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PORTO RICO and the VIRGIN ISLANDS

VOLUME XIX—Part 1

Meteorology of the Virgin Islands

Robert G. Stone

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This natural history survey of Porto Rico and the Virgin Islands, conducted by The New York Academy of Sciences, was established in 1913. Continuous publication of the results of this survey is made possible through contributions from the Department of Agriculture and Commerce of Porto Rico, and the University of Porto Rico.

METEOROLOGY OF THE VIRGIN ISLANDS

By Robert G. Stone*

CONTENTS

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Text Tables

Appendix Tables

Figures

ACKNOWLEDGMENTS

This part of the volume on meteorology was not envisaged by the late Dr. Oliver L. Fassig, who restricted his projected volume to Porto Rican meteorology alone. While the present author was in Porto Rico in 1939 on invitation of the School of Tropical Medicine, the opportunity arose to extend the scope of the study to include the Virgin Islands. The appropriateness of this extension is obvious; but it would not have been possible to offer such a comprehensive discussion had the writer not been able to visit the U. S. Weather Bureau at San Juan and the U. S. Marine Corps Aerological Station on St. Thomas.

We are happy to acknowledge the favors of many people in the islands, who, in one way or another, aided the work on this part of the monograph. Special thanks are due to Mr. Morris de Castro, Secretary to the Virgin Islands Government, to Col. Francis P. Mulcahey, in command of the U. S. Marine Corps base at St. Thomas in 1939, and to Mr. N. N. Nichols, Director of the Experiment Station, St. Croix, for facilitating the acquisition of data and general information in the field; to Sgt. Michael Davidovic, U.S.M.C. Aerographer, formerly stationed at the Marine Corps base at St. Thomas, who under authority from his superior officers was most helpful in putting at my disposal the facilities and observations of the station at Bourne Field; to Mr. R. W. Gray, official in charge, and to his assistants, Messrs. Kronberg, Cintrón, and Maldonado, of the U. S. Weather Bureau, San Juan, for their help in copying and tabulating data from their files; to my own assistants at the School of Tropical Medicine, Miss Maria Ruísanchez and Mr. George del Toro, Jr., for their faithful and intelligent handling of many tedious computations and tabulations; to Hon. W. C. Roy, Agricultural Officer of the British Virgin Is., for a transcript of weather observations at the Experiment Station, Tortola. Dr. George W. Bachman, Director of the School of Tropical Medicine, San Juan, and Prof. Gleason W. Kenrick of the University of Porto Rico, have made available for this part of the work all the resources which were also provided for the Porto Rican section, acknowledgment for which is made in detail in Part 3.

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Prof. Earl B. Shaw of Worcester (Mass.) State Teachers College has generously allowed us to reproduce passages and illustrations from his Doctoral Dissertation on the Virgin Islands (Clark University, 1931).

Mr. Harold Larson, in charge of the Territorial Section of the National Archives in Washington, kindly searched the Virgin Islands records in the Archives for climatological material; he discovered the large series of hitherto unpublished Danish West Indies weather observations which we have summarized and printed herewith, a most remarkable and valuable find. We are also indebted to him for translating several articles from the Danish. Mr. J. B. Kincer, Chief of the U. S. Weather Bureau's Division of Climate and Crop Weather, provided facilities of his staff for computing the averages from these data.

We are grateful to Mrs. H. W. Dooley, Mrs. G. W. Kenrick, Misses Maria Velasquez, Rose Vickers, Edna Scofield, Leoni Bleston, Mr. Ralph Burhoe, and Mr. B. Acevedo, for kindnesses and help in certain particulars.

INTRODUCTION

The chapters in this section are in the form of topical notes designed to assist in interpreting the weather observations summarized in the accompanying tables and in the literature (see annotated bibliography at end). No attempt is made to give a complete or well-rounded analysis of all the elements nor a synthesis of the general character of the climate, as it does not differ sufficiently from the climate of Porto Rico which is described in Part 3 of this volume. The meteorological background of Porto Rican climate also applies generally to that of the Virgin Islands, because the latitude, wind system, and surrounding ocean surfaces are essentially the same. The differences are due mainly to the smaller area and lesser elevations of the Virgin Islands.

From the standpoint of climate, geology, soils, and vegetation, the islands of Vieques and Culebra, political dependents of Porto Rico, should be considered as part of the Virgin Islands; but the climatic data for them are given in the section on the meteorology of Porto Rico, in order to conform to the political alignment, for the convenience of those who will use the observations.

HISTORY OF THE OBSERVATIONS

The history of weather observations in the Virgin Islands is rather interesting. Excellent data were compiled during the Danish régime, from about 1825 on (APPENDIX TABLE 1). Educated Europeans working in the islands early took an interest in the climate and as a result there are extant several series of regular observations by instruments from the period before the Danish Government officially organized the taking of observations in 1876–77. Some official Danish stations were still reporting in 1917, but thereafter the United States Government gave no special attention or encouragement to these or other weather observers, except at Charlotte Amalie and Christiansted, until the U. S. Weather Bureau began to establish more "cooperating" stations in 1920. The Bureau increased the number of cooperating stations in 1938–39. Since about 1830 many of the sugar estates on St. Croix and some on St. John and St. Thomas measured rainfall for their own interest. Some of these observations found their way into print, but most of them were inaccessible until 1911 when the Agricultural Experiment Station began to collect the current data and publish them. Many of the early records are lost, though some are on file at the Danish Meteorological Institute in Copenhagen. Finally, the observations of travelers and visiting ships, though covering very brief periods, may illustrate some important details of the weather. Numbers of these appear in the literature, but as there is no bibliographic guide to them, they remain mostly unknown to those who might use them.

HOMOGENEITY OF THE RECORDS

It must be emphasized that as most of the various weather records for the Virgin Islands are not strictly comparable with one another because they cover different periods and were made in different ways, great caution must be used in drawing conclusions from them as to *geographical* distribution of temperature and rainfall. The interpolation of missing observations for certain days or months in a broken series, by comparison with the records of nearby stations, is seldom justified in this region, except possibly with temperatures, because the weather is marked by decided local contrasts. Localities only half a mile apart at the same elevation and in the same valley can have very different rainfall values; likewise showers are usually so limited in area that within a day or month it is largely chance that two neighboring places receive the same rainfall. These anomalies of locality and of short periods tend to equalize over longer periods, so that the total annual rainfalls of neighboring stations generally show a parallel or definitely correlated course, however different their normal or average precipitation may be.*

In the tables, the records of the Danish period are in most cases separated from those of the American period, because the kinds of instruments used, instructions followed (see APPENDIX A), and other circumstances affecting the official records were uniformly different. Unofficial observers both in the Danish and American periods probably used a variety of instruments and conventions. In most cases these circumstances are unknown, and therefore it is well to accept such records with reservations. On the other hand some of these private records are undoubtedly more accurate than some of the official ones.

TABULATIONS

In APPENDIX TABLE 1 is a list of the stations and their periods of records, with elevations, elements recorded, and place of publication or file. Inquiries in the Virgin Islands and in Denmark would probably turn up much more of such essential information. The records of the Danish colonial government of the islands and files of some of the island newspapers,

* The parallelism of the mean rainfall of two neighboring stations is tested by the *constancy of the ratios,* month by month or year by year, between the rainfalls of the two. The parallelism of the mean temperatures at neighboring stations is tested by the *constancy of the differences* between the means, month by month or year by year.

now deposited in the National Archives in Washington, were examined for weather records by Mr. Harold Larson in charge of the territories section in the Archives. He discovered the manuscript reports of the official Danish observations for St. Thomas and St. John from 1877 to 1917; complete except for a few missing months. As these had never been published, except from 1877 to 1888 in the "Sct. Thomae Tidende", an abstract was made of them and means computed (APPENDIX TABLES 2 and 3). The official observations from St. Croix apparently were mostly sent to Denmark where some were published and the rest probably filed in the Danish Archives or the Danish Meteorological Institute. Their inaccessibility will not be so keenly felt, because we have fairly extensive published records for many St. Croix stations since 1911, as well as the Christiansted record from 1875, and some other miscellaneous data. For the other islands, however, the Danish period supplies the chief material, though very recently in the American régime considerable data are again being obtained.

Relatively much less material is available for the British Virgin Islands. In fact, Schomburgk's paper of 1837 is still the best discussion of the climate. The modern records cover only a few decades at Tortola and Virgin Gorda. The absence of plantation agriculture in the last hundred years no doubt accounts for the lack of interest in keeping weather records there.

Tabular summaries of pressure, temperature, rainfall, humidity, evaporation, sunshine, cloudiness, winds, visibility, and some upper-air conditions are given in TEXT TABLES 1 to 23 and in APPENDIX TABLES 2 to 10.

GENERAL CLIMATIC FEATURES

The general climatic features do not differ from those in certain parts of Porto Rico, e.g., Vieques, Guayama, Arecibo, and Isabela, but on the average the rainfall and relative humidity are less, the sunshine greater. Indeed the traveler from Porto Rico or from other rainier parts of the Caribbean will be impressed by the prevailing moderate dryness or semi-aridity of the Virgin Islands, which the vegetation reveals at every hand.

The islands are so small that the climate approaches more nearly that of the surrounding ocean than in the case of Porto Rico. Some of the extremes of temperature and rain recorded in the latter island are probably never attained in the Virgin Islands. Owing to their more easterly location, the influence of continental cold-air outbreaks from higher latitudes is weaker than in Porto Rico. In the winter half-year storms passing across the Atlantic in higher latitudes cause the same constant heavy ground swells from the north as are observed in the islands farther west (a fact noted and correctly explained by Schomburgk in the 1830's).

Before introducing details about the variation of each of the weather elements over the islands, it may assist the general reader as well as the specialist to have a concise view of all the elements for one typical station on St. Croix and one on St. Thomas. The official Danish observations at Christiansted from 1875 to 1916 are the most complete for any Virgin Islands station and serve this purpose well. The averages of each element are tabulated together in TEXT TABLE 1 for ready comparison. Further details for Christiansted are given in other tables under special headings and in the appendix tables. The summary for Charlotte Amalie (TEXT TABLE 2) is a copy of the table prepared by the U. S. Weather Bureau for use in the publications of the U. S. Hydrographic Office. The figures in these tables do not agree in detail with some of those given for the same place elsewhere in this monograph, owing to differences in period of years covered, or in the source of the data. Also, the wind-velocity and cloud-amount data for Charlotte Amalie cover such a few years that they are probably misleading as to details of the month to month variations.

VEGETATION AND CLIMATE

It has long been recognized that types of virgin vegetation as well as various species of plants are usually limited in their geographical distribution by some climatic factors. In earlier times this obvious fact was often used to judge the suitability of new lands for crops and settlers. Early travelers to the Virgin Islands described its vegetation. Later observers compared the contemporary scene with past accounts. In this way some curious notions about the climate, particularly as to alleged changes with time, have become popular in the islands.

The results of modern botanical and geographical studies do not reveal any simple correlation of climate and vegetation. But when proper allowance is made for non-climatic factors, such as soil, plant succession, effects of deforestation, grazing, and cultivation, introduction of new species, etc., a general association of the boundaries of the "climax vegetation" types with certain mean temperature and rainfall limits is evident.* "Climax vegetation" is the ecologist's term for the virgin growth which represents the most luxuriant that the given climate will support, the final equilibrium stage of the plant succession.

In the absence of extensive systematic instrumental observations of the climatic elements, the climax vegetation may serve as a rough indication of the climatic type. It is, however, a problem for the well-trained and ex-

* Well described in James, P. E. "An outline of geography", N.Y., 1937; and in "Climate and Man", 99–127. U. S. Dept. Agric., Yearbook for 1941.

Text Table 1

Summary of Danish Weather Records at Christiansted, St. Croix, 1875–1916*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean max. temp. (17 yrs., 1900–16) °F.	80.8	80.8	81.7	82.8	84.9	85.6	85.8	86.2	86.5	85.8	84.2	82.0	83.9
Mean min. temp. (17 yrs.) °F.	72.3	71.8	72.1	73.6	75.6	76.6	77.0	77.5	77.0	76.3	75.2	73.6	74.9
Mean temp. (17 yrs.) °F.	76.6	76.3	76.9	78.2	80.2	81.1	81.4	81.8	81.8	81.0	79.7	77.8	79.3
Mean temp. (28 yrs., 1892–1916) °F.	76.6	76.3	76.8	78.3	79.9	81.0	81.5	82.0	81.7	80.8	79.3	77.5	79.3
Highest temp. (33 yrs., 1882–1915) °F.	86	87	91	91	95	96	94	91	91	91	92	91	96
Lowest temp. (33 yrs.) °F.	65	66	64	67	69	69	70	70	69	69	69	65	64
Relative humidity:													
mean (8 A.M. + 2 P.M. + 9 P.M.) (17 yrs.) %	74	73	72	72	74	76	74	75	77	78	78	77	75
mean (2 P.M.) (4 yrs., 1913–16) %	68	70	65	68	72	69	69	69	70	72	75	72	70
Cloudiness: mean (8 A.M. + 2 P.M. + 9 P.M.) (19 yrs.) tenths of sky	3.7	3.5	3.5	3.7	4.0	4.4	4.3	3.9	4.0	3.9	3.7	3.7	3.9
Rainfall: mean (37 yrs., 1875–1916) inches	2.32	2.05	1.24	2.97	4.39	4.53	3.46	4.26	5.59	5.88	5.89	3.87	46.43
Ave. no. days with rain (37 yrs.)	13	10	7	8	11	11	12	12	12	13	14	13	136
Ave. no. of thunderstorms (19 yrs.)	0.2	0.05	0.05	0.4	2	2	2	3	2	3	1	1	16
Prevailing wind dir. (to nearest 8 points) (4 yrs.)	E	E	E	E	E	E	E	E	E	E	E	E	E

* Reed, W. W. U. S. Mon. Wea. Rev. pp. 133–160. April 1926. Based on Dr. Neumann's records published in the Yearbooks of the Danish Meteorological Institute, Copenhagen, 1875–1916. They were taken in the town proper near sea level, and with standard instruments. The instructions of the Danish Meteorological Institute were followed. There were no observations for 1878–81, and those for 1876, 1877, 1899, and 1916 were not complete for all months.

Text Table 2

Climatological Summary, Charlotte Amalie, St. Thomas, 1917–1936*

(Prepared by U. S. Weather Bureau)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Air temperature °F.													
Mean													Mean
Monthly, 1917–36	77	77	78	79	80	82	82	83	83	82	81	79	80
Maximum, 1921–36	82	81	82	83	85	86	87	88	88	87	85	83	85
Minimum, 1921–36	73	72	73	75	76	77	78	78	78	77	76	74	76
Extreme													Extreme
Maximum, 1923–38	85	85	87	89	89	90	90	91	92	91	91	89	92
Minimum, 1923–38	65	63	67	68	66	70	71	70	68	70	68	69	63
Rainfall													Total
Ave. amount in inches	2.99	2.21	2.21	2.09	4.60	2.91	3.68	4.42	6.17	6.12	6.25	3.10	46.75
Ave. no. of rainy days, 1921–36	17.9	12.2	13.2	11.2	14.1	14.6	16.9	17.6	17.0	15.8	17.2	17.6	186
													Extreme
Maximum in 24 hours in inches, 1921–36	2.33	1.56	1.50	2.81	7.28	3.41	5.28	4.65	10.02	4.15	3.55	2.12	10.02
Wind													
Mean velocity mi./hr.													Mean
at 8 A.M., 1917–21	6.7	6.3	6.9	5.6	6.8	6.5	6.8	7.4	6.2	5.2	5.0	6.3	6.3
Mean velocity mi./hr.													
at 8 P.M., 1917–21						7.3	8.9	8.1	5.8	6.1	5.2		
Percentage of observations from†													Mean
N	1	2	1	‡	‡	‡	‡	1	1	‡	3	1	1
NE	30	24	17	11	5	2	9	14	13	15	24	28	16
E	56	55	58	58	55	67	78	64	51	52	42	60	58
(1917– SE	5	9	14	24	34	28	12	14	22	20	14	5	18
1936) S	1	1	3	3	4	1	‡	4	5	4	2	1	2
SW	1	2	2	0	1	‡	‡	1	2	3	3	‡	1
W	‡	0	‡	0	‡	‡	0	‡	‡	‡	1	0	‡
NW	‡	‡	1	0	‡	0	0	‡	‡	0	2	‡	‡
Calm	6	7	3	3	2	‡	‡	1	5	5	9	5	4
Barometric pressure, in. at sea level, 1919–28													Mean
Mean (8 A.M. + 8 P.M.)/2	30.03	30.03	30.05	30.03	30.00	30.02	30.04	30.01	29.95	29.94	29.95	30.00	30.00
Highest	30.18	30.18	30.18	30.17	30.13	30.16	30.16	30.15	30.08	30.06	30.10	30.16	30.18
Lowest	29.87	29.84	29.85	29.88	29.83	29.91	29.85	29.73	29.30	29.71	29.75	29.81	29.30
Cloud amount (0–10), 1917–20													Mean
8 A.M.	4.2	4.0	4.0	4.0	5.3	6.0	5.3	3.8	4.4	4.3	4.8	4.0	4.5
8 P.M.						4.6	4.8	3.3	3.8	3.7	4.1		

* U. S. Customs House; two-story stone building in town on shore of harbor; elevation 27 feet; Lat. 18° 13′ N.; Long. 64° 29′ W.
† (8 A.M. + 8 P.M.)/2 for June–November; other months 8 A.M. only.
‡ A few cases, but less than 1 per cent.

perienced ecologist or geographer; the amateur is apt to overlook important factors and thus come to unscientific conclusions.

Even the existing "secondary" vegetation, greatly altered as it often is by the artificial influences of human settlement, may suggest climatic conditions which are otherwise unnoticed or outside the scope of ordinary instrumental observations of the weather elements. This is particularly useful in studying local influences of the vegetation on the *microclimates,* the small-scale variations in the air layers near the ground which have much practical importance for man and agriculture.

A description of the vegetation (not the flora) is therefore not out of place here. Since practically no detailed quantitative ecological field studies have been made in the West Indies, the interpretation of the vegetation-climate relationships is necessarily conservative and general.

Bøgeson, writing in 1898, sketched the forest situation succinctly:

> "In consequence of their location, the islands have a tropical vegetation, but the comparatively scanty rainfall does not, as a rule, permit the development of as rich and luxuriant a plant life as is found in other places in the Tropics where the precipitation is greater. In spite of this, however, the vegetation may be almost as rank as that of the jungle in valleys possessing a sufficient supply of moisture. As in all small islands, with a relatively large population, man's intervention has left its stamp on the vegetation. The story goes that at the time of their discovery they were covered with thick forests of which, however, hardly anything is left. During the period of colonization the forests were burned off and the little that probably survived, along with what later grew up, has been partly destroyed by reckless cutting, a practice which is indulged in up to the present time. There is nevertheless some forest vegetation in the northwestern part of St. Croix, on some mountain slopes of St. Thomas, and especially in St. John, but mostly of secondary growth. The original vegetation in all probability is best preserved in the mangrove swamps along the coasts and in the forests growing on the sandy beaches, where the quality of the soil gives no encouragement to cultivation".

Although the vegetation was undoubtedly originally "forest" (i.e., merely arborescent) in most parts, it probably included some of the very dry thorn-bush landscape which appears more widely today. St. Croix, St. Thomas, and St. John, at least, were all deforested during the 18th and early 19th centuries by cutting to provide timber and by burning to clear for cultivation. On most of St. John the bush has been allowed to return, and it is now returning to much of St. Thomas, although St. Croix, except for the dry eastern end and the hilliest northern sections, remains largely under cultivation for sugar cane or in pasturage for cattle. Grazing is also an important industry on St. Thomas. Grass, thorn forest, and bush are generally conspicuous on St. Croix today, which, owing to its greater range of climates and soils, is said to have a greater variety of vegetation types than the other islands.

There are numbers of endemic species, but they do not seem to have specialized climatic adaptations. Britton and Wilson (1923: 4) observed that

> ". . . they are scattered in distribution, not being restricted to wet, dry, high or low districts or to specific types of soil, though many of them appear from our present knowledge to be very local in distribution. All the endemic species are more or less closely related to other species inhabiting other West Indian islands, indicating community of origin, and differentiation through isolation".

The vegetation has been so altered by man that much caution must guard any inference about climate from the present character and distribution of the vegetation. The heaviest woods on St. Thomas are now growing in certain ravines on the north side of the island, but one cannot conclude that the rainfall is therefore more abundant in that vicinity; evaporation, topography, desirability of the soil for other purposes, charcoal burning, grazing, lumbering, and accidents of plantation abandonment also have to be considered.

In connection with this question, the following statement in a recent official publication* is of interest,

> "It has been generally supposed that the Virgin Islands were once covered with mahogany and other valuable cabinet woods and that dense forests of these trees were cut off in the early days and then again later to make place for cane when the slave labor cultivated even the steep hillsides. Qualified foresters, however, consider this extremely doubtful, and do not believe that these cabinet woods were ever plentiful on these islands. They do grow well here, but the specimens scattered sparsely throughout the islands or standing in clumps about old ruins and along the sides of many roads, are believed to have been imported. Little natural young growth of these trees is to be found, but thousands are now being set out, and seem to do well. Most of St. Thomas and St. John and much of St. Croix is thickly covered with many different types of trees, but these are not of accepted commercial value, nor of size or character to be considered forests. Where the land is not cleared for cultivation or grazing, these scattered trees are interspersed with dense growths of underbrush and vines that rapidly reclaim any land that is left uncared for even a year or two. Many of these trees afford food in the form of wild fruits, such as the mango, the soursop, etc.; but most of them are valuable only as wood for the burning of charcoal — the universal fuel of the Virgin Islands".

The dry vegetation of eastern St. Croix, where the rainfall probably averages but 25 inches or less a year, considerably resembles some of that of the semi-arid southwestern United States and northern Mexico.†

The trees and bushes on exposed slopes have been forced by the prevail-

* "The Virgin Islands of the United States", p. 5. U. S. Dept. of the Interior, Washington, D. C. 1935.

† Cf. Shreve, F., Lowland vegetation of Sinaloa. Bull. Torrey Bot. Club **64**: 605–613. Dec. 1937. Britton, N. L., Cactus studies in the West Indies. Jour. N. Y. Bot. Garden **14**: 99–109. 1913; The vegetation of Anegada. Mem. N. Y. Bot. Garden **6**: 565–580. 1916. Gleason, H. A. & Cook, M. T., Plant ecology of Porto Rico. Sci. Surv. Porto Rico and V. I. **7**: 1–173. 1927.

ing trade winds to grow with a bend to the leeward; this asymmetry is presumably due to the effect of the salt carried by the wind and deposited on the exposed branches. The wind-deformed vegetation points rather uniformly towards west by south, suggesting that the prevailing wind direction is from slightly north of east. Actually such a wind direction predominates only for the winter season, so that probably the stronger winds and more salt spray of the winter months have a predominating effect on the vegetation (see FIGURE 1A).

ATMOSPHERIC PRESSURE

Barometric observations in the Danish period are available from Hornbeck's record (1833–51) at Charlotte Amalie, from Ste.-Claire Deville's (1848) and Stenzel's visits (1886) to St. Thomas, and from the official Danish station at Christiansted (1875–1916). During the hurricane season (July to October), special daily barometer reports have been made at St. Thomas since 1878, first by A. Wallöe and later by the harbor masters. These were cabled or radioed to San Juan or to the United States for the U. S. Government weather service. It appears that these observers read the barometer in other months also, but only the means computed from these reports for the years 1919–28 are available (TEXT TABLES 2 and 3). Such reports were also made from Christiansted, but no tabulations were published. For some years after 1911, the Experiment Station at Anna's Hope, St. Croix, maintained an aneroid barograph, and photographs of the daily charts for several years are reproduced in the first two reports from the station. These give as adequate a picture of the pressure variations as necessary for most purposes, and their value is enhanced by the concurrent temperature curves which are reproduced in the same reports. The extremely low pressures experienced in hurricanes are illustrated in Appendix B. Barograph records are now being kept at the aerological station at Bourne Field, U. S. Marine Corps, on Lindbergh Bay, St. Thomas, and probably at the new Army air bases on St. Croix. No pressure readings for the British Virgin Islands are available except those of Schomburgk (1833–37), which are not reduced to sea level. All the early 19th century observations are from instruments of doubtful accuracy.

As in Porto Rico, many planters, merchants, and professional men own a barometer of some sort which is watched during the hurricane season for signs of local disturbance, in spite of the efficient broadcast warning service now available from the U. S. Weather Bureau at San Juan. These instruments are often improperly calibrated, uncompensated, and exposed

A

B

FIGURE 1. Effects of weather on vegetation.

A. Tree deformed by prevailing wind. Picture taken a few miles east of Christiansted, near the north coast of St. Croix. (Photo by E. B. Shaw, 1930.)
B. Dry weather is sometimes fatal to the palm trees as well as to the sugar crop. These palms "lost their heads" during a severe drought period on St. Croix. (Photo by E. B. Shaw, 1930.)

at various elevations, so that the readings from them are usually reliable only for showing relative changes in the pressure rather than the absolute values.

Pressure Variations

The barometric pressure mean values and variations observed in the Virgin Islands are entirely similar to those experienced at San Juan where an extensive and accurate series of readings has been kept by the Weather Bureau since 1899. The average is lowest in May and November and highest from January to March and July to August. The semi-diurnal daily cycle of the barometer (i.e., double maximum–double minimum at about 10 A.M. and 11 P.M., 4 A.M., and 4:30 P.M., respectively) is the most pronounced feature, as everywhere in the tropics, and at San Juan has an average amplitude of .063–.085 inch (=2.14–2.98 millibars), largest in February and July, least in May and November.

There are occasional spells of some days' or weeks' duration that may occur in any season, when the regular daily cycle is largely suppressed or greatly disturbed by various factors, including cloudy or rainy spells, hurricanes, and longer-period pressure "waves". In addition there are gentle swells in the general level of the barometer curve, rising and falling in long steady swings lasting several days to several weeks. These are often associated with noticeable changes in temperature and rainfall and are due to disturbances of the trade winds set up by passing cyclones and anticyclones in higher latitudes in winter, and in summer to the changes in the intensity and position of the Azores-Bermuda anticyclone and passing allobaric systems.* In the winter half of the year nearly all the coolest nights recorded at the Experiment Station at Anna's Hope, St. Croix, occurred during the middle of a few-days period of relatively low pressure for that season, and vice versa the warmest days (highest temperatures) come at times of higher than normal pressure for the season. This relation is probably general, at least for all sheltered locations in the interior of an island.

Knox (1852) correctly observed, ". . . with NE winds the barometer almost invariably rises, and generally falls when the wind is SE or S. We have observed it to rise to 30.15 inches with a fresh NE breeze, but this great tide seldom takes place. Passing showers seldom or never cause the mercury (i.e., the barometer) to fall . . ." The little fluctuations on the barograms when showers or thunderstorms pass are usually less than one millibar in amplitude.

* Frolov, S., Bull. Am. Met. Soc. 22: 198–210. 1941; *id.*, "On the synchronous variations of pressure in tropical regions", in the same journal, (5) 1942. Dunn, G., Bull. Am. Met. Soc. 21: 215–229. 1940.

Text Table 3

Sea-Level Mean Pressures at St. Thomas (in inches)*

(With Extensions by Reduction from Readings at San Juan, P. R., 1899–1933)

Hour, Atlantic Standard Time		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
8 A.M. (1919–28) 10-year mean		....	....	....	....	....	....	30.03	29.99	29.95	29.93	....	....
6 P.M. (1919–28) 10-year mean		....	....	....	....	....	....	29.99	29.95	29.91	29.89	....	....
8 A.M. + 8 P.M. 10-year mean (1919–28)		30.03	30.03	30.05	30.03	30.00	30.02	30.04	30.01	29.95	29.94	29.95	30.00
Probable true 24-hr. mean		30.01	30.01	30.00	29.97	29.96	29.99	30.01	29.97	29.92	29.90	29.91	29.97
Reduced to 30-year normal (1899–1933) (compared to San Juan)	mb.*	1016.9	1016.9	1016.6	1015.6	1015.2	1016.3	1016.6	1015.6	1013.8	1013.2	1013.5	1015.6
	in.	30.03	30.03	30.02	29.99	29.98	30.01	30.02	29.99	29.94	29.92	29.93	29.99
Probable highest reading (1899–1933). Estimated from San Juan		30.23	30.22	30.23	30.20	30.17	30.16	30.19	30.18	30.12	30.19	30.14	30.18
Probable lowest reading (1899–1933). Estimated from San Juan		29.76	29.70	29.77	29.71	29.73	29.82	29.60†	29.28†	28.83†	29.57†	29.65†	29.78

* Since 1939 the U. S. Weather Bureau has been reporting pressures in *millibars* rather than inches; tables for conversion from inches to millibars or vice versa (and from millimeters) will be found in the "Smithsonian Meteorological Tables" and other handbooks of meteorology. The factor is 1 inch = 33.8640 mb. The mean station pressures at Bourne Field, 1937–38, are given in the table of upper-air data in APPENDIX TABLE —.

† There is no special significance in the values after the decimal in these cases, as the lowest pressure observed was in part determined by how near the centers of certain hurricanes passed to the station, a matter of chance; the probability that the lowest pressure observed is the lowest possible under natural conditions for the region increases with the number of years of observation. (See also TEXT TABLE 2.)

The nature of the shorter-period pressure variations in relation to the weather and the general circulation are discussed below under The Upper Air and General Circulation, etc.

PRECIPITATION

Rain is the climatic element of most practical concern in the islands because it is often insufficient to mature sugar cane in one or two seasons; a drought of six or nine consecutive months occurs every decade or so, causing much hardship to the townspeople and small native farmers as well as to sugar and cotton estates and cattle ranches.

Since early in the nineteenth century rainfall in the Virgin Islands has been measured in a unique unit of depth, called the "line". The reason for the adoption of this measure is not known. It is an old English measure, in which 1 inch = 8 lines (= 25.40 millimeters). In Denmark they once used the Paris measure of 12 *Linien* = 1 *Tomme* (Paris inch) = 27.07 *millimeters* = 1.0658 *inches*. 1 *Paris line* = 2.256 mm = .0888 inch = 1/144 foot, whereas the *Danish West Indian* (*or English*) *line* = 3.175 mm = 1/8 inch. It is conceivable that as many of the residents were British this "line" was adopted locally from using English rain-measuring glasses or sticks graduated in eighths of an inch. Since the American occupation inches have been used.

Accuracy of the Measurements

The accuracy of rainfall measurements is a difficult problem in general, and is especially serious in tropical countries.* We have already referred to the lack of standards in the instruments and observation procedures at Virgin Islands stations, and here we must add that where the rainfalls are frequently light and the monthly and annual totals are small the errors of measurement are greatest on a percentual basis. The common practice of measuring the catch only once each 24 hours allows some water to evaporate from the gage before it is read, particularly in a warm windy climate. The use of a funnel is common and tends to cut down the evaporation. Where most of the rain falls at night, it is better to read the gage in the morning, and where it falls more in the day an evening observation hour is preferable; two readings a day would be still better, and best of all the use of recording gages or the habit of reading the gage after each shower. It has been shown that a considerable difference in a given

* For a comprehensive discussion see Brooks, C. F., Need for universal standards for measuring precipitation, snowfall, and snowcover. Trans. Meet. Int. Comm. Snow and Glaciers, Int. Assoc. Hydrol. Bull. **23**: pp. 1–52. Riga. 1938.

month's total may result at the same spot between a gage read each morning and a gage read each evening. But it is difficult to estimate the magnitude of this effect in the Virgin Islands except to say that the results from gages read only in the morning are probably somewhat lower than they would be if read only in the evening. The hours of observation at the various stations are not stated or known in many cases and at some stations they were changed from time to time.

Rain gages of different diameter and different height of orifice above the ground do not give comparable catches, but it is believed nearly all the gages used in the Virgin Islands since 1870 have been of the standard 8-inch diameter with rim about 3 feet high (cf. appendix A). The wind eddying around the gage may keep away some of the rain that should go in the gage. In windy places the catch may average 20 per cent too low from this cause, but we judge from tests made elsewhere with shielded gages that this error in the Virgin Islands probably does not average over 10 per cent (i.e., readings are 10 per cent too low on average from the wind effect alone). If we may assume that this error applies roughly equally to all the gages in the Caribbean region, it may be overlooked in practical comparisons. However, the error due to wind effect increases as the wind velocity increases and therefore the catch during severe storms, hurricanes, is apt to be more than 10 per cent too low. High wind sometimes blows the gage over resulting in loss of a large catch of rain. Occasionally during heavy rains the gage may overflow before it is read. Considering all these sources of error, it is evident that on the average the recorded rainfalls are systematically lower than the true rainfalls.

In addition there may be mistakes and falsifications on the part of observers, which are unsystematic in their effect on the results and largely hidden in the averages. An inspection of the daily entries and the reputation of the observer are the only bases for accepting observations as genuine, where the stations are not under regular inspection of an efficient national weather service. We have not found any record of inspections by the Danish government, and the U. S. Weather Bureau inspections have been too infrequent to be effective.

General Distribution

From APPENDIX TABLES 2 and 3 we note that the *mean annual* rainfall differs considerably at the various stations, ranging between about 35 and 70 inches. The *absolute range* between driest and rainiest years at these stations is not much larger, however, the extreme annual totals ranging from about 25 inches to nearly 95 inches (APPENDIX TABLE 1). If we had

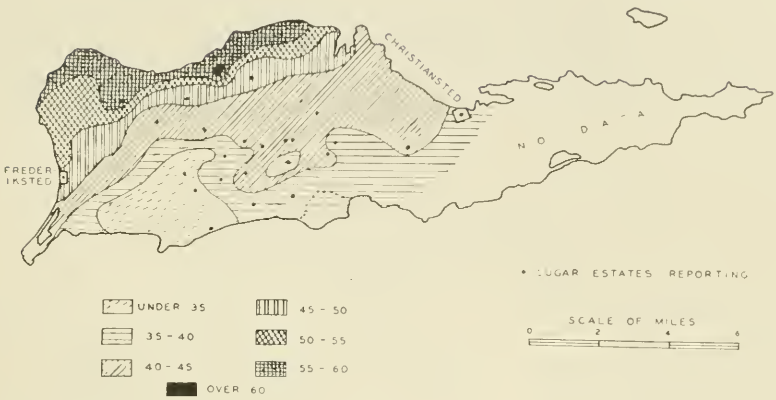

FIGURE 2. Rainfall map of St. Croix, 1921–30. (From Shaw, 1932.)

records from eastern St. Croix and from the mountain tops, these extremes would be greater, probably reaching from 15 to more than 100 inches. A rainfall map of most of St. Croix is shown in FIGURE 2.

The *seasonal distribution* generally shows two maxima, a smaller one in May or June and a larger one in October. The winter minimum is much more pronounced than the summer one. The lowest monthly amounts on record indicate that severe drought conditions can occur in almost any month; even October has sometimes had less than 2 or 3 inches at most stations (see TEXT TABLE 4). Rose points out that the middle and western sections of St. Croix have somewhat opposite tendencies in departures of rainfall from normal — from 1903 to 1908 the middle was drier than the west, but from 1909 to 1915 the middle was wetter, and after 1915 the middle was again the drier. This may possibly be due to a quasi-cyclic shift in the relative frequency of winds from slightly north and slightly south of east, which would be accompanied by changes in the average temperatures and humidities of the trade winds as well as contrasted orographic effects.

Forests and Rainfall

E. Taylor in his "Leaflets from the Danish West Indies" (London, 1888: 42) suggests that St. Croix formerly had a greater rainfall because an early book on the islands by Oldendorp (1777) reported a greater amount of forest growth than is now found. Although a change of climate is possible, the present condition is better explained by the known destruction of the forest by the inhabitants. TEXT TABLE 5 shows no *permanent* change in the rainfall of St. Croix since 1852. St. John and Tortola have the most forests at present because they are too mountainous for economi-

TEXT TABLE 4

FREQUENCY OF MONTHLY RAINFALL TOTALS GREATER THAN SPECIFIED AMOUNTS, ST. CROIX

Average of 3 stations for 63 years, 1852–1914
(From Ravn)

Month	Number of years with rainfall		
	Over 20 lines (2.50 in.)	Over 40 lines (5.00 in.)	Over 60 lines (7.50 in.)
January	25	2	–
February	13	1	–
March	13	1	–
April	33	5	1
May	37	24	11
June	38	19	9
July	44	12	3
August	50	22	8
September	57	32	10
October	60	38	18
November	54	30	13
December	39	11	4

cal sugar-cane culture, though at one time both were under considerable cultivation. There is no reason to believe that either St. John or Tortola receive much more rain than St. Thomas or St. Croix merely because they are now more forested. Indeed, the rainfall observations (cf. APPENDIX TABLES 2–6) lend no support to that notion.

Orographic Effects

The rainfall increases with elevation on all the islands, as residents and travelers can readily observe and as one would expect. But rain-gage stations are lacking at high elevations, except Pearl, Mafolie, Liliendal, Wintberg, and Dorothea. Shaw's rainfall map (FIGURE 2) based on rainfall records (see APPENDIX TABLE 7) of sugar estates on St. Croix leaves no doubt that even moderate elevations are better watered. Yet the *rate* of increase of rainfall with elevation does not here seem to be as large as in the parts of Porto Rico where the mountains rise steeply to 3000 feet or more directly in the path of the prevailing winds. Rose suggests that the rainfall of the islands is not as great as one would expect from the topography because the winds blow mostly parallel to the mountain trends. The reason

Text Table 5

Average Rainfall for Each 10-Year Period, 1852–1911 (in inches)*

"St. Croix, Virgin Islands" = (Christiansted's Fort + Kings Hill* + Fredericksted's Fort)/3
(From L. Smith)

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1852–61	1.90	1.60	1.68	3.12	5.53	3.76	3.51	4.92	7.26	8.16	4.43	2.68	48.61
1862–71	2.11	1.65	2.36	2.06	3.35	3.86	3.10	4.18	5.26	7.80	4.07	3.40	43.00
1872–81†	2.85	1.33	1.57	1.43	4.16	4.48	3.37	4.25	5.28	5.11	6.61	2.33	44.86*
1882–91†	2.78	2.10	1.15	3.27	3.22	3.97	4.06	4.62	4.92	7.50	5.92	3.67	47.50*
1892–1901	2.16	1.45	1.32	2.15	6.33	4.60	5.42	4.58	6.81	5.47	5.46	4.08	49.87
1902–11	2.52	2.31	1.12	2.52	4.26	3.40	2.47	5.40	6.92	4.68	4.96	5.05	47.62
Total	14.33	11.45	10.21	15.57	26.90	24.08	21.95	28.11	36.45	39.38	31.45	21.23	281.35
Average for 60 years (1852–1911)	2.38	1.91	1.70	2.60	4.47	4.01	3.65	4.70	6.07	6.56	5.23	3.53	46.89

* These are from the same observations used in text tables 19 to 22, here converted to inches from the "lines" in which rainfall was measured (8 lines = 1 inch). From "Reports of the Virgin Islands Experiment Station, 1911".

† Kings Hill was omitted from the averages for Oct. 1878 to Oct. 1888, inclusive.

for this may also be contained in some observations of the writer: on several occasions during his stay at St. Thomas in June, 1939 when the summit of the island (1800 feet) was visited, he noticed that any large cumulonimbus cloud that had been initiated by forced ascent of the wind over the island would lean to the leeward so that most of the rain falling from it would fall on the ocean surface somewhat to the lee of the island. In other words the orographic influence on the rainfall was not fully enjoyed by the island itself owing to its small size and narrow form. This observation is confirmed (oral communication) by Sergeant Davidovic, the Aerographer stationed at the U. S. Marine Corps Fleet Air Base on St. Thomas in 1939.

In general the annual rainfall does not seem to increase more than about 10 inches between sea level and 1000 feet elevation, but some of the lower stations have as much rain as places high up on the leeward slopes or in high protected valleys (compare Adrian and Cinnamon Bay, or Barracks and Liliendal, *in the same years*) (APPENDIX TABLE 2). In generally rainy years or months the rainfall differences between stations of different elevation are much greater than in generally dry seasons.

At the U. S. Marine Corps station on Lindbergh Bay three rain gages have been set a few hundred yards apart in a line from the water to the foot of the mountain. These gages show a decided increase in rainfall (APPENDIX TABLE 12) as the mountain is approached, although they are all about at the same elevation. This demonstrates how sensitive the rain-producing process is to the topography. For this reason, within the hilly town of Charlotte Amalie, or of Christiansted, the average annual rainfall probably varies considerably (up to 5 inches?) from block to block; hence records taken at different spots in such a town cannot justifiably be combined as if from one station. Likewise different parcels of an estate often have very different rainfall (e.g., Eden, Emmaus, Caroline; Adrian, Susannaberg).

We have not attempted to construct rainfall charts of St. Thomas and St. John owing to the non-homogeneity of the records. Shaw's map of St. Croix (FIGURE 2) is based on a homogeneous though short (10 years) series of 26 records from the flatter parts of the island, which should give a reliable and consistent pattern.

Year to Year Variation

The variability of the mean annual rainfall is of prime economic consequence because in over half the years the actual rainfall is well below the *normal* rainfall,* which is just about sufficient for an annual yield of sugar

* It is characteristic of the frequency distribution of either daily, monthly or annual rainfalls, that the most frequent value (*mode*) is generally much less than the average, and in some cases the zero value is most frequent.

cane, long the chief crop, and the cane yield suffers accordingly (Dr. Shaw discusses this problem with respect to St. Croix, in paragraphs quoted below). Du Tertre and Oldendorp mention great droughts in 1661 and 1753; the poor crops of 1841, 1864, 1869, 1872 to 1877, 1891, 1892, 1899, 1904, 1923 to 1924 were due to low rainfall (see TEXT TABLES 20 to 23). Contrary to the impression of many residents and travelers, there is no real evidence that the rainfall is slowly and steadily decreasing from century to century (see Forests and Rainfall). The question of cyclic variations has not been scientifically studied here, but results elsewhere generally show long quasi-periodic fluctuations of considerable amplitude in the rainfall. These undoubtedly exist here too but the records are not long enough to reveal any but the shortest "cycles". The average rainfall is so near the critical limit for sugar cane that even the small short-period fluctuations are important. It does not contribute much either to fundamental understanding of the variations nor to practical precautionary measures for the farmers merely to describe the rainfall curve as quasi-periodic. All attempts to forecast the fluctuations by means of extrapolating "cycles" derived from analysis of past records have been failures. Scientific bases for long-range forecasting are being sought in many directions but the solutions offered do not yet give results of practical value and general applicability, however promising the method or enthusiastic the advocates. The most successful results so far are for certain special conditions and places, none of which have been in the West Indies.

