GENERAL EXAMINATION

OF

THE ATLANTIC OCEAN.

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BY

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WITH

NAUTICAL DIRECTIONS FOR AVOIDING HURRICANES

AND

A MEMOIR ON THE CURRENTS OF THE ATLANTIC.

TRANSLATED FROM THE THIRD FRENCH EDITION
BY
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TRANSLATOR'S PREFACE.

The works of the late Captain C. H. Philippe De Kerhallet, of the Imperial French Navy, on the winds, currents, and navigation of the great oceans, are among the most concise, comprehensive, and practical extant. They not only afford abundant proof of the research and scientific attainments of their author, but also of his thorough knowledge as a practical navigator and seaman, which adds much to their value with those of the same profession.

The *General Examination of the Pacific Ocean*, by the same author, was translated by Commander (now Rear-Admiral) Charles Henry Davis, United States Navy, in 1859, and since published by the Bureau of Navigation. In translating this volume of the series I have given a literal translation as nearly as the idioms of the two languages admit, reducing measures of distances, depths, height of barometer, &c., to our own standards. I have added a few additional remarks on the winds, &c., of the West Indies and Gulf of Mexico, translated from the third part of the *Manuel de la Navigation dans la Mer des Antilles et dans le Golfe du Mexique*, a discussion by the late Professor A. D. Bache, Superintendent of the United States Coast Survey, on the observations on the winds at Fort Morgan, Key West, and Galveston, made under his direction during the years of 1847, 1849, 1851, and 1852, and observations on the winds, &c., of the Straits of Magellan, by Captain Richard Mayne, R. N., commanding Her Britannic Majesty's surveying vessel *Nassau*, 1868.

I have also appended to Chapter II on the *Currents of the Atlantic Ocean* a table of the temperatures and the specific gravity of its waters from 50° N. to 50° S. latitude, taken from the sailing directory for the South Atlantic Ocean, by A. G. Findlay, F. R. S.

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PREFACE TO THE SECOND EDITION.

The General Examination of the Atlantic Ocean, published in 1851, was written principally as an introduction to the *Manuel de la Navigation à la Côte Occidentale d'Afrique.*

In this first work, therefore, our attention was specially given to the most important facts in relation to such winds and currents as would be more particularly useful for the navigation of the coast of Africa, and for the routes from Europe to this continent.

Since then we have continued the study of the great seas of the globe, and have successively published the *General Examination of the Indian and Pacific Oceans*, accompanied by three charts showing the general winds and currents, and the routes for traversing these seas.

The *dépôt général* of the marine having decided that the three oceans should be issued uniformly, the Atlantic as well as the two others will be furnished with three charts and a more complete memoir than that first published.

In this edition, while preserving the most important parts of our first work, we treat of those which were then excluded.

For this purpose we have studied the winds at large in the different regions of the Atlantic Ocean, and then making the tour of the basin of this sea, we have indicated the winds peculiar to each locality which are either predominant or periodical.

We have besides given in detail the usual routes for traversing this ocean in every direction. In borrowing information referring to this subject from various works, we have left out all local detail. It would be necessary, then, to consult these works when navigating in certain localities, or when coasting. Among the numerous works we have consulted are the following: *Blunt's Coast Pilot; Sailing Directions for the River St. Lawrence*, by Bayfield; *Derrotero de las Antillas; Le Pilote du Brésil*, by Admiral Barron Roussin; *Directions on Patagonia*, by King; *Descrip-*

tion of the Falkland Islands, by Captain Sullivan; *Les Instructions sur la Guiane Française*, by M. Lartigue; *The India Directory*, Horsburgh; *The Sailing Directory of the Atlantic Ocean*, Purdy; *The Memoir of Purdy to accompany the Chart of the Atlantic Ocean; Wind Chart of the Atlantic*, Maury; *The Atlas of Berghaus and of Johnston; Rennel's Atlas of Currents; History of the British Colonies*, by Montgomery Martin; *The Winds, Currents, and Tides*, by Romme; *Voyages of Parry; Voyages of Cook, Sir James Ross, and of Dumont D'Urville, to the South Pole;* and a great number of voyages, both ancient and modern, which we have mentioned in the preface of *Les Considérations sur l'Océan Pacifique.*

For the length of a great number of voyages in the Atlantic Ocean, we have made use of a manuscript which M. Daussy, hydrographic engineer-in-chief of the depot of the marine, had kindly placed at our disposal. To him we would extend our warmest thanks. It is from this document that we have given, when possible, the length of the greater part of the voyages.

In reading the manuscript of M. Daussy, we were struck with the difference of time employed by ships to make the same voyage, thus only to cite a single example: Horsburgh, leaving England, made the Cape of Good Hope in sixty-seven days, while the greater number of other navigators were from ninety to one hundred and ten days in making the same distance. Many causes may operate to make this difference in the same voyage; nevertheless, in the rapid trip of the celebrated English captain, it is proper, perhaps, to attribute something to the science and knowledge of the great general phenomena of the ocean, which he so skillfully used.

From this, we are in hopes that the examination of the three great seas of the globe, forming, in a measure, a general treatise of navigation, may not be without utility to seamen.

CH. PHILIPPE DE KERHALLET.

PARIS, *February* 1, 1852.

PREFACE TO THE THIRD EDITION.

In this new edition of the *General Examination of the Atlantic Ocean* we have made some corrections and important additions. The quick disposal of the first two has convinced us that this work is not without value to seamen, and we feel flattered at the favorable reception it has met. We have labored to complete it by inserting new documents which we have been enabled to collect since the issue of the second edition. We have besides introduced general observations on hurricanes and the laws which govern these formidable atmospheric disturbances. In Appendix No. 1, placed at the end of the volume, will be found nautical directions which should be followed in these tempests, as also the maneuvers to be made, if such is possible, according to the position which the vessel may occupy in the storm. We owe this important work to the kindness of the learned hydrographic engineer M. Keller, and we are happy to acknowledge our obligation. Not only has he kindly authorized us to make extracts from his memoir published in 1847, but he has furnished us a very important extract from another memoir on the same subject, as yet unpublished. The nautical directions given by M. Keller and deduced from a long and profound study of these phenomena, are simple and very clearly described. We doubt not their being of the greatest service to seamen.

A second appendix is joined to this work. It is a very interesting discussion relating to the currents of the Atlantic Ocean, by M. Irminger, captain in the Danish navy, and translated by M. le Baron Delong, consul general of Denmark. In this memoir the author, an officer as distinguished as conscientious, gives the observations he has made upon the submarine currents, using the instrument invented by M. Aimé for this kind of research. Although to the present time the study of submarine currents does not appear to have afforded any result practically beneficial to navigation, the physical sciences will certainly profit by it,

and for the whale fishery it is of the greatest importance. Captain Irminger has added to these observations made on the currents of the coasts of Africa and Guinea, on the equatorial current, &c., and he has paid particular attention to noting, on the chart which accompanies his work, the temperatures observed in the Icy Sea, which is a subject on which little is as yet known. These observations are very useful for a knowledge of the currents of this sea and for those of that portion of the ocean comprised between the coast of Greenland and the Shetlands, where Iceland and the Isles of Faroe are situated. Observations of this kind are of great interest to science and to navigation. It gives us the greatest satisfaction to be able to place before French seamen this work of Captain Irminger. We pray M. le Baron Delong, who in translating this work has been the means of this gratification, to accept our most cordial thanks.

We hope that these observations, collected with much care, may induce seamen navigating in these localities to make additional ones. At any rate those of Captain Irminger will facilitate the navigation of this part of the Atlantic Ocean, as yet little studied in this particular.

In this work we have indicated but briefly the winds, currents, and navigation in the West Indies and the Gulf of Mexico. To have treated them in detail would have obliged us to have gone beyond the bounds laid down for this work. We will refer to the *Manuel de la Navigation dans la Mer des Antilles et dans le Golfe du Mexique*, chapters 8, 15, and 18, those who may wish to study more completely these two seas.

CH. PHILIPPE DE KERHALLET.

PARIS, *December* 1, 1853.

NOTE.

We give to the winds the name of the point from which they blow; to the currents, that of the points of the compass toward which they run.

The direction of the winds, that of the currents, the courses, the trend of the land, and the bearings, are corrected for the variation of the magnetic needle, except when otherwise stated.

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CHAPTER I.

GENERAL WINDS.

The basin of the Atlantic, unequally inclosed between the west coasts of Europe and Africa and the east coast of America, presents a deep valley, which, to the north and south, appears to be only limited by the poles of the globe; the ice barriers alone having arrested those navigators who have attempted to explore its limits.

In order to study the general winds of this ocean we will divide it into three regions: The first, comprised between the parallels of 30° N. and 30° S. latitude; the second, between the parallel of 30° S. latitude and the South Pole; and the third, between the parallel of 30° N. latitude and the North Pole.

We will divide the two last regions into two zones each—the temperate zone, from the parallel of 30° of latitude to 60°; and the frigid zone, from 60° to each pole.

We will at first study the winds of each of these regions clear of the coast; then, commencing at one of the extremities of the basin, we will indicate in turn what are the winds ordinarily encountered near the coasts.

Origin of winds.

The currents of the air owe their origin to every action which tends to disturb the equilibrium of the atmosphere. Science has attempted to determine the causes of winds and the general laws which they follow. Philosophers attribute them to the heat of the sun, so different and so variable at the surface of the earth, combined with the diurnal movement of the earth itself.

The difference between the temperature of the polar regions and of those bordering on the Equator being considerable, there should result, they say, from this inequality, a

constant exchange of air between these two regions; thus, the air of the polar regions, cold and dense, goes to replace the heated and expanded air of the Equator, which, rising and forming an upper current, should flow N. and S. to establish the equilibrium.

If the earth was in a state of repose, the winds near its surface would be uniformly directed from N. and S., according to the hemisphere in which they blow; but, the globe turning from west to east on its axis, the speed of rotation of its different points being so much greater as these points approach the Equator, it results that the cold currents of air passing from high latitudes toward this great circle, and arriving progressively at the regions where the rotatory motion is more and more considerable, and not being able to partake of this motion from their want of cohesion with the earth, they take an opposite or contrary direction to the movement of rotation of the globe, viz., from E. to W.

Thus, from the combination of the movement of the rotation of the globe, and the difference of temperatures of its surface, the currents of air coming from the N. and from the S. in each hemisphere are modified in their direction and bent toward the N. E. and S. E., forming the winds called general winds, or the trade-winds of the torrid zone.

Passing by the different theories which have been originated on this subject, and the numerous objections raised to each of them, we will confine ourselves to giving the principal facts which have been recognized regarding the winds of the Atlantic—the knowledge most useful to navigation.

Polar winds, northern and southern.

The two currents of air directed from the North and South Poles toward the Equator, which have been indicated above, are named the polar winds—northern and southern, according to the hemisphere in which they exist.

Tropical winds, northern and southern.

In opposition, the tropical winds are called northern and southern as directed from the Equator toward the poles. These last appear to be counter-currents of the polar winds.

First region of the Atlantic Ocean or torrid zone.

In the northern hemisphere the polar winds blow from N. E.; in the southern hemisphere, from the S. E.; and take a direction more inclining to E. as they approach the Equator. Between the tropics these winds are commonly called the *trade-winds* of each hemisphere; they are named, besides, the general winds of the torrid zone. These winds render the voyages in the Atlantic from the Old to the New World both easy and expeditious.

Trade-winds.

The trade-winds appear to be the only primitive winds. Where they blow steadily the weather is constantly fine and the sky generally clear. If they cease for a moment the sky becomes overcast, and in certain localities storms and rains are experienced. They are stronger and more durable as the localities are nearer or further removed from the Equator. In the localities where the trade-winds do not blow, squalls and storms are frequent; and where, from any cause, they are interrupted only, bad weather is experienced, and their return is accompanied by a violent reaction.

The trade-winds in the northern and southern zones have resemblances and differences which will be pointed out hereafter.

Limit of the trade-winds.

The polar limit of the trade-winds, both N. E. and S. E., stretches generally to the parallels of 30° N. and 30° S. of the Equator, but this limit varies much in different parts of the ocean, being subject to the temperature; thus it extends about 3° further north or south, as the sun's declination is north or south.

The equatorial limit of the N. E. and S. E. trade-winds is equally variable, from the same cause. That of the N. E. trades, as a mean, is about the parallel of 8° N. latitude, that of the S. E. about 2° to 3° N. latitude.

From a great number of observations the following table was formed; this, however can only be considered as an approximation:

Limits of the trade-winds.

Seasons.	Polar limits of the N. E. and S. E. trades.	Equatorial limits of the N. E. trade.	Equatorial limits of the S. E. trade.	Polar limits of the N. E. trades according to the months.	
	Lat. N. and S.	*Lat. N.*	*Lat. N.*		*Lat. N.*
Winter	24° 45′	5° 45′	2° 30′	January	23° 24′
				February	28° 39′
				March	27° 19′
Spring	28°	5° 45′	1° 30′	April	28° 18′
				May	28° 31′
				June	31° 25′
Summer	30° 45′	11° 20′	5° 15′	July	29° 36′
				August	31° 11′
				September	32° 04′
Autumn	28° 20′	10°	3° 15′	October	25° 38′
				November	27° 14′
				December	22° 15′

In the Atlantic Ocean the N. E. trade-winds blow with less force over the space comprised between Cape Verd and the coast of Guiana than the S. E. trades do in the neighborhood of the Equator. This is caused, without doubt, by the configuration of the coasts which confine this portion of the ocean. Near the Windward Islands the trade-winds blow generally fresh from E. to N. E.

It is, besides, remarked that in the zone comprised between the Equator and the parallels of 28° latitude N. and S., when the sun is near the great circle, these winds blow from nearly N. E. in the northern, and from S. E. in the southern hemisphere.

But if the sun is in the northern hemisphere, and at its greatest distance from the Equator, the winds in this hemisphere have a tendency to blow more directly from the E., and heavier squalls are experienced than at any other time.

In the southern hemisphere the trades then blow more directly from S.

If, on the contrary, the sun is in the southern hemisphere, the same takes place inversely; then in this hemisphere the winds blow more from the E., while in the northern hemisphere they haul more to the N., and arrive at their limit nearest approaching the Equator.

Squalls, rains, and storms may be expected in the zone where the sun is vertical.

During the winter the trade-winds of the N. are at times encountered before reaching the latitude of Madeira; this is, however, an exception to the general rule mentioned in speaking of the polar limit of these winds.

At other times the variable winds of the temperate zone extend as far as the parallel of 20° N. without appearing to be subject to any general law, and this may take place in any season.

In the southern hemisphere similar facts are presented; thus, during the clear season the limits of the S. E. trades are found in the neighborhood of the parallel of the Cape of Good Hope, while from June to August the westerly winds prevail between this parallel and the Tropic of Capricorn.

It is further to be remarked that near the polar limit of the trade-winds calms and light variable breezes, with light squalls and rain, are often encountered, even through the extent of the belt which separates the tropics from the parallels of 29° of latitude N. and S.

Thus it is seen that the polar limits of the trade-winds are very variable. In the southern hemisphere this limit, though sometimes near to the tropic, is oftener in the vicinity of the parallel of the Cape of Good Hope.

In this zone of the S. E. trades, it has been observed that in places situated to the southward of 16° of S. latitude, the winds have a greater tendency to vary toward the N. E. than toward the S. E., and blow rather from the E. to the N. E. than from the E. to the S. E. This change is quite frequent. During a year of residence at St. Helena, Halley found that the S. E. trades blew always from or nearly from S. E., and that they varied oftener from S. E. to E. than from S. E. to S. With the winds at E. the weather was overcast, and the return of clear weather depended on the return of the wind to S. E.*

Finally, to terminate these remarks, we will observe that on approaching the coast of America, the polar limits of the two zones of trade-winds are found to extend more to the north in the northern hemisphere, and more to the south in the southern hemisphere than upon the coast of Africa,† by 3° or 4°.

Disturbances in the trade-winds.

It happens at times in the regions of the trade-winds that their course is momentarily interrupted by winds blowing from an opposite direction. These winds are never of long duration, and are only due to accidental causes. D'Après‡ met with winds from the N. W., between 24° and 22° S. latitude, from the 12th to the 18th of March, 1735. We ourselves have also had the wind from N. N. W. in the latitude of 18° N. and nine hundred miles to the eastward of Martinique, while making the passage from Brest to that island. These winds lasted but two days and were feeble.

Near the islands situated in the zone of the trade-winds, these winds are also disturbed; thus, in the Cape Verd Islands, the N. E. trades are often lost; and in the belt comprised between the parallel of 10° and the Equator, and the western meridian of this group and Cape Verd, it is remarked that there is in reality no definite prevailing wind, but gusts and cat's-paws, or winds of short duration.

In the vicinity of the Island of Trinidad, situated near the coast of Brazil, the frequent variation of the trades from S. E. to S. is equally marked. Variable winds are also

* Romme. † Blunt's *Coast Pilot*. ‡ *Neptune Oriental*.

found blowing oftener from the N. than from the S.* and heavy squalls from the W. are also met with.

In the two last cases which we have cited, the vicinity of the coasts of Africa and America are without doubt the principal cause of these disturbances.

Variable winds of the torrid zone.

The trade-winds are separated in their equatorial limits by a zone or belt of calms and variable winds; a zone very variable in its extent from N. to S., the mean parallel of which is about 8° of N. latitude. In this zone calms, squalls, and light breezes, blowing from every point of the compass, but principally from S. W., are mostly encountered.

This zone extends more to the north of the Equator during the summer, and is then found as far as the parallel of 14° and even 15° of N. latitude.† On the other hand, in the winter it is narrower, when the sun approaches the Tropic of Capricorn; it then, at times, extends only to the parallel of 3° N., but always remains to the north of the Equator.

We have frequently been able to verify the correctness of the data in the following table, of the extent of the belt of variable winds of the torrid zone, prepared by Horsburgh, from observations made from 1791 to 1807, and taken from the log-books of two hundred and fifty vessels, which had traversed the zone of the variable winds of the Equator, between the longitudes of 20° and 30° W.

It will be seen from this table that the zone of variable winds is the broadest from June to December, and the narrowest from December to June.

The favorable season for crossing the line.

Thus, in making passages from one hemisphere to the other and crossing the line, in coming from the north or south, the most favorable months to traverse the zone of variable winds are those from December to June. According to the season, when the line is crossed, the passage may be longer or shorter by several weeks, depending on the greater or less delay from the calms, squalls, and variable breezes of the Equator, with which the navigator may expect to be annoyed, particularly during the months of June, July, August, and September.‡

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* Capt. Leslie, Lieut. Hamilton—(Purdy, 6th edition.)

† Cook, Wallis, LaPérouse, and many other navigators. Valliant lost the N. E. trades in 0° 30′ N., (voyage of the *Bonite;*) Dumont d'Urville in 13° 50′, (voyage of the *Astrolabe;*) Dupetit-Thouars in 5°, (voyage of the *Venus.*)

‡ See Maury's Charts, 1851.

Months.	(going south the N. E. trades were lost in latitude N.	Returning north the N. E. trades were taken in latitude N.	Mean.	(coming north the S. E. trades were lost in latitude N.	(going south the S. E. trades were taken in latitude N.	Mean.	Breadth of the belt of variable winds of the torrid zone.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′
January	5 to 10	3 to 6	5 45	0 30 to 4 N.	2 to 4	2 45	3 00
February	5 to 10	2 to 7	6 00	2 S. to 3 N.	0 30 to 1	1 15	1 45
March	2 30 to 8	2 to 7	5 00	1 S. to 2 N.	0 30 to 2 30	1 15	3 45
April	4 to 9	4 to 8	5 45	2 S. to 2 30 N.	0 to 2 30	1 45	4 30
May	5 to 10	4 30 to 7	6 30	1 to 4 N.	0 to 1	2 45	3 45
June	5 to 13	5 to 12	9 00	1 to 5 N.	0 to 5	3 00	6 00
July	8 30 to 15	11 to 14	12 00	1 to 6 N.	1 to 5	3 30	8 30
August	11 to 15	11 to 14 30	13 00	3 to 5 N.	1 to 5	3 15	9 45
September	9 to 14	11 to 14	14 45	2 to 4 N.	1 to 5	3 00	8 45
October	7 30 to 13	8 30 to 14	10 00	2 to 5 N.	1 to 5	3 00	7 00
November	6 to 11	7 to 10	8 00	3 to 4 N.	3 to 5	3 45	4 15
December	5 to 7	3 to 6	5 30	1 to 4 N.	1 to 4 30	3 15	2 30

The following remarks upon the zone comprised between the parallels of 4° to 10° N., and the meridians of 18° to 25° W., that is, between the N. E. and S. E. trade-winds, may be useful to mariners.*

The winds in the zone which separates the trade-winds generally incline to the southward, and few vessels pass from one trade to the other without meeting with very unpleasant weather, in the form of calms, light baffling winds, squalls and rain, particularly when the sun is much to the northward.

In June, July, and August heavy squalls seem to prevail from S. W., with a great deal of rain, and the wind often blows hard from this quarter for several hours together and then falls calm, leaving a heavy and confused short sea, which strains a vessel more than a fresh gale.

When the sun is far to the southward the weather is comparatively fine, with light southerly and S. E. winds, interrupted, however, occasionally by squalls and rain; the calms then are of shorter duration, owing probably to the limited breadth between the trade-winds at this season.

In this part of the ocean when much lightning is seen in a heavy dense cloud, in any quarter of the compass, the wind may be expected to come out suddenly from that quarter, especially if there is any rain, even though the wind may be blowing at the same time with moderate force from an opposite quarter. Whenever there is much lightning, and the wind is unsteady and baffling, prepare for a change. A heavy, dense cloud, having a squally appearance, may rise and pass slowly over the vessel directly to leeward, with perhaps little or no increase of wind, and when the danger might be supposed over, the vessel is taken aback by a smart squall; this probably arises from the cloud, which has just gone over the ship, being opposed in its progress to leeward by a stronger current of air from an opposite quarter. On this account, when clouds are in motion from opposite quarters of the compass, a better lookout, if possible, should be kept to leeward than to windward.

In June, July, and August the weather is very wet and squally. Sometimes dense masses of clouds are seen in rapid motion from the southeast, south, and southwest quarters of the horizon; these clouds have a bulky and confused appearance, as if rolling over each other, are of a

* Captain Midgley, (*Purdy's Memoir, &c.*)

dirty, dark drab color, with ragged edges, with inky-looking small clouds flying about their borders. In their approach toward the zenith they appear gradually to unite and form the apex of an angle, and thus united blow with violence from the S. W. quarter, (veering two or three points or more,) for upwards of two hours, during which time the rain descends in torrents, perhaps accompanied by a water-spout or whirlwind.

In this part of the ocean much sheet lightning is a suspicious sign, and forked lightning universally so; the latter is, in some degree, indicative of a change, as well as an increase of wind.

After the wind has blown steadily, with fine weather for a few hours, and then commences to fly about, squalls and rain may be expected.

The month of July is probably the worst month of the year to traverse from N. to S. the belt which separates the trade-winds; in this month fresh winds from the S. W., heavy squalls, and rain in torrents are encountered, the sea is short, and the currents run to the N.

