because it was less extraordinary, occurred in corresponding latitudes in the interior of North America this winter. The oceanic effect with the prevailing westerly winds is so strong in Europe in a normal winter that a change to continental conditions with easterly winds is striking. The usual position of the axis of high pressure in winter in Europe is only a little to the north of the Mediterranean, and in a latitude where severe cold does not usually develop. This winter, however, the axis of high pressure was about 10 degrees of latitude farther north, bringing extreme continental weather over central and northern Europe in consequence.

THE STEAMSHIP "METEOR" SURVEY OF THE TROPICAL AND SOUTH ATLANTIC OCEAN

Preliminary Report[1]

SUMMARY OF METEOROLOGICAL PORTION[2]

By CHARLES F. BROOKS

The comprehensive 2-year oceanographic and meteorological expedition of the German gunboat *Meteor*[3] to the little-known tropical and South Atlantic Ocean grew out of the late Dr. Alfred Merz's desire to test and develop his new theory of oceanic circulation. Doctor Merz's plans were so well laid that, in spite of his most unfortunate and untimely death early in the expedition, the other scientists, under the leadership of Capt. F. Spiess, were able to complete the survey as projected. Descriptions of equipment, methods, and preliminary results, and the narrative account published during the progress of the work early provided much valuable information, that was helpful, for example, for the program of the *Carnegie*, which set sail on its 3-year cruise less than a year after the *Meteor* returned. This review will take up, first, a few of the outstanding features brought out in the narrative, then, the special investigations of evaporation, meteorology of the surface layer, and aerology.

NARRATIVE OF THE EXPEDITION

After a month's trial trip followed by two months in port making changes, the expedition sailed from Wilhelmshavn in April, 1925, and enjoyed an introductory profile across the zones en route to Buenos Aires. The first 5 of the 14 crossings of the Atlantic (see fig. 1) were between the subtropical high-pressure belt and the south polar region, a stretch of ocean that gave the expedition a full measure of its proverbial storminess in winter and spring. The summer weather, while the expedition was in the highest latitudes, was exceptionally favorable, however. Once the ship found itself in the rather quiet center of a fairly strong cyclone for 10 hours, and the observers succeeded in making a kite flight. In latitudes about 60° and higher, beyond the poleward boundary of the westerlies, the flights showed pronounced surface inversions of temperature.

The SE. trade was found to be a cold-air body, that with a sharp top rises from a shallow sheet at the African coast and steeply falls off at a varying distance from the American coast. Apparently this western limit is in a standing wavelike motion, which for the South American coast area has the same significance as the polar front for the west-wind zone. On Profile VII, latitude 22° mostly, the clouds were regular St. Cu. at 1,400 meters and above these, at the height of the temperature inversion, many kite flights showed a 6° to 16° C. rise in air temperature.

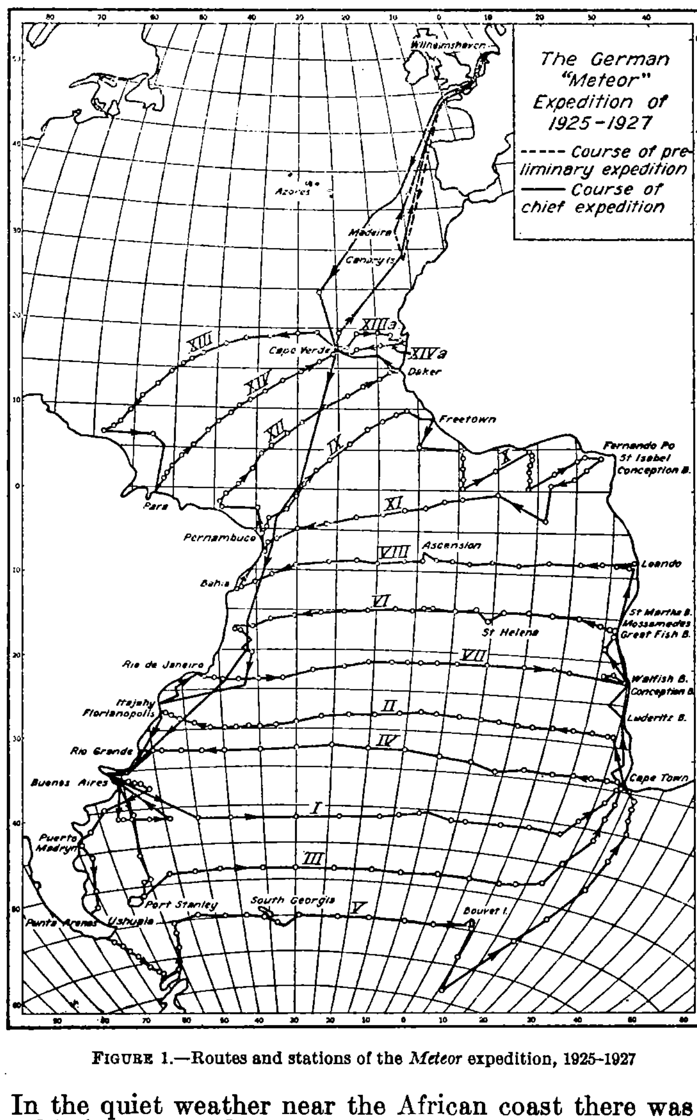

FIGURE 1.—Routes and stations of the *Meteor* expedition, 1925–1927

In the quiet weather near the African coast there was a cold-air sheet only 20 meters deep over the Benguela current. Fog was frequent there, being especially dense and wet where the temperature was lowest, 12° C. near Luderitz Bay (lat. 27). Nearer the Equator, to latitude 9, cool weather with clear skies and light SW. winds was typical along the coast.

The NE. trade, which was investigated in the same season a year later, was found to be stronger but less

[1] Berichte der Deutschen Atlantischen Expedition, I–IV. By F. Spiess, G. Wüst A. Schumacher, E. Hentschel, Otto Pratje, Freiherr von Recum, H. Wattenberg, J. Reger, E. Kuhlbrodt, C. W. Correns, A. Defant, G. Böhnecke, K. Quasebarth. Zeitschr. d. Gesellschaft für Erdkunde zu Berlin. 1926, p. 1–77, 209–272; 1927, p. 81–169, 251–338; photos, maps, diagrams.
Festsitzung zur Begrüssung der Expedition am 24. Juni 1927 veranstalted von der Notgemeinschaft der Deutschen Wissenschaft und der Gesellschaft für Erdunde zu Berlin. By L. Diels, F. Spiess, A. Defant, and F. Schmidt-Ott.
Cf. also the briefer account: Die deutsche atlantische Expedition auf dem Vermessungs- und Forschungschiff *Meteor*. By Spiess, v. Recum, Schumacher, and Kuhlbrodt. An. d. Hydr. u. Mar. Met., 1926, 54: 73–94, 393–399, and Köppen-Beiheft, 57–64; 1927, 55: [169], 245–248, photos, maps, diagrams.
NOTE.—"Die Meteor-Fahrt," by Capt. F. Spiess, a comprehensive popular book on the *Meteor* expedition, was published in Berlin in the autumn of 1928, by Dietrich Reimer (Ernst Bohsen); it contains 376 pages, 420 photographs, 34 diagrams, and 4 maps, including a large general map of the voyages.

[2] Presented in brief before the American Meteorological Society at Washington, D. C., Apr. 28, 1928.

[3] Steamship and auxiliary sails: Displacement 1,200 tons, length 75 meters, draft 4 meters, speed 9 knots, cruising radius 6,000 sea miles, crew 133.

cool than the SE. trade. The wind was particularly strong (20 m/s) where constricted between the Cape Verde Island. The same cool, foggy thin layer of air near the African coast was observed. Sixty miles from Dakar, for example, while the temperature in the trade wind on deck was 19° C. that in calm air at the top of the mast was 27° C. There was much dust and sand in the air near Africa. The clouds were less persistently St. Cu. and the sky cover rapidly changeable.

Between the trades and in a belt along the American coast in trade-wind latitudes the typical trade-wind temperature lid gave way to a condition of fairly uniform lapse rate at 0.6° C. to the greatest heights reached. Here heavy showers occurred now and then, in marked contrast to the almost daily very light showers of the trades. In a narrow belt, from the mouth of the Amazon to the Gulf of Guinea, the rains were heaviest, and occurred almost daily. Near Para the weather in April was particularly damp and rainy. On the African side, thunderstorms were very numerous and were at times attended by strong squalls. In mid Atlantic the cooler countercurrent (2–3° N.) between the equatorial currents was marked by a belt of cool air, (23½° C.) high pressure (761 millimeters) and calm, while warmer low-pressure belts (both 757.8 millimeters) were near by at latitude 5° north and south. Rains were particularly heavy north of the high-pressure belt.

Table I gives in brief numerical form some of the climatic conditions found on the several profiles, which here are arranged according to latitude to facilitate comparison. This table was gleaned chiefly from the running account by Captain Spiess.

TABLE I.—*Certain climatological data for different latitudes on the Atlantic Ocean between 64° S. and 19° N.*

Profile	Latitude		Dates (1925–1927)	Number of days	Temperature			Relative Humidity			Cloudiness	Precipitation			Pressure		Wind velocity		
	Mean	Extreme			Mean	Maximum	Minimum	Mean	Maximum	Minimum		Days	Total	Maximum days	Maximum	Minimum	Mean	Maximum	Gales
					°C.	*°C.*	*°C.*	*Per cent*	*Per cent*	*Per cent*	*Tenths*	*Per cent*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*M/s*	*M/s*	*Days*
V Ewd	55° S	34°–64° S	Jan. 22–Mar. 8, 1926	45	2.9	8.0	0.2	----	----	----	9	----	----	12	767	727	(8)	20	(4+)
III Ewd	48° S	34°–52° S	Sept. 19–Oct. 25, 1925	36	4.3	9.0	0.0	----	----	----	8	78	----	----	----	----	10	30	6
I Ewd	41° S	40°–42° S	June 4–July 12, 1925	38	8.4	14	4	----	----	----	7	91	----	----	----	----	12	40	15
IV Wwd	33° S	32°–34° S	Nov. 12–Dec. 7, 1925	26	16.8	22.2	11.6	----	----	----	7.4	65	71	34	770	745	9.3	----	6
II Wwd	29° S	27°–30° S	July 28–Sept. 5, 1925	39	17	----	----	----	----	----	5	36	----	----	----	----	7	20	4
VII Ewd	23° S	22°–24° S	July 8–29, Aug. 12–15	26	19.6	----	13	72	----	----	5½	58	54	50	770	(763)	7	(12)	1
VI Wwd	16° S	15°–34° S	Apr. 22 and May 3–June 8, 1926	46	22.9	----	12	71	----	----	5½	57	35	22	765	760	6	11	----
VIII Wwd	9° S	8°–13° S	Aug. 29–Sept 27	29	22.8	25	21	76	----	----	6	38	6	3	763	760	6.7	14	----
XI Wwd	3° S	8° S–4° N	Dec. 16, 1926–Jan. 10, 1927	25	25	27.5	----	(80)	84	75	(5)	(1)	----	32	759	756.5	(7)	12	----
X Ewd	3° N	Eq.–8° N	Nov. 10–Dec. 2, 1926	23	26.2	30	(24)	82	----	----	6	39	68	----	760	757.7	5.2	9	----
IX Ewd	3° N	6° S.–10° N.	Oct. 10–30, 1926	21	26.6	28.5	23.5	80	----	----	6	----	124	60	761	757.8	5.6	----	----
XII Ewd	7° N	2° S.–15° N.	Jan. 29–Feb. 22, 1927	25	----	27.5	18	80	----	----	(6)	----	(61)	----	762	758	7.5	20	----
XIV Ewd	11° N	1° S.–19° N.	Apr. 19–May 5, 1927	17	----	(27)	20	80	87	68	6	(1)	----	54	763	758	(8)	----	----
XIII Wwd	14° N	1° S.–19° N.	Mar. 3–10, Mar. 16–Apr. 6	30	(24)	27	17	(80)	90+	58	6	(1)	----	55	766.5	758	9	17	1

[1] Almost daily.

NOTE.—Figures in parentheses are incomplete or approximate.

The expedition returned to Germany late in May, 1927, successfully concluding their voyages of two years two months over 67,500 sea miles.

THE SPECIAL OBSERVATIONS

Evaporation observations by Dr. A. Schumacher were carried on under difficulties, but every effort was made to obtain measures of this climatic element which also shows the exchange between sea and air. No previous observations had been made in the eastern South Atlantic nor in high southern latitudes. Two evaporation vessels were used near each other. One was a cylindrical vessel with a long, narrow, cylindrical reservoir, and the other was a simple cylinder. (See figs. 61 and 143 in Captain Spiess's new book, mentioned at end of footnote 1.) Both were filled with 2,500 cubic centimeters of seawater. The surfaces exposed were 290 and 330 square centimeters. The surface temperatures of the water were obtained by a knitting-needle type of thermometer; temperature and humidity by Assmann aspiration psychrometer, wind velocity by hand anemometer, both inside and outside the vessels. Occasionally the air movement was only estimated. The evaporimeters were fixed on the stern, both starboard and port sides. Close by the starboard vessel was a Hellman recording rain gage. The exposure was bad only in a calm or with light head wind, when soot fell on the instruments. The shrouds and booms sheltered this area least. A few 12-hour determinations of evaporation were made, but mostly the 24-hour values were observed, 8 a. m. to 8 a. m. in the middle and higher latitudes and daily at 6 to 7 a. m. in lower latitudes. The evaporation from the two pans differed by a few tenths to half a millimeter, but the differences were not systematic. Individual values were found to be of the same order as those of earlier series. The interferometer method for determination of chlorine content calibrated by chlortitration was used where the waters were cool, with an accuracy of within 0.2 millimeter of evaporation, and the chlortitration method direct was employed for the warmer waters. All things considered, the chlortitration method was found better for use at sea, though the interferometer method was quick and reasonably accurate.

Comparative meteorological observations were made at 8 and 11 a. m., 2, 5, and 8 p. m., and 2 a. m. Wind velocity, air temperature, and humidity, and temperature of the water in the evaporimeter. The full diurnal course of these elements was then obtainable by interpolation from the recording instruments.

Both evaporimeters were considered as standards, the simple type because it was easiest to use and the other because its smaller range of temperature and humidity simulated more closely the actual sea-surface temperature. The older, more complex type was employed chiefly to provide values comparable with observations of previous expeditions.

In quiet weather a small boat was lowered for observations that would give the actual rate of evaporation from the sea. The temperature of the surface film of the sea down to very small depths was made with a precision thermometer with a fine knitting needle form of bulb. Air temperatures and humidities were obtained at 0.1 and 1 meter above the surface with the Assmann instrument, and on the ship at 5 and 8 meters. For continuous temperatures of the general surface layer of the sea an electrical resistance thermometer recorded intake temperatures (except when corrosion of the tube had rendered it useless).