Diurnal Variation

The diurnal distribution of the rainfall, as at San Juan, shows a much greater amount of rain by day than by night, judging from Mr. A. Wallöe's observations at Charlotte Amalie, published in the "Sct. Thomae Tidende", 1888. He gives the following figures.

TEXT TABLE 6

NIGHT AND DAY RAINFALL, CHARLOTTE AMALIE, 1888*

Month (1888)	Total	By day	By night
July	38.4	26.8	11.6
August	77.2	55.9	21.3
September	69.0	44.6	24.4

* In lines; 8 lines = 1 inch.

The frequency of rain is no doubt also greater by day but the contrast is probably not so pronounced because the intensity of the day showers is heavier.

At sea the rainfall frequency is a maximum at 6 A.M. with a secondary maximum at about 10 P.M. The amplitude of this daily variation is presumably smaller than the one observed over the islands, where the maximum comes in the afternoon. It is very likely that the sea maximum at 6 A.M. affects the islands, or at least their shoreward margins, causing a secondary maximum at that hour. No hourly observations are available from the islands but the sunrise shower seems to be recognized by the residents as a more or less regular phenomenon. The daily double period in the rainfall is of course reflected in the cloudiness (TEXT TABLE 17) and in the frequency of thunderstorms.

Intensity and Frequency

The rainfall in this low latitude and oceanic situation is entirely of the shower type, and therefore it is of great practical importance to know how frequently showers occur, how long they last, how much rain falls per shower, and what are the average and maximum rates of fall over short periods of time. Unfortunately systematic observations using recording rain gages were begun in the islands only very recently, so we are forced to infer much from the usual rainfall observations which give only monthly totals and numbers of rainy days. The average rainfall per rain day (APPENDIX TABLES 10 and 12; FIGURE 10) indicates some important characteristics.

The "showers" of the winter and spring seasons are characteristically brief and light, often mere sprinkles, from cumulus clouds of small or moderate size and spaced by large intervals of blue sky (cf. TEXT TABLE 9). Sometimes "norther" effects cause a low overcast cloud deck with drizzling rain punctuated by occasional heavier showers, which condition may persist a day or two. However, very heavy rains up to 2 or 3 inches in a day have fallen even in the driest months. In the "rainy season", from May to November, heavier and more enduring showers, with squalls or thunder and lightning at times, are to be expected much more often; at least one shower of some sort then falls almost every day. Heavy rains lasting as much as 6 or 8 hours, even with brief intermissions, are normally very rare, but passage of a hurricane within 50 or 100 miles can cause enormous rainfall totals (over 10 inches) in a day or two from virtually continuous downpours. The high wind during hurricane weather adds greatly to the destructive effect of the rain.

Some significant deductions can be made from the results of the recording rain gages, in spite of the short period they have been in use.

At the Marine Barracks of Bourne Field on St. Thomas a recording rain gage has been operated since 1935. An analysis of the results (APPENDIX TABLE 12 and FIGURE 10) indicates that the average rainfall per rain day and also per rain hour for each month is proportional to the greatest rainfall during any 24 hours of the corresponding months. This is a very interesting relation because in the absence of recording rain gages at other places we can assume that the "greatest rainfall in 24 hours", which is tabulated by the U. S. Weather Bureau for all its stations, gives a rough basis for estimating the *average* intensity of rainfall per day and per hour.

Since February 1940, the Soil Conservation Service has been tabulating rainfall rates monthly from recording gages at Anna's Hope and Jolly Hill estates on St. Croix. An abstract of the results appears in TEXT TABLES 7 and 8. Although the period of observation is too short to give any definite averages or extremes likely to occur, the figures are already significant. A study of the tables reveals a closer correlation by months between the total rainfall and the maximum intensities than between the total rainfall and the average intensities. This is not surprising because one or two intense showers probably have more effect on the monthly totals than the more numerous lighter showers. There is nevertheless some tendency for the average intensity to be greater in the rainier months than in the drier months. It will be noted, however, that the average intensity in the spring months appears to be as high as or higher than in the autumn months, whereas the total rainfall is usually much greater in the autumn than in the spring. This is a curious fact which we have already suspected from the greater frequency of hail in the late spring and early summer than in the late summer and autumn. Over a period of many years the average intensity of rainfall will actually be greatest in the autumn or late summer because of hurricanes. The important conclusion is that, if hurricanes are excluded, winter and spring showers probably have as great *average* intensity as the autumn rains, but the *maximum rates* of rainfall in short periods, as shown in TEXT TABLES 7 and 8, are generally two or three times greater in the "rainy season" than in the winter and spring. It is impossible to infer to what extent this conclusion is justified for all parts of the islands, as the topography may greatly affect the rainfall intensities as well as the totals, but the Bourne Field results (APPENDIX TABLE 12) seem to show similar features to those of Anna's Hope and Jolly Hill estates.

Any practical interpretation of the average rainfalls reported in the Virgin Islands, especially on St. Croix, should take into account the fact that a large proportion of the rain falls in light showers and brief sprinkles (see TEXT TABLES 9 and 10). Many of these light rains are measured in the rain gages and they augment the total rainfall out of proportion to their significance for crop growth and for vegetation because they barely wet

Text Table 7

Rainfall Intensities Measured at Station SCS No. 18 F. S. A., Jolly Hill Estate, St. Croix, V. I.

(From U. S. Soil Conservation Service)

Month	Total Rainfall, inches	Total Duration, hours*	Average Intensity, in./hr.	Maximum Intensity for Different Intervals 5-min.	10-min.	20-min.	60-min.	120-min.
1940								
February	0.90	15.02	0.06	1.00	0.75	0.35	0.13	–
March	0.52	1.92	0.27	–	–	–	–	–
April	1.97	6.42	0.31	2.00	1.50	0.80	0.50	0.28
May	7.10	30.00	0.24	3.50	2.00	1.40	1.10	0.70
June	3.05	8.10	0.38	2.00	1.50	0.90	0.55	0.30
July	2.14	5.07	0.42	5.00	3.50	2.80	1.30	0.65
August	3.05	12.37	0.25	3.00	1.75	0.95	0.30	0.15
September	4.19	12.65	0.33	7.00	5.00	3.40	1.40	0.75
October	7.47	22.45	0.33	4.50	2.75	2.80	1.70	1.05
November	7.15	25.37	0.28	5.00	3.50	2.40	1.45	0.90
December	3.47	20.25	0.17	3.50	2.25	1.60	0.85	0.45
1941								
January	1.97	5.02	0.39	2.00	1.75	0.90	0.40	0.20
February	0.21	0.80	0.26	–	–	–	–	–
March	1.33	1.13	1.17	1.50	1.00	0.50	0.18	–
April	2.28	9.45	0.24	3.75	2.50	1.40	0.56	0.30

* Intensities of less than 0.10 in./hr. are not included.

Text Table 8

Rainfall Intensities Measured at Station SCS No. 15 F. S. A., Anna's Hope Estate, St. Croix, V. I.

(From U. S. Soil Conservation Service)

Month	Total Rainfall, inches	Total Duration, hours*	Average Intensity, in./hr.	Maximum Intensity for Different Intervals 5-min.	10-min.	20-min.	60-min.	120-min.
1940								
January	0.35	2.77	0.13	–	–	–	–	–
February	2.09	17.18	0.12	1.80	1.25	0.75	0.30	0.18
March	0.99	4.92	0.20	1.00	0.75	0.35	0.13	–
April	1.55	4.20	0.37	3.50	1.75	1.20	0.80	0.43
May	2.88	15.05	0.19	2.00	1.50	0.80	0.40	0.25
June	1.56	4.60	0.34	3.00	2.25	1.20	0.40	0.20
July	1.17	4.23	0.28	1.00	0.75	0.35	0.13	–
August	1.75	7.48	0.23	3.00	2.00	0.80	0.30	0.15
September	5.24	6.67	0.82	7.00	5.00	4.20	2.30	1.18
October	8.43	22.05	0.38	4.00	3.00	2.00	0.80	0.50
November	6.05	14.67	0.41	7.00	5.50	3.30	1.10	0.60
December	2.36	14.10	0.17	1.50	1.00	0.45	0.18	–
1941								
January	3.67	12.25	0.30	4.00	2.50	1.60	0.60	0.38
February	0.19	2.50	0.08	–	–	–	–	–
March	1.05	2.83	0.37	1.50	1.00	0.50	0.20	0.15
April	2.48	7.25	0.34	4.00	3.00	2.60	0.92	0.48

* Intensities of less than 0.10 in./hr. are not included.

the vegetation and the top of the soil and do not sink into it, and so are quickly evaporated by the sun and wind.

Text Table 9

Percentages of Days with Specified Amounts of Rainfall. Christiansted, St. Croix, 1852–1907

(From Willaume-Jantzen and Ravn)

Month	0–5 mm (0–0.20″)	$\geqq$ 20 mm (0.79″ or more)	$\geqq$ 50 mm (1.97″ or more)
January	67	5	0
February	64	3	0
March	66	4	0
April	55	16	2
May	56	10	4
June	46	14	3
July	55	10	2
August	54	11	4
September	45	15	4
October	44	18	7
November	48	12	3
December	52	8	2
Year	54	11	3

Text Table 10

Average and Extreme Numbers of Days with Rain, Christiansted, St. Croix, 1852–1907

(From Willaume-Jantzen)

Month	Mean	Highest in any one year	Lowest in any one year
January	11	20	2
February	9	23	1
March	6	14	0
April	7	13	2
May	11	26	3
June	10	20	4
July	11	17	4
August	11	17	4
September	13	19	6
October	12	19	6
November	14	20	4
December	13	19	6
Year	128	177*	84*

* These figures are not sums of the columns above, but are the extreme totals on record for any one year in the period covered by the table.

Evaporation

The actual water loss from the ground by evaporation and by transpiration of plants is probably high, judging from the general weather conditions and from the measures of *evaporating power* of the air made at the Experiment Station (see APPENDIX TABLE 8). Consequently, the roughly 45 inches of measured average annual rainfall in the Virgin Islands is by no means the equivalent for plant growth of 45 inches of measured precipitation in rainier parts of the West Indies or in the southern United States.

Thunderstorms, Squalls, and Hail

Thunderstorms occur, as in Porto Rico, chiefly from July to October, according to the records at Christiansted and Bourne Field (TEXT TABLE 1 and APPENDIX TABLE 12). Schomburgk in 1837 reported that 5 to 10 per cent of the days in a year had thunderstorms, mostly in September and October, which roughly agrees with the Christiansted data, although at Bourne Field more of the storms occur in July and August. Most storms probably occur in the afternoon, as at San Juan. They are apt to be squally and inflict wind damage at times, but lightning damage is usually slight.

Squalls are sometimes associated with heavy showers and probably with most thunderstorms. The familiar downrush of cold air under a thunderstorm or tall cumulonimbus cloud can be so violent as to capsize small boats and damage dwellings, trees, and crops. When the observer is located on the sunny side of the cloud, it may appear white until after the squalls reach him, giving rise to the term "white squall" of the West Indian natives; but when the observer is under or on the shaded side of the cloud, it appears very dark and ominous, so the accompanying gusts are called "black squalls". White squalls are also reported without heavy clouds nearby, but these are merely gusts when the trades are blowing strongly. The West Indian sailor well knows that the squalls are apt to be especially violent and dangerous to boats along a coast which rises to high mountains immediately back of the shore.

Hail is rarely reported and most residents spend a lifetime in the islands without seeing any. There are enough authenticated reports to leave no doubt that it falls at least every few years, even several times in some years in which conditions are favorable for it. Much hail, with cold and rainy weather, occurred in Virgin Gorda in January 1833, according to Schomburgk, who also wrote of hail on the north side of Tortola in November 1829. Knox mentions that hail as big as hen eggs fell in St. Croix on April 13, 1844; and that a Mr. Nissen told him of a hailstorm at St.

Thomas on May 13, 1829. A reliable eyewitness reported that hail fell in St. Thomas in 1938. Although in Porto Rico most hail comes in spring and early summer, the cases cited for the Virgin Islands are chiefly in the winter and spring; perhaps the winter hailstorms are more phenomenal and thus more likely to be remembered or noticed.

Chemistry of Rainwater

Chemical analyses of rainfalls were regularly made at the Experiment Station from 1911 to 1915 (see TEXT TABLE 11). Rainwater (fresh) contained an average of 9.6 parts per million of chlorides, 0.262 parts of nitrogen in the form of ammonia, and 0.324 parts of nitrogen as nitrates. These figures varied greatly from month to month and storm to storm. The amounts do not seem to have a definite seasonal variation, nor do they appear to depend on the total monthly rainfall, though it is quite possible that they are related to the intensity and amount of the individual shower. These chemical constituents of the rain have an important effect on the soil and the nourishment of crops, a subject much studied by agronomists.

Water Supply and Irrigation

Owing to the small and erratic rainfall, the dry porous soils, high evaporation, and the few permanent streams, it has been a serious problem to obtain domestic water supply. Rain water is diligently caught from roofs and stored in cisterns, and several acres of steep slopes are paved with concrete to catch rain for use by the town people. Drought periods enforce strict economy in use of water and sometimes necessitate importing water. Shallow dug wells are used for cattle and gardens, and salt water is pumped for flushing the sewers. The cisterns for drinking water are stocked with "mosquito fish" and screened, for in the past malaria was spread chiefly by mosquitoes that bred in uncovered cisterns. Irrigation of La Grange plantation from a dammed mountain brook in northwestern St. Croix was started in 1910 and perhaps similar projects are feasible, but not on a scale sufficient for all fields during a drought. Deep wells have not yet been tried. Stored surface water might deposit alkali or salt in soils on which it was used for irrigation.

TEMPERATURE

Geographical Controls

Temperatures in the Virgin Islands are more uniform than at most Porto Rican stations owing to the more insular exposure and relatively small land area available for local radiational and insolational influences.

TEXT TABLE 11

CHEMISTRY OF RAINFALL AT ANNA'S HOPE, ST. CROIX (EXPERIMENT STATION)
(From Reports V. I. Exp. Sta., 1911–15)

Date	Rainfall in lines (1 line = ⅛ in.)	Parts per million of			
		Chlorine	Nitrogen as ammonia	Nitrogen as nitrates	Nitrogen total
1911					
Sept.	29.8	5.5	0.290	0.234	0.524
Oct.	50.3				
Nov.	17.0	4.0	0.260	0.074	0.334
Dec.	43.6	7.5	0.290	0.124	0.414
1912					
Jan.	10.1	11.0	0.370	–	–
Feb.	19.5				
March	14.9	14.5	0.390	0.310	0.700
April	12.2				
May	10.9	9.0	0.440	0.254	0.694
June	33.5				
July	22.58	10.0	0.070	0.500	0.570
Aug.	10.24				
Sept.	6.72	6.0	0.420	0.220	0.640
Oct.	75.28				
Nov.	70.32	8.0	0.100	0.380	0.480
Dec.	10.96				
1913					
Jan.	28.24	14.0	0.180	0.274	0.454
Feb.	12.64				
March	21.36	9.0	0.370	0.423	0.793
April	32.00				
May	66.72	8.0	0.100	0.266	0.366
June	3.68				
July	19.20	14.0	0.180	0.710	0.890
Aug.	14.88		.... contaminated		
Sept	29.60	10.0	0.400	0.810	1.210
Oct.	42.40		.... contaminated		
Nov.	18.16	9.0	0.440	0.320	0.760
Dec.	19.60	8.0	0.160	0.230	0.390
1914					
Jan.	21.76	10.0	0.100	0.280	0.380
Feb.	14.40	17.0	0.400	0.260	0.660
March	9.60				
April	7.76	9.0	0.320	0.110	0.430
May	86.96				
June	28.00		.... contaminated		
July	11.04	11.0	0.240	0.450	0.690
Aug.	19.04				
Sept.	10.64	8.0	0.500	0.340	0.840
Oct.	20.40				
Nov.	38.32	6.0	0.200	0.120	0.320
Dec.	23.28				
1915					
Jan.	11.28	11.0	0.080	0.130	0.210
Feb.	6.88	13.0	0.300	0.160	0.460
March	20.00				
April	102.00	10.0	0.080	0.160	0.240
May	80.40	8.0	0.060	0.180	0.240
June	95.20	10.0	0.060	1.120	1.180
Average	–	9.6	0.262	0.324	0.586

The climate is fairly sunny, and the insolation on some days, especially in spring, is very intense.

Owing to the small number of temperature station records and their lack of homogeneity, it is not feasible to construct reasonably accurate isothermal charts of the islands. However, a true isothermal map would show very much the same pattern as the topographic contour map, because the mean temperature varies chiefly with elevation, though the vertical gradient varies somewhat with exposure and distance from the coast (cf. Vertical Temperature Gradient, *infra*). The geographical distribution of the temperature shows much less range and complexity than the rainfall distribution and is of correspondingly less practical concern.

The nearness of the sea and the prevailing trade winds prevent excessive maximum temperatures from local insolational heating in the interior. The mean temperatures (computed from observations recorded in the standard louvred thermometer shelter) do not differ much from place to place, and are controlled chiefly by the temperature of the ocean surface to the windward, and by elevation (APPENDIX TABLES 9–10 and TEXT TABLE 15). In sheltered interior valleys such as Anna's Hope, St. Croix, the night minimum temperatures are somewhat lower and the wind dies down more at night than at coastal points or on exposed slopes. Dew is frequently reported on clear nights especially at such interior places, and is not unknown at any point.

It is the impression of many residents and students of the Virgin Islands that St. Croix is somewhat warmer than the other islands. There is no doubt that on any of these islands the windward sides must be, and do "feel", somewhat cooler than the leeward sides, if only because of a contrast in cloudiness and wind velocity. Consequently, when comparing Christiansted or Fredericksted with Charlotte Amalie, the latter is usually rated somewhat cooler, although the mean temperatures are similar. It has even been thought that St. Croix as a whole is noticeably warmer because of its more southern location. There is as yet no observational evidence from sea-water nor air-temperature data to justify such a conclusion, and if it be qualitatively true, the magnitude of the difference must be small. As St. Croix is only 40 miles south of St. Thomas, equal or greater differences are to be expected from one place to another on any of the islands, except possibly the smallest "rocks". It is quite misleading to attempt to differentiate climates within the islands from the available weather records.*

* Owing to the fluctuations of the mean temperature above and below the normal from year to year, the averages of the shorter-period weather records are probably not representative and should not be compared with the longer records without some allowance for the trends. About 10 years are required to give an acceptable approximation to the temperature normal under tropical conditions, but 30 years are needed to smooth out the small-amplitude so-called sunspot-cycles, while a large-amplitude cycle of about 100 years must be reckoned with in most climates. (Rainfall fluctuates much more than temperature, so that 30 to 100 years are needed to give a reliable normal.)

The limited area of forest cover on St. Croix, compared to well-wooded St. John and Tortola and partly-wooded St. Thomas, is certainly a factor that may tend to elevate the temperature. In the mean temperatures for the whole 24 hours of the day, the effect of the greater insolational heating of a barren land is offset to a large extent by a greater radiational cooling at night. Thus we may expect, other things being equal, St. Croix to have a greater daily range of temperature than the other islands. The relative flatness and somewhat greater extent of St. Croix also favor a greater daily range. Comparing the temperature records (APPENDIX TABLES 9 and 10), note that Anna's Hope in central St. Croix has an annual average daily range of 14° F., whereas the coastal stations have about 9 or 10° daily range. The mean minimum temperature at Anna's Hope is slightly lower than at any other station and the mean maximum slightly higher.

Extremes: Cool Spells and Warm Spells

The coldest winter nights at Anna's Hope generally follow immediately after a series of abnormally warm nights (minima above 75° F.). A slight shift of wind takes place between these episodes from south of east to north of east. The warm nights are due to the deep current of moist air imported with the southeast component of the wind, which prevents much cooling of the ground by radiation at night; but the cold nights are due to the drier upper air and lack of clouds that follow in the wake of the northerly component in the trades. The first night with more northerly air may remain quite warm due to low clouds resulting from cooler air passing over the warm sea, but the second and third nights will usually clear off and become cool unless the normal air circulation has completely re-established itself by this time. It is not unusual for three or four nights in succession to have minima of 60° F. or less in the winter. Schomburgk mentions a minimum of 36° F. occurring once at Tortola in the early part of the last century, which caused the natives much suffering, but such a low temperature seems impossible and must be a misprint for 56° F. It will be recalled, however, that temperatures were abnormally low in the United States in the early decades of the 19th century, when there must have been many severe "northers" in the Caribbean.*

The weather of January 16–20, 1914, is an excellent, if somewhat ex-

* The "Sct. Thomae Tidende" for March 15, 1837, reported, "The weather has been cool for some time past, and of late we have had frequent stiff breezes from the north [*sic!*], both probably arising from the prevalence of cold weather in America". On March 22 of the same year the "Tidende" related, ". . . the Packet *Express* . . . arrived here late on Monday, in 15 days from Barbados, being, it is said, the longest passage ever known, of either mail boat or packet from windward . . . it is accounted for by the strong northerly wind that has prevailed for some time past".

treme, example of a cold winter night between rather warm nights, as is shown by the data of TEXT TABLE 12.

TEXT TABLE 12

TEMPERATURE AND RELATIVE HUMIDITY, JANUARY 15–21, 1914 AT ANNA'S HOPE, ST. CROIX

(Data from V. I. Agric. Exp. Sta. Report, 1914)

Date	Min., A.M.	8:30 A.M.		12 noon		Max., P.M.	4 P.M.		9 P.M.
1914 January	Temp. ° F.	Temp. ° F.	Rel. Hum. %	Temp. ° F.	Rel. Hum. %	Temp. ° F.	Temp. ° F.	Rel. Hum. %	Temp. ° F.
15	70	79	80	81	81	82	79.5	84	74
16	66	74	88	78	76	80	78	68	71
17	68.5	75	72	78.5	72	79.5	78	–	66
18	52	64	–	79.8	–	80	79.5	–	59.5
19	[55?]	77	78	81	88	86	75	89	75.5
20	74	76	81	82	86	85	82	–	76
21	68	78	79	82	–	83.5	80	72	70

This is a striking example. Note how the temperature failed to fall below 68.5° on the early morning of the 17th in spite of the rather low humidity which had already set in on the afternoon of the 16th. The warm night was due to clouds which also kept the temperatures from getting abnormally high during the day. The night of the 17th was clear and cold (52° min.) and likewise the next night (18th), with continuing low humidity. The 19th and 20th were clear and the sun heated the air up to 86° and 85°. The humidity rose again on the 19th and it was cloudy that night so that the minimum on the morning of the 20th was high, 74°. No rain fell from the 16th to the 20th.

Long cloudy, rainy spells sometimes reduce the daily range of temperature to less than 5°, a disagreeable type of weather in the tropics, but it does not happen as a rule more than five to ten times a year in the Virgin Islands.

What might be called *hot spells* occur practically every year, particularly between May and November. These are times when the daily maximum temperature exceeds 88 or 90° F. for several days in succession, especially when the humidity is unusually high and the wind light at the same time. The daily maximum at low-level stations holds rather constantly from 83 to 88° F. in the warmer half of the year, wherefore an occasional day with 90 or 95° F. is very noticeable to the residents. Spells with daily maxima above 90° F. are disagreeable not so much because of the maxima as because of the minima, which are often about 78 to 80° F., so that the nights do not allow one to recuperate from the heat of the days.

Character and Effects of Changes

Changes from season to season, from day to day* and night to day, or because of storms, wind-shifts, or showers are small as compared to those in high latitudes and in more continental parts of the subtropics, but they are important to the health and comfort of more or less permanent residents in the islands. This was noticed long ago, and is mentioned by many writers. Knox (1852) noted a sudden drop in temperature of 5.4° F. during the passage of a shower, but this is unusual. Nevertheless, he says it had as serious an effect on the health of the inhabitants as a drop of 26° F. would in New York, because "influenza, ague, or bowel complaints, etc., succeed such falls of temperature". In July and August 1851, 4000 of the population were affected by influenza. Knox wondered if the epidemic were not caused by the few cool hours of rain which followed a period of more than usual heat and drought — a theory which may be discounted in this case as epidemic influenza, once begun, rapidly spreads to all corners of the earth as fast as the germs can be transported. Nor can we agree with Knox's conclusion that, "It is owing to the very minute daily variations that this climate is healthy, and so happily adapted to the individuals suffering under pulmonary attacks."

The chief drawback to this climate is the *lack* of stimulating variations, which lowers the resistance to unusual changes when they do come and permits a marked slackening of tone in those who fail to return to the higher latitudes at intervals.† Indeed, many residents and physicians (and Knox himself) have admitted that a change to a temperate climate every few years is almost as necessary in the present relatively hygienic era as in the more disease-ridden Danish times.

Schomburgk observed at Tortola a very unusual drop of temperature on April 29, 1832, from 79.5° F. at 9:15 A.M. to 73° F. at 9:25 A.M. to 71° F. at 12:15 P.M.; there was a quick drop of 6.5° F. in 10 minutes, and of 8.5° F. in 2 hours.

Daily Cycle

Of course the regular diurnal temperature changes are a source of physiological stimulation. Everywhere they average less than 15° F. and at many localities are less than 10° F. (see APPENDIX TABLES 9, 10, and 12), but for the individual days the range varies considerably depending on the

* The mean interdiurnal (day to day) temperature variability at San Juan is a little more than 1° F. in all months. The figures for the Virgin Islands stations would be about the same, and certainly less than 2° F. even at interior locations.

† Stone, R. G. "Some results of modern physiological research in relation to acclimatization in the tropics". Appendix 1 in Price, A. G. "White Settlers in the Tropics". New York, 1939.

amount of clouds, wind velocity, and rains. Normally the hottest hour comes between noon and 2 P.M., perhaps averaging a little later in winter than summer; sunrise is the coolest (see TEXT TABLES 13 and 14). In clear weather the diurnal cycle is surprisingly regular, but irregularities in the thermograph traces are common, due to the passage of clouds and rain, and to changes in wind velocity or direction. There seem to be various characteristic types of these daily curves. Knox illustrates three from the month of September 1845, and Stenzel's 1886 figures are interesting. The many curves for Anna's Hope in the Experiment Station Reports for 1911 through 1915 show all the likely variations.

Especially noteworthy is the characteristic alternation of spells of contrasted types of daily temperature cycles, for example:

(A) small daily range
1. high maximum temperature and high minimum temperature (due to clouds at night?)
2. low maximum and low minimum (due to heavy rain or clouds by day?)
3. low maximum and high minimum (due to steady rain, and clouds day and night)

(B) large daily range
1. high maximum temperature and low minimum temperature (clear day and night?)
2. normal maximum and very low minimum (dry air, some clouds by day, none at night)
3. very high maximum and normal minimum (dry air, light wind and clear by day, partly cloudy or humid and windy by night)

Other combinations are also observed. A curious secondary rise in temperature often appears around 2 A.M. and abates by sunrise, perhaps due to a night-time increase in the wind velocity. The uniformity of the daily range from day to day is closely related to the regularity of cloudiness.

TEXT TABLE 13

STE.-CLAIRE DEVILLE'S TEMPERATURE OBSERVATIONS AT ST. THOMAS DURING 1840 (BROKEN SERIES)*

Months	Mean temperature	Temperature difference 6 A.M.–1 P.M.	Hours of extremes (approx.)	Hours at which the mean temperature is reached
March–April	25.5° C. 77.9° F.	4.2° C. 39.6° F.	6 A.M., 1 P.M.	7:50 A.M. 6:36 P.M.
July–August	27.6° C. 81.7° F.	4.1° C. 39.4° F.	6 A.M., 1 P.M.	7:50 A.M. 6:36 P.M.
October–November	26.8° C. 80.2° F.	3.2° C. 37.8° F.	6 A.M., 1 P.M.	7:50 A.M. 6:36 P.M.

* Hornbeck's averages of 5 years' observations at Charlotte Amalie, 1829, 1830, 1834, 1835, 1836, are: 77.9° F. at 7 A.M., 81.7° F. at 4 P.M. and 78.8° F. at 8 P.M. These seem to give too small a range, probably owing to defective exposure of the thermometer.

TEXT TABLE 14

MEAN TEMPERATURES AT DIFFERENT HOURS AT CHRISTIANSTED, ST. CROIX, 1913–15

(From "Meteorologisk Aarbog")

Year	8 A.M.	2 P.M.	9 P.M.
1913	26.0° C. 78.8° F.	27.6° C. 81.7° F.	25.3° C. 77.5° F.
1914	26.2° C. 79.2° F.	28.4° C. 83.1° F.	25.7° C. 78.3° F.
1915	26.7° C. 80.1° F.	28.3° C. 82.9° F.	26.1° C. 79.0° F.

Vertical Temperature Gradient

The expected decrease of temperature with elevation is definitely observable in the range of elevation from sea level to over 1000 feet, but this amounts to only a few degrees on the average (compare Canaan, Wintberg and Charlotte Amalie, St. Thomas; and St. Bernard's and Roadtown, Tortola). Ste.-Claire Deville in 1840 found that the average gradient was 1° C. per 100 meters up to 500 meters. Knox made (1845?) the following comparisons between Charlotte Amalie and Louisenhoj (778 ft.):

TEXT TABLE 15

TEMPERATURE DIFFERENCE BETWEEN CHARLOTTE AMALIE AND LOUISENHOJ, ST. THOMAS

Hour	Charlotte Amalie (20–100 feet?)	Louisenhoj (778 feet)	Difference (*ca* 700 feet)
6 A.M.	76.1° F.	72.1° F.	4.0° F.
2 P.M.	83.8	79.1	4.7
8 P.M.	78.8	73.7	5.1

These differences are rather large and lead us to suspect they may represent unusual days or else the thermometers or their exposures were not comparable or proper. On the other hand, since Louisenhoj is on a summit well ventilated by the trade winds, and Charlotte Amalie is sheltered therefrom and overheated by virtue of its stone surfaces, it is conceivable that these "superadiabatic" gradients can exist much of the time. Airplane soundings made from Bourne Field (APPENDIX TABLE 17) also reveal slightly superadiabatic lapse rates for the lowest 500 meters in the summer months (8 A.M.), but those data are open to various interpretations and criticisms.*

* See McDonald, Bull. Am. Met. Soc. 23: 75–76. Feb. 1942; Conrad, V. Meteorological results of the "Meteor" expedition 1925–27. Bull. Am. Met. Soc. 23 (4): 143–147. 1942.

HUMIDITY, SUNSHINE, AND CLOUDS

Absolute Humidity

The absolute humidity may be judged here from the vapor-pressure observations because the barometric pressure varies so little. TEXT TABLE 17 gives the values for Christiansted. The *specific humidity* (grams of water

TEXT TABLE 16

MONTHLY MEAN HUMIDITY

Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Relative Humidity, per cent of saturation													
Frederikssted, 7 A.M. mean													
1879	77	79	81	80	85	84	78	83	83	85	83	(77)	81
Christiansted, mean (8 A.M. + 2 P.M. + 9 P.M.)/3													
17 years (1900–16)	74	73	72	72	74	76	74	75	77	78	78	77	75
Bourne Field, mean (8 A.M. + 12 M. + 4 P.M.)/3													
4 years (1935–39)	73	70	68	72	73	72	72	74	71	74	74	74	72
Specific Humidity, grams per kilogram													
Bourne Field, 8 A.M.													
1937	14.9	15.4	14.8	15.7	17.5	17.6	17.6	18.7	19.2	16.6	18.4	15.4	16.8

TEXT TABLE 17

VAPOR PRESSURE, RELATIVE HUMIDITY, AND CLOUDINESS AT CHRISTIANSTED FOR DIFFERENT HOURS OF THE DAY, 1913–15

(From "Meteorologisk Aarbog")

Year	Vapor Pressure (mm.)			Relative Humidity (per cent)			Cloudiness (in tenths of sky covered)		
	8 A.M.	2 P.M.	9 P.M.	8 A.M.	2 P.M.*	9 P.M.	8 A.M.	2 P.M.	9 P.M.
1913	18.4	18.7	18.7	74	68	78	4.1	4.5	3.0
1914	19.2	19.2	19.5	75	67	80	4.2	3.8	3.7
1915	20.4	20.5	20.4	78	71	81	4.9	4.7	4.0

* Mean 2 P.M. relative humidity for 4 years was 70 per cent, ranging from 65 per cent in March to 75 per cent in November; see TEXT TABLE 1 for details.

per kilogram of moist air) is also given for Bourne Field in TEXT TABLE 16. After 1916 no vapor pressures are available from the Virgin Islands, but San Juan, Porto Rico, values may be taken as a rough indication of mean conditions at sea level in the islands.

Relative Humidity

At Christiansted, the mean annual relative humidity (TEXT TABLES 16 and 17) for the hours 8 A.M., 2 P.M., and 9 P.M is 3 per cent lower than that for San Juan, Porto Rico; the 2 P.M. mean (TEXT TABLE 1) is 6 per cent lower than the noon mean for San Juan. It seems likely that these figures indicate a real, though small, difference in the respective climates, which might be expected from the lower rainfall and more sheltered situation of Christiansted. The four-year record at Bourne Field, St. Thomas (sea level, southwest coast), shows a mean annual (8 A.M. + 12 M. + 4 P.M.)/3 relative humidity (TEXT TABLE 16) of 72 per cent; the (9 A.M. + 9 P.M.)/2 mean for these years at San Juan was 80 per cent, and the 8 A.M. mean at St. Thomas was about 5 per cent below the 9 A.M. mean of San Juan for the same period; thus St. Thomas is appreciably drier than San Juan.

Even where the rainfall supports only cacti, the humidity is probably still rather high (but 5 to 15 per cent below that at sea) owing to the proximity of the sea and the constant draft of moist ocean air circulated over the islands by the trades. This high humidity and the salt content of the sea air naturally cause corrosion and deterioration of metal, furniture, and buildings, though by no means so severe as in the rainier tropical and equatorial climates. The average diurnal range of the relative humidity is certainly less than 15 per cent, since at both Bourne Field and Christiansted the difference between 8 A.M. and 12 noon or 2 P.M. readings is well under 10 per cent. The highest humidity may be expected at sunrise, when the temperature is lowest; and the lowest between noon and 2 P.M., when the temperature is highest. October and November in the rainiest season, and March in the driest season are the periods of highest and lowest average humidity respectively, but the difference is only 6 per cent or less. (NOTE: The "hygrodeik" readings published in the St. Croix Experiment Station Reports, 1911–15, are from an unventilated instrument, and not comparable to, nor as accurate as, the standard ventilated psychrometer observations.) Typical day to day variations are illustrated in TEXT TABLE 12.

Sunshine and Radiation

No measures of solar radiation are available but the intensities probably do not differ greatly from those at San Juan where several years' records are available. Slightly more insolation than at San Juan may be expected due to lesser cloudiness and humidity. Whether there is an abnormally early diurnal maximum of total radiation and sunshine (between 11 A.M. and noon) in the rainy season, as at San Juan, cannot be surmised.

Cloudiness

Records of cloudiness from Christiansted and Bourne Field (see TEXT TABLE 1 and APPENDIX TABLE 15) are probably reliable. The Charlotte Amalie record is short and hence erratic (TEXT TABLE 2). The tables (APPENDIX TABLE 11) of clear and cloudy days for the other stations should not be relied upon too closely as the different observers were allowed to judge for themselves what constitutes a "cloudy day", etc. (In Porto Rico, the results of such observations were found to be very misleading.) In general, the cloudiness (and, complementarywise, sunshine) varies considerably with location where there are mountains sufficient to interfere with the trades. The windward side of the upper slopes frequently is shaded by, or shrouded in, clouds, especially in the rainy season; however, one can observe in the Virgin Islands how the large cumulus clouds which originate where the air is pushed over the mountains lean far out to the leeward and shade the lee side as much as or more than the windward. It is recorded in a book cited by Rose that Crown Mount, 1750 feet high, is often in the clouds during the rainy season. Judging from the Christiansted (TEXT TABLE 17) and Bourne Field records (APPENDIX TABLE 15), the amount of clouds, or rather the percentage of the sky covered by them, averages only slightly greater during midday and afternoon than in morning and early evening. However, these are coastal stations whose horizons encompass a large part of the sky over the water where the afternoon clouds from the land may not reach. The real diurnal range of cloudiness over the islands proper is certainly greater than the figures available suggest. The diurnal range of variation in amount of cloud cover is as great as, if not greater than, the annual range; the diurnal variation is much more marked over land and around the mountains than over the open sea, since it results chiefly from an insolational increase in vertical convection. Over the open sea a maximum of clouds (and rainfall) occurs between 4 and 6 A.M., and this undoubtedly also affects such small islands as the Virgins so that they have in addition to a chief maximum in the afternoon a secondary one near sunrise.

Except possibly in the rainiest months the high clouds (chiefly stratiform) are generally much more extensive than (though not so dense as) lower ones (mostly cumuliform). The cloudiness does not vary greatly from month to month; the dry months of February and March usually average between a third and a half of the sky covered; the rainy period of July to November averages between 0.4 and 0.6 of the sky covered, depending on elevation and exposure of the station. Perfectly clear or entirely overcast days are rare.

The prevailing character of the clouds in these two seasons is apt to be rather different, however. The rain-season clouds are more often cumulonimbus or cumulus of considerable vertical development with much cirrus, whereas the clouds of the dry season are smaller fair-weather cumulus and broken stratiform types (stratocumulus and altocumulus) for the most part. One's impression is that the sky exhibits a greater variety in form, density, and arrangement of clouds from season to season than the observations of "amount of cloudiness" would suggest. The cloudscapes also reflect certain subtle changes, not yet fully understood, in the general weather situation; these changes tend to offset some of the monotony of other aspects of the weather.

STORMS

The characteristics and forecasting of "hurricanes" in this region are discussed in our report on Porto Rican meteorology; the characteristics and effects of hurricanes in the Virgin Islands do not differ significantly from those in Porto Rico and the other Antilles.

The list of hurricanes in appendix B, compiled from many sources, is probably complete for only the 19th and 20th centuries. Only nine storms were recorded between 1700 and 1800, whereas twenty-six were noted in the next century and seventeen so far in the present century. Some small and weak storms were reported in recent years, but before 1900 many such storms must have "grazed" the islands without exciting special mention in the annals. Some of the storms listed were recorded as passing only close enough to cause heavy rains and moderate gales with but minor, if any, damage. Somewhat less than thirty hurricanes actually struck one or more of the islands in full force and with very serious damage since about 1770 (when fairly complete annals begin). The summary in appendix B indicates about 43 per cent of the storms have struck in August, 35 per cent in September, 18 per cent in July, and the rest in October.

It is not minimizing the danger from these storms to say that they rarely strike with great severity. The hurricane of August 1772 was described in a now widely-quoted letter, written by Alexander Hamilton (appendix B), then a youth of St. Croix, who left the island soon after for North America. Perhaps the most destructive storm at St. Thomas was that of October 29, 1867, of which graphic accounts were published in the "Sct. Thomae Tidende" in early November of that year; a severe earthquake and tidal wave on November 18 added to the misery. That of September 1876 was also devastating. Of recent years the storms of October 9, 1916, August 28, 1924, and September 13, 1928 (St. Croix), were especially damaging. It should be noted that only about a third of the storms that pass over St. Thomas pass over St. Croix or cause damage there, and vice versa. Only twenty of the fifty-one storms since 1738 listed in appendix B affected both islands, though they had about the same total number of storms (St. Thomas 39, St. Croix 33). This is easily explained by the small diameter of the damaging part of most hurricanes and by the various directions from which they approach the islands (from E through SSE, approximately).§ Hurricanes passing to the south of St. Thomas, even a hundred miles away, can severely damage shipping and docks in the harbor merely from the heavy southerly swell, though no gale or rain may be observed; the harbor is protected from swells if the storm passes well to the north. For details of some of the past storms in the islands see appendix B and the bibliography.

WIND

Surface Wind Velocity and Direction

We have little representative data concerning wind velocities and directions. The anemometer on the Custom House roof at Charlotte Amalie apparently has only been used for spot readings, which in the hurricane season have been cabled or radioed to the U. S. Weather Bureau; means for several years appear in TEXT TABLE 2.* At Bourne Field a pressure-tube anemometer has been in operation for several years and the records are on file there and at the U. S. Navy Department, Bureau of Aeronautics, in Washington. Mean velocities cannot be obtained easily from this kind of instrument but the maximum gust velocities are given in APPENDIX TABLE 16. At Anna's Hope, St. Croix, an anemometer has been exposed beside the evaporation pan (1½ feet above the ground in a spot somewhat sheltered by nearby buildings). The record is summarized in TEXT TABLE 18. These values must be multiplied by at least 4, or 5, to obtain an estimate of the velocity that would be recorded on top of a tower 30 feet above the ground but are representative of a typical microclimate. It is interesting to note† how the wind dies down at night near the ground at Anna's Hope; the nocturnal radiation forms a shallow layer of cool, stable air which remains nearly calm in the valley because it is denser and exerts more frictional resistance than in daytime. The result is a more or less pronounced diurnal cycle in the wind like that in Porto Rico with highest speeds in the afternoon, lowest in the early morning.

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§ See the maps in Tannehill, I. R. "Hurricanes, their nature and history". Princeton, 1938.

* No severe hurricane struck the island during this period, though some passed near enough to cause high winds. The anemometers are usually carried away by a full hurricane hence the highest velocities are not known; they often exceed 150 miles per hour.

† The anemograms were inspected by the writer at San Juan and Anna's Hope.