It is seen by the foregoing table that, in the northern hemisphere, the N. E. trade-winds approach, more or less, the Equator according to the season, but very rarely pass to the southward of it. On the contrary, the S. E. trades generally reach the Equator and pass considerably to the northward of it; at times as far as the parallel of 5° N., particularly in the neighborhood of the coast of America. It happens, however, exceptionally, that the N. E. and S. E. trades unite in the open sea off the coast of Africa, and about the meridian of 30° or 35° W. longitude; one passes then from one of these winds to the other, without a calm, by a sudden shift of wind or a squall.

Sometimes even, but principally from December to February, in the vicinity of the coast of Africa, the N. E. and S. E. trades approach so nearly that the limit of either is extremely uncertain.

Near the Equator the winds shift oftener from the E. to the S. than from the E. to the N. However, winds blowing from W. to N. W and from W. to S. are found in this zone of variable winds, but principally from July to September.

The preceding considerations are of the greatest importance in the general navigation of the ocean, and particularly for the Gulf of Guinea.

We will enlarge upon them hereafter in speaking of the routes to be followed in traversing the Atlantic, for whatever the route may be it is important to choose the point of crossing the Equator.

The foregoing observations upon the winds of the first region of the Atlantic have been made in open sea, removed from the coasts; those, by their influence, modify the winds at large in their force and direction; however, it is stated. that in their northern and southern zones the trade-winds advance often very nearly to the coast of America, while they do not commence to be regularly felt to within about four hundred and twenty miles of the southern coast of Africa, and about four hundred and eighty from the coast comprised between Cape Verd and Cape Palmas. In this locality, at certain periods, principally from June to September, and even October, as far as the meridian of 28° W., variable winds are encountered blowing from the W. to N. W. and to the S. W., interrupted by calms, and accompanied by rains and thunder-storms.

The islands situated in this region exercise in their vicinity a certain influence upon the trade-winds; this influence, however, is less sensible than that produced by the continents. It is remarked that the higher these islands are, the more they are subject to rains. In general, in the torrid zone, the winds which are steady in the open sea become variable in the vicinity of land which is high and of considerable extent.

Seasons in the torrid zone.

In the Atlantic, under the torrid zone, the weather differs greatly, according to the situation of the places and the period of the year. It is observed that the air is more agitated in the spring time than in the autumn; more at the time of the equinoxes than during the months of summer and winter.

In this zone, when the rainy season exists to the north of the Equator, it is dry to the south of it and *vice versa*. North of the Equator, in the torrid zone, the rainy season, commencing in the month of April or May, lasts until the month of September or October. The dry season commences in October or November, and lasts until April or May.

In the torrid zone in places situated to the southward of the Equator the seasons are the opposite of those situated to the northward of it, and the changes take place about

the same months. As a general rule the winter or rainy season in each hemisphere commences when the sun removing from the Equator passes to the zenith of the place, and the dry season when the sun returning to the Equator has passed again the zenith of that place. Although this law indicates plainly the seasons, it is subject to many exceptions, so that the seasons neither commence nor end precisely at the epoch of these passages of the sun, but they take place about that period.

There is also a period of doubtful and uncertain weather between each season, with variable winds, calms, squalls, and storms, some of which are called *tornadoes*.

In many localities these storms take place at the commencement and end of the rainy season and are bounded by the period of the heavy rains.

According to the law indicated it is seen that the duration of winter depends in a great measure upon the latitude of the place, and that it should be longer as the locality is more approximate to the Equator.

The warmest season under the torrid zone is the winter; it is also the season of variable winds and calms. In the dry season, on the contrary, the breezes are fresh and established, and the land and sea breezes blow with regularity, near the coast.

In the region near the Equator some distinguish four seasons, two dry and two rainy, but in reality they have named the *dry seasons* a portion of the rainy season, when the rains are less abundant and when the storms occur with intervals of tolerable weather.

Second region of the Atlantic.

The second region of the Atlantic is, as has been said, that comprised between the parallel of 30° latitude S. and the South Pole. In this region we distinguish two zones, the frigid and the temperate zone.

In the region of the frigid zone, where but few have penetrated, there is a scarcity of observations; besides, they relate to but one season, the summer, when navigators are able to penetrate furthest to the southward in this zone. The celebrated Cook, Admiral Dumont d'Urville, and Captain Ross are the navigators who have penetrated into this gloomy region of the Atlantic. Cook, between the parallels of 60° and 70° S. latitude, states that the winds are generally moderate; Foster adds that they blow frequently from E. Cook besides discovered that the currents

in these high latitudes, though inconsiderable, carried the ice to the N. E. by N. and N. W. During a sojourn of forty-nine days in this region, where he was not able to advance beyond the parallel of 63° 33′ S. latitude and where he remained closed in by the ice for many days in latitude 62° 22′ S., longitude 39° W., Admiral Dumont d'Urville has given the following observations which we extract from the cruise of the *Astrolabe*, in 1837.*

Winds from E., variable from N. N. E. to S. S. E. and S., for twenty-seven days; variable from N. N. W. to S. S. W. during the months of January, February, and the commencement of March. In this interval the corvettes *Astrolabe* and *Zélée* experienced a gale from the N. accompanied by rain and fog; with the winds from S. S. W. and S. W. the weather was at times clear, at times overcast; the winds from these quarters were in general moderate, though sometimes fresh.

The winds from N. E. to E. N. E. were sometimes accompanied with clear, but most frequently with cloudy and foggy, weather. Snow fell generally with the winds at E. S. E., N. N. W., and N. E.; the same winds brought fog. The strongest winds were those from the E., the E. S. E., and S. S. E., which in general blew very fresh.

Captain Ross crossed the parallel of 60° S. latitude the 23d of December, 1842. During his stay in the frigid zone, which extended to the 1st of March, he made observations upon the winds, of which the following is the resumé:†

December, 1842, winds from W., variable from N. W. to S. W., six days; wind N. a half day; wind S. a day and a half; wind S. E. a day. The winds were moderate, those from the S. blew a stiff breeze.

January, 1843, winds to the E., variable from the N. E. to S. E., twelve days; wind from the N. two days; wind from S. three days and a half; winds from W., variable from N. N. W. to S. S. W., thirteen days and a half. In this month two days only the winds were very fresh from N. W., the remainder they were but fresh and moderate.

February, winds to the E., variable from N. N. E. to S. S. E., eighteen and a half days; wind from N. two days; wind from S. three days; wind to the W., variable from N. W. to

* *Partie physique, rédigée par M. Vincendon-Dumoulin, ingénieur hydrographe, p.* 44.

† *Sir James Ross's Voyage to the Southern Seas,* (vol. ii, p. 330,) &c.

S. W., four and a half days. There was one day of strong wind blowing from the N., and one day with a stiff wind from the E.; for the remainder the winds were fresh or moderate.

We gather from the preceding observations that during the summer, in the frigid zone, the second region of the Atlantic, the winds blow variably from the E. and W., the winds from the E. predominating.

Temperate zone of the south.

In the temperate zone of this region the winds from W. predominate and vary from N. W. to S. W. In this portion of the Atlantic Ocean, however, the winds are variable and blow without regularity.

The winds from the W. extend often to the Tropic of Capricorn, and, at times, to the parallel of 20° S.

It is remarked that in the zone comprised between the parallel of 28° and 35° S., the winds are extremely variable; those which are most frequently encountered vary from the N. E. to the N. W. by the N., and from the N. W. to the W. S. W. by the W., principally in June, July, and August.*

The winds from the westward varying from N. W. to S. W., which predominate between the parallels of 30° and 50° S., appear to be produced by the fusion of the return currents, directed from the W. to the E., occasioned by the trade-winds, which we have styled "tropical winds," with the polar currents directed from the poles toward the Equator.

The winds which result from these two currents of air should take nearly a mean direction, depending on the force of the contending currents, and necessarily this direction must be very variable, though inclining generally to the W.

It is observed that between the parallels of 30° to 50° S. the winds blow periodically from S. W. to N. W.; varying from W. to N. W. while the sun is in southern declination, and during the remainder of the year from W. to S. W., accompanied by storms and bad weather.† In this zone the easterly winds are never of long duration. When the winds haul to the southward a calm generally follows, and between Cape Horn and the Cape of Good Hope, when the wind blows for many days in succession from the N., it brings overcast and rainy weather. If they pass to the S. of W. the sky clears and the weather becomes fine.‡

Third region of the Atlantic.

The third region of the Atlantic Ocean is comprised be-

* Dampier. † Nicholson. ‡ D'Après de Mannevillette.

tween the latitude of 30° N. and the North Pole; as the preceding, we divide it into two zones, the frigid zone and the temperate zone.

Frigid zone of the north.

In the frigid zone of the north, comprised between the parallel of 60° N. latitude and the pole, and embraced between Europe and America, in which are situated Spitzbergen and Iceland, there appears to be no regular wind; the vicinity of the land, the snow and ice which covers and surrounds it, exercise upon the currents of air an influence varying greatly with the season. The different navigators who have passed over this zone, called the "Frozen Arctic Ocean," have not found that the winds follow any law,* particularly during the summer;† many navigators, however, recognize the winds from the N. as predominant.

All the winds in this zone are accompanied by cold and snow, except during a part of June, July, and August; at this period, with the winds from the S., the climate is comparatively mild, though snow and rain fall, and fog accompanies these winds, during these months. The coldest winds are those from N. and N. E.; in June and July the winds frequently blow from S. S. W., and at times with considerable violence.

During the months of April and May the southerly winds bring snow; during the remainder of the year, bad weather with thick fogs.

Spitzbergen.

At Spitzbergen it is said that during the first months of the year the winds blow from the southward, and during the other months from the northward. The winds from S. E. and N. E. are those which bring most snow.‡

The following observations were made by Captain Parry in his voyage to the North Pole, in the *Hecla*, on the winds between the parallels of 70° and 82° 40′ N. during the months of May, June, July, and August, 1827:

	Days.		Days.
N	7½	S. S. E	2
N. N. W	5½	S. E	12
N. W	9	E. S. E	0½
W. N. W	2	E	17½
W	13	E. N. E	0
W. S. W	1	N. E	9½
S. W	9	N. N. E	11
S. S. W	1	Calms	13½
S	4	Variable	4½

* *Phipp's Voyage to the North Pole;* Barrington, of the Society of London, who has collected the observations of whalers.

† Captain Standidge. ‡ Grey.

At Nova Zembla, from September to May, the wind blows from the northward almost without interruption; from May to August, from the westward.* Nova Zembla.

In the temperate zone, comprised between the parallels of 30° and 60° N. latitude, the prevailing winds are as in the corresponding zone of the opposite hemisphere, from the westward, varying from N. W. to S. W. The predominant westerly winds of this zone are, without doubt, due to the same causes indicated for those in the corresponding zone in the southern hemisphere; they are produced by the currents of air, called "tropical winds," directed from the W. to the E., and the polar currents directed from the N. to the S. The direction which they assume depending upon the relative intensity of these two currents, should be the mean. The predominance of the S. W. winds in the temperate zone of the northern hemisphere is established by the fact of the difference between the time taken for the voyage from the north of Europe to North America, and that for the return voyage. From Liverpool to New York, the mean is about forty days; from New York to Liverpool the mean is about twenty-three days. Temperate zone of the north.

The mean direction of the prevailing wind in this zone, deduced from numerous observations, has been determined as follows by Kaemtz: France, S. 88° W.; England, S. 66° W.; Germany, S. 76° W.; Denmark, S. 62° W.; Sweden, S. 50° W.; Russia, N. 87° W.; America, S. 86° W. Russia is the only country where the direction of the wind inclines to the N. Its most general direction in the Atlantic is between S. 45° W. and S. 70° W.

When the sun is in the northern hemisphere the prevailing westerly winds are from S. W. to W. S. W. On the contrary, if the sun is in the southern hemisphere, the winds are from W. N. W. to N. W.; this last period is that of storms and bad weather on the coasts of North America and Europe.

Having indicated the winds met with in the open sea, in the Atlantic Ocean, it now remains, in terminating the discussion, to speak of those encountered near the coasts which form this basin. We will commence by making some general remarks upon the coast of Africa.

Land and sea breezes blow with great regularity on certain coasts, particularly in the continents between the Land and sea breezes.

* Romme.

tropics and the islands situated in the torrid zone, so much so that they could be ranked with the periodical winds.

In general the sea breeze blows during the day, and the land breeze, commencing toward the evening, continues during a part of the night, blowing in the opposite direction; it ceases, ordinarily, shortly after sunrise, seldom continuing until 9° or 10° a. m. Philosophers attribute these breezes to the difference of temperature of the sea and land.

On the coast of Africa, and near to its shore, it is remarked that on the coast of Morocco the sea breeze blows oftenest from N. W.; upon the coast of Guinea, from S. to S. W.; upon that of Loango and Congo, from S. W. to W.

These breezes alternate almost always with the land breezes; ordinarily they are only felt at a short distance from the land, though at times they find their way well in the offing, when they diminish gradually, until, arrested by the regular winds, they disappear.

The localities where these contacts take place are most always subject to storms accompanied with rain.

The general explanation of the alternating breezes of land and sea as given by philosophers, is, that in the morning the temperature of the earth and the sea being nearly the same, it is calm near the coast; but when the sun rises above the horizon and the earth becomes heated more than the water, the sea breeze springs up; light at first, it increases gradually until it attains its maximum, with the maximum heat of the day, then it diminishes gradually with the fall of the temperature until night, when there is an interval of calm; at night, when the earth is colder than the sea, the land breeze springs up and attains its greatest force at the period of the minimum temperature of the night. It continues until day, and at times, according to the locality, until 8 or 9 a. m.

A knowledge of these breezes is useful, and particularly advantageous to local navigation, and should always be taken advantage of to shorten a voyage.

Solar breezes. There exist, besides, on some parts of the west coast of Africa, breezes which might be termed *solar*, their variations appearing to be subject to the action of the sun. In N. latitude they are found principally on the coast of Senegambia and on the coast which extends from Cape Lopez to Cape Negro, to the south of the Equator.

Upon the former these breezes vary from N. W. to S. W.,

upon the latter, from S. E. to S. and S. W., and even to W. S. W.

These breezes blow fresh on the coast of Senegambia, more especially from November to April, and upon the latter coast from October to March and even to April. The breeze from the offing blows during the day, gaining its greatest force after noon and dying away towards evening. In the night it hauls and blows more from the land.

In the local navigation on these coasts the tacks should be so regulated as to be near the land when the night breeze commences and in the offing when it shifts to the day breeze. These breezes, so similar to the land and sea breezes, never blow directly from the land. They are at times very strong, though never felt far from the coast; to profit by them short tacks should be made of twelve, fifteen, or at most thirty miles.

The *harmattan* is a wind peculiar to the west coast of Africa; it blows from the E., variable to E. N. E; on the northern coast, from the latitude of Madeira to that of the Gaboon River; it is at times very fresh upon the coasts of Senegal and Senegambia, but it is light generally on the coast of Guinea. Harmattan.

It is a cold, drying wind, blowing ordinarily in series of three, six, or nine days, generally from the end of November to February and March. It extends but a short distance from the coast. It sometimes commences at sunrise and dies out after noon.

This wind is often accompanied by a haze, and at times it is charged with a fine, red dust so thick that objects can be distinguished only at a short distance, especially near the coast.

Its dryness at Senegal is extraordinary and produces the most remarkable effects. It is called healthy, though very disagreeable and troublesome. Its great advantage is the production of the gum. It arrests suddenly the circulation of the sap, which is very active at this season, when the winter rains finish, and compels it to leave the trunk of the shrubs upon which this product, the principal commercial riches of Senegal, is formed.

Tornadoes are sudden storms of short duration and frequent on the west coast of Northern Africa. To the south they are little felt and not very strong. These squalls, which have taken their name from the sudden variations Tornadoes.

of wind during their continuance, are indicated, long in advance, by clouds of a palish or copper color by day, and excessively dark at night. They collect to the N. and N. E., coming up generally against the wind; almost always electric phenomena give notice of tornadoes, and little by little the prevailing wind falls and dies away.

All precautions should by this time have been taken. The clouds, black and gloomy, extend rapidly along the horizon, and rise slowly, forming a smooth, regular arc of a circle, furrowed every moment by lightning. The more regular and distinct the arc is, the more violent you may expect the wind.

There are some seconds of calm, then all at once you feel the breeze from N. E. violent, and chasing before it the storm, which bursts with all its fury when it has attained 30° to 40° above the horizon.

From the N. E. the wind jumps quickly to the E. or to the S. E., blowing with the same force; the storm ceases then with rain. When the wind, commencing to die out, passes to the S. or to the S. W. it is often calm after a tornado. It is generally remarked that those are the most violent where the wind precedes the rain.

Every vessel should reduce sail in time to these sudden storms, which seldom continue more than an hour or an hour and a half. One can never foresee the extent of these violent commotions of the atmosphere, which at times resemble, from their force, hurricanes of short duration, in which the wind shifts so suddenly that if a sail shakes it will inevitably go.

The S. W. winds on the west coast of Africa are momentarily interrupted at certain periods, especially in winter, from polar currents of air, which, forming in the Mediterranean and upon the coast of Portugal, arrive abruptly to increase the trade-winds of the N. and make them suddenly approach toward the Equator. The meeting of these winds with the S. W. winds, there predominant at this period, may contribute to cause tornadoes. They are very frequent and violent in the northern hemisphere. On the contrary, as has been stated, to the south of the Equator, these atmospheric disturbances are rarely experienced.

On the coast of the Gaboon and in the Gulf of Biafra tornadoes blow sometimes from the N. W. to the W. and to the S. W., but this is of very seldom occurrence. In the

northern hemisphere tornadoes may be expected principally at the commencement of the winter, therefore the period when they prevail varies with the locality. Thus they are encountered at Cape Palmas a month before they are at Sierra Leone. They arrive at Gorée and at Saint Louis a month and a half after they reach Sierra Leone.

In many localities they occur equally at the end of the winter season, but principally from the Bissagos Archipelago as far as Cape Palmas and the coast of Guinea. In the Gulf of Guinea they blow especially in the months of March, April, and May, and recommence in November and December, in some localities.

South of the Equator the tornadoes blow generally from S. E., and take place particularly from March to June and from September to October. They decrease in violence as you proceed south, and in the latitude of the Congo River they are most frequently squalls without wind, forming in the E., hauling to the S., and terminating at S. W.

They resemble much squalls which are at times met with in the northern hemisphere. They are analogous with tornadoes, from the variations of the wind, but not in their violence.

On the coasts of Angola and Benguela these squalls are frequent in the evening, in November and December, but wind rarely accompanies them. On the contrary, the heavier the clouds bank up the more the wind falls to a flat calm. They scatter generally about 10 or 11 o'clock in the evening, and a light breeze springs up off the land, which often lasts during the night.

Vicinity of the Cape of Good Hope.

For about six hundred miles to the westward of the Cape of Good Hope the S. E. winds are found, generally from the month of October to March and even April. From the month of May to August, in this locality and for about three hundred miles west of the cape, the winds are very variable from N. W. to S. W., with bad weather and a rough sea. The same winds extend six hundred miles to eastward of the Cape of Good Hope. In coming from the east or west during this season, the weather becomes worse as you approach the cape. The winds from N. W. bring fogs, rain, and mist. With the wind from S. W. the weather is clear and cold. These winds are felt both to the eastward and to the westward of the cape, but only in squalls during the months of April and May. These squalls are indicated by

the banking up of the clouds in the west; the wind commences to blow with violence from W. N. W. to W.; it shifts suddenly to the S. W., and hauling to the southward it moderates and becomes calm.*

To double the Cape of Good Hope from the east.

When the season is advanced, in doubling the Cape of Good Hope from the east, D'Après de Mannevillette recommends not to keep at a greater distance from the coast than forty miles, and not to approach it nearer than eighteen miles, in order to keep in a locality where the winds are less violent and the sea less heavy.

The squalls and storms spoken of above are very frequent in the winter; they are accompanied by rains so abundant that often two pleasant days do not occur consecutively. According to many navigators this bad weather is experienced as far east as the meridian of Madagascar.

On the parallel of 36° S. from six hundred to seven hundred and fifty miles to the eastward and westward of the Cape of Good Hope, the winds from N. W., which are violent in its vicinity, become more moderate and shift to the S. S. W. In general between the parallels of 33° S. and 36° S. the winds from the westward appear to predominate.

To double the Cape of Good Hope from the westward.

In coming from the westward to double the Cape of Good Hope, it will be most advantageous to run well off shore, on the parallel of 35° or 36° S., and to enter the Indian Ocean on this last parallel, thus taking advantage of the Atlantic currents flowing to the eastward.

Winds at the Cape of Good Hope.

At the Cape of Good Hope and Table Bay, September, October and November are the spring; December, January, and February the summer; March, April, and May the autumn, and June, July and August the winter months.

The following table is a resumé of the prevailing winds through the year, taken from a series of observations made for many years at Cape Town.†

During the winter ships should not anchor in Table Bay.‡ If they put into port at this season of the year they should enter False Bay.

The approach of winter in the vicinity of the Cape of Good Hope is announced by interruptions in the prevailing S. E. winds, which blow equally, but with less force.

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* D'Après de Mannevillette. † *Horsburgh's India Directory.*

‡ A secure mole is now nearly constructed at Cape Town.

Winds at the Cape of Good Hope.

Months.	Winds.	Remarks.
January	S. E.	Dry, warm; occasional rains with winds from N. W.
February	S. E.	Temperature variable; occasional heavy rains with wind from N. W.
March	S. E.	Strong squalls from N. W.; storms; light rains; fog.
April	S. E. and N. W	Strong squalls, temperature variable; fog.
May	N. W	Weather fine at the commencement of this month, thunder and storms at the end.
June	N. W	Strong squalls at times from S. E. and N. E.; rain, thunder, and storms.
July	N. and N. N. W	Frequent squalls; cold; fog; snow; rain; hail.
August	N. W	Same weather.
September	S. E.	Weather variable and mild.
October	N. W	Heavy rains, thunder and lightning.
November	N. W. and S. E	Warm, dry; moderate breezes.
December	S. E.	When the wind blows N. W. fine breezes; warm and dry.

If a line is drawn from the Cape of Good Hope to Cape Palmas, this line will indicate nearly the boundary which separates the S. E. trade-winds from the prevailing winds which blow during the whole year in the space comprised between this line and the coast of Africa, varying from S. S. E. to S. S. W. and S. W. General winds on the western coast of Africa, between Cape of Good Hope and Cape Palmas.

The distance from the coast that these winds are felt is variable, as will be seen by their boundary, and they will increase in strength as they approach the Cape of Good Hope. It has been remarked that most frequently the wind on this portion of the coast makes an angle of about 22° with the coast.

At two hundred and forty or three hundred miles from the coast, north of Guinea, and upon the line of demarcation mentioned, the ordinary S. E. trade is found, which at this distance commences to incline towards the coast, and as this distance decreases it hauls to the S., S. S. W., and to the S. W. On the line of demarcation of the trades, calms, variable winds and storms are frequent.

