ing a rigid proof of a variable solar emission, would still be the best suited to keep account of the fluctuating condition of the sun after such a variability has been thoroughly established.

THE INFLUENCE OF SOLAR ATMOSPHERIC ABSORPTION.

Some work has been done by heat methods and by photometry to compare the radiation of the spots with that of the photosphere, notably by Langley about 1875. This work shows that the spots radiate distinctly less than the photosphere surrounding them, though not so much less that the radiation received from a spot at the center of the sun's disc would fall below the amount received from an equal angular area of the sun's disc near the limb where it suffers great absorption in its long path through the solar atmosphere. Langley showed indeed that the direct influence of spots in diminishing the total radiation of the sun is not worth taking into account. At about the same time the investigations of the absorption of the sun's atmosphere by Langley, Vogel, and others showed how marked an iufluence this solar atmospheric absorption exerts on the amount of solar radiation received at the earth. It would probably be within bounds to say that a quarter of the radiations of that interior surface, which may roughly be spoken of as the radiating surface of the sun, are stopped by what may roughly be called the solar atmosphere.

Halm, in papers which appeared in recent numbers of the Astronomische Nachrichten and of Nature, uses this absorbing property of the solar atmosphere as the basis of a most ingenious theory to account for the periodicity of sun spots and the other associated periodic solar phenomena as well as of differences of emission which may exist. His discussion leads to the view that the solar radiation emitted is less as the sun-spot maximum period approaches, and that the spots, prominences, and faculæ are the volcanic evidences of a superheated condition within, which has resulted from a restriction of the freedom of radiation by the cooling and consequent increasing opaqueness of the outer layers of the absorbing atmosphere. The interior of the sun is heated by contraction, according to Halm, faster than its atmosphere allows the heat to be diminished by radiation, Thus a periodic restoration of the temperature equilibrium must take place. This is brought about by the increased circulation, reheating, and resulting greater transmissibility of the solar atmosphere. By this view the atmosphere, after such a gradual increase of transmissibillity, which reaches its maximum long after the maximum of sun spots, becomes more opaque again by gradual cooling of its outer layers during the succeeding relatively calm state. The truth of this could be determined by observations of the radiation from different parts of the sun's disc with the spectrobolometer of Langley, or with the spectral photometer of Vogel. Such an investigation to determine the transmissibility of the solar atmosphere by observations of the energy spectra at different parts of the sun's disc has been made within the past year at the Smithsonian Astrophysical Observatory. If continued for a period of eleven years this study ought to show any such variations of transmissibility as Halm's theory requires.

CONCLUSION.

These new views then, like all their predecessors, point to the complexity of the sun, and the uncertainty of deductions based on our present knowledge. At the same time the probability of a vital connection between the solar changes and matters of great interest upon the earth has been more and more confirmed within the last thirty years. It would seem that satisfactory progress in our understanding of these relations requires that observations of the energy of the solar spectrum be carried on at the highest practicable altitude in or near the Tropics, for a term of years that shall be not less, but preferably more, than a complete sun-spot period of eleven years. Such an investigation would determine, it may be hoped, whether or not the sun emits different quantities of radiation in different years; whether observations at lower altitudes may be relied upon to follow the sun's condition, and it might also throw light on the cause of solar periodicity.

THE CIRCULATION OF THE ATMOSPHERE IN THE TROPICAL AND EQUATORIAL REGIONS.

By A. LAWRENCE ROTCH, Director, Blue Hill Meteorological Observatory, dated May 6, 1902.

It is evident to students of meteorology and physical geography that our theories about the circulation of the atmosphere above the trade winds and doldrums are based on very scanty data and consequently that any method of increasing our knowledge of the subject should be welcomed. After I had demonstrated last summer that kites could be employed on a steamship to obtain meteorological observations in the upper air during both calm and windy weather, and in regions hitherto inaccessible (see MONTHLY WEATHER REVIEW, September, and December, 1901), it seemed that the most useful field for kites was the equatorial and tropical oceans. With a view of ascertaining the state of our knowledge on the subject, as well as when and where atmospheric soundings should be made, I consulted Prof. H. H. Hildebrandsson, of Upsala, Sweden, who, by reason of his discussion of the international cloud observations and measurements, and the attention he has given to the study of the circulation of the atmosphere, is one of the best authorities on the subject. With the consent of Professor Hildebrandsson, his answers to my inquries are here given almost verbatim.