TEXT TABLE 18

AVERAGE MONTHLY WIND VELOCITY AT THE EVAPORATION PAN* AT EXPERIMENT STATION, ANNA'S HOPE, ST. CROIX

(From U. S. Weather Bureau, San Juan)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1920	1.8	1.4	1.9	1.4	1.8	2.2	2.8	2.4	1.8	1.1	1.2	1.7	1.8
1921	–	–	–	–	–	–	2.1	1.7	1.4	1.0	1.3	0.7	1.9
1922	1.2	2.0	2.1	2.0	2.3	2.3	2.5	2.3	2.0	1.1	1.1	1.6	1.9
1923	2.0	2.3	2.4	2.0	2.0	2.6	2.8	2.6	2.0	2.4	0.7	1.9	2.1
1924	2.3	1.8	1.5	1.6	2.1	2.1	2.5	2.2	2.0	0.8	0.9	1.4	1.8
1925	1.5	0.8	1.7	1.3	1.2	1.1	1.0	1.1	0.7	1.2	1.2	1.0	1.2
1926	1.9	1.7	1.3	2.0	1.6	1.7	1.6	1.2	0.9	0.8	0.9	1.5	1.4
1927	1.3	1.3	1.2	1.5	1.4	1.5	2.0	1.0	0.6	0.7	1.2	1.2	1.2
1928	1.5	1.4	1.5	1.6	1.2	1.5	1.6	1.2	2.9	0.8	0.5	1.2	1.2
1929	2.1	1.6	1.8	1.4	1.6	1.5	1.9	1.6	1.0	0.9	1.6	2.0	1.6
1930	1.9	1.0	1.3	1.5	1.4	2.2	2.2	1.8	1.7	1.2	1.5	1.6	1.6
1931	1.3	1.4	1.6	2.0	1.6	1.5	1.7	1.8	1.0	0.4	0.5	1.9	1.4
1932	2.3	1.8	1.8	2.1	1.8	2.0	1.8	1.7	1.3	1.4	1.7	1.7	1.8
1933	1.7	3.0	2.7	1.9	2.2	1.8	2.4	1.5	1.6	1.2	1.5	1.9	1.9
1934	1.5	1.4	2.3	1.9	2.1	1.7	2.1	1.5	1.0	1.1	1.5	2.0	1.7
1935	0.9	1.1	1.8	1.2	1.3	1.3	1.7	1.2	1.4	0.7	0.7	1.2	1.2
1936	1.8	1.4	0.8	1.4	1.0	0.9	1.2	1.0	1.4	0.8	–	0.5	–
1937	1.2	0.6	0.9	0.9	0.9	1.1	1.1	1.1	0.8	0.6	0.7	1.0	0.9
1938	1.2	1.2	1.2	1.0	0.9	1.0	0.7	0.8	0.5	0.2	0.6	0.4	0.8
Totals	29.3	26.2	29.8	28.7	28.4	30.0	35.7	29.7	26.0	18.4	19.3	26.4	–
Averages (Mi./hr.)	1.63	1.41	1.65	1.59	1.57	1.66	1.88	1.56	1.37	0.97	1.07	1.39	1.48

* The anemometer is mounted about 1½ feet above the ground and hence gives velocities which are much lower than those read from anemometers as usually exposed on high poles or tops of buildings.

The more exposed, especially windward, parts of the Virgin Islands do not experience such a locally-produced night calm, though the winds may die down slightly at night, because at sea the trade wind has a diurnal velocity range of less than 1 mile per hour. Palgrave (*infra*) thought that the wind force at St. Thomas often showed a secondary increase between 2 and 6 A.M., thus tending to produce a double maximum for the day (afternoon and early morning). We have no data from the Virgin Islands to verify this. Since it is not in accordance with observations from ships over the tropical seas,* if real it can only be the effect of the diurnal temperature changes over the island on the stability and frictional stress in lowest air layers, which normally occurs in more striking form only over larger islands (see second paragraph *infra*).

Leeward slopes and shores have some protection from the full force of the trades, but it is surprising how these winds pass over and around the islands without much diminution in velocity so that few spots lack a relatively fresh "sea breeze" most of the day whenever the trades attain considerable velocity over the surrounding sea.

* Conrad, V. Meteorological results of the "Meteor" expedition 1925–27. Bull. Am. Met. Soc. 23 (4): 143–147. 1942.

From day to day the general velocity of the trades often varies decidedly; one day it may average 5 miles per hour and the next 15 miles per hour. Trades in excess of 15 miles per hour of course occur more frequently in the months of highest average velocity, which are in winter and in mid-summer. Calm spells may be expected during May, June, September, and October. The winds at sea blow as hard from one quarter as another, except in October and November when SE and S winds are usually lighter than others. The prevailing fresh breezes, coupled with the open vegetation, dry soil, ample sunshine, and moderate rainfall explain the reputation of the islands for a relatively healthy and comfortable subtropical climate. The changes in wind velocity from day to day are probably more important as physiological stimuli than the temperature changes, which average only 1° or 2° from day to day.

On St. Croix the agriculturalists have found a need for windbreaks, especially in the flat southwestern section, to protect garden crops and orchard fruit trees from the effects of the constant trade winds. The fruit trees have an unthrifty appearance in unprotected sites on St. Croix and it is found that such trees suffer from heavy scale infestations. In the lee of windbreaks of suitably chosen type the scale insects are held in check by the fungi that thrive better in the more humid conditions provided by the protection of the windbreak; less spraying of the trees is necessary in the lee therefore. The Experiment Station has been trying out various plants for windbreaks. In any case the protective effect does not extend more than several hundred feet to the leeward. In some parts of the island there is ample natural protection from woods and hills.

The islands are too small to develop a noticeable system of *land and sea breezes* as is found in Porto Rico. Since the wind has some diurnal variation in velocity and normally speeds up during the morning and falls off at night, residents often speak of the "sea breeze" arriving in the morning. There may be a relative calm at night (as at Anna's Hope), especially in sheltered valleys and on leeward sides, which increases the discomfort on summer nights, but no true off-shore "land breeze" at night seems possible. Sometimes shallow layers of radiationally cooled air may be detected slowly flowing down the hillsides into valley bottoms in the early morning hours, but this is a very weak and restricted phenomenon here compared with what it is in the Greater Antilles and in higher latitudes, for it produces neither a marked local cooling nor a noticeable "breeze" (less than 1 meter per sec.). Usually the trades blow strong enough to mask almost completely any tendency for land and sea breezes to change *the wind directions.*

The wind-direction data from Christiansted (TEXT TABLE 19), St.

Thomas (TEXT TABLE 2), and other stations (APPENDIX TABLE 11) are not exactly representative of the general winds because of the interference of nearby hills and mountains.*

TEXT TABLE 19

PERCENTAGE FREQUENCY OF WIND DIRECTIONS (1875–1907)
CHRISTIANSTED, ST. CROIX (MEAN OF 3 OBSERVATIONS PER DAY)
(From Willaume-Jantzen)

	Direction								
	N	NE	E	SE	S	SW	W	NW	Calm
January	3	28	51	9	1				8
February	3	25	47	13	2			1	9
March	5	29	43	10	2	1		2	8
April	3	21	43	18	5	1			9
May	1	10	46	27	7				9
June		10	57	25	3				5
July		20	62	15	1				2
August	1	22	51	16	3				7
September	1	15	42	19	5	1		1	16
October	1	13	36	19	7	1	1	1	21
November	2	25	42	12	2	1			16
December	5	29	45	8	2			1	10
Year	2	21	47	16	3	<1	<1	1	10

Upper Winds

The directions of the lower clouds, as given in APPENDIX TABLE 16 for Bourne Field and in Palgrave's notes below, are roughly indicative of the undisturbed trade winds. The pilot-balloon ascents made by the Navy at Bourne Field have not been summarized. A technical discussion of the Caribbean upper-air circulation appears elsewhere.†

Winds and Weather Types (after Palgrave)

W. G. Palgrave, a one time authority on the West Indies, observed the following features during residence at St. Thomas (written in 1874).

"During an average period of nine months in the year the regularity of the air-currents over the Virgin group resembles clockwork. The surface, or lowest current, is formed by the trade wind, which blows briskly from the east-north-east, with a slight variation northward during the night and early morning, and a corresponding deflection southward from noon till near sunset. Its greatest strength is usually at or near 3–4 a.m.; and about the same hours p.m. It generally bears with it light masses of cumulus, from which there fall occasionally showers, heavy, but very short in duration. This air current is known as the trade wind of these regions.

* Wind roses for the surrounding waters will be found on the "Pilot Charts of the North Atlantic" (monthly), published by the U. S. Hydrographic Office.

† Stone, R. G. On the mean circulation of the atmosphere over the Caribbean. Bull. Am. Met. Soc. 23 (1): 4–15. 1942.

Next above this current comes the south-west wind, rarely absent; it brings with it light cirrus clouds, but seldom cumulus or other indications of rain. . . . Highest of all the west wind reigns, manifested by very light cirrus clouds, rapidly formed and as rapidly disappearing. These three winds blow with scarcely any interruption from November to June inclusive; almost the only variation being then afforded by the north or north-north-east wind which sometimes prevails, but near the surface only ['norther' influence], for a few days together during three winter months. When — a rare but much desired event [for the crops and water supply] — a southerly current occurs about this time, it brings heavy clouds and abundant rain. While the wind is from the north and north-east [relatively], great dryness is indicated by the hygrometer. But in the months of August, September, and October, and often in the latter half of July, the polar or north-east current loses its strength and is often neutralized or even conquered by the southerly winds. These during the summer are usually light, and accompanied by a clear and serene sky, only clouded when the north-east, regaining for a time its supremacy, drives the south back, and precipitates heavy showers, amid thunder and lightning, sometimes lasting for three or even four hours; after which the wind veers round again to the south-east and south. The same phenomena, when intensified, concentrate themselves into a hurricane or cyclone — a rare occurrence in this island, not more than four of any great severity having taken place at St. Thomas in the course of the present century [1800–74].

"Another phenomenon peculiar to the winter and spring months are the white squalls, which take place on calm days, generally at noon, and most often at no great distance from shore; their area is very limited, and their duration does not exceed a few minutes; in some respects they resemble a miniature hurricane, and appear to be due to similar causes; but neither have I witnessed in them nor heard recorded any instance of circular motion. They are much dreaded by the small craft of these seas; a slight fall of the barometer is their only premonitory indication". ["Black squalls" with dark shower clouds are also feared by the sailors along the West Indian coasts. — R. G. S.]

The above note shows a good elementary comprehension of the wind system for one writing at such an early date. In general the upper winds over the Virgin Islands are no different from those over San Juan, Porto Rico, which have been given special study by Fassig, Ray, and Stone.* Quin (1907) has published observations of the wind behavior over the Virgin Islands preceding hurricanes passing the vicinity.

VISIBILITY

The visual range ("visibility") seaward from the U. S. Marine Corps Base at Bourne Field on St. Thomas is given in APPENDIX TABLE 14. The visual range is more constantly good than at San Juan, as there is no smoke or land haze. On specially clear days the mountains of eastern Porto Rico, some sixty miles away, can be seen. The factors affecting the visibility are discussed in Part 3. The range is never less than 2.5 miles except during heavy rains.

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* Stone, R. G. Bull. Am. Met. Soc. 23 (1): 4–15. 1942.

CLIMATE, DISEASES, AND HEALTH*

We have already mentioned some effects of temperature changes and winds on comfort and health. Of course, in earlier times the knowledge of medicine and public hygiene was insufficient to cope with the predisposing conditions for certain diseases and debility which a warm, moist, monotonous climate offers. It was formerly believed that the climate itself directly produced tropical diseases, and much was unfairly blamed on the climate which we now recognize as only indirectly, if at all, related to the climate. The monotony and mildness tend to lower the resistance of the body, but better individual and public hygiene can probably offset this danger. A certain percentage particularly of white people cannot tolerate the climate well in spite of good hygiene, yet this is true in some degree of any climate. Constitutions differ due to inherited or acquired idiosyncrasies, and some are better adapted to one place than another. In another decade we expect research in tropical physiology will make it possible to select by previous examination the persons who will adapt well to a tropical climate, and many of the tragedies that follow assignments to tropical stations will be largely avoided. On the other hand, it must be recognized that the benefits of hygiene and medicine are achieved in the tropics at a greater cost of money and inconvenience than in higher latitudes because the continually warm moist conditions cause a greater growth of pathogenic organisms which have to be combatted, than in a climate with a cold winter. It can be said in favor of the subtropical climate that the tendency to degenerative functional diseases of the heart and to metabolic diseases is distinctly less than in higher latitudes with their many sharp weather variations that can overtax the body.

Knox (1852) described conditions which are not much different from those of today as follows:

> ". . . in winter and spring, fever and ague are apt to prevail in the low grounds and towns; bilious fevers make their attacks more generally in the fall, induced by exposure to rains and the hot sun or *intemperance* [author's italics]. Consumption carries off many of the inhabitants [as today]. Rheumatism and neuralgia are common. Dysentery and influenza are epidemic. Whooping cough, scarlet fever, and measles are almost unknown. The continuous heat of summer and winter ultimately debilitates the system and induces disease, especially bowel complaints. Foreigners are less sensitive to cold in the West Indies than the Creoles, but they feel the heat more."

Owing to defects in diagnosis, the Danish official statistics of disease and death are probably in part misleading as to the prevailing ailments. After 1917 the United States administration has paid more attention to public health, and conditions are now vastly improved. Some prevalent dis-

* Stone, R. G. "Health in tropical climates", in "Climate and Man". 246–261. U. S. Dept. Agric., Yearbook for 1941.

eases were formerly not understood or barely mentioned, such as hookworm, venereal diseases, and elephantiasis. The relative dryness of the islands considerably limits malaria, schistosomiasis, hookworm, and probably other parasitic diseases. St. John, being heavily wooded and thus having moist ground, has more malaria. The swamps, crabholes, and ponds near the coast, and moist crypts of trees and bushes, as well as cisterns and ditches, form the foci for local endemism of malaria, elephantiasis, and other mosquito-borne diseases. An unusually rainy season is followed by an epidemic increase of malaria (Shaw).

McKinley ("A Geography of Disease" 1935) lists the following as important diseases in Porto Rico and the Virgin Islands: Malaria, leprosy (a few cases), syphilis, typhoid and paratyphoid, sprue, ascoriasis, hookworm, schistosomiasis, filariasis, elephantiasis, ulcus tropicum, malnutrition, measles, German measles, varicella, influenza, colds, pneumonia, tuberculosis, meningitis, diphtheria, nephritis, pellagra, and cardio-vascular ailments.

It is of interest to note the terrible consequences of a hurricane (see Red Cross report on 1928 storm) — the death rate increases not only because of injuries at the time, but also from overcrowding and malnutrition during the next few months.

The intensity of the sunshine and its richness in ultraviolet have an important indirect influence on health by drying the soil and killing bacteria and parasites. The ultraviolet (UV) will give the untanned skin an intense sunburn (erythema) in a fraction of an hour when the sky is clear and the sun is high. Although severe erythema should be guarded against, the general exposure to UV produces vitamin D in the skin and helps underprivileged folk to withstand malnutrition and especially rickets.

Heat stroke and sunstroke are rare in the islands because the combinations of wind, temperature, and humidity are seldom so extremely uncomfortable as are the hot spells of more continental climates.

Milam and Smillie (1931) studied "colds" and oral bacterial flora of natives on St. John finding the flora very constant through the year with but few of the transient flora and seasonal changes found in northern United States. This is due both to the even climate and the isolation.

CLIMATE AND SUGAR CANE IN ST. CROIX*

Lack of sufficient moisture has always been the major limiting factor to the sugar industry of St. Croix. For an average crop† at least 45 inches of

* Extract with minor changes and some additions by R. G. Stone, from "Geographic Studies on the Virgin Islands of the United States", by Earl B. Shaw, Ph.D. Thesis, Clark University. pp. 36–58. 1932.

† The average production for plant cane is 17 tons per acre, for cane ratoon, 8 tons; these averages and rainfall requirements for "good" and "average" crops were furnished by Glen Briggs (formerly) Director U. S. Agricultural Experiment Station, St. Croix.

well-distributed rainfall are necessary, and from 50 to 60 inches are required for what may be termed a good yield. Rainfall records for 80 years at Christiansted show that during only 43 years was the annual total 45 inches or more, while during the remaining, the totals range down to 29.48 inches (1873) (see TEXT TABLES 20, 22, and 23). Not only is the yearly total rainfall unfavorable to sugar production but the distribution throughout the year is not dependable. There may be a yearly total of 50 inches or more, enough for a good crop if rightly distributed. But if approximately one-fourth to one-third of this rainfall comes during one month of the year, as it often does (see TEXT TABLES 3, 6, and 7), due in most cases to hurricane influence, and the balance not always well apportioned during the remaining months, the yearly total has little significance.

Although monthly rainfall is often unequally distributed, the data on the average number of days with rain (APPENDIX TABLES 3–6, and 12) indicate that the daily distribution may be favorable. In general, this does not convey the whole truth. Rain may fall frequently throughout the growing season, but after the cane covers the ground it takes a heavy shower to reach the roots and to benefit the plant. Such showers come too infrequently for ideal crop development, as St. Croix is too small and too low to bring about marked local heat-convectional or orographic rainfall.

Wind is another climatic hazard to sugar cane in St. Croix. Tropical hurricanes may come anytime from June through November and sometimes damage a growing cane crop or ruin it entirely (see appendix B). These storms not only cause loss of cane, but also inflict serious injury to buildings and the laborers. They are regarded with such dread by the people that special prayers for deliverance are made at the beginning of the hurricane season, and a thanksgiving service is held when the period of danger is past. The constant trade winds also cause a high rate of evaporation which is unfavorable to soil-moisture conservation. The mean annual evaporation from a water-filled pan over a period of years (1920–38) shows that the *potential evaporation* exceeds the mean annual rainfall by about 27 inches (see APPENDIX TABLE 8); but the *actual evaporation* from the land and vegetation is not as great as from a water surface represented by the pan.

On the other hand, temperatures and sunshine are favorable for sugar production, low latitude and altitude eliminate frost danger, and the large percentage of possible sunshine favors a high sucrose content (see TEXT TABLES 1, 17, and APPENDIX TABLES 9–12, 15).

The rainfall map of St. Croix (FIGURE 2) was made from data furnished by the Agricultural Experiment Station at Anna's Hope. Rainfall records (APPENDIX TABLE 7) from 26 stations (mostly sugar estates), including Christiansted and Frederiksted, for a period of ten years were used in drawing the isohyets. Only one station (Cotton Grove) with but one year's precipitation records was available for the far eastern section, but it is known that eastern St. Croix has a considerably lower rainfall than other parts of the island (see discussion of Vegetation and Climate).

Northwestern St. Croix is the rainiest section, and the south has less precipitation. The trades (prevailing direction ENE–ESE) blowing over the northwest upland account for the greater precipitation there. In eastern

TEXT TABLE 20

SUGAR-CANE YIELD AND RAINFALL OF ST. CROIX, 1862–1938

Years 1862–1902

(From St. Croix Gov't: "Statistics concerning sugar production . . .")

Year fiscal	Acres taxed	Yield *hogshead/ acre	Rainfall† "lines"
1862	18,074	0.72	330
1863	17,535	0.56	272
1864	17,449	0.38	316
1865	17,602	0.47	396
1866	17,475	0.73	371
1867	17,505	0.60	373
1868	17,326	0.64	302
1869	17,276	0.37	382
1870	17,276	0.54	410
1871	17,277	0.99	287
1872	17,221	0.40	255
1873	17,137	0.40	237
1874	17,089	0.18	385
1875	16,835	0.61	245
1876	16,554	0.32	286
1877	16,608	0.30	391
1878	16,576	0.62	454
1879	16,574	0.53	541
1880	15,664	0.64	331
1881	15,980	0.62	464
1882	15,963	1.02	354
1883	16,486	0.68	386
1884	16,700	0.94	356
1885	16,508	0.91	365
1886	16,548	0.80	433
1887	16,511	0.90	383
1888	16,440	0.81	438
1889	16,479	1.16	437
1890	16,489	0.98	243
1891	16,333	0.21	403
1892	16,404	0.94	282
1893	16,587	0.62	448
1894	16,633	1.22	352
1895	16,011	0.85	446
1896	15,974	1.15	448
1897	16,149	1.21	439
1898	16,181	1.04	404
1899	16,187	1.28	273
1900	16,298	0.70	364
1901	16,441	1.23	535
1902	16,428	1.29	491

Years 1900–1938

(From U. S. Dept. Interior: "The Virgin Islands of the U. S.", 1935)

Year fiscal	Acres taxed	Yield short tons	Rain-fall† in.
1900	16,298	8,614	45
1901	16,441	15,111	67
1902	16,428	15,937	61
1903	15,820	9,419	45
1904	15,704	11,231	37
1905	15,194	4,978	53
1906	15,068	8,541	56
1907	13,986	7,940	38
1908	13,550	4,859	45
1909	14,007	6,444	52
1910	13,901	7,516	43
1911	13,710	7,209	45.5
1912	13,397	4,831	37
1913	12,744	4,203	39
1914	11,898	3,653	37.5
1915	12,474	3,037	65.5
1916	12,220	15,334	59
1917	12,627	7,725	39
1918	12,718	5,841	46
1919	12,498	9,723	51.5
1920	12,847	13,329	34.5
1921	11,854	–	30
1922	9,662	6,345	26.5
1923	9,014	1,948	33
1924	9,208	2,385	39
1925	9,585	10,653	52
1926	9,196	6,343	39
1927	9,250	6,860	48.4
1928	8,240	11,275	43
1929	8,135	2,825	60
1930	5,892	–	39
1931	5,009	1,787	49
1932	4,686	4,287	70
1933	4,505	4,125	68
1934	5,386	4,088	53
1935	5,800	1,670	40
1936	6,277	3,725	68
1937	5,266	5,749	44
1938	6,112	4,664	43

* Hogshead = 1,500 lbs. † Averages of 2 or 3 stations, as in APPENDIX TABLE 3 and TEXT TABLE 5.

St. Croix, the elevations are insufficient to produce much orographic rainfall and the windward situation and narrow land cause fewer and less intense convection showers from local insolation than the wider leeward western portions.

The TEXT TABLES 20, 21, and 22 show that the years of heavier sugar production generally follow those of increased rainfall. This is not always

TEXT TABLE 21

DEPARTURES OF RAINFALL AND SUGAR YIELD IN EXTREME YEARS FROM THEIR NORMALS FOR 1881–1904 AND 1882–1905, RESPECTIVELY, IN ST. CROIX

(Mean rainfall was 1242 mm.; mean sugar yield 1202 lbs. per acre)

(From Ravn)

A. Wet Years					B. Dry Years				
	Annual		April–November			Annual		April–November	
Year	Rainfall departure %	Sugar yield departure (next yr.) %	Rainfall departure %	No. days with 20 mm. or more rain	Year	Rainfall departure %	Sugar yield departure (next yr.) %	Rainfall departure %	No. days with 20 mm. or more rain
1881	+19	+ 8	+31	–	1882	−15	−26	−18	10
1886	+11	− 4	+ 6	16	1890	−38	−76	−54	3
1888	+12	+26	+15	11	1892	−28	−30	−24	7
1889	+12	+ 4	+18	22	1899	−31	−24	−26	–
1893	+14	+28	+19	11	1904	−24	−49	−31	5
1895	+14	+25	+ 5	14					
1896	+14	+32	+18	15	Mean	−27	−41	−31	6
1897	+12	+ 9	+14	17					
1901	+37	+40	+44	17					
1902	+25	− 6	+22	–					
Mean	+17	+16	+19	15					

TEXT TABLE 22

FREQUENCY OF ANNUAL RAINFALL TOTALS, 1852–1914 (AVERAGE OF 3 STATIONS), AND CORRELATED SUGAR YIELDS, 1878–1915, ON ST. CROIX

(From Ravn)

		Sugar yield	
Class intervals Inches of rainfall	Number of cases	Tons of cane per acre (1878–1915)	Hogsheads of sugar per acre
26–35	6	4.7	37
35–45	20	7.0	58
45–55	27	9.7	87
55–65	8	10.6	98
65–70	2	12.2	(97)

the case, for sometimes a large percentage of ratoon cane and an epidemic of plant diseases or insect pests cause a low yield even after years of heavy precipitation. The distribution of rainfall through the year is equally as important as the mean annual rainfall. The data illustrate the erratic nature of the rainfall, a characteristic much emphasized in discussions of some of the temperate regions but not always stressed sufficiently for parts of the tropics. The area of production showed a gradual decline from approximately 20,000 acres in 1850 to about 12,000 in 1900. Since then the acreage has decreased rapidly until in 1930 it dropped below 6,000.

Text Table 23

Rainfall of the Five Wettest and Five Driest Years, St. Croix, 1852–1914, in Inches (average of 3 stations)

(From Ravn)

Wettest		Driest	
1861	58.8	1863	34.0
1879	67.6	1872	32.0
1881	58.0	1873	29.6
1901	66.9	1875	30.6
1902	61.4	1890	30.3

THE UPPER AIR AND GENERAL CIRCULATION IN RELATION TO THE WEATHER AND CLIMATE

Aerological observations have been made at Bourne Field by the U. S. Marine Corps since 1935, airplane-meteorograph soundings being included since January 1937. The pilot-balloon ascents have reached only several kilometers on the average and have not been summarized. A long series of observations of winds aloft at San Juan, discussed elsewhere,* is sufficiently representative of conditions over the Virgin Islands, except for the lowest 500 meters.

Some of the most general features of the circulation are mentioned in the note by Palgrave above. More specifically, the troposphere in this region stratifies itself into two primary layers which form two closely-related fundamental branches of the general circulation of the whole earth's atmosphere, viz., the *trades,* an easterly current at the surface, and the *antitrades,* a westerly current flowing above the trades. Both currents are present throughout the year but they vary seasonally in depth, velocity, direction, and steadiness. The average height of the center of the transition zone between the top of the trades and the bottom of the antitrades ranges

* Stone, R. G. Bull. Am. Met. Soc. 23 (1): 4–15. 1942.

here from about 4.5 kilometers in winter to 10 or 12 kilometers in summer. The transition is rarely sharp but may be from tens or hundreds of meters to several kilometers thick; also it varies rapidly in height from day to day about its mean height. Rarely the westerly winds may come down to the very surface, as in the front of approaching hurricanes or with "northers". The trades blow rather constantly from slightly north of, or due, east in winter and from somewhat south of east in summer (see TEXT TABLES 2 and 3); but at the surface other directions appear more frequently than aloft due to the deflection by hills and the effects of showers and squalls, and possibly to land and sea breeze tendencies. The friction of the winds with the earth's surface causes a regular logarithmic diminution in the speed from about five hundred meters down to the ground, and also causes a slight turning of the direction more to the left (looking downwind) which means the surface wind comes from more south of east than aloft, on the average. All wind observations for the lower atmosphere, whether from cloud motions, balloons, or wind vanes and anemometers, must be interpreted with these facts in mind.

APPENDIX TABLE 15 gives a summary of mean *resultant motions* of lower, middle, and upper-level clouds at 3 observations a day at Bourne Field. The results show the general prevalence of trades and antitrades but there is much variation from year to year and month to month which is not to be taken as entirely real since the clouds are apt to be associated more often with certain directions than others. The monthly resultants from regular daily pilot-balloon ascents at San Juan do not show such large variations as do these cloud observations, and the former are for various reasons probably more representative of the true conditions.

APPENDIX TABLES 17–20, containing the average temperatures, pressures, and humidities at fixed heights up to 5000 meters, are based on airplane-meteorograph soundings made daily during 1937 and 1938 at Bourne Field. In 1939, 1940, and 1941 soundings were resumed during the hurricane season (July–November) and on special occasions (maneuvers). The interpretation of individual soundings and their significance for various problems in tropical meteorology would be disproportionately long and out of place here; but there are several features of the prevailing thermodynamic structure of the free air which should be described briefly because they determine to a large extent the rainfall régime of the islands.

A perusal of the mean values of the upper-air humidities shows that the specific humidity is considerably higher in the summer (rainy) season than in winter both at the surface and upper levels; but the relative humidity variation differs with height, for while aloft it is much higher in summer than winter, in the lowest 2.5 kilometers it is rather uniformly high through

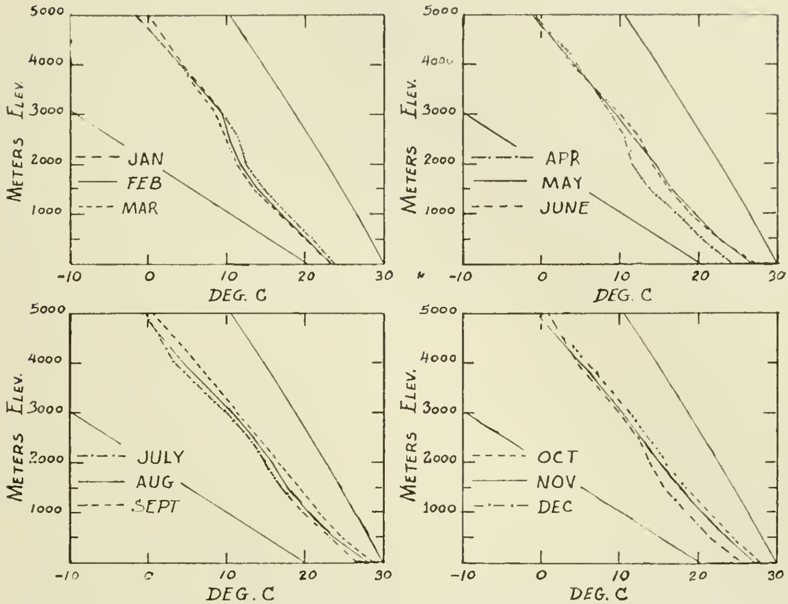

FIGURE 3. Average lapse rates over St. Thomas, 1937–38. Temperature in ° C. plotted against height in meters. One dry and one wet adiabat are added for reference, originating at 20° and 30° C. at the surface, respectively.

the year. This distribution of relative humidity is graphed in FIGURE 9. Now recalling the annual course of monthly average rainfall totals at stations in the islands (APPENDIX TABLES 3–7), it is evident that the "rainy season" from May through November coincides with the period during which the humidity in the levels above 3 kilometers is high. Such a relation is not surprising from what is generally understood or assumed about the nature of tropical rainfall processes, for the more active the convection and the further upward it reaches the greater rainfall that may result, other things being equal. The convection both carries moisture aloft with it and in turn is able to penetrate higher by virtue of the resulting increase in humidity (the condensation of which converts latent into kinetic energy).

It remains to consider the reason for an increase of convective vigor in the so-called rainy season. A corresponding change in the vertical stability of the air column with season is indicated *a priori,* and readily verified by an examination* of both the mean monthly lapse rates (vertical temperature gradients) and the lapse rates day by day through the year. FIGURES 3, 4, and 5 show the mean monthly lapse rates and two soundings of contrasted types.

* The adiabatic charts for each sounding were inspected at Bourne Field and at the U. S. Weather Bureau, Washington.

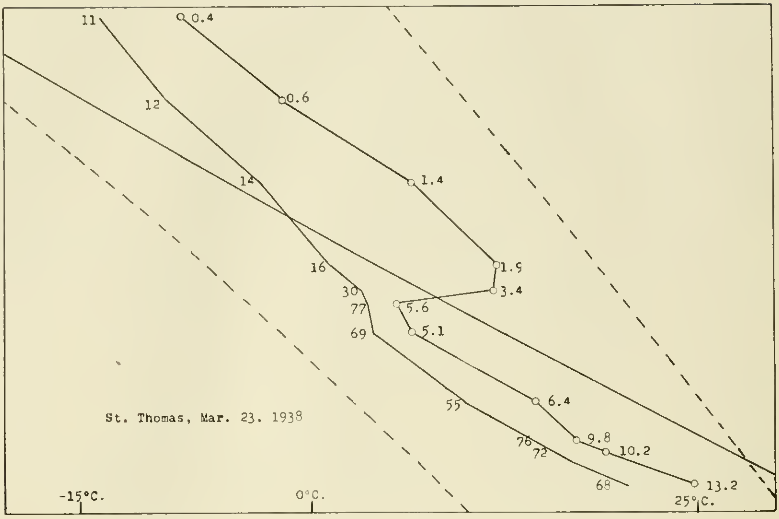

FIGURE 4. Upper-air sounding at St. Thomas, March 23, 1938. Plotted on an emagram (coordinates: temperature and logarithm of pressure). The dashed lines are two wet adiabats and the sloping full straight line is a dry adiabat. The right hand curve of the sounding is temperature with specific humidity values written beside the significant points. The left hand curve of the sounding is the wet-bulb temperature, with relative humidity values added for each significant point. The range of pressure from bottom to top of the chart is from 1050 to 500 millibars. This sounding reached to about 18,000 feet.

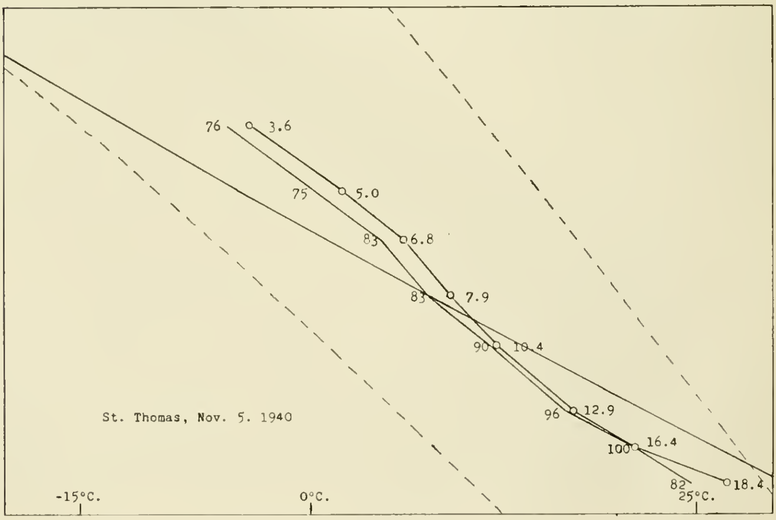

FIGURE 5. Upper-air sounding at St. Thomas, Nov. 5, 1940. Plotted similarly to FIGURE 4. This sounding reached about 14,000 feet.

The soundings made at St. Thomas were the first extensive series from this part of the sub-tropical Atlantic. From them the writer has noted that the structure of the trades in the Caribbean is similar to that found years ago from soundings in the eastern Atlantic off the Canary Islands and Cape Verde. This structure explains why the whole region of the subtropical North Atlantic (or "Azores") anticyclone has relatively little cloudiness and rain, for the moist unstable surface air layers in which the trade-wind cumulus clouds form are constantly overlaid by a deep warm, dry, stable layer (or layers) which generally prevents any convection originating in the surface layers from reaching high enough to produce heavy showers.

The formation and maintenance of this upper stable layer are not yet fully understood, except that it undoubtedly has its immediate origin in the subsidence of the antitrades into the core of the anticyclone. The surface moist current is separated from the upper dry current by an inversion of the temperature lapse-rate, or by at least a zone of isothermal lapse rate or of greater stability than below and above. This is called the *trade inversion*. Presumably in many cases the so-called *Ts*, or *S, inversion* often noted above tropical Atlantic air-mass invasions into the United States were originally trade inversions. The St. Thomas soundings show the trade inversion in some degree during most of the year. This is not surprising since the Virgin Islands are nearly always under the southwestern margin of the Azores anticyclone, but what it probably really means is that the inversion is being constantly carried along outwards from where it is formed in the central and eastern parts of the anticyclone. A comparison of soundings made in different parts of the anticyclone shows that the height of the base of the inversion tends to rise in all directions from the center of the anticyclone.* Thus near the Cape Verde Is. it is only about 500 meters above sea level on the average but increases to 1800 meters near the equator and over the Caribbean. The stability, dryness, and thickness of the upper current tend to decrease as the height of the inversion increases, and vice versa.

When the daily soundings at a fixed station, such as St. Thomas, are compared successively it is immediately apparent that the inversion and the air above it vary remarkably in height, thickness, intensity, and other characteristics from day to day. Furthermore a closer analysis leaves an impression that the day to day changes in cloudiness, rain, and wind are somehow related to the changes in the stability of the air aloft. But to date it has not been possible to find a simple or clear-cut correlation, owing to the complications introduced by local convection and surface influences.

* von Ficker, H. Die Passatinversion. Veröffentl. Meteorol. Inst. Univ. Berlin 1, Heft 4, 1936.

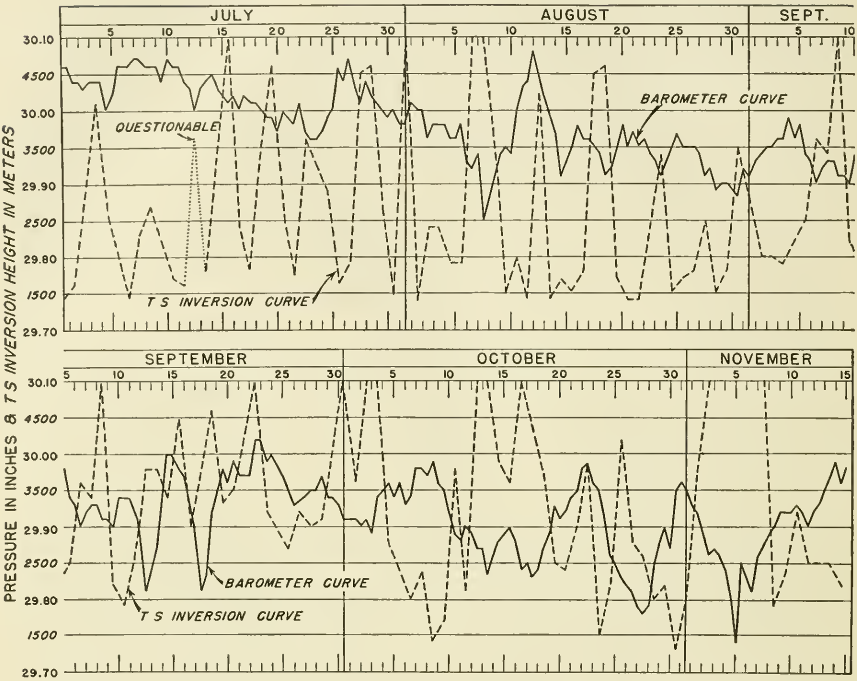

FIGURE 6. Surface pressure and height of the trade (= "Ts") inversion, July–November 1938, at St. Thomas. (After Dunn, Bull. Am. Met. Soc. p. 225, June 1940.)

and to inadequate data.* The attempts of Frolov and of Dunn to find clues to this problem through isallobaric analysis should be studied by those interested in further details.† It appears from daily North Atlantic weather maps that the Azores anticyclone fluctuates from day to day in size, intensity (maximum pressure), and in position, which in turn causes some of the day to day changes in the trade inversion at St. Thomas mentioned above. Note in FIGURE 6, from Dunn, how the surface pressure (Barometer Curve) has a rough tendency to be high when the height of the inversion (Ts Inversion Curve) is low. Dunn found that in the July period (shown on this figure) there were eight major "waves" of pressure change and that in each case the pressure-fall phase of the "wave" was associated with a lifting of the inversion and usually also with an increase of specific humidity and temperature at the 3000-meter level. Hurricanes

* See ref. to correlation coefficients computed by Bice, Bull. Am. Met. Soc. 21: 219, also fig. 2 on p. 218. 1940.

† Bull. Am. Met. Soc. 21: 216–229. 1940, and 22: 198–210. 1941.

are observed to develop through continued "deepening" of a pressure-fall of this type. Of course, the great majority of these falls do not become hurricanes but remain of small amplitude (.01 to .11 inch) or die out. J. E. Miller and G. Emmons have investigated this phenomenon further.* All these pressure changes studied by Dunn were found by plotting maps of the 24-hour pressure differences which show 48-hour periodicities. The areas of rise and fall on these maps tend to move from east to west at 15

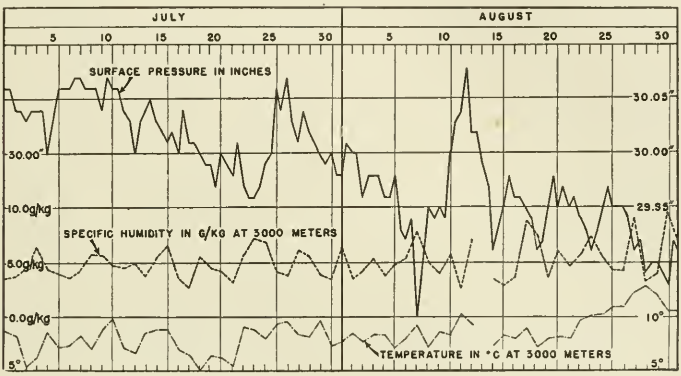

FIGURE 7. Surface pressure, upper-air temperature, and specific humidity at 3000 meters, July–August 1938, St. Thomas. (After Dunn, Bull. Am. Met. Soc. p. 218, June 1940.)

to 25 miles per hour. However, Frolov has studied the 72-hour pressure differences which show six-day periodicities. These do not propagate from east to west but rise and fall in unison at all stations affected by the southern half of the Azores anticyclone from Africa to Central America. This fact can only mean that these longer fluctuations are produced by expansion and contraction of the entire Azores anticyclone. The shorter-period changes that propagate are superimposed on these longer periods. No correlation of Frolov's 6-day period in pressure with variations in the other elements has been made. An inspection of the daily rainfall tables in the "Climatological Data: West Indies and Caribbean Service" suggests that the chief variation of rainfall within a month has a rough period of about a week to 15 days, as a rule. This corresponds to the largest "see-saws" in pressure shown on one of Dunn's figures (FIGURE 7). Apparently these

* U. S. Dept. of Commerce, Weather Bureau, "Curso para el Estudio de los Huracanes, Tomo I: Caracteristicas del Tiempo en el Caribe y Método de Análisis". Mimeo., Wash., D. C., pp. 65–84. Feb. 1942.