On the coasts of Hottentotia and Cimbebasia (or Damara) the breezes are fresh from S. during nearly the whole year, varying from S. S. E. to S. S. W. They are affected at times by heavy squalls. As you draw off from the coast these Coast of Hottentotia and Cimbebasia (or Damara.)

breezes diminish in strength, and hauling to S. and S. S. E. they are lost in the S. E. trades.

Coast of Benguela and Angola.

On the coast of Benguela and Angola the weather is generally fine the year round, excepting during the months of March and April.

In the months of November, December, January, and February, the breezes blow fresh from the S. S. W., hauling to S. W., W. S. W., and exceptionally to W. N. W., and render the navigation of the coast easy at this period.

In November and December light rains occur, especially in the morning, when the wind comes to S. E. or to S.; as soon as it blows from S. W. the weather clears. Sometimes there are indications of squalls with lightning, particularly in the evening. It is rarely the case that these squalls contain wind; on the contrary, the breeze generally decreases to a calm.

It is seldom the case, as has been already said, that these indications continue beyond 10 or 11 o'clock in the evening, and as soon as they dissipate a light land breeze springs up lasting generally during the night.

March and April are the worst months of the year; they are the months of storms and rains. But immediately on the wind coming from S. W. the weather clears. The land breeze prevails at this period, blowing from the S. E. in squalls, and at times from the N. E. These squalls have no resemblance to the tornadoes which are experienced to the northward of the Equator.

From the month of May to the month of October, called the *fine season*, the weather is frequently overcast, particularly in the morning. It is then seldom the case that the breeze from the offing comes in fresh; it is also rare, on the contrary, that it fails when the sky is clear, and the quicker the sky clears the fresher will be the breeze.

In May and June there is less calm, the sea breeze commences late and the land breeze continues fresh after sunrise.

In July, August, September and October the S. W. winds are fresh and steady. They are felt near the coast at 10 or 11 o'clock in the morning, and die out gradually at sunset, seldom lasting beyond 7 or 8 o'clock in the evening. In the month of October they last sometimes until midnight; they are replaced by the land breeze until 8 or 9 o'clock in the

morning. In the interval between these breezes it is generally calm.*

On the coast of Congo the breezes are generally moderate: they blow from September to March between the S. and W. From March to October they prevail from S. S. E., and at times blow with force from between E. and N. Exceptionally they are found fresh between N. and W., principally from the month of April to August. In this season there are heavy rains. Coast of Congo.

In the fine season, from September to March, the land and sea breezes succeed each other with regularity. They are less steady during the rainy season, which lasts three months, from November to February.

In the Congo River the seasons and winds are nearly the same as upon the coast to the southward of this river. But the further south the more the seasons are retarded. Thus, in the Congo River the rainy season is from October to January. River Congo.

On the coast of Loango, from the month of September to March, the prevailing winds are from S. to W. In December and January there are violent squalls from W. to S. W. From March to October the winds are generally from S. S. E., varying to S. and S. W. Coast of Loango.

The land and sea breezes are regular upon this coast, except during the rainy season from September to December. Tornadoes occur in March, April, May, often in September and October, and sometimes in January and February. These tornadoes, though generally less violent than those encountered north of the Equator, are sufficiently so to necessitate taking in all sail.

In the vicinity of Cape Lopez, from the month of June to October, the winds blow almost always from the S. They are in general moderate, as are also the winds from S. S. W., which blow in the other months. Cape Lopez.

Toward the end of November there are storms and heavy rains. The heaviest tornadoes are experienced in March and April: they blow even in November, December, and January. There are also squalls which only differ from tornadoes in being less violent.

On the east coast of the Gulf of Biafra, there are recognized generally but two seasons. That of tornadoes and storms lasts from March to the middle of September. July Gulf of Biafra.

* Captain Simon, *Directions for the Coast of Angola and Benguela.*

and August are comparatively the driest months, and the breezes from S. S. W. are generally fresh in these months. They vary to S. S. E., blowing fresh at times, and then they extend to the north of the Equator as far as 2° or 3° N. latitude. The rainy season commences in September and lasts until March; it is the season of calms and light breezes from S. to W. S. W. and S. W.

Prince's Island, San Thomas, and Annobon.

The islands of the Gulf of Biafra, Prince's Island, Saint Thomas, and Annobon have the same winds as are found on the coast opposite to which they are situated, only the sea and land breezes are more regular and fresher. These breezes cease nearly during the rainy season. They never extend far from the coast of either the continent or the islands.

North coast of Gulf of Biafra, Gulf of Benin and coast from Saint Paul to Cape Palmas.

On the north coast of the Gulf of Biafra, of Benin, and generally on the coast of the Sea of Guinea, the prevailing winds are from S. W. to W., and blow more or less fresh, according to the season, the year through. These winds are always moderate.

The harmattan blows upon this coast in November, December, and January. Its direction is E., and it is never strong.

From October to February, the period called the *fine season*, the land and sea breezes blow near the coast; the former never extend more than twelve miles from the coast, and are always light.

The tornadoes blow on this coast from March to May. In the latter month, in the Gulf of Benin and the Gulf of Biafra, one may be expected every forty-eight hours, and even two on the same day. They are extremely violent. On the ivory and gold coasts they occur in June.

The season of the heavy rains in the Gulf of Benin and the Gulf of Biafra is from August to September. On the ivory and gold coasts it is from May to June.

The fogs, which are very dense upon this part of the coast of Africa, occur in July, August, and September, and also from December to February upon the ivory and gold coasts. In the Gulfs of Benin and Biafra they are found mostly from October to February. These fogs commence, ordinarily, at 3h. in the morning, and disperse at from 10h. to 11h. before noon.

Island of Fernando Po.

In the Island of Fernando Po the climate is the same as that on the neighboring coast of the Gulf of Biafra. The

harmattan blows there from December to February, which is the most healthy season.

On these coasts and islands the land and sea breezes either cease or are very irregular during the rainy season.

Island of St. Helena.

At the Island of St. Helena the S. E. winds blow nearly the whole year. They are only interrupted eight or nine days during the year by light winds from the W. These interruptions are principally in June, July, and November. In the last month there are sometimes six days of winds from this direction.

Island of Ascension.

At the Island of Ascension the winds are the same as at St. Helena, and are moderate throughout the year.

Cape Palmas.

In the vicinity of Cape Palmas, to south of the cape, the prevailing winds are from W. S. W.; to the north of the cape they blow from S. W. and from S. S. W., and in the fine season, from December to March, they vary from W. S. W. to W. N. W. The rainy season lasts from May to October.

Coast of Liberia.

The same winds prevail on the coast of Liberia. The heavy rains occur in July and August; in April and May violent tornadoes. These cease during the heavy rains, to commence again in October and November.

In the fine season the sea and land breezes are steady; the latter are felt twelve miles off the coast. The land breeze varies from N. N. W. to N. N. E., and blows from midday to midnight. The sea breeze varies from W. S. W. to W. N. W. The change takes place by a gradual hauling of the wind to the northward in the middle of the season—to the southward at its commencement or end.* There is often an interval of calm between the land and sea breeze.

The harmattan blows in December, only at intervals, and without violence. It is neither cold nor disagreeable as upon that part of the coast situated north of Cape St. Anne. It is a general remark that upon the coast of Liberia, during the rainy season, the weather is always better near the coast than it is thirty or forty miles in the offing. At this distance, during this season, calms, heavy rains, light and variable breezes prevail; tornadoes and squalls also occur. In the latter, as in tornadoes, the wind blows principally from the E., but without violence.

Coast of Sierra Leone.

On the coast of Sierra Leone, in the fine season, from

* Le Commandant Baudin; le Commandant Bouët-Willaumez.

November to April, the prevailing winds are those from N. N. W. to N. W. In the winter they are from S. W., variable to W. S. W. and W. N. W., blowing at times with force from the W.

The harmattan blows with violence at times in November and December; in the other months it is a light and moderate breeze. It is not permanent, and only blows at intervals, and varies from E. S. E. to N. E. by the E.

Tornadoes occur in May; they cease, in a great measure, during the heavy rains of June to September, and they reappear in September, October, and November.

In the winter season the breezes are mostly light, varying from S. W. to W. S. W., interrupted by breezes from N. W.

In the fine season, from the Isles of Los to Cape St. Ann, the alternate land and sea breezes blow. The angle of their variation is comprised between W. S. W. and E. N. E., shifting by the N. The sea breeze blows from 10h. or 11h. in the morning until midnight. The change of the land and sea breeze is by the N. after a calm interval, or a successive hauling of the breeze to W. N. W., N. W., N., and N. E.

Finally, the prevailing winds on this coast are from the westward—W. N. W. in the fine season, and W. S. W. to S. W. during the winter, from May to November.

Sierra Leone.

The following is a table of the winds in the River of Sierra Leone, from numerous observations during a year:

Winds in the River of Sierra Leone.

Months.	Winds.	Remarks.
January	N. W	Sea breeze in the afternoon, harmattan in the morning.
February	N. W	Occasional storms with rain.
March	N. W	Tornadoes.
April	N. W. to S. W	Do.
May	S. E. to S. W	No tornadoes; occasional thunder-squalls.
June	S. E. to S. W	Rains with wind at S. E.; heat oppressive.
July	S. E. to S. W	Do.
August	S. E. to S. W	Do.
September	E. to S. W	Tornadoes.
October	W. N. W. to S. W.	Weather overcast; heat oppressive.
November	N. E. to W. N. W.	Do.
December	N. E. to N. W	Weather overcast, thunder and lightning in the evening.

In the year 1834, on an average, there were in January thirty-one pleasant days; in February, twenty-eight: in March, thirty-one days overcast or with mist: in April, twenty-six fine days, and four with fog: in May, fourteen days with fine weather, thirteen with rain, and three with fog; in July, five fine days, twenty-three with rain, and three with fog; in August, two fine days and twenty-nine with rain; in September, ten fine days and twenty days with rain: in October, twenty fine days, six with rain, and five with fog; in November, twenty-one good days, five of rain, and four of fog; in December, twenty-three fine days, four with rain, and four with fog.

Coast of the Bissagos Archipelago.

On the coast, and in the Archipelago of the Bissagos, the winds from W., variable to W. N. W. and S. W., prevail during nine months of the year. They blow without cessation during the winter months, from May to October, from W. N. W. to S. W., shifting by the W. They are at times violent in the months of July and August. The tornadoes happen principally in June; also in September and October.

The harmattan blows at times with considerable force in November, December, January, and in the first part of February. During the fine season, on the whole of this coast, and in the archipelago, the land and sea breezes blow. The land breeze from N. E to E. N. E. and E. S. E. until 8h. or 9h. in the morning; until 11h., or to noon, it is calm; then the sea breeze comes in from W. N. W. or W. S. W., and lasts until after sunset, giving place to the land breeze, which commences toward midnight.

Coast of Senegambia.

On the coast of Senegambia, during the fine season, which continues from September or October to May, the prevailing winds are from N. E., varying to N. W. by the N. Upon all this coast the solar breeezes are well established and regular; they are in general moderate, though at times fresh. The harmattan blows with violence in November, December, and January, and becomes moderate in February and March. It continues at times three, six, or nine consecutive days, and at others only during a forenoon.

In the winter months violent tornadoes are experienced in May and June. The heavy rains commence in July, and continue during the month of August, and at the end of this month tornadoes may be expected again. The prevailing winds in this season are from S. W., light and inter-

rupted by calms. Exceptionally they blow with force from the W.

During the fine season the land and sea breezes are experienced on this coast; but the most regular are the solar breezes, varying from N. N. E. to N. in the morning, and from N. to N. N. W. and W. in the evening. During the night the breeze blows weak from E. and E. N. E.

Cape Verd Islands.

In the Cape Verd Islands, from November to May, the general winds vary from N. E. to N. and N. N. W. During the three first months they are ordinarily more to the N. than upon the coast of Senegal. In June they blow from the E., and diminish in force. The rains commence at the end of this month. From July to October there are tornadoes and rain. In the rainy season, from June to October, the winds are from the S., variable to the S. E. and S. W., with storms and frequent fog, and blow at times with violence. After the 15th of August it is not prudent to anchor in the bays of these islands which are exposed to the S. W. and S. E.

Coast of Senegal.

On the coast of Senegal, and from Cape Blanco to Cape Verd, the winds from E. to N. E. prevail from October to May; that is, during eight months. The winter season lasts from June to October, and during this season there are tornadoes and light winds from S. W. to W. S. W.

At some distance from the coast, in the fine season, winds are often found from the N. W., which blow on the shore, while more in the offing the N. E. winds are found. This coast is also subject to the solar breezes, varying from N. E. to N. N. W; the breeze from N. N. W. blows in the afternoon, the others during the night and the forenoon.

Canary Islands.

In the Archipelago of the Canaries, situated near the limit of the N. E. trade-winds, the prevailing winds are from N. N. W. to N. N. E., shifting by the N., during nearly the whole year, but more decidedly from April to October. From this last month to February their direction is nearly the same. They are, however, interrupted by violent winds from the S. E. to S. W., which blow at times seven or eight days. It is in December and January that these blows usually take place. With the winds from S. E. to S. W. there is much rain.

The roadsteads of this archipelago are dangerous with these winds, and should not be frequented at this period.

That of the Grand Canary, the Bay of Palmas, is the only one which can be used without danger in December and January, because there sail can be made with any wind.

At the Canaries the barometer is very sensitive to the variations of the atmosphere; a rapid rise indicates a wind from the E., while a fall, on the contrary, is the precursor of a wind from the W. or S. W. Winds from the E. are accompanied by hazy or foggy weather; it clears as soon as the wind hauls to the N. When it blows strong from this direction it is called by the islanders *la brisa parda*.

Island of Madeira.

At Madeira the N. E. trade-winds are established toward the middle of April, and last until the end of September. In October the periodical rains may be expected, which usually last fifteen days; they are frequently accompanied by strong winds from the S. E., which turn to S. W., and continue to haul as far as N. W., when the weather clears. The roadstead of Funchal is very dangerous with these winds.

During the months of November and December there is some fine weather, and the wind from the N. E. blows irregularly. January and February are the two months during which violent winds from the S. W. to S. are experienced; it often happens, however, that the N. E. wind prevails during these months. In March the prevailing winds are generally from N. W., and at times very strong. During this month snow falls upon the mountains of the island.

April is sometimes bad to the middle of the month, and the wind at times very strong. The weather is generally, however, fine from its commencement. In May, June, and July the nights are clear and the days cloudy, and the regular land and sea breezes blow.

It is in August and during a part of September that the harmattan blows, called by the natives the *east wind*. It blows at times from E. for six or nine consecutive days with great force upon the coast of Morocco, situated opposite to Madeira.

There are no gusts of wind in the island from the middle of April to the end of September. They should be feared in November and December. They commence a few degrees to the E. or W. of S., and passing gradually to the W., end at N. W.

Coast of Morocco.

On the coast of Morocco the prevailing winds are, in the fine season, from N. E. to N. W., varying by the N., and blow generally fresh. During the winter the prevailing winds are those from S. W. and S. S. W., varying at times to W. S. W., and blowing occasionally with violence. The changes of winds from S. E. to S. W. and W. S. W. are rapid in the winter, and bring heavy weather. When the wind passes to W. N. W. and N. W. the weather becomes good.

Coast of Portugal.

On the coast of Portugal, and in general from Cape Finistère to Cape St. Vincent, during ten months of the year the winds are from the N., varying from N. E. to N. N. W. They blow moderately fresh with fine weather, especially during the summer. If during the winter there is a gale of wind, it will be most frequently from S. to S. W., and at times from W. S. W., and blows with great violence. From Cape St. Vincent to the Canaries the winds from N. E. to N. W., varying by the N., predominate.

The following table, formed from meteorological observations made at Lisbon, will give a good idea of the winds which have prevailed there for two consecutive years from the 1st of October, 1863, to the end of September, 1865, with the heights of the barometer and thermometer corresponding to the wind:*

Winds.	Number of days it lasted.	Barometer.		Thermometer.		Observations and remarks.
		Max.	Min.	Max.	Min.	
Calm	10					
N.	128	30.4	29.7	76	36	They are generally clear and fresh during all the year, especially from May to September.
N. N. E.	96	30.5	29.6	81.5	40	
N. E.	110	30.5	29.6	84	36	
E. N. E.	28	30.2	29.9	86	36	
E.	38	30.4	29.5	81	40	
E. S. E.	18	30.2	29.8	74	50	
S. E.	9	30.1	29.3	68	50	They are fresh and attended with rain or snow from October to April, especially with winds from S. S. E. to W. S. W. Fogs are frequent from October to February, and generally with S. E. to S. W. winds.
S. S. E.	2	30.2	30.1	67	47	
S.	28	30.1	29.6	77	49	
S. S. W.	45	30.2	29.3	71	48	
S. W.	50	30.4	29.2	68	48	
W. S. W.	25	30.2	29.3	73	48	
W.	26	30.2	29.7	78	43	
W. N. W.	13	30.1	29.3	71	50	They are fresh with snow, showers, and often rain in summer. In winter fresh and showery.
N. W.	49	30.5	29.8	79	42	
N. N. W.	56	30.3	29.8	77	47	

* *Anuario Hidrografico*, 1867. *The Gulf of Cadiz and Western Shore of the Spanish Peninsula;* by Señor Don P. Riudavets y Tudure.

The foregoing may be resolved into the following table:

Months of observation.	Winds of N. E. quarter.	Winds of S. E. quarter.	Winds of S. W. quarter.	Winds of N. W. quarter.
1863.	*Days.*	*Days.*	*Days.*	*Days.*
October	12	5	8	5
November	21	5	0	1
December	26	0	2	2
1864.				
January	19	7	2	3
February	12	0	11	5
March	13	3	11	2
April	12	3	6	6
May	14	5	8	6
June	15	4	3	8
July	14	5	3	9
August	18	2	5	6
September	19	6	2	3
October	8	3	17	4
November	13	3	6	8
December	5	2	4	10
1865.				
January	6	2	15	8
February	15	2	3	8
March	20	.....	1	7
April	9	4	10	7
May	15	2	9	5
June	14	4	5	6
July	20	.....	1	10
August	14	.....	6	11
September	17	.....	7	5
In the two years	363	67	148	144

From the foregoing we may conclude that winds from the northward, or those from between N. W. and N. E., both inclusive, have prevailed for..... 439 days.
From S., or between S. E. and S. W..... 134 days.
From E., or between E. N. E. and E. S. E..... 84 days.
From W., or between W. N. W. and W. S. W... 64 days.

So that the prevailing winds for the period of two years were from the N., with a remarkable preponderance over the rest, and they were the most lasting in the months from May to September.

It must be noted that the observations were made at nine a. m., a time when perhaps the wind for the day is not established according to that outside, especially in winter; and that the place of observation was the observatory, which, besides being well up the River Tagus, (or, rather,

the Lisbon estuary,) is subject to the prevalence of the land wind, which commences at the lower part of the Tagus. Observations carefully made at the light-house on the Berlings will giveus hereafter a better idea of the winds which prevail on the western coast of the peninsula. Nevertheless, we may be satisfied from the above results that the prevailing winds on the coast of Portugal are northerly, those of the opposite quarter prevailing from October to April, and alternating with those from W. and N. W.

Bay of Biscay. The winds in the Bay of Biscay are very variable; it has been observed, however, that in the winter they blow from S. W. to N. W., hauling by the W., and that the latter are the most frequent.

From May to September, sometimes even in December and January, winds are experienced from E. N. E., E., and E. S. E. During the last two months they are fresh and durable. From the N. E. they are accompanied by heavy showers, and if there is a gale of wind it will be from the E. or S. E. and usually violent.

On the coast of Brittany, the prevailing winds are from S. W., varying to W., W. N. W., and N. W. They are of long duration, extend far and blow during seven or eight months, bringing violent squalls, particularly during the winter.

The winds from W. S. W. to S. W. are most generally accompanied by rain and fog, while those from the N. W. cause rain squalls, but in the interval the sky and horizon are clear. If the winds from N. W. blow moderately they generally bring good weather, interrupted in winter by violent squalls, which are at times accompanied by hail and thunder. On the west coast of France these are commonly named *storms of the sea.*

More reliance can be placed upon the winds which blow from this quarter than from any other. At times they traverse the whole breadth of the Atlantic, from America to Europe.

During the summer the winds from S. W. prevail, at times moderate, at times fresh with heavy weather; but in this season the sky is generally clear.

I have remarked in traversing the Atlantic in this season that with the wind from S. W. and fine weather, if the wind hauled to N. W., its strength generally increased, but the weather continued good.

In the Channel, or in the Bay of Biscay, when the wind blows from S. W. in heavy squalls, either in winter or in summer, if you perceive that the wind and rain increase, that the squalls become harder and more frequent from the same quarter, with a slight tendency to haul, everything should be in readiness for a sudden shift of wind. Ordinarily they pass abruptly from S. W. to W. and often to N. W. in a single rain squall, and the wind is then stronger than before the shift. This might be a serious danger for ships hove-to on the port tack, and even for those who, running with the wind on the quarter or the wind aft, allowed themselves to be caught without reducing sail. Sudden shifts of wind from S. W. to N. W. in the Bay of Biscay.

At times the sudden shift of wind from S. W. to N. W. is preceded by a short lull, which should always be mistrusted. It is observed in the Bay of Biscay that when the wind springs up from a point opposite to the sun it is of short duration, and denotes only a momentary derangement of the atmosphere.

Winds from the N. and S. are not frequent, they prevail from time to time, but neither over a great extent or for a long interval: although they bring sometimes fresh breezes and even gusts of wind, those from the S. quickly turn to the S. E. or S. W., and those from the N. to the N. E. and N. W. Winds from N. and S.

At the entrance of the Channel, although the winds are very variable, it has been observed that the winds from W. are particularly persistent in September, October and November, and that they are frequently from the eastward in December, January and February. Entrance of the channel.

In the Islands of Great Britain the prevailing winds differ but little from those in the Bay of Biscay. It is observed, however, that in Scotland the winds from the N. are frequent, and easterly winds blow particularly from March to June. In Ireland and England the winds from S. to S. W. are the prevailing winds; and on the coast of Cornwall it has been observed that the wind from the westward blows for about nine months of the year. British Isles.

On the coast of Holland the prevailing winds are from the western quarter, they bring rain and fog. The winds from S. E., S., and N. W. are rare, but the northerly and easterly winds are frequent, and occur during every month of the year. They blow during four months of the winter, bringing dry cold weather. Coast of Holland.

Coast of Norway.

On the coast of Norway the prevailing winds are from S. W. to S. the entire length of the western coast. There is frequently rain with these winds.

Having reviewed the winds of the coasts of Africa and Europe, we will continue by following the basin of the Atlantic, and indicate those of the east coast of America. In descending this coast from north to south, we will make but a few remarks on Greenland.

Greenland.

In Greenland there is no periodical wind. From May to July the weather is good with variable winds, which seem to blow more especially from S. S. W. with considerable force; to September the winds are variable. Rains are not frequent, storms are rare and of short duration, the most violent squalls come from the southern quarter, the coldest winds are those from N. E. There is but little information concerning Greenland.