THE UPPER ANTITRADE AND ITS INVESTIGATION.

Theories of atmospheric circulation.—It has been believed from the time of Halley, and more fully developed theories have been put forward by Dove, Maury, and Ferrel, that the ascending currents above the thermal equator proceed immediately as southwest and northwest antitrades over the northeast and southeast trade winds. A part of the antitrade, perhaps, sinks down over the high barometric pressures in the North and South Atlantic oceans and returns with the trade winds, but the greater part of the antitrade first descends to the surface of the ocean north and south of the trade winds and continues to the poles as the prevailing southwest or northwest winds of the north or south temperate zones. The facts upon which this theory is based are very meager. It is only on the Peak of Teneriffe (12,180 feet) that the antitrade can be observed the whole year. Its mean lower limit is at the height of 9,000 feet, and this height is greater in summer than in winter. In October it sinks to 6,000 feet. Leopold von Buch (as cited by Dove, Das Gesetz der Sturme, p. 27) wrote in 1825, as follows: "Should we not believe that the west wind sought for on the summer voyages from Teneriffe to England in the latitude of the Azores and ordinarily found there * * * is, as well as the west wind on the summit of the Peak, the upper equatorial current that has here come down to the level of the sea? It would then follow that the equatorial current of the upper regions, at least over the Atlantic Ocean, does not reach the pole."

So far as I know this is the only empirical fact upon which the theory is founded, but, on the other hand, it should be said that it is not proved that the surface wind at the Azores is the prolongation of the antitrade. When the center of the barometric maximum shifts to the south, the southwest wind also moves to lower latitudes, and as the antitrade sinks near the center at the same time, it probably must be at a lower level on the Peak when the center is approaching. But, as already stated, it is not certain that the antitrade reaches the surface of the ocean north of this center of high pressure.

Ascertained facts.—Our knowledge is very limited. We know that the antitrade exists over the trades, at least in the north Atlantic and at the Sandwich Islands, but no one has found this upper current in Central America or in Ecuador, while the smoke of the highest volcanoes around Quito constantly indicate a strong wind from the east. On the accompanying map, fig. 2, the isobars and surface winds for July are copied from Hann's Atlas der Meteorologie, while the long arrows indicate the directions of movement of the cirrus clouds in July. We see that there is a broad upper stream flowing from the east both above and on each side of the thermal equator. At Manila the direction is east-northeast, in India southeast, Congo east-southeast, Guiana and Costa Rica due east, Jamaica and Havana east-southeast, though in winter it is west-southwest at Havana. In about latitude twenty degrees the direction is west-southwest at Key West and west-northwest at Mauritius, while over the whole temperate zone of the Northern Hemisphere, from the United States in the west, to Assam and Shanghai in the east, westerly winds prevail. At Melbourne the direction is also west 16° north. In fig. 1 are given the mean monthly directions of the upper clouds extracted

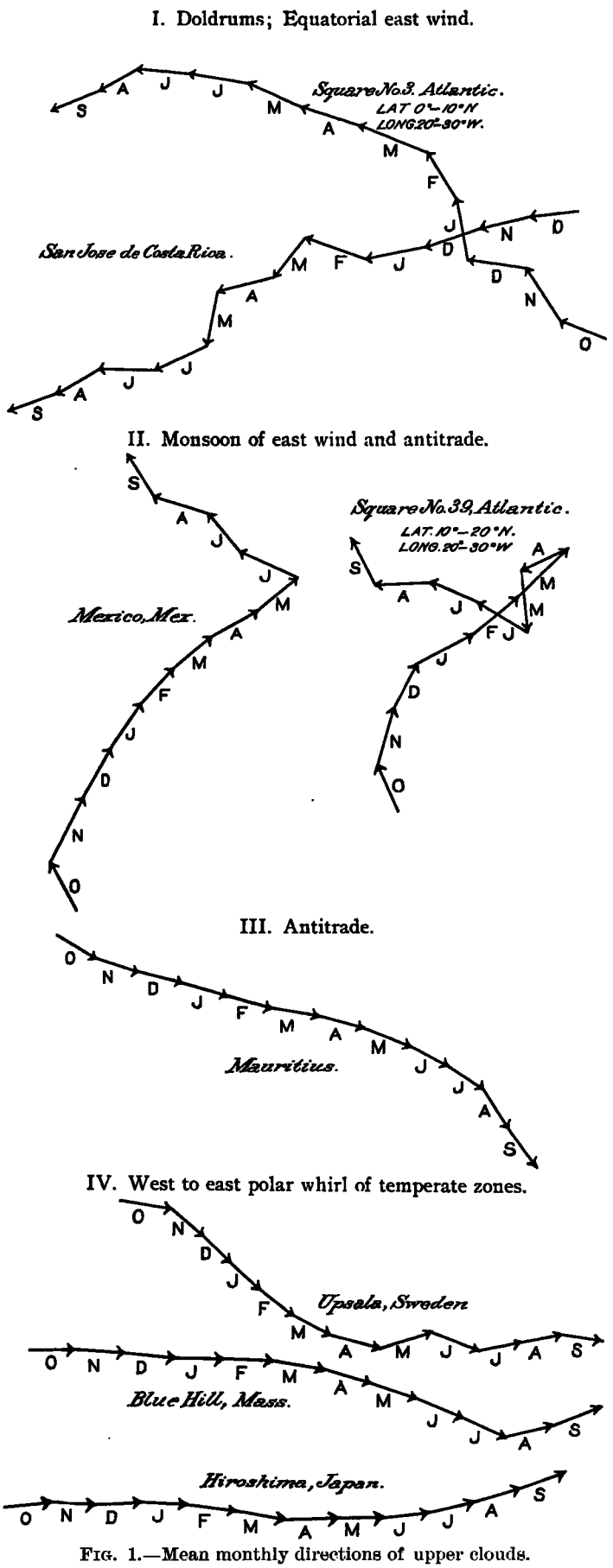

FIG. 1.—Mean monthly directions of upper clouds.

rom the forthcoming Rapport sur les Observations Internationales des Nuages au Comité Météorologique International, which will probably be issued this year. The directions are indicated by arrows for each month, beginning with October (O.) and ending with September (S.). Therefore, the observations indicate that there exist in the upper regions:

(1) A strong easterly wind above the equatorial belt.

(2) Strong westerly winds over the two temperate zones, forming two immense polar cyclones, in which our ordinary cyclones are formed as satellites.

(3) At about twenty degrees north and south latitudes the easterly wind rapidly shifts to the southwest and west. Above the Peak of Teneriffe the antitrade blows from almost due west in winter; there are no observations in summer.

The late Mr. Abercromby observed with great care the upper currents in the doldrums of both the Atlantic and Indian oceans, and came to the conclusion that at high levels the two trade winds rather tend to coalesce into a single wind from the east and that the poleward motion of air near the equator is very small. These results were got by watching very carefully the vertical succession of upper currents. In the Northern Hemisphere, if one stands with his face to the wind, the upper winds will be found coming more and more from the left-hand the higher they are. In the Southern Hemisphere the rule is reversed, for then the upper currents flow more and more toward the left. Now, in his investigations, Abercromby found that with the surface wind blowing from southeast or southwest there was a more easterly wind at higher levels, or, in other words, that the vertical succession of winds proper to the Southern Hemisphere prevailed also for some distance north of the equator. In the southern Indian Ocean from ten to twelve degrees south, during its season of northwest monsoon, he found the upper clouds coming from north-northeast or east, or, in other words, the rule of succession for the Northern Hemisphere extends a little over the equator into the Southern Hemisphere. Hence it is proved that the trades and monsoons do not meet, rise, and flow back poleward, but that the two winds coalesce to form one general easterly wind or one general current toward the west over the doldrums, which was observed directly after the eruption of Krakatoa in August, 1884. The dust went around the world at the equator in a few days, but did not reach middle latitudes until two or three months later. Our knowledge of the vertical variation of temperature and humidity is almost nothing, and we do not know whether there is a sudden change in these elements between the trade and the antitrade, etc.

Method of exploration proposed.—The first experiment could best be performed in July and August, for at that season the thermal equator is at its most northerly latitude, and, of course, the doldrums and the prolonged southeast trade winds are broadest and best developed, since they extend over ten degrees of latitude, namely from 0° to 10° north. Besides, we have then a fixed point in the Azores, exactly in the center of the barometric maximum in the north Atlantic, and a party landed there during the expedition could do much interesting work in studying the central region of a tropical anticyclone. The expedition should leave Boston, Mass., at the end of June and follow the track indicated by crosses and broken arrows on the map in fig. 2. In skirting the isobar of 762 millimeters you should observe carefully the direction of the different clouds, and I trust you will find, as usual, that the upper winds come more and more from the left-hand the higher they are, and will not find any trace of a descending "equatorial current." By means of vertical soundings with kites you will probably obtain the same result as at Blue Hill under the same weather type, although I confess that this part of the experiment would probably be more conclusive in winter when the gradient between the Azores and Iceland is steeper. From the English Channel go directly to the Azores, cutting at right angles the isobars where they are widest apart, and, if possible, land a party at San Miguel to observe the clouds and make kite soundings in the very center of the barometric maximum. Then go by way of Madeira to Teneriffe, namely, over that part of the ocean where the antitrade is always found at a height of about 9,000 feet, and try to find its inclination, if any, with the underlying sea surface, the vertical variations of temperature and humidity in the two currents, etc. Then proceeding south past the Cape Verde Islands to the doldrums, avoid the irregular conditions in the Gulf of Guinea, and go west between 10° and 0° north to the South American coast at about right angles to the southeast and southwest monsoons. You will then have a totally unknown field to explore, but I think that you will find the surface winds becoming more and more easterly with increase of height, without any sort of antitrade, as at Teneriffe. In this course with the thermal equator the vertical soundings will surely prove of great interest. But it will be of the greatest interest if, in steaming against the southeast trade to the latitude of Ascension, you can find any evidence of the antitrade. It is curious that at Mauritius the upper winds are from west-northwest, against the southeast trade; in summer when there are no doldrums in the Indian Ocean, the southeast trades at Mauritius and the southwest monsoon of India form an uninterrupted surface wind. Does there then exist a different wind above the southeast trade of the south Atlantic? If the kites do not reach up far enough, and if, as I fear, there are no cirrus to observe, try to send up from Ascension Island a balloon without instruments—a true *ballon-perdu*—to the greatest possible height and watch its drift. In July the southeast trade is strongest, steady, and normal. From Ascension return over a more easterly track through the calms southwest of Guinea

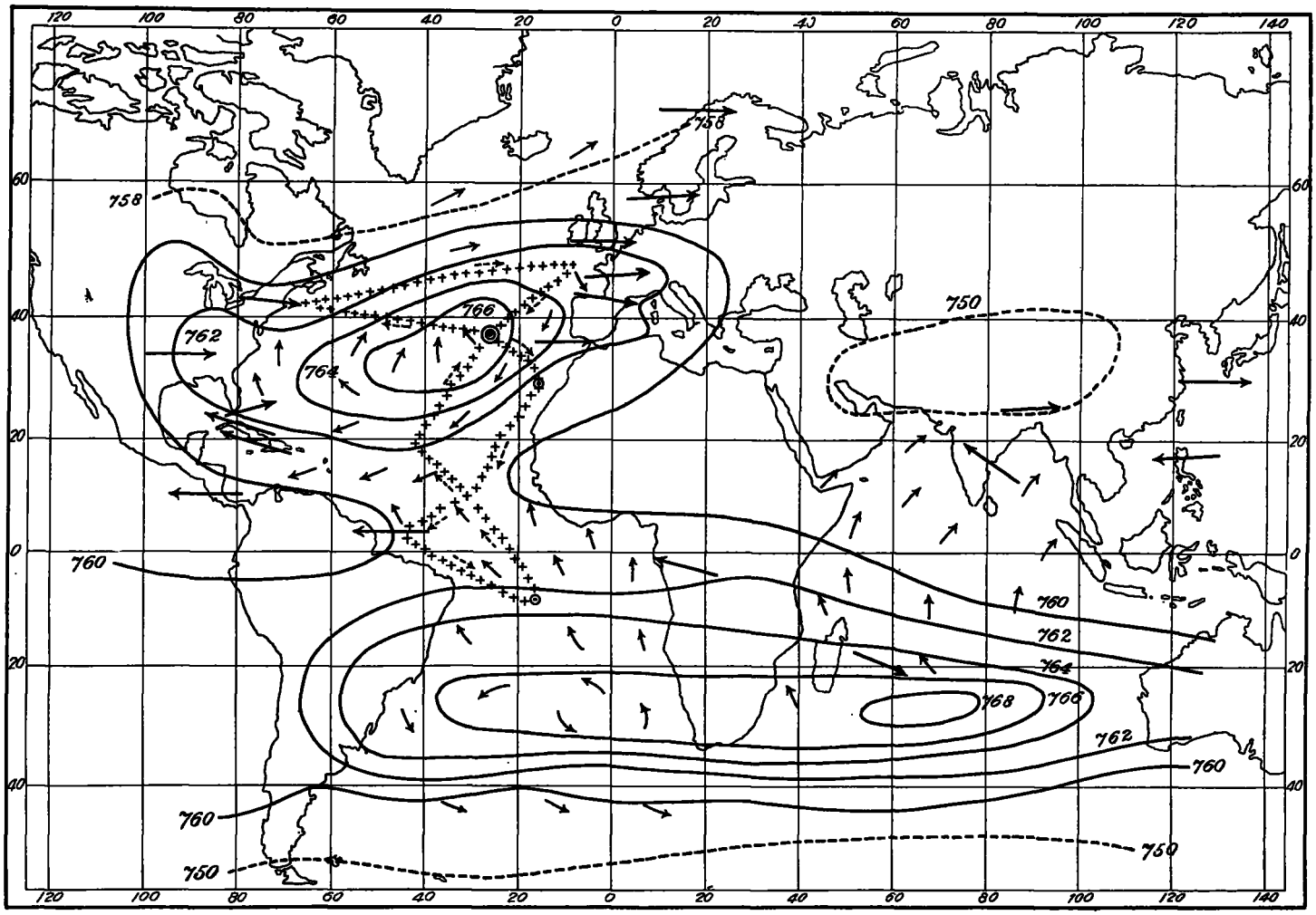

FIG. 2.—Isobars and winds for July.

and the doldrums, then over a more westerly track to the Azores, and thence home, as indicated on the map. Try to find the upper trade wind in this westerly part of the northern barometric maximum. Thus, in a few weeks, you will be able to solve some of the most important problems in meteorology.

The project suggested by the present writer and commented on by Hildebrandsson in the above communication is included among the questions to be discussed by the International Aeronautical Committee at its meeting this month, in Berlin. Since, however, the object of publishing this communication is to bring the matter before meteorologists at large, the opinion of readers of the MONTHLY WEATHER REVIEW as to the feasibility of the project, as well as communications relative to the theory of the trade winds are desired.

NOTES AND EXTRACTS.

JAMAICA METEOROLOGICAL SERVICE.

The Introduction to Vol. III, Jamaica Meteorological Service, announces that on April 1, 1902, the work of collecting statistics of rainfall and other meteorological information, hitherto compiled by Mr. Maxwell Hall, was transfered to the Island Chemist's Office, under the board of agriculture.

The retirement of Mr. Hall from a position he has as long and faithfully filled is to be regretted. His corps of voluntary observers is a credit alike to himself and to his government. We extend to his successor, H. H. Cousins, our best wishes for his success in the field of meteorological research, and trust that the high standard of work hitherto maintained may continue.

CORRIGENDA.

MONTHLY WEATHER REVIEW, January, 1902, page 28, transfer the last two lines of note 65 in column 1, to follow line 7 of same note in column 2.

MONTHLY WEATHER REVIEW, March, 1902, page 122, column 2, line 14, for "vertical" read "vortical."

THE WEATHER OF THE MONTH.

By Prof. ALFRED J. HENRY, in charge of Division of Records and Meteorological Data.

CHARACTERISTICS OF THE WEATHER FOR APRIL.

The weather of April, 1902, was not marked by any special features. During the first two weeks of the month it was dominated by areas of low pressure that moved from the Pacific coast southeastward over the Plateau region to the west Gulf States and thence northeastward along the Atlantic coast. From the end of the second week to the close of the month the lows moved from the middle Plateau region east-northeast