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West Indian hurricanes rarely occur except in the months June to November. Table 1 shows the monthly distribution of 69 major hurricanes from 1923 to 1946. It seems probable that in these months, especially in August, September, and October, there is such an unstable meteorological condition in those regions that only a slight impulse suffices to precipitate the cataclysm.

TABLE 1.—*Distribution of West Indian hurricanes, 1923-1946*

Month	June	July	August	September	October	November
Number	3	5	19	25	14	3

Many years ago the late Herbert Janvrin Browne came to me with a dozen dates of first reports of West Indian hurricanes. He pointed out that on these dates Smithsonian solar-constant values had been depressed. I was so sensible of the accidental errors of individual solar-constant results that I was inclined to regard his observation as merely a coincidence. However, I prepared a table of sequences of solar-constant values from 10 days before to 10 days after his dates. The mean value of the 21 columns did indeed show a slight depression at the date of first report, but so slight that I was disinclined to attribute any significance to it.

Since then the solar-constant values from 1923 to 1946 have all been carefully gone over and revised to final form. They are now, of course, several times as numerous as they were then. It has occurred to me to re-examine this question with the advantage of better and more extensive data.

With the kind advice of the United States Weather Bureau, I collected 69 dates, partly from the December numbers of Monthly Weather Review, partly from Tannehill's "Hurricanes," when major West Indian hurricanes occurred in the years 1923 to 1946. Six of these dates were omitted because of almost complete lack of solar-

constant data, or because of very closely overlapping sequences. Corresponding to each of the remaining 63 dates I wrote out the values of the solar-constant as observed at Montezuma, Chile, from 10 days before to 12 days after the dates when the hurricanes were first reported. On 17 of these remaining dates the 21-day sequences of solar-constant values, especially in the neighborhood of the hurricane dates, were so fragmentary that I disregarded them. This left 46 dates to be considered with more or less complete solar-constant sequences closely adjacent to the hurricane dates.

I should remark that I used the solar-constant values as observed, not those marked "preferred" in table 24, volume 6, Annals of the Astrophysical Observatory of the Smithsonian Institution. I also disregarded all marks of "grade." I have become convinced by several researches that the procedure used to obtain "preferred values" is undesirable, and that the "grades" of volume 6 were sometimes assigned with prejudice against wild values which after all may have been good. The daily solar-constant values from 1939 to 1946 are as yet unpublished but were made available to me. Mr. Aldrich informs me that when assigning "grades" to them he and his colleagues were very careful not to be influenced by the wildness of a value. Hence I felt justified in rejecting a very few discordant values of low grades in this later work. I may add that I rejected the solar-constant values of September 9, 10, and 12, 1930, which fall far out of line, because they preceded a spell of bad weather from September 11 to 24 when only 2 days of observation at Montezuma occurred in that whole interval, and these also gave values abnormally low. I also rejected the solar-constant value of September 25, 1923, because it is very abnormally high.

Table 2 gives the dates of hurricanes, including the entire 69, of which the 17 rejected for fragmentary sequences of solar-constant values are starred, and the 6 omitted as stated above have daggers.

Table 3 gives the values of solar constants for the 46 remaining hurricanes from 10 days before to 12 days after the date of first report. The number of solar-constant values included in each of the means is given just above the means themselves. The mean values are plotted in figure 1. As given in table 3 they should be understood as prefixed by 1.9 calories.

There appears a gradual descent of the solar constant prior to the date of reports, amounting to 0.0016 calorie. Then comes a sudden drop of 0.0031 calorie to a sharp minimum on the actual day of first reports. After that the solar constant recovers on the third day, but not quite to its former level.

Although the depressive effect is very clear in the mean values, not all the sequences of solar-constant values show a depression on the day of first report of a hurricane. In fact, of the 46 cases used to form the means, there are 14 in which on the day of first report of the hurricane the solar constant was observed as high, and in a few cases even slightly higher than on the days preceding and following. I doubt if this discrepancy should be attributed to accidental error. Hence we