Arctic region of America.

In the following table we give the observations on the winds collected by Captain Parry, during his voyage to the Arctic regions, to discover a passage from the Atlantic to the Pacific Ocean. These observations are the more interesting, as they are successive; without interruption from July 1819 to September 1820, and they accordingly show the prevailing winds in these frozen regions for more than a year. This table is only a résumé of those published in the voyage of Captain Parry, who from the month of July, 1819, to August, 1820, remained between the parallels of 74° and 75° of N. latitude.

Months.	N.	N. N. W.	N. W.	W. N. W.	W.	W. S. W.	S. W.	S. S. W.	S.	S. S. E.	S. E.	E. S. E.	E.	E. N. E.	N. E.	N. N. E.	Calm.	Variable.	Remarks.
1819.																			
July	2	5½	3	....	4½	....	2½	....	1	2½	3	....	2	....	....	1½	2½	....	E. and S. E., fresh with rain; the other breezes light; much fog; snow with wind from the N.
August	4	....	5	....	1½	....	6	....	2	½	1½	....	4	....	2½	1½	1	1½	E., strong breezes and fogs; N., moderate and cloudy; S.W., rain; N. N. W., fresh; cloudy; fogs.
September	7	4	4	....	3½	....	5½	....	....	....	....	....	....	....	1½	4½	....	....	W., strong in squalls; N. N. E., strong; fogs; snow with wind; N., strong; the other winds moderate.
October	10½	7½	1	....	5½	....	3	....	....	1	....	....	1	....	1	....	....	½	N., fresh clear weather; N. W., strong and cloudy; W., strong; snow and fog; S. W., strong, thick fog; E., strong; snow.
November	16	6	1	....	1½	....	1½	....	....	1	....	....	....	....	....	....	1	2	N., moderate, fine weather, snow with squalls; S. W., fine; other winds moderate.
December	5½	3	5	....	2	1	½	....	3½	....	1	3½	5	....	....	....	....	1	E., strong, cloudy; haze and fogs, with the wind at S.
1820.																			
January	11½	7½	½	....	4½	....	....	....	....	1	1½	1	2½	....	....	....	½	....	S. S. E., strong, fine weather; N. to N. N. W., strong or fresh; weather clear; much fog in this month.
February	9	9	....	....	3	....	....	....	1	....	1	....	1	....	....	....	2	3	N. N. W., strong; N., fresh, much fog.
March	17½	4	2½	....	2	....	....	....	1	½	....	1	....	....	....	....	....	2	N., strong, weather clear, snow at times; S., weather clear; W., strong.
April	9½	4	3	....	....	....	....	....	....	½	1	2	2½	....	....	1½	1	5	N. N. W., strong; N., light, snow, weather fine; E., fresh, snow.
May	11	3	5	½	....	....	....	....	4	½	....	1	1	....	1	....	3	1	N. to N. N. W., strong, weather alternately clear and cloudy; N. W., by squalls.

Winds of the arctic regions of America—Continued.

Months.	N.	N. N. W.	N. W.	W. N. W.	W.	W. S. W.	S. W.	S. S. W.	S.	S. S. E.	S. E.	E. S. E.	E.	E. N. E.	N. E.	N. N. E.	Calm.	Variable.	Remarks.
1820.																			
June	7	2½	2	....	4	....	....	2½	2	1	3½	....	½	....	....	....	....	5	N., strong; good weather, cloudy; rain; fogs; snow during two days.
Total for a year	110½	56	32	½	32	1	19	2½	14½	8½	12½	8½	19½	....	6	10	11	21	
July	9	1	1	3	1½	....	1½	1	4	2	1	....	....	....	....	3	....	3	N., strong, cloudy; S., fresh, rain at intervals; S. S. W., strong, frequent fogs.
August	1½	1	3	3	8½	....	....	1	....	....	....	2	1½	1	....	....	1½	5	W. N. W., N. N. W., E. S. E., fresh; snow; fog; haze; weather mostly cloudy.
September	1	2½	4½	1	1½	2	1	....	4	1	5	....	1	....	2½	1½	....	....	S. W., strong; seven days snow; haze; fogs; variable breezes, strong, and often in squalls.
Total	11½	4½	8½	7	11½	2	2½	2	8	3	6	2	2½	1	2½	4½	1½	8	

NOTE.—The figures indicate the number of days during which the wind has blown from the point of the compass indicated in the first horizontal column of the able.

Resumé of observations of temperature made on board the Hecla during the twelve months that she remained between 74° and 75° latitude N.

Months.	Temperature of air in the shade.			Barometer.			Remarks.
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	
1819.	°	°	°	*Inches.*	*Inches.*	*Inches.*	
September	+37	— 1	+22.54	30.42	30.36	29.905	The thermometer, when placed on shore or on the ice at a distance from the ship, invariably stood 32, 42, or 52, and even 72, on some occasions, lower than that registered on board; the mean temperature for the year may then be fairly considered as —2°. The lowest temperature registered on the ice was —55°; it did not rise above —51° for 17 hours on February 14 and 15, 1820.
October	+17.5	—28	— 3.46	30.32	29.10	29.840	
November	+ 6	—47	—20.60	30.32	29.63	29.945	
December	+ 6	—43	—21.79	30.45	29.10	29.865	
1820.							
January	— 2	—47	—30.09	30.77	29.59	30.078	
February	—17	—50	—32.19	30.45	29.32	29.769	
March	+ 6	—40	—18.10	30.26	29.00	29.803	
April	+32	—32	— 8.37	30.86	29.40	29.978	
May	+47	— 4	+16.66	30.48	29.25	30.109	
June	+51	+28	+36.24	30.43	29.50	29.833	
July	+60	+32	+42.41	30.01	29.13	29.669	
August	+45	+32	+32.68	30.03	29.46	29.734	

The two preceding tables will render unnecessary any further observations on the arctic region of America, and to complete them as far as possible, we give the following table of observations, made also by Captain Parry during his third voyage to discover the Northwest Passage. These observations embrace a period of sixteen months, from June 1824 to September 1825.

Observations made at Port Bowen, in latitude 73° 43′ 39″ N.; longitude, 88° 54′ 48″ W.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Variable.	Calm.	Remarks on the weather.
1824											
June	$\frac{1}{2}$	2	11	1	$8\frac{1}{2}$	3	.....	2	2	.....	Much fog and rain; good weather with wind E.
July	$9\frac{1}{2}$	5	$\frac{1}{2}$	5	$2\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$5\frac{1}{2}$	.....	.....	Winds very variable; fogs; light winds.
August	$3\frac{1}{2}$	$1\frac{1}{2}$	3	7	$3\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{2}$	7	$1\frac{1}{2}$	.....	Remarkable for the quantity of rain and snow.
September	$1\frac{1}{2}$	$1\frac{1}{2}$	$4\frac{1}{2}$	9	.....	2	9	$1\frac{1}{2}$	.....	1	Breezes fresh by squalls.
October	4	$2\frac{1}{2}$	$10\frac{1}{2}$	$6\frac{1}{2}$	1	.....	$\frac{1}{2}$	5	1	.....	Winds fresh from E. and fogs.
November	2	.....	$8\frac{1}{2}$	8	.....	$2\frac{1}{2}$	$1\frac{1}{2}$	$5\frac{1}{2}$	2	.....	Winds strong by squalls; clear, with the wind N. W.
December	4	1	15	$4\frac{1}{2}$	.....	1	$1\frac{1}{2}$	2	2	.....	Very fine month, with winds E.; weather clear, but little snow.
1825.											
January	3	$2\frac{1}{2}$	18	$1\frac{1}{2}$	.....	.....	.....	3	3	.....	Fine month, some squalls.
February	3	2	$18\frac{1}{2}$	.....	.....	.....	1	$2\frac{1}{2}$	.....	1	Do.
March	.....	$\frac{1}{2}$	18	.....	.....	2	2	$7\frac{1}{2}$	1	.....	Fine, some squalls.
April	$2\frac{1}{2}$	.....	18	2	.....	.....	4	$2\frac{1}{2}$	1	.....	Fine, some squalls; a little snow during five days.
May	3	3	$9\frac{1}{2}$	1	3	1	$2\frac{1}{2}$	$7\frac{1}{2}$	1	.....	Strong breezes S. E.; weather cloudy; squalls; snow.
June	$1\frac{1}{2}$	1	$12\frac{1}{2}$	$2\frac{1}{2}$	2	$4\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	.....	.....	Went to sea; very variable for the season; fogs.
July	4	1	.....	5	$2\frac{1}{2}$	3	12	4	.....	.....	Mostly very overcast and cloudy.
August	9	$8\frac{1}{2}$	1	.....	$1\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{2}$	7	.....	.....	Cloudy; fogs; rain; light breezes.
September	$1\frac{1}{2}$	3	$3\frac{1}{2}$	1	$5\frac{1}{2}$	3	$4\frac{1}{2}$	8	.....	.....	Cloudy; rain; fogs; light breezes.

It can be concluded from all these observations that in the arctic regions the winds are very variable, and follow no rule, and that in general they are moderate, even in all seasons of the year.

In Hudson's Bay it has been observed that from the month of October to May the prevailing winds are those from N. to N. W., and that from June to October they are those from the S. E. to E. In this bay heavy gales from the N. are experienced; they are most frequent in the spring and autumn.* Hudson's Bay.

According to some authors the winds in Canada blow regularly from the northern quarter during the five months of winter; according to others the winds from N. E. and S. W. prevail alternately, the first at the end of the autumn and during the winter, the second during the remainder of the year. From December to April the weather is, in general, serene. The occasional winds from N. W., which spring up during the season, are colder than those from N. E., and they only occur during the season of ice. These do not appear in the seas of this locality, excepting about the month of March; they increase in June, and from that time diminish successively.* Canada.

The following table is a resumé of the winds observed during 1834 in Lower Canada:†

Months.	Winds.	Remarks on the weather.
January	W. N. W.	Weather generally fine.
February	W. to E. N. E	Much snow.
March	W. to E.	Snow and rain.
April	Variable	Variable with the winds.
May	do	Generally fine.
June	do	Do.
July	do	Do.
August	do	Do.
September	do	Rain and cloudy weather.
October	E. N. E.	Snow and rain.
November	S. S. E.	Snow.
December	W. N. W.	Variable.

On the east and south coast of the Island of Newfoundland the most frequent winds are those from the southern quarter, from the month of May to the month of October. Newfoundland.

* Romme, p. 63; Table of winds, &c.

† Montgomery Martin's *History of British Colonies*.

These winds are very variable, and, in general, moderate during this period. There are, however, occasionally heavy squalls from the S. E., with rain and fog, which is particularly frequent in July and August.

The winds from N. W., which blow from time to time, are dry and cold, and almost always bring a clear sky. In the month of October these winds become violent. There are frequently in the localities of Newfoundland winds from S. W., very variable in force at this season of the year.

Gulf and River St. Lawrence.

In the Gulf and River St. Lawrence,* during the navigable season, the prevailing winds enter directly into the gulf and river, following the direction of the chains of mountains which form the sides of the great valley through which it runs. Thus the winds S. E. in the gulf become E. S. E. between Anticosti and the south coast; E. N. E. above the Point de Monts, and N. E. beyond Green Island.

The winds from W. do not appear to follow so exactly the course of the high land, except on the south coast, where those from W. S. W. become at Bic Island W., W. N. W., and N. W. in descending the south coast, which is high and in form of a curve; they then turn to N. N. W. at Cape Gaspé.

The winds above mentioned blow often strong during three or four days; those from W. being nearly always accompanied with clear and fine weather, those from the E. being as often cold and foggy.

In the spring the easterly winds prevail, blowing at times without interruption many weeks. As the summer approaches the westerly winds become more frequent; those from S. W. may be regarded as the prevailing winds during the summer in the gulf and river.

Winds from S., light and variable, blow occasionally in this season; from the N. they are rare at this period, though they do occur.

The strong winds from the N., if they blow at all before September, only continue for a few hours, when the wind goes to the eastward; succeeded by calm it is the forerunner of a strong wind. They haul generally to the S. W.

The wind from N. W. is dry, and when it blows the sky is clear and without clouds. After the autumnal equinox the winds to the N. and W. become more common; they are often strong, and blow a long time from the same direction. In the months of October and November the wind

* Bayfield.

from N. W. is frequently violent, in heavy squalls, bringing rain, hail, snow, and heavy frosts.

Squalls are frequent in July and August, but seldom last more than one or two hours; the wind accompanying them is, in general, instantaneous and violent, especially in the vicinity of a mountainous part of the coast; sail should be quickly reduced before their approach.

The violent winds very seldom chop round from one point of the compass to the point directly opposite, or nearly so. In general they moderate gradually, and it becomes calm; then they are replaced by a wind from an opposite direction. It sometimes happens that they shift their direction several points. The winds from N. W. rarely, or rather never, shift by the N. to N. E., E. and S. E., but often turn gradually to the S. W. in moderating. The winds from S. W. vary very seldom from that direction to N. W., N., and E., but sometimes by the S. to S. E. and E. The winds from E. diminish gradually to a calm, and are replaced by the wind from an opposite direction.

In the fine weather of the summer the W. winds are a fresh top-gallant breeze; it moderates often in the evening and becomes calm during the night; the next morning it springs up again from the same point. It is only under these circumstances that a land breeze is found near the northern shore; the same has been observed on the southern shore, but it is not so plainly defined as on the northern; the land breeze does not extend far from the land either on the one or the other. Occasionally about sunrise the land breeze of the north shore is found to extend nearly to the southern shore, while the land breeze of the southern shore seldom extends five or six miles into the offing.

Under the same circumstances, with fine weather and the wind W. dying away after sunset, a breeze from S. W. from the land often blows into the offing from the north shore of Anticosti; it continues during the night and into the morning. If, however, the weather is undecided and the wind does not die away at sundown, the shore should not be approached during the night with the expectation of a land breeze, for this would, in general, be more detrimental than useful.

Such is the ordinary course of the winds in the Gulf of St. Lawrence, and with the ordinary weather violent winds do not often occur from May to October, though fresh

breezes are common. There are, however, exceptionally, years when these winds take the character of tempests, and squalls of extreme violence succeed each other rapidly and at very short intervals.

Barometer.

In the Gulf of St. Lawrence, Bayfield mentions that, during the navigable season, the barometer varies from 29 to 30.5 inches; that from its variations follow with remarkable regularity the changes of the wind and weather. The movement of the column of mercury is greater and more frequent than in lower latitudes, and a sudden variation, which in other climates would be alarming, may take place in the gulf without being followed by a change of wind or weather. Nevertheless the mariner should always follow closely the barometer and observe its slightest fluctuations; this study alone can make him capable of appreciating the decisive indications of the mercury, which rarely deceive.

The following remarks apply to decided variations of the barometer, which generally indicate a storm or change in the direction of the wind and weather, a change, the foreknowledge of which is of the greatest importance to the seamen and to the security of the ship which he commands.

After a series of westerly winds with fine weather, when the barometer has risen as high as possible, that is to say, a little above 30.5, if it commences to fall a little, a wind from the E. should be expected. If to this showing of the barometer the following circumstances are added, a warm spell, a greyish atmosphere during the day, with an abundant dew at night and the stars sparkling, or an aurora borealis, the approach of an E. wind is in a great measure certain. If the land is in sight and appears deformed by the terrestrial refraction, if the vessels in sight are drawn out of proportion by the mirage or exhibit two or three images, these phenomena would confirm positively the change of weather indicated by the barometer. Probably the wind from E. will be light at first, with a clear sky, but this only continues for a few hours. If the barometer continues to fall, the wind will soon increase gradually and the sky cloud by degrees until it is entirely covered. The rain and fog follow and will last with the E. wind, with very little intermission, until dispersed by a wind from an opposite direction.

If the fall of the barometer, during an easterly wind, is very slow, the wind probably will last, and will not be very

violent. If, on the contrary, the fall of the barometer is rapid, it will last but a short time, but with considerable violence. In the case where the mercury falls to about 29 inches, an immediate change is almost certain, and the wind will, in general, come from the N. W.; the force of this wind will be in proportion to the fall of the barometer and that of the E. wind which preceded it. There is rarely, in this case, an interval of a few hours between one of these winds and the other. The wind from E. fails gradually and it falls calm; in a few hours after, or even at times much quicker, the wind commences from N. W., and for some time a heavy sea is encountered, caused by the preceding wind. The barometer commences sometimes to rise in the interval of calm which precedes the wind from N. W.; at others it does not rise until the commencement of this wind; then the weather becomes nearly clear in a few hours, sometimes immediately. The force of the N. W. wind is generally greatest immediately after its commencement, and decreases as the barometer rises, hauling gradually to the W. and S. W.

. It is worthy of remark that the circumstances above mentioned are reproduced exactly, but inversely, when the wind is to come from the E. This wind commences generally with clear weather and the barometer high; light at first from S. to S. E., it increases gradually in proportion as it hauls to the E., with a continuous fall of the barometer.

To return to the wind from the W., we would state that after it has hauled to S. W., if it becomes moderate and the barometer remains stationary at a moderate height, good weather can be expected. If it remains at a great height, but undecided, fluctuating between certain limits, equally variable weather may be expected. If, however, it rises quickly to a great height, a repetition of the E. wind may be expected. There are seasons when it may be said that the mercury hardly rises with one wind, before it commences to fall to another, and these disturbances of bad augury continue for several months. At other seasons there is hardly a breeze during the whole summer, to which it is necessary to double-reef the top-sails. In reality there are so great differences in the weather, according to the seasons, that it is very difficult to state any fact which is not subject to many exceptions. There is, nevertheless, a well-determined accordance which exists nearly in every

case between the indications of the barometer and the variations of the winds and weather.

The first case is the very common one that we have indicated, the coincidence of a falling barometer with a wind from E., accompanied with humidity and fog, and replaced by a strong wind from the opposite quarter, coinciding with a rising of the barometer. A second case, which is more rare in ordinary seasons, (except in the spring or at the commencement of summer,) is that of a wind from E. blowing with a rising barometer, which, though not commencing with clear weather during its first few hours, brings almost always a clear sky, and finishing with fine weather. A third case can be regarded as sure; it is when the barometer falls suddenly and considerably, the wind may at all times be expected from the N., and probably a very violent gust from the N. W. It does not follow that this gust should be immediate, for it may be preceded by a strong squall from the S. W. of some hours' duration, during which the barometer seldom rises, but almost always continues to fall. Then when the wind from S. W. ceases, the wind from N. or N. W. follows immediately and the barometer rises.

Finally, it is seen, on the one side, that a considerable fall of the barometer may take place without being followed by a violent wind, and, on the other, that a breeze of considerable force may blow without its being indicated by this instrument; however, this never takes place in a sudden gust of wind. It should be here observed, that in this climate and under the circumstances mentioned above, the barometer being very high indicates a wind from the E.

It is remarkable that in the Gulf of St. Lawrence, the barometer being very high may be considered as foretelling the damp, foggy weather, which accompanies its fall, while the barometer being very low announces equally dry weather, and this accompanies its rise. The barometer is, then, in the navigation of this gulf, a most useful instrument; for, by observing constantly its state and its variations, and comparing them with the wind and weather which precedes them, as also with the appearance of the sky, the change of the wind and weather can be foreseen with a certain degree of confidence, and in many cases prevent being surprised near a lee shore without a sure anchorage. These variations of the barometer can be equally utilized in

taking such a course as would place a ship in a position to benefit by the coming change.

The climate of Sable Island seems to be greatly under the influence of the Gulf Stream, from which it is distant only seventy miles. Climate of Sable Island.

The winds blowing from its direction soon melt the snow which may fall upon this island during the winter. These winds, coming from a quarter comparatively warm, bring with them much humidity and are always accompanied by thick fogs.

The winds from the southern quarters generally prevail during the summer months, and are interrupted by winds from the N. Winds from S.

With the winds from the southward the barometer rarely rises: but if while they blow, it falls with rapidity there is wind and rain. If the fall is considerable, after the middle of the month of August, a blow may be expected.

The winds between N. and E. prevail during the spring and the beginning of autumn. They are often accompanied by fine weather and a high barometer, particularly when nearly from N. In autumn and winter the winds from the eastward generally bring bad weather and a low barometer. Winds from N. and E.

Some of the most violent storms experienced in this island have been from this quarter, and they are generally followed, after the barometer has attained its lowest point, by a sudden gust of wind from the N. W., equally violent, bringing always clear weather, accompanied by a rise of barometer.

The winds from E., as those from S., bring fog. The last mentioned winds are less frequent towards the end of the summer, when the westerly winds and clear weather become proportionately less rare.

It is the fog much more than the current which renders Sable Island so dangerous; it lasts for several days and nights without interruption, with the wind from E. or S., and prevails during the summer.

The winds from N. and W. are frequent in the autumn and winter; they bring, most always, clear weather; they are violent and very cold in the winter.*

The following table is an abstract of observations upon the winds, made at Halifax, situated on the southeast coast of Nova Scotia.† Nova Scotia.

* Bayfield. † Montgomery Martin's *History of the British Colonies.*

Observations upon the winds, made at Halifax.

Months.	Winds.	Remarks on the weather.
January	N., S., and W	Clear; rain; snow.
February	N. W., and variable	Clear; rain; cloudy.
March	N. W. and S. W	Clear; cloudy; rain.
April	W	Do.
May	N. and W	Clear; rain at intervals.
June	W., N., and N.W	Do.
July	W., N., and S., variable	Clear; fog.
August	W. and S., variable	Clear; cloudy; a little rain; fog.
September	N. W. and S., variable.	Do.
October	S.W., N., and N.W	Clear.
November	W. and S. W	Clear; rain and fog.
December	N. W. and N. E	Clear; rain.

New Brunswick.

In New Brunswick the following observations were made at Fredericton, the capital of this colony.*

Observations upon the winds, made at Fredericton.

Months.	E.	S.	W.	N.	Variable.	Pleasant.	Rain.	Fog.	Snow.
January	4	.....	7	6	14	24	2	1	4
February	2	4	4	2	16	23	1	.....	4
March	23	2	5	.....	1	22	2	2	5
April	12	4	11	.....	3	22	7	.....	1
May	20	1	7	.....	3	18	8	5	.....
June	19	1	10	.....	.....	15	6	9	.....
July	20	.....	7	2	2	18	3	10	.....
August	17	.....	9	4	1	23	3	5	.....
September	17	.....	10	2	1	17	5	8	.....
October	14	.....	8	.....	9	22	7	2	.....
November	11	5	.....	14	.....	15	8	3	4
December	.....	.....	9	14	8	26	.....	2	3
Total	159	17	87	44	58	245	52	47	21

East Coast of North America.

There have not been found on the east coast of North America any constant winds or those blowing with regularity. The region of the trade-winds extends further to the north on this coast than upon the corresponding coast of Africa, and these winds at times extend as far as the parallel of Bermuda and even to that of 32° N. As they approach the coast they blow the more directly from the E. On the coast of that part of America which comprises the United States the most frequent winds are those

* Sir James MacGregor.

from N. W. and S. E. Generally in winter the winds blow from N. W. and are mostly dry. The winds from E., E. S. E., and S. E. bring rain, and they are sometimes very strong from the last direction.