J. E. Miller, "The Significance of Allobaric Systems in Forecasting Cyclogenesis in the Caribbean". MS Thesis. College of Eng., New York Univ. Oct. 1941.

grosser fluctuations are due to shifts in the position of the Azores anticyclone in combination with changes in its size and maximum pressure. But they can be effectively studied only with the aid of weather maps of the whole northern hemisphere, because they are actually a direct manifestation of changes in the intensity of the general circulation of the earth's atmosphere.*

The east-to-west moving allobaric systems are apparently prevalent only in the "rainy season" (June–November). In the winter season they move from west to east. The winter systems are of different origin and character than the summer ones. The latter form closed circular areas whereas the former are long troughs that extend south or southwestward from cyclones of middle latitudes well into the tropics if not often to the very edge of the doldrums. These troughs are originally associated with the cold fronts of polar-air outbreaks across the United States from Canada or the Pacific; the warm Caribbean waters quickly efface any observable temperature discontinuity at the surface before the polar air reaches the Virgin Islands, except in the relatively rare cases of "northers." The anticyclones that follow the cold fronts often continue southeastward to merge with the west or north side of the Azores High; such anticyclones are already largely transformed from cold-air domes to warm-air dynamic anticyclones by the time they reach the subtropics. The airflow through the preceding trough and the warm ocean surface are then unfavorable to the continued existence of a temperature discontinuity, but the trough remains as a col between the newly developed dynamic anticyclone and the preexisting one represented by the Azores High. The younger anticyclone does not simply amalgamate with the Azores High but often appears to "grow" and to move eastward at the expense of the older High. In this way the trough between them appears to move eastward across the Atlantic Ocean. A connection of this trough with the northern part of the cold front from which it originally derived may often be maintained during the eastward progress across the ocean, or else with a new secondary (or wave) cyclone which may have formed on the front when it was off the eastern coast of America. In any case the passage of one of these troughs over the Virgin Islands and the other Antilles usually leads to a noticeable sequence of changes in the weather: before the trough passes, a slight shift of winds toward the south with increasing warmth, moisture and clouds;

* *Cf.* Papers in Physical Oceanography and Meteorology. Mass. Inst. Techn. and Woods Hole Oceanogr. Inst. **8**, no. 3. 1940; and **9**, no. 1. 1941. Rossby indicates that the Azores High shifts north and south with changes of intensity in the zonal circulation of the westerlies (Jn. Mar. Res. **2** (1): 38–55. 1939). Clayton correlates these shifts with sunspots (Trans. Am. Geophys. Un. **1941** (II): 420–423).

then as it passes, a shift towards the north with more rain and cooler air; after which, clearing and drier weather, gradually reverting to average trade conditions. The troughs tend to pass this region about once every 5 to 7 days, and thus the fluctuations which they cause may be considered as part of the "normal" picture for the season. The late Dr. O. L. Fassig in 1909 began to notice the "influence of passing highs and lows to the north" on weather in Porto Rico, but he never published his manuscript notes on the subject.* Only recently has the phenomenon again come to the attention of American meteorologists.† The accompanying changes in the upper air and the mechanism by which the trough affects the clouds and rainfall have not yet been fully investigated. However, it appears that the belts of convergence and divergence produced by a sinusoidal field of flow, as demonstrated by J. Bjerknes,‡ could account for all or part of the weather changes by raising and lowering the trade inversion. In addition, the southerly component in the forward side of the trough might import moister air aloft from lower latitudes. The intensity and frequency of troughs should be directly dependent on the character of the meridional interchange of polar and tropical air masses over eastern North America — indeed, there is some evidence that during colder winters in eastern United States the weather is relatively cool, rainy, and cloudy in the Antilles.

The origin of the allobaric systems of summer is surmised to be in Africa; from May through November systems of similar character parade from east to west across West Africa and out to sea past the Cape Verde Islands. Violent squalls ("tornadoes") are associated with the katallobaric centers. Although the ship observations are too few to definitely trace the systems eastward to the Antilles, many meteorologists believe that at least they may occasionally develop into hurricanes upon approaching the Antilles. Hubert§ indicates a high probability that the great "New England Hurricane" of 1938 had such a history. But the "tornadoes" are always observed to weaken east of the Cape Verde Islands and therefore some process must favor their rejuvenation in the western Atlantic region.||

* These were edited by us and will appear in Part 3 of this volume.

† See U. S. Dept. of Commerce, Weather Bureau, "Curso para el Estudio de los Huracanes", Tomo I: 57–62. The role of these troughs in the weather of the Canary Islands region was first recognized by Roschkott in "Festschrift der Zentralanst. f. Met. u. Geodynamik in Wien, zur Feier ihres 75 jähr. Best." Vienna, 1926, p. 121 ff. See also Piersig, W., Schwankung Luftdruck und Luftbewegungen. Archiv d. Deut. Seewarte. **54** (6): 1936.

‡ Bjerknes, J., Theorie der aussentropischen Zyklonenbildung. Met. Zeit. **54** (12): 462–466. 1937. Lt. Geo. P. Cressman, of New York University, has applied Bjerknes' principle to the winter troughs of the Azores High, in an unpublished manuscript, 1942.

§ Abstract by C. F. Brooks, in Trans. Am. Geophys. Un. **1940** (II): 251–253; also critique by Portig, Ann. d. Hydrographie, **67** (7): 398–400. 1939.

|| Regula, H. Druckschwankungen und Tornadoes an der Westkuste von Afrika. Ann. d. Hydrogr., **64**: 107–111. 1936; also Piersig, W., *op. cit.*

The occurrence of east-to-west allobaric centers and of West African "tornadoes" is limited to the period when the boundary between the trades of the north and south hemispheres is well north of the equator; it is therefore a reasonable assumption that the Coriolis force is essential for the maintenance‡ of these allobaric systems, though they apparently arise merely from the large diurnal period in temperature, pressure, and wind over subtropical Africa.§ However, we recognize the possibility that the allobaric systems observed in the Antilles may also have a more immediate origin over the ocean to the southeast due to surges of southern hemisphere trades pushing into the northern trades; such surges are observed in the doldrums but it is generally believed that many of them are in turn consequences of the "tornadoes" from West Africa.||

The subdivision of the subtropical high-pressure belts into cells can perhaps be better understood in physical terms as a result of lateral mixing. Rossby and his collaborators* have shown that above the layer of surface influences the subtropical highs break up into a train of large anticyclonic eddies, in a manner called for by the assumption of a jet stream suffering lateral mixing with its environment on a rotating earth. In particular an analysis by Simmers* of a case of warm anticyclogenesis suggests that the lateral-mixing process may explain how the separate highs maintain their identity as they pass across the subtropical Atlantic in winter. In summer, too, anticyclonic eddies prevail aloft over the United States and Gulf of Mexico in the seasonal extension of the Atlantic high pressure belt northward and westward.* No studies have been made as yet to discover whether the weak summer allobaric systems are associated with observable eddy tendencies aloft.† We offer the tentative view that the winter cells and troughs of the Azores High are the result of jets of polar air driven into the westerlies, and the summer allobaric systems are the result of jets of equatorial or southwest-monsoon air driven into the trades. The much

‡ Perhaps in a manner analogous to the wedges and troughs in the westerlies as demonstrated by Rossby, C. G. Papers in Phys. Ocean. and Met., M.I.T. and W.H.O.I., 8 No. 3: 1940.

§ Regula, *op. cit.;* Hubert, H. Grains orageux et les pluies en Afrique Occidentale. Paris, 1922; *id:* Nouvelles études sur la météorologie de l'Afrique Occidentale Française. Paris, 1926; Frolov, S. Variations de la pression en A.O.F. Ann. de phys. du Globe de France d'Outre-mer, **3** (14): 46–50, 57–58. 1936; Weisse, L. and Barberon, J. Note au sujet du grain du 28 au 30 Juin 1933. Études mét. sur l'Afrique Occidentale Fr., Publ. Comm. d'Études Hist. Sci. A.O.F., Sér. B No. 3: 47–61. Paris, 1937. Goualt, J. Vents en altitude à Fort Lamy (Tchad). Ann. Phys. du Globe Fr. d'Outre-mer, **5**: 90–91. 1938; Farquharson, J. S. The diurnal variation of wind over tropical Africa. Quart. Jour. Roy. Met. Soc. **65**: 165–184. 1939.

|| Ferraz, J. de S. Hurricanes and South Atlantic circulation. Bull. Am. Met. Soc., **20** (8): 334–335, 1939; also Regula, H. Schwankungen der Passatgrenzen. Ann. d. Hydrogr. **65** (10): 458–460. 1937; Durst, C. S. The doldrums of the Atlantic. Geophys. Mem. (London, Met. Off.) **28**: 1926.

* Rossby, C. G. and collaborators. Fluid mechanics applied to the study of atmospheric circulations, Papers in Phys. Ocean. and Met., 7 no. 1, 1938. See also Namias, J. Isentropic analysis, in "An introduction to the study of air mass and isentropic analysis". 5th ed., Am. Met. Soc., 1940, pp. 136–161.

† Note, however, the isentropic charts for the hurricane of 1938 by Pierce in U. S. Mon. Wea. Rev. **66**: 237–285. 1938, and the mean monthly isentropic charts published regularly in the same journal since 1939.

larger, more intense development of the winter systems compared to the summer ones reflects the difference in latitude and hence in the respective Coriolis effects.

The mean conditions of a month at a station such as St. Thomas are thus the result of a complex of fluctuations of various types and causes. The rainfall is increased by any process which weakens or lifts the inversion, whether it be simple heating from the surface, convergence from a passing pressure-change system, or a shift of the Azores anticyclone northward so that the lesser stability normal to regions nearer the equator spreads to somewhat higher latitudes. The annual march of rainfall in the West Indies can be explained for the most part by seasonal migrations of the Azores anticyclone (dry) and of the equatorial Low (rainy). The effect of this migration on the inversion over the Virgin Islands is thus a regular weakening from winter into the rainy season (May–November), with a brief partial return to winter-like conditions in July, and a rather rapid intensification of the inversion from November to January. FIGURE 4 is an example of the temperature-height curve when the trade inversion is very marked over the Virgin Islands region; the opposite extreme, in which very little stability is present, is exemplified in FIGURE 5. The more typical and frequent conditions are of course intermediate between these rather extreme types.

In APPENDIX TABLES 17 to 20 are averaged together the 1937 and 1938 soundings month by month and level by level for temperature (° C.), pressure (millibars), and relative humidity (per cent), and for 1937 we have copied the monthly mean specific humidities and equivalent-potential temperatures as published. The levels for which the data are given are: surface, 500 m, 1000 m, 1500 m, 2000 m, 2500 m, 3000 m, 4000 m, and 5000 m.

The mean temperature-height curves are plotted in FIGURE 3 for each month. A wet adiabat is drawn to the right and a dry adiabat to the left on each diagram. The general prevalence of conditional equilibrium (lapse rate between dry and wet adiabatic, i.e., air is stable if unsaturated, but unstable if saturated, as when a cloud has formed) is very striking. Also the great stability, approaching inversion conditions, in the layer from 1000 to 3000 meters is prominent from December to April. The trade inversion is present on so many days that there is almost an inversion in the averages, in spite of the varying height of the inversion and the large intervals between the standard levels for which the averages are computed.

In order to get a clearer picture of the stratification of thermal stability and instability, we have read off the lapse-rate types between each level for each month and tabulated them as follows:

Types of Mean Lapse Rate above St. Thomas (1937–38)

C stands for conditional equilibrium; W for approximate wet adiabatic equilibrium; S for absolute stability (approaching isothermalcy or inversion); and U for absolute instability (dry adiabatic equilibrium) (limits given in meters above sea level)

January	February	March
C to 1500 m W 1500–2000 m S 2000–2500 m W 2500–3000 m C 3000–5000 m	C to 1500 m W 1500–2000 m S 2000–3000 m C 3000–5000 m	C to 1500 m W 1500–2000 m S 2000–3000 m W 3000–5000 m
April	May	June
C to 1500 W 1500–2000 S 2000–2500 W 2500–4000 C 4000–5000	U to 500 C 500–1500 W 1500–2000 C 2000–5000	U to 1000 C 1000–1500 W 1500–2000 S 2000–2500 C 2500–5000
July	August	September
C to 1500 W 1500–2500 C 2500–4000 W 4000–5000	U to 500 C 500–1500 W 1500–2500 C 2500–5000	C to 5000
October	November	December
C to 5000	C to 5000	C to 1500 S 1500–2500 C 2500–4000 S 4000–5000

From this table a cross-section, FIGURE 8, has been drawn in which the layers or zones of each lapse-rate type are separated by lines, smoothed somewhat to give a more simple schematic appearance and to interpret in a logical way some of the improbable angularities imposed on the data by the limitation of averaging at only a few fixed levels. Various interpretations could be given in this smoothing procedure, depending on the interpreter's preconception of the most probable scheme and on other information that may be available indirectly to corroborate or guide him, assuming of course that the observations were accurately made and reduced in the first place and that the number of observations is sufficient to give normal or typical values.

The writer believes that the data for these two years indicate a nearly normal state of the upper air in the region in spite of the short record because the conditions in this tropical maritime region are known to have a relatively small variability. More data would alter details but not the major features. An inspection of the individual soundings served to confirm the interpretation of the mean conditions given in FIGURE 8.

The vertical arrows in FIGURE 8 indicate the relative intensities of upward convection and resistance thereto from stability aloft (downward arrows). When FIGURE 10, showing the rainfall totals and intensities and temperatures at Bourne Field for the same years as the soundings cover, is compared with FIGURE 8 and FIGURE 9 the close relation of the mean rainfall to the mean upper-air conditions becomes evident.

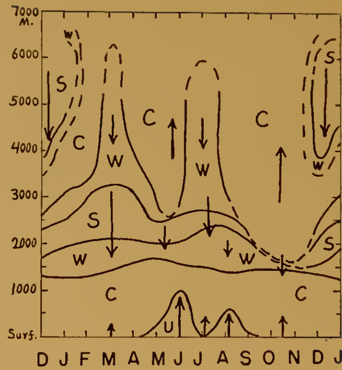

FIGURE 8. Scheme of upper-air structure over the Virgin Islands. Months plotted against height in meters. S = Stable, W = Wet Adiabatic, C = Conditional, U = Unstable. Arrows pointed up indicate by their length the relative intensity of convection and downward arrows the relative resistance to convection.

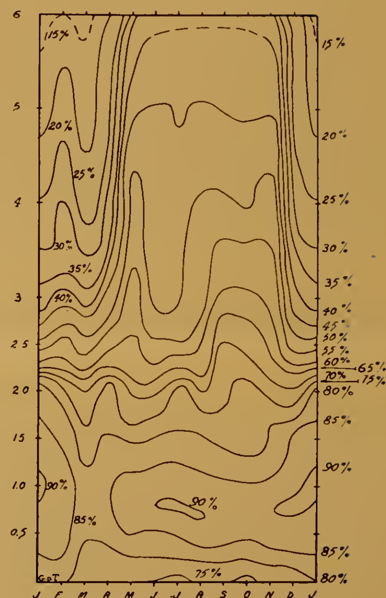

FIGURE 9. Mean relative humidity in the upper air over the Virgin Islands, 1937–38. (Months plotted against height in kilometers.)

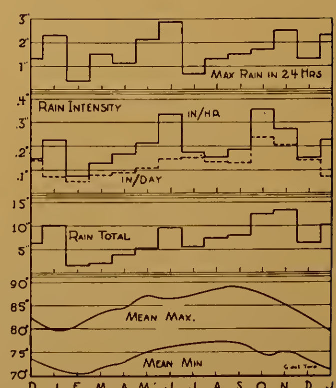

FIGURE 10. Monthly mean rainfalls, mean rainfall intensities, in inches per rain day and per rain hour, and mean maximum and minimum temperatures at Bourne Field, St. Thomas, 1937–38.

The two chief rainfall maxima, in May–June and October–November, characteristic of this region probably have somewhat different causes, if these two years are typical. The June period had a few heavy showers lasting some hours but many days with only light showers. The autumn period had relatively many more heavy showers but the average intensity was no greater than in the June period (cf. the discussion of rainfall intensities, *supra*). Although the June maximum is nearly as rainy as the autumn one, the stability aloft is still marked in June whereas it is practically absent in the autumn. However, the lowest 1000-meter layer is very unstable in June. It appears therefore that the spring rains are due to heating of the surface by the increasing solar altitude which forces the convection to penetrate the trade inversion occasionally with resulting intense showers. The mid-summer rains are apparently of similar character, for the solar altitude is a maximum again in July and instability in the surface layers is high through August. But the autumn rains require less energy at the surface since there is less stability aloft and any small convergence or heating will easily bring a good shower. We note that the second rainfall maximum is not in August, just after the second zenith-sun period, but much later when cooling into winter has already progressed for several months. This is *not* characteristic of most of the tropics nor of all of the Caribbean region, and therefore calls for some comment. The cooling of the North American continent in autumn is more rapid than the cooling of the Caribbean Sea, so that relatively cool air masses begin to encroach on the Caribbean from the north. There is as a result a tendency for convergence over the Caribbean. The slightest disturbance of this sort to the air column when it is very moist and in conditional equilibrium to high levels is apt to set off ample rains.* This happens more and more frequently towards winter and leads to greater and greater rainfall totals, until ultimately the return of the trade inversion in December chokes off the convection in the upper levels. The suddenness of the decrease in rainfall from November to December is characteristic and is obviously the direct consequence of the sudden return of a strong trade inversion in December.

At times in autumn a large flat low pressure area hovers over the Caribbean for weeks, giving rise to almost steady rains over a wide region. The gentle incessant convergence up to perhaps 6 or 10 km under such conditions soon destroys any weak stability aloft that may have extended out from the now retracted Azores High. Some years, however, have relatively dry autumns when these conditions are presumably reversed, i.e., warmer than usual in North America and the High shifted more southwestward than usual.

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* Examples analyzed in Externbrink, H., Kaltlufteinbruche in die Tropen. Archiv d. Deutschen Seewarte, 57, nr. 7. 1937; and Culnan, R. N., in, "Curso para el Estudio de los Huracanes". U. S. Dept. Commerce, Wea. Bur. Tomo 1: 85–90. mimeo. Wash. 1942.

Finally, we have to explain the large rainfall in February for the years 1937–38, which does not appear in the longer-period averages for this or other Virgin Islands stations. This abnormal rainfall was associated with an abnormal increase in the humidities aloft (FIGURE 9). The lapse rate in February was very stable; however, in the course of February 1937 some heavy rains occurred during a few brief periods when convection reached to abnormal heights, which is the explanation for the great difference between the intensity per rainy day and that per rainy hour in that month.

The diagram of monthly mean relative humidities plotted against height (FIGURE 9) is very helpful in the interpretation of the lapse rates, in particular for distinguishing the W layers that are stable (dry) from the unstable cloudy ones (moist). The rapid extension of the high surface humidities into the upper levels between April and May is most striking; as likewise the return to the winter dryness aloft between November and December. The spring transition period, moreover, coincides with the beginning of the seasons for some of the most severe instability phenomena, such as hurricanes, high rainfall intensities, hail, and thunderstorms.

The question arises here whether the large accumulation of energy indicated by the high summer temperatures and humidities of the surface air parcels is sufficient to carry the low-level moisture to high levels by convection, penetrating the upper stability, or whether the horizontal advection of air currents aloft from moister source regions (the Doldrums?) does not labilize the upper layers enough to permit the surface air particles to proceed to higher levels by free convection.* This problem cannot be discussed until much more upper-air data from the whole subtropical region become available. It is interesting to note, however, the temporary drop in relative humidity during June and July between 2500 and 5000 meters, an indication of the closer approach of the anticyclonic core.

During early winter the humidity reaches the remarkably high average of over 90 per cent in the lowest cloud layers around 800 to 1000 meters, owing to the steep lapse rates from the more rapid cooling into winter of the lands (and the air over it) than of the sea, and to the "lid effect" of the lower trade inversions; in view of the error of the hair hygrograph there must have been clouds or near-saturation almost every day in these layers. It is in March that the inversion is most intense, but by that time the frequent cold-air invasions from the continent bring cooler and drier trade-wind air (the wind roses on the Pilot Charts show fewer southerly components in March than at any other time). Hence the low levels are relatively driest in March.

* See the interesting but speculative discussions by Externbrink, H., Met. Zeitsch. **54**: 354–9, 413–17. 1937; and Scofield, E., Bull. Am. Met. Soc., **19**: 225. 1938.

APPENDIX A

NOTES ON THE ORGANIZATION, INSTRUCTION, AND HISTORY OF THE OFFICIAL D. W. I. RAINFALL STATIONS, 1877–1917

According to records and correspondence now deposited in the National Archives, Washington, the Danish West Indies Government early in 1877 acquired twelve rain gages with measuring glasses from the Danish Meteorological Institute, Copenhagen. Eleven observers in St. Thomas and St. John were given gages and glasses, and a copy of the printed instructions of the Danish Meteorological Institute with amendments in ink indicating how to construct the gage supports and to substitute the local units of measurement, "lines," for the European metric ones. Blanks for entering and returning the recorded rainfalls were also sent out. The returns were forwarded to St. Thomas and filed; a summary or copy was also probably forwarded from St. Thomas to Copenhagen, but except for the years 1877–88 in the "Sct. Thomae Tidende," the reports seem never to have been published.

DELIVERY OF OFFICIAL RAIN GAGES TO ST. THOMAS AND ST. JOHN, 1877

Drafts of letter "No. 4", below, dated January 6, 1877, were sent in English translation to Th. Stevenson, C. Danielson, Wesselhøft (Smiths Bay), Rev. Warner, and Gottlieb, Esq., and in original Danish to Planter Harthmann, Dr. Møller, and Capt. Leigh (all residents of St. Thomas).

According to your kind promise to take charge of a station for measuring the fall of rain on your estate, I hereby beg leave to forward to you a printed copy of 'Directions for the measurement of the atmospheric precipitation (rainfall),' together with 12 monthly lists to be filled up in the course of the year, at the same time requesting that you please send to the Barracks for a rain gage and appurtenances thereto and to cause the same to be placed in a suitable locality on your premises. The lists, after being filled up, are to be sent to Government Office at the end of each month.

Respectfully,

[unsigned]

The National Archives also contains a rough copy of the letter of January 6, 1877, "No. 4", to the Country Sheriff at St. John, forwarding 3 rain gages, 3 copies of the printed instructions (see below), and a spare measuring glass (also monthly forms); one gage is for Cruz Bay, one for Adrian, and one for Caroline (with consent of estate owners); monthly completed rainfall reports to be sent to the Government, St. Thomas.

There is also a rough draft of a letter, dated February 7, 1877, to the Country Sheriff at St. John, forwarding a reserve measuring glass and requests that rain be measured at Cruz Bay with both the old and new gage and reports sent in to St. Thomas.

INSTRUCTIONS TO D. W. I. RAINFALL OBSERVERS, 1877

Translated excerpts from "Veiledning til Moaling af Nedbor, Udorbejdet af Meteorologisk Institut (Copenhagen) 1873" (4 pp.), marked original, D. W. I. copy of which is in the National Archives (translation by Harold Larson).

The equipment consists of a supporting stand, a can, and a measuring glass.

The stand consists of four legs which are screwed fast at the top on each side of the four-covered frame and lower down are secured to each of the arms of the wooden crossbar [a drawing is entered on the margin of the copy in the National Archives]. The bottom ends of the legs of the stand are buried in the earth. It will be expedient to fasten to each leg a small crosspiece, so that after being covered with earth the framework cannot easily be pulled up or pressed down deeper into the ground.

The can is placed in the framework from the top. It consists of a collecting rim at the top, therefrom a funnel and finally a container supplied with a spout (or lip) and a handle.

The rim of the collector encircles a definite horizontal area (namely 1/10 square meter). The original circular form of the aperture must therefore be carefully preserved. Its position must be horizontal and its height above the surface of the earth 6 feet, whereby the grounding of the framework must be directed.

The funnel, in addition to a vent, is also supplied with two (2) other small holes, whereby air in the container can escape. These three (3) holes must always be kept clean.

The tightness of *the container* should be examined into now and then by filling it with water.

The spout should always be closed with a stopper in order to prevent the evaporation of the rain collected or the flowing in of rain in this manner.

Measurement: by the depth of the rainfall is understood the depth to which the fallen rain would stand if it remained lying as an even layer over a level surface of the earth. This depth is given in lines, and the measuring glass into which the can is carefully emptied, after being removed from the framework is precisely so divided that a quantity of rain caught by the collecting rim, and which makes a depth of rain of 1 line will fill the glass from one figure to the next. The space between the figures is also divided by small marks into 8 parts, so that one can read thereon both lines and eighths. Thus if the rainwater stands at 7 small marks above the figure 4 of the glass, it is read 4⅞ lines. (While being read, the measuring glass must be held precisely vertical.)

[*NOTE:* 1 mm = 0.3115 of an *English line;* the *Paris line* used in Denmark was never used in the Danish West Indies. There are exactly eight English lines to an inch, but approximately 11.3 Paris lines to the English inch. Why the generally obsolete English line was so widely adopted in the D.W.I. is not known, but possibly it was introduced by the planters from British countries or by merchants selling old English measuring devices. — *R. G. S.*]

[*The supporting stands* for the rain gages, according to marginal sketches and notes on the Archives copy of these "Instructions", were constructed of pitch-pine sticks in a tripodal design, to hold the upper rim of the gage at 36 inches above the ground (the present standard height in many countries). Each stand cost $2.25 for the wood and 40 cents for painting, i.e., $2.65 per stand or $31.80 for the twelve gages. — *R. G. S.*]

LÖVENLUND RAIN GAGE RECALLED, 1884

A rough copy of a request, dated October 12, 1884, to Planter C. Møller, Lövenlund, that the latter return to the Government Secretary the rain gage issued to him at the close of the year, is on file in the National Archives.

TRANSFER OF RAIN GAGE FROM EMMAUS TO EDEN, 1892

St. John, Country Sheriff's Office.
9 Mar., 1892.

This is to report the removal of the rain gage, hitherto set up in the yard of the Pastor (Jacobs) at Emmaus; in view of Pastor's leaving the rain gauge was today moved to Eden (a parcel of Emmaus), the owner of which, Quarter Officer (Rev. E.) George, has promised to note rainfall and make monthly reports.

APPENDIX B

LIST OF HURRICANES PASSING OVER OR NEAR THE VIRGIN ISLANDS*

Year	St. Thomas	St. Croix	Year	St. Thomas	St. Croix
1713	(?)	(?)	1871	August 21	August 21
1738	August 30 (?)	August 30	1876	September 13	September 13
1742	September 28	....	1881	August 23	....
1772	August 31–Sept. 1	August 31–Sept. 1	1889	....	August 16
1773	July	....	1889	September 3	....
1775	....	July 30	1891	....	August 18
1780	October 13–14	October 13–14	1893	....	August 16
1785	....	July 25	(?)1894	October 13	....
1793	August 12	....	1899	....	August 7–8
1804	September 3	September 3	1906	September 2	September 2 (?)
1809	....	September 2	1908	September 10	(?)
1819	September 21	....	1910	....	September 6
1825	....	July 26	1916	July 14	July 14
1827	August 17	August 17	1916	August 22	....
1827	August 28	August 28	1916	October 9	October 9
1830	August 12	....	1917	September 21	September 21
1835	August 12	August 12	1919	September 3	September 3
1837	....	July 27	1921	September 9–10	September 9–10
1837	July 31	....	1924	August 17	August 17
1837	August 1–2	August 1–2	1924	August 28–29	August 28
1837	August 15	August 15	1928	....	September 12–13
1848	August 29–30	August 29–30	1931	September 10	....
1851	August 18	....	1932	September 26	....
1852	September 24	September 24	1933	July 26	....
1859	....	September 2	1938	August 8	August 8
1867	October 29	October 29	1940	August 5	August 5

* Compiled by R. G. Stone from the works of Garriott, Reid, Poëy, Redfield, Alexander, Fassig, Mitchell, and histories of the Virgin Islands. Since 1900 the U. S. Mon. Wea. Rev. gives complete reports of storms. In later years (1900—) this list includes weaker disturbances which caused some rain, wind, or swell.

Tally by Months, 1738–1941

	June	July	August	September	October	November	Total
St. Thomas	0	4	18	13	4	0	39
St. Croix	0	5	15	10	3	0	33
Both islands (no duplication)	0	8	22	17	4	0	51

ACCOUNTS OF SOME VIRGIN ISLANDS HURRICANES

The following are quoted for convenience; see parts on Porto Rican meteorology and references in bibliography for further information.

HURRICANE OF AUGUST–SEPTEMBER 1772

During the last days of August and the first days of September a hurricane passed over the West Indies causing frightful havoc among the Leeward Islands. The disastrous effects of this storm were felt nowhere more forcibly than at Santa Cruz where, it is said, the sea rose 72 feet above its usual height, carrying every ship at the island on shore, some as far as 100 yards inland. Large stones were brought down from the mountains, and there was a terrific electrical display. Four hundred and sixty houses were thrown down at Christianstadts, and all but three at Fredericstadt. The magazines and stores were quite ruined. The total damage [in the W. I.] was estimated at $5,000,000. The damage at St. Thomas was placed at $200,000. (Garriott, Bull. H, U. S. Wea. Bur. 1900.)

HURRICANE OF AUGUST 31, 1772

Excerpt from Alexander Hamilton's letter to his father describing the St. Croix hurricane of August 31, 1772.

St. Croix
September 6, 1772

Honored Sir:

I take up my pen, just to give you an imperfect account of one of the most dreadful hurricanes that memory or any records whatever can trace, which happened here on the 31st ultimo at night.

It began about dusk, at north, and raged very violently till ten o'clock — then ensued a sudden and unexpected interval, which lasted about an hour. Meanwhile the wind was shifting round to the southwest point, from whence it returned with redoubled fury and continued till nearly three in the morning. Good God! What horror and destruction — it is impossible for me to describe — or you to form any idea of it. It seemed as if a total dissolution of nature was taking place. The roaring of the sea and wind — fiery meteors flying about in the air — the prodigious glare of almost perpetual lightning — the crash of falling houses — and the ear-piercing shrieks of the distressed were sufficient to strike astonishment into Angels. A great part of the buildings throughout the island are leveled to the grounds — almost all the rest very much shattered — several persons killed and numbers utterly ruined — whole families wandering about the streets, unknowing where to find a place of shelter — the sick exposed to the keenness of water and air — without a bed to lie upon — or a dry covering to their bodies — and our harbors entirely bare. In a word, misery, in its most hideous shapes, spread over the whole face of the country. A strong smell of gunpowder added somewhat to the terrors of the night; and it was observed that the rain was exceedingly salt. Indeed the water is so brackish and full of sulphur that there is hardly any drinking it. . . .

(Alexander Hamilton)

HURRICANE OF 1830

This storm or hurricane was severe at the Island of St. Thomas, on the night between the 12th and 13th of August, 1830. (Reid 1838.)

HURRICANE OF JULY 26 TO 27, 1837

Copy of a manuscript report at Lloyd's, dated St. Croix (Reid 1838).

About midnight on Wednesday, the 26th of July, it came on to blow smartly from the east-south-east, shifting by Thursday morning, the 27th of July, to south-east, blowing a gale of wind until towards noon, when it began to moderate.

(Signed) Andrew Lang.

STORM OF AUGUST 2 TO 3, 1837, AT ST. THOMAS

A. Observations quoted by DeBooy:

Hour	Pressure (mm)	Wind Direction and Remarks	
1 P.M.	757	....	
2	755	....	
3	754	....	
3:45	753.3	N	pressure began to drop rapidly
4	752	N	strong gusts
5	747.5	NE	storm increasing
6	744.5	NE	hurricane force
6:30	740	NW	" "
6:45	731	NW	" "
7:05	731	NW	" "
7:15	726	NW	" "
7:25	718	NW	" "
7:30	715	NW	" "
7:35	713	calm	
7:45	712	calm	
8:00	712	calm	
8:15	711.8	calm	
8:20	712	S	hurricane again
8:30	721	SSE	" "
8:45	728.5	SE	(since 8:35)
9:10	731	SE	hurricane
9:15	736	SE	"
9:20	740	SE	"
9:30	744.5	SE	"
9:50	746.5	SE	"
10:10	749.3	SE	"
10:40	751	SE	"
11:15	751.5	SE	"
11:30	752	SE	"
12:00	753	....	
1:00	754	....	
2:00	755	....	
3:00	756	....	

B. Observations of Mr. Hoskiaer (quoted by Dove 1841, and Reid 1838):

Hour	Barometric Pressure (in "lines"; 1 line = 2.16 mm)	Wind	
Aug. 1; 18h 0m	337 lines	....	
Aug. 2; 2h 10m	335	NW	
3 20	334	N	increasing tempest
3 45	334	N	
4 45	332	N	
5 40	331.5	NE	
5 45	330	NE	
6 30	328	NW	
6 35	325.5	NW	
6 45	324	NW	hurricane
7 0	324	NW	
7 10	322	NW	
7 22	318.5	NW	
7 30	317	NW	
7 35	316.5	Dead calm	
7 52	316	" "	calm center
8 10	316	" "	
8 20	316	" "	
8 23	320	SSE	
8 33	321	SE	
8 38	322	SE	
8 45	323	SE	
8 50	324	SE	
9 0	326	SE	
9 10	328	SE	hurricane
9 25	329	SE	
9 35	330	SE	
9 50	331	SE	
10 10	332	SE	
10 35	333	SE	
11 10	333.25	SE	
11 30	333.5	SE	
14 45	335	SE	
20 0	336.5	SW	
21 0	336.75	E	

C. Extract from the log-book of the brig, "Water-Witch", W. Newby, Commander, from Liverpool to St. Thomas (kept by the mate), made by Mr. Gilbert Ker, consignee of the vessel (in Nautical Time):

Hour	Course	Wind	Remarks on board, Wednesday, Aug. 2, 1837
P.M.			
2	N.W.b.W.	N.E.	P.M. Fresh breezes and clear; people employed variously; made the island of St. Kitts; in lower and all lee studding-sails.
4			At 2, made the island of Saba.
6			At dusk, in all studding-sails, Saba bearing N.N.E.; and Eustatia E.N.E.; at 8, in flying jib and royals; midnight, fresh breezes and cloudy; in top-gallant-sails.
8	N.W.½W.		
10			
12			
A.M.			
2			A.M. Do. weather.
4			At 7, made the island of St. John's, and shortly after that of St. Thomas.
6			Noon, squally; double reefed the topsails, and stowed the jib; the town in sight.
8			
10			

D. Extract of a letter from Captain Newby, of the British brig, "Water-Witch", from Liverpool to St. Thomas, and which left Liverpool, July 19, 1837.

Arrived off St. Thomas on the 2nd of August; morning squally, and the *Water-Witch* was off St. John's, and standing for St. Thomas's, the wind north and north-north-west. Noon, shipping in the harbour visible; at 1 P.M. squalls violent; at 3 P.M. we had beat up within half a mile of the forts, when we could proceed no further for the violence of the squalls, and anchored in ten fathoms water; sent down top-gallant-yards, &c; did not suspect a hurricane. At 5 P.M. squalls ceased and began a heavy gale of wind, at that time off the land. At 7 P.M. a hurricane beyond all description dreadful; the windlas capsized, and I could not slip my cables, ship driving until I was in twenty fathoms water; a calm then succeeded for about ten minutes, and then, in the most tremendous unearthly screech I ever heard, it recommenced from the south and south-west; I now considered it all over with us, for the wind was directly on shore, and the sea rose and ran mountains high. The foretop-gallant-mast (though struck) and the gig were carried up some feet in the air, and the vessel drove again into twelve fathoms. We were obliged to steer her all night, and keep her head to wind, for when she got her bows to it she went down on her broadside. At 2 P.M. the gale abated somewhat, and the barometer rose an inch; at daylight, out of forty vessels, the *Water-Witch* and one other were the only two not sunk, ashore, or capsized.

E. Extract from the log of H. M. S. "Spey".

Sunday, August 6, 1837

A.M. Arrived at Tortola. Here the hurricane has destroyed the town and several plantations. One brig from St. John's, with a great number of small craft, total wrecks.

P.M. at 2:30. Came to an anchor in St. Thomas's harbour and landed the mails. Here the hurricane of the 2nd appeared to have concentrated all its power, force, and fury; for the harbour and town were a scene that baffles all description. Thirty-six ships and vessels totally wrecked all around the harbour, among which about a dozen had sunk or capsized at their anchors; some rode it out by cutting away their masts, and upwards of 100 seamen drowned; but what was very extraordinary, there was not one English vessel in the port. The harbour is so chocked up with wreck and sunken vessels, that it is difficult to pick out a berth for a ship to anchor. The destructive powers of this hurricane will never be forgotten. Some houses were turned regularly bottom up. One large well-built house was carried by the force of the wind from off its foundation, and now stands upright in the middle of the street. The fort at the entrance of the harbour is levelled with the foundation, and the 24-pounders thrown down: it looks as if it had been battered to pieces by cannon-shot. In the midst of the hurricane shocks of earthquake were felt; and to complete this awful visitation, a fire broke out in the back stores of Messrs. Stubbs and Co. Heavy tiles were flying about from the tops of the shaking and trembling houses, killing and wounding many persons. One fine American ship, 500 tons, was driven on shore under the citadel, and in an hour nothing could be seen of her but a few timbers. Several fine merchant ships and brigs are at anchor, dismantled, with cargoes; and not a spar or rope for standing rigging to be had in the island. No place hitherto has suffered so much from a hurricane in all the West Indies as St. Thomas's. Thank God we escaped so well out of it.

(Signed) R. B. James

F. Extract of a letter from Lloyd's Correspondent, dated at Santa Cruz.

On Monday, 31st July, 1837, the weather was moderate; several ships sailed on Tuesday, the 1st of August; in the evening the wind was north-east and the weather moderate. On Wednesday the 2nd, the wind during the night had shifted to the north; the weather looked squally, cloudy, and suspicious, and continued so during the forenoon; the wind shifted gradually to the north-north-west.

At 1 P.M. the falling of the barometer, the appearance of the weather, and the increasing wind, left us no doubt of the approaching storm, and it came on from the north-west, between 3 and 4 P.M. The mercury continued falling, and the gale increasing until half-past 6 P.M. when the wind became westerly. At 7 P.M. the mercury began slowly to ascend, but yet the storm increased in violence. At 8 P.M. it was blowing a hurricane from west-south-west to the south-west, coming in furious gusts until 10 P.M., when a certain decrease in their violence had taken place, which abatement continued until Thursday morning, the 3rd of August, when it blew a fresh gale from the south.

(Signed) Andrew Lang

HURRICANE OF AUGUST 1837, AT TORTOLA

The brig, Jane, of St. John's, N.B., was driven on shore during the gale on the 2nd of August. (Tortola, August 6.)

At Tortola the hurricane commenced at 3 P.M., and increased in violence until 9 P.M., when it began to abate. (Reid 1838.)

HURRICANE OF SEPTEMBER 2, 1859

On September 2, a hurricane of rather mild form passed over St. Kitts, that is the center passed right over the island. It wrecked a number of boats besides other damage. It passed over St. Croix after leaving St. Kitts. (Garriott: 1900. *op. cit.*)

HURRICANE OF OCTOBER 29, 1867

On the 29th October, 1867, at 7h A.M., the weather presented no unusual appearance. There had been several showers of rain during the previous night.

At 11h A.M., the weather became very threatening, the barometer falling slowly, and the wind blew occasionally in hard puffs from the N.W. At noon the wind had veered to the W.N.W., and began to blow furiously. At 7h A.M., the barometer indicated a pressure of 29.76 inches and it fell slowly and gradually until noon when the reading was 29.64 inches. After the reading at noon it fell very rapidly until 1h 30m P.M., when the reading was 28.50 inches. It remained stationary at this point until 2h P.M. when it began to rise rapidly, and at 6h P.M. had reached 29.65 inches.

The wind blew very hard, capsizing or dismasting most of the small vessels in the outer harbor, until 1h 30m P.M. when a lull or calm occurred, lasting thirty minutes. At the expiration of the calm the wind commenced to blow from the S.S.E., the opposite direction from which it blew immediately before the calm, with greatly increased fury and power, and rain fell in torrents.

Previous to the calm only the lighter vessels in the harbor had suffered, but as the wind increased the larger vessels were either driven from their anchors and swamped, or stove on the rocks and piers, or were sunk at their moorings. Very few rode out the storm, but of those that did the majority depended upon their anchors. The fury of the storm, after the lull, lasted only about one hour, but in that short time a fearful amount of destruction was accomplished. Between sixty and seventy vessels were driven ashore or sunk at St. Thomas and vicinity, and many others were entirely dismasted or otherwise damaged.

Nearly all the small craft in the harbor were lost early in the storm, and there are no means of ascertaining the number of vessels of that class or the number of lives lost in them. On shore the destruction was nearly equal to that in the harbor. Many houses were unroofed, many toppled from their foundations, and others scattered in a confused mass of rubbish. Vegetation was literally scathed. A metallic diving bell weighing several tons was carried by the force of the wind a considerable distance. The Gas Works were completely destroyed. The large gas holder was rent *outward* near the *top,* in an aperture about eight inches in diameter.

It has been estimated that at and about St. Thomas the value of the property destroyed was between four and five millions of dollars, and that at least five hundred lives were lost. More than one hundred and twenty bodies were recovered and buried. The thermometer was not observed during the progress of the storm, but it is affirmed by Mr. T. H. Jahnecke, who furnished the following data from his barometrical observations on the 29th, that the temperature did not decrease more than 4° during the storm.

Atmospheric Pressure at St. Thomas 29th October, 1867

Hour	Pressure	Hour	Pressure
	in.		in.
7 A.M.	29.76	1.30 P.M.	28.50
8 "	29.75	2 "	28.50
9 "	29.73	3 "	28.90
10 "	29.72	4 "	29.20
11 "	29.69	5 "	29.48
12 M.	29.64	6 "	29.65
1 P.M.	28.86		

The following list [of 79 ships, not reproduced] exhibits a statement of the casualties to vessels at and near St. Thomas during the storm. . . . T. H. Jahnecke estimates the velocity of the wind at St. Thomas at 74 miles per hour. . . . At St. Croix the wind was N.W., W., and S.W. . . . it is concluded that, at the time the storm passed St. Thomas the diameter of the destructive portion was about thirty-four miles . . ., the diameter of the central calm was about 7.5 miles. . . . (Eastman 1868: 8–9, 13–14.)