TABLE 2.—*Dates of first report of major West Indian hurricanes, 1923 to 1946*

1923: Sept. 24.
1924: Aug. 16, 27; Sept. 14.
1925: Nov. 29 *.
1926: July 22; Aug. 21 †; Sept. 6; Oct. 14.
1928: Sept. 6 †.
1929: Sept. 22.
1930: Aug. 31.
1931: Sept. 6 *, 9 †.
1932: Aug. 11, 30 *; Sept. 26 *; Oct. 31 *.
1933: June 27; July 25 *; Aug. 17 *, 28 †, 31 †; Sept. 10, 16; Oct. 1, 26.
1934: June 4; Sept. 5; Oct. 1; Nov. 21.
1935: Aug. 31 *; Sept. 23 †; Oct. 19, 30 *.
1936: July 27; Aug. 28 *; Sept. 8, 24.
1937: Sept. 14, 20.
1938: Aug. 14, 23; Sept. 16.
1939: Oct. 12, 29.
1940: Aug. 5, 30; Sept. 11.
1941: Sept. 18, 23 *; Oct. 3.
1942: Aug. 21; Nov. 5.
1943: July 26; Aug. 30; Sept. 11; Oct. 11 *.
1944: July 30; Aug. 16; Sept. 8 *, 19 *; Oct. 13 *.
1945: June 20; Aug. 24; Sept. 11 *; Oct. 2 *.
1946: Sept. 12; Oct. 6 *.

* Rejected because of fragmentary sequences of solar-constant values.
† Omitted because of almost complete lack of solar-constant data.

are not to infer that a depression of the solar constant is always necessary to bring on a hurricane. Nevertheless frequently it appears to be the impulse which starts the cataclysm.

Lest some critic should suspect that the 17 dates rejected for fragmentary solar-constant sequences might have been unfairly rejected, and, if included, would lead to a different conclusion, I have thought well to take the mean values for all of the 17 rejected sequences, fragmentary though they are. The means are given in table 4 with the numbers of values entering into each mean. The means of these values are very divergent, partly because the observations are few, but more because parts of these sequences lie at different levels of

TABLE 3.—*Montezuma solar-constant values from 10 days before till 12 days after first reported dates of West Indian hurricanes*

Dates of first report	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12
1923, 9, 24	56	62	57	32	45	60	54	53	58	49	47	70	51	52	52	49	46	43	40	50	40	50	40
1924, 8, 16	61	64	60	45	41	39	..	38	44	45	45	45	41	32	..	..	..	..	32	38	44	37	44
" 8, 27	45	41	32	..	..	..	..	32	38	44	37	44	..	..	..	41	40	..	..	53	43	43	54
" 9, 14	..	..	53	43	54	..	..	..	40	51	47	50	..	46	..	55	49	44	45	..	..	..	54
1926, 7, 22	50	44	..	42	52	43	44	..	40	54	37	44	..	48	44	40	51	43	47	44	45	43	47
" 9, 6	56	44	57	..	37	37	47	40	39	47	49	47	47	44	..	44	..	35	..	..	..	41	48
" 10, 14	..	34	..	..	..	39	47	41	47	46	41	38	42	39	42	45	41	43	52	37	..	..	..
1929, 9, 22	42	31	37	37	40	33	37	42	44	38	31	45	41	48	45	..	40	46	40	35	46	39	..
1930, 8, 31	44	49	46	46	51	53	46	56	46	48	42	51	52	49	49	50	45	47	47	31	35	..	30
1932, 8, 11	38	..	..	52	47	..	45	48	48	38	39	47	43	..	..	44	..	32	..	..	..	..	36
1933, 6, 27	41	43	43	43	37	50	42	42	42	34	30	48	39	..	25	..	..	..	44	41	..	49	..
" 9, 10	39	49	..	..	35	45	50	47	50	55	..	39	48	41	45	40	46	49	47	52	..	..	59
" 9, 16	50	47	50	55	..	40	46	51	45	40	46	49	47	52	..	59	..	..	..	47	47	52	54
" 10, 1	..	59	..	..	..	47	52	54	40	..	41	..	..	55	..	..	..	..	52	..	51	56	46
" 10, 26	..	55	42	..	49	59	65	49	48	34	..	..	45	49	..	..	..	43	48	42	..	34	..
1934, 6, 4	51	43	44	44	47	45	45	..	..	52	56	52	45	46	..	..	61	..	..	..	52	56	57
" 9, 5	45	48	..	..	..	..	37	39	45	51	53	53	50	52	47	43	49	47	49	57	51	48	..
" 10, 1	54	51	..	52	49	39	50	47	..	..	44	51	47	47	54	52	51	..	54	..	43	59	57
" 11, 21	53	..	..	52	58	..	..	..	49	52	48	49	51	..	50	45	58	54	49	51	50	55	51
1935, 10, 19	..	..	46	44	..	49	48	55	52	48	..	33	31	..	47	41	..	52	..	48	50	50	45
1936, 7, 27	..	40	..	..	49	50	46	39	45	45	49	47	43	44	42	43	..	..	..	..	..	..	44
" 8, 28	..	..	45	41	41	45	49	47	45	42	..	..	52	..	..	..	..	..	36	..	38	41	39
" 9, 8	..	52	..	..	..	..	..	36	..	38	41	39	..	43	40	38	40	41	44	41	38	50	55
" 9, 24	40	41	44	41	38	50	55	54	52	49	51	57	42	44	47	41	45	43	47	42	..	..	..
1937, 9, 14	..	38	41	52	48	50	43	47	51	46	48	..	48	59	47	47	46	51	46	43	43	30	36
" 9, 20	43	47	51	46	48	..	48	59	47	47	46	51	46	43	43	30	36	38	36	40	43	40	..
1938, 8, 14	..	..	41	48	50	49	..	..	..	51	49	49	43	46	42	46	47	48	46	..	50	42	..
" 8, 23	51	49	49	43	46	42	46	47	48	46	..	50	42	..	41	48	..	..	..	..	44	..	49
" 9, 16	52	..	..	46	38	48	48	50	48	33	..	..	39	47	45	53	42	46	48	51	50	46	49
1939, 10, 12	42	..	35	54	38	..	..	..	53	..	31	33	50	51	..	..	52	42	39	46	33	38	38
" 10, 29	52	42	39	46	33	38	38	..	44	41	22	31	28	36	..	..	..	..	..	..	43	35	38
1940, 8, 5	..	..	49	50	50	48	..	..	..	52	51	42	57	53	..	50	..	51	49	51	47	51	47
" 8, 30	51	55	52	53	..	..	..	..	..	47	47	56	..	48	55	52	64	55	..	..	..	..	..
" 9, 11	56	..	48	55	52	64	55	..	..	46	..	..	60	41	63	55	..	61	55	58	57	..	52
1941, 9, 18	..	..	58	45	54	51	..	..	..	49	48	56	54	..	66	..	..	..	..	..	..	51	..
" 10, 3	55	..	..	..	..	..	51	..	42	59	55	57	52	58	52	48	..	..	49	53	51	51	..

1942,	8, 21	51	47	42	..	47	41	41	44	53	49	39	47	51	50	..	43	30	43	39	45	49	..	44
"	11, 5	50	46	50	46	42	..	46	45	47	47	47	..	42	..	38	41	52	47	51	45	53	51	50
1943,	7, 26	32	..	47	47	49	48	49	48	47	49	..	48	..	54	52	52	52	47	49	44	46	53	43
"	8, 30	..	52	54	55	52	54	52	48	57	52	44	27	45	47	47	51	51	49	51	43	39	..	35
"	9, 11	..	46	47	47	51	51	49	51	43	39	35	45	49	50	49	..	51	50	54	45	44	..	44
1944,	7, 30	..	..	..	41	36	..	32	43	44	52	28	40	..	..	44	45	50	51	43	44	39	47	..
"	8, 16	44	45	50	51	43	44	39	47	45	29	25	41	46	43	45	44	..	..	58	..	..	..	..
1945,	6, 20	49	48	46	43	42	37	39	43	45	47	46	..	..	..	46	51	36	47	47	..	..	..	45
"	8, 24	43	44	42	..	46	..	..	21	36	04	21	..	30	34	..	..	..	..	..	33	..	..	..
1946,	9, 12	..	..	..	40	45	48	51	48	44	46	49	..	41	46	49	39	..	..	..	..	..	44	..
Sums		1436	1456	1497	1577	1680	1536	1632	1551	1751	1931	1605	1601	1680	1637	1453	1529	1271	1536	1533	1319	1336	1382	1400
Numbers		30	31	32	34	37	33	35	34	38	43	38	35	37	35	31	33	27	33	33	29	29	30	30
Means		479	469	468	464	466	465	466	456	461	449	422	457	454	468	469	463	471	465	465	455	461	461	467
Means of threes			472			465			461						464			466			459			

TABLE 4.—*Mean values of solar constant from 17 fragmentary sequences*

Days from 1st report																								
No. of days	−10	−9	−8	−7	−6	−5	−4	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	11	12
Number reporting	9	11	8	10	12	11	14	11	15	11	8	9	11	10	10	8	9	8	10	11	13	12	15
Mean values	502	445	476	436	433	444	441	445	433	449	454	434	427	439	435	411	433	426	436	450	413	442	435
Means of threes		474			438			439						434			423			436			

the solar constant. If in any column it happens that fragments of sequences remain representing periods of prevailingly high solar constant, and in another column the fragments which remain represent prevailingly low periods of the solar constant, the two means are not comparable. Unfortunately the mean at the hurricane day is among the weakest in table 4, having fewest observations, only 8 out