To the south of Newfoundland sudden and violent squalls of wind are very frequent, which, after blowing strong from one direction, chop round suddenly and blow with equal violence from the opposite direction.

The winds in the Gulf of St. Lawrence are not subject to so sudden variations as they are to the eastward of Breton Island. The weather to the south of the Magdalene Islands, between there and Prince Edward Island, is generally clearer than to the north.

South Carolina.

On the coast of South Carolina, when the winds blow strong from N. E. without rain, it lasts ordinarily from about three to four days; but if it rains with this wind it generally hauls to the E., E. S. E., and S. E. These last blow directly on the coast and it is seldom that they are without rain or that they are of long duration; six, eight, or ten hours after they are first felt the sky is overcast and a little after the rain falls. If the rain is very abundant and the wind strong it may be expected to haul and become fixed at N. W.; it holds at this point for twenty or thirty hours, blowing with violence.

Winds from N. W.

The winds from N. W. are always accompanied by clear weather; they are at times violent and seldom last more than thirty hours. The most durable winds are those from S. S. W., variable to W. N. W., and those from N., varying to E. N. E. The weather is sufficiently settled with the wind from these directions.

Squalls.

During the summer squalls are frequent on this coast; they come always from N. E., and are at times so violent that no sail can withstand them; they burst with so much force and rapidity that it requires the greatest precaution to escape their violence. They are first announced by a very black cloud, the weather heavy and suffocating and winds light and variable. On the first appearance of these squalls sail should be taken in and furled. In general the squall rises so rapidly as to allow scarcely time to stow all the sails.

Vicinity of St. Augustine.

From the 1st of November to the end of February the gusts of wind are generally very strong in the vicinity of the coast near St. Augustine; the winds from N. N. E. to

S. S. E., whatever be their direction, if from the eastward, come on rapidly, in this season, with all the force of violent squalls, without any indication.

When the wind blows against the direction of the sun, accompanied by a slight rain, the sea commences to rise before the wind is felt. It is then necessary to be prepared for a blow, which will last generally from fifty to sixty hours. If near the land all sail possible should be carried in order to get well off shore before the squall is in full force, and then heave to.

It must be recollected besides, that the flood running to the S. will not be available outside of soundings of twelve fathoms, and that there the counter-current of the Gulf Stream is met running to the S. until in forty-five fathoms, which is about forty-five miles from the land; then you will meet the Gulf Stream coming from the Bahama Channel, and increase very rapidly the depth of the soundings.

Island of Bermuda.

The Islands of Bermuda are remarkable for the richness of their vegetable productions; for the salubrity of the climate, which is acceptable to Europeans, which may be regarded as one perpetual summer.

The following table* gives a general idea of the climate, of the temperature and the prevailing winds of these islands. It is the mean of observations made during a number of years.

Months.	Mean temperature.	Prevailing winds.	Remarks.
	°		
January	66	N. W	Cold; frequent rain.
February	63	N. E	Do.
March	63	N. W. by W	Milder; fine breezes.
April	76	S. E	Warm; rain squalls.
May	80	S. S. E	Oppressive heat; thunder.
June	86	S. W	Hot; light breezes.
July	79	E	Hot; thunder-storms.
August	79	S. E	Oppressive heat; heavy showers.
September	79	S. W. by W	Hot; frequent showers.
October	79	N. E	Storms; abundant rains.
November	71	N. W	Cold; heavy rains.
December	66	N. E	Cold; thunder and lightning.

From this table it is seen that the coldest months are those of December, January, February, and March, when the minimum of the temperature is 50°; the warmest month

* Montgomery Martin's *History of the British Colonies*, vol. ii. p. 396.

is June, and the maximum 88°; that the winds from the southward, varying from S. E. to S. W., prevail during the summer, and the winds from the northward, variable from N. W. to N. E. prevail during the winter. Winds blowing directly from N. or S. are rare.

Storms and tempests are frequent in this island. Situated as it is at the variable limits of the N. E. trade-winds and of the prevailing winds of the temperate zone, and also in the neighborhood of the Gulf Stream, scarcely a fall passes without storms more or less violent. To the north of the island sudden storms and squalls are the most frequent. During the autumn and winter the sea is most always heavy, and violent winds from N. W. frequently occur, bringing fog and a cloudy sky. Storms and tempests.

The tempests at the Bermudas are sudden and violent, especially during the winter. Toward the evening the whole horizon is obscured by heavy black clouds; thunder and lightning are the precursors of the wind which rises very rapidly. When it commences to blow it varies continually, with violent squalls at intervals of from twenty to thirty minutes, during which intervals it is calm; the sea becomes very high and dangerous for small vessels from its irregularity. Under these circumstances it is best to furl the sails and run before it.* It is remarked, that in the vicinity of the Bermudas there is often a conflict between the winds, and they are very variable.

In the spring the wind blows frequently from S. E. to S. W., varying to N. W. In the south of the group the weather is generally mild and the sea smooth.

When the N. E. trade-wind extends to the north of the parallel of 30° N., the winds from N. W., which are experienced to the north of these islands, become more impetuous; while between the parallels of 28° and 30° N. latitude the sea is smoother, the winds variable and exempt from storms.

Cape Hatteras is celebrated for the continual bad weather encountered there during the greater part of the year. Cape Hatteras.

On the coast of the United States, says Franklin, storms occur from the northeastward, which commence in the southwest portion of the United States, in Georgia, and from thence pass successively over the States in their course

* Lieut. Evans. This is not our advice. We are of opinion that, as in hurricanes, it is proper to heave-to and observe the variations of the wind, to maneuver as described in the Appendix.

north, reaching at times as far as Newfoundland. These winds are violent and last sometimes two or three days; they are accompanied by rain with heavy clouds.

Gulf of Mexico. In the interior of the Gulf of Mexico the trades are the prevailing winds, and in proportion to the force of the local winds they approach nearer or are further removed from the coasts.*

Gales from the N. From the month of October to the month of March, gales from the N. occur. They are very violent and at times accompanied by rain; they are encountered as far as the Bahama Channel. These northerly gales in the Gulf of Mexico are generally announced by a great diminution of the swelling of the sea upon the shores of the Bay of Campechy, by a great humidity of the atmosphere, and by a black cloud seen in the northwest in the morning and evening, from 9° to 10° above the horizon, for two or three days. Sometimes before the gust, lightning in the northwest and northeast, and white threads called *fils de la vierge*, are seen during the day in the rigging. These, as also the phosphorescence of the sea, are indications of a coming norther.

The distinctness with which the high land is seen, and the girdle of white clouds around the mountains of San Martin to the southward of Vera Cruz, are also certain signs of a norther.

The barometer indicates, in the great number of cases most decidedly, these gales from the N. by its falling before the gust comes, and a few minutes before it bursts the column of mercury rises slowly. This is always the case.

The wind rises in the S., weak at first; it then shifts round the compass to the westward until it arrives at N. N. W., when it blows with violence. These blows, which are very dangerous in the Gulf of Mexico, generally last two or three days. The wind being at N. W., if the black cloud mentioned disappears, the blow will not continue long, and the wind blowing only a stiff breeze returns to the E., and if it passes to N. E. it will moderate.†

At other times, the weather being perfectly good, with a light breeze, when the stars sparkle and are more brilliant than usual, when the night is moist, the wind comes

* For details see *Le Manuel de la Navigation dans la Mer des Antilles.*

† From *Le Manuel de la Navigation dans la Mer des Antilles,* by Captain De Kerhallet.

suddenly from the N. without other indication, the noise of the sea which it raises preceding the wind but a few minutes. The northerly gales which commence thus are very dangerous, as they are in general very violent. They are less enduring than the others, and in them the barometer varies but little. At Vera Cruz at this season the mercury is never higher than 30.6 inches, and does not descend below 29.8 inches, an oscillation of 0.8 inches; the mean height of the barometer is 30.1 inches. In these blows there is frequently much rain, and the weather is hazy. They always get up a heavy sea.

Dry season.

The winds from N., called *nortes* by the Mexicans, prevail in the Gulf of Mexico from the middle of September to the middle of March. This is the dry season. In September and October these winds are not usually strong, and if not felt at this season the prevailing winds are interrupted by squalls of wind and rain. In November they are well established, are fresh, and continue during December, January and February. In March and even in April when they blow they are clear, and are then more violent during the first day than when they blow in the preceding months; they haul also less to the N. W. Occasional gusts from the N. occur in the months of June, July and August. The strongest are called *huesos colorados*, the more moderate *chocolateros.*

Wet season, or season of the trade winds.

The wet season in the Gulf of Mexico is from March to September. From the latter part of March and during the month of April the trade-winds, interrupted from time to time by the winds from the N., blow from the E. S. E., sometimes with a clear sky, at others cloudy, and inclining to the S. E.; they last then all the night. From the month of July to October, frequent and strong gusts are experienced, accompanied by thunder, lightning, and heavy rains. Those which come from the E. are the most violent, but have the shortest duration.*

When the storm ceases the sky is generally hazy, with a moderately fresh breeze. If it lights up to the southeast it is ordinarily an indication of the end of the bad weather. These storms generally last from twelve to twenty-four hours when the weather becomes fine, with the wind E. S. E. to S. E.

* *Bernardo de Orta, Derrotero de las Antillas. Manuel de la Navigation dans le Mer des Antilles, &c.*, Part III, by Captain De Kerhallet.

During the season of the trade-winds the variation of the barometer is 0.45 inch, the maximum being 30.4 inches, the minimum 29.95 inches. In June the thermometer rises to 87°, and does not descend below 83.°5. In December the maximum is 80°.6, the minimum 66°.5.

Season of hurricanes.

The period of storms in the Gulf of Mexico, as in the West Indies, is principally from August to October, and the rainy season in these localities, as the corresponding season on the coast of Africa, commences when the sun passes to the zenith of the place in going north, and terminates when it repasses the zenith of the same place in going south. This is called the winter season.

The following table is taken from a memoir by Admiral Bérard, together with the accompanying remarks:*

Dry season or season of the trade-winds.

Month.	Winds from midnight to noon.	Winds from noon to midnight.	Remarks on weather and winds.	
			From midnight to noon.	From noon to midnight.
April	S. S. W., S. S. E., S. E., E. S. E.	E. S. E., E. N. E., N. N. E., N. N. W.	Light	Light breezes.
May	S., S. S. E., E. S. E.	E. S. E., E. N. E	Light	Light breezes.
June	S. S. E. to S. E	E. S. E., E. N. E	Light	Moderate.
July	S. to S. S. E., W. N. W. to N. W.	E. S. E., E. N. E., N. N. E.	Light	Moderate.
August	S. W. to W. S. W., W. N. W. to N. W.	E. S. E. to E., N. E., N. E. to N. N. E.	Light	Moderate.
September	S. W., W., W. N. W., N. W.	N. E. to N. N. E., N. to N. N. W.	Light	Variable.

Dry season or season of northers.

October	W. N. W., N. N. W., N. N. E.	N. W., N. N. W., N. N. E.	Fresh	Fresh.
November	N. W., N. N. W	N. N. W., N	Fresh; period of squalls.	Fresh.
December	N. W., N. N. W	N. W., N. N. W., N.	Nearly always fresh.	Gusts of wind.
January	W. N. W., N. W., N. N. W.	N., N. N. E	Fresh	Period of squalls.
February	N. N. W., N., N. N. W.	N. N. W., N. N. E	Fresh	Fresh.
March	N. W., N. N. W	N., N. N. E., N. E	Moderate	Fine breezes.

**Manuel de la Navigation dans la Mer des Antilles, &c.*, part iii, by Captain De Kerhallet.

Wet season. April.

During the month of April the weather is very fine; the most general winds are those which vary from E. S. E. to E. N. E., and to N. N. E. In the morning the wind is frequently from N. W., variable to S. S. E. and E., and in the afternoon these winds haul to the E. N. E.

When the wind commences at N. in the morning, it blows from N. N. W.; in the afternoon it hauls to the N. N. E. and E. N. E.; in the night it is often calm from 10 p. m. to 2 a. m.

During this month there are at times appearances of winds from the N.

May.

The weather is fine during the month of May. The prevailing winds are those from the E. In the morning they are from S., variable to the S. S. E. and E. S. E.; in the afternoon from E. S. E. to E. N. E., and even to N. E. It is often calm during the night; the wind from E. is light in the morning, fresher towards noon, and is sometimes very fresh in the afternoon, in which case it is observed that it lasts during the night. Towards the end of his month it happens that the wind blows from the E. several days in succession without interruption.

June.

During the month of June the winds from eastward predominate; in the morning they are from the S. S. E. to S. E., sometimes at W. N. W. to the N. W. or N. N. W., and afternoon they haul to the eastward and become fixed between E. S. E. and E. N. E. It is only from this quarter that they become fresh; they last at times twenty-four hours without interruption; at others, they are interrupted by calms.

In this month there are frequent storms; they rarely take place on the sea, but generally burst on the land. There is also over the land very frequent and vivid lightning.

July.

During the month of July, in the gulf, and at large, the trade-winds blow without interruption: they are only variable in their force.

The excessive heat of this month, added to the influence that the neighboring coast exerts on the direction of the winds, occasions many squalls: there is one nearly every day, and a great number burst at sea. They make their appearance to the S. E., the S., the S. W., and N. W. Some come from the E. These storms are called tornadoes.

August.

During the month of August, near the coasts, the regular land and sea breezes prevail; the land breeze usually commences between 11h. p. m. and midnight, sometimes

even after midnight, and lasts until 10h. in the morning. An interval of calm succeeds this breeze, and toward noon, sometimes at 11 a. m., the sea breeze commences and blows until 11h. in the evening or midnight. It is generally followed by an interval of calm. Sometimes the sea breeze blows for twenty-four hours without interruption.

In this month the sky is almost always overcast. While the sea breeze blows clouds and squalls form over the high land; on the other hand they form at sea when the breeze blows from the land.

The month of August is that in which the most rain falls, and in which storms are the most frequent. The winds are very variable, and when they go to the N. are light. There are at times squalls and tornadoes, in which the wind is very strong from the E., but they are of short duration. The squalls are accompanied by torrents of rain and great electricity of the atmosphere.

September. In the month of September the land and sea breezes exist near the coast. In this month the change of season takes place, sometimes hurricanes occur of extraordinary violence, and following these, heavy bores. The winds most frequent in the month of September are those from N. N. E. to N. N. W., at times moderate, occasionally quite fresh.

Dry season. October. In the month of October the prevailing winds are from W. N. W., N. W., and N. N. W., very rarely interrupted by breezes from E. S. E. to E. N. E., these winds are often fresh. In the month of October there are frequently blows from the N.

November to February. In the months from November to February, inclusive, there are, at intervals, violent winds from the N. The prevailing winds are variable from N. to W. N. W.; when they commence they are strong and the sky is overcast. As soon as they haul to the E. or E. S. E., the weather becomes good. These winds have never a long duration, and in general never blow longer than five or six days in succession. The winds from the N. are fresh and sometimes strong in these months; they bring, at times, sharp squalls, and from time to time gales of wind, which have been already described. The month of December is the one in which these northerly gales occur oftenest; sometimes there are four or five during this month.

The winds from the N., when only strong or fresh, moderate toward sunset, and are strongest from 9 a. m. to 3 p. m.

This rule is modified when the wind from N. does not

commence until afternoon, then it continues during the night and increases in force. During these months, in the interval between the northerly winds, the weather is fine and the regular land and sea breezes blow.

In the month of February the gales of winds from the N. have a tendency to blow from the N. N. E., and toward the end of the season they are oftener from between N. N. E. and N. E.

March. In the month of March the winds from N. are less frequent; they are, however, still fresh, and even smart gales occur, indicated by light, curly clouds, called cirro-stratus. In this month the winds from N. bring clear weather, and are, during their first day, stronger than in the preceding months. From what has been said of winds from the N., the necessity will be seen, when at anchor and without protection near the west coast of the Gulf of Mexico, of being constantly in readiness to get under way. It is certainly preferable, with these winds, to lay to in the offing than to run the risk of foundering at anchor.

If near the south coast of the gulf, as soon as a gale from the N. is indicated, it is well to attempt to reach the Bank of Campeachy, where the sea is always sufficiently smooth when to the westward of the meridian of Sisal, and heave to on the parallel of 20° N., and await good weather.

Following the general remarks we will make the tour of the Gulf of Mexico, and indicate the winds peculiar to some localities, and the periods when they blow.

In the Bahama Channel the trade-winds are found from the N. E.; they are interrupted during the winter by the winds from the N., and in the summer by calms. In the winter, from November to April, the winds there are variable from the E. to S., and from S. to the W. In December and January the wind often comes from the N., variable to the N. W., and blows with violence at times for seven or eight days in succession.

In summer, from May to September, the prevailing winds in this channel are from S. E. to S. W., hauling by the S. In March and April the winds are frequentl

West coast of Florida. From the parallel of 28° N. to the cays, south of Florida, the trade-winds prevail, and last during the summer until a little after noon; they are then replaced by the breeze from the offing, blowing between the S. and W. In the winter, especially from November to March, the winds are

from S. to W., and raise a heavy sea. In July and August tornadoes occur, blowing generally from S. W. and S. S. W.

Appalachee Bay.

In Appalachee Bay the winds from W. and N. W. blow nearly all the year, and with considerable force from 9h. to 10h. in the morning until midnight. In the spring there are strong winds from the S., which are rare during the summer and winter. The winds from N. E., which are at times violent in the spring and autumn, are never of long duration.

Coast from Appalachee Bay to the Mississippi.

On the coast comprised between Appalachee Bay and the Mississippi, and in a zone extending as far as 28° N. latitude, from the month of March to July, the winds blow in the morning from N. to E., and from E. to S.; in the afternoon they pass to the S. W. In August the winds are generally from N. E. to E., from S. E. and S. W. In September, October, and November they are from the N. E. It can be said that the prevailing winds on this coast are those from the E., for during a year the number of days during which these winds prevail, compared with those of westerly winds, is as two to one.

On the west coast of Florida the land and sea breezes are generally experienced.

Pensacola.

At Pensacola in the morning the breezes are from N. to E., and from E. to S.; these are replaced in the afternoon by winds from the S. W.; this takes place particularly from April to July. The breezes from S. W., or from the offing, are called "*virazones;*" they blow in violent squalls in August, September, and October. At this period also storms and gusts of wind come from the S. From November to March the winds prevail from the N.; they commence at S. E. and S. with heavy rain, passing to the S. W. and W., where they remain some time and blow strong until they haul to the N. W. and N., when the weather becomes good.

The following observations, made in 1847, 1849, 1851, and 1852, are added by the translator; they are taken from "Notes on the winds of the coast of the United States on the Gulf of Mexico," by the late Professor A. D. Bache, Superintendent United States Coast Survey:

"The observations were made in connection with those of the tides, at the Coast Survey stations at Key West, Florida, Fort Morgan, Alabama, and Galveston, Texas, and included the direction of the wind and its force by estimate.

The description of the means of observation, of the scale used in estimating its force from 0 to 10, and of the mode of obtaining from the observations the quantity of wind blowing from different directions, given to the American Association for the Advancement of Science at the Charleston meeting, and published in its proceedings, applies to the present observations and results. The accompanying comparative diagram is plotted on a compass rose, the average quantity of wind from each direction for the year being laid off from the small circle described about the center of the rose, and is represented on a scale of 18,000 miles to the inch.

"The results at the different stations are shown in different kinds of lines, and the distances representing the quantity of air moving from the several points are, for greater distinctness, laid off from a small circle described about the center of the compass rose as a center.

"The dates of observations were from June, 1851, to June, 1852, for Key West; from June, 1847, to June, 1849, for Fort Morgan; and from July, 1851, to July, 1852, for Galveston. * * *

"The following remarks in reference to these results present themselves, but the generalizations lose much of their point when expressed in words. The diagram enables the eye to seize them with ease and certainty. It is quite probable that some of these may not be exact for every year, though indicated in the result before us. The results have a direct bearing on navigation, and an incidental one on the progress of the surveying operations themselves. Commerce in this sea, closed to the westward and swept by the trade-winds, must be especially indebted to steam-power; the summer sea breeze along part of the coast points this out as the track for sailing vessels making to the eastward, at least along part of the coast. The current of the Gulf Stream is an essential aid to the navigator of the Florida Pass, constantly impeded by the prevalence of easterly winds.

Winds. Fort Morgan, Galveston, and Key West.

"The mixed character of the winds at Fort Morgan and Galveston, as distinguished from those at Key West, is instructive, when considered in reference to their positions in relation to land and water. The geographical positions of these places are appropriate to the investigation of the winds of the Gulf; Key West, in latitude 24° 33′ N., and longitude

81° 48′ W., being near the eastern entrance; Fort Morgan, latitude 30° 13′ N., and longitude 88° 00′ W., near the middle of the northern coast of the gulf; and Galveston, latitude 29° 18′ N., and longitude 94° 46′ W., on the western coast, not quite one degree north of Key West, and but half a degree further west of Fort Morgan than that position is of Key West.

"The winds observed in connection with the tides at intermediate points between these, and extending the observations to the Rio Grande, will be discussed in turn.

"Following the diagram, I propose, first, to trace the prevailing winds in the year; second, those in the several months and seasons and at the different places; third, the changes in quantity with the season; fourth, the varieties in direction from one season to another of winds from nearly the same quarter.

"1. Winds from some northern quarter prevail from September until February, both inclusive, and southwardly winds from March to August, inclusive. Winds from the eastward prevail throughout the year, except at Fort Morgan in May, June, July, and August, when the sea breeze is from the S. W. In the whole year the winds from the same quarter N. and S. balance each other nearly, while the eastwardly wind greatly predominates over the westwardly.

"2. As remarked in my former paper, the months may be classed, according to the prevailing winds, into the following classes: The winter, consisting of December and January; the spring, of March and April; the summer, of May, June, and July; of preparation for change, August; the autumn, of September, October, and November.

"The winter and summer types are extremely distinct. At Key West, in December and January, N. E. and N. are the prevailing winds; at Fort Morgan, N., E. S. E., and E.; at Galveston, N. and N. W., then E. N. E. and S. E. I suppose the general course of the N. E. trade-wind to be disturbed by local action at Fort Morgan and Galveston, the local position of greatest warmth being the Gulf.

"The summer type, May, June, and July, gives S. E. as the prevailing wind at Key West; the S. E., S., and S. W. (sea breeze) at Fort Morgan; the S., S. E., and E. at Galveston, blowing toward the land.

"August resembles July, with the appearance of winds which prevail in the autumn.

"In September, October, and November, at Key West, E. N. E. prevail; at Fort Morgan, N., N. E., E.; and at Galveston, N., N. E., E., and N. W.

"In March and April, the spring period, S. E., S. S. E., and E. winds prevail at Key West; N., S. S. E., and E. S. E. at Fort Morgan; and N., S. E., and S. at Galveston.

"February resembles January with a preparation for the spring period, and, like August, it is characterized at Fort Morgan and Galveston by a general diminution in the quantity of wind.