Of the 320 observations two-thirds were undisturbed by rainfall; light precipitation had to be taken into account in others, and several were computed from the meteorological data, owing to heavy rain. Observations from a small boat were made at 14 places. The data are most complete in the SE. trades, and there is in addition a fine set in the NE. trades. Also, an exceptionally good series was obtained in subpolar latitudes. Preliminary values indicate a daily evaporation of 5 millimeters in the Gulf of Guinea, and an average of 9 millimeter in the SE. and NE. trades, with a range in the trades from 4–6.5 millimeters over the cool water in the east to 8–12 millimeters over the warm water in the middle and west.

Hundreds of determinations were made of atmospheric oxygen, H ion, and carbon dioxide.

Meteorological observations in the lower layers were made with the instruments on a program of a station of the first order: Thermometers, 2 rain gages (1 with shield, see figs. 60 and 143 in book), evaporimeters (described above), radiation instruments, marine barometer (hung amidships at sea level), 3 barographs (tridaily, weekly, monthly), 2 hydrographs (2-day clock; one in use while other being cleaned of salt and soot), thermograph, Assmann aspiration psychrometer, 4 resistance thermometers (inside, on foremast, 28 meters up on stern mast, and in shelter), 3 anemometers on the masts (see fig. 66 in book), the highest at 31 meters, and, for part of trip, a recording wind vane. The thermometer shelter was freely exposed on the roof of the chart house 9 meters high. It was well ventilated in general. Outside the shelter the Assmann psychrometer was always used on the windward side of the bridge. In the Tropics dew formation on the inner contacts of the registering apparatus of the resistance thermometers made some records uncertain. The two meteorologists, Doctor Reger and Doctor Kuhlbrodt, made thrice-daily observations, at 7, 14, and 21 hours local time, of pressure, temperature, humidity, sea temperature, cloudiness (form and cover), wind direction and velocity, state of the sea, and visibility. The navigating officers on the bridge made 4-hour observations of the usual elements, and hourly of cloudiness, sea temperature, and wind.

Radiation measurements.—A Michelson and a Linke actinometer on the stable setting of the mirror theodolite (fig. 72 in book) could be used only occasionally, for the rolling and steering of the ship made it difficult to keep the sun long enough in the opening. A place out of the wind and out of the smoke train was also difficult to find. Obviously, most of the 65 series of observations (on 22 days) were made in low latitudes. A Robitzsch (sun and sky) radiation recorder set on gimbals on the quarterdeck was of little use in southern profiles, though many valuable records were obtained elsewhere. Sometimes the instrument had to be put away from boarding seas. There was much disturbance by smoke and the rigging. Nocturnal radiation in terms of sum totals for the entire night was measured by a tulipan. Wholly clear nights were rare.

AEROLOGICAL OBSERVATIONS

The aerological was the most important part of the meteorological program, for few such observations had been made before at sea, especially in the equatorial and South Atlantic. Professor Reger and Doctor Kuhlbrodt (figs. 9, 10, and 65 in book) had an arduous task, with their daily balloons and biweekly kite flying in addition to their other observations.

Pilot balloon ascents have the advantage of being independent of the motion of the vessel. Usually there were two ascents a day. To avoid clouds favorable moments were chosen and high ascensional rates (250–400 m/min) were used. The balloons (fig. 63 in book) were filled from tanks. The altitude and azimuth (from ship's axis) were followed with a mirror theodolite (fig. 65 in book), and the reading of the compass was noted with each observation. The distance of the balloon was measured with the distance measurer (range-finder principle.) (Fig. 64 in book.) [5] Most of the balloons disappeared in or behind clouds. The hundreds of cloud heights thus obtained are valuable. The smoke train ended many balloon observations. So did dense cirrus and dust haze near North Africa, though a red filter helped considerably. When the ship was going against the wind, the pitching made observations (always from the stern) appreciably more difficult. On occasions of rapidly changing clouds or strong winds smoke bombs (8.8-centimeter gun, fig. 39 in book) were used with the distance finder and mirror theodolite. The bombs were shot through holes in the clouds, and were observed up to over 7,000 meters and for 20 minutes at a time. Cloud motions were observed frequently, especially cirrus, to round out the aerological data. The mirror theodolite and distance finder were used for this, and double determinations were often made for checking. About 500 cloud photographs were taken.

Owing to low clouds and strong winds the heights reached by the balloons were generally low in the westerlies, and the average for Profiles I to V was but 3,560 meters. The St. Cu. sheet of the SE. trades also limited the heights attained. The more changeable clouds of the NE. trades, however, permitted better results, and the best were obtained in the western portions of Profiles XII to XIV, where the 41 ascents averaged 13,500 meters. In the equatorial zone ascents were often impossible because of continuing rain. Where ascents were made either dense low clouds limited the runs or early bursting of the greatly deteriorated balloons, even though less inflated than usual, brought them to an early close. After so much trouble near the Equator, heavier, double-ply balloons of about 430 grams weight were employed successfully. In spite of the equatorial troubles, the average for Profiles VI to XIV was 8,300 meters. The general bursting height was 18 to 20 kilometers, or well within the stratosphere. The greatest height reached was 21,100 meters. Altogether, there were 812 well-distributed pilot balloon ascents, which as a whole show the major air movements in the troposphere at least over the tropical South Atlantic and the air exchanges along the coasts.

Sounding balloons (figs. 38 and 62 in book) could be used but few times, owing to the generally low speed and restricted coal supply of the ship. The winds would have carried the balloons away faster than the ship could follow. By the time the latitudes of small wind were reached the deterioration of the rubber restricted the chances of success still further. In some cases the second of the two supporting balloons burst before the ship arrived. The instrument was lost in one. The sounding balloons did, however, make a valuable, though small, addition to the kite records.

[5] The balloons, distance measurer, and theodolite are described in some detail by Dr. E. Kuhlbrodt in the Köppen-heft of An. d. Hydr. u. Mar. Met., 1926, pp. 57–63. The theodolite is described in brief by Lieut. F. W. Reichelderfer in Bull. Am. Met'l Soc., 1928, 9:151–152.

Kite flying (figs. 67–71 in book) was highly successful. An electric motor and an effective brake were employed. Collapsible box kites, easy to land and requiring little space to store, were commonly used, but were found of untested stability and sank too readily if they fell into the sea. The landing field was but 8 meters long. An extra pulley on a gaff was found helpful in starting and concluding flights. In stormy weather the turbulence caused by the ship threw the kites about and made much trouble. Sometimes kites were sent up without instruments, to get the wind at least. The limited coal often meant limited kite flights. None were possible when sails were set, for the lee whirl throws a kite into the water. The numerous flights in the stormy westerlies were possible because of the large wire used, which, however, could not be lifted high.

The lighter trade winds permitted a finer wire: 1,800 meters of 0.7-millimeter, 4,000 meters of 0.8-millimeter, 6,000 meters of 0.9-millimeter, and an outrun of 100 meters of 0.8-millimeter wire. The supporting surface of the instrument kite and one or two others was 8 square meters. These large kites proved better than 5 square meter kites in strong winds, for the latter lie on a side during hard inpulling. The formation of kinks by the pulley system caused the loss of three instrument kites. Frequent renewal of the top 1 or 2 kilometers of wire is advised. The loss of meteorographs necessitated the use of balloon meteorographs on the last three profiles. These were slung on wires 5 meters long attached 130 to 140 meters back of the leading kite, far enough for the kite to be free of the ship's eddies. Owing to pendulation of the instrument, the sun when high affected the temperature indications. Good results were obtained in two ascents after sunset. Flights could be made when the wind relative to the ship was 6 m/s or more.

Of the 217 kite flights, 150 were in the Tropics. Frequently no ascents could be made in the westerlies because of storms. On Profiles III and V ice frequently formed on the wires, holding the kites down. The maximum heights attained were in Profile IX in the equatorial zone. On the whole, the so-called calm belt was a fruitful field for kite flights. There were 33 between 4° N. and 4° S., and of these 14 exceeded 3,000 meters and 4 went over 4,000 meters. The average altitude reached in the 217 kite flights was 2,200 meters and the maximum, 4,870 meters.

CONCLUSION

The foregoing summary of the work of the *Meteor* expedition tells a story of heroic labors in the interest of science. Such a large volume of data was collected with the utmost scientific care that the final results of study can not fail to be highly illuminating. First, there will be a notable contribution to the climatology of the Atlantic. Altogether, an unbroken record of pressure, air temperature, humidity, wind direction, wind velocity, and precipitation was kept throughout the 26 months' voyage. Hourly values for cloudiness, state of the sea, and water temperatures were also obtained for the entire period at sea. The extensive evaporation measurements and the considerable series of radiation observations also deserve special mention. Second, there will be the most extensive contribution ever made by a single expedition to knowledge of the temperature, humidity, and circulation of the atmosphere. These aerological observations were made at all seasons and in large number and cover in a fairly uniform way the entire width of the South Atlantic Ocean near the Antartic Continent to the Equator and the portion of the North Atlantic which is between South America and Africa. Tropical wind variability was found to be greater than supposed; winds at all heights vary considerably, and there is no antitrade in the old sense.

There could be no better memorial to Doctor Merz than the monumental results that will come from this remarkably successful expedition, planned by him and begun under his direction, and carried through with competence and indefatigable zeal.

EDITORS OF THE MONTHLY WEATHER REVIEW

By A. J. HENRY

The first issue of the MONTHLY WEATHER REVIEW was that of October, 1872, rather than January, 1873, as frequently hitherto given. The first issue was reprinted in the annual report of the Chief Signal Officer for 1873, page 981. This issue contained less than 1,500 words and a single chart, viz, one showing the paths of cyclonic storms for that month. The late Prof. Thompson B. Maury with the assistance of Observer-Sergt. Henry Calver,[1] was responsible for the first issue. Mr. Calver, who joined the Signal Service in 1871, suggested to General Myer in August of that year the issue of a weekly review of the weather for the benefit of the press and commercial organizations. He was commissioned to prepare and issue such a report and doubtless the idea of a monthly review grew out of Calver's weekly report for we find that Professor Maury, with whom Calver served, to have been responsible for the first issue.

Strange as it may seem there is no official record of the responsible editors of the REVIEW during the régime of the military weather service; it was the custom at that time for the official who had served as "indications" officer to have editorial charge of the MONTHLY WEATHER REVIEW during the month immediately following his tour of duty on the indications work as it was then called.

It is not now possible to give a categorical list of the early editors more than to say that the work was divided among the civilian professors, Abbe and Maury, and the following-named Army officers who had been detailed for service in the Signal Service of the Army, viz, Craig, Dunwoody, Greely (later Chief Signal Officer), Story, Powell, Allen, Thompson Glassford, Finley and possibly others, including the late Prof. Henry Allen Hazen, who took up the work in September, 1887.

Effective in July, 1891, when the weather service was transferred to the Department of Agriculture and the present Weather Bureau was created, the editorship of the REVIEW was vested in a board of editors composed of Mr. Horace E. Smith, chief clerk of the Bureau and Profs. Russell, Hazen, and Marvin together with Edward B. Garriott, who served as the actual editor during the life of the board.

In July, 1893, Prof. Cleveland Abbe was named as editor and it is to him more than any other person that the publication reached its high standing as a meteorological journal.

In July, 1909, a radical change was made in the scope and form of the REVIEW. The United States was divided into 12 major subdivisions on the basis of the

[1] Mr. Calver, a successful patent attorney still practicing his profession in Washington, D. C., has the distinction of being the sole survivor of the Signal Service central office of 1871.—ED.