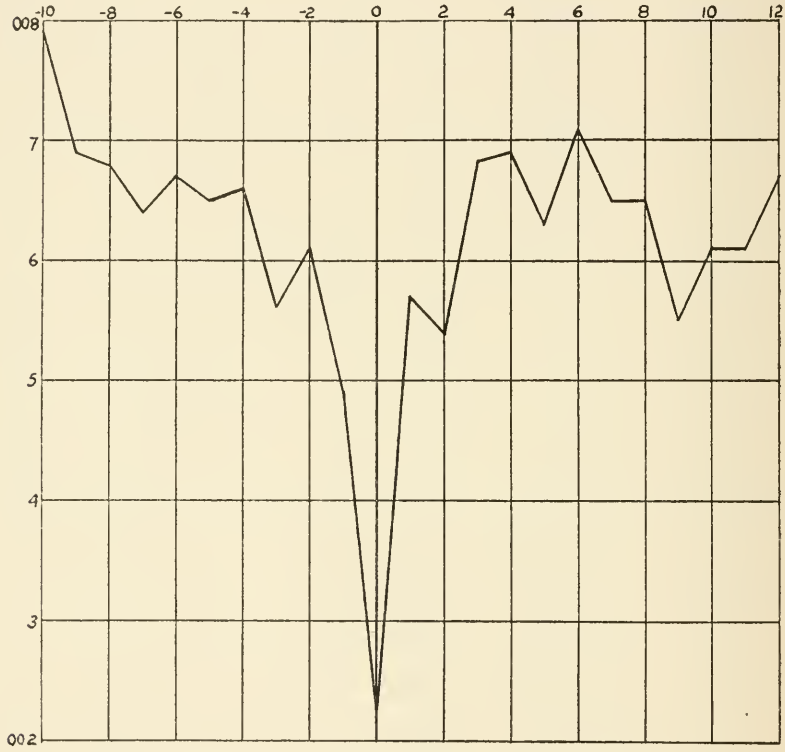

FIG. 1.—Mean solar-constant values preceding and following first reports of West Indian hurricanes. Abscissae, days before and after report dates; ordinates, solar-constant values, to be prefixed by 1.94.

of 17 cases reporting. Despite the paucity and raggedness of these data, they tend, on the whole, in the same sense as table 3. That is, the solar constant tends to decrease before the hurricanes, and does not quite recover to its former average value within 12 days afterward.

Although we may wish that stations better even than Montezuma might have been available, so that solar-constant values could have been more accurate and more complete, the results of this investiga-

tion, and of those that I have described in several earlier papers,[1] show that these solar-constant values are useful, that they disclose solar variations which are correlated with solar and terrestrial events, and that the variations of solar radiation are of major importance for meteorology.

Although the present research shows, I think definitely, the importance of solar variation in starting West Indian hurricanes, it cannot serve as a basis for predicting them for several reasons. First, the depression of solar radiation is not clearly marked until the beginning of a hurricane is already observed. Second, it appears that a considerable proportion (though still a small minority) of the hurricanes start without the impulse of a fall in solar radiation. Third, no doubt depressions of solar radiation occur, even in the hurricane season, when conditions are not ripe for a cataclysm. Finally, even if the probable formation of a hurricane could at some future time be anticipated for a few days by aid of greatly improved solar observations, there would still be no way to predict where it would start, or whither it would travel.

What has been accomplished here is, first, to show that changes of solar radiation are of importance in starting hurricanes; second, to confirm earlier impressions that Smithsonian solar-constant values, imperfect and incomplete as they are, still are helpful in the discussion of meteorological phenomena.

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[1] Smithsonian Misc. Coll., vol. 94, No. 10, 1935; vol. 95, No. 12, 1936; vol. 95, No. 15, 1936; vol. 101, No. 1, 1941; vol. 104, No. 5, 1944; vol. 104, No. 12, 1945; vol. 104, No. 13, 1945; vol. 107, No. 4, 1947; vol. 107, No. 9, 1947; vol. 107, No. 10, 1947. See also Ann. Rep. Smithsonian Inst. for 1935, pp. 93-115, and for 1944, pp. 119-154. Also, of course, vol. 6, Annals, Astrophysical Observatory of the Smithsonian Institution.