"January presents the full winter type of the winds on the Gulf, and June and July the full summer type. The changes are quite gradual and tolerably regular from one extreme to the other.

"3. The following deductions are made from these observations in regard to the least and the greatest quantities of wind in the principal directions in different portions of the year.

"The N. wind is a minimum at the three places in July, and a maximum in January. It is a very remarkable feature at all three places in January. The N. W. almost dies out at all three from May to September, first gaining strength at Galveston in October, and reaching its maximum in all the places in December. Its quantity at Key West and Fort Morgan is small when at the maximum.

"The northers and northwesters both appear in force in April, at Galveston. There is very little W. wind at either place, but more at Fort Morgan than either of the others and chiefly during the months of June and July.

"S. W. wind is of rare occurrence except at Fort Morgan, where it constitutes the sea breeze of summer, and reaches its maximum in June and July, suddenly diminishing in September.

"There is but little S. wind at Key West; at Fort Morgan it increases in amount in the spring and is the greatest in June. It is decidedly a marked feature as one of the prevailing spring winds at Galveston, reaching its maximum in May and becoming quite small in August, reappearing in the winter, and rapidly increasing in March.

"The N. E. wind is a minimum at the three places in July and August; is largest in quantity in September, October, November, and December at Key West; in September and October at Fort Morgan; and in September. De-

cember, and January at Galveston. The sudden increase of this wind in September, after its small quantity in August, is remarkable at all three places.

"The winds intermediate between N. E. and S. E. occur during the changes from N. E. to S. E., and it would be of little value to refer to the greatest and least quantities.

"The S. E. wind is a minimum in December and January at Key West; in January and February at Fort Morgan; in December and January at Galveston. It is a maximum at Key West in July, but being replaced during the summer to a great extent by the sea breeze (S. W.) at Fort Morgan, makes its maximum in November, and at Galveston in May, doubtless from the disturbing effect of the land; it is again large in July. This is the sea breeze of Key West, and, as well as the S. wind, that of Galveston.

"4. The movement of the prevailing wind at Key West, where the disturbing causes of the land are the least, is very instructive.

"The prevailing wind in April, May, June, and July is the S. E., hauling to the eastward in August, and becoming E. S. E. In September and October it passes further north to E. N. E., and in November and December becomes N. E., in January it reaches N.; returning southward in February it is N. N. E., in March E., and reaches the S. E. in April. The local action is thus seen to prevail for the greater part of the year over the general. For the whole year the S. E. wind exceeds any other from an eastwardly point.

"The eastwardly wind at Fort Morgan reaches no further south than E. S. E., in the spring and summer. In September the prevailing wind is N. E., passing to E. N. E. in October, and back to E. S. E. in the winter and spring. The general tendency for the year is then E. S. E.

"The changes at Galveston resemble those at Key West, the general absence of E. N. E. and E. S. E. winds being due to defects in the observations.

"5. Of the winds in the three localities it may be said that the S. E. is the characteristic between Key West and the others; the S. W. between Fort Morgan and the others, and the N. W. between Galveston and the other places.

"The S. wind is another peculiar feature of Galveston, shared in a corresponding degree during one month only by Fort Morgan. In the prevalence of trade-winds during certain months Fort Morgan and Galveston are alike.

"The characteristic forms of the surface, representing the whole quantity of wind each month at Key West is very marked. It is shared by Galveston fully only in July and August.

"From May onward to September, inclusive, there appears to be little danger of northers, yet the month of June shows a considerable amount of this wind.

"The velocity of the wind represented in the diagram for May at Galveston corresponds to 11.7 miles per hour, which is nearly the velocity for the average of the whole year.

Table of quantity and direction of wind at Key West, Florida, 1851–'52.

Months.	N.	N. N. E.	N. E.	E. N. E.	E.	E. S. E.	S. E.	S. S. E.	S.	S. S. W.	S. W.	W. S. W.	W.	W. N. W.	N. W.	N. N. W.
June	59	52	53	266	913	1086	2303	1105	338	75	110	109	20	29	56	31
July	5	43	184	103	1483	2017	3230	479	125	4	6	1	1	1	19	60
August	262	96	221	642	2398	3263	2034	988	416	19	24	1	70	204	192	135
September	169	93	766	1996	1486	538	590	209	227	191	461	173	81	132	89	128
October	213	826	2004	3179	1248	623	361	163	364	.....	26	13	95	26	145	44
November	916	1443	2283	1391	1193	596	665	115	173	49	36	21	104	164	78	249
December	1271	886	2452	2220	523	344	191	207	117	134	12	13	65	92	270	406
January	2465	1365	1650	1043	177	135	133	15	53	114	141	6	49	257	402	583
February	1156	1165	1024	472	573	384	791	303	59	108	71	20	15	21	92	330
March	321	483	719	488	1505	1369	1569	927	344	90	57	137	264	591	356	189
April	484	372	158	41	349	414	832	608	586	366	235	234	238	1138	826	346
May	190	179	1206	462	852	1732	1826	160	31	13	1	.....	.....	.....	93	113
Whole year	7306	7006	12720	12307	12699	12707	14550	5284	1936	1188	1181	728	997	2663	2526	2590

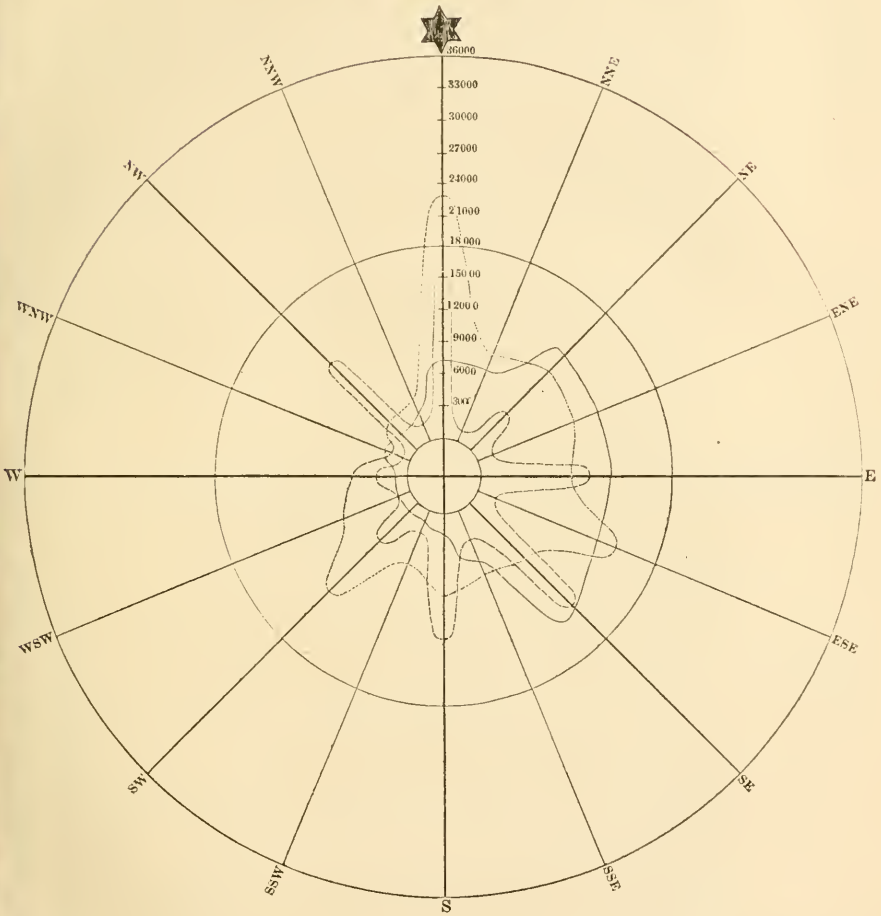
Table of quantity and direction of wind at Fort Morgan, Alabama. Mean of two years, 1847–'48–'49.

Months.	N.	N. N. E.	N. E.	E. N. E.	E.	E. S. E.	S. E.	S. S. E.	S.	S. S. W.	S. W.	W. S. W.	W.	W. N. W.	N. W.	N. N. W.
June.....	725	134	492	400	785	1095	840	243	1505	310	2242	653	702	170	192	219
July.....	516	73	222	112	1091	257	445	578	1049	502	2475	960	828	77	325	175
August.....	986	248	328	679	390	770	539	530	736	321	1577	1034	615	408	372	105
September...	2725	1103	2757	1720	852	994	497	209	441	212	378	381	298	125	257	228
October.....	2467	1580	2155	2128	732	760	273	232	562	497	630	281	419	220	195	203
November...	3141	952	871	1392	377	787	1114	621	158	34	172	151	259	65	600	566
December....	1720	718	680	699	1350	1527	700	538	323	184	195	278	321	547	679	504
January.....	2482	683	563	898	964	1170	565	503	212	132	211	144	157	40	101	499
February....	1870	814	820	721	430	699	326	605	353	199	206	434	452	66	54	720
March.....	1907	1282	877	477	954	1566	791	1504	923	1130	745	417	376	89	234	188
April.....	2086	564	616	307	651	2457	725	446	747	559	933	1096	430	107	51	466
May.....	1815	359	358	454	460	2127	590	598	820	1042	1933	1180	382	123	268	243
Whole year..	22449	8510	10739	9987	9036	14209	7405	6607	7832	5122	11797	6731	5239	2037	3328	4026

Table of quantity and direction of wind at Galveston, Texas, 1851–'52.

Months.	N.	N. N. E.	N. E.	E. N. E.	E.	E. S. E.	S. E.	S. S. E.	S.	S. S. W.	S. W.	W. S. W.	W.	W. N. W.	N. W.	N. N. W.
July	9	3	26	319	359	992	1831	811	261	428	358	16	2	16	30	.....
August	81	.....	32	60	266	191	739	902	538	405	101	.....	21	.....	13	1
September	473	103	943	574	1639	191	417	92	180	65	121	10	85	13	10	9
October	1530	51	632	8	462	.....	399	.....	401	86	242	13	92	17	668	58
November	2485	128	574	.....	165	.....	745	125	664	114	108	28	511	104	2388	65
December	2098	.....	1169	223	1612	39	475	20	189	32	195	.....	300	69	2172	.....
January	2764	599	1252	233	510	.....	464	206	332	1	478	24	461	225	2136	17
February	531	.....	771	.....	657	12	997	203	613	216	535	.....	106	128	744	.....
March	1727	.....	104	325	962	14	2297	160	1678	5	1320	82	227	.....	641	612
April	1894	119	535	.....	830	115	2052	319	1726	24	661	190	360	98	2186	520
May	325	17	23	.....	883	430	2851	.....	4047	167	277	.....	192	.....	132	232
June	1610	1	307	89	2315	156	644	32	1366	301	348	.....	132	4	388	.....
Whole year	15527	1121	6368	1831	10660	2240	13911	2870	11995	1974	4744	363	2489	674	11508	1514

WHOLE YEAR.



NOTES.

The curve for KEY WEST is represented thus:————————

The curve for FORT MORGAN is represented thus:·····

The curve for GALVESTON is represented thus:----------

The diagram plotted on a compass rose represents the average quantity of wind from each direction for the whole year on a scale of 18,000 miles to the inch.

The circumference of the small circle drawn around the center of the compass rose represents the zero or starting point.

The observations were made at KEY WEST from June, 1851, to June, 1852; at FORT MORGAN from June, 1847, to June, 1849; and at GALVESTON from July, 1851, to July, 1852.

Coast from the Mississippi to the Bay of Matagorda.

From the mouths of the Mississippi to the Bay of Matagorda, from the month of April to August, the land breeze blows at daybreak; a little after, the wind hauls to E. S. E. or to S. E., and blows from S. W. in the afternoon.

In July, August, and September, squalls are frequent with wind and rain; there are also winds from the S. varying from S. to S. W. in sharp squalls and lasting several days.

The worst months for navigating this coast are those of August, September, October and November, because the winds are violent and blow upon the coast, and sufficient sail cannot frequently be carried to get an offing if necessary.

In February, March, and April there is much fog at the mouth of the Mississippi. From December to March the winds are often from the N. and blow with violence. If these winds turn to the E. or to the S. of E. the weather becomes hazy, cloudy, and foggy.

Coast from the Bay of Matagorda to Tampico.

From the Bay of Matagorda to Tampico the winds from the S. E. quarter are constant from the month of April to August; during the other months violent winds occur from E. to E. S. E., which last two or three days before it comes from the N.

During the fine season the land breezes are regular from 11h. p. m. to 9 or 10h. a. m.

Coast from Tampico to Vera Cruz.

On the coast of Tampico and Vera Cruz, from April to July, the winds during the day blow from the E., variable to E. S. E.; during the night they go to the S. and S. W., that is, they blow from the land. If the land breeze should go to the N. W., accompanied with a light rain, the wind will ordinarily come the next day from the N., N. N. E., or from N. E., especially in August and September. The land breezes are called *vientos de cabeza* or *vendavales;* these winds are generally light and extend from sixty to ninety miles from the coast, and at this distance they are from E. or from E. S. E.*

Vera Cruz.

At Vera Cruz the winter commences about the middle of May and ends toward the middle of July. There are then frequent interruptions in the trade-winds, much fog and many storms. From the end of July to the middle of October, the period at which the northerly winds set in, the storms are heavier; the most violent come from the E. and last

*Bernardode Orta, *Derrotero de las Antillas.*

but a short time; the winds from the N. prevail after the middle of October to the month of March.

The winds from this quarter moderate generally at sunset; they are strongest from 9h. in the morning until 3h. in the evening, but they do not commence until afternoon or toward the end of the day; they continue during the night increasing gradually in force. It happens at times that at night, and even after midnight, the wind hauls to N. W. and blows off the land. In this case, should it go to the S. W. toward morning, it is probable that the wind from N. will not continue, and that the breeze from the offing will return at the usual hour, from 9 to 10 in the morning; but if this does not take place about or at the time of sunrise, at the commencement of the flood, the winds from the N. will commence again with the same force as on the preceding day; it is then called the *tide wind* from the N., *norte de la marea.*

The winds from the N. end by turning to the eastward—this is a guarantee of good weather. If the wind goes to the N. E. in the afternoon, then, even should the sky be clouded over the following morning, if during the night the land breeze has blown from the S. to W., the sea breeze may be calculated on in the evening; the weather then remains good for five or six days; this is about the longest period with the winds from N.

In the case when from N. E. the wind returns to N. N. E. and to N., the weather is very uncertain.*

The state of the sea is also a good index of the end of a norther;† it goes down gradually, becoming smoother four or five hours before the wind ceases to blow. Wishing to return to an anchorage it is well to be aware of this circumstance.

These remarks upon the winds are important in making the land at Vera Cruz.

Coast of Mexico from Vera Cruz to Point Piedras.

On the coast of Mexico, from Vera Cruz to Point Piedras, during the dry season, the regular land and sea breezes blow; the sea breezes from the northward, that from the land from the southward, from 7h. to 8h. in the evening to 8h. or 9h. in the morning. The dry season lasts from September to April or May; it commences with tornadoes and violent squalls, which become more and more frequent

* Bernardo de Orta, *Derrotero de las Antillas.*

† *Manuel de la Navigation dans la Mer des Antilles,* Captain de Kerhallet.

in May and June. The heavy rains fall in July and August; they are then continual and abundant. In this season there are at times heavy winds from E. S. E., which last for three or four days.

The winds from N. to N. E. commence in October; they are very strong in December and January and then decrease in strength to March. Generally they are fresh and dry, and stronger than the ordinary winds.

Coast from Point Piedras to Cape Catoche.

On the portion of the coast comprised between Point Piedras and Cape Catoche the seasons are nearly the same as those just indicated, only the prevailing winds are those from N. E., interrupted, in the season in which they predominate, by strong winds from the N. In April tornadoes may be expected, blowing from the N. E. to the S. E. This season of sharp, sudden squalls continues to September, and as long as it lasts the winds of the offing blow upon the coast from N. N. W. to N. W. These breezes come up at about 11h. in the morning, and during the night they haul to the E. and E. S. E., then to S. E.; they can be regarded as land breezes.

It is remarkable that the stronger the winds from N. N. W. to N. W. are, the more violent are the tornadoes which interrupt them momentarily.

On this part of the coast it is observed, besides, that the rainy season is much shorter than on the neighboring coast to the west.

We will for a time leave the coast at Cape Catoche, the southern limit of the Gulf of Mexico, to describe the winds in some of the West India Islands.

West India Islands.

The trade-winds from N. E., varying to the S. E., prevail, particularly in the Caribbean Sea, but on approacoing the shores of the islands there are disturbances in these winds which we will indicate. On the coast of the Greater Antilles, Cuba, Jamaica, San Domingo, and Porto Rico the sea breeze blows regularly during the day, and that from the land during the night. These land breezes are the freshest that are known, and are extremely favorable to navigators going from W. to E. in this sea.

In the Lesser Antilles or Windward Islands there are no land breezes, or rather they blow too short a distance off the coast to be of service to navigation.

In these islands two seasons are marked, the dry and the rainy. The limits of these seasons vary according to the

positions of the islands; it may be said, however, that the former lasts from October to June and the latter from June to October.

During the dry season the N. E. trades blow regularly and fresh, with a clear sky. During the winter, from June to October, there are tornadoes and hurricanes, which take place particularly between the 15th of July and the 15th of October.

The following chronological table of the principal hurricanes which have devastated the West Indies during a period of one hundred and sixty-two years, is from Johnston:

1675, August 31, Barbadoes.
1681, Antigua.
1707, Antigua.
1712, August 28, Jamaica.
1722, August 28, Jamaica.
1726, October 22, Jamaica.
1740, Antigua.
1744, October 20, Jamaica.
1751, September 2, Jamaica.
1766, August 13, San Domingo and Hayti.
1772, Antigua.
1780, October 3, Jamaica.
1780, October 10, Barbadoes, Martinique, Porto Rico, San Domingo, Bermudas.
1781, August 1, Jamaica.
1784, July 30, Jamaica.
1785, August 27, Jamaica.
1786, October 20, Jamaica.
1791, October 20, Jamaica.
1792, Antigua.
1795, August 1, Antigua.
1804, September 3, Antigua, &c.,
1804, September 19, Islands of Bahama.
1805, July 25, the vicinity of the Islands of Bahama.
1806, September, the vicinity of the Islands of Bahama.
1807, October 14, between Jamaica and Santa Marta.
1809, August 3, Porto Rico, San Domingo.
1810, August 18, Porto Rico, San Domingo.
1812, August 14, Jamaica.
1812, October 12, Jamaica.
1813, August 1, Jamaica.
1815, October 18 and 19, Jamaica.
1818, September 10 to 12, Cayman and Campeachy.

1818, September 19, Alta Vela and San Domingo.
1818, September 21, Barbadoes and Dominica.
1818, September 22 to 25, Antigua.
1818, October 7, Jamaica.
1819, ———, Barbadoes.
1821, September 1, Bahama, Carolinas, &c.
1827, August 17, St. Martin, St. Thomas.
1830, August 12, St. Thomas.
1830, August 22, Islands of Bahama.
1830, September 29, north part of the West Indies.
1831, June 23, Trinity, Tobago, and Grenada.
1831, August 10, Barbadoes.
1835, August 12, Antigua, St. Thomas.
1835, September 3, Barbadoes.
1835, July 10, Barbadoes, St. Vincent, and Santa Lucia.
1837, July 26, Barbadoes.
1837, August 2, Antigua, St. Thomas.
1837, August 16 to 25, north coast of the Windward Islands.

From the above it is seen that in a period of one hundred and sixty-two years the hurricanes of the West Indies occurred as follows: In June, 2; July, 4; August, 18; September, 11; October, 10.*

We will review, in the following pages, the hurricanes of the three great seas of the globe in a few general remarks. A special study of these terrible tempests would be beyond the province of this work.

Hurricanes.

Hurricanes† take place in the three great seas of the globe—the Atlantic, the Indian, and the Pacific Oceans; the latter, *soit dit en passant*, could be more suitably called the *Great Ocean*.

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* According to Blodget: Climate of United States, p. 400, from observations extending over nearly four centuries, hurricanes have occurred in the West India Islands and their vicinity in the following ratio per 100 for the different months of the year:

January, 1.5; February, 2; March, 3; April, 2; May, 1.5; June, 3; July, 7; August, 28.5; September, 24; October, 20.5; November, 5; December, 2.

† For a more complete description of hurricanes, &c., we would refer mariners to the excellent treatise of M. Keller, hydrographic engineer, Paris: *Traité sur les Ouragans, &c.;* and also to *Silliman's Journal;* to Reid, *Attempt to Develop the Laws of Storms;* to Thom, *Inquiry into the Nature and Laws of Storms;* to Piddington, *Horn Book of Storms, Observations on Revolving Storms, British Admiralty;* and the *Memoir on the Storms of the East Indies,* by Lieutenant Lefebvre.

In the Atlantic Ocean, the West Indies is the center of the most terrible hurricanes known. In the Indian Ocean it is about the position of Rodriguez, Mauritius, and Réunion Islands. In the Pacific, where very few observations have thus far been made, it is supposed to be in the vicinity of the Tonga Islands.

Period of hurricanes.

In the West Indies and their vicinity, the season during which hurricanes may be expected is that comprised between the months of August and October; at this period the navigation of the West Indies, of the Gulf of Mexico, and south coast of the United States, should be avoided as much as possible.

If it is necessary to winter in these localities a perfectly protected port should be chosen. Hurricanes seldom occur in June or July.

In the Indian Ocean, hurricanes take place from December to April; that is, during the warmest months of the southern hemisphere; they seldom occur in November and in May, and are unknown during the other months of the year.

In the Pacific Ocean, to the south of the Equator the known hurricanes have taken place in November and in December, and they appear to have much similarity to those of the Indian seas.

The supposed extent of the zones where hurricanes are met with.

In the Atlantic Ocean, to the north of the Equator, the supposed extent of the zone where hurricanes are experienced is comprised between the latitude of 10° and 50° N., and the longitude of 50° and 100° W.

In the Indian Ocean, the extent of this zone in longitude is three thousand miles, from the west coast of Australia to that of Madagascar, and is comprised between the latitude of 6° or 8° S. and 22° S.*

Having indicated the different treatises published on hurricanes, we cite particularly that of M. Keller and the memoir of M. Lefebvre, and would refer all seamen to these works who may wish to familiarize themselves with the manner in which the general laws of storms are deduced from theory, as also the practical rules for escaping their violence. This subject does not enter into the plan of this memoir, in which we only state facts without searching for the causes. We will limit ourselves by giving the general laws of hurricanes, as deduced from numerous observations,

* See *General Examination of the Indian Ocean.*

and refer for the practical directions to the Appendix No. 1 at the end of this work.

These tempests have a double movement; the one gyratory, or rotary, the other of translation, or movement from one place to another.*

Gyratory movement. To the north of the Equator the gyratory movement is from the right to the left in passing by the N.; that is to say, in an opposite direction to the movement of the hands of a watch. In the southern hemisphere, on the contrary, it is from right to left in passing by the N., or in the same direction as the movement of the hands of a watch.