HURRICANE AT SAINT THOMAS, W. I., AUGUST 21, 1871

The Island of St. Thomas, W. I., again claims public notice, and sympathy. On Monday the 21st instant, a terrific Hurricane burst over the Island, causing more suffering and misery among the poorer class of the Inhabitants than was experienced in the Tornado of 1867. Since Sunday evening the weather bore a threatening aspect, the wind blowing in strong puffs from N.N.E. to N.E., which continued all night until Monday morning, when the squalls increased in violence, and the Barometer indicated 29.90. By 9 A.M., the weather gradually became more threatening, Barometer steadily falling. At 1 P.M. the Quicksilver was down to 29 (in.) and the gusts of wind increased in fury, blowing from N.N.E.; the Hurricane had now complete charge, heavy squalls continuing until 3.30 P.M., when the wind veered to the North, and came down over the hills in fearful whirlwinds, shifting from N.N.E. to N.N.W. From this time to 5 o'clock the worst part of the Hurricane was experienced, and nearly all the damage to the eastern part of the town was effected then. The first part of the Hurricane was now over, and a calm of about 30 minutes succeeded, as if the elements were preparing for a greater outbreak. At 5 P.M., the Barometer had reached its lowest point about 28.10 to 28, the wind now changed to S.W. to S. and blew heavily, but the Mercury commenced to rise gradually and the Hurricane passed away to the Westward.

The extent of damage which has been done in the Island has been very great; the eastern part of the town has suffered most, and presents a desolate spectacle as the

Hurricane seems to have expended its utmost fury in that quarter, — in some streets only a couple of houses are standing, which are badly injured, whole squares of houses have been blown down, and the ruins lie jumbled together — the Military Hospital had the roof blown off; the Roman Catholic Chapel in Cocoanut Square, is in a ruinous state. The French Masonic Lodge, "Les Coeurs Sinceres," No. 141, was completely blown away, leaving only the walls of the foundation standing, but owing to the activity of a large number of the Members, the greater part of the valuables of this Lodge have since been saved from the debris, foremost amongst which, we may record the library and Archives. The residences of the Dutch Consul, and of the acting French Consul, have been unroofed, and otherwise badly injured. At Madam Bjerge, only two or three houses are standing, — this quarter, occupied by the poorer class, suffered much. In fact the effects of this visitation are dreadful, — in 1867, the damage was more general, and not as concentrated as it has been in this instance — the lower part of the town, the "Back-of-all," has suffered likewise, but not as much as the eastern part already alluded to. In the harbour the loss has been trifling, in consequence of the small number of vessels in port.

The American steamer "Florida," cut away both masts, to ride out the gale. The French steamer "Sonora," was run ashore, after parting from her moorings. The steam tug "Vice-Governor Berg" stranded at the "Haul-over," and a couple of other small craft sustained some slight injury. The British barque "Duke of Wellington," with cargo sugars in hhds., lying off Prince Rupert's Rock, parted her cables, and drifted towards Water Island, where the crew was safely landed. The vessel was then blown about the Triangle rocks to the East of the entrance to the harbour, where she was wrecked. The British barque "Jane Lamb" and Danish brig "Axelstad" collided, sustaining some damage.

But what is most distressing, is the loss of life and personal injuries sustained by many unfortunates, in the first blow; many of the poorer people living in the vicinity of the parade ground and other streets were crushed by the falling houses, — in one house five persons were killed. By the Police Reports we learn that thirty bodies have been discovered and buried, and that about seventy are maimed.

The Police Department acted with zeal and activity in rescuing the wounded, and rendering assistance to the destitute; during Monday night and Tuesday morning the Constables were indefatigable in their efforts to do good to the sufferers, and the thanks of this Community is due to them, and the Military, for the promptness with which the streets have been cleared, and broken houses removed, thereby precluding theft, and permitting the necessary sanitary measures to be taken, as regards decomposing matter.

Our Colonial Council convened a meeting on the 22nd instant, and voted funds for the relief of the sufferers, and many of those who lost everything, and might under the circumstances have been without a morsel of food, have been at least placed above want by the promptitude of our Representatives. The Mercantile Community, with their accustomed liberality have nobly answered the appeal, and given freely, — the place is seldom invoked in vain, as unfortunately the visitations of past years has too well proved.

The distress and suffering have been very great, but it is hoped that the worst has passed, and that we may be preserved from further calamities. — Printed by A. Wallöe, St. Thomas, W. I. (Reprint from the "Sct. Thomae Tidende", Aug. 23, 1871.)

STORM OF SEPTEMBER 12, 1876

Early in the afternoon of the 12th a telegram was received (at San Juan, Porto Rico) from St. Thomas announcing that the barometer was falling rapidly there and that, according to information from the island of St. Kitts, a fierce storm was raging there, with signs of being a hurricane.

Data	St. Thomas	Vieques
Extent of barometric oscillation:	16 mm Hg	16 mm
Changes in wind direction:	NE, E, NE	NNE, NE, calm, SE, SSE
Hours of greatest intensity:	4 A.M., 13th	6 A.M., 13th

Thus the center of the storm passed S of St. Thomas, over St. Croix and Vieques. It traveled about 35 km per hr. Three ships at St. Croix and seven at St. Thomas were sunk or wrecked. (U. S. Mon. Wea. Rev. Suppl. 24, pp. 35–38.)

HURRICANE OF AUGUST 22 TO 26, 1881

The center of the storm was reported at St. Thomas at 3 A.M., August 23, and at Turks Island, W. I., 3 P.M. on the 24th. (Garriott: 1900. *op. cit.*)

ST. THOMAS–HATTERAS HURRICANE OF SEPTEMBER 3 TO 12, 1889

From the reports of vessels sailing to the eastward of the Windward Islands, this storm is thought to have been central September 1 in latitude north 14° and longitude west 57°. Passed over St. Christopher during the night of the 2d; barometer 29.50 wind northeast. The storm was central near St. Thomas on the 3d, and near to and north of Puerto Rico on the 4th while on the 5th it had moved about two degrees in a northwesterly curve away from Puerto Rico. (Garriott: 1900. *op. cit.*)

HURRICANE OF OCTOBER 7 TO 12, 1916

After a few days' respite another disturbance appeared in the vicinity of the Island of Dominica, the barometer at 8 A.M. October 7 reading 29.84 inches with calm air and rain falling. Notification was sent at once to the Windward Islands and to the United States Naval Radio Service, and special observations called for. Nothing of value was received during the day, but on the morning of the 8th it was apparent that the disturbance was near and east of Puerto Rico and moving northwestward or northward. Advices to this effect were sent to West Indian points and to Weather Bureau stations on the Atlantic and Gulf coast and broadcast by United States Naval Radio. No further reports were received until the morning of the 9th when the regular reports showed the storm to be still east of Puerto Rico. Special evening reports afforded the first definite information as to the location of the storm center. These reports were to the effect that the storm center had passed over the Danish West Indies, Santa Cruz reporting pressure of 29.42 inches at 3 P.M. with a gale, and St. Thomas 29.26 inches at 6 P.M. This information was immediately given wide distribution over the water and along the coasts and shipping warned to exercise great caution. By the morning of the 10th the storm had recurved slightly and had passed to the northeastward of Puerto Rico. Nothing further was heard from the storm until the captain of the barque *Bellas* reported by mail that he had encountered it, in the form of a severe hurricane with southeast to southwest gales, on October 12, in latitude 27° 40′ N., longitude 62° 20′ W. (U. S. Mon. Wea. Rev. **44**: 583–584. October 1916.)

The "Sct. Thomae Tidende" for October 14, 1916 remarked that the toppling of the coal crane at St. Thomas gave the best indication of the strength of the wind in the hurricane of October 9, since the crane was built to withstand 180 km/hr.

The Rainfalls Recorded at Some Stations in This Storm Were as Follows:

Barracks:	Oct. 9	61 lines
Sekretariat:	Oct. 9	30 lines
"	Oct. 10	25 lines
Cruz Bay:	Oct. 10	60 lines, estimated, as gage was blown down during storm.
Susannaberg:	Oct. 10	59 lines

Pressures during the Virgin Islands Hurricane of October 9, 1916*

Time	Pressure	Time	Pressure	Time	Pressure
8:00 A.M.	29.80	4:40	28.99	6:10	28.70
12:00 M.	29.65	4:55	28.95	6:15	28.65
2:00 P.M.	29.50	5:00	28.90	6:40	28.73
2:50	29.45	5:15	28.75	6:50	28.70
3:00	29.35	5:20	28.70	7:10	28.80
3:15	29.30	5:25	28.75	7:15	28.85
3:30	29.15	5:45	28.70†	7:18	28.90
3:55	29.07	5:55	28.68	7:25	28.95
4:30	29.05	5:57	28.65	7:30	29.00

* Observations by Miss Emily Quin, Christiansted, St. Croix.
† A calm existed from 5:25 P.M. to 6:45 P.M. when the wind, which prior to 5:25 had been blowing from ENE, returned in great force from the SW.

STORM OF SEPTEMBER 3 TO 10, 1921

St. Thomas, September 11, 1921.

Dear Sir:—

From September 3rd to September 8th, 1921, light variable winds and calms, clear weather, high visibility, St. Croix 40 miles away seemed quite near and distinct. Max. temperatures 90° and 91° and very oppressive. Bright sunsets, red and copper colored, pressure during these days about .05 below normal.

Sept. 8th. Small patches Cirrus and Cirrus-Stratus appeared in the sky from NE to SE. Pressure slightly below normal with a downward tendency. At 1 P.M. received first storm warning from Central Station at San Juan, Weather fine, light variable winds.

Sept. 9th. At 8 A.M. the sea that had hitherto been very smooth, began to show signs of a swell rolling in from SE. At noon sky began to get overcast, about 6.10 Ci. and St. with patches of scud from E. At 6 P.M. swell increased considerably breaking heavily on south coast. Wind from ENE to E about 18 miles per hour, sometimes shifting to SE in gusts. Pressure 29.82, temp. 90°.

Sept. 10th. At 3 A.M. tremendous swell from S breaking across mouth of harbor. Brisk E to SE wind, velocity 20 miles. Between 10 A.M. and 2 P.M. wind and sea at its height. Max. vel. 40 miles. At 6 P.M. signs of swell abating and coming from SW. Overcast.

Sept. 11th. 6 A.M. Sea considerably smoother, wind SE. 20 miles. Cloudy. Presssure 29.84. At 4 P.M. marked improvement in weather generally.

Note: At no time during the passing of this storm was the barometer below 29.80. Precipitation was practically nil. — Wm. O. Simmons (Acting Special Observer, U. S. Weather Bureau). (From letter to Dr. O. L. Fassig, then in charge, U. S. W. B., San Juan.)

HURRICANES OF AUGUST 17 AND 28, 1924

During the latter half of the month two tropical disturbances reached the Lesser Antilles from the region to the eastward. The first of these was centered between

Dominica and St. Lucia the morning of the 17th and the second a short distance northeast of Dominica the evening of the 27th. The tracks of these two disturbances were almost directly northwestward from the Lesser Antilles, the first at the rate of approximately 270 miles and the other at 200 miles a day. The former continued to move in a northwesterly direction until it reached a latitude 28° N and longitude 75° W. It then moved slowly in a westerly direction for 48 hours, after which it turned abruptly and moved north-northeastward with rapidly increasing speed and its course gradually changed toward the northeast.

The first tropical disturbance was of only slight intensity in the region of the Lesser Antilles and of moderate intensity when its center passed between Puerto Rico and the Virgin Islands during the evening of the 18th. It increased gradually, however, both in intensity and size after passing to the north of Puerto Rico and within three days, when its center was in about latitude 27° 36′ N and longitude 74° 30′ W, the winds near the center had increased to hurricane force.

The second tropical disturbance evidently developed much farther east than the first, inasmuch as it was already a storm of considerable intensity when it appeared near Dominica on the 27th. By the time it reached the Virgin Islands it had attained hurricane intensity. The barometer fell to 29 inches at St. Thomas at 3 A.M. of the 29th and great damage was done by the storm in these islands. A number of lives were lost, hundreds of houses were destroyed and thousands damaged, and much damage was done to crops. So great were the losses in the Virgin Islands that appeal was made to the American Red Cross for substantial aid. (U. S. Mon. Wea. Rev. **52**: 410–411. August 1924.)

A tropical disturbance at the beginning of September was central about latitude 25° N and longitude 70° W. The history and subsequent movement of this disturbance is discussed in the Monthly Weather Review for August [see above "Hurricane of August 17, 1924"].

Later information which has just come to hand indicates that the center of this storm passed between Antigua and Montserrat (Lesser Antilles) at 3:30 A.M. of the 28th. At 2 A.M. of the 29th the center with a reading of 28.56 inches passed over the eastern end of the island of St. John. The western end of the island of Tortola experienced hurricane winds from 6 P.M. of the 28th to 6 A.M. of the 29th. The storm was accompanied by torrential rains and by winds estimated about 100 to 110 miles an hour. . . . serious damage resulted to crops along the path of the storm from Montserrat to St. Thomas. The observer at St. Thomas estimated the wind at 110 miles per hour from the north-northeast between midnight and 2 A.M. of the 29th. Estimates of 100 to 110 miles per hour were also made at Montserrat and Antigua between 3 A.M. and 4 A.M. of the 28th. (U. S. Mon. Wea. Rev. **52**: 464. Sept. 1924.)

Notes from the Daily Observation Book, San Juan, U. S. Weather Bureau, August 27–29, 1924.

August 27, 1924:

Noon special observations were called for from all special meteorological stations, except Santo Domingo and Puerto Plata. Special reports were also requested from Antigua, St. Croix and Martinique. Request for vessel reports was made through the Naval Radio Stations and several vessels reported giving their position, barometer reading, wind direction and force, etc.

The following advisories were issued:

Advisory 2 P.M. — Moderate disturbance over the Virgin Islands at noon to-day, apparently moving north west. Lowest barometer 29.82 inches at St. Thomas. The center will probably pass north of Puerto Rico tonight or Tuesday morning. No high winds expected over Puerto Rico. — Fassig.

Advisory 6 P.M. — Unsettled weather continued to prevail in the vicinity of the Virgin Islands. The disturbance is of moderate intensity and is moving very slowly northwestward and apparently not increasing. No high winds are expected over the Virgin Islands or Puerto Rico. — Fassig.

The above advisories were duly disseminated.

Cirrus clouds were observed moving from the southeast at 6:30 P.M.

San Juan, August 27, 1924. Special observations were called for at 7 P.M. from St. Croix and Antigua. Based on P.M. reports the following advisory was issued:

Advisory 8 P.M. — Indications of a disturbance of moderate intensity apparently centered near Dominica, Windward Islands. The disturbance will probably move slowly westward with moderate to strong northerly winds and rain over the Virgin Islands and Puerto Rico tonight and Thursday morning. — Fassig.

The above advisory was duly disseminated.

August 28, 1924:

Noon specials were called for from all regular stations except Port of Spain, Santo Domingo and Puerto Plata. Special observations were called for at 8 A.M. and noon from St. Croix, Antigua, and Granada. Following hurricane warning issued for Virgin Islands: Observer St. Thomas. Hoist hurricane warning 10 A.M. Storm central over St. Kitts with barometer 29.56 inches. The storm will move slowly northwestward over the Virgin Islands accompanied by moderate to high northeast winds and rain today, changing to southerly winds to-night or Friday morning. — Fassig.

Following advisories were issued:

Advisory 10 A.M. The storm increased in intensity during the night and moved northwestward from Dominica to St. Kitts accompanied by moderate to high northeast winds and rain throughout the Virgin and Windward Islands. The lowest barometer reported was 29.56 inches at St. Kitts. The storm will move slowly northwestward over the Virgin Islands and Puerto Rico with moderate to high northeast winds and rain today changing to southerly winds during tonight or Friday morning. — Fassig.

Advisory at 3 P.M. At noon today the storm center was between St. Thomas and St. Kitts and moving slowly northwestward. The lowest barometer reading reported was 29.74 inches at St. Kitts. Moderate to high northeast winds and rain will occur this afternoon or tonight over the Virgin Islands and over Porto Rico, especially the eastern portion, changing to southerly Friday morning. Caution advised shipping interests. — Fassig.

The above warning and advisories were duly disseminated.

August 29, 1924:

Advisory 9 A.M. Storm center passed north side St. Thomas at 3:00 A.M. with northeast gales shifting through north to southwest by 7 A.M. Lowest barometer 29.00 inches reported by U. S. Tug *Grebe* in St. Thomas Harbor. Storm center is apparently moving slowly northwest. Moderate to strong southerly winds will prevail over the Virgin Islands today and moderate northerly shifting to southerly over Puerto Rico. — Fassig.

The above advisory was duly disseminated.

(From Notes in Daily record U. S. Wea. Bur. San Juan.)

Appendix Table 1

Register of Stations and Available Records

Station	Island	Elev. (feet)	Period of observations known	Elements*	References in bibliography and to locations of original data†
DANISH AND UNITED STATES VIRGIN ISLANDS					
Adrian Estate	St. John	630	Feb. 1877–July 1900; Apr. 1935–March 1936	R; Rd	USA; 62
Adventure Estate	St. Croix	200	1911–; 1938–	R; Rd	54, 62, ES, WB
America Hill Estate	St. John	526	1920–33	Rd	62, 63, WB
Anguilla Estate	St. Croix	35	1911–; 1937–	R; Rd	54, 62, ES, WB
Annaly Estate	St. Croix	650	1911–; 1920– (broken)	R; Rd, C, Wd	54, 62, 63, ES, WB
Anna's Hope Estate and Agric. Exper. Sta.	St. Croix	240	1911–; 1920–	Rr, Rd, T, Wd, Wv, E, C, H, P	54, 62, 63, 64, ES, WB, SCS
Anna's Retreat, on Charlotte Amalie Estate	St. Thomas	150–200?	1920–38	Rd	62, 63, WB
Barracks (Salut Batteriet), Charlotte Amalie	St. Thomas	10	Feb. 1877–March 1917	Rd	USA
Barren Spot Estate	St. Croix	140	1911–	R	54, ES
Bethlehem (Old Works)	St. Croix	95	1911–; 1937–	R; Rd	54, 62, ES, WB
Bethlehem (New Works)	St. Croix	200?	1911–; 1938–	R; Rd	54, 62, ES, WB
Betty's Hope Estate	St. Croix	25	1911–	R	54, ES
Bonne Esperance Estate	St. Thomas	675	1929–	Rd	62, 63, WB
Bonne Esperance Estate	St. Croix	260	1911–; 1922–36	R; Rd	54, 62, 63, ES, WB
Bourne Field, Lindbergh Bay (U.S.M.C.)	St. Thomas	10	Nov. 1935–	Rr, Rd, T, Wd, Wv, P, C, H, A, Th	USN
Calquhoun (Mt. Pleasant) Estate	St. Croix	250	1911–; 1937–	R; Rd	54, 62, ES, WB
Canaan Estate	St. Thomas	425	1923–27	Rd, T, Wd, C	62, WB
Canaan Estate	St. Croix	350	1911–	R	54, ES
Caroline(-berg) Estate	St. John	160	Feb. 1877–Aug. 1878	Rd	USA
Castle Coakley Estate	St. Croix	100	1938–	Rd	62, WB, ES
Central Factory	St. Croix	100?	1938–	Rd	62, WB, ES
Charlotte Amalie Estate (Anna's Retreat)	St. Thomas	200?	Feb. 1877–June 1880; 1938–	Rd; Rd	62, USA, WB
Charlotte Amalie (Town)‡					

* *Key to Elements:* R = rainfall (monthly totals only available); Rd = rainfall totals and number of rain days; Rr = rainfall intensities from recording gage; T = temperature; Wd = wind direction; Wv = wind velocity; C = cloudiness; S = sunshine duration; P = pressure; H = humidity; E = evaporation; A = aerological observations; Th = thunderstorms.

† *Key to locations of original data:* USA = United States Archives, Terr. Sect.; ES = Experiment Station, Anna's Hope, St. Croix; WB = U. S. Weather Bureau, San Juan, or Wash., D. C.; USN = Bureau of Aeronautics, U. S. Navy Dept., Wash.; DMI = Danish Meteorological Institute, Copenhagen; TES = Experiment Station, Tortola, British V. I.; SCS = Soil Conservation Service, San Juan.

‡ See Barracks; Sekretariat; Custom House; Knox's Residence; Wallöe's Residence; Hornbeck's Residence; Kjaer's Hill.

Appendix Table 1 (continued)

Station	Island	Elev. (feet)	Period of observations known	Elements*	References in bibliography and to locations of original data†
Christiansted Fort	St. Croix	25	1938–	Rd, T, (Wd, C?)	62, WB
Christiansted (Town, various residences)	St. Croix	20–80?	1852–1937 (broken)	Rd, T, Wd, P, C, H, Th	9, 55, 62, 63, 65, 40, 34, 27, 22, DMI, ES, WB
Cinnamon Bay Estate	St. John	20	Sept. 1878–April 1885	Rd	USA
Cotton Grove Estate	St. Croix	100	1920–23 (broken)	Rd	62, 63, WB, ES
Cowell's Hill (or Battery)	St. Thomas	260	Feb. 1877–Jan. 1905	Rd	USA
Cruz Bay (Christiansfort; Commissioner's Residence)	St. John	10–30?	Jan. 1871–1917; 1917–	Rd; Rd, T, C, Wd	65, 27, 62, 63, USA, WB, DMI
Custom House, Charlotte Amalie	St. Thomas	27	ca. 1890(?)–; 1917–	Rd, T, P, Wd, C, H, Wv	62, 63, 47, (27, 64?) USA, WB
Dolby Hill Estate	St. Croix	200	1937–	Rd	62, WB, ES
Dorothea Estate	St. Thomas	775	1939–	Rd	62, WB
Eden Parcel (of Emmaus Mission)	St. John	40	March 1892–Aug. 1917	Rd	USA
Eliza's Retreat Estate	St. Croix	160	1838–51	R	34, 27, 65
Emmaus Estate (Moravian Mission)	St. John	50	May 1885–Feb. 1892	Rd	USA
Estate Morning (Morning Star)	St. Croix	125	ca. 1830–60?	R	46
Fountain Estate	St. Croix	360	1911–	R	54, ES
Fredensborg Estate	St. Croix	200	1911–	R	54, ES
Frederiksted Fort	St. Croix	60	1825–30; 1852–79, 1882–1914; 1938–	T; Rd, T, H, C, Th, Wd; Rd	40, 27, 64, 55, 34, 22, 62, 63, DMI, WB, ES
Glynn Estate	St. Croix	80	1911–	R	54, ES
Golden Grove Estate	St. Croix	90	1911–	R	54, ES
Granard Estate	St. Croix	65	1937–	Rd	62, WB, ES
Great Pond Estate	St. Croix	20	1937?	Rd	WB, ES
Hornbeck's Residence, Charlotte Amalie	St. Thomas	20–100?	1829–36	R, T, P	20, 34, 65, 25, 47, 27, 48
Jealousy Estate	St. Croix	165	1911–	R	54, ES
Jolly Hill Estate	St. Croix	200	1911–; 1920– (broken)	R; Rd, Rr	54, 62, 63, 9, ES, WB, SCS
King's Hill, Police Station; Estate	St. Croix	210	1852–78; 1882–1914; 1911–; 1920– broken)	Rd, T; Rd; R; Rd	55, 65, 27, 40, 22, 54, 62, 63, 9, DMI, ES, WB
Kjaer's Hill (Blackbeard's Castle), Charlotte Amalie	St. Thomas	295	Feb. 1877–Sept. 1878	Rd	USA
Knox's Residence, Charlotte Amalie	St. Thomas	20–100?	1845–47	R, T, (Wd, P?)	25, 34, 48, 27, 65
La Grange Estate	St. Croix	30	1923–25	Rd	62, ES, WB
La (Little?) Princesse Estate	St. Croix	20	1933–34	Rd	62, WB, ES
Liliendal Estate	St. Thomas	1020	Feb. 1877–Sept. 1883	Rd	USA
Lindbergh Bay (see Bourne Field; Mosquito Bay)	St. Thomas	15			
Louisenhoj Estate	St. Thomas	778	1845–47?	T	25, 34
Lövenlund Estate	St. Thomas	200	Feb. 1877–Dec. 1879; May 1905–Dec. 1909	Rd	USA
Lower Love Estate	St. Croix	92	1911–	R	54, ES
Ma Folie Estate	St. Thomas	875	Feb. 1877–Dec. 1882	Rd	USA

APPENDIX TABLE 1 (continued)

Station	Island	Elev. (feet)	Period of observations known	Elements*	References in bibliography and to locations of original data†
Manning Bay Estate	St. Croix	50	1911–	R	54, ES
Morning Star Estate (see Estate Morning)					
Mosquito Bay (now Lindbergh Bay)	St. Thomas	10?	1924–26	Rd	62, 63, WB
Mt. Pleasant (see Calquhoun)					
Nisky (Moravian Mission)	St. Thomas	50	Feb. 1877–June 1889	Rd	USA
Pearl Estate	St. Thomas	700–1000?	Feb. 1877–Sept. 1882	Rd	USA
Prosperity Estate, near Frederiksted	St. Croix	35	1911–; 1923–37 (broken)	R; Rd	54, 62, ES, WB
River Estate	St. Croix	180	1911–	R	54, ES
St. Georges Estate	St. Croix	150	1911–	R	54, ES
Sekretariat (Administration Bldg.), Charlotte Amalie	St. Thomas	165	Jan. 1910–March 1917	Rd	USA
Sion Farm (near Anna's Hope)	St. Croix	200	1938–	Rd	62, ES, WB
Slob Estate	St. Croix	140	1911–	R	54, ES
Southgate Estate	St. Croix	50	1937?	Rd	WB, ES
Strawberry Estate	St. Croix	150	1911–	R	54, ES
Susannaberg Estate	St. John	620	Aug. 1900–Aug. 1917	Rd	USA
Two Friends Estate	St. Croix	475	1911–	R	54, ES
Wallöe's Residence, Charlotte Amalie	St. Thomas	20–100?	ca. 1876?–95?	R, T, P (?)	47, 65, 27, WB
Whim Estate	St. Croix	90	1937–	Rd	62, WB, ES
Wintberg Estate	St. Thomas	700	July 1938–	Rd, T, Wd, C	62, WB
BRITISH VIRGIN ISLANDS					
Experiment Station (Botanic Sta.) (near Roadtown)	Tortola	20	1901–	Rd, T	21, 62, 63, WB, TES
St. Bernard's Estate	Tortola	860	1831–33	R, T	48
Spanishtown (Rev. Murdoch's Res.)	Virgin Gorda	50?	1909–20?	R	21, (TES?)

Appendix Table 2

Synoptic Table of Annual Rainfall Totals, Virgin Islands, 1875–1940*

Stations	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906
St. Thomas																																
Cowell's Hill			(56.61)	54.91	71.56	32.27	48.92	32.58	58.16	44.27	35.12	57.99	38.93	—	(44.98)	27.65	46.27	34.49	41.34	42.17	51.81		43.00	39.00	46.04	36.64	53.17	36.72	30.41	26.46	—	
Barracks			(60.37)	68.21	80.92	32.66	53.31	33.72	65.28	[50.52]	42.03	65.95	41.55	—	(53.15)	33.79	50.11	33.14	[39.78]	47.24	58.29		45.82	45.35	43.75	53.83	54.42	43.84	39.85	31.25	41.49	43.99
Nisky (Mission)			(56.54)	57.83	69.66	32.58	48.51	35.80	60.40	41.92	[44.24]	[54.00]	40.86	—	—																	
Liliendal			(66.85)	68.67	77.55	40.23	56.38	34.66	—																							
Pearl			(69.00)	75.25	81.29	—	64.14	—																								
Lovenlund			(60.91)	57.92	—																										—	46.71
Ma Folie			(63.51)	54.39	—	35.01	—	28.47																								
Kjaer's Hill			(59.91)	—																												
Charlotte Amalie Estate			(53.17)	60.64	—	—																										
			(Jan., no obs.)											(Records partly lost)	(January records lost)							(Records lost?)										
St. John																																
Cruz Bay (Fort)	[30]	[40]	[53]	56.93	65.73	30.86	40.49	35.13	52.33	58.47	47.19	63.59	53.54	45.64	(55.33)	33.11	52.22	31.87	42.57	51.68	59.36		41.06	51.25	44.88	49.72	60.91	50.47	43.62	33.47	47.03	44.81
Adrian			(58.89)	[67.74]	80.89	32.24	48.07	32.83	53.77	59.70	50.69	70.66	58.42	—	(52.29)	26.67	49.21	28.43	[50.94]	54.58	67.59		49.35	[47.26]	40.14	[41.78]						
Cinnamon Bay Est.				—	94.46	40.18	59.24	48.57	68.61	62.71	—																					
Emmaus (Mission)											—	57.28	[52.97]	—	(60.05)	29.56	51.86	—														
Caroline(berg)			(50.83)	—																												
Eden Parcel																		—	43.37	46.20	58.09		42.19	41.88	40.77	40.68	53.72	42.07	35.44	37.22	42.11	39.66
Susannaberg																										—	56.73	[45.13]	36.10	26.30	34.94	42.00
America Hill																																
St. Croix																																
Christiansted	25.17	42.91	43.30					37.23	52.11	41.66	49.70	60.82	57.05	65.47	58.49	32.52	45.36	37.18	54.95	47.31	57.89	55.10	61.01	44.15	—	42.67	62.85	59.43	32.70	28.62	49.25	44.50
Frederiksted	[32]	39.64	57.24		72.87											29.11	56.16															
Kings Hill	[26]															29.39	51.00															
Anna's Hope																																
Jolly Hill																																

Stations	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
St. Thomas																																		
Barracks and Custom H'se	35.39	45.96	56.60	47.16	51.02	(36.32)	35.41	48.38	42.46	65.86	Cust. H.	42.79	49.55	47.41	44.48	36.90	41.05	49.27	41.91	42.09	60.48	57.34	39.30	39.18	65.43	57.03	68.67	36.18	32.67	46.25	39.68	44.37	37.32	36.74
Nisky (Mission)																																		
Lovenlund	30.07	40.52	60.60																															
Sekretariat				49.97	50.88	(38.50)	35.38	47.74	45.63	66.55	—																							
Charlotte Amalie Estate																																40.12	34.77	37.53
Anna's Retreat														39.63	36.11	32.47	35.57	49.50	37.58	42.02	57.75	56.97	33.74	37.35	61.79	58.39	64.77	35.50	36.87	51.26	38.76			
Mosquito Bay																		—	37.21	—							Bourne Field:		—	(50.29)	37.61	48.01	32.51	
Bonne Esperance																							—	44.38	78.61	60.94	74.87	41.49	48.88	60.74	48.58	53.05	46.27	50.56
Canaan															—	31.86	40.22	—	53.87	44.30	—													
Dorothea																																—	—	45.34
Wintberg																																—	37.32	39.99
St. John																																		
Cruz Bay (Fort)	35.47	48.41	61.35	46.81	52.63	(42.06)	42.43	44.97	48.67	62.72	—	(Records lost?)	(Records lost?)	41.66	32.55	37.51	[32.38]	48.34	32.44	40.04	60.09	46.46	38.30	31.47	66.08	60.95	60.94	34.94	29.81	—	—	—	37.07	38.22
Adrian																													—	—				
Eden Parcel	34.78	41.24	53.80	41.57	54.53	(35.57)	[26.04]	—	46.18	[68.50]	—																							
Susannaberg	25.41	34.09	45.00	41.25	51.41	(37.69)	26.44	—	[39.64]	—	—																							
America Hill														49.97	40.30	42.11	41.68	67.18	42.93	42.98	68.23	46.08	34.57	40.51	75.00	80.21	—							
St. Croix																																		
Christiansted	25.10	35.52	54.08	44.03	38.51	40.59	39.17	33.90	73.94	50.87	37.13	41.45	52.80	[30.65]	25.57	26.81	30.51	50.08	34.42	31.53	52.79	46.05	44.01	34.19	65.58	53.99	67.22	—				34.14	19.00	—
Frederiksted†														—	†41.94	29.28	—	†55.72	44.37	46.48	65.66	50.80	42.46	45.35	75.12	62.16	82.53	43.83	46.45	—	49.73	†43.95	—	43.00
Kings Hill														—	—	25.79	30.72	46.14	37.97	35.74	54.28	51.15	35.41	40.62	65.73	52.58	59.55	41.39	38.72	—	—	44.25	29.65	31.83
Anna's Hope														35.81	33.72	31.58	33.80	55.82	37.23	35.29	57.89	44.30	44.55	35.10	65.75	54.27	67.59	39.14	41.88	61.13	38.28	41.31	32.29	(29.88)
Jolly Hill																																51.88	40.16	50.72
Annaly														40.94	50.53	43.44	44.16	65.73	46.86	56.01	67.96	—	47.88	51.12	79.14	63.42	76.40	—				52.68	38.97	—
Bonne Esperance																—	[37.41]	51.97	38.22	35.59	47.25	50.44	40.55	39.86	63.65	[57.07]	66.94	41.45	48.88	—				
Anguilla																															—	36.28	26.88	—
Bethlehem (Old Works)																															—	37.42	26.49	30.99
Bethlehem (New Works)																																—	16.04	(19.73)
Calquhoun (Mt. Pleasant)																															—	48.29	31.91	35.67
Castle Coakley																																—	—	33.75
Central Factory																																—	23.70	31.72
Dolby Hill																															—	44.70	31.59	(33.92)
Granard																															—	35.15	25.76	—
Sion Farm																															—	40.80	30.53	31.06
Whim																															—	42.19	25.71	31.75
British V. I.																																		
Tortola, Exper. Sta.															45.95	55.71	39.98	55.01	38.39	31.01	63.63	51.82	43.25	49.52	75.03	88.31	91.16	52.81	47.89	65.53	56.25	56.28	46.56	(43.54)

* Figures in brackets are approximate, one or two months having been estimated by interpolation. Figures in parentheses have one month or part of a month of observations missing and, as no interpolation was made, these figures are too low by amounts up to possibly 10 inches. The official records for 1888, 1896, and January 1889 have not been found. St. Thomas and St. John stations were not opened until mid-January 1877. Dashes indicate less than a full month of observations.

† Frederiksted = LaGrange Estate 1921–23; Prosperity Estate 1923–37; Fort 1938–.

Appendix Table 3

Average Monthly Rainfall, St. Croix Stations, Danish Period 1838–1917, and St. Bernard's, Tortola, 1831–1833

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Eliza's Retreat[1]	2.02	1.74	0.87	2.29	3.41	2.53	2.48	3.54	4.09	4.42	4.74	2.57	33.63
Christiansted[2]	2.32	2.05	1.24	2.97	4.39	4.53	3.46	4.26	5.59	5.88	5.89	3.87	46.43
Frederiksted (Fort)[3]													
1875 Rainfall	—	—	1.89	0.65	1.70	2.25	3.30	5.36	2.06	4.45	3.81	2.91	—
1875 Days with rain	—	—	20	7	13	15	18	15	17	20	20	18	—
1876 Rainfall	5.34	1.54	1.07	2.26	3.03	4.00	2.11	2.88	7.56	2.14	5.64	2.07	39.64
1876 Days with rain	26	16	12	8	20	11	15	13	15	16	18	17	187
1877 Rainfall	2.85	3.74	2.97	4.40	1.48	6.05	7.35	7.72	6.11	5.53	4.77	4.26	57.24
1877 Days with rain	26	9	11	10	8	19	20	19	19	21	20	20	282
1879 Rainfall	1.70	3.89	2.39	5.01	9.42	10.36	3.03	11.09	4.38	8.22	8.37	5.20	72.87
1879 Days with rain	18	12	9	19	16	14	13	13	13	16	24	14	181
Kings Hill[3]													
1879 Rainfall	—	—	—	0.84	0.98	2.29	4.25	4.57	1.97	2.64	3.84	1.43	—
1879 Days with rain	—	—	—	7	9	11	19	13	17	20	17	15	—
Average for St. Croix[4]	2.38	1.91	1.70	2.60	4.47	4.01	3.65	4.70	6.07	6.56	5.23	3.53	46.89
St. Bernard's[5]	2.05	1.96	2.75	3.06	5.09	6.62	7.95	10.70	10.35	7.27	4.06	3.87	65.73
Christiansted,[6] 1852–1907 (in mm)													
Average	59	51	40	69	122	116	97	120	154	176	142	96	1242
Greatest	147	183	170	193	473	321	395	356	442	466	468	329	1942
Least	10	2	7	4	14	9	13	28	41	51	11	27	665
Frederiksted,[6] 1852–1907 (in mm)													
Average	62	45	48	69	111	101	93	127	154	173	130	84	1197
Greatest	148	112	175	303	471	318	248	277	553	545	300	202	1741
Least	9	3	3	7	17	9	9	38	22	45	37	25	728
Kings Hill,[6] 1852–Oct. 1878; Oct. 1888–1907 (in mm)													
Average	59	44	40	62	103	92	92	109	149	156	125	87	1118
Greatest	137	128	173	247	446	244	264	292	486	409	370	284	1619
Least	5	4	2	5	16	10	17	24	38	52	21	25	682
St. Croix: Average of Christiansted, Frederiksted, and Kings Hill (same records as above)—table showing percentage of years that each month had the highest and lowest rainfall of the year													
Highest	1	0	1	1	13	8	4	10	21	26	12	3	100
Lowest	11	20	32	19	6	6	2	1	1	0	2	0	100

[1] Average of 14-year period, 1838–51. Observations of Major Long, quoted by Orsted; originally published in part in the "St. Croix Avis" and in the "St. Croix Agricultural Reporter". Lowest annual rainfall was 16.75 in 1842; highest annual rainfall was 54.00 in 1850.

[2] Average of 37 years — 1876, 1877, 1882–1916. See TEXT TABLE 1.

[3] From "Meteorologisk Aarbog" (Copenhagen) pt. 2, for years 1875–79.

[4] Christiansted, Kings Hill and Frederiksted, 1852–1911. See TEXT TABLE 5 for further details.

[5] Average of 3-year period, 1831–33. From Schomburgk, 1837.

[6] These are averages computed by Willaume-Jantzen from records he found in the Danish archives and Meteorological Institute; he converted them from lines to millimeters. We have not converted them into inches owing to the errors that would accumulate with repeated conversions from casting off decimal remainders.

