the smoke concentrated over the city by locally converging winds. The city being warmer and at a lower elevation than the surrounding country, the colder air from the surrounding territory tends to converge on the city. In late winter and spring, the cold sea to the east contributes to this convergence also. Even though a sea breeze may not develop, the usual general pressure gradient favoring off-shore winds is weakened at the coast. If the general wind is northerly there will also be convergence along the coast owing to the greater (Coriolis) deflection of the wind over the sea.

The normal occurrence of inversions of temperature at low levels in the cold season, and their intensification in the clearest, calmest, driest weather, which, being coldest, favors greatest smoke production, results in a greatly restricted vertical dispersal of the smoke. Indeed, since the tops of these smoke-holding inversions are below the level of Blue Hill, but seldom below that of the top of the Post Office, it follows that for the first few hours of the morning, until convection has raised the top of the inversion well above Blue Hill, the Hill will enjoy bright sunshine while Boston stays dim. One might say that comparing Boston at low elevation with Blue Hill at high, gives Boston an unfair percentage of dimness. It is true, but only in small degree, for in clean air the insolation on the Post Office Bldg. should be only 1% less than on Blue Hill owing to the difference in airmass traversed. Also negligible is Blue Hill's lower latitude, by only 10 minutes of arc.—*C. F. Brooks.*

[6] *Jour. Nat. Bur. Standards,* Vol. 16, p. 315, 1936. (R.P. 871.)

[7] Shaw and Owens, *The Smoke Problem of Great Cities,* p. 72, London, 1925.

[8] *Trans. Amer. Geoph. Union,* Vol. 38, Apr. 1938, pp. 134–140.

[9] *Mo. Wea. Rev.,* Vol. 60, Dec. 1932, pp. 256.

Third Partial Report on Artificial Production of Precipitation—Orographic Stratiform Clouds—California, 1949

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DURING 1948, the Cloud Physics Project conducted 40 cloud seeding experiments in stratiform clouds in the vicinity of Wilmington, Ohio. The results of these Ohio experiments have already been reported [1, 2]. In order to secure a large and representative sample, these tests were all conducted in one particular locale. The findings were not necessarily of universal application, and areas might be found that have more favorable cloud conditions. Therefore, it was decided to conduct a number of tests where it was believed that thick supercooled stratiform clouds would be formed systematically by the lifting of moist maritime air over a high mountain barrier. The particular area chosen for the tests reported here was in the vicinity of the Donner Pass of the Sierra Nevada Range, northeast of Sacramento, California. Seeding experiments were conducted there during the months of February, March and April, 1949.

Experience gained in the Ohio tests indicated that at least two aircraft were necessary for the proper observation of results. Therefore, in the California tests, a B-17 seeding aircraft was used to fly above the seeded cloud and, whenever possible, a C-47 was used for observations from beneath the cloud deck. Because radar information had proved invaluable in properly evaluating the Ohio data, a high-powered 10-cm search radar which was installed in a bomber aircraft was also used to monitor these tests. The general plan of attack was much the same as that previously described [1, 2].

It was hoped during the period of these tests that it would be possible to seed a number of supercooled, orographically-initiated stratiform clouds. However, this type of cloud seldom occurred. It is noted that of the 9 days on which seeding operations were conducted, 6 had frontal clouds which contained some natural ice crystals

TABLE 1

Date	Sdg. run	Frontal or non-frontal	Convergence, divergence, neutral	Height and temperature of top	Height and temperature of base	Rate of sdg. lbs. per mile	Were clds. supercooled?	Results	Comments
Feb. 15	1	F	D	10,650; − 7.0°	9,800; − 6.0°	3	Yes	Boundary area opened	Natural holes near by
Feb. 22	1	F	C	13,000; − 8.0°	9,000; − 1.0°	3	Yes	Possibly slight building	Chaotic sky interferred with observations
Feb. 24	1	F	C	10,000; − 7.0°	8,500; − 5.0°	3	Yes?	None	Chaotic sky interferred with observations.
	2	F	C	10,000; − 7.0°	8,500; − 5.0°	3	Yes?	None	Chaotic sky interferred with observations
Mar. 1	1	F	D	13,100; −11.0°	12,600; −12.0°	3	Yes	Boundary area opened	Natural hole nearby
			Single-pellet drop also with no results observed.						
Mar. 2	1	F	D	18,500; −27.0°	10,600; −10.0°	3	Yes (Also ice crystals)	Change in texture	Also built up about 500 feet
			Single-pellet drop also with no results observed.						
Mar. 9	1	F	C	12,200; −10.0°	2,250; + 8.0°	3	Yes (Also ice crystals)	Narrow seeding line observed for short period only	
Mar. 23	1	NF	N	9,600; −11.0°	4,000; − 2.0°	3	Yes	None	
			Single-pellet drop also with no results observed.						
	2	NF	N	8,450; − 8.0°	4,000; − 2.0°	2	Yes	Hole opened	Natural dissipation adjacent
	3	NF	N	7,800; − 5.0°	4,000; − 2.0°	1	Yes	None	
Mar. 24	1	NF	D	12,800; −15.0°	12,300; −14.0°	3	Yes	Boundary area opened	Natural hole along seeded path
			Single-pellet drop also with no results observed; possibly dropped in natural hole.						
	2	NF	D	13,300; −15.0°	12,300; −14.0°	3	Yes	Boundary area opened	Natural holes near by
			Single-pellet drop also with no results observed.						
	3	NF	D	15,900; −21.0°	12,300; −14.0°	10# drop	Yes	Boundary area opened	Natural holes near by
Apr. 7	1	NF	N	14,000; −10.0°	13,500; − 8.0°	3	Yes	Boundary area opened	Natural dissipation nearby
	2	NF	N	14,000; −10.0°	13,700; − 8.0°	Number of single pellets	No?	None	

necessary for the formation of precipitation even before seeding. Only on 3 days during the period of these tests did the desired type of orographic cloud exist. This would seem to indicate that even as favorable an area as the one selected has suitable cloud conditions for seeding only on relatively few occasions. This statement is further borne out by the fact that in addition to the seeding flights, 10 reconnaissance flights made in the area during the same period indicated that natural clouds with ice crystals existed to over 25,000 feet as a result of frontal activity.

TABLE 1 briefly summarizes the data and results obtained. Complete descriptions of each of the seedings will be included in an official Weather Bureau Research Paper. Of the 15 seedings, 7 resulted in the partial dissipation of the seeded deck. Holes as a result of seeding occurred in the boundary area between the ice and water droplet regions. However, in each of these cases there was positive and definite natural dissipation occurring simultaneously in the immediate vicinity. The TABLE also indicates the correlation between the divergence field as calculated by Bellamy's method [3], and the opening of holes in the cloud deck by cloud seeding. This TABLE quite clearly shows that seeding was capable of dissipating sections of cloud only when natural conditions were favorable; i.e., horizontal divergence existed. As a matter of fact, it was particularly difficult on the non-frontal days to find widespread areas of orographic decks without large natural breaks. Of the 7 cases in which no dissipation results were observed, 5 were associated with frontal systems and it is possible that the chaotic condition of the sky and the preexistence of ice crystals accounted for the absence of positive observations. In addition to the continuous seedings, 4 single-pellet seeding drops were made under favorable conditions. No results of large enough scale to be observed were indicated from any of these.

Precipitation amounts are not included in TABLE 1 since if any fell as a result of seeding, it was not detected. The orographic clouds seeded were thin and often broken in nature. Seeding could only have caused traces of precipitation from them.

REFERENCES

[1] (a) R. D. Coons, R. C. Gentry, and Ross Gunn. *Bull. Amer. Met. Soc.*, Vol. 29, No. 5, May, 1948, pp. 266–269.
(b) *U. S. Weather Bureau Research Paper* No. 30, August, 1948.

[2] (a) R. D. Coons, E. L. Jones, and Ross Gunn. *Bull. Amer. Met. Soc.*, Vol. 29, No. 10, December, 1948, pp. 544–546.
(b) *U. S. Weather Bureau Research Paper* No. 31.

[3] J. C. Bellamy. *Bull. Amer. Met. Soc.*, Vol. 30, No. 2, February, 1949, pp. 45–49.

Verification of Temperature Predictions Based on an Alleged Periodicity in Solar Radiation

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IN *Smithsonian Miscellaneous Collections,* Vol. III, No. 6, the temperature predictions made by C. G. Abbot for Washington, D. C., for 1948 are verified, and the predictions for 1949 are announced. The verification data as published are very interesting, but not more so than some comparisons which are summarized in TABLE 1. These data show, for example, that the approximate dates for Washington *minimum* temperature specified by Dr. Abbot for 1948 and the first five months of 1949 actually averaged *warmer* than the remaining days of the period. They also indicate that cooler temperatures have intervened between the specified pairs of dates as frequently as days with warmer temperature.

Dr. Abbot's predictions are based on a cycle of 6.6456 days which he has observed in ΔT, the departure from normal of the daily mean temperature. A great deal of study has been directed to the complex problem of assessing the reality of cycles in time series data. One method of investigating the existence of a proposed cycle is the correlogram technique. Correlation coefficients are computed for successive lags well beyond the period of the proposed cycle. If the cycle exists, the correlation coefficient at the lag equal to the period of the cycle will be positive and large with respect to the antecedent and the subsequent correlations. Kendall [1, 2] has stressed that for most time series an auto-regressive or auto-

TABLE 1. TEMPERATURE DEPARTURE FROM NORMAL (ΔT)

	Jan.–Dec., 1948			Jan.–May, 1949		
	No. of Cases	Forecast	Observed	No. of Cases	Forecast	Observed
(a) Average ΔT for Abbot's dates	55		2.20	23		6.4
(b) Average ΔT for all other dates	311		2.13	128		5.5
(c) Average highest ΔT between Abbot's dates	54		9.16	22		13.9
(d) Average lowest ΔT between Abbot's dates	54		−4.33	22		−1.9
(e) (c)–(a)		7.1	6.96		6.9	7.5
(f) (d)–(a)			−6.53			−8.3
(g) Number of cases when highest ΔT between pairs of dates is greater than mean ΔT of pair			48			18
(h) Number of cases when lowest ΔT between pairs of dates is lower than mean ΔT of pair			45			20

TABLE 2. CORRELATION COEFFICIENTS, LAGS 0–10

Lag / City	0	1	2	3	4	5	6	7	8	9	10
Washington (1948)	1.00	.66	.34	.20	.20	.19	.17	.15	.12	.13	.15
New York (average within correlation 1937–41)	1.00	.68	.30	.01	−.07	−.14	−.13	−.21	−.28	−.30	−.18

correlation scheme is more appropriate and less misleading than the results obtained by periodogram analysis. The temperature correlogram was computed for Washington, and since Abbot states that if the method of prediction succeeds in Washington, it will probably succeed equally well in all other places, the analysis for New York, prepared by Wadsworth [3], is also presented in TABLE 2. To support Abbot's hypothesis, the correlation for lag 7 or 6 should be inflated.

Since the correlation coefficients for neither city reflect the presence of the proposed cycle, its existence is extremely doubtful.

REFERENCES

[1] Kendall, M. G.: *The Advanced Theory of Statistics.* C. Griffin & Co., Ltd., London, 1945.
[2] Kendall, M. G.: On the Analysis of Oscillatory Time-Series. *J. Roy. Stat. Soc.,* 108 (1945): 93.
[3] Wadsworth, G. P.: Short Range and Extended Forecasting by Statistical Methods. U. S. Air Force, *Air Weather Service Technical Report No. 105–38* (1948).

MINUTES OF THE COUNCIL

(Continued from the June BULLETIN, p. 222.)

Corrigenda

(May 1949 BULL., p. 167, 42nd List for Membership)

Murille, Louis I., should be Murillo, Louis I.
Vadhanapanich, Charden, should be Vadhanapanich, Charoen.

Meeting of April 19, 1949, at Washington, D. C.

Place: Conference Room, U. S. Weather Bureau. *Time:* 5:40 to 11:02 p.m. *Present:* President Orville, Past-President Reichelderfer, Secretary Brooks, Treasurer Ward, Councilors Byers (until 6:35), Holzman, Ludlum, Merewether, Spilhaus, Wexler, and Yates; and, by invitation, Executive Secretary Spengler, and CIBAM Chairman, C. C. Bates (latter half of meeting).

The following 14 votes were taken, all but that on *Weatherwise,* being unanimous:

12. VOTED, to hold the Philadelphia meeting on Thursday and Friday, September 15 and 16, beginning in the afternoon. [This meeting has since been cancelled; see p. 260.]