Movement of translation. The movement of translation is upon a parabolic curve, the apex of which is always turned toward the W., and the branches throw themselves out to the E. The apex of this curve is tangent to the meridian about the latitude of 30° in the northern hemisphere, and about that of 26° in the southern hemisphere; that is to say, nearly at the polar limits of the trade-winds. The hurricane moves on this curve in departing from the Equator; in other words, the point of departure of the hurricane is at the eastern extremity of the curve of its path nearest approaching the Equator, and in a latitude nearly equal to the declination of the sun; from thence, the hurricane, in the first half of its course, is directed toward the apex of the curve, or toward the W.; then it follows this apex as tangent to the meridian, bending afterward to the E., in the portion of the curve of its path the furthest removed from the Equator.

Velocity of translation. The velocity of the translation is in proportion to the violence of the tempest. In the mildest hurricanes observed, it has not been less than ten miles an hour, and in the most violent it has not exceeded thirty miles.†

Diameter of the vortex. Nearly all authors on this subject, observes M. Lefebvre, have sought to measure the diameter of the vortex, and, this diameter being known, to determine from the force of the wind and the falling of the barometer at what distance the observer was from the center. They have succeeded but indifferently; the diameter of the vortex of hurricanes

* The following is taken from the treatise of M. Keller.

† M. Lefebvre states that for the Indian Ocean these velocities are too great, and he estimates for the movement of translation a velocity of from five to six miles an hour, as a mean, for, he adds, hurricanes do not change their place but at a rate of velocity of two miles per hour.—*Memoir on the Hurricanes of the Indies, &c.*, page 12.

is very variable. M. Keller states that the initial diameter of the gyratory movement is from 3° to 4° of the terrestrial arc, and that it increases progressively as it advances, until it attains 8° or 9° at the extremity of the curve of its path.

Dangerous semi-circle.

In the northern hemisphere, the vessels placed on the edge of the right parallel to the path of the center, and in the southern hemisphere those placed on the edge of the left, are those most injured.

A ship surprised by a hurricane perceives successively every direction of the rotary movement of the air on a secant parallel to the path of the center of the meteor;* these changes of direction never make the tour of the compass. When the secant traverses the center of the meteor the wind changes sixteen points at the center perpendicularly to the line of translation, and after an interval of calm.

Oscillations of the barometer.

On each secant the barometer falls gradually to the instant of the passage of the point nearest the center, then it rises progressively from this moment until the end of the tempest, which corresponds to the extremity of the secant. But, says M. Lefebvre, the violence of the wind is no more connected with the diameter of the vortex than the fall of the barometer is. The wind increases as the center is approached, and the barometer constantly falls; this is all that can be said. To attempt to establish a general rule on this point would most likely lead to error.†

Such, according to M. Keller, are the laws principally observed in hurricanes. These laws known, the attempt has been made to utilize them, and to give to seamen the means of avoiding the violence of these terrible phenomena. The two problems to solve were these: 1st, to determine in a hurricane the position occupied by the vessel in relation to the movement of translation of the meteor; 2d, this position known, to determine which may be the best maneuver to make to receive the hurricane or to cross it in the manageable semicircle. The first problem is easily resolved, and M. Keller has given us on this subject a very important general rule which can be applied to every type of tempest, whether they have a convergent or divergent character; that is to say, whether the wind in turning describes a circle, or whether it is directed from the circumference to

* Some authors state that in these tempests the wind attains a velocity of even ninety miles an hour.

† *Memoir on Hurricanes, &c.*, page 11.

the center of the vortex, or from its center toward the circumference.

The following is the principle on which can be determined in every case whether you are to the right or to the left of the path of the storm:*

"Every vortex, in moving, causes to be felt at fixed points on its passage to the left of the path of its center a successive change of wind, turning by compass to the left, or in an opposite direction to the movement of the hands of a watch. It causes to be experienced at points situated to the right of this path a succession of winds which turn by the compass to the right, with the movement of the hands of a watch."

Thus, when a hurricane threatens, by remaining one or two hours in nearly the same position, and observing with great care the successive variations of the wind, the position of the vessel with regard to the line of its path can be determined without difficulty, and consequently whether you are in the dangerous or manageable semicircle.

In hurricanes of a rotary type it is very easy to determine the bearing of the center of the tempest with regard to the vessel. We have said, in effect, that in these tempests, that to the north of the Equator the wind turns from right to left, contrary to the movement of the hands of a watch, and that to the south of the Equator it turns from left to right. Then whatever may be the space occupied by the tempest, the wind blows always in describing a circle. Evidently the center of this circle should be found on the perpendicular to the direction of the existing wind. Consequently, it is sufficient to determine by compass the direction of the wind, and the center will be 90° to the right, if in the northern hemisphere, and 90° to the left if in the southern hemisphere.

In order to avoid error in this particular, the following table can be used, which gives at once, from the direction of the wind, the bearing of the center of the storm for each hemisphere:

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* *Memoir on the Typhoon of 11th to 14th September*, 1840, page 3. In a memoir much more comprehensive, which includes the researches made by M. Keller on hurricanes, which is yet unpublished, the principle which we give here in so condensed a shape will be accompanied by explanations, &c., which will demonstrate its correctness and its practical application.

Northern hemisphere.		Southern hemisphere.	
If the wind is—	The center bears—	If the wind is—	The center bears—
N.	E.	N.	W.
N. by E.	E. by S.	N. by E.	W. by N.
N. N. E.	E. S. E.	N. N. E.	W. N. W.
N. E. by N.	S. E. by E.	N. E. by N.	N. W. by W.
N. E.	S. E.	N. E.	N. W.
N. E. by E.	S. E. by S.	N. E. by E.	N. W. by N.
E. N. E.	S. S. E.	E. N. E.	N. N. W.
E. by N.	S. by E.	E. by N.	N. by W.
E.	S.	E.	N.
E. by S.	S. by W.	E. by S.	N. by E.
E. S. E.	S. S. W.	E. S. E.	N. N. E.
S. E. by E.	S. W. by S.	S. E. by E.	N. E. by N.
S. E.	S. W.	S. E.	N. E.
S. E. by S.	S. W. by W.	S. E. by S.	N. E. by E.
S. S. E.	W. S. W.	S. S. E.	E. N. E.
S. by E.	W. by S.	S. by E.	E. by N.
S.	W.	S.	E.
S. by W.	W. by N.	S. by W.	E. by S.
S. S. W.	W. N. W.	S. S. W.	E. S. E.
S. W. by S.	N. W. by W.	S. W. by S.	S. E. by E.
S. W.	N. W.	S. W.	S. E.
S. W. by W.	N. W. by N.	S. W. by W.	S. E. by S.
W. S. W.	N. N. W.	W. S. W.	S. S. E.
W. by S.	N. by W.	W. by S.	S. by E.
W.	N.	W.	S.
W. by N.	N. by E.	W. by N.	S. by W.
W. N. W.	N. N. E.	W. N. W.	S. S. W.
N. W. by W.	N. E. by N.	N. W. by W.	S. W. by S.
N. W.	N. E.	N. W.	S. W.
N. W. by N.	N. E. by E.	N. W. by N.	S. W. by W.
N. N. W.	E. N. E.	N. N. W.	W. S. W.
N. by W.	E. by N.	N. by W.	W. by S.

The bearing of the center of a hurricane from the vessel being known, it is certainly desirable to determine its distance; for this, however, no precise rule has as yet been found. Some very good inferences may be drawn from the quickness or sluggishness with which it appears to develop itself, from the increasing violence of the squalls, from the irregularity of the sea which rises in several directions, and above all from the rapid variations of the barometer.

A remarkable trait of the rotary gale is the increase of the wind in the vicinity of its center, although at the center itself it blows so irregularly and by squalls as to render it impossible for a ship to complete a maneuver. The nearer the center is approached the more sudden are the changes

of the winds, which instead of shifting point by point, as is the case at the entrance of the circle of the tempest, it shifts all at once sixteen points. The ship is enveloped in a terrible squall, and gathers stem-board against a frightful sea, the disastrous consequences of which it would be unnecessary to detail.

The undulations and currents of hurricanes appear to be the constant results of these violent atmospheric shocks. These two phenomena deserve to be the subject of serious study and research.

Undulations of the hurricane.

The undulation of the hurricane is a mass of water of greater or less diameter, according to the force of the tempest raised above the ordinary level of the ocean by the atmospheric pressure or other cause. This mass is driven before the storm in its course until it encounters some obstacle, as the mouths of rivers, bays or coasts, when it often produces serious inundations or heavy bores.

Currents of the hurricane.

The currents of a hurricane can be briefly defined as circular currents, where the circumference of the tempest is of a rotary type.

There are also in every hurricane two forces, independent of that of the wind, which act upon a vessel, the one drawing her directly in the line of the path of the storm, the other drawing her toward the circumference of that portion of the rotary circle where she is placed; thus while the drift due to the undulation of the hurricane sets towards the W., the current of the hurricane will set towards the W. on the northern portion of the rotary circle; it will set to the E. on the southern part of this circle, to the S. on the western portion, and to the N. on the eastern portion of the same circle. If the rotary motion is from E. to W. passing by the N., as in the hurricanes of the northern hemisphere, the rotary motion would be in the opposite direction in the hurricanes of the southern hemisphere.* Electricity seems to take a great part in hurricanes, though very often it may escape observation.

Among the thirty-two hurricanes of the Indian Ocean, of which the data is precise, eleven have been accompanied by thunder and lightning, while in twenty-one no electric phenomena were observed. Thom† says that these phenomena are five times more frequent on the north side of the curve

* *Inquiry into the Nature and Course of Storms.*

† *Horn Book of Storms.*

of translation of hurricanes than on the south side, that is, in the position where the monsoons of the W. prevail. He adds that it was so common for lightning in the N. and N. W. to precede a gale, that the Dutch captains when going from the Cape of Good Hope to India had orders to reduce sail and take every precaution when they saw lightning.

In addition to the menacing aspect of the sky which generally precedes all storms, that thick circle round the sun or moon, clouds heaped up and distended with their gloomy lines of light and their fantastical colors, often of copper color, forming a heavy curtain at the horizon, with menacing points and lines of pale lightning, is known to every sailor. These clouds rise little by little, covering soon the whole horizon. In approaching the zenith squalls form before the strength of the tempest; the rain falls in torrents, and at the same time the hurricane bursts.*

The barometer and sympiesometer are most valuable instruments in the region of hurricanes, and should be attentively consulted. In these regions a great fall of the mercury below its ordinary level never takes place without being followed by a tempest. We have given above its course in hurricanes.

Heavy rains always accompany tempests of a rotary type. At a distance of one hundred miles from each side of the rotary circle, there is a heavy bank of clouds giving out torrents of water without interruption, and this during several weeks.

Hurricanes seldom penetrate into the Gulf of Mexico, though three or four have ravaged its coast, and reached as far as Vera Cruz. Among others that of 18th of August, 1810, and that of 23d of June, 1831.

Calms and squalls near the West India Islands.

To leeward of the high land which forms the greater part of the West India Islands calms are often experienced, interrupted by violent and dangerous squalls descending the gorges of the mountains. It is only two or three leagues in the offing that the regular breeze is felt. The flaws are announced only by a sharp whistling, and at times by the ripple on the surface of the sea. It is necessary to be guarded against these flaws when sailing to leeward of the islands. Ships have been dismasted by these gusts, and some have even been capsized at the entrance of the bays where they intended to anchor.

Races.

Strong races occur during the winter in most of the bays

* Lefebvre.

of these islands; they come generally after a calm or light breezes.

Cuba. In Cuba the rainy season is from June to September. Around the island the N. E. trade blows with regularity from March to October. During the other months it frequently takes the direction of N. variable to the N. W., and then it is very violent.

In the fine season the land and sea breeze is regular on the northern coast; it commences about 11 a. m. or noon, and ceases in the evening, to give place to the land breeze. It is observed that while the trade-wind predominates on this coast, the winds blow often from S. to E. in the morning, shifting afternoon to E. N. E. and to N. E. until evening. At Havana the sea breeze springs up generally at 10 a. m. On the southern coast the land and sea breezes alternate; the land breeze commences a little after sunset.

Bayamos The sudden gusts of wind called *los bayamos** are local squalls, which blow from the land to the offing on the south coast of Cuba. They have received this name from being more violent in the vicinity of the Bay of Bayamos, situated to the north of Cape Cruz, than elsewhere. The *bayamos* are announced by thick clouds covering the mountains, and by the thunder which nearly always precedes the wind. As soon as the first clap of thunder is heard, sail should be taken in and furled, for in the majority of cases the wind will arrive immediately after. These squalls are of short duration, but they are at times very violent, and as they succeed each other at the interval of an hour and even of a half hour, it is necessary to watch well the weather, particularly during the night, to avoid being surprised, for if caught under the upper sails there is nearly a certainty of being dismasted or endangering the ship.

These sudden squalls are accompanied by flashes of lightning which succeed each other with frightful rapidity; they are extremely brilliant and leave behind them a bluish tint. During the bayamos the sea becomes white with foam and rain falls in torrents.

The following table is a résumé of the observations which we have collected on the wind and weather of the Island of Cuba. The winds marked with an asterisk (*) are those which blow the most frequently: *

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* *Manuel de la Navigation dans la Mer des Antilles, &c.*, part iii.

Months.	Most frequent winds.	Observations on wind and weather.
January	N., N. E.,* E.,* S. E., S., S.W., W., N.W.	Generally cloudy; strong winds from N.; cloudy; squalls; land and sea breezes irregular.
February	N., N. E.,* E.,* S. E., S., S.W., W., N.W.	Generally cloudy; winds fresh; some strong winds from N.
March	N., N. E.,* E.,* S. E.,* S., N.W.	Sea breezes fresh; some gusts; weather generally clear.
April	N., N. E.,* E.,* S. E.,* S., S.W., W., N.W.	Fine generally; winds moderate; land and sea breezes.
May	N., N. E.,* E.,* S. E., S., S.W. W., N.W.	Fine; some rain squalls; winds moderate; land and sea breezes.
June	N. E.,* E.,* S. E.,* S., S. W.	Fine; weather dry; winds moderate; land and sea breezes.
July	N. E., E.,* S. E.,* S., S. W., W.	A portion very pleasant; fresh breezes; rain at intervals; calm; squalls.
August	N. E., E.,* S. E.,* S., S. W., W., N. W.	Squalls with rain; calms; storms; light winds; some rain-squalls.
September	N., N. E.,* E.,* S. E.,* S. W., W., N. W.	Very fine; calms; sea breezes, light; sky cloudy; storms.
October	N., N. E.,* E., S. E ..	Very fine; moderate breezes; occasional squalls.
November	N.,* N. E.,* E., S. E., S. W., W,, N. W.	Moderate breezes; occasional squalls; winds fresh; light rain; winds from N. occasionally; generally fine.
December	N., N. E.,* E.,* S. E., S. W., N. W.	Good weather; gales from N.; fresh breezes; cloudy.

We give below a series of observations made during a year at Nassau, New Providence:* Bahama Isl'ds.

Months.	Winds.	Remarks on the wind and weather.
January	S., N. E., N. N. E., N	Fresh breezes with clouds.
February	N. E., S. E., N. E	Moderate and variable.
March	N. E., S. E., N. E., N	Clear, with squalls.
April	E., N. E., S. E., N. W	Clear; a little rain.
May	Variable	Moderate; showers.
June	....do	Clear; dry.
July	S. E., E., S., N. E	Light; clear.
August	N. E., E., N. W., S	Squalls with rain.
September	N. E., N. N. W., S	Clear; rain and fog.
October	E., N. E., N. W	Light; rain and squalls.
November	S., S. W., W. S. W	Moderate; squalls.
December	S., S. W., N. W	Variable; light; clear.

* Montgomery Martin, *History*, &c.

Barometer.

At the Island of New Providence * the movement of the mercury of the barometer is greater during the winter than in the summer. The oscillations are never so considerable as observed in higher latitudes; but as little as they may be, they are wholly appreciable.

The rain has but little influence on the barometer; sensitive only to the winds, it rises and falls in accordance with the direction from which they blow; thus the barometer will be much higher with the winds from N. to E., accompanied by rain, than when they vary from S. W. to N. W. by the W., without rain. The barometer attains its maximum height with the winds from N. E., and its minimum with those from N. W.

If during the winter, that is from the commencement of October to the end of March, the wind blows strong from the N. E., the barometer stands between 30 and 30.1 inches to 30.2 inches. If then the weather becomes bad and the barometer rises much, (that is 0.05 to 0.10 inch,) it announces a blow or a very fresh breeze from this quarter. This is remarkable, for in all the other cases of very fresh winds, the barometer falls.

If, with the winds from N. E. the mercury falls, the winds will turn to the eastward; if it continues to fall, it will turn to the S. E., to the S., and successively to the N. W. The barometer will then reach its minimum, with the ordinary winds from N. W.; this is about 29.86 inches. But if, instead of falling gradually as we have said, it falls much and suddenly, with the wind at N. E., or at any intermediate point between N. E. and S., it is probable that there will be a sudden calm, and that the wind will fly quickly to the N. W. However, if, after the mercury has descended gradually, it again rises with any intermediate wind, this wind, under these circumstances, will turn to the E. and N. E. and will remain in that quarter until another fall of the barometer.

When the wind is N. W., if the mercury remains low, it may be expected that the wind will blow some time from this direction; if the mercury rises it is a certain indication that the wind will turn to the N.; and if the mercury continues to rise, that it will approach to the N. E.; but if it descends with the wind at N., the wind will return to the N. W. When the upward movement with the wind at N.

* Observations made by S. C. Lees at Nassau.

W. is rapid and considerable the wind will not remain long at N., but will haul to the N. E.

During the summer months the winds vary from N. E. to S.; those which prevail blow between E. and S. The barometer in this season varies 0.75 inch above and below 30 inches; it is higher than this on the approach of winds from the N. E. and while it blows, and lower when the wind is coming from the southward and while it lasts. There is, however, a general light wind from the S., which blows in the morning and evening and extends but a short distance from the land and resembles the land and sea breezes near the large islands; it produces no effect on the barometer.

When in the months of hurricanes the barometer falls considerably and rapidly, bad weather should be expected and every precaution taken. If, for example, the barometer is at 30.2 inches, and descends suddenly to 29.8 inches, this fall should cause mistrust; and if it should fall below this point, there is nearly a certainty of soon having a gale. This fall of the barometer might, sometimes, precede a hurricane by one or two hours only.

Jamaica.

At the Island of Jamaica the land and sea breezes are well established in the fine season; the former extends as far as twelve miles from the coast, and they cease about 4h. in the morning. The following observations have been made on the winds at this island:

Months.	Winds.	Remarks on the wind and weather.
January	N. to S. E	Fine; light rains; strong winds from N.
February	do	Fine and dry; strong sea breezes.
March	do	Do.
April	do	Very dry; moderate breezes.
May	do	Fine; showers.
June	do	Fine generally; heavy rains.
July	do	Much rain; fine generally in the intervals.
August	S. S. W	Some heavy rains.
September	S. S. W. and S. E	Fine mornings; much rain afternoon.
October	do	Heavy rains at intervals; generally fine.
November	do	Do.
December	do	Little rain; generally fine.

Santo Domingo.

The winds in the Island of Santo Domingo or Hayti vary according to the different parts of the coast where they blow. The winter continues from the end of April to November. In this season gusts and storms are frequent; at the same period strong S. E. winds are experienced in the

Bay of Gonaives, and in the Channel of St. Marc. In November, December, January, and February, the winds from N. variable to N. W., blow with force, principally on the northern coast of the island. On the southern coast, frequent storms occur in June, July, and August, in which the winds come from the S., and are violent principally from that direction.

On the entire coast of this island the land and sea breezes blow; their direction varies according to the trending of the land. The sea breeze commences at from 8 to 9 a. m., increases until midday, or 4 p. m., when it diminishes and gives place to the land breeze, which lasts until 4 or 6 in the morning.

Porto Rico.

At Porto Rico the rains fall from June to August. The trade-winds are from N. E. The sea breeze commences at 8 a. m., and lasts until 4 in the evening, when it gives place to the land breeze. On the coast of this island the land breeze, while it lasts, is very weak, and it cannot be counted on.

Windward Islands.

The following observations made at Trinidad and at Dominica will give a general idea of the winds met with in the Windward Islands, as also their climate. The first table is for the Island of Trinidad:

Months.	Winds.	Observations on wind and weather.
January	E., E. N. E., and E. S. E.	Cloudy; rain.
February	E. and E. N. E.	Cloudy; heavy dews.
March	....do	Fine; dry.
April	E. N. E.	Fresh breezes.
May	S. E., E. N. E.	Strong breezes; thunder.
June	E. N. E., E. S. E	Rainy; breezes variable, in force.
July	E. N. E.	Subject to tempests, rains, and storms.
August	E. S. E	Wind in squalls; rain and storms.
September	....do	Heavy rains; storms.
October	....do	Strong breezes.
November	E. and E. N. E.	Fine; occasionally warm.
December	....do	Cold.

The following table is for the Island of Dominica:

Months.	Winds.	Observations on wind and weather.
January	E. N. E. and N.	Cloudy.
February	E. N. E. and S. E	Cold.
March	N. E. to S. E.	Fine; sometimes cloudy.
April	E. N. E., S. E., S	Fine; moderate breezes.
May	N. E. to S. E. and E.	Calm; weather clear.
June	S. E., E. to N. E	Calm; fogs and rains.
July	do	Calm; nights cold.
August	S. E. and N. E	Calm; nights cold; storms and sudden gusts.
September	S. and S. E	Generally fine, rain at intervals.
October	N. E. to S. E	Cloudy and fine alternately.
November	do	Fine and dry.
December	do	Fine, dry, and cold.

We will now take up again the coast from Cape Catoche and continue it to the southward.

Coast east of Yucatan, Vera Paz, Honduras, and the Mosquito coast.

On the coast east of Yucatan, and upon that of Honduras and Mosquito, which form the western boundary of the basin of the Caribbean Sea, the N. E. trade-winds blow from April to September. They are sometimes interrupted, and especially in the first two months, by winds from the W. In June and July the winds on this coast vary from E. to W. by the S., bringing frequent rain-squalls and calms. August and September are the pleasantest months, the winds are moderate from the sea, interrupted by variable winds. In October, November, December, and January, they blow from S. to N., hauling by the W., with gusts from the W. S. W. to the W. N. W., variable to the N.*

Coast from San Juan de Nicaragua to Cape de la Vela.

On the coast between San Juan de Nicaragua and Cape de la Vela the winds are very variable.† From January to June they are from N. E. to E.; in May and in June they are, however, frequently interrupted by tornadoes. Between the months of July and December, but principally in July and August, there are winds from the W., very uncertain and quite light; they blow at times seven or eight days,

* We would observe that the people of the country call several winds, winds from the N., with little reference to the quarter from which they blow. Their nomenclature of winds is: land breeze, sea breeze, and north wind. That which the inhabitants call a dry north wind, is a wind from the W., violent, with clear weather; a wind from the W., moderate, is called a little norther.

† Dampier.

when the N. E. winds return; the winds from W., however, predominate in this season. When the winds from W. blow on this coast with more force and for a longer time, the trade-wind from the eastward prevails at large, as in the other seasons. It is found too within twenty-four to thirty miles of Cape de la Vela, even when the wind from W. blows on the coast in the vicinity of the cape.

Puerto Bello. At Puerto Bello, and between this point and Carthagena, the wind is N. E. from the 15th of November to the 15th of May. At the end of May it turns to the S. W. and to the W. S. W., and extends to the parallel of 12° N. latitude. These winds from S. W. and W. S. W. are, at times, strong and bring rain. At sixty miles in the offing from Puerto Bello the winds which blow from the southern quarter in the bight of the gulf change to the N. E. The winds from the S. extend generally twenty-four to twenty-seven miles from the coast. The winds from the S. W. to W. S. W. are called *vendavales.*

Carthagena. In general, at Carthagena, the winds are N. E. from the middle of December to the end of April; this is the fine season. During the winter, from May to November, there are continual rains and storms. In the summer season the N. E. trade-winds commence to be established about the 15th of November. In the winter season the winds blow from S. W. to W. S. W., extending as far as the parallel of 12° N. latitude, beyond which the winds are from N. E.

In November and December there are strong breezes, with much rain.* On all this coast, during the winter, tornadoes often occur.

Coast of Caracas and Cumana. The trade-winds have their ordinary course on the coasts of Caracas and Cumana, as far as Cape de la Vela; but from that cape to Point San Blas, their direction varies from N. E. to N. N. E. In the months of March, April, May, and June, they are more regular, blowing from E. N. E.; they are then very strong. These strong breezes extend from the middle of the channel to within six or nine miles of the land, and lose their intensity as they approach it.

On these two coasts, and even as far as the Gulf of Nicaragua, from July to December, and, at times, to January, winds from the W. with rain are experienced, called *vendavales*, of which we have already spoken.

*Malham.

Coast of Guiana.

On the coast of Guiana the trade-winds from N. N. E. to E. N. E. blow from November to May: in April, May, and June there are variable winds and calms; then the winds change to E. S. E. and S. E., and blow especially from S. E. from June to December. The rainy season lasts from December to June. During the dry season there are frequent showers and violent squalls.

The following table is a summary of observations made on the winds at Demerara:

Months.	Winds.	Remarks on the winds and weather.
January	E	Cold; fresh breezes.
February	N. E	Heavy clouds, with showers; weather gloomy.
March	E. N. E.	Heavy clouds; very frequent showers.
April	E	Hot; no rain.
May	N. E	Heavy clouds; weather dull; frequent lightning; rain.
June	S. and variable	Hot; rain at intervals.
July	E. and S	Hot and oppressive.
August	S	Hot; rain at intervals.
September	S. and E	Heat; thunder and lightning.
October	Variable	Fresh breezes; light showers.
November	N. and E	Fine breezes; light showers.
December	N. N. E	Heavy rains; strong breezes; cold.

French Guiana.

On the coast of French Guiana, according to Commander Lartigue, the winter commences in November and ends in July, the dry season being from July to November. The winds from E. N. E. blow during the first period, those from E. S. E. during the second. The season of heavy rain is from December to February, prolonged, at times, until March, and sometimes commencing about the 15th of November.

In March and April there is an interval of three weeks or a month, during which the rains cease. This period in French Guiana is called *l'été de mars;* they recommence falling about the middle of April, and terminate toward the middle of July. The period during which the heavy rains of May fall is called *la poussinière.*

From November to March the winds are from N. N. E. to N. E.; during March and April they vary from E. to S.; from May to July they return to the N. E.; calms then are rare, and there is no land or sea breeze.*

* Commandant Lartigue, *Instructions sur la Guiane.*

It has been remarked at Guiana that the winds from E. to S. are the least rainy.*

North coast of Brazil.

On the north coast of Brazil, as far as Cape St. Roque, the prevailing winds are from the N. E. to the S. E., shifting by the E. From July to December the winds from S. E. to E. prevail; from December to July those from the N. E. to E. The month of June is the epoch of the change of these periodic winds, and in this month, near the land, frequent calms are experienced, interrupted by squalls, which, at times, bring wind, always heavy rain. The heaviest squalls are those which blow from E. to N. E.

On this coast, at a short distance from the land, there are frequently during the night and morning land breezes varying from S. S. E. to S., which cease toward 8 or 9 a. m.

Winds and seasons at Para.

At Para the year is divided into two seasons, the rainy season or winter, the dry season or summer. The season of rains commences ordinarily in January and ends in June; the dry season continues from July to December. During the intervening months the weather is very variable, and partakes of the character of both seasons.

During the winter the prevailing wind is only experienced at long intervals. At this period there are long calms, interrupted by sudden squalls from N. E. to S. W., shifting by the W., which are almost of daily occurrence in the river; they are accompanied by torrents of rain. In general the rain in this season commences to fall about 11 a. m., and lasts often until 10 to 11 p. m. During the remainder of the night and morning the weather is good. During the dry season the winds are constant from the eastward; they are moderate in the months of July and August, and very fresh during the other months.

The squall named *grain du Para* takes place then most frequently after noon, toward 2 or 3 o'clock.

During the summer it is rare that the wind varies more from the E. than from E. N. E. and E. S. E. These winds at the entrance of the river Para are in general very fresh, and they continue always fresh as far as the Bay of Sol. During the night they moderate in the upper part of the river and do not regain their force before the middle of the forenoon.

Winds and seasons at Maranham.

At Maranham, according to Commandant Montravel, the season of rains commences at the end of December or at

* Commandant Lartigue, *Instructions sur la Guiane.*

the beginning of January, and continues to June or July. During this season the rain falls in torrents, the squalls are frequent and very strong. The winds often shift round the compass in twenty-four hours; the most frequent winds are those from E. N. E. and N. E., varying at times to N., to the N. W., W., and the S. W.; in this case, there are squalls divided by intervals of calm or light variable winds. It rains less, however, at Maranham than at Para, and it is by no means rare, even in this season to have some fine days and several days in succession of passable weather.

The dry season lasts from July to December. During this period there is generally a fresh breeze varying from N. E. to E. N. E., and sometimes as far as E. S. E. If it rains it is only by squalls. From September to November the winds are generally strong; they moderate after sunset and recommence in the forenoon. During this season there is frequently much lightning during the evening, but seldom thunder. About the month of July the seasons change. The sea is very rough in the dry season on the coast and in the Bay of San Marcos.

East coast of Brazil.

On the east coast of Brazil, the winds are periodical. From September to March, they blow from the E. N. E. to the N. E.; from March to September, they blow from S. S. E. to E. S. E., these winds do not extend more than one hundred and twenty to one hundred and fifty miles from the coast. Beyond this limit, the trade-wind prevails and blows oftenest from S. E. by E. At this limit, however, the winds are found variable from S. S. W. to the S. E., with rains and storms.

On the north part of this coast principally there is much rain and variable winds; in March and September, the period of the change of the periodic winds, heavy and sudden squalls occur.

Remarks on the monsoons.

The monsoons which we have spoken of on the east coast of Brazil are far from being regular, as might be believed from the rule we have given. On this subject we will cite the opinion of Admiral Roussin given in the *Pilote du Brésil*.

"After observations made during a hundred and thirteen days of the S. E. monsoon, there were but thirty-five days in which the winds were from S. to E., that is, those which might have been expected in that season, from the generally

received opinion; during thirty-eight days the winds were from N. variable to the E., which would seem to belong to the opposite monsoon; and lastly there were sixteen days of winds from N. to W., and twenty-three days they were from W. to S. During a hundred and fifty-three days of the N. E. monsoon, the winds were for seventy-five days from S. to E.; seven days from N. to W.; six and one-half days from S. to W.; and only sixty-two days from N. to E., which, from the general opinion, should have been the wind of this season; the remaining days were calm. These facts prove that the two monsoons of Brazil are not regularly established.

"In this variety, certain special winds are distinguished, some accidental, the others periodical, which appear to be connected to some spontaneous phenomena, or to belong to certain localities.

Accidental winds.

"In the first rank should be placed the sudden storms from S. W., which blow frequently during the rainy season at the epoch of the full and change; these are called *los rebojos*, they last three or four days, moderate, they are accompanied by rain, and they acquire force when the sky is clear.

"The other accidental winds are a species of rain squalls; they are met with principally about the Abrolhos, when the season is very rainy. These rain squalls are frequent in the months of May, June, July, and August, and blow from the E. S. E.; they come from round, white clouds, having little appearance of wind, but burst with a force which makes it necessary to mistrust them.

Land breeze.

"The land breeze is regular on the coast of Brazil, and blows most every night throughout the year. It prevails on all points of the coast, from the Island of St. Catherine to Maranham, but has more or less strength and regularity according to the season and locality. The nearer the Equator is approached, the more it is distinctly established. At Rio Janeiro it is nearly daily, and seldom fails to blow about 9 in the evening, and does not die out entirely until the following morning. It is the same at Espiritu Santo, Porto Seguro, Bahia, Pernambuco, and other places similarly situated.

"In the N. E. monsoon the land breezes are more regular than in the other monsoon; they are also stronger, for then the wind from the offing blowing on the coast more di-

rectly and more constantly, the reaction caused by the freshness of the night on the land makes them stronger and more regular.

"During the S. E. monsoon the winds are often variable from S. and the S. W.; the land breezes are confounded with them, and are not distinguished from them.

"The stronger the sea breeze has been, the stronger will be the breeze from the land; ships can thus, almost always, leave the ports of Brazil on a fixed day."

Bay of All Saints.

In the Bay of All Saints, (Todos os Santos,) the winds are E. N. E. from September to April; from April to August they blow from the southern quarter with violence, varying from S. E. to S. S. W. In April they commence to change to the S. and S. S. W.; their greatest force is in May, June, July, and August. During these months they blow from S. E., varying by the S. to S. S. W. The seasons change in April and September; the wet season commences in April in this bay, as upon the coast of Brazil; the fine weather returns in September.

Rio Janeiro.

At Rio Janeiro, the sea breeze which blows from the E., commences in the offing about 11 a. m.; it does not arrive in the harbor and city until from 2 to 3 p. m., although the city is but nine miles from the sea. The sea breeze continues until sunset; the land breeze commences in the evening and lasts until morning; its duration and force depend, besides, on the season.

Paraguay.

On the coast of Paraguay, the sea breeze sets in at 9 or 10 a. m., and continues until sunset.

Rio de la Plata.

We borrow from Captain Chiron du Brossay, who was a long time in the Rio de la Plata, the following observations on the winds of this river and the places in its vicinity:*

"The winds in La Plata and at its mouth follow the seasons, but the configuration and proximity of the land exercise so great an influence on their force and direction, that they are hardly ever the same at the mouth as at the interior of the river; this is also sometimes the case on the two shores of the river; it is noted that a violent blow at Buenos Ayres was not felt on the north shore of the river.

"Nearly all the pilots attribute a great influence to the phases of the moon; they also agree in saying that it is very difficult to foretell the weather with any degree of cer-

* *Instructions Nautique sur l'Atterage et la Navigation de La Plata.* (*Annales maritimes*, 1845.)

tainty, so much is the atmosphere subject to sudden variations which baffle all predictions. The storms form and burst so suddenly and with so great violence that it is always necessary to be prepared. Examples are cited of very violent pamperos coming up during clear weather, announced only by a curling cloud. They do not come up in this manner excepting with the wind N. W. and W.

"In the country the wind from S. W. is called *pampero;* it is announced, generally, by heavy black clouds which seem to roll one upon the other; at other times an immense black arch covers the sky from the west to the east; soon the horizon clears to the S. W., then the pampero bursts with an impetuosity, of which an idea can hardly be formed. Often it is accompanied by lightning, thunder, and rain; the temperature falls to a point so low as to render it uncomfortable. The sky soon clears, and remains so while the pampero lasts.

"Nearly always, in moderating, the wind hauls to S. and S. E. Before the pampero bursts the barometer shows a great depression; the mercury commences to rise at the end of the gale, or when the wind hauls to the S.

"In La Plata and at sea, on the same parallel, the winds are very variable; clear of the land, in the pleasant season, from September to March, the prevailing wind is from N. E.; the horizon is charged with vapors and the sky dotted with rounded, irregularly formed clouds.

"In approaching the river the wind hauls to the E., sometimes to S. E., fresh with rain or cloudy weather.

"In the river, during the season, the wind from S. E. blows quite regularly and with force in the afternoon; at night it falls and goes to the N.; this breeze is called virazon; when it fails and the wind from N. to N. W. continues, before the virazon is re-established, a sudden storm from the S. W. (a pampero) may be expected, more or less strong. We repeat that every precaution should be taken against being surprised by these sudden pamperos.

"Near the time of new and full moon there are frequently fresh breezes from S. E., with rain; sometimes also the wind blows from the N., but with less strength than from the S. E., and the temperature is higher.

"The pilots pretend that the wind from S. E. blows when the declination of the moon is south, and those from the N. when her declination is north. Under these circumstances

the wind from N. goes most always to the N. E., if it is dry; if it is accompanied by rain or heavy dew it hauls to N. W.: often it becomes very strong and blows in squalls from this direction, and finishes by going to the S. W. very fresh: with this wind the sea rises very quick and falls as quickly when it ceases.

"From March to September the most frequent winds at the entrance of La Plata are from W. to S. W.; going up the river they are more frequently to the N. than to the S. of W.

"In the road of Buenos Ayres the winter season is preferable to that of summer, for the wind being generally from S. W. to N. W. the sea is smooth and communication easier.

"In the months of July, August, and September there is frequently thick fog, especially from the mouth of the river as far as the Ortiz Bank; more inside it is less frequent.

The inhabitants of La Plata attribute noxious influences to the N. wind; it is in effect warmer, and while it blows the atmosphere is charged with electricity; the wind from this quarter ends, most always, by a storm, in which the wind goes to the S. W. and re-establishes the equilibrium.

"Sometimes the pamperos extend to sea and pass the latitude of the Island of St. Catherine.

"When they are clear they last longer than when they commence with a clouded sky.

"The description which has been given of the winds in the offing, at the entrance, and in the Rio de la Plata, is as they are generally found; it would be by no means surprising to find them different, for the wind is so variable that neither its direction or its endurance can be relied on; often for many years in succession, in the same season, the winds are extremely different."

East coast of Patagonia.

The vessels leaving the Atlantic destined for any port in the Pacific Ocean will find it to their advantage to keep within less than one hundred miles of the east coast of Patagonia, as much to avoid the heavy sea, raised by the westerly winds which prevail to the eastward, and are stronger as you recede from the coast, as to profit by the irregularity of the wind; when it is from the western quarter, near the coast, from the month of April to September, when the sun is in north declination, the winds keep more between W. N. W. and N. N. W. than at any other point; the winds

from E. are rare; but when they do occur, as they blow obliquely upon the coast, there is no risk run of being driven too near the land. In the opposite season, when the sun is in his southern declination, the winds are from S. to W., and are often very strong; but as the coast is to windward the sea falls immediately with the wind. Although at this season the winds are of a nature to impede the progress of a vessel, still they are rarely fixed and frequently vary six or eight points in the space of a few hours; from this circumstance an advantage is gained in being near the coast.*

Tierra del Fuego.

Fogs are extremely rare on the coast of Tierra del Fuego, but the weather is nearly always dull and rainy, accompanied by violent winds; the sun is seldom seen; the sky, even in good weather, is covered with clouds and it is seldom clear.

The winds succeed each other at short intervals and last several days; sometimes the weather is good for perhaps two weeks, but this is a rare occurence.*

In the localities of Tierra del Fuego and Cape Horn the months of the equinoxes are the worst, the winds are then very heavy, though it does not always blow on the days of the equinox.

The months of August, September, October, and November are, in general, the worst months of the year. In these months the winds from W. prevail, with rain, snow, and hail, and the cold is intense.

December, January, and February are the warmest months, the days are long, and the weather sometimes good, but in these months the westerly winds, at times very violent and accompanied by much rain, are the prevailing winds; thus the summer in these localities only affords the advantage of long days with a less rigorous temperature. March is subject to tempests, and it is perhaps the worst month of the year on account of the sudden storms which then occur. It is less rainy, however, than the summer months.

Passage from the Atlantic to the Pacific Ocean.

In April, May, and June, there is frequently good weather, and though the days grow shorter in this period, it resembles more the summer than any other epoch of the year; bad weather is, however, experienced in these months,

Directions for the Coast of Patagonia, by Captain King.

but the winds from E., which are frequent, bring with them fine days which can be relied on. June and July are very similar, except that in July the winds from E. are more frequent. The short days and the extreme cold render these months very disagreeable, though they are perhaps the most favorable for going from the Atlantic to the Pacific Ocean, as the winds blow oftener from the E.

Passage from the Pacific to the Atlantic Ocean.

The months of summer, December and January, are, on the contrary, the best for the passage from the Pacific to the Atlantic Ocean, though this passage is so short and easy that it may be made at any season.

In these localities, thunder and lightning are little known. Violent squalls come from S. and S. W., which are announced by masses of clouds; they are at times accompanied by snow and very large hail, which makes them more formidable.

We will now make some important remarks on the course of the winds.

The westerly winds prevail during the great part of the year in these localities and in the vicinity of Cape Horn. Those from the E. generally blow only occasionally in the winter months; they are at times very violent in this season and are rare during the summer.

Winds from E.

The winds from E. always commence light with clear weather, and gradually increase. The weather then changes and the wind becomes at times very fresh; most frequently they attain about the force of a three-reef-topsail breeze, and either gradually die out or fly to another quarter.

Winds from N.

The winds from the northern quarter commence moderately, but the weather is more overcast and the sky more charged with clouds than with the wind from the E., and a light rain generally falls. As it freshens, it hauls successively towards the W. and increases in force, blowing between N. and N. W.

The sky is then covered with heavy clouds and the rain falls abundantly. At the N. W. the wind blows with violence, and when its fury is spent, (which requires twelve to fifteen hours,) or even when it is still blowing quite fresh from this quarter, it shifts suddenly to the S. W. and blows with more violence than before; this wind dispels the clouds and in a few hours it becomes perfectly clear; in the mean time ere are at intervals very heavy squalls. The wind remains

several days in the S. W. quarter, generally very strong, when it moderates little by little, and two or three days of good weather follow.

The winds from the N. blow generally during the summer, and it is a fact based on experience, that all the changes or shifts of wind from N. to S. take place by the W. in this season, which would merit little its name, if the days were not longer and the atmosphere a little milder. The wind and the rain much exceed those of the shorter days. It should be remembered that the bad weather never comes suddenly from the E. and that a wind from S. W. or S. never shifts suddenly to the N.; on the contrary, the winds from S. and S. W. come up suddenly and with violence.

Fresh winds from S.

The winds from S. and the squalls from S. W. are preceded and accompanied by clouds flying very low; the sky is obscured and other clouds at a great height appear above the first; the sun is hardly visible through them and presents a reddish aspect.

Some hours and even a day before a wind from the N. or N. W., the altitude of the sun cannot be taken, although it is visible, on account of the haze in the upper atmosphere preventing its disk being sufficiently defined.

Sometimes, but seldom with a light breeze varying from N. N. W. to N. N. E., there are some days of good weather.

Falkland Isl'ds.

We will terminate our remarks on the winds of the Atlantic Ocean with those of the Falkland Islands.

It would be difficult to find a region more exposed to tempests, winter and summer, than these islands.

The winds are very variable, rarely moderate, as long as the sun is above the horizon, and at times very violent even during the summer; a day of calm is extraordinary.

Usually, it blows less during the night than in the day; however, neither by night nor by day or at any period of the year is there any security against sudden and violent squalls or a heavy gale, though, generally, it lasts but a few hours. The prevailing direction of the wind is W., the gales generally commence at the N. W., and shift quickly to the S. W. by the W. It is observed that when a wind from N. W. is accompanied by rain it very soon goes to the S. W., and blows very strong from this quarter. The winds from N. bring cloudy weather, and when they are light are often accompanied by a thick fog. It is also remarked that they

blow, generally, more about the time of the full and change. The winds from N. E. and N. bring very dismal weather with much rain; sometimes they are strong and hold to the N. N. E., but most frequently they turn in hauling to the W.

The winds from S. E. also bring rain; they blow with force, but are not frequent; as they increase they haul toward the S.

During the winter the winds are principally from N. W., and in summer most frequently from S. W.

Although there are fogs sometimes with light breezés from the E. or N., they do not often continue longer than a day. The gales of wind, as also the squalls, are more sudden and stronger from the southern quarter, between S. W. and S. E., than when they come from any other direction.

The winds from E. rarely last long; they bring, in general, pleasant weather. They can be expected in April, May, June, and July more than at any other period. There are, though seldom, intervals of good weather, with the winds variable from E. S. E. to E. N. E. Thunder and lightning seldom occur, and when the latter is seen a wind from the E. may be expected. If there is lightning in the S. E., and at the same time the barometer is low, a heavy blow may be expected from this quarter.

Gales from the S. E. and S. last longer than those from W., generally, and they raise an enormous sea on the southern coast of these islands.

In the winter there are generally less violent winds than in the summer. During this season the weather, though colder, is more settled and more dry. Every important change in the weather is announced by the barometer to those who consult it frequently, however little they may understand the oscillations of this instrument.*

Such are the general observations on the winds at the different points of the basin of the Atlantic. We will finish this chapter with some general remarks, useful to mariners, borrowed, in part, from *Horsburgh's India Directory.*

Squalls. Three kinds of squalls are distinguished: arched, descending, and white squalls.

Arched squalls are very frequent; generally they rise above the horizon, forming an arch, (as in tornadoes;) often

* *Nautical Directions for the Falkland Islands*, by Captain Sullivan.

they have the shape of a heavy black cloud, particularly when they are charged with much rain or are accompanied by much electricity. These squalls sometimes rise with great rapidity, giving barely the necessary time to reduce sail before the wind is felt, which takes place when the cloud approaches the zenith. At other times this cloud moves slowly and divides without the cloud acquiring sufficient force to reach the ship. It can be regarded, as a general rule, that when the squalls commence with rain a sharp gust will soon follow; but if the wind is felt first they are seldom violent, and the squall ends with a light rain. Local circumstances, however, destroy this general rule, as in the tornadoes the contrary takes place, as has been already remarked.

Descending squalls are not so easily recognized as the former, as they proceed from clouds formed near the observer in the lower portion of the atmosphere; they are generally charged with rain and sharp gusts of wind. In the Gulf of Mexico these squalls are frequent.

White squalls are quite rare; they are, however, sometimes met with in the tropics and their vicinity, especially near high land; they are most frequently violent, and of short duration. They take place with a clear sky and with nothing in the atmosphere to signal their approach, which renders them very dangerous. The only indication of their approach is the white broken water on the surface of the sea raised by the violence of the wind.

Squalls as well as tempests are sometimes progressive, at others regressive; when they are arrested by an opposite wind there is then a strife and their route depends on the position of the most rarefied point of the atmosphere.

When a squall meets an opposing wind it is retarded in its course, and it frequently happens that one ