unexceptionable result. However, let us assume that this slight influence really does exist, and let us examine the amount of this influence a little more closely. Its magnitude is expressed by the percentages of the favorable cases. We will, however, for once greatly exaggerate and assume that these favorable cases amount to a surplus of 5 per cent. That is to say that in 100 cases 55 succeed and 45 fail. Now, if you use such lunar rules for weather predictions, what does it advantage you in isolated, single cases? For instance, you are in doubt as to whether the rain is to be expected or not; the influence of the moon indicates rain with a weight of 0.05. In spite of this small weight, if now you forecast bad weather, you will, if 100 such cases occur, have a failure in 45 cases. Had you paid no attention to the influence of the moon, you would possibly have had 50 failures. Thus, in this case of 5 per cent of surplus, that would be the whole effect of your consideration of the moon's influence. But we have in fact assumed an exaggerated case, and the real influence of the moon is in every case less than one-half of this, if indeed it really exists at all.

You may rest assured that the professional meteorologists accept, nay even seek for, everything that can give them any assistance whatever in their weather predictions. By constant investigation and study we may hope to advance step by step, and per cent by per cent. Every single per cent of agreement that is gained is an important advance and success.

KITE FLYING IN THE TROPICS.

By OLIVER L. FASSIG, dated Baltimore, Md., December 25, 1903.

On June 1, 1903, an expedition under the auspices of the Geographical Society of Baltimore, directed by Dr. George B. Shattuck, Secretary to the Society, left Baltimore on the two-masted schooner *Wm. H. Van Name* for the Bahama Islands. The purpose of the expedition was to make a scientific survey of the islands along the lines of geology, physiography, botany, climatology, terrestrial magnetism, marine life, and tropical diseases. The scientific staff, comprising 25 members, was selected largely from men at one time or another connected with the Johns Hopkins University and from representatives of several of the scientific departments of the United States Government.

Included in the equipment for a study of the climatological conditions of the islands was a complete outfit for investigating, on a small scale, the conditions of the upper atmosphere, loaned to the director of the expedition by the Chief of the Weather Bureau. This outfit consisted of one medium-sized and one large box kite, two meteorographs, a hand reel with 15,000 feet of steel piano wire, and a nephoscope for altitude measurements. In addition, the instrumental equipment included a Richard barograph, a thermograph, and a hygrograph, a sling psychrometer, a rain gage, and a rain recorder, the property of the Maryland State Weather Service. Provision was also made for observations of ocean surface temperatures from Baltimore to Nassau and return, for tide observations, and for a magnetic survey of the islands by the writer, the results of which will be published later. The present report is confined to a discussion of the results of kite flying at Nassau, the principal town of the Bahama Islands.

Head winds and rough weather caused considerable delay and inconvenience on the outward voyage, and the expedition did not reach Nassau until the 17th of June. Through the courtesy of Mr. Flagler, the use of the grounds and clubhouse connected with the Colonial Hotel was kindly granted for the kite experiments. These grounds were by far the most suitable place to be found in the vicinity of Nassau for the purpose, being one of the few open stretches of field upon the entire island. Situated west of the town of Nassau, along the northern coast of the island and just below the ruins of old Fort Charlotte, the field afforded a free sweep of the air in the direction of the prevailing easterly winds of these latitudes. The Island of New Providence, upon which Nassau is situated, is a small island, measuring less than 20 miles from east to west and about 7 or 8 miles from north to south at its widest point. It lies about 150 miles to the east of the southern point of Florida, in latitude 25° north, longitude 77° 30′ west, along the northern edge of the trades.

Several days were spent in unpacking and mounting the meteorological, magnetic, and tide instruments, and the kites, and in waiting for favorable winds. It was not until the 27th of June that the wind seemed of sufficient strength to warrant an attempt to raise a kite. At this season of the year winds above 10 miles per hour can not be counted on daily, excepting for short periods. Beginning at sunrise with a breeze of 5 or 6 miles from the east-southeast, the strength increased by noon to 8 or 9 miles, with occasional higher velocities, but seldom exceeded 15 miles per hour.

To one accustomed to the rapid and extreme fluctuations of temperate zone weather, the tropical conditions appear monotonously uniform; clear skies with intense sunshine, a few patches of loosely formed cumulus clouds, an occasional shower of short duration, a small range of the thermometer, generally, at this season, keeping within the limits of 80° and 90°, these are conditions which may repeat themselves day after day for long periods. Though the direct sunshine is intense, the atmosphere is not excessively oppressive, being moderately dry, and seldom stagnant. So far as personal comfort is concerned, these conditions are less trying than the warm, muggy days of the coastal plain of the Middle Atlantic States. In these islands there is generally a sufficient breeze for comfort when not exposed to the direct rays of the sun; from the warm moist and stagnant atmosphere of the Middle States there is often no escape, even under the shelter of roof or tree.

A preliminary flight was made on June 27, between 11 a. m. and 1 p. m., using the smaller 7-foot kite. The wind was east-south-east, and blowing with a velocity of about 10 miles per hour. No effort was made to reach any considerable height, the main purpose being to test the kite and apparatus. The maximum elevation was slightly over 1000 feet.

In all of the experiments conducted at Nassau, the kite meteorograph was checked by means of an aneroid barometer and a sling psychrometer at the surface just before the kite was raised, and at short intervals until the close of the flight. In addition, the barograph, thermograph, and hygrograph were installed in the Nassau Cable Office, about three-fourths of a mile distant, by the courtesy of Mr. P. H. Burns, Superintendent of the Bahama Cable; these instruments in turn were checked frequently by means of eye observations of the thermometers and mercurial barometer at the Cable Office.

On July 1 the kite was raised at 10 a. m. and not lowered until nearly 5 p. m. The wind was east-southeast, with a velocity of 15 miles, until 1 p. m., when the velocity fell to 11 miles, which was maintained until the end of the flight. The day was marked by an unusual amount of cloudiness, varying between five and seven tenths, mostly cumulus, with a few alto-cumulus. A light scud occasionally passed under the kite. On several occasions the kite was entirely obscured, being sometimes in the passing cloud, and sometimes above it. The greatest elevation attained was about 2600 feet at 12:23 p. m., with a temperature at the kite of 69°, and a surface temperature of 83°. The atmospheric pressure, as registered on the kite meteorograph, was 27.60 inches, and at the surface 30.03 inches. It was with considerable difficulty that the kite was maintained at the higher elevations. The tracings of the kite meteorograph, (see figs. 1, 2, 3), show constant fluctuations, doubtless largely due to frequent reeling and unreeling in attempts to increase the altitude of the kite, but in a measure also to be attributed to variation in the strength of the wind.

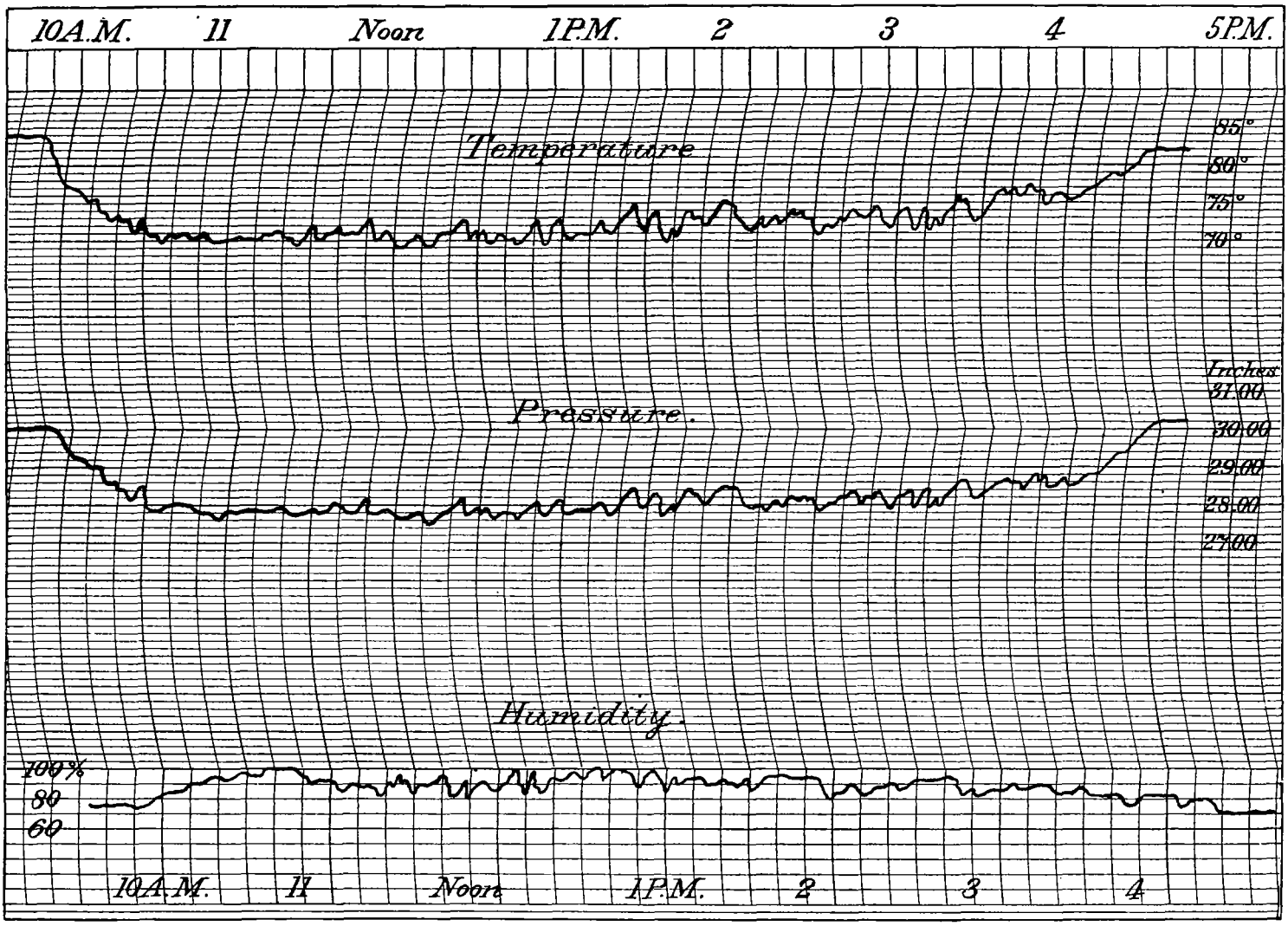

FIG. 1.—Nassau, Bahama Islands, July 1, 1903, 9 a. m. to 5 p. m.

On the following day, July 2, the larger 9-foot kite was launched. The wind was from the east-southeast, and unsteady, with a velocity varying between 8 and 10 miles per hour; the sky was from three to four tenths clouded. Not much was to be expected under these conditions. The greatest elevation slightly exceeded 2500 feet. The kite was raised shortly after 3 p. m., and lowered a little before 6 p. m. The lowest temperature recorded at the kite was 70°, with 85° at the surface; the pressure fell from 30.03 inches at the surface to 27.60 inches at the highest level. The same irregularities in the meteorograph tracings are to be found in the records of this ascent as were noted in the previous ascent. In fact this is a characteristic of all of the tracings, which would seem to point to a rapid falling off in wind velocity above a moderate elevation.

The next ascent was attempted late in the afternoon of July 3, between 5 and 8 p. m. A good strong wind was blowing from the east-southeast, the weather conditions were unsettled, the cloudiness varying from five to seven tenths cumulus and cumulo-nimbus. A squall arose about 6:30 p. m., with a short shower of rain, during which my colleague and myself sought shelter in the clubhouse. The rain and squall lasted from ten to fifteen minutes. The kite wire was carefully grounded, but small discharges of atmospheric electricity were several times felt. We had no facilities for measuring the potential, but the shocks experienced now and then on accidental contact with the wire were not severe, even on the approach of the squall. The kite reached an elevation of nearly 4000 feet, and was maintained at a high elevation for fully two hours without much manipulation of the reel. The kite behaved well from ascent to landing, and an interesting and valuable record was looked for; but to our dismay on examining the meteorograph it was found that the clock had stopped within fifteen minutes after the beginning of the ascent. Save for the maximum and minimum points of pressure, temperature, and humidity, and the altitude observations, there was no record of one of the most interesting of the 6 ascents made during our stay at Nassau. The lowest temperature recorded was 65°, with a surface temperature of 78°; the lowest pressure was was 26.30 inches, with 30.03 inches at the surface.

On the day preceding our departure from Nassau, namely, on July 6, we determined to try the experiment of flying one of our kites from the deck of a moving vessel. The practicability of this method had already been fully demonstrated by Mr. Rotch, Director of the Blue Hill Observatory, near Boston, and by others who followed his initiative, in the North Atlantic waters. We hoped by this method of artificially "raising a breeze" to attain a higher altitude than we had reached in the light land winds, and at the same time counted upon adding to our knowledge of the temperature and humidity conditions over the ocean in these latitudes. There was very little material to select from in the way of steam locomotion, wind being the motive power for practically all the water craft in this vicinity. The choice lay between a large and powerful

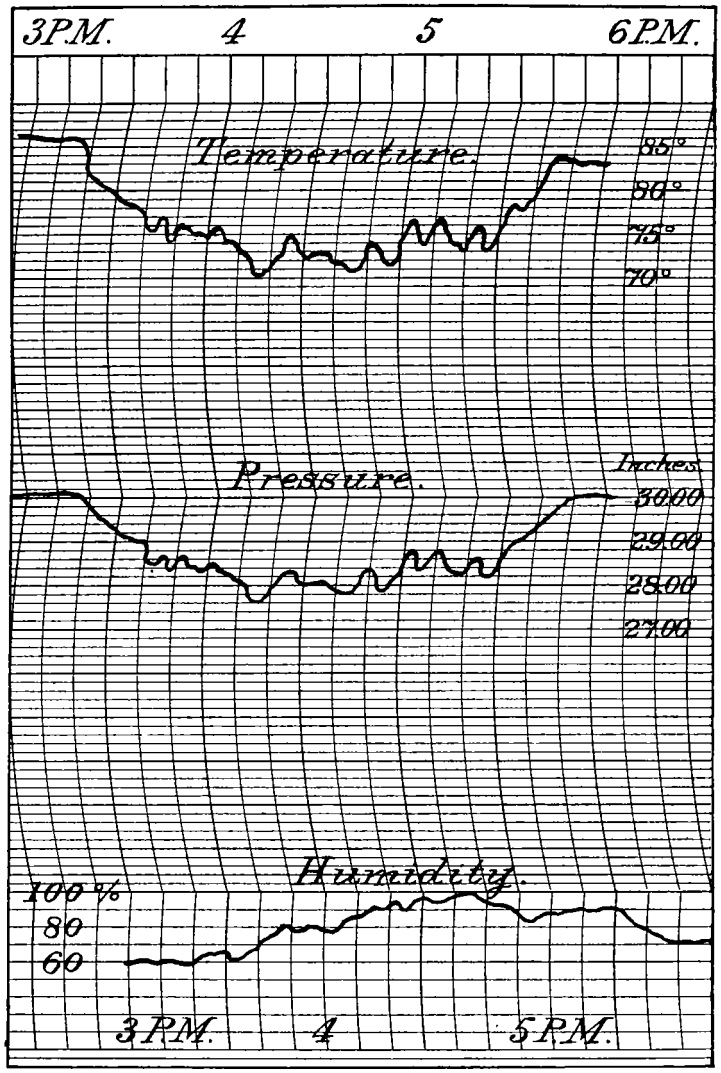

FIG. 2.—Nassau, Bahama Islands, July 2, 1903, 3 to 6 p. m.

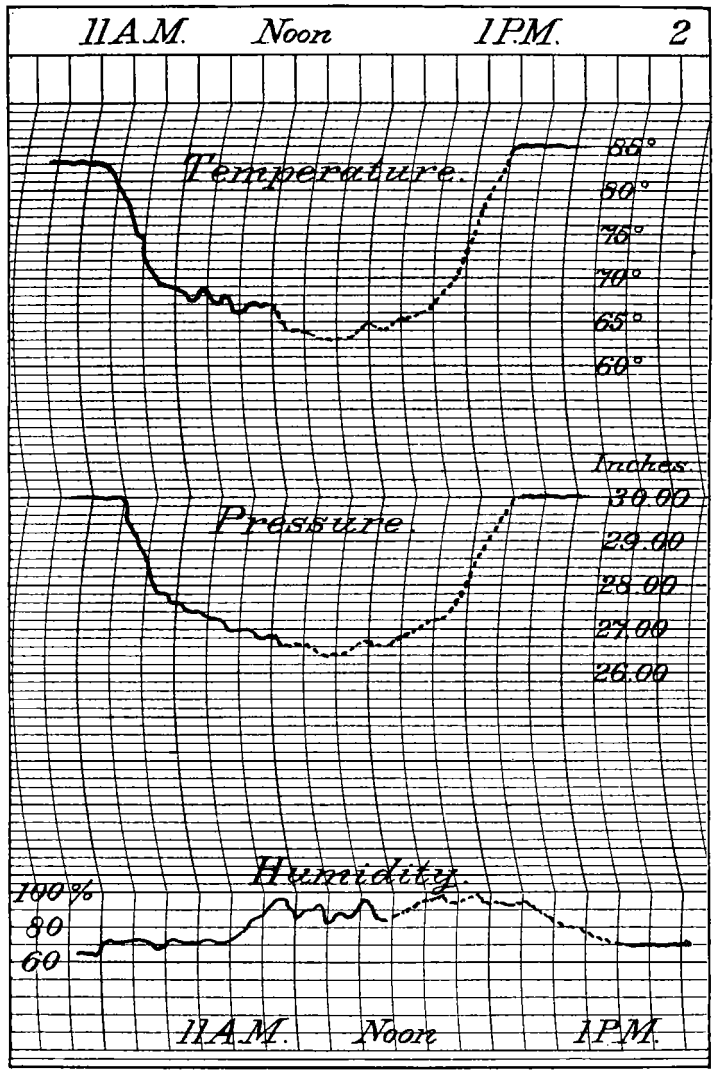

FIG. 3.—Nassau, Bahama Islands, on board the steam launch *Alicia*, July 6, 1903, 11 a. m. to 1 p. m.

steam tug belonging to the company running the regular line of steamers between New York, Nassau, and Havana, but for which an exorbitant charge was demanded, and a small steam launch used for conveying passengers across the channel to a pleasure resort on Hog Island. The smaller vessel was chosen. At 11 a. m. we left the harbor of Nassau on the *Alicia* with the larger of the two kites and the complete outfit. The party accompanying me comprised in addition to the crew of three men, my colleague, Mr. J. E. Routh, who took charge of the nephoscope for the altitude observations, Rev. Mr. Lamont, who acted as recorder, and two natives at the reel. Leaving the channel we steamed out to the north of Hog Island, a long and narrow strip of land lying to the north of the Island of New Providence. Going a mile or two beyond land, we steamed into the wind with a velocity of about 5 to 6 knots an hour. The boat was small and somewhat top-heavy, and there was a considerable ground swell; between the rolling and pitching of the boat and the resulting physiological effects it was with difficulty that we kept ourselves and the reel right side up. Barring a slight delay caused by the snapping, at the moment of ascent, of the small steel safety line attached to the kite, which had to be replaced by a piece of twine, there were no hitches or accidents. The kite rose swiftly and steadily to an elevation of about 4000 feet. With a vessel of greater speed we could doubtless have reached a higher elevation. The surface wind was about 12 miles per hour; to this we added about 5 miles, the speed of our launch. It seems doubtful from our experience during 5 ascents, whether it would be possible greatly to exceed this limit at this season of the year without the aid of an artificial wind, even by means of additional kites. There is apparently a diminution of wind velocity above the elevation of about 4000 feet, in this respect differing from the conditions in the temperate latitudes, where the velocity steadily increases up to the limits thus far attained. This supposition is also borne out by observations of the few upper clouds seen during our stay of five or six weeks in these latitudes. A few clouds of the upper layer were observed, but their slight northward motion was to be detected only after the most careful observations by means of the nephoscope.

The lowest temperature recorded during the ascent of the 6th was 63°, with a surface temperature of 83°; the lowest barometric pressure was 26.40 inches, with a surface reading of 30.05 inches. The humidity ranged from 73 per cent at the surface to 98 per cent. A portion of the record was lost owing to the stopping of the clock a few minutes before the highest elevation was reached, but practically all the record during the ascending branch of the curve was intact. The kite left the boat at 11:10 a. m., reached its greatest elevation at 12:20 p. m., and was lowered at 1:12 p. m. The surface wind was east-southeast throughout, as during all preceeding flights. The kite varied but little in azimuth from that of the surface wind, however, there was always a slight change to a more southerly direction of the wind in the region of the kite.

The east-southeast wind carried the kite beyond the limits of the island in all but the first ascent. In the subsequent higher elevations the kite was always a considerable distance beyond the coast line over the sea. In view of this fact and the small size of the island, all of the observations may be regarded practically as ocean conditions, excepting those recorded within the first two or three hundred feet above the surface.

TEMPERATURE RESULTS.

The average temperature conditions from the surface to an elevation of approximately 4000 feet are presented in tabular form, and charted in figs. 4 and 5. Observations on the

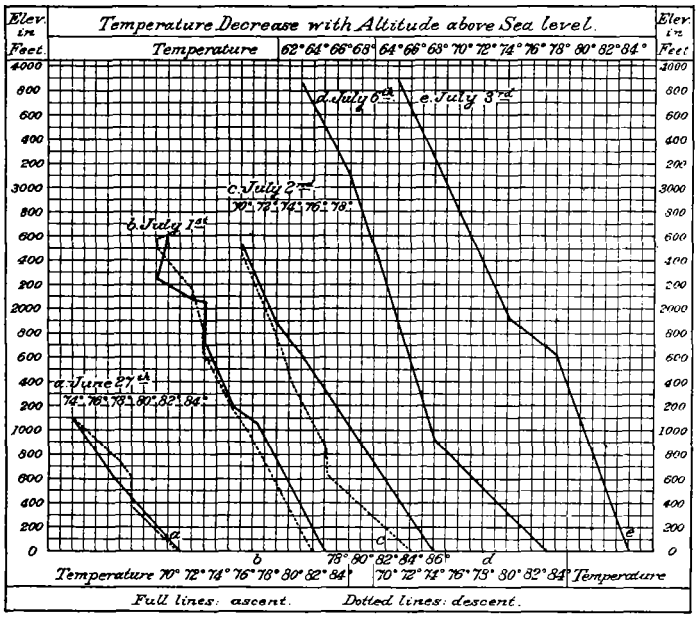

FIG. 4.—Nassau Bahama Islands, June 27 to July 6, 1903.

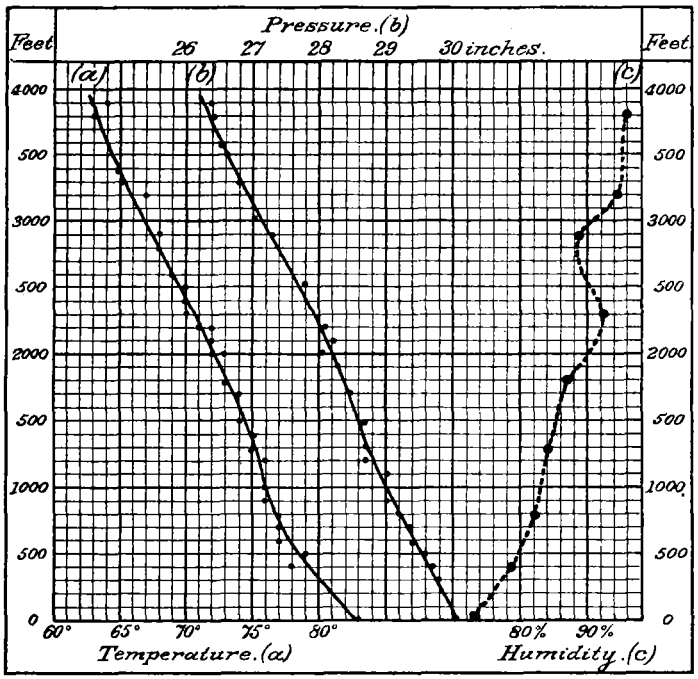

FIG. 5.—Nassau, Bahama Islands, June 27, July 1, 2, 6, 1903. Average condition during four ascents.

nephoscope for angular elevation of the kite, and readings of the dial on the reel for length of wire out, were made every five or ten minutes and sometimes more frequently. From these records and from the tracings of the kite meteorograph, averages were computed and plotted for each 100 feet and each 500 feet of elevation. The actual decrease in each 500 feet, the rate of decrease per 1000 feet, and the number of feet of elevation causing a decrease of 1° F. are shown in the following table:

Temperature decrease. Average of four ascents and seventy observations.

	500	1000	1500	2000	2500	3000	3500	4000	Mean.
Departure from surface temperature, degrees	5	7	9	11	13	16	18	20	
Rate of decrease per 1000 feet, degrees	10.0	7.0	6.0	5.5	5.2	5.2	5.1	5.1	6.1
Number of feet per 1° decrease in temperature	100	143	167	182	192	192	196	196	164

Comparing these results with those obtained at other points under the auspices of the Weather Bureau in the summer of 1898 we find a close agreement. Practically all of the Nassau experiments were conducted in the afternoon. Taking from Bulletin F, of the Weather Bureau, the results of the Washington, D. C., afternoon observations and the mean of the afternoon observations at 17 localities in the United States, and placing them alongside the Nassau observations, the rate of decrease is seen to be almost identical:

Comparative rate of decrease in temperature per 1000 feet.

Elevation in feet.	Washington p. m.	Mean of 17 localities in the United States, p. m.	Nassau, p. m.
	°	°	°
500	...	...	10.0
1000	8.1	7.5	7.0
1500	6.5	6.4	6.0
2000	5.8	6.0	5.5
2500	...	...	5.2
3000	5.5	5.5	5.2
3500	...	...	5.1
4000	4.9	4.9	5.1
Mean	6.2	6.1	6.1

The rate of decrease in temperature computed from averages for each 100 feet is also shown in fig. 5 *(a)*.

DECREASE IN PRESSURE.

As the altitude of the meteoragraph is determined trigonometrically we may compute the average rate of decrease in pressure during 4 flights as shown in the following table, which also shows the number of observations employed and the average temperature of the air in each column of 1000 feet:

Rate of decrease in pressure.

Altitude.	Number of observations.	Average temperature.	Fall of 0.1 inch.
Feet.		°	*Per feet.*
0–1000	16	80.4	95
1000–2000	25	78.3	103
2000–3000	26	69.8	109
3000–4000	7	64.6	105
Means ...		73.3	103

In fig. 5 (*b*) the rate of decrease in pressure is shown graphically. The plotted observations for which the curve is drawn are averages for each successive 100 feet. The total number of observations employed in the construction of the curve is about 75.

RELATIVE HUMIDITY.

Observations of relative humidity at the surface were obtained by means of a Richard hygrograph, checked by direct determinations of humidity by means of a sling psychrometer. The readings derived from the kite hygrograph tracings were averaged for each 100 feet of elevation, and these averages in turn grouped in order to obtain average values for each successive column of 500 feet. In the following table these value are reproduced; the average humidities are also shown graphically in curve (*c*) of fig. 5:

Increase of relative humidity; average of four ascents.

Elevation.	Number of observations.	Relative humidity.	Elevation.	Number of observations.	Relative humidity.
Feet.		*Per cent.*	*Feet.*		*Per cent.*
Surface.	10	73	2500–3000	9	89
0–500	5	79	3000–3500	1	95
500–1000	12	82	3500–4000	2	96
1000–1500	15	84			
1500–2000	16	87		88	86.3
2000–2500	18	93			

As will be seen by inspection of the percentages of relative humidity, there is a steady increase from the surface to the highest elevations reached, namely 4000 feet, excepting the layer between 2500 feet and 3000 feet, where there is an interruption to the steady increase. The drop from 93 per cent to 89 per cent near the 3000-foot level is probably due to an excessive value just below the 2500-foot level, brought about by the kite passing through a cloud at this level on three or four occasions.

Observations at Nassau, June 27, 1903.

Time.	Elevation of kite.	Atmospheric conditions. Surface. Pressure.	Surface. Temperature.	Surface. Humidity.	Surface. Wind direction and velocity.	At kite. Pressure.	At kite. Temperature.	At kite. Humidity.	Ascent for 0.1 inch of pressure decrease.	Ascent for 1° F. of temperature decrease.
a. m.	*Feet.*	*Inches.*	°	%		*Inches.*	°	%	*Feet.*	*Feet.*
[a]10:55	0	30.05	83	74	ese., 10	30.05	83	73	0	0
11:34	585	30.05	83	74	..do ...	29.40	77	78	90	98
11:36	642	30.05	83	74	..do ...	29.40	78	76	99	128
11:41	758	30.05	83	74	..do ...	29.00	75	82	72	95
11:43	827	30.05	83	74	..do ...	29.00	75	82	79	103
11:52	896	30.05	83	74	..do ...	29.00	75	84	85	112
11:55	1089	30.05	83	74	..do ...	28.80	74	85	87	131
Noon.	750	30.05	83	74	..do ...	29.40	78	81	115	150
p. m.										
12:12	602	30.05	83	74	..do ...	29.43	78	80	97	150
12:15	377	30.05	83	75	..do ...	29.70	78	80	108	94
12:19	430	30.05	83	75	..do ...	29.60	79	80	96	108
12:23	*372*	30.05	83	75	..do ...	29.70	79	79	106	93
12:26	425	30.05	83	76	..do ...	29.60	79	79	94	106
12:29	266	30.05	83	76	..do ...	29.80	80	78	106	90
12:30	0	39.05	83	76	..do ...	30.05	83	76	0	0

[a] 6 cumulus, 10 a. m. to noon. Average pressure decrease 0.10 inch per 95 feet. Average temperature decrease 1° F. per 112 feet. Figures in italic are interpolations.

Observations at Nassau, July 1, 1903.

a. m.	*Feet.*	*Inches.*	°	%.		*Inches.*	°	%	*Feet.*	*Feet.*
10:00	0	30.05	83	75	ese.,15	30.05	83	75	0	0
10:12	1,053	30.05	83	75	..do ...	29.37	77	85	155	150
[a]10:20	1,235	30.05	83	77	..do ...	29.00	75	90	118	137
10:30	1,711	30.05	83	77	..do ...	28.60	73	94	118	156
[b]10:40	2,066	30.05	83	67	..do ...	28.40	73	97	125	188
10:50	2,057	30.05	83	67	..do ...	28.20	72	100	111	171
[c]10:53	2,112	30.05	83	67	..do ...	28.10	71	100	108	162
[d]11:00	2,280	30.05	83	72	..do ...	27.80	69	100	101	152
11:10	2,623	30.05	83	72	..do ...	27.80	70	92	112	187
11:20	2,382	30.05	83	72	..do ...	27.80	70	90	106	170
11:32	2,263	30.05	83	70	..do ...	27.80	70	90	101	162
11:40	2,476	30.05	83	70	..do ...	27.98	72	82	120	206
p. m.										
12:04	1,900?	30.03	83	75	..do ...	28.20	73	90	104	173
12:23	2,593	30.03	83	75	..do ...	27.60	69	96	107	173
[e]12:52	2,334	30.03	83	75	..do ...	27.83	70	99	106	167
[f]1:05	2,495	30.03	83	74	ese.,11	27.78	69	98	111	166
1:15	2,440	30.03	83	74	..do ...	28.00	71	90	120	188
1:25	1,968	30.03	83	74	..do ...	28.00	72	90	97	164
1:40	2,281	30.03	83	74	..do ...	27.90	71	93	107	175
2:00	1,837	30.02	82	84	..do ...	28.10	72	93	95	153
2:20	2,176	30.02	82	84	..do ...	28.10	72	87	113	181
[g]2:28	2,024	30.02	82	78	..do ...	28.10	72	90	105	184
2:40	2,010	30.02	82	78	..do ...	28.20	73	90	110	201
[h]2:49	2,067	30.02	81	72	..do ...	28.30	72	93	120	118
3:00	1,812	30.02	81	72	..do ...	28.30	73	85	105	201
3:10	2,218	30.02	81	73	..do ...	28.20	71	87	122	202
3:20	1,840	30.02	81	73	..do ...	28.58	73	87	112	204
3:40	1,614	30.02	81	73	..do ...	28.40	73	85	100	179
3:50	1,165?	30.02	81	73	..do ...	28.70	76	81	98	194
[i]4:00	1,230	30.02	82	77	..do ...	28.70	75	75	93	154
[j]4:05	1,121	30.02	82	77	..do ...	28.75	76	82	88	160
4:10	1,298	30.02	82	79	..do ...	28.62	75	82	93	162
4:15	1,023?	30.02	82	79	..do ...	28.80	76	75	85	148
4:20	1,083	30.02	82	79	..do ...	29.00	77	80	106	180
4:25	735	30.02	82	79	..do ...	29.20	78	78	90	147
4:30	.....	30.02	82	.....	..do ...	29.60	80	70	.....	.....
4:40	0	30.02	82	79	..do ...	30.02	82	70	.....	.....

[a] 5 cumulus, 2 alto-cumulus. [b] Light scud under kite. [c] Kite in cumulus at 10:57 a. m. [d] Light rain; kite in cumulo-nimbus. [e] Kite in cumulus. [f] Kite obscured by cumulus. [g] Whole sky clouded in region of kite. [h] Kite in cumulo-nimbus. [i] Thunder at 4:05 p. m. [j] A few cirrus clouds apparently moving northward. Average pressure decrease 0.10 inch per 107 feet. Average temperature decrease 1° F. per 173 feet.

Observations at Nassau, July 2, 1903.

Time.	Elevation of kite.	Atmospheric conditions. Surface. Pressure.	Surface. Temperature.	Surface. Humidity.	Surface. Wind direction and velocity.	At kite. Pressure.	At kite. Temperature.	At kite. Humidity.	Ascent for 0.1 inch of pressure decrease.	Ascent for 1° F. of temperature decrease.
p. m.	*Feet.*	*Inches.*	°	%		*Inches.*	°	%	*Feet.*	*Feet.*
3:18	0	30.03	86	72	ese., 9½	30.03	86	72	0	0
3:42	1,656	30.03	86	72	..do ...	28.50	75	73	108	151
[a]3:52	1,605	30.03	86	72	..do ...	28.60	75	75	112	146
4:04	1,872	30.03	85	73	..do ...	28.40	73	76	115	156
4:14	2,526	30.03	85	73	..do ...	27.60	70	90	104	168
4:24	1,643	30.03	85	73	..do ...	28.40	74	90	95	149
4:32	1,890	30.03	85	73	..do ...	28.20	72	93	103	145
4:40	2,455	30.02	85	74	..do ...	27.80	70	95	111	164
4:50	1,829	30.02	85	74	..do ...	28.36	83	92	110	152
5:00	1,473	30.02	85	75	..do ...	28.60	74	90	104	134
5:10	1,412	30.02	85	75	ese., 8	28.80	75	88	116	141
5:20	1,318	30.02	85	75	..do ...	28.65	75	90	96	132
[b]5:25	1,831	30.02	85	75	..do ...	28.20	72	87	101	141
5:30	1,430	30.02	84	75	..do ...	28.80	73	90	101	130
5:32	817	30.02	84	75	..do ...	29.10	77	88	89	117
5:36	619	30.02	84	75	..do ...	29.20	76	80	86	77
5:38	662	30.02	84	76	..do ...	29.40	77	80	107	95
5:48	0	30.02	84	77	..do ...	30.02	83	70	.....	.....

Clear day. [a] 4 cumulus from the southeast. [b] 3 cumulus from the southeast. Average pressure decrease 0.10 inch per 104 feet. Average temperature decrease 1° F. per 136 feet.

Observations at Nassau, July 3, 1903.

p. m.	*Feet.*	*Inches.*	°	%		*Inches.*	°	%	*Feet.*	*Feet.*
5:30?	0	30.03	83	63	ese.,12	30.00	83	.....	.....	.....
5:36	.....	30.03	83	63	..do ...	29.65	81	62	.....	.....
5:41	1,643	30.03	84	80	..do ...	29.20	78	68	.....	.....
5:48	1,910	30.03	83	80	..do ...	28.60	74	80	.....	.....
[a]5:55	2,068	30.03	83	80	..do ...	.....	.....	.....	.....	.....
[b]6:00	2,305	30.03	83	77	..do ...	.....	.....	.....	.....	.....
6:11	3,070	30.03	75	77	..do ...	.....	.....	.....	.....	.....
6:18	2,825	30.03	75	77	..do ...	.....	.....	.....	.....	.....
[c]6:21	3,246	30.03	75	77	..do ...	.....	.....	.....	.....	.....
[d]6:27	3,425	30.03	76	85	..do ...	.....	.....	.....	.....	.....
6:35	3,184	30.03	76	85	..do ...	.....	.....	.....	.....	.....
[e]6:47	*3,207*	30.03	76	85	..do ...	.....	.....	.....	.....	.....
6:54	3,674	30.03	76	85	..do ...	.....	.....	.....	.....	.....
7:00	3,858	30.04	78	85	ese., 8	*26.30*	*65*	.....	.....	.....
[f]7:14	3,856	30.04	78	85	..do ...	.....	.....	.....	.....	.....
7:30	2,900	30.04	80	85	..do ...	.....	.....	.....	.....	.....
7:42	2,237	30.04	80	85	..do ...	.....	.....	.....	.....	.....
7:50	2,030	30.04	80	85	..do ...	.....	.....	.....	.....	.....
8:05	1,040	30.04	79	85	..do ...	.....	.....	.....	.....	.....
8:15	957	30.04	79	85	..do ...	.....	.....	.....	.....	.....
8:20?	0	30.04	.....	.....	..do ...	.....	.....	.....	.....	.....

[a] Azimuth of kite changed from 100° to 110°. [b] Azimuth of kite returned to 100°. [c] Kite entered cloud at 6:15 p. m. [d] Squall with rain, 6:20 p. m. [e] 6 cumulus with occasional cumulus nimbus. [d] 6:44 kite in or over cumulus. [f] Began to lower kite at 7:16 p. m. Figures in italic are interpolations.

*Observations at Nassau, July 6, 1903.**

p. m.	*Feet.*	*Inches.*	°	%		*Inches.*	°	%	*Feet.*	*Feet.*
11:10	0	30.05	83	73	ese., 12	30.05	83	73	0	0
11:20	904	30.05	83	73	..do ...	28.60	74	85	62?	100?
11:25	2,532	30.05	83	73	..do ...	27.78	69	93	112	181
11:30	2,825	30.05	83	73	..do ...	27.52	69	90	112	200
11:35	2,500?	30.05	83	73	..do ...	27.40	68	90	94	167
[a]11:40	2,792	30.05	83	73	..do ...	27.20	68	80	98	186
[b]11:45	2,855	30.05	83	73	..do ...	27.20	67	85	100	178
11:50	2,925	30.05	83	73	..do ...	26.90	66	90	93	172
11:55	3,115	30.05	83	73	..do ...	26.80	67	95.	96	195
[c] Noon	2,875	30.05	83	73	..do ...	*27.20*	*67*	.....	*101*	*184*
p. m.										
[d]12:05	3,564	30.05	83	73	..do ...	*26.52*	*64*	.....	*101*	*184*
12:10	3,455	30.05	83	73	..do ...	*26.63*	*64*	.....	*101*	*184*
[e]12:15	3,600?	30.05	83	73	..do ...	*26.49*	*63*	.....	*101*	*184*
12:20	3,850	30.05	83	73	..do ...	26.40	63	98	105	192
[f]12:25	3,700	30.05	83	73	..do ...	*26.45*	*63*	.....	*101*	*184*
12:30	3,375	30.05	83	70	..do ...	*26.71*	*65*	.....	*101*	*184*
12:35	3,560	30.05	83	75	..do ...	*26.53*	*64*	.....	*101*	*184*
12:40	3,328	30.05	83	75	..do ...	*26.76*	*65*	.....	*101*	*184*
12:45	3,256	30.05	83	75	..do ...	*26.83*	*65*	.....	*101*	*184*
12:50	2,935	30.05	83	75	..do ...	*27.14*	*67*	.....	*101*	*184*
12:55	2,500	30.05	83	75	..do ...	*27.58*	*69*	.....	*101*	*184*
1:00	1,948	30.05	83	75	..do ...	*28.12*	*72*	.....	*101*	*184*
1:05	905	30.05	83	75	..do ...	*29.15*	*78*	.....	*101*	*184*
1:12	0	30.05	83	75	..do ...	30.05	.....	.....	.....	.....

* On board steam launch *Alicia*; length 25 feet, width 8 feet, speed 5 knots. [a] 3 cumulus; wind from east; kite in cumulus cloud. [b] Cumulus cloud passed over kite. [c] Kite in cloud. [d] Kite in cloud. [e] Kite entered cloud. [f] Kite left cloud. Average pressure decrease 0.10 inch per 101 feet. Average temperature decrease 1° F. per 184 feet. Figures in italic are interpolations.

It may be of interest to record the relation existing between the length of wire out and the angular and vertical elevation of the kite. This relationship is shown in the following table, in which the average values for all observations of each flight are given:

Relation between length of wire and elevation of kite.

Date.	Number of observations.	Average length of wire.	Average angular elevation.	Average elevation of kite.
		Feet.	° ′	*Feet.*
June 27	12	1081	38 0	637
July 1	34	3547	33 30	1869
July 2	16	2722	38 36	1565
July 3	18	3979	44 42	2635
July 6	22	4728	42 30	2865
June 27–July 6	102			
Means		3211	39 28	1914

The average ratio of elevation to length of wire for all heights is a trifle less than 0.60. This value is based on 102 observations. The ratio varied but little throughout the experiments. The average ratio for 18 elevations exceeding 3000 was 0.59. The average angular elevation of the kite was 39° 28′ for all observations, and 38° 30′ for the 18 elevations exceeding 3000 feet.

THUNDERSTORMS AT LINCOLN, NEBR.

By JAMES H. SPENCER, Observer, United States Weather Bureau, dated Lincoln, Nebr., December 19, 1903.

The following extracts, revised to December 1, 1903, are from an article on Thunderstorms, by Mr. James H. Spencer, Observer, United States Weather Bureau, Lincoln, Nebr., which was officially published in the Proceedings of the Nebraska Academy of Sciences, Vol. VII:

Thunderstorms have more than usual interest to the residents of most of the States lying between the Mississippi River and the eastern slope of the Rocky Mountains. In this great region they probably supply not less than two-thirds of the precipitation during the summer months, and crop failure or success depends very largely upon their frequency, extent, and the amount of rainfall.

* * * * * * *

Careful records of thunderstorms have been kept for Lincoln, Nebr., since April 1, 1896, and although a longer record is necessary to establish trustworthy averages for comparison, the statistics deduced from the record for the eight years ending November 30, 1903, particularly for the crop seasons will be found of interest.

The total number of thunderstorms passing over the station[1] for the entire period was 302, or an average of 38 for each year. About 50 per cent occurred during the night (from 7:00 p. m. to 7:00 a. m.) and about 70 per cent. between noon and midnight. Nearly 90 per cent. were recorded as coming from some westerly direction. Two hundred and forty-four of the 302 thunderstorms, or 81 per cent. of the entire number, occurred during the forty months of the eight crop seasons—from April to August, inclusive—the time of year in Nebraska when moisture is most needed. The distribution of the storms by years, and for the five months of the crop season, the total rainfall for each month, and the approximate amount which fell during thunderstorms, are given in the following table:

Thus it is found that about 70 per cent. of the total amount of rainfall for the crop season is due to the passage of thunderstorms, and that the percentage of rainfall from thunderstorms during the most critical crop months in Nebraska—July and August—is still greater. The average rainfall for each crop season, excluding that due to thunderstorms, was only 6.25 inches.

* * * * * * *

The maximum wind velocity for the eight years, and the highest ever recorded for five minutes at Lincoln, was 80 miles per hour, occurring in the thunderstorm of May 12, 1896. No very great damage resulted from this storm.

The year 1900 furnished an unusual number of excessive wind and precipitation records for Lincoln. Both the number of thunderstorms and the rainfall were considerably above the normal. During the thunderstorm of July 15 over 3 inches of water fell, more than two-thirds of which occurred in one hour. A month later, on August 16 and 17, 4.27 inches of water fell in twenty-four hours, an amount more than 1 inch in excess of the normal rainfall for that month. During the thunderstorm of August 23, 0.61 of an inch was recorded in five minutes. At this rate our entire annual precipitation would occur in less than four hours. During the storm of August 21 occurred the highest wind velocity for the year, averaging 78 miles per hour for five minutes, but for one minute exceeding 100 miles per hour. Hundreds of trees were blown down or had large limbs blown off and the roofs of a number of buildings were badly damaged.

The summer of 1902 also gave some very interesting thunderstorm data for Lincoln. The total rainfall for June and July was 20.18 inches, or within 6.58 inches of the yearly normal; of this amount 86 per cent. occurred during thunderstorms. The July rainfall was 11.35 inches, or three times the normal amount. It is interesting to note that of this amount only 0.89 of an inch occurred during the twelve hours ending at 8 p. m.

The thunderstorm of May 26, 1903, was the most destructive on record at the station. A maximum wind velocity of 76 miles an hour was recorded. About one mile southwest of the office the storm appeared to be even more severe, and several large buildings were damaged by the wind to the extent of nearly $100,000.

Thunderstorms at Lincoln, Nebr.

Year and month.	Number of thunderstorms.	Precipitation (in inches). Total for month.	Precipitation (in inches). Total during thunderstorms.
1896.			
April	3	4.57	2.62
May	8	10.11	4.20
June	5	3.05	2.43
July	4	5.63	3.92
August	3	3.39	1.77
Total for crop season	23	26.75	14.94
1897.			
April	3	6.15	2.96
May	3	2.22	1.32
June	3	2.17	0.63
July	0	2.54	0.00
August	5	2.69	1.82
Total for crop season	14	15.77	6.73
1898.			
April	3	3.88	0.22
May	4	4.33	2.90
June	3	3.99	1.26
July	3	3.93	3.69
August	3	3.45	2.68
Total for crop season	16	19.58	10.75
1899.			
April	4	1.49	0.87
May	12	2.29	1.57
June	11	8.39	8.35
July	4	1.47	1.15
August	6	2.66	1.74
Total for crop season	37	16.30	13.68
1900.			
April	7	4.33	1.44
May	7	4.50	4.14
June	11	2.50	2.44
July	9	6.66	5.78
August	7	9.07	8.91
Total for crop season	41	27.06	22.71
1901.			
April	1	1.46	0.53
May	3	1.96	1.69
June	9	1.42	1.24
July	5	2.94	2.88
August	7	1.02	0.78
Total for crop season	25	8.80	7.12
1902.			
April	3	0.67	0.11
May	9	3.65	1.34
June	11	8.83	7.20
July	13	11.35	10.21
August	7	4.35	3.87
Total for crop season	43	28.85	22.73
1903.			
April	3	3.50	2.73
May	12	10.72	7.57
June	7	2.60	1.52
July	11	3.07	3.07
August	12	6.45	5.93
Total for crop season	45	26.43	20.82
Total for 8 crop seasons	244	169.54	119.48
Average for each crop season	30.5	21.19	14.94

[1] The instructions for Weather Bureau observers require that thunderstorms be recorded when thunder is heard at the station, without reference to any other feature.—ED.

RECENT STUDIES ON THE SOLAR CONSTANT OF RADIATION.

By C. G. ABBOT. Reprinted from Smithsonian Miscellaneous Collections (Quarterly Issue), volume 45. Published December 9, 1903. (Revised by the author.)

INTRODUCTION.

Within the last two years the observations of the Smithsonian Astrophysical Observatory under the direction of the