Appendix Table 4

Average Monthly Rainfall Totals and Days with Rain, St. Thomas Stations

A. Rainfall at Barracks (Salut Batteriet), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	5.23	2.38	4.75	0.81	5.80	10.53	3.62	6.94	4.73	11.75	3.83	(60.37)
1878	2.97	4.94	3.94	3.78	6.58	4.61	9.56	6.90	9.99	4.81	7.18	2.95	68.21
1879	3.25	2.66	3.69	6.90	11.16	19.15	4.53	4.12	3.70	9.19	10.70	1.87	80.92
1880	1.89	0.81	0.56	1.97	11.50	2.09	2.00	0.62	2.08	5.19	2.86	1.09	32.66
1881	2.58	0.37	0.31	1.28	8.78	6.47	1.06	7.25	8.09	7.90	6.19	3.03	53.31
1882	1.69	2.50	3.06	1.00	1.22	1.65	5.06	3.22	4.63	3.70	3.41	2.58	33.72
1883	3.94	2.95	4.39	4.36	9.33	1.50	3.23	9.28	7.63	4.89	7.00	6.78	65.28
1884	2.36	2.22	1.16	0.36	2.22	3.06	5.78	6.08	6.22	14.42	3.75	2.89	50.52
1885	0.81	1.52	0.39	4.05	1.47	1.87	1.91	8.64	2.14	5.12	8.89	5.22	42.03
1886	1.14	2.77	1.19	7.50	2.20	6.69	4.84	5.67	6.22	10.17	13.78	3.78	65.95
1887	2.64	1.53	1.05	4.29	4.05	5.42	6.20	5.03	3.86	1.76	5.32	0.40	41.55
1888	1.39	2.28	1.29	2.98	3.58	3.45	3.71	7.98	5.94	—	—	—	—
1889	—	1.39	1.56	4.58	11.81	9.19	1.91	3.89	10.78	3.23	3.14	1.67	(53.15)
1890	5.22	2.45	1.48	4.75	0.77	1.31	1.92	3.20	3.95	2.03	2.77	3.94	33.79
1891	1.47	1.61	0.56	1.50	1.91	7.02	5.25	8.61	2.45	11.23	6.11	2.39	50.11
1892	3.37	1.09	0.65	1.56	4.11	0.46	1.99	3.88	3.45	3.42	7.61	1.55	33.14
1893	0.65	2.66	1.20	2.83	3.50	5.02	4.06	9.22	3.71	3.41	[1.60]	1.92	[39.78]
1894	2.06	1.34	1.37	2.15	4.89	2.52	7.37	1.79	5.28	10.83	3.53	4.61	47.74
1895	1.76	1.02	1.39	2.02	4.75	1.87	2.60	4.73	7.78	9.94	6.80	13.63	58.29
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	5.34	0.31	0.94	3.98	14.69	1.68	2.36	1.90	6.03	2.72	3.48	2.39	45.82
1898	1.69	0.66	0.56	0.98	5.72	3.09	7.05	4.45	9.97	5.92	2.78	2.47	45.35
1899	2.86	0.83	1.09	0.89	1.67	2.59	2.25	14.56	1.94	5.92	8.42	0.72	43.75
1900	4.36	0.75	0.80	4.92	2.47	14.42	3.75	3.31	5.50	8.47	2.22	2.86	53.83
1901	3.55	1.12	2.88	0.59	4.88	7.16	8.48	2.19	4.61	7.34	7.97	3.66	54.42
1902	5.42	0.00	1.56	2.50	8.08	8.86	1.66	0.72	3.78	2.67	3.84	4.72	43.84
1903	1.12	1.34	0.89	3.89	1.48	4.36	2.69	3.50	5.62	4.28	5.75	4.91	39.85
1904	1.64	1.67	3.81	1.66	2.08	0.38	2.09	3.47	5.70	5.03	2.74	0.98	31.25
1905	3.62	0.41	2.25	1.31	8.08	0.91	3.80	6.06	3.61	5.38	4.78	1.28	41.49
1906	0.80	1.31	7.14	0.64	6.06	2.77	4.61	2.69	4.97	4.14	1.91	6.95	43.99
1907	1.38	4.97	0.72	1.72	1.02	2.09	3.14	2.64	2.08	5.98	4.34	5.31	35.39
1908	4.91	2.52	2.67	0.98	5.53	3.27	3.19	2.12	4.56	5.31	5.56	5.33	45.96
1909	2.38	4.67	3.61	1.78	1.17	4.67	1.38	9.92	3.62	8.16	11.55	3.69	56.60
1910	3.85	1.62	2.08	1.27	0.86	0.27	4.70	4.39	13.06	3.55	5.09	6.44	47.16
1911	4.16	4.11	0.38	2.38	6.39	0.61	3.09	1.25	1.86	5.74	6.56	14.50	51.02
1912	2.24	1.77	1.44	4.42	—	4.52	1.84	1.50	0.81	7.72	7.78	2.25	(36.32)
1913	2.08	3.19	3.45	3.25	4.17	2.50	1.25	1.50	3.77	4.91	2.50	2.84	35.41
1914	0.50	3.64	1.89	4.53	10.05	5.03	1.17	3.24	0.52	6.78	9.02	2.02	48.38
1915	1.84	2.45	1.74	6.77	5.25	4.80	1.62	2.31	2.58	2.42	8.81	1.86	42.46
1916	3.14	2.24	1.19	1.66	3.66	2.72	5.08	6.38	7.42	20.41	11.25	0.74	65.86
1917	1.56	0.34	0.59	—	—	—	—	—	—	—	—	—	—
Total	97.60	81.27	73.33	112.77	187.95	165.83	148.72	181.83	196.85	238.82	228.75	140.01	—
No. Years	38	40	40	39	38	39	39	39	39	38	38	38	—
Means	2.57	2.03	1.83	2.88	4.95	4.25	3.81	4.66	5.05	6.28	6.02	3.68	48.01

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

B. Days with Rain at Barracks (Salut Batteriet), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	8	12	11	6	21	17	12	12	19	18	11	(147)
1878	14	8	11	10	14	14	20	11	20	17	14	9	162
1879	13	11	9	12	14	12	12	12	19	21	19	12	166
1880	18	5	6	5	17	11	10	12	12	19	15	8	138
1881	9	3	4	7	12	18	10	16	18	17	18	14	146
1882	19	11	14	6	6	6	19	12	14	13	15	14	149
1883	18	17	10	14	19	11	11	12	15	19	20	20	186
1884	14	11	10	3	8	13	13	17	19	16	16	17	157
1885	11	6	9	9	2	10	13	14	9	11	18	16	128
1886	5	14	9	13	9	13	18	18	19	14	22	16	170
1887	14	13	7	10	10	10	12	13	14	13	15	3	134
1888	9	7	8	16	10	16	14	13	17	—	—	—	—
1889	—	10	8	8	24	19	16	15	12	16	21	14	(163)
1890	17	17	12	13	6	10	15	12	12	11	14	14	153
1891	13	9	2	7	14	17	14	15	17	15	15	13	151
1892	13	5	9	11	14	9	10	15	12	16	20	10	144
1893	5	14	5	13	12	14	18	10	12	11	8	[15]	[137]
1894	14	10	13	8	18	14	15	12	17	15	20	16	172
1895	10	7	9	7	15	13	15	17	15	12	16	15	151
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	10	5	7	11	20	10	10	12	14	14	14	10	137
1898	12	6	6	6	11	6	14	15	13	17	11	18	138
1899	16	10	7	6	7	19	14	16	11	13	16	8	143
1900	17	8	6	11	8	20	17	15	13	23	11	15	164
1901	11	9	12	3	14	13	18	15	11	24	12	13	155
1902	12	0	11	15	14	12	16	7	9	11	18	14	139
1903	13	10	7	12	12	15	11	13	16	13	18	18	158
1904	14	14	15	6	13	7	7	17	16	14	11	10	144
1905	11	7	14	4	11	5	10	11	16	14	11	10	124
1906	12	13	13	11	13	17	17	8	14	17	11	23	169
1907	13	12	10	5	10	11	13	11	11	12	20	23	151
1908	18	19	13	9	5	12	11	13	18	12	25	15	170
1909	13	17	12	12	10	18	11	18	12	15	16	11	165
1910	19	17	11	4	7	11	9	15	9	9	9	17	137
1911	21	10	3	8	16	4	12	5	14	13	20	16	142
1912	16	7	15	9	—	10	13	11	7	11	20	11	(130)
1913	21	13	19	11	17	10	14	7	10	15	16	14	167
1914	5	16	8	12	17	14	14	16	7	16	19	13	157
1915	12	11	7	12	12	9	16	9	16	12	16	17	149
1916	21	11	8	7	14	11	13	14	20	21	18	8	166
1917	10	4	9	—	—	—	—	—	—	—	—	—	—
Total	513	405	380	357	461	485	532	506	542	571	616	521	—
No. Years	38	40	40	39	38	39	39	39	39	38	38	38	—
Means	13.5	10.1	9.5	9.2	12.1	12.4	13.6	13.0	13.9	15.0	16.2	13.7	152.2

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 4 (continued)

C. Rainfall at Charlotte Amalie Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	5.55	2.22	2.92	0.91	5.17	8.66	3.30	5.55	2.61	12.33	3.95	(53.17)
1878	3.17	4.94	2.25	4.83	6.16	4.98	6.36	4.84	9.90	5.03	6.22	1.96	60.64
1879	3.50	1.97	2.33	4.28	10.59	14.18	—	—	6.97	6.78	8.69	3.90	—
1880	—	0.25	—	2.31	17.37	3.25	—	—	—	—	—	—	—
Total	6.67	12.71	6.80	14.34	35.03	27.58	15.02	8.14	22.42	14.42	27.24	9.81	—
No. Years	2	4	3	4	4	4	2	2	3	3	3	3	—
Means	3.34	3.18	2.27	3.58	8.76	6.90	7.51	4.07	7.47	4.81	9.08	3.27	64.24

D. Days with Rain at Charlotte Amalie Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	8	6	9	3	16	17	10	14	16	22	13	(134)
1878	12	9	8	7	9	11	15	9	18	13	13	8	132
1879	12	8	6	10	18	10	—	—	24	16	16	13	—
1880	—	3	—	7	19	13	—	—	—	—	—	—	—
Total	24	28	20	33	49	50	32	19	56	45	51	34	—
No. Years	2	4	3	4	4	4	2	2	3	3	3	3	—
Means	12	7	7	8	12	12	16	10	19	15	17	11	146

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

E. Rainfall at Cowell's Hill (or Battery)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.50	1.39	4.03	1.50	4.20	12.34	3.19	5.12	4.34	12.88	3.12	(56.61)
1878	2.33	3.75	2.45	3.86	5.80	4.12	6.48	5.34	9.69	3.73	5.64	1.72	54.91
1879	3.88	1.42	3.69	3.81	10.17	14.25	3.48	5.34	2.73	9.28	11.52	1.99	71.56
1880	1.65	0.89	0.51	1.20	8.67	2.95	1.86	1.29	1.79	6.19	2.44	2.83	32.27
1881	2.58	1.61	0.64	0.62	7.57	7.08	1.44	7.30	7.12	5.33	4.64	2.99	48.92
1882	1.69	3.15	2.03	0.53	0.75	1.28	5.00	2.43	3.55	5.80	4.58	1.79	32.58
1883	3.41	3.08	2.95	2.44	7.81	1.25	3.45	8.51	5.70	5.78	7.00	6.78	58.16
1884	2.43	1.83	1.08	0.02	2.77	2.92	4.58	4.67	6.31	12.40	2.55	2.71	44.27
1885	0.80	0.36	0.34	3.78	1.28	1.67	2.62	9.64	1.08	6.76	1.40	5.39	35.12
1886	1.62	3.56	1.94	7.02	1.39	3.67	4.26	4.53	5.42	9.42	11.86	3.30	57.99
1887	2.28	1.19	0.43	4.15	3.53	5.59	5.67	4.31	3.12	3.56	4.22	0.88	38.93
1888	1.39	1.61	1.31	2.09	3.23	4.06	3.89	7.98	4.65	—	—	—	—
1889	—	1.28	1.29	2.98	8.62	9.16	1.50	2.95	10.27	2.88	2.22	1.83	(44.98)
1890	6.08	1.91	1.52	3.70	0.67	1.09	1.20	2.80	1.81	1.76	1.92	3.19	27.65
1891	1.14	3.35	1.20	1.13	1.65	8.48	5.53	6.72	1.79	8.55	4.64	2.09	46.27
1892	4.14	1.28	0.55	1.42	4.37	0.34	2.17	4.98	2.78	4.03	7.14	1.29	34.49
1893	1.16	3.58	1.24	3.03	3.70	4.84	4.36	7.50	3.81	4.08	(1.63)	2.41	41.34
1894	1.09	1.14	1.26	2.70	3.78	2.43	6.94	2.56	3.45	10.70	2.23	3.89	42.17
1895	1.97	1.24	1.91	0.70	4.36	1.08	2.52	4.20	7.69	7.74	6.33	12.07	51.81
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	3.80	0.09	1.22	3.78	14.33	1.66	2.36	1.34	5.98	2.72	3.33	2.39	43.00
1898	3.52	0.31	1.11	0.81	3.61	2.80	6.23	3.28	8.87	4.30	2.22	1.94	39.00
1899	1.52	0.56	1.30	1.34	1.06	3.52	1.77	9.50	8.91	4.84	10.20	1.52	46.04
1900	2.64	0.50	0.94	3.48	1.77	6.70	3.30	3.20	4.03	5.20	2.30	2.60	36.64
1901	3.39	0.80	2.28	0.98	3.38	6.18	12.22	2.42	3.59	7.36	7.30	3.27	53.17
1902	5.50	0.00	1.12	2.80	5.75	6.34	1.53	0.75	2.06	3.00	3.55	4.31	36.72
1903	0.72	0.92	0.77	2.77	1.64	3.30	2.31	2.02	4.69	3.00	4.36	3.92	30.41
1904	0.88	1.77	3.70	1.28	1.16	0.53	1.16	2.66	3.75	5.34	3.06	1.17	26.46
1905	2.62	—	—	—	—	—	—	—	—	—	—	—	—
Total	64.23	45.68	40.17	66.44	114.31	111.47	110.17	121.41	129.76	148.09	131.14	81.38	—
No. Years	26	27	27	27	27	27	27	27	27	26	26	26	—
Means	2.47	1.69	1.49	2.46	4.23	4.13	4.08	4.50	4.81	5.70	5.04	3.13	43.73

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

F. Days with Rain at Cowell's Hill (or Battery)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4	11	12	5	15	22	13	12	12	17	11	(134)
1878	9	5	7	12	10	12	14	8	18	17	16	9	137
1879	12	5	11	1	16	11	9	14	12	16	19	10	136
1880	15	7	5	4	9	8	8	9	11	14	15	12	117
1881	12	9	5	8	10	20	10	17	18	14	18	14	155
1882	16	9	10	3	4	5	15	8	9	15	12	11	117
1883	18	19	8	5	16	8	16	12	12	17	20	20	171
1884	17	15	9	1	9	15	11	14	14	16	15	15	151
1885	10	6	9	9	2	10	11	15	7	9	5	14	107
1886	8	14	8	6	8	14	17	17	19	14	21	16	162
1887	15	16	9	7	10	11	10	10	9	11	11	6	125
1888	7	5	5	9	8	13	8	12	9	—	—	—	—
1889	—	5	4	10	21	21	12	9	13	13	14	15	(137)
1890	19	12	13	15	7	13	13	13	10	11	12	18	156
1891	12	19	2	4	7	13	13	13	16	16	15	14	144
1892	12	5	8	10	13	7	11	12	12	17	15	9	131
1893	6	13	3	12	8	9	16	10	12	13	5	14	121
1894	10	14	13	10	12	13	14	9	13	13	12	11	144
1895	14	9	9	5	16	7	12	12	16	11	16	15	142
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	12	3	5	9	21	8	16	9	18	9	15	12	137
1898	16	4	8	8	13	8	12	13	14	12	7	10	125
1899	17	7	9	7	9	18	15	13	11	10	16	9	141
1900	12	8	9	11	9	15	13	12	13	18	12	13	145
1901	13	9	11	4	15	18	17	14	14	19	13	16	163
1902	12	0	6	14	12	13	16	5	13	10	13	14	128
1903	11	10	5	9	9	10	15	13	13	11	16	16	138
1904	11	14	14	8	9	5	9	14	15	15	9	10	133
1905	13	—	—	—	—	—	—	—	—	—	—	—	—
Total	329	246	216	207	288	320	355	320	353	353	359	334	—
No. Years	26	27	27	27	27	27	27	27	27	26	26	26	—
Means	12.6	9.1	8.0	7.7	10.7	11.9	13.1	11.9	13.1	13.6	13.8	12.8	138.3

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 4 (continued)

G. Rainfall at Kjaer's Hill (Blackbeard's Castle), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	5.48	3.00	4.75	1.14	5.27	10.52	3.06	6.81	4.17	12.05	3.66	(59.91)
1878	2.28	5.39	2.64	2.88	4.47	3.81	6.29	4.88	6.52	—	—	—	—
Total	2.28	10.87	5.64	7.63	5.61	9.08	16.81	7.94	13.33	4.17	12.05	3.66	—
No. Years	1	2	2	2	2	2	2	2	2	1	1	1	—
Means	2.28	5.44	2.82	3.82	2.80	4.54	8.40	3.97	6.66	4.17	12.05	3.66	60.61

H. Days with Rain at Kjaer's Hill (Blackbeard's Castle), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	8	11	14	6	17	16	9	9	15	15	14	(134)
1878	11	8	11	10	10	16	19	11	20	—	—	—	—
Total	11	16	22	24	16	33	35	20	29	15	15	14	—
No. Years	1	2	2	2	2	2	2	2	2	1	1	1	—
Means	11	8	11	12	8	16	18	10	14	15	15	14	152

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 4 (continued)

I. Rainfall at Liliendal Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	5.45	3.17	3.70	0.89	7.69	13.75	3.34	7.52	5.34	12.22	3.78	(66.85)
1878	4.14	5.78	2.86	2.56	4.22	5.63	8.44	7.80	7.65	8.69	9.40	1.50	68.67
1879	3.47	2.09	4.50	7.09	12.59	17.89	4.63	3.92	4.26	8.97	6.94	1.20	77.55
1880	1.31	0.06	1.72	1.70	10.37	3.44	2.47	2.62	4.31	6.14	3.79	2.80	40.73
1881	1.48	0.00	0.34	1.55	9.52	9.02	2.38	8.75	8.19	7.81	6.09	1.25	56.38
1882	0.56	2.58	1.53	1.13	0.81	1.62	3.50	5.03	4.25	3.62	6.50	3.53	34.66
1883	13.94	6.94	5.59	—	11.06	—	—	—	16.43	—	—	—	—
Total	24.90	22.90	19.71	17.73	49.46	45.29	35.17	31.46	52.61	40.57	44.94	14.06	—
No. Years	6	7	7	6	7	6	6	6	7	6	6	6	—
Means	4.15	3.27	2.82	2.96	7.07	7.55	5.86	5.24	7.52	6.76	7.49	2.34	63.03

J. Days with Rain at Liliendal Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	12	8	9	5	16	16	11	9	16	15	13	(130)
1878	16	9	6	7	10	13	11	11	13	12	14	2	124
1879	10	6	14	12	15	15	12	7	10	19	16	9	145
1880	12	1	4	3	17	10	8	7	5	15	16	11	109
1881	11	0	1	5	14	18	6	10	13	14	11	3	106
1882	4	7	4	2	1	2	5	7	10	6	11	11	70
1883	20	16	11	—	14	—	—	—	14	—	—	—	—
Total	73	51	48	38	76	74	58	53	74	82	83	49	—
No. Years	6	7	7	6	7	6	6	6	7	6	6	6	—
Means	12	7	7	6	11	12	10	9	11	14	14	8	121

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 4 (continued)

K. Rainfall at Lövenlund Estate*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.84	2.06	3.55	1.53	7.27	10.97	4.73	7.33	4.40	10.14	4.09	(60.91)
1878	3.08	5.88	2.25	4.06	3.27	4.98	7.40	4.53	6.19	6.40	8.44	1.44	57.92
1879	—	1.78	1.61	6.88	12.12	16.15	4.90	—	2.31	7.65	—	2.73	—
1905	—	—	—	—	6.34	2.66	3.47	8.09	3.83	5.38	4.91	1.06	—
1906	0.73	1.17	7.16	0.67	5.17	4.50	5.23	1.75	6.58	1.58	4.70	7.47	46.71
1907	1.03	3.84	0.41	0.38	1.42	2.03	2.77	2.25	1.00	7.39	3.08	4.47	30.07
1908	4.44	2.11	2.42	0.33	4.25	3.86	3.11	1.61	5.16	5.67	4.24	3.33	40.52
1909	2.77	4.06	4.94	0.92	2.04	4.11	2.03	10.84	3.95	9.28	12.84	2.80	60.60
Total	12.05	23.69	20.85	16.79	36.15	45.56	39.88	33.80	36.35	47.76	48.35	27.39	—
No. Years	5	7	7	7	8	8	8	7	8	8	7	8	—
Means	2.41	3.38	2.98	2.40	4.52	5.70	4.98	4.83	4.54	5.97	6.91	3.42	52.04

* The Lövenlund gage was recalled by the Government on Oct. 12, 1884. The gage used at Cowell's Hill until Feb. 1905 was apparently sent to Lövenlund in April, and taken from there to the Sekretariat in Jan. 1910.

L. Days with Rain at Lövenlund Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4	5	10	7	17	14	7	9	11	11	11	(106)
1878	11	6	8	10	8	12	12	6	13	16	14	4	120
1879	—	6	7	12	17	8	8	—	19	20	—	15	—
1905	—	—	—	—	9	7	7	12	17	13	11	10	—
1906	5	8	9	6	8	14	14	6	14	9	8	23	124
1907	8	14	5	4	8	12	13	8	7	12	14	26	131
1908	19	12	13	2	5	8	7	7	10	5	12	10	110
1909	12	14	9	6	7	13	8	16	11	11	17	6	130
Total	55	64	56	50	69	91	83	62	100	97	87	105	—
No. Years	5	7	7	7	8	8	8	7	8	8	7	8	—
Means	11.0	9.1	8.0	7.1	8.6	11.4	10.4	8.9	12.5	12.1	12.4	13.1	124.6

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

M. Rainfall at Ma Folie Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.70	2.13	3.84	1.20	6.44	13.14	3.08	6.83	[6.50]	12.81	2.84	(63.51)
1878	2.59	4.63	2.50	2.56	3.25	5.01	6.31	5.61	7.17	5.37	7.70	1.69	54.39
1879	3.66	2.14	2.45	5.48	10.88	12.37	—	—	—	—	—	—	—
1880	1.39	1.02	0.33	1.94	9.93	2.22	2.45	1.47	2.14	7.17	3.19	1.76	35.01
1881	1.29	0.00	1.05	1.61	8.31	6.84	—	7.39	5.86	8.11	4.17	—	—
1882	1.36	1.20	3.58	0.62	1.03	1.20	3.73	1.91	3.66	3.14	4.29	2.75	28.47
Total	10.29	13.69	12.04	16.05	34.60	34.08	25.63	19.46	25.66	30.29	32.16	9.04	—
No. Years	5	6	6	6	6	6	4	5	5	5	5	4	—
Means	2.06	2.28	2.01	2.68	5.77	5.68	6.41	3.89	5.13	6.06	6.43	2.26	50.66

N. Days with Rain at Ma Folie Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	11	12	14	8	22	18	13	9	[9]	16	17	(149)
1878	12	6	12	9	10	14	16	13	21	15	19	9	156
1879	13	10	9	12	8	7	—	—	—	—	—	—	—
1880	14	5	8	7	18	13	9	10	10	17	19	10	140
1881	10	0	6	9	16	15	—	11	13	14	15	—	—
1882	7	7	5	2	4	5	8	3	6	6	4	3	60
Total	56	39	52	53	64	76	41	50	59	52	73	39	—
No. Years	5	6	6	6	6	6	4	5	5	5	5	4	—
Means	11	7	9	9	11	13	10	10	12	13	15	10	130

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

O. Rainfall at Nisky (Moravian Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	6.47	1.47	4.20	1.11	5.03	11.11	3.50	4.77	4.20	10.92	3.76	(56.54)
1878	2.77	4.40	2.75	2.39	5.36	4.55	6.58	6.94	8.36	4.29	7.47	1.97	57.83
1879	3.27	1.28	3.09	4.36	10.72	13.17	4.83	5.34	2.66	9.75	9.64	1.55	69.66
1880	1.42	0.84	0.55	1.40	8.31	2.53	1.48	0.86	2.73	6.92	3.15	2.39	32.58
1881	1.62	1.29	0.67	0.51	7.03	6.96	1.08	7.96	6.33	6.44	6.09	2.53	48.51
1882	1.44	2.29	3.94	0.59	1.14	1.83	3.62	3.33	4.98	3.70	6.69	2.25	35.80
1883	3.61	2.62	3.17	4.61	7.06	1.40	3.75	9.36	5.86	7.19	4.14	7.63	60.40
1884	2.53	1.63	0.92	0.67	1.83	2.13	6.83	5.12	6.97	8.39	2.38	2.52	41.92
1885	1.14	1.16	[0.28]	2.83	2.15	1.52	3.12	7.11	2.60	7.65	9.54	5.14	[44.24]
1886	2.44	3.64	1.17	7.11	1.55	4.23	4.08	4.67	4.97	9.64	8.50	[2.00]	[54.00]
1887	1.78	1.17	0.99	2.55	4.15	6.75	2.81	6.17	4.64	2.14	7.06	0.65	40.86
1888	1.72	1.28	1.17	5.15	—	5.53	3.76	7.96	5.11	—	—	—	—
1889	—	0.88	1.69	3.45	10.90	7.90	—	—	—	—	—	—	—
Total	23.74	28.95	21.86	39.82	61.31	63.53	53.05	68.32	59.98	70.31	75.58	32.39	—
No. Years	11	13	13	13	12	13	12	12	12	11	11	11	—
Means	2.16	2.23	1.68	3.06	5.11	4.89	4.42	5.69	5.00	6.39	6.87	2.94	50.44

P. Days with Rain at Nisky (Moravian Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	13	11	9	7	15	19	14	12	15	15	12	(142)
1878	14	6	7	12	13	13	15	14	19	14	17	13	157
1879	14	5	12	15	14	14	15	17	14	20	13	12	165
1880	13	6	6	4	14	13	6	8	11	17	13	10	121
1881	12	9	5	8	13	16	10	16	15	15	13	12	144
1882	12	10	11	5	6	6	10	13	13	16	15	10	127
1883	20	16	7	8	16	9	12	11	16	17	5	19	156
1884	17	12	9	4	8	10	12	12	14	14	14	13	139
1885	11	6	[8]	8	3	9	13	10	13	14	15	14	124
1886	6	12	11	8	7	13	15	14	10	16	16	[12]	[140]
1887	11	12	6	6	11	17	8	10	13	5	14	5	118
1888	11	7	5	13	—	16	12	9	13	—	—	—	—
1889	—	4	5	9	21	17	—	—	—	—	—	—	—
Total	141	118	103	109	133	168	147	148	163	163	150	132	—
No. Years	11	13	13	13	12	13	12	12	12	11	11	11	—
Means	13	9	8	8	11	13	12	12	14	15	14	12	141

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

Q. Rainfall at Pearl Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	6.61	2.19	5.63	1.63	4.88	10.81	2.62	10.14	4.68	14.92	4.89	(69.00)
1878	4.40	6.23	3.33	1.59	4.25	4.83	6.29	10.61	7.89	13.12	9.59	3.12	75.25
1879	3.55	1.75	4.09	7.90	15.89	17.47	5.95	4.78	4.15	7.76	6.14	2.36	81.79
1880	2.88	—	0.81	1.22	20.39	3.19	—	1.36	4.64	10.06	7.09	1.25	—
1881	2.75	0.70	0.64	0.78	8.12	10.64	3.92	9.11	10.79	5.73	6.08	4.88	64.14
1882	0.89	1.62	—	—	0.61	—	—	—	1.29	—	—	—	—
Total	14.47	16.91	11.06	17.12	50.89	41.01	26.97	28.48	38.90	41.35	43.82	16.50	347.48
No. Years	5	5	5	5	6	5	4	5	6	5	5	5	—
Means	2.89	3.38	2.21	3.42	8.48	8.20	6.74	5.70	6.48	8.27	8.76	3.30	67.83

R. Days with Rain at Pearl Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	13	4	13	4	11	12	4	10	8	14	9	(102)
1878	11	6	6	5	6	7	9	10	13	13	9	4	99
1879	10	4	8	12	15	7	11	5	6	9	7	3	97
1880	4	—	3	4	12	4	—	(2?)	6	9	10	5	—
1881	6	3	3	4	7	11	8	15	13	10	10	7	97
1882	4	5	—	—	2	—	—	—	4	—	—	—	—
Total	35	31	24	38	46	40	40	34	52	49	50	28	—
No. Years	5	5	5	5	6	5	4	4	6	5	5	5	—
Means	7	6	5	8	8	8	10	8	9	10	10	6	95

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 4 (continued)

S. Rainfall at Sekretariat (Administration Bldg.), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1910	3.69	1.61	2.52	1.58	0.97	0.67	5.33	4.89	12.80	3.34	6.66	5.92	49.97
1911	4.09	4.11	0.50	2.25	6.39	0.67	3.52	1.42	1.75	5.77	5.27	15.14	50.88
1912	2.16	2.05	1.38	5.25	—	4.52	1.72	1.25	0.97	8.45	8.42	2.34	(38.50)
1913	1.84	3.66	3.30	3.06	4.28	2.19	1.12	1.28	4.36	5.38	2.19	2.72	35.38
1914	0.44	3.80	0.88	4.45	8.62	6.55	1.14	3.20	0.70	5.58	10.12	2.25	47.74
1915	2.02	3.20	2.09	7.25	5.80	4.55	1.58	1.98	3.66	2.56	8.61	2.33	45.63
1916	3.16	2.27	1.56	1.50	3.92	3.08	5.92	6.61	7.38	18.78	11.14	1.24	66.55
1917	1.56	0.50	0.64	—	—	—	—	—	—	—	—	—	—
Total	18.95	21.19	12.86	25.35	29.99	22.22	20.33	20.64	31.61	49.86	52.41	31.94	—
No. Years	8	8	8	7	6	7	7	7	7	7	7	7	—
Means	2.37	2.65	1.61	3.62	5.00	3.17	2.90	2.95	4.52	7.12	7.49	4.56	47.96

T. Days with Rain at Sekretariat (Administration Bldg.), Charlotte Amalie

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1910	15	14	10	5	6	12	11	15	12	8	9	13	130
1911	16	9	6	8	15	5	15	8	10	16	16	20	144
1912	12	6	12	11	—	11	6	5	6	9	19	11	(108)
1913	14	13	17	7	13	8	10	7	9	13	15	15	141
1914	6	14	9	13	13	15	10	14	7	15	14	8	138
1915	10	12	5	12	11	9	13	8	14	12	16	14	136
1916	19	10	8	8	18	8	13	11	15	21	16	7	154
1917	11	5	8	—	—	—	—	—	—	—	—	—	—
Total	103	83	75	64	76	68	78	68	73	94	105	88	—
No. Years	8	8	8	7	6	7	7	7	7	7	7	7	—
Means	12.9	10.4	9.4	9.1	12.7	9.7	11.1	9.7	10.4	13.4	15.0	12.6	136.4

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5

Average Monthly Rainfall Totals and Days with Rain, St. John Stations

A. Rainfall at Adrian Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.75	2.19	1.86	2.80	5.77	8.16	4.31	7.78	7.65	9.31	4.31	(58.89)
1878	6.31	[5.00]	2.89	5.19	4.75	4.48	11.08	5.78	7.62	4.33	9.05	1.26	[67.74]
1879	2.36	3.31	2.03	5.12	10.48	15.45	4.61	9.37	4.61	5.15	15.15	3.25	80.89
1880	4.09	1.03	1.65	1.14	6.40	2.00	1.72	1.70	2.03	3.84	3.83	2.81	32.24
1881	1.74	1.72	0.83	0.97	5.09	6.83	2.58	8.86	5.15	3.58	7.94	2.78	48.07
1882	1.50	2.69	1.75	2.25	2.61	1.25	4.88	1.81	3.44	3.55	5.66	1.44	32.83
1883	3.22	2.23	2.17	4.18	6.64	3.45	2.84	6.96	4.56	5.12	6.12	6.28	53.77
1884	3.37	2.77	1.16	1.55	2.50	4.89	7.50	3.39	9.80	16.93	2.62	3.22	59.70
1885	3.29	1.39	1.22	5.94	0.00	1.89	2.33	14.72	0.95	8.12	4.75	6.09	50.69
1886	2.60	3.17	1.08	10.06	2.06	5.06	4.00	12.75	4.70	6.96	13.94	4.28	70.66
1887	6.37	4.09	0.86	1.36	10.65	6.19	4.63	7.45	3.90	1.78	10.64	0.50	58.42
1888	2.39	0.75	1.37	2.97	2.53	7.28	2.81	4.06	4.50	—	—	—	—
1889	—	2.22	3.37	5.75	9.40	11.19	2.62	1.72	9.16	2.62	2.93	1.31	(52.29)
1890	3.62	1.56	1.33	3.88	0.62	1.02	2.41	2.25	3.37	1.56	2.44	2.61	26.67
1891	1.50	3.06	0.31	1.55	5.44	4.56	5.68	6.72	3.71	9.31	5.50	1.87	49.21
1892	0.56	1.24	1.28	1.47	4.31	1.31	2.31	6.03	1.62	2.93	3.75	1.62	28.43
1893	0.88	2.25	[1.40]	3.90	5.25	11.45	5.56	9.93	4.39	3.39	0.75	1.79	[50.94]
1894	0.61	0.45	0.33	2.20	5.70	5.53	3.51	3.09	3.81	17.37	6.06	5.92	54.58
1895	3.66	0.78	2.03	0.72	5.69	2.41	3.92	6.65	9.17	11.24	6.62	14.70	67.59
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	3.22	0.56	0.47	2.20	17.67	2.22	4.34	1.81	4.98	4.92	4.63	2.83	49.85
1898	2.66	0.25	0.95	0.97	4.83	1.33	8.50	6.11	4.25	9.73	[4.38]	3.30	[47.26]
1899	2.95	1.06	1.70	0.47	3.77	4.72	3.20	10.75	2.83	2.69	5.88	0.12	40.14
1900	3.19	1.31	1.25	5.19	0.41	11.38	2.81	*—	—	—	—	—	—
Total	60.09	47.64	33.62	70.89	119.59	121.65	102.01	136.22	106.33	132.77	131.94	72.30	—
No. Years	21	23	23	23	23	23	23	22	22	21	21	21	—
Means	2.86	2.07	1.46	3.08	5.20	5.29	4.44	6.19	4.83	6.32	6.28	3.44	51.46

* Gage was transferred to Susannaberg Estate, a parcel of Adrian Estate, during the latter part of July 1900.
Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

B. Days with Rain at Adrian Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	15	6	6	11	16	15	12	13	22	14	13	(143)
1878	13	[11]	8	9	8	16	20	16	13	12	12	9	[147]
1879	11	11	7	11	16	11	15	10	10	10	14	13	139
1880	12	3	5	3	11	11	7	6	10	17	18	9	112
1881	9	3	5	3	8	10	7	12	15	9	12	7	100
1882	7	6	2	1	7	3	9	6	9	11	12	3	76
1883	14	13	5	4	8	8	12	11	6	11	12	14	118
1884	9	9	4	5	9	16	19	13	23	24	15	17	163
1885	15	12	6	4	0	15	17	16	4	14	12	13	128
1886	8	13	5	8	7	10	10	13	7	11	14	19	125
1887	10	12	4	3	6	8	4	12	7	10	13	3	92
1888	11	3	7	7	17	17	6	7	6	—	—	—	—
1889	—	4	3	8	15	10	9	7	8	2	8	5	(79)
1890	7	8	8	13	3	2	10	9	10	7	9	15	101
1891	6	14	1	6	10	6	9	12	10	10	9	4	97
1892	2	4	7	7	8	4	7	5	7	7	11	3	72
1893	3	12	[3]	9	6	7	6	4	7	8	6	8	[79]
1894	5	3	2	5	18	8	14	9	7	11	12	13	107
1895	12	7	8	7	10	9	14	16	18	13	14	21	149
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	12	3	4	9	22	5	20	10	13	16	21	16	151
1898	14	3	7	7	17	3	15	13	10	10	[10]	12	[121]
1899	17	5	9	6	7	9	6	8	6	9	11	2	95
1900	11	4	3	7	2	13	10	—	—	—	—	—	—
Total	208	178	119	148	226	217	261	227	219	244	259	219	—
No. Years	21	23	23	23	23	23	23	22	22	21	21	21	—
Means	9.9	7.7	5.2	6.4	9.8	9.4	11.3	10.3	10.0	11.6	12.3	10.4	114.3

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

C. Rainfall at Caroline(-berg) Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.61	1.19	0.81	2.09	6.08	5.25	4.45	5.59	8.62	7.89	4.25	(50.83)
1878	5.19	—	2.46	6.28	5.23	5.19	11.88	6.81	*—	—	—	—	—
Total	5.19	4.61	3.65	7.09	7.32	11.27	17.13	11.26	5.59	8.62	7.89	4.25	—
No. Years	1	1	2	2	2	2	2	2	1	1	1	1	—
Means	5.19	4.61	1.82	3.54	3.66	5.64	8.56	5.63	5.59	8.62	7.89	4.25	65.00

* The gage was transferred to Cinnamon Bay Estate about this time.

D. Days with Rain at Caroline(-berg) Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	7	5	3	6	8	7	6	11	16	10	9	(88)
1878	8	—	5	8	4	14	15	—	—	—	—	—	—
Total	8	7	10	11	10	22	22	6	11	16	10	9	—
No. Years	1	1	2	2	2	2	2	1	1	1	1	1	—
Means	8	7	5	6	5	11	11	6	11	16	10	9	105

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

E. Rainfall at Cinnamon Bay Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1878	—	—	—	—	—	—	—	—	8.70	5.84	11.40	2.66	—
1879	2.75	3.53	2.56	13.09	10.67	17.88	5.92	10.75	4.88	6.62	13.12	2.69	94.46
1880	5.28	0.88	1.61	1.81	7.96	2.48	1.91	2.88	2.48	6.11	3.97	2.81	40.18
1881	2.75	1.81	1.00	1.45	8.39	10.42	2.75	9.48	7.75	2.48	7.81	3.15	59.24
1882	1.62	3.06	1.45	2.11	2.44	1.86	6.38	3.30	6.50	8.67	8.12	3.06	48.57
1883	4.80	4.84	3.55	3.50	8.62	4.09	4.75	8.53	6.16	5.37	7.02	7.40	68.61
1884	3.75	3.99	1.45	1.67	3.48	3.69	5.58	4.84	9.26	17.83	3.53	3.64	62.71
1885	1.61	1.26	0.75	4.61	*—	—	—	—	—	—	—	—	—
Total	22.56	19.37	12.37	28.24	41.56	40.42	27.29	39.78	45.73	52.90	54.97	25.41	—
No. Years	7	7	7	7	6	6	6	6	7	7	7	7	—
Means	3.22	2.77	1.77	4.03	6.93	6.74	4.55	6.63	6.53	7.56	7.85	3.63	62.21

* The gage was removed to Emmaus Estate about the first of May.

F. Days with Rain at Cinnamon Bay Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1878	—	—	—	—	—	—	—	—	10	14	13	9	—
1879	8	7	6	9	12	10	8	10	12	12	12	7	113
1880	9	3	3	6	12	9	5	7	11	15	13	9	102
1881	9	3	4	4	9	11	7	11	16	6	14	6	100
1882	7	5	3	1	7	6	10	7	10	10	10	7	83
1883	11	12	5	5	9	9	9	9	6	13	10	16	114
1884	10	10	15	9	10	13	14	10	14	14	12	13	144
1885	12	6	4	7	—	—	—	—	—	—	—	—	—
Total	66	46	40	41	59	58	53	54	79	84	84	67	—
No. Years	7	7	7	7	6	6	6	6	7	7	7	7	—
Means	9	7	6	6	10	10	9	9	11	12	12	11	112

Appendix Table 5 (continued)

G. Rainfall at Cruz Bay (Christiansfort), Station A*

(In lines: 8 lines = 1 inch)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1871	22.00	6.75	22.75	13.50	20.75	15.00	13.75	61.50	23.50	67.25	34.25	37.75	338.75
1872	7.00	11.75	8.00	34.00	22.50	8.25	18.50	9.00	30.00	32.00	23.75	19.75	224.50
1873	18.50	8.00	36.50	4.25	16.75	6.25	20.75	35.00	21.00	16.00	6.75	25.50	215.25
1874	8.00	27.00	7.75	2.50	34.25	26.75	23.50	21.50	41.00	26.00	53.75	13.00	285.00
1875	16.75	4.50	11.25	4.75	6.50	12.50	19.25	24.50	6.75	30.25	31.00	19.50	187.50
1876	29.00	6.25	1.75	10.00	21.25	41.25	17.25	16.25	80.50	14.50	19.75	19.50	277.25
1877	23.25	33.00	8.75	8.25	12.75	44.50	59.50	20.00	66.50	32.75	82.50	28.75	420.25
1878	36.00	30.50	13.75	21.50	33.25	19.75	62.50	32.50	59.50	50.50	49.25	12.00	420.75
1879	16.00	20.75	25.50	53.25	65.25	104.75	25.75	49.75	26.75	39.00	72.50	18.00	517.25
1880	27.25	4.00	12.25	9.00	55.75	13.75	13.50	15.25	24.75	28.50	28.00	12.25	244.25
Total	203.75	152.50	148.25	161.00	289.00	292.75	274.00	285.25	380.25	336.75	401.25	206.00	3130.75
Means 10 yr.	20.38	15.25	14.83	16.10	28.90	29.28	27.40	28.53	38.03	33.68	40.13	20.60	313.08
Means in inches	2.55	1.91	1.85	2.01	3.61	3.66	3.43	3.57	4.75	4.21	5.02	2.58	39.14

* These data were taken (see Appendix A) at the same place and by the same observers as the later observations for Cruz Bay, 1877–1917, in the next table; but for the years 1877–80 in which the two series overlap the totals do not agree, the first series being consistently lower by several inches per year. As the difference is not constant, it is probably due to use of different gages in the same immediate vicinity. The two records should not be combined, but the earlier series at least serves to give relative comparisons with later years.

H. Rainfall (in inches) at Cruz Bay (Christiansfort), Station B

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	4.17	1.16	1.11	1.70	5.73	7.61	2.67	8.58	4.34	10.48	3.83	(51.38)
1878	4.73	3.90	1.84	2.78	4.31	2.59	8.03	4.20	9.90	6.53	6.59	1.53	56.93
1879	2.09	2.64	3.35	6.75	8.31	13.30	3.39	6.29	3.30	4.89	9.11	2.31	65.73
1880	3.41	0.58	1.55	1.11	7.03	1.74	1.67	2.11	3.06	3.39	3.66	1.55	30.86
1881	1.14	1.72	0.95	1.00	5.00	8.40	2.38	5.95	4.43	4.00	3.33	2.19	40.49
1882	0.53	1.78	1.22	1.65	1.36	1.42	4.05	2.62	5.90	5.42	6.90	2.28	35.13
1883	3.70	3.66	3.83	2.03	5.48	3.00	3.33	8.11	4.33	4.50	5.97	4.39	52.33
1884	2.97	2.64	1.79	1.14	2.75	5.70	6.88	3.37	8.33	15.75	3.56	3.59	58.47
1885	1.48	0.70	1.05	3.51	0.34	2.20	3.94	11.41	2.60	7.45	7.28	5.23	47.19
1886	2.19	3.19	0.72	9.31	3.31	5.95	3.84	8.12	7.34	8.84	7.09	3.69	63.59
1887	2.84	2.97	0.78	1.16	7.19	9.89	2.25	8.50	3.25	3.73	9.62	1.36	53.54
1888	1.94	0.68	0.75	3.48	1.97	5.22	3.66	4.97	5.28	—	—	—	45.64*
1889	—	2.52	1.72	5.90	9.23	12.58	2.97	2.14	9.71	3.84	2.70	2.02	(55.33)
1890	5.53	3.03	2.00	3.64	1.22	1.74	2.13	1.97	3.41	3.59	2.41	2.44	33.11
1891	1.56	4.37	0.68	0.91	4.53	4.71	5.56	8.44	4.28	9.13	5.90	2.15	52.22
1892	1.44	1.06	0.43	1.65	4.75	1.81	2.80	6.03	2.15	2.47	6.06	1.22	31.87
1893	1.03	2.28	1.56	2.90	3.25	9.31	3.15	8.90	3.86	2.93	1.03	2.37	42.57
1894	0.83	1.22	1.34	1.19	7.56	4.12	3.97	2.37	4.15	14.03	6.50	4.40	51.68
1895	2.15	0.65	1.65	0.56	4.37	1.56	3.75	5.90	8.06	9.56	6.09	15.06	59.36
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	2.53	0.50	0.59	1.97	14.50	1.88	3.16	1.31	2.56	4.44	5.03	2.59	41.06
1898	1.78	0.19	2.25	1.22	4.59	2.28	9.66	4.03	5.75	10.66	5.00	3.84	51.25
1899	3.28	1.28	1.88	0.69	1.72	4.34	2.66	8.41	7.50	4.62	7.66	0.84	44.88
1900	4.09	0.91	1.78	5.09	1.00	11.00	5.38	2.97	5.88	5.97	2.34	3.31	49.72
1901	3.06	1.56	2.34	1.22	2.50	8.75	12.59	2.53	7.78	9.38	6.12	3.06	60.91
1902	4.41	0.06	1.66	3.16	10.78	9.06	2.06	2.25	2.06	2.75	6.97	5.25	50.47
1903	1.81	0.97	0.53	2.84	1.53	3.34	4.00	5.75	5.56	5.41	5.59	6.28	43.62
1904	1.03	1.62	3.88	0.91	2.91	1.88	2.50	3.34	4.38	6.84	1.97	2.22	33.47
1905	4.50	1.81	1.59	2.28	6.53	2.00	3.91	7.28	3.09	7.66	4.62	1.75	47.03
1906	0.94	1.81	2.94	0.59	6.38	3.50	5.22	0.81	10.09	3.28	3.31	5.94	44.81
1907	1.06	2.66	0.75	0.50	3.81	3.62	2.91	2.62	2.53	6.50	2.62	5.88	35.47
1908	2.25	3.22	1.91	1.25	3.12	2.47	3.81	5.16	4.78	6.00	8.15	6.31	48.41
1909	4.03	5.00	4.09	1.28	2.00	7.72	2.56	10.50	3.03	9.53	8.56	3.06	61.35
1910	3.88	1.75	4.75	1.25	1.53	0.88	4.06	8.31	11.72	2.22	2.78	3.69	46.81
1911	4.25	2.94	1.12	3.06	8.50	0.50	4.59	1.94	2.94	4.56	6.06	12.16	52.63
1912	3.31	1.84	2.38	1.56	—	4.84	2.41	2.22	2.94	8.62	8.78	3.14	(42.06)
1913	3.74	3.56	4.06	2.84	4.62	2.36	2.47	2.58	4.41	6.25	3.22	2.31	42.43
1914	1.28	3.97	0.72	2.12	6.34	4.09	1.50	4.06	2.72	3.19	10.47	4.50	44.97
1915	2.41	2.38	1.19	5.81	5.27	3.97	3.34	5.00	3.72	5.72	6.88	2.97	48.67
1916	2.66	1.94	2.59	0.62	6.72	6.36	4.25	6.78	4.22	†18.36	7.68	0.56	62.72
1917	1.84	0.47	1.16	0.47	3.29	5.03	3.09	2.75	—	—	—	—	—
Total	97.73	84.20	72.52	92.53	181.34	190.85	161.52	194.68	199.57	246.34	218.07	141.29	—
No. Years	38	40	40	40	39	40	40	40	39	38	38	38	—
Means	2.57	2.10	1.81	2.31	4.65	4.77	4.04	4.87	5.12	6.48	5.74	3.72	48.18

* This is the total for all 12 months of 1888.
† Over 7.5 inches fell in the storm of October 10; the amount was partly estimated as the gage was blown over during the storm.

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 5 (continued)

I. Days with Rain at Cruz Bay (Christiansfort), Station B

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1877	—	10	10	13	14	23	25	14	20	23	17	21	(190)
1878	18	11	9	9	11	15	22	18	18	16	17	13	177
1879	12	9	11	15	18	18	21	15	15	15	18	13	180
1880	15	8	3	5	17	10	11	16	13	16	18	9	141
1881	9	7	6	6	10	20	12	16	14	16	16	12	144
1882	6	10	5	2	8	7	16	14	17	12	17	13	127
1883	19	20	8	9	8	13	14	11	9	17	18	15	161
1884	18	13	15	6	10	18	17	13	23	16	18	20	181
1885	16	5	7	9	2	12	12	15	13	12	13	11	127
1886	6	14	4	12	8	13	17	21	16	18	20	12	161
1887	18	14	5	6	7	17	12	22	14	17	17	9	158
1888	12	8	7	14	12	10	14	14	13	—	—	—	—
1889	—	12	6	12	21	19	15	13	13	10	21	14	(156)
1890	19	17	16	15	11	9	13	14	12	15	16	15	172
1891	15	22	1	7	14	12	15	16	19	15	16	15	238
1892	12	6	7	11	10	10	14	17	12	17	16	11	143
1893	10	18	5	14	13	11	16	14	13	12	14	20	160
1894	12	15	12	10	16	15	17	13	21	15	23	14	183
1895	13	8	9	7	14	11	16	16	20	15	15	22	166
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	8	4	7	13	20	9	16	10	12	15	15	14	143
1898	15	5	6	9	14	8	20	24	17	23	15	21	177
1899	21	12	15	7	12	21	17	14	14	16	20	8	177
1900	19	8	7	9	10	20	18	16	16	22	19	14	178
1901	12	10	15	7	14	17	19	19	20	14	9	14	170
1902	12	2	12	15	15	19	20	11	16	18	20	16	176
1903	14	14	7	10	10	15	16	17	17	16	17	20	173
1904	11	12	19	8	12	10	8	14	18	16	14	17	159
1905	17	17	13	9	20	8	14	15	17	19	17	14	180
1906	13	13	10	7	18	19	21	7	20	18	13	23	182
1907	14	13	9	6	11	14	17	16	17	12	15	23	167
1908	18	21	19	14	6	11	15	14	20	5	17	16	176
1909	14	18	12	7	11	21	20	21	15	18	18	11	186
1910	19	16	9	5	11	12	17	18	12	12	10	16	157
1911	17	9	9	9	22	8	15	10	15	16	23	23	176
1912	17	6	16	13	—	9	10	13	9	13	20	18	(144)
1913	21	12	24	10	15	13	17	9	11	15	9	14	170
1914	7	14	7	10	17	13	12	16	16	13	20	19	164
1915	7	8	6	11	11	11	18	9	18	17	14	10	140
1916	19	13	8	5	17	17	17	13	14	20	20	8	171
1917	12	6	10	5	13	20	18	11	—	—	—	—	—
Total	524	460	386	371	503	558	644	589	609	595	635	578	—
No. Years	38	40	40	40	39	40	40	40	39	38	38	38	—
Means	13.8	11.5	9.6	9.3	12.9	14.0	16.1	14.7	15.6	15.7	16.7	15.2	165.1

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

J. Rainfall at Eden Parcel (of Emmaus Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	—	—	*0.73	1.11	3.17	1.87	1.37	6.22	1.92	2.36	6.38	1.58	—
1893	0.91	2.11	0.90	1.58	4.64	11.65	2.90	8.12	3.86	5.28	0.29	1.13	43.37
1894	0.99	0.48	0.42	0.48	6.31	3.58	4.70	2.45	3.05	10.88	4.64	7.22	46.20
1895	2.55	0.40	0.94	0.12	7.64	1.76	3.27	5.02	8.28	7.06	6.11	14.94	58.09
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	3.24	0.19	0.50	2.97	14.06	2.22	3.09	1.17	4.72	4.42	3.00	2.61	42.19
1898	1.56	0.86	0.58	0.86	4.59	0.66	6.62	2.22	7.12	9.05	4.42	3.33	41.88
1899	1.83	0.44	1.22	1.17	0.92	5.97	1.80	8.09	5.72	3.24	9.59	0.78	40.77
1900	2.45	0.48	0.84	4.69	1.00	10.20	3.70	3.05	5.62	5.69	0.59	2.34	40.68
1901	2.84	0.62	1.74	1.05	2.25	4.42	11.42	2.28	9.75	6.78	7.00	3.56	53.72
1902	3.78	0.25	1.09	2.22	11.94	6.98	2.31	0.83	1.70	2.11	5.70	3.14	42.07
1903	1.47	0.64	0.55	0.86	0.79	5.22	4.06	2.86	4.03	5.25	4.19	5.53	35.44
1904	1.94	1.86	3.12	2.39	2.50	1.70	2.31	2.91	4.52	9.67	1.97	2.34	37.22
1905	3.11	1.67	0.25	1.72	9.00	1.25	2.24	7.05	4.59	6.45	3.78	1.00	42.11
1906	0.92	0.94	1.14	0.31	1.89	4.75	5.31	0.91	13.20	3.38	2.45	4.45	39.66
1907	0.98	1.09	0.36	0.59	7.66	4.06	3.11	1.62	2.31	4.77	2.72	5.50	34.78
1908	2.67	2.86	3.25	0.30	4.62	1.77	1.77	4.02	4.45	2.77	5.45	7.31	41.24
1909	2.31	3.81	1.59	1.38	1.11	8.14	1.84	8.41	3.86	5.25	14.33	1.77	53.80
1910	3.19	0.67	4.17	0.38	0.36	0.75	3.72	6.25	11.22	1.74	3.89	5.24	41.57
1911	3.67	2.70	2.88	3.42	7.94	1.02	3.47	2.98	2.02	6.53	4.31	13.58	54.53
1912	1.75	1.92	2.24	0.55	—	2.42	2.59	2.50	1.31	8.27	8.94	3.08	(35.57)
1913	1.75	1.97	2.50	2.06	2.34	2.22	1.14	2.21	2.00	5.16	[1.25]	1.44	[26.04]
1914	1.28	3.98	0.62	1.84	6.25	—	—	3.05	0.74	2.47	9.83	—	—
1915	0.84	1.24	1.66	5.66	7.02	4.62	1.55	3.56	1.38	6.94	7.86	3.86	46.18
1916	3.31	1.06	1.61	0.38	9.31	6.95	6.14	[7.50]	6.31	20.47	5.16	0.30	[68.50]
1917	—	0.62	0.25	0.67	2.02	2.94	2.64	2.14	—	—	—	—	—
Total	49.37	32.89	35.15	38.75	119.33	97.14	83.09	97.41	113.70	145.98	123.86	96.02	—
No. Years	23	24	25	25	24	24	24	25	24	24	24	23	—
Means	2.15	1.37	1.41	1.55	4.97	4.05	3.46	3.89	4.74	6.08	5.16	4.13	42.96

* The gage was brought to Eden from Emmaus on March 9, but the rainfall for the first 9 days is included here.
Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

K. Days with Rain at Eden Parcel (of Emmaus Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1892	—	—	6	7	9	6	6	8	5	8	9	4	—
1893	3	6	1	8	10	6	6	4	13	7	2	5	71
1894	7	4	3	3	13	6	10	7	7	8	9	10	87
1895	10	4	4	1	10	5	10	9	13	8	9	13	96
1896	—	—	—	—	—	—	—	—	—	—	—	—	—
1897	8	1	2	3	19	5	9	6	8	10	8	7	86
1898	6	3	2	5	10	4	11	11	10	10	10	13	95
1899	9	3	3	4	4	15	7	10	11	8	17	4	95
1900	11	4	3	4	6	12	10	10	11	10	3	9	93
1901	5	2	4	3	9	10	12	10	11	13	11	11	101
1902	8	1	4	5	10	9	7	7	11	11	12	9	94
1903	7	3	5	6	5	13	8	10	10	13	12	17	109
1904	8	10	12	9	9	4	6	13	10	13	7	12	113
1905	16	10	2	5	15	5	9	9	13	14	8	8	114
1906	8	4	4	3	9	14	11	5	15	11	5	13	102
1907	8	7	4	3	4	11	12	6	7	10	8	18	98
1908	10	14	14	3	4	5	6	7	12	5	10	10	100
1909	8	9	5	7	7	14	7	11	7	13	10	5	103
1910	15	7	7	3	3	5	10	15	10	6	7	12	100
1911	14	6	7	7	12	6	11	8	10	12	14	21	128
1912	9	3	11	3	—	6	5	8	5	6	15	8	(78)
1913	8	7	8	4	3	6	3	7	2	8	[4]	6	[66]
1914	4	5	3	6	11	—	—	11	4	8	15	—	—
1915	3	4	3	8	8	8	9	8	4	14	10	11	90
1916	11	2	2	1	11	10	10	[11]	11	15	14	2	[100]
1917	—	3	2	2	3	10	11	5	—	—	—	—	—
Total	196	122	121	113	204	195	206	216	220	241	229	228	—
No. Years	23	24	25	25	24	24	24	25	24	24	24	23	—
Means	8.5	5.1	4.8	4.5	8.5	8.1	8.6	8.6	9.2	10.0	9.5	9.9	95.3

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 5 (continued)

L. Rainfall at Emmaus Estate (Moravian Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	—	—	—	—	0.61	2.47	2.68	11.99	2.20	9.67	3.41	7.27	—
1886	2.89	2.67	0.72	10.21	3.33	2.73	3.64	5.44	7.67	7.44	7.52	3.02	57.28
1887	[3.50]	3.23	0.58	1.34	9.93	5.50	3.69	8.48	3.66	3.14	8.33	1.61	[52.97]
1888	2.08	0.64	0.43	2.56	1.67	6.94	3.33	4.90	7.78	—	—	—	—
1889	—	2.37	1.28	5.20	10.27	11.79	2.52	2.77	11.37	4.84	4.80	2.84	(60.05)
1890	3.14	2.89	2.95	4.18	1.31	1.69	1.70	1.48	2.48	2.11	2.36	3.27	29.56
1891	2.33	2.80	0.68	1.75	5.77	5.23	4.89	5.69	4.81	9.34	6.09	2.48	51.86
1892	1.39	1.44	*—	—	—	—	—	—	—	—	—	—	—
Total	15.33	16.04	6.64	25.24	32.89	36.35	22.45	40.75	39.97	36.54	32.51	20.49	—
No. Years	6	7	6	6	7	7	7	7	7	6	6	6	—
Means	2.56	2.29	1.11	4.21	4.70	5.19	3.21	5.82	5.71	6.09	5.42	3.42	49.73

* The gage was transferred to Eden Parcel of Emmaus Mission on March 9, 1892; the rainfall for the first 9 days of March is included in the total for Eden for March.

M. Days with Rain at Emmaus Estate (Moravian Mission)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1885	—	—	—	—	4	11	8	9	15	18	16	16	—
1886	8	9	6	10	8	8	11	11	13	13	13	9	119
1887	[15]	12	7	8	11	12	5	13	11	10	12	6	[122]
1888	8	6	4	11	9	16	14	11	15	—	—	—	—
1889	—	6	4	6	15	11	8	6	12	10	15	9	(102)
1890	8	6	11	8	3	8	8	6	11	11	10	14	94
1891	9	12	2	5	14	10	11	7	14	13	14	10	121
1892	5	3	—	—	—	—	—	—	—	—	—	—	—
Total	53	54	34	48	64	76	65	63	91	75	80	64	—
No. Years	6	7	6	6	7	7	7	7	7	6	6	6	—
Means	9	8	6	8	9	11	9	9	13	12	13	11	118

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

APPENDIX TABLE 5 (continued)

N. RAINFALL AT SUSANNABERG ESTATE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1900	—	—	—	—	—	—	—	2.44	5.25	4.19	1.31	3.06	—
1901	3.19	1.12	2.12	1.00	2.55	6.19	9.94	2.00	8.12	10.75	7.06	2.69	56.73
1902	[4.38]	0.12	1.56	2.75	10.06	7.81	2.19	1.62	1.12	2.62	6.69	4.19	[45.13]
1903	1.81	0.88	0.69	1.06	1.06	4.50	3.36	4.88	3.88	5.00	2.44	6.50	36.10
1904	1.06	1.19	3.31	1.00	1.20	1.38	2.03	3.31	3.56	5.62	0.94	1.69	26.30
1905	3.88	2.12	0.25	1.50	5.44	1.00	1.75	4.31	3.19	5.75	4.56	1.19	34.94
1906	0.50	0.88	2.56	0.88	3.81	3.62	5.00	0.31	11.88	2.00	2.56	8.00	42.00
1907	0.62	2.19	0.00	0.50	4.50	3.81	2.62	1.00	0.56	4.00	1.72	3.88	25.41
1908	1.59	1.19	1.50	0.50	3.25	1.94	1.62	4.88	4.19	3.75	4.75	4.94	34.09
1909	1.38	3.25	2.44	1.25	1.38	6.75	1.25	8.56	1.94	4.75	9.12	2.94	45.00
1910	2.56	0.62	4.25	0.62	1.25	0.94	3.69	6.38	12.06	1.12	3.25	4.50	41.25
1911	3.25	3.19	0.94	5.06	8.50	0.12	3.19	1.81	1.81	3.67	4.38	15.50	51.42
1912	2.81	3.00	1.75	2.25	—	3.75	1.94	1.94	2.75	6.00	8.88	2.62	(37.69)
1913	2.12	2.00	2.50	2.19	3.06	1.38	0.56	1.00	3.12	5.62	1.12	1.75	26.44
1914	—	—	0.00	1.62	5.94	3.00	0.88	3.00	0.12	1.06	9.50	3.38	—
1915	1.19	0.44	0.50	6.38	8.44	3.62	1.77	3.06	2.38	2.25	6.88	[2.75]	[39.64]
1916	2.88	1.12	1.38	—	7.12	6.25	—	3.78	3.19	23.16*	—*	0.69	—
1917	2.94	0.75	1.12	—	2.19	4.83	2.67	1.88	—	—	—	—	—
Total	36.16	24.06	26.86	28.56	69.75	60.89	44.45	56.16	69.13	91.33	75.16	70.25	—
No. Years	16	16	17	15	16	17	16	18	17	17	16	17	—
Means	2.26	1.50	1.58	1.90	4.36	3.58	2.78	3.12	4.07	5.37	4.70	4.13	39.35

* Gage pan blown away about end of October 1916; found November 1; sent to St. Thomas for repairs; and reinstalled November 19.
Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 5 (continued)

O. Days with Rain at Susannaberg Estate

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1900	—	—	—	—	—	—	—	10	11	9	6	9	—
1901	6	4	3	7	11	13	16	8	13	20	14	9	124
1902	[9]	1	7	11	12	14	14	7	8	11	14	12	[120]
1903	5	8	5	6	8	12	10	10	8	11	6	14	103
1904	8	5	11	8	9	7	6	12	13	15	4	9	107
1905	9	7	2	3	14	4	6	4	9	10	6	7	81
1906	2	5	7	3	9	10	11	2	15	6	7	17	94
1907	3	6	0	2	5	8	8	5	3	7	7	20	74
1908	9	8	8	7	4	7	5	9	10	8	8	9	92
1909	5	7	4	4	7	11	5	11	7	10	13	7	91
1910	10	2	6	3	6	5	11	10	11	6	6	10	86
1911	8	7	3	9	13	2	12	8	7	9	10	16	104
1912	8	7	4	9	—	5	6	5	6	7	22	9	(88)
1913	8	3	12	9	8	5	3	5	4	7	8	4	76
1914	—	—	0	5	7	8	5	11	2	5	14	10	—
1915	7	2	2	7	10	8	7	4	12	9	11	[8]	[87]
1916	9	4	5	—	13	13	—	4	7	19	—	5	—
1917	8	4	5	—	7	12	11	7	—	—	—	—	—
Total	114	80	84	93	143	144	136	132	146	169	156	175	—
No. Years	16	16	17	15	16	17	16	18	17	17	16	17	—
Means	7.1	5.0	4.9	6.2	8.9	8.5	8.5	7.3	8.6	9.9	9.8	10.3	95.0

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 6

Monthly Average and Extreme Rainfall and Days with Rain, American Period 1917–41

A. Currently Operated Stations*

Average Monthly Rainfall

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Charlotte Amalie Estate	3.11	2.09	1.68	2.10	4.02	2.73	3.62	4.44	5.92	5.82	5.17	3.08	44.79
Charlotte Amalie (Custom House)	3.13	2.21	2.20	2.32	4.15	3.07	3.71	4.27	5.52	5.87	6.13	3.14	45.72
Cruz Bay	2.30	1.92	1.91	1.86	5.01	2.71	3.71	4.27	5.66	5.40	5.07	3.14	42.96
Bonne Esperance (St. Thomas)	3.09	2.53	2.07	3.48	5.75	3.90	4.27	5.64	6.20	6.25	6.51	4.30	53.99
Annaly	3.25	2.52	2.25	2.99	4.65	3.58	4.66	5.74	7.23	7.65	5.91	3.61	54.04
Christiansted Fort	1.43	0.96	0.88	1.59	2.74	1.95	2.72	2.38	2.60	3.91	5.98	1.86	29.00
Anna's Hope	2.86	1.84	1.96	1.93	3.52	2.67	3.39	4.28	6.66	6.41	5.64	2.95	44.11
Jolly Hill	3.05	2.28	2.02	2.46	4.76	3.35	4.38	4.89	6.47	6.66	6.39	3.97	50.68
King's Hill	2.57	2.01	1.68	1.83	3.62	3.12	3.43	3.91	5.70	5.43	5.65	2.86	41.81
Wintberg	1.64	2.16	1.76	4.36	4.68	1.83	3.10	4.66	4.13	4.12	5.43	2.52	40.39

Days with Rain

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Charlotte Amalie Estate	15	11	10	9	11	12	13	14	13	15	15	14	152
Charlotte Amalie (Custom House)	19	14	13	13	15	16	17	19	18	18	19	19	200
Cruz Bay	15	11	11	9	13	13	15	16	15	15	15	16	164
Bonne Esperance (St. Thomas)	9	6	6	5	7	7	7	9	9	10	9	9	93
Annaly	16	12	13	11	12	13	14	15	14	15	15	16	166
Christiansted Fort	6	5	6	5	11	8	11	12	9	12	15	10	110
Anna's Hope	15	11	10	9	11	13	12	14	14	16	15	14	154
Jolly Hill	19	14	12	10	12	15	16	18	17	18	19	20	190
King's Hill	9	7	7	5	7	9	10	11	10	12	11	10	108
Wintberg	11	10	12	13	16	14	16	16	16	18	20	16	178

* Periods: Charlotte Amalie Estate, Jan. 1920–Dec. 1940; Charlotte Amalie (Custom House), July 1917–Dec. 1940; Cruz Bay, Jan. 1920–Dec. 1940; Bonne Esperance, Sept. 1929–Dec. 1940; Annaly, Jan. 1920–Feb. 1940; Christiansted Fort, Oct. 1937–Dec. 1941; Anna's Hope, Jan. 1920–Dec. 1940; Jolly Hill, Jan. 1920–Dec. 1940; King's Hill, Jan. 1920–Dec. 1940; Wintberg, July 1938–Dec. 1941. (*Note:* Charlotte Amalie Estate data were actually from Anna's Retreat, nearby, until 1938.)

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
GREATEST RAINFALL IN 24 HOURS													
Charlotte Amalie Estate	2.13	1.73	1.22	4.00	4.25	2.42	5.05	7.31	13.00	4.15	3.54	2.88	13.00
Charlotte Amalie (Custom House)	2.33	1.45	1.50	4.20	7.28	3.41	5.28	4.65	10.02	4.15	3.55	2.12	10.02
Cruz Bay	2.25	1.95	1.85	3.20	7.30	2.06	4.80	6.60	7.50	4.00	2.37	2.00	7.50
Bonne Esperance (St. Thomas)	2.13	2.35	1.40	7.70	4.58	3.58	3.90	2.20	4.47	3.50	4.20	2.90	7.70
Annaly	2.00	1.53	1.59	4.15	5.20	2.75	5.37	5.73	5.33	5.62	3.43	2.36	5.73
Christiansted Fort	1.13	0.70	0.40	2.29	1.04	0.84	2.43	1.25	1.25	1.50	2.75	0.92	2.43
Anna's Hope	2.02	1.64	2.18	4.10	5.33	3.60	3.10	7.42	8.50	6.00	3.15	2.78	8.50
Jolly Hill	3.81	2.37	2.13	4.73	4.69	3.14	4.01	3.35	5.00	4.49	4.83	2.64	5.00
King's Hill	2.00	2.10	1.40	2.60	4.78	2.26	3.64	4.05	7.00	6.00	5.58	1.80	7.00
Wintberg	0.83	1.01	0.75	4.62	1.55	1.60	1.09	2.97	1.69	1.43	3.02	1.16	4.62
GREATEST MONTHLY RAINFALL													
Charlotte Amalie Estate	11.32	4.73	2.87	7.89	12.04	8.02	8.19	10.92	22.10	11.49	10.97	7.14	64.77
Charlotte Amalie (Custom House)	11.31	4.80	4.33	6.38	19.99	9.33	7.98	9.81	18.78	12.07	12.50	7.46	68.67
Cruz Bay	3.86	4.72	4.14	8.52	20.67	7.83	7.30	10.33	18.62	10.82	13.27	6.33	66.08
Bonne Esperance (St. Thomas)	11.74	5.58	4.39	7.70*	10.70	10.56	8.50	9.25	12.94	13.32	13.79	8.52	78.56
Annaly	6.45	5.33	4.25	7.57	18.55	12.71	9.14	17.44	12.82	12.64	12.92	6.52	79.14
Christiansted Fort	2.32	2.14	1.18	2.81	5.20	3.15	5.60	2.76	3.22	5.86	11.86	3.31	34.14
Anna's Hope	8.91	3.53	3.94	6.87	9.60	7.88	9.20	19.79	14.62	13.08	12.11	4.77	67.59
Jolly Hill	4.81	4.89	5.24	7.01	18.11	10.48	7.86	12.91	16.09	10.92	14.03	6.35	82.53
King's Hill	7.59	5.42	3.46	6.08	15.27	10.33	7.45	12.24	18.95	9.56	13.61	4.77	65.73
Wintberg	2.14	4.57	2.73	6.26	6.68	2.80	4.20	6.93	5.12	5.20	7.95	4.02	40.24
LEAST MONTHLY RAINFALL													
Charlotte Amalie Estate	0.89	0.35	0.79	0.18	0.35	1.31	1.38	1.36	2.62	2.66	0.85	1.00	32.47
Charlotte Amalie (Custom House)	1.14	0.56	0.34	0.48	0.40	0.80	0.98	1.64	3.20	2.15	2.36	0.72	32.67
Cruz Bay	0.80	0.36	0.58	0.17	0.17	0.44	1.49	1.45	0.94	2.65	1.27	0.78	31.47
Bonne Esperance (St. Thomas)	1.25	0.50	0.89	0.84	1.41	1.30	1.98	2.58	1.91	2.95	3.10	1.93	41.49
Annaly	0.77	0.50	0.79	0.13	0.34	1.05	1.28	2.88	2.69	4.02	0.93	1.25	38.97
Christiansted Fort	0.46	0.04	0.63	0.81	0.96	1.01	0.71	2.01	1.97	3.25	2.74	0.79	19.00
Anna's Hope	1.09	0.61	0.42	0.05	0.36	0.94	1.16	1.24	2.94	2.05	1.65	1.26	31.58
Jolly Hill	1.11	0.96	0.55	0.19	0.57	0.52	1.43	1.44	2.60	2.83	1.87	1.52	29.28
King's Hill	0.91	0.71	0.55	0.00	0.21	1.17	0.85	1.25	1.90	1.42	1.60	0.89	28.75
Wintberg	1.69	0.08	1.22	3.02	1.03	1.09	2.59	2.44	2.64	2.97	2.74	1.15	37.32

* All fell on one day — see "Greatest Rainfall in 24 hours".

Appendix Table 6 (continued)

B. Closed Stations

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
St. Croix													
Bonne Esperance													
Average 1922–36	2.92	1.70	1.83	2.05	3.90	3.12	3.82	4.32	6.79	6.20	5.89	2.68	45.22
Highest monthly	5.70	4.01	3.40	7.10	11.70	9.27	8.08	14.02	21.32	11.00	14.90	4.61	66.94
Lowest monthly	0.35	0.28	0.68	0.68	0.31	1.36	0.97	1.47	3.48	2.26	1.36	0.70	30.70
Greatest in 24 hrs.	3.40	1.90	1.22	4.00	4.50	2.70	6.60	4.46	11.57	6.50	6.40	2.35	11.57
Average days with rain	7.7	5.3	4.4	5.0	5.2	6.8	6.4	7.9	6.9	8.4	9.0	8.1	81.10
Christiansted													
Average 1920–34	2.69	1.39	1.66	2.08	4.36	2.62	3.23	4.70	6.71	5.66	5.37	2.48	42.95
Highest monthly	5.79	2.55	3.06	9.26	6.72	9.01	5.40	18.72	18.69	11.16	13.68	3.93	68.58
Lowest monthly	0.85	0.59	0.36	0.61	0.43	1.23	1.44	0.72	1.77	1.83	0.72	1.26	25.56
Greatest in 24 hrs.	1.50	0.96	1.05	7.84	4.09	2.04	2.13	5.82	7.80	6.44	2.64	1.86	7.84
Average days with rain	11.7	7.5	8.2	7.0	9.7	10.1	10.5	12.5	11.3	12.5	12.4	10.6	124.0
St. John													
America Hill													
Average 1920–32	2.79	2.61	2.07	3.35	4.29	3.86	3.92	6.92	5.88	7.32	5.81	2.83	51.65
Highest monthly	5.42	5.15	6.13	13.47	8.24	11.35	6.05	31.24	15.79	14.53	12.31	5.72	80.21
Lowest monthly	0.90	1.45	0.60	0.46	0.98	0.99	1.43	1.96	2.40	1.04	2.02	0.71	34.57
Greatest in 24 hrs.	2.35	1.80	4.00	5.55	7.35	3.20	3.05	20.40	10.00	4.85	3.92	1.55	20.40
Average days with rain	8.9	8.0	7.7	6.2	8.0	9.0	9.7	9.8	9.8	12.0	15.4	9.6	114.10
Adrian Estate													
Average rainfall													
1935				1.01	5.36	5.03	2.68	3.19	3.62	4.82	3.10	0.23	
1936	0.23	0.19	0.50										
Days with rain													
1935				2	10	14	15	18	14	27	17	11	
1936	3	6	4										
Greatest in 24 hrs.	0.10	0.07	0.31	0.68	2.33	2.04	1.02	0.52	1.00	0.60	1.45	0.07	
St. Thomas													
Canaan Estate													
Average 1923–27	3.12	2.18	2.15	5.72	2.00	2.62	3.87	4.78	5.89	8.02	6.35	2.87	49.57
Greatest in 24 hrs.	1.54	1.64	1.20	15.02	0.68	1.03	2.30	1.00	3.30	3.50	4.20	1.48	15.02
Average days with rain	19	15	13	13	12	16	16	16	11	15	15	11	172
Mosquito Bay													
Average rainfall													
1924										4.56	12.89	3.29	—
1925	2.37	0.37	3.50	2.48	2.53	1.78	3.07	1.87	5.99	6.18	6.10	0.97	37.21
1926	1.83	1.71	3.45	0.53									—
Greatest in 24 hrs.	0.60	0.30	1.34	0.78	0.65	0.48	0.80	0.50	2.00	1.39	5.41	0.85	2.00
Days with rain													
1924										16	16	20	—
1925	15	6	18	8	13	14	15	12	12	19	19	7	158
1926	9	13	11	5									—

Appendix Table 6 (continued)

C. Average Rainfall per Rainy Day*

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Annaly	.20	.20	.17	.28	.41	.26	.33	.44	.51	.50	.33	.21	.32
Anna's Hope	.19	.17	.19	.22	.36	.21	.31	.31	.53	.42	.36	.22	.30
Jolly Hill	.15	.18	.20	.26	.40	.22	.31	.28	.39	.38	.31	.19	27
King's Hill	.32	.31	.24	.37	.59	.35	.38	.41	.61	.51	.51	.31	.42
Bonne Esperance (S. Thos.)	.37	.38	.35	.57	.92	.60	.62	.58	.67	.66	.67	.47	.57
Anna's Retreat	.20	.20	.15	.29	.39	.22	.28	.33	.49	.42	.35	.21	.29
Cruz Bay	.14	.17	.17	.22	.39	.21	.23	.26	.38	.39	.34	.19	.26
Christiansted	.23	.19	.20	.30	.45	.26	.31	.38	.59	.45	.43	.23	.35

* These figures were computed by dividing the average total in inches by the average number of rainfall days, for the same period of years in each case. The periods used were: Annaly, 1920–34; Anna's Hope, 1920–35; Jolly Hill, 1920–35; King's Hill, 1920–35; Bonne Esperance (S. Thos.), 1929–38; Anna's Retreat, 1920–35; Cruz Bay, 1920–35; Christiansted, 1920–34.

D. British Stations

Stations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Tortola													
St. Bernard's 1831–33	2.05	1.96	2.75	3.06	5.09	6.62	7.95	10.70	10.35	7.27	4.06	3.87	65.73
Experiment Station													
Average 1921–35	3.75	2.59	2.64	3.24	5.56	3.96	4.19	5.71	6.50	6.84	6.70	3.62	55.30
Average 1901–20	2.95	2.97	2.47	2.35	4.76	4.56	3.94	3.97	4.95	6.71	7.35	5.36	52.34
Average days with rain 1921–35	16	11	10	8	12	14	14	14	15	15	16	14	160
Average rain per rainy day 1921–35	.23	.24	.26	.41	.46	.28	.30	.41	.43	.46	.42	.26	.35
Virgin Gorda													
Spanishtown (Rev. J. J. Haddock) Average (12 yrs. 1909–20?)	2.10	2.40	1.28	1.59	3.12	3.15	2.09	3.23	3.64	4.51	5.69	3.53	36.33

Appendix Table 7

Average Monthly Rainfall for Estates in the Sugar Area of St. Croix, 1921–30*

Estate	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Adventure	1.72	1.91	1.33	2.24	3.82	1.41	2.34	4.41	4.69	4.91	4.98	2.74	37.46
Anguilla	2.07	2.22	1.03	2.17	3.18	2.04	2.61	4.83	5.41	4.83	4.81	2.36	38.88
Annaly	3.63	3.91	2.33	4.09	6.90	2.74	4.32	5.62	5.38	7.99	7.06	4.52	59.77
Anna's Hope	2.46	2.35	2.25	2.28	4.67	2.19	3.16	4.81	4.80	5.63	4.70	2.79	41.63
Barren Spot	2.07	2.71	1.75	2.36	5.06	2.17	2.87	3.69	5.64	5.24	4.78	2.73	41.24
Bethlehem (Old Works)	2.18	2.80	1.48	2.56	4.70	1.86	2.76	4.78	6.64	5.56	4.85	3.31	44.85
Bethlehem (New Works)	1.74	2.33	1.54	2.61	4.23	1.46	2.70	4.22	6.43	5.36	5.62	2.56	40.94
Betty's Hope	1.54	1.75	1.13	2.09	3.54	1.67	2.18	3.48	4.49	4.13	4.08	2.51	33.18
Bonne Esperance	2.15	2.27	2.06	2.32	3.74	3.26	3.06	3.85	6.15	6.52	4.83	3.14	41.90
Canaan	2.78	2.59	1.91	3.38	7.81	3.06	2.06	2.22	3.91	6.59	5.12	5.78	47.20
Christiansted	2.73	1.56	1.67	1.48	2.58	1.96	3.14	4.36	6.34	4.93	4.59	2.43	37.41
Fountain	2.67	2.82	1.33	3.37	3.33	1.92	3.36	4.38	5.02	6.17	6.70	3.47	46.90
Fredensborg	2.04	2.45	1.32	2.35	3.55	2.53	3.01	3.99	6.25	5.38	4.99	2.16	40.46
Frederiksted (Prosperity Estate)	2.67	2.41	2.48	2.30	3.83	3.32	4.55	4.61	7.13	5.96	6.57	3.68	49.51
Glynn	1.68	2.08	1.35	1.90	4.70	1.80	2.78	3.45	5.30	5.40	5.27	2.79	39.31
Golden Grove	2.16	2.37	1.41	2.37	4.88	1.32	2.51	4.42	5.51	4.42	4.73	3.00	44.29
Jealousy	1.85	2.25	1.44	2.60	5.54	2.06	2.82	3.38	4.52	4.92	5.76	2.74	42.29
King's Hill	3.13	2.89	2.79	2.37	3.24	3.15	4.04	4.65	5.30	6.07	5.71	3.61	46.95
Lower Love	2.27	2.53	1.44	2.31	4.82	1.83	2.11	3.62	4.60	4.52	4.58	2.83	36.94
Manning Bay	2.05	2.18	1.13	2.17	3.42	1.58	2.70	2.53	6.08	5.30	4.40	2.33	39.53
Mt. Pleasant	2.45	2.13	1.64	2.72	4.73	1.80	2.37	4.02	4.80	5.13	5.18	2.71	33.95
River	1.87	2.17	1.49	3.04	4.99	1.47	3.22	3.88	5.96	5.90	5.48	3.14	43.63
St. Georges	1.31	1.46	1.07	1.68	2.56	1.23	2.40	4.98	5.22	3.92	4.43	1.56	33.10
Slob	1.82	2.39	1.63	2.28	4.54	1.85	2.88	4.00	5.95	5.66	4.91	2.61	41.63
Strawberry	2.69	2.41	1.50	2.04	4.78	1.89	2.66	3.51	5.37	4.79	4.02	4.59	37.75
Two Friends	2.52	1.77	1.02	2.56	3.81	1.58	3.08	5.31	5.68	5.04	5.48	2.48	42.64
Average	2.22	1.60	1.60	2.45	4.42	2.03	2.91	4.12	5.49	5.36	5.14	3.03	41.67

* Compiled from manuscript records at the Experiment Station, by E. B. Shaw. The returns for 1911–20 and 1931–40 are available in manuscript at the Experiment Station, Anna's Hope.

Appendix Table 8

Water Loss by Evaporation from Standard Weather Bureau Pan, Experiment Station, St. Croix*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1920	4588	4921	6387	7360	6895	7340	7958	7190	6338	6205	4577	4473	74232
1921	4476	5154	7547	7876	8255	7898	7474	7163	5672	5082	5154	3453	75204
1922	4897	4966	6116	7629	9252	7877	8023	8427	7158	5517	4896	4409	79167
1923	5120	5597	7450	6862	9335	7402	8491	7569	7371	7252	5521	5551	83521
1924	5747	5017	6818	7559	8165	7282	7829	7072	6009	5667	3882	4337	75384
1925	4604	4570	6144	6273	7775	6683	7007	6718	5596	5810	4517	4003	69700
1926	5180	5093	6344	8315	7268	6202	6230	6009	6075	5409	4517	4801	71443
1927	4106	4801	6172	6462	4638	5989	6420	8525	5943	5657	3407	(6000)	68120
1928	(5000)	(5000)	6797	7327	6473	6766	6897	6639	4920	5494	3896	4210	69419
1929	4692	(5448)	6048	6611	5474	5956	6222	5770	6468	4796	4015	4148	65648
1930	4160	4486	6067	6947	6117	6604	7189	(7000)	(6000)	6147	5663	4522	70902
1931	4645	5203	6595	7460	5891	5536	6838	6105	5089	4666	3660	4262	65950
1932	5080	5455	6779	6607	6692	6692	6710	6802	6005	5934	4582	4627	71965
1933	4476	5534	6285	6561	6612	6360	6309	6433	5576	5081	4348	4050	67625
1934	4739	4677	5947	6501	6942	6349	7237	7427	7131	6818	7329	7112	78209
1935	5433	4835	6815	7130	7058	6965	7853	6566	6494	4996	4197	5794	78135
1936	6603	6215	6271	6759	6029	6073	6085	6509	6290	5547	5039	5488	72908
1937	5539	5438	6230	6546	6551	6265	7098	6577	6356	4784	4819	4031	70236
1938	4361	5124	6185	6074	6365	5798	6677	5293	6923	4723	4244	4099	65866
Mean	4908	5133	6474	6950	6936	6634	7029	6358	6180	5557	4645	4704	71510
1939	4323	5013	5980	7804	7304	—	—	—	—	—	—	6192	—

* These values are to be divided by 1000 to give correct amounts in inches; the figures in parentheses are estimates from incomplete observations. The U. S. Weather Bureau published these data as of Christiansted but the pan was actually at Anna's Hope, nearby.

Appendix Table 9

Average Monthly Temperatures, Virgin Islands (Danish Records) and Tortola, in ° F.

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
St. Thomas													
Charlotte Amalie													
1833 daily max.[1]	84.9	84.5	84.9	87.2	86.0	88.3	88.3	90.5	91.1	88.3	88.3	83.8	87.2
1833 daily min.[1]	74.8	73.6	73.6	74.8	75.9	78.1	79.3	77.0	77.0	78.1	77.0	74.8	76.2
1833 average[1]	79.6	79.0	78.2	80.7	80.7	82.7	82.8	82.9	83.7	82.1	81.6	81.3	81.1
1845 average[2]	79.0	77.5	80.4	80.2	81.7	83.5	83.8	84.2	83.6	83.1	82.9	81.0	80.8
1846 average[2]	79.5	79.0	79.7	79.9	80.6	82.9	83.3	83.5	84.0	84.2	81.5	80.2	81.7
1847 average[2]	77.0	77.5	78.3	78.4	79.7	82.2	82.9	83.8	84.2	82.4	81.0	79.5	80.6
1845–47 average (3 yrs.)[2]	78.4	78.1	79.5	79.5	80.6	82.9	83.3	83.8	84.0	83.3	81.8	80.2	81.0
1829–36 average (5 yrs.)[3]	77.0	77.2	77.2	78.1	79.5	80.8	81.7	81.9	81.7	80.8	79.5	77.2	79.5
1914–16 average (3 yrs.)[4]	80.2	78.4	78.0	79.5	79.5	80.6	82.9	83.3	83.8	84.0	83.3	81.9	81.0
St. Croix													
Frederiksted Fort[5]													
1825–30 ave. daily max.	84.0	83.0	83.3	88.0	92.0	91.0	92.5	91.5	92.0	90.0	89.0	87.0	88.6
1825–30 ave. daily min.	74.5	73.3	74.5	77.0	78.5	79.0	80.0	82.0	79.0	76.5	76.0	76.0	77.2
1825–30 daily average	80.0	79.0	79.1	81.8	82.6	85.4	84.9	85.2	84.5	81.1	79.9	79.1	81.8
1879 average	75.2	74.8	74.7	77.7	78.3	80.1	80.8	79.5	79.7	77.5	77.2	(74.7)	77.5
King's Hill													
1875	—	—	(76.3)	77.0	79.5	80.8	80.9	82.2	82.4	81.1	78.8	77.5	—
Christiansted[6]													
1882–1916 average	76.6	76.3	76.8	78.3	79.9	81.0	81.5	82.0	81.7	80.8	79.3	77.5	79.3
Tortola													
St. Bernard's Estate[7]													
2 P.M. (3 yrs.)	84.0	83.8	84.3	86.0	85.8	87.0	87.3	91.0	87.5	87.0	86.8	84.5	86.3
6 A.M. (3 yrs.)	69.0	63.0	68.0	70.5	72.3	72.5	75.0	74.3	72.5	72.5	72.0	71.0	71.1
6 A.M. + 2 P.M. + 6 P.M. mean	77.4	77.0	76.1	78.4	78.6	80.8	80.8	82.0	81.0	81.0	80.0	80.0	79.4
Mean difference (6 A.M. to 2 P.M., 2 P.M. to 6 P.M.)	10.0	11.5	11.3	12.5	12.3	10.0	10.0	10.3	14.3	15.0	14.5	14.3	12.2
Greatest difference (6 A.M. to 2 P.M., 2 P.M. to 6 P.M.)	15.0	17.8	16.3	15.5	13.5	14.5	12.3	17.5	15.0	14.5	14.8	13.5	17.8

[1] These 1833 records, cited by Schomburgk, are probably part of Dr. Hornbeck's series. "Max." is probably 4 P.M. reading, "min." the 7 A.M.
[2] Rev. Knox's observations. Probably means of 3 observations per day. The figures quoted by Orsted differ slightly from those of Knox.
[3] Dr. Hornbeck's observations; means computed from 7 A.M., 4 P.M., and 8 P.M. readings by formula $(7 + 4 + 8)/3$, for years 1829, 1830, 1834, 1835, 1836 (from Orsted).
[4] This is from the "Census of the Virgin Islands, 1917", p. 17, authority not given but probably by the harbor master. Presumably computed from maximum and minimum temperatures.
[5] Observations of Garrison-Surgeon Ravn, 1825–30, 5½ yrs. (from Willaume-Jantzen). "Max." and "min." are probably from obs. at fixed morning and afternoon hours.
[6] See also TEXT TABLES 1 and 14.
[7] Elevation 860 feet. Observations quoted by Sir Robert Schomburgk, 6 A.M., 2 P.M., 6 P.M., 1831–33. Taken by Dr. Donovan?

Appendix Table 10

A. Average and Extreme Maximum and Minimum Temperatures*

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
MEAN MAXIMUM TEMPERATURE													
Charlotte Amalie	81.5	80.7	82.0	83.1	84.4	86.0	87.0	87.4	87.4	86.7	85.1	83.2	84.5
Cruz Bay	83.2	83.4	83.8	85.4	87.0	87.7	88.2	89.0	88.8	87.9	85.7	84.5	86.2
Anna's Hope	83.4	83.5	84.3	85.3	86.7	88.0	88.5	88.9	88.6	87.6	86.1	84.5	86.3
Wintberg	81.2	81.6	82.0	84.0	85.0	86.5	86.9	87.3	87.0	86.4	84.2	83.3	84.6
MEAN MINIMUM TEMPERATURE													
Charlotte Amalie	72.6	72.1	72.9	74.3	76.1	77.6	78.1	78.3	78.1	77.1	75.9	74.2	75.6
Cruz Bay	71.2	71.8	72.6	73.8	76.0	76.5	76.5	77.0	76.4	75.8	74.5	73.0	74.6
Anna's Hope	68.6	67.6	68.4	70.1	72.5	73.6	74.1	74.1	73.2	72.3	71.2	69.5	71.3
Wintberg	68.3	68.4	68.4	69.6	70.9	72.4	72.7	72.8	72.5	72.4	71.1	69.7	70.8
HIGHEST TEMPERATURE													
Charlotte Amalie	87	85	87	89	89	90	90	91	92	91	91	89	92
Cruz Bay	88	88	89	92	90	90	92	94	92	93	90	88	94
Anna's Hope	93	89	93	90	92	92	94	99	94	92	91	90	99
Wintberg	86	87	88	89	90	90	91	91	92	91	88	87	92
LOWEST TEMPERATURE													
Charlotte Amalie	65	63	67	67	67	70	71	70	68	70	69	69	63
Cruz Bay	67	66	65	69	70	72	72	73	71	72	70	69	65
Anna's Hope	56	55	58	61	62	67	67	67	62	65	63	58	55
Wintberg	64	64	63	65	61	60	68	69	68	68	66	68	60

* From U. S. Weather Bureau, San Juan, in manuscript, April 1941. Additional data will be found in the other tables, but the figures for the same stations do not agree because the periods of years covered are different. Observation periods for stations: Charlotte Amalie, 1923–40; Cruz Bay, August 1938–December 1941; Anna's Hope, January 1920–December 1940; Wintberg, July 1938–December 1941.

Appendix Table 10 (continued)

B. Average and Extreme Temperatures at Anna's Hope and Christiansted, St. Croix

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Experiment Station, Anna's Hope													
Mean temperature (1920–35)	75.7	75.2	76.1	78.0	79.4	80.6	81.0	81.3	80.6	79.7	78.4	76.7	78.6
Mean maximum (1919–30)	82.6	82.7	83.4	84.7	86.5	87.9	88.2	88.7	88.4	87.3	85.1	83.4	85.7
Mean minimum (1919–30)	69.0	68.2	68.6	70.4	72.8	73.9	74.5	74.4	73.8	72.5	71.3	69.7	71.6
Highest (1920–38)	90	89	93	90	92	92	94	99	94	92	92	90	99
Lowest (1920–38)	55	55	58	61	62	67	66	67	62	65	63	58	55
Greatest daily range (1920–38)	29	28	28	26	27	20	24	23	23	27	25	26	29
Mean daily range (1920–30)	13.3	14.5	14.8	14.3	13.7	14.0	13.7	14.3	14.4	14.8	13.8	13.7	14.1
Christiansted													
Mean temperature (1921–30)*	75.9	75.4	75.7	77.5	79.7	80.8	81.3	81.5	81.1	79.7	78.1	76.6	78.6

* Mean of 8 A.M. + 2 P.M. + 9 P.M. From Clayton, World Weather Records, vol. 2.

C. Average and Extreme Temperatures at Charlotte Amalie, St. Thomas

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean temperature (1917–35)	77.1	76.9	77.4	78.6	80.2	81.6	82.2	82.9	82.5	81.9	80.5	78.5	80.0
Mean maximum (1923–30)	81.9	81.7	82.1	83.2	84.6	86.1	87.0	87.8	87.6	87.0	85.3	83.5	84.8
Mean minimum (1923–30)	72.6	72.1	72.7	74.3	76.1	77.1	77.5	78.2	77.6	76.8	75.6	74.0	75.4
Mean daily range (1923–30)	9.3	9.6	9.5	8.9	8.5	9.0	9.5	9.6	10.0	10.1	9.7	9.5	9.4
Greatest daily range (1923–38)	15	17	16	15	16	15	15	15	16	17	19	17	19
Highest (1923–38)	85	85	87	89	89	90	90	91	92	91	91	89	92
Lowest (1923–38)	65	63	67	68	66	70	71	70	68	70	68	69	63

Appendix Table 10 (continued)

D. Average and Extreme Temperatures at Canaan Estate, St. Thomas

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean maximum temperature													
1925	77.9	79.2	—	—	—	86.3	86.4	86.8	86.4	84.7	81.5	80.9	—
1926	79.6	80.6	82.5	84.6	87.3	87.2	86.9	87.5	88.5	85.8	82.7	79.8	84.4
1927	78.1	78.8	81.0										—
Mean minimum temperature													
1925	68.7	67.8	—	—	—	72.9	73.4	74.8	74.5	73.1	71.8	70.7	—
1926	70.2	69.7	69.8	71.4	73.7	74.1	74.3	74.9	75.4	74.0	72.7	70.9	72.6
1927	69.1	68.3	69.1										—
Highest 1925–27	82	84	86	87	90	90	89	92	94	91	87	84	92
Lowest 1925–27	66	66	67	69	71	70	70	71	72	69	69	68	66

E. Comparative Temperatures at Four Stations in 1939*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Charlotte Amalie, St. Thomas (27 ft. elev.)													
Mean temperature	77.2	76.3	76.3	77.4	79.4	81.7	83.0	83.2	84.2	82.7	81.0	79.0	80.1
Highest temperature	84	83	82	84	86	88	90	90	90	90	88	87	90
Lowest temperature	70	68	67	67	72	72	74	72	72	72	71	72	67
Mean daily range	9.0	9.2	8.7	8.8	7.8	8.3	8.5	8.7	7.6	8.2	8.5	8.7	8.5
Wintberg, St. Thomas (700 ft. elev.)													
Mean temperature	74.3	73.8	73.8	75.2	78.2	79.9	80.6	80.0	80.4	79.6	77.4	75.4	77.4
Highest temperature	83	82	82	86	90	90	91	90	92	90	87	84	92
Lowest temperature	67	64	63	65	68	60	69	70	68	68	66	67	60
Mean daily range	12.0	12.1	12.5	13.7	15.6	15.5	15.3	13.7	16.2	13.6	12.5	11.9	13.9
Cruz Bay, St. John (25 ft. elev.?)													
Mean temperature	76.6	75.6	76.3	77.8	82.7	81.6	82.4	82.9	82.6	82.2	80.3	78.2	79.9
Highest temperature	84	83	85	85	87	90	92	92	92	93	88	86	93
Lowest temperature	67	66	65	69	72	72	72	74	73	72	72	70	65
Mean daily range	11.2	11.6	11.8	10.9	11.2	11.1	11.5	12.2	13.0	11.6	10.7	11.4	11.5
Christiansted, St. Croix (25 ft. elev.)													
Mean temperature	76.2	75.8	76.2	77.8	79.4	81.4	82.6	82.3	82.1	80.8	79.4	78.6	79.6
Highest temperature	88	86	86	90	90	91	93	94	94	91	91	89	94
Lowest temperature	61	64	61	65	69	70	70	70	68	67	68	67	61
Mean daily range	16.4	16.4	16.7	16.3	15.4	15.5	16.1	16.4	16.4	16.2	17.7	17.2	16.4

* From U. S. Weather Bureau, Climatological Data, West Indies and Caribbean Service, 1939. The corresponding data for Bourne Field, 1939, are given in Appendix Table 12.

Appendix Table 11

Average Number of Clear and Cloudy Days, and Prevailing Wind Directions, at Virgin Islands Stations, 1920–30

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Annaly													
Days clear	21	21	24	24	24	25	25	24	16	23	22	21	270
Days pt. cloudy	7	5	5	2	5	2	2	3	6	3	4	7	51
Days cloudy	3	2	2	4	2	3	4	4	8	5	4	3	44
Prevailing wind direction	E	E	E	E	SE	SE	SE	E	E	E	E	E	E
Cruz Bay													
Days clear	25	22	27	29	26	26	25	27	25	25	23	25	305
Days pt. cloudy	0	0	0	0	1	0	0	0	0	0	0	0	1
Days cloudy	6	6	4	1	4	4	6	4	5	6	7	6	59
Prevailing wind direction	E	NE	E	SE	SE	E	NE	E	E	SE	NE	NE	E
Frederiksted													
Days clear	13	14	16	12	13	12	10	11	14	11	12	14	152
Days pt. cloudy	13	10	11	12	9	12	14	14	9	13	10	13	140
Days cloudy	5	4	4	6	9	6	7	6	7	7	8	4	73
Prevailing wind direction	E	E	E	SE	SE	E	E	E	E	E	E	E	E

Appendix Table 12

Monthly Temperatures and Rainfall at Bourne Field, St. Thomas

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Temperature Mean maximum	1935											83.8	83.7	—
	1936	82.4	81.9	82.1						87.5	85.4	84.3	83.8	—
	1937	79.3	81.2	86.2	86.7	89.4	88.0	88.8	89.9	91.0	88.7	88.2	83.0	86.7
	1938	80.3	80.3	81.4	82.2	85.4	85.0	86.5	86.7	87.6	87.2	83.2	82.2	84.0
	1939	81.2	80.7	81.3	82.6	84.7	86.8	87.9	88.3	88.8	88.1	85.7	82.7	84.9
	Mean	80.8	81.0	82.7	82.8	86.5	86.3	87.7	88.3	88.7	87.5	85.0	83.1	85.0
Mean minimum	1935											72.8	72.2	—
	1936	71.4	71.1	70.5						76.2	75.5	74.0	72.4	—
	1937	70.9	70.0	72.2	73.6	76.0	76.7	77.3	77.5	77.8	76.3	76.1	73.3	74.8
	1938	71.8	70.5	71.3	71.7	74.6	75.6	76.1	77.2	76.6	72.5	74.3	73.7	73.8
	1939	71.5	70.8	71.1	72.4	74.6	76.7	77.6	77.3	77.5	77.5	74.8	72.9	74.6
	Mean	71.4	70.6	71.2	72.6	75.1	76.3	77.0	77.3	77.0	75.4	74.1	72.9	74.2
Highest	1935											86	86	—
	1936	84	84	87	87					93	89	87	86.5	(93)
	1937	83	85	90	93	92	91	92	93	95	92	93	89	95
	1938	85	86	86	85	91	88	90	90	93	90	87	85	93
	1939	84	83	84	87	88	90	90	91	93	92	89	88	93
Lowest	1935											67	67	—
	1936	68	67	63	71					74	73	70	70	63
	1937	65	65	69.5	72	71.5	71	75	73	73	73	73	72	65
	1938	67	66	67	68	71	69	74	73	71	71	70	70	66
	1939	69	66	67	69	72	73	75	73	73	71	69	70	66
Rainfall Aerological base station on field	1935											4.84	2.54	—
	1936	1.38	2.16	0.37	0.73	4.42	—	9.67	10.43	5.87	5.07	3.72	6.47	(50.29)
	1937	7.89	0.74	0.52	2.30	3.79	3.19	2.70	3.61	3.40	5.66	2.23	1.58	37.61
	1938	2.15	0.97	1.43	1.66	1.14	6.54	2.89	3.83	4.63	6.88	11.08	4.81	48.01
	1939	1.30	2.06	1.27	3.39	0.87	1.33	1.60	4.70	1.86	3.92	7.20	3.01	32.51
Catchment station on hill	1937					4.37	4.01	3.48	4.27	4.61	5.08	2.00	2.95	—
	1938	2.60	1.38	1.61	1.66	1.30	6.91	3.24	3.98	4.99	9.25	11.23	4.45	52.60
	1939	1.84	2.23	1.89	4.90									—

Note: ( ) [ ] see footnote to appendix table 2.

Appendix Table 12 (continued)

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Runway station at foot of mountain	1938													
	1939	1.20	1.74	1.10	2.83								(2.94)	— —
Rainfall days (.01″ or more)	1935											15	22	—
	1936	20	13	10	14	13	—	23	21	17	21	14	21	(187)
	1937	27	13	7	13	13	11	17	23	22	15	22	21	204
	1938	18	12	12	11	11	18	15	24	21	20	26	24	212
	1939	23	21	18	23	20	18	22	26	18	23	21	20	253
Rainfall duration in hours	1935											23.6	22.0	—
	1936	18.3	19.2	4.4	8.8	24.0	—	73.5	52.6	34.4	52.3	45.8	59.3	(392.6)
	1937	96.0	14.7	5.6	30.0	38.3	28.4	24.4	30.8	27.5	29.1	28.3	26.6	379.7
	1938	43.0	19.8	18.8	16.3	11.2	38.8	12.6	24.7	34.1	23.5	37.8	19.2	299.8
	1939	10.2	16.5	—	—	12.7	5.3	9.9	18.9	12.8	34.7	41.3	22.4	—
Thunderstorms	1935											1	0	—
	1936	0	0	0	0	0	—	6	3	2	2	0	1	(14)
	1937	4	0	0	3	1	1	2	4	2	2	2	0	21
	1938	0	0	0	0	0	3	2	5	3	5	0	0	18
	1939	0	0	0	0	0	1	2	4	6	1	0	0	14
Rainfall intensity: Inches per rainy day	1935											.323	.1154	—
	1936	.690	.166	.037	.052	.340	—	.420	.497	.345	.241	.266	.308	(0.310)
	1937	.292	.056	.074	.177	.291	.290	.159	.157	.155	.377	.101	.075	0.184
	1938	.120	.081	.119	.151	.104	.363	.193	.160	.222	.344	.426	.200	0.207
	1939	.057	.098	.071	.148	.044	.074	.073	.181	.103	.170	.343	.151	0.126
Rainfall intensity: Inches per hour with rain	1935											.205	.115	—
	1936	.754	.113	.084	.083	.184	—	.132	.199	.171	.097	.081	.109	(0.182)
	1937	.082	.063	.093	.077	.010	.114	.111	.117	.124	.195	.079	.059	0.094
	1938	.051	.049	.076	.102	.102	.169	.229	.155	.136	.293	.293	.252	0.160
	1939	.128	.125	—	—	.069	.251	.162	.249	.145	.113	.174	.134	0.155

Note: ( ) [ ] see footnote to APPENDIX TABLE 2.

Appendix Table 13

Relative Humidity, Bourne Field, St. Thomas

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
8 A.M.	1935											76	81	—
	1936	80	79	78	80	81	—	77	79	78	81	81	78	79
	1937	82	80	75	73	79	77	78	79	75	74	80	77	77
	1938	76	72	72	67	71	75	74	75	76	78	80	81	75
	1939	76	73	69	70	68	72	72	74	73	76	78	79	74
	Mean	78	76	74	72	75	75	75	77	76	77	79	79	76.1
12 M.	1935											67	69	—
	1936	67	67	71	66	75	—	79	76	68	75	71	66	71
	1937	78	66	64	64	68	68	67	70	67	67	68	67	68
	1938	70	63	63	60	64	68	65	67	69	71	74	75	67
	1939	67	64	62	67	64	67	65	69	65	65	70	70	66
	Mean	70	65	65	64	68	68	69	71	67	70	70	69	68.0
4 P.M.	1935											72	75	—
	1936	71	72	76	76	75	—	75	75	72	80	77	76	75
	1937	79	69	65	70	73	72	68	72	72	69	70	71	71
	1938	70	66	62	62	67	70	67	70	67	71	76	78	69
	1939	68	68	62	67	66	61	67	70	68	73	74	73	68
	Mean	72	69	66	69	70	68	69	72	70	73	74	75	70.6
8 A.M. + 12 M. + 4 P.M.	Mean	73	70	68	72	71	70	71	73	71	73	74	74	72

Appendix Table 14

Visibility, Bourne Field, St. Thomas*

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1935	8 A.M.											7.9	7.8	—
	12 M.											8.0	7.9	—
	4 P.M.											8.0	7.9	—
1936	8 A.M.	8.0	8.0	8.0	8.0	7.9	—	7.8	7.6	8.1	7.9	7.8	8.1	7.9
	12 M.	8.0	8.0	8.0	8.0	8.0	—	7.4	7.4	8.2	8.0	8.0	7.7	7.9
	4 P.M.	8.0	8.0	8.0	8.0	8.0	—	7.4	7.5	8.2	8.0	7.9	8.9	8.0
1937	8 A.M.	7.1	7.9	8.0	8.5	8.2	8.0	8.1	8.0	8.0	8.0	8.0	8.0	8.0
	12 M.	7.4	8.1	8.0	8.6	8.5	8.0	8.0	8.0	8.1	8.0	8.0	8.0	8.1
	4 P.M.	7.7	8.1	8.0	8.5	8.5	8.0	8.0	7.8	8.0	8.0	8.0	8.0	8.0
1938	8 A.M.	8.0	7.5	7.5	7.9	7.9	7.3	7.5	7.4	7.8	8.3	7.7	7.7	7.7
	12 M.	7.8	8.0	7.4	7.8	8.0	7.4	7.6	7.2	7.9	8.4	7.6	8.0	7.8
	4 P.M.	7.9	7.8	7.7	7.8	7.8	7.4	7.5	7.3	7.8	8.1	7.6	7.8	7.7
1939	8 A.M.	8.0	8.0	7.9	8.3	8.7	8.0	7.8	8.1	8.3	8.3	8.3	8.5	8.2
	12 M.	8.1	8.0	8.1	8.2	8.8	8.1	8.0	8.0	8.4	8.4	8.3	8.6	8.3
	4 P.M.	8.0	7.6	8.0	8.2	8.6	8.1	7.8	7.8	8.3	8.1	8.1	8.4	8.1

* These are averages of visibility numbers of the International Meteorological Code: 6 = 2.5–5 miles; 7 = 6–11 miles; 8 = 12–29 miles; 9 = 30 miles+.

Appendix Table 15

Cloudiness, Bourne Field, St. Thomas

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Lower Clouds														
8 A.M.	1935											2.7	3.1	—
	1936	2.7	4.3	2.7	4.1	4.0	—	5.0	4.5	3.6	2.9	2.9	3.4	3.6
	1937	4.5	4.0	3.0	4.0	4.0	4.0	4.1	3.0	4.0	3.0	3.0	4.4	3.8
	1938	4.1	4.3	4.0	3.3	3.2	3.7	3.1	3.7	3.1	2.5	3.0	3.2	3.4
	1939	2.7	2.2	3.2	3.6	3.8	4.3	4.0	4.1	3.8	3.8	4.0	3.4	3.6
	Mean	3.5	3.7	3.2	3.8	3.7	4.0	4.1	3.8	3.6	2.8	3.1	3.5	3.6
12 M.	1935											4.1	3.5	—
	1936	3.8	5.1	4.1	3.7	3.9	—	5.9	5.1	5.0	3.5	2.9	4.0	4.3
	1937	4.0	4.0	3.0	5.6	4.0	4.5	5.1	4.0	5.0	4.0	4.0	4.4	4.3
	1938	6.0	3.6	5.2	4.2	4.0	4.4	3.2	4.2	3.5	4.1	3.9	4.4	4.2
	1939	3.8	4.1	3.6	3.5	3.7	4.1	3.6	4.8	3.6	4.4	4.5	4.5	4.0
	Mean	4.4	4.2	4.0	4.2	3.9	4.3	4.5	4.5	4.3	4.0	3.9	4.2	4.2
4 P.M.	1935											3.3	2.6	—
	1936	3.3	4.7	3.8	4.5	3.1	—	6.0	4.7	4.7	3.6	2.9	4.5	4.2
	1937	4.0	3.0	3.0	4.0	4.0	4.4	5.1	4.0	5.0	5.0	4.0	4.4	4.2
	1938	5.0	3.9	3.6	3.7	3.7	3.3	2.8	4.2	2.9	3.7	4.0	4.2	3.8
	1939	3.4	3.9	2.9	3.4	3.3	3.6	3.6	4.0	3.6	4.0	4.0	4.3	3.6
	Mean	3.9	3.9	3.3	3.9	3.5	3.8	4.4	4.2	4.1	4.1	3.6	4.0	3.9
Upper Clouds														
8 A.M.	1935											0.9	2.3	—
	1936	0.6	0.4	1.7	1.6	2.1	—	1.2	1.7	3.2	3.1	2.0	1.0	1.7
	1937	3.0	0.9	1.3	0.8	3.0	2.6	3.0	2.0	1.0	3.0	3.0	2.3	2.2
	1938	0.8	0.5	0.6	2.0	2.7	3.5	2.7	2.1	3.8	3.0	2.6	1.7	2.2
	1939	1.3	1.0	0.9	2.2	3.4	3.5	2.0	2.8	2.3	3.6	2.0	3.4	2.4
	Mean	1.4	0.7	1.1	1.7	2.8	3.2	2.2	2.1	2.6	3.2	2.1	2.1	2.1
12 M.	1935											0.9	1.7	—
	1936	0.6	0.9	0.7	1.0	2.8	—	1.1	2.0	3.3	2.6	2.2	0.9	1.6
	1937	3.0	0.8	0.1	1.8	3.0	2.3	1.0	2.0	1.0	4.0	3.0	2.6	2.0
	1938	0.7	0.4	0.9	1.6	2.1	2.9	2.4	2.2	3.6	2.5	2.1	1.7	1.9
	1939	0.9	1.0	1.6	2.6	3.0	4.0	2.3	3.1	2.8	3.4	2.0	2.5	2.4
	Mean	1.3	0.8	0.8	1.8	2.7	3.1	1.7	2.3	2.7	3.1	2.0	1.9	2.0
4 P.M.	1935											1.3	1.8	—
	1936	0.8	1.0	0.7	0.8	3.3	—	0.8	2.5	3.5	2.5	1.8	1.2	1.7
	1937	2.0	0.7	0.3	1.2	3.0	1.8	1.1	2.0	2.0	3.0	3.0	2.9	1.9
	1938	0.5	0.1	1.2	1.7	2.1	4.2	2.3	2.1	4.3	3.4	2.1	1.6	2.1
	1939	1.1	1.1	1.9	2.5	4.4	4.2	3.0	3.6	3.0	3.9	2.5	3.1	2.9
	Mean	1.1	0.7	1.0	1.6	3.2	3.4	1.8	2.6	3.2	3.2	2.1	2.1	2.2

Appendix Table 16

Sea Temperature, Cloud Motions, and Ceilings, Bourne Field, St. Thomas[1]

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Sea Temperatures														
Mean	1936											80.5	78.5	—
	1937	74.5	75.5	78.5	82.5	83.5	81.5	—	85.5	86.5	85.0	85.0	80.0	81.6
	1938	78.0	76.5	77.5	78.0	81.0	82.0	83.2	82.7	84.0	83.5	82.5	79.0	80.7
Mean difference 8 A.M.–4 P.M.	1935–38	1.5	1.5	2.0	1.5	2.0	1.5	2.5	2.7	2.5	1.5	2.7	1.7	2.0
Highest	1935–39	83	81	86	85	86.5	85	86	90	89	87	89	84	90
Lowest	1935–39	73	70	72	73	76	77	81	80	84	80	83	77	70
Maximum Gust Wind Velocity[2]	1935–39	44	46	38	35	33	52	44	52	41	46	40	39	52
Cloud Motion[3]														
Upper Clouds														
8 A.M.	1935											W	W	
	1936	E	E	NE	E	W	—	E	E	SE	SE	SE	ESE	
	1937	E	E	E	E	W	SW	SW	E	NE	NE	SE	E	
	1938	E	ENE	ENE	W	W	ESE	E	ESE	E	E	E	E	
	1939	E	ENE	E	E	W	W	E	ESE	SE	SW	SE	W	
Resultant prevailing		E	ExN	ExN	E	W	S	ESE	ExS	E	ESE	SE	SE	
12 M.	1935											W	W	
	1936	E	E	W	E	W	—	E	E	SE	SE	S	E	
	1937	E	E	E	W	W	W	SW	SE	NE	NE	SE	NE	
	1938	E	NE	E	W	W	SW	E	E	E	NE	E	ENE	
	1939	E	E	E	E	W	SE	E	E	NE	S	SE	SE	
Resultant prevailing		E	ExN	ExN	E/W	W	S	ESE	ExS	E	E	SSE	ENE	
4 P.M.	1935											W	W	
	1936	E	E	W	E	W	—	E	E	SE	SE	S	E	
	1937	E	E	E	E	W	W	SW	E	N	NE	E	NE	
	1938	E	NE	E	W	SW	SW	—	E	E	E	E	NE	
	1939	E	E	E	E	NW	SW	E	SE	E	SW	SE	W	
Resultant prevailing		E	ExN	ExN	ExN	W	SW	SSE	ExS	E	E	SE	NNE	
Lower Clouds														
8 A.M. and 12 M. and 4 P.M.	1935											E	E	
	1936	E	E	E	E	E	E	E	E	E	E	E	E	
	1937	E	E	E	E	SE	E	E	E	E	ENE	SE	E	
	1938	E	E	ENE	E	E	E	E	E	E	E	ENE	E	
	1939	E	ENE	ENE	E	E	E	E	E[4]	E[5]	E[5]	E	E	
Percentage of hours with ceilings above 10,000 ft.[6] (6 A.M. + 6 P.M.) in 1939		74	71	79	93	87	86	83	58	79	58	73	73	

[1] Lindbergh Bay, formerly called Mosquito Bay.
[2] Measured by pressure-tube anemometer, 10 feet above the ground, in miles per hour.
[3] Directions *from* which clouds are observed to move.
[4] ESE at 12 M.
[5] Sept. was ESE, Oct. ENE, at 8 A.M.
[6] Favorable flying weather is reported for more than 97 per cent of the hours all the year, but an occasional month may have only 90 per cent of the hours favorable.

Introduction to Tables 17–20

Daily airplane soundings have been made by the U. S. Marine Corps at its airplane base on St. Thomas since January 1, 1937. The flights were made at 6 A.M. local time every day until May 10, 1937, thereafter at 8 A.M.; 352 soundings were made in 1937, and 359 in 1938, 711 in all. Nearly all these flights reached 5,000 meters or more. The soundings were discontinued in mid-January 1939, but were resumed during the hurricane seasons of 1939, 1940, and 1941.

The mean values for standard heights up to 5000 meters have been published regularly in the "U. S. Monthly Weather Review."

Bourne Field is situated on the southwest coast of the island, practically at sea level; the mountains here rise steeply to 1700 feet within several miles back from the coast. In making the flights a competent aerologist always accompanied the pilot, making notes on clouds and visibility. During most of the flights the plane kept within 15 or 20 miles of the base. Generally the pilots flew up through any cumulus clouds present within range, but often entered or emerged from the sides of clouds. In the averages, therefore, the conditions within and without the clouds are about equally represented. The relative humidities in 1938–39 appear to be about 10 per cent lower than the true values due to the characteristics of the instrument, as it reads about 90 per cent even when in dense clouds.

The results of each day's soundings were reduced and plotted on an adiabatic chart, later to be sent to the Bureau of Aeronautics, Aerological Division, U. S. Navy, Washington, D. C.; copies of the adiabatic charts were also made for and deposited with the Aerological Division, U. S. Weather Bureau, Washington. The cloud notes were written on the adiabatic charts.

The fact that the soundings from January 1 to May 10, 1937 were made at 6 A.M., whereas thereafter they were made at 8 A.M., introduces some heterogeneity in the results for the lowest kilometer or so, because the surface temperature averages about 2° warmer at 8 A.M. than 6 A.M., and the relative humidity is correspondingly lower.

Appendix Table 17

Mean Upper-Air Temperatures at Bourne Field, St. Thomas,* in ° C.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Surface	1937	23.4	22.6	23.0	23.8	27.0	28.1	28.8	28.8	29.4	28.6	28.0	25.7	26.4
	1938	24.3	23.5	24.3	24.7	26.5	26.5	27.1	27.7	28.0	27.6	26.7	25.5	26.0
	Mean	23.85	(23.05)	23.65	24.25	26.75	27.3	27.95	28.25	[28.7]	28.1	27.35	25.6	26.2
500 meters	1937	21.4	21.3	20.7	21.3	23.4	23.9	24.5	24.6	25.0	24.6	23.9	21.3	23.0
	1938	20.5	19.3	19.5	19.8	21.8	21.4	22.0	22.7	24.6	24.2	23.4	22.4	21.8
	Mean	20.95	20.3	(20.1)	20.55	22.6	22.65	23.25	23.65	[24.8]	24.4	23.65	21.85	22.4
1000 meters	1937	18.6	18.6	17.8	18.5	19.9	20.0	20.7	21.2	21.8	21.0	20.7	17.6	19.7
	1938	16.7	15.3	15.7	16.0	18.2	17.9	18.7	19.5	21.6	21.5	20.3	19.6	18.4
	Mean	17.65	16.95	(16.75)	17.25	19.05	18.95	19.7	20.35	[21.7]	21.25	20.5	18.6	19.5
1500 meters	1937	15.8	15.7	14.8	15.1	17.3	17.4	18.1	18.5	19.1	18.2	18.0	14.6	16.9
	1938	13.6	12.1	12.4	12.7	15.8	15.1	15.8	17.0	19.2	18.8	17.7	16.6	15.6
	Mean	14.7	13.9	(13.6)	13.9	16.55	16.25	16.95	17.75	[19.15]	18.5	17.85	15.6	16.25
2000 meters	1937	13.6	13.2	12.2	12.5	15.0	15.5	16.0	15.9	16.7	15.7	15.3	13.2	14.6
	1938	11.1	9.9	10.0	10.7	13.6	13.2	13.8	16.0	16.4	16.2	14.9	14.4	13.4
	Mean	12.35	11.55	(11.1)	11.6	14.3	14.35	14.9	15.95	[16.55]	15.95	15.1	13.8	14.0
2500 meters	1937	11.7	11.5	10.9	11.1	12.4	13.6	14.0	13.5	14.2	13.5	12.8	12.1	12.6
	1938	11.5	9.2	9.0	10.3	11.2	11.4	11.8	13.6	13.8	14.0	12.6	12.7	11.8
	Mean	11.6	10.35	(9.95)	10.7	11.8	12.5	12.9	13.55	[14.0]	13.75	12.7	12.4	12.2
3000 meters	1937	9.5	10.7	9.8	9.3	10.0	11.0	10.9	11.0	11.6	11.1	10.3	9.8	10.4
	1938	10.1	7.4	7.8	8.3	8.6	8.5	9.0	10.4	11.5	11.4	10.4	10.5	9.5
	Mean	9.8	9.05	(8.8)	(8.8)	9.3	9.75	9.95	10.7	[11.55]	11.25	10.35	10.15	9.9
4000 meters	1937	4.2	6.0	5.1	5.2	4.6	4.8	4.2	5.4	6.4	6.0	4.9	4.6	5.1
	1938	4.4	2.4	3.3	3.5	3.6	2.6	2.7	3.9	6.2	5.9	5.4	5.4	4.1
	Mean	4.3	4.2	4.2	4.35	4.1	3.7	(3.45)	4.65	[6.3]	5.95	5.15	5.0	4.6
5000 meters	1937	1.8	0.3	−0.3	−0.2	−0.6	1.4	1.5	0.0	1.6	0.4	−1.1	−1.7	−0.5
	1938	−1.8	−3.2	−2.8	−1.5	−1.4	−3.2	−2.3	−1.4	0.1	0.1	0.1	0.4	−1.4
	Mean	0	−1.45	(−1.55)	−0.85	−1.0	−0.9	−0.4	−0.7	[0.85]	0.25	−0.5	1.05	−0.95

* Based on 711 airplane-meteorograph soundings during 1937 and 1938. Soundings were made one or two hours after sunrise, mostly near 8 A.M. local time.
Note: [ ] maximum values; ( ) minimum values.

Appendix Table 18

Mean Upper-Air Relative Humidities, St. Thomas

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Surface	1937	84	91	85	85	79	75	72	76	75	68	78	75	79
	1938	76	72	70	67	71	75	75	75	76	78	78	80	74
	Mean	80	[81.5]	77.5	76	75	75	73.5	75.5	75.5	(73)	78	77.5	76.5
	1939							74	76	72	77	78		
500 meters	1937	91	89	87	88	86	86	86	90	91	83	91	89	88
	1938	87	83	77	78	84	83	86	86	86	88	86	87	84
	Mean	88	86	(82)	83	85	84.5	86	88	[88.5]	85.5	[88.5]	88	86.0
	1939							88	90	90	91	92		
1000 meters	1937	88	87	86	87	88	90	92	87	86	85	86	94	88
	1938	92	89	77	82	86	86	86	86	87	83	87	84	85
	Mean	[90]	88	(81.5)	84.5	87	88	88.5	86.5	86.5	84	86.5	89	86.5
	1939							90	86	84	84	85		
1500 meters	1937	87	82	80	85	81	81	83	81	78	76	80	89	82
	1938	91	86	75	80	77	82	82	81	78	79	80	82	81
	Mean	[89]	84	(77.5)	82.5	79	81.5	82.5	81	78	(77.5)	80	85.5	81.5
	1939							82	82	76	78	74		
2000 meters	1937	80	72	69	79	71	66	68	75	72	74	72	70	72
	1938	83	79	71	74	68	72	73	65	77	78	77	74	74
	Mean	[81.5]	75.5	70	76.5	69.5	(69)	75.5	70	74.5	76	74.5	72	73.0
	1939							72	80	71	71	66		
2500 meters	1937	58	58	48	61	62	52	51	64	66	65	63	46	58
	1938	47	56	57	56	62	57	60	55	74	71	69	60	60
	Mean	(52.5)	57	(52.5)	58.5	62	54.5	55.5	59.5	70	[68]	66	53	59.0
	1939							61	74	60	66	67		
3000 meters	1937	47	41	31	47	53	43	49	57	60	56	58	35	48
	1938	27	44	42	49	58	53	51	50	66	65	61	50	51
	Mean	37	42.5	(36.5)	48	55.5	48	50	53.5	[63]	60.5	59.5	42.5	49.5
	1939							56	66	51	66	61		
4000 meters	1937	33	26	19	27	56	42	47	55	48	40	52	18	39
	1938	18	34	28	36	50	51	48	49	55	58	49	41	43
	Mean	25.5	30	(23.5)	31.5	[53]	46.5	47.5	52	51.5	49	50.5	29.5	41
	1939							52	58	46	56	61		
5000 meters	1937	26	18	15	19	49	41	42	49	39	37	47	16	33
	1938	13	31	22	29	40	52	48	46	48	50	41	30	38
	Mean	19.5	24.5	(18.5)	24	44.5	46.5	45	[47.5]	43.5	43.5	44	23	35.5
	1939							—	54	—	—	—		

Note: [ ] maximum values; ( ) minimum values.

Appendix Table 19

Equivalent-Potential Temperature (Θ_E) and Specific Humidity (q) from St. Thomas Airplane Soundings, 1937, and Mean Noon Vapor Pressure (e) at San Juan, P. R.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Θ_E, ° Absolute													
Surface	(337)	(337)	(337)	339	348	350	350	354	356	348	[353]	341	346
500 meters	341	340	(337)	339	346	348	350	353	[356]	349	352	340	346
1000 meters	338	337	(334)	337	342	343	347	347	[349]	345	345	336	342
1500 meters	336	333	(330)	333	339	338	341	[343]	[343]	339	341	333	337
2000 meters	334	329	(327)	330	334	334	336	339	[341]	338	336	329	334
2500 meters	328	328	(324)	328	331	330	331	334	[338]	336	333	325	330
3000 meters	327	327	(323)	326	329	328	330	333	[336]	333	332	324	329
4000 meters	326	326	324	326	331	328	328	[333]	[333]	329	331	(322)	328
5000 meters	326	327	326	326	332	330	329	334	[335]	331	331	(324)	329
q, grams/kilogram													
Surface	14.9	15.4	(14.8)	15.7	17.5	17.6	17.6	18.7	[19.2]	16.6	18.4	15.4	16.8
500 meters	15.2	14.7	(14.0)	14.7	16.2	16.6	17.3	18.2	[18.9]	16.8	17.8	14.8	16.3
1000 meters	13.0	12.8	(12.1)	12.8	14.2	14.7	15.5	15.1	[15.6]	14.7	14.7	13.1	14.0
1500 meters	11.5	10.6	(9.9)	10.8	11.9	11.8	12.6	[12.7]	[12.7]	11.7	12.2	10.9	11.6
2000 meters	9.7	8.5	(7.7)	9.0	9.1	9.0	9.6	10.6	[10.8]	10.3	9.7	8.3	9.4
2500 meters	6.6	6.4	(5.4)	6.8	7.4	6.6	6.8	8.1	8.9	8.4	7.8	[5.4]	7.1
3000 meters	4.9	4.7	(3.4)	4.9	5.7	5.0	5.5	6.6	[7.2]	6.4	6.4	3.8	5.4
4000 meters	2.7	2.4	1.8	2.4	4.6	3.5	3.9	[4.8]	4.5	3.5	4.4	(1.5)	3.3
5000 meters	1.5	1.1	(1.0)	1.1	3.2	2.7	2.7	[3.4]	3.0	2.5	3.0	(1.0)	2.2
e, inches of mercury, at San Juan													
Noon Average, 1937	.767	.756	.824	.836	.839	.883	.918	.921	.915	.883	.892	.762	.850
Normal (1900–39)	.730	.714	.722	.753	.813	.852	.864	.876	.881	.865	.826	.770	.805
Difference	.037	.042	.102	.083	.026	.031	.054	.045	.034	.018	.066	—.008	.045

Note: [ ] maximum values; ( ) minimum values.

Appendix Table 20

Mean Upper-Air Pressures in Millibars at St. Thomas

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Surface	1937	1016	1016	1015	1016	1016	1019	1018	1017	1014	1014	1013	1015
	1938	1018	1018	1018	1017	1017	1018	1017	1015	1015	1014	1014	1015
	Mean	1017	1017	1016.5	1016.5	1016.5	[1018.5]	1017.5	1016.5	1014.5	1014	(1013.5)	1015
500 meters	1937	960	962	960	961	961	965	964	962	959	959	958	959
	1938	962	963	961	961	961	962	962	959	960	959	958	960
	Mean	961	962.5	960.5	961	961	[963.5]	963	960.5	959.5	959	(958)	959.5
1000 meters	1937	906	908	905	907	907	910	910	908	906	905	904	905
	1938	907	907	907	906	907	908	908	906	906	906	905	906
	Mean	906.5	907.5	906	906.5	907	[909]	[909]	907	906	905.5	(904.5)	905.5
1500 meters	1937	854	856	853	855	855	858	858	856	854	854	853	853
	1938	854	854	855	854	855	856	856	854	856	855	854	855
	Mean	854	855	854	854.5	855	[857]	[857]	855	855	854.5	(853.5)	854
2000 meters	1937	805	807	804	806	807	810	810	808	806	806	804	804
	1938	805	805	805	805	806	808	807	806	807	806	805	806
	Mean	805	806	(804.5)	805.5	806.5	[809]	808.5	807	806.5	806	(804.5)	805
2500 meters	1937	758	760	757	758	759	763	762	761	759	759	757	757
	1938	758	757	757	757	759	760	760	759	761	760	759	759
	Mean	758	758.5	(757)	757.5	759	[761.5]	761	760	760	759.5	758	758
3000 meters	1937	714	715	713	714	715	719	719	717	716	715	713	713
	1938	713	713	713	713	714	716	715	715	717	717	715	715
	Mean	713.5	714	(713)	713.5	714.5	[717.5]	717	716	716.5	716	714	714
4000 meters	1937	632	634	632	632	634	637	637	635	634	634	632	634
	1938	632	631	631	631	633	634	633	633	636	635	634	634
	Mean	632	632.5	(631.5)	(631.5)	633.5	[635.5]	635	634	635	634.5	633	633
5000 meters	1937	558	561	559	560	560	563	563	562	561	561	559	558
	1938	559	557	557	558	559	560	560	560	562	561	560	561
	Mean	558.5	559	(558)	559	559.5	[561.5]	[561.5]	561	[561.5]	561	559.5	559.0
Normal sea-level pressure (1899–1933)		1016.9	1016.9	1016.6	1016.6	1015.2	1016.3	1016.6	1015.6	1013.8	1013.2	1013.5	1015.6

Note: [ ] maximum values; ( ) minimum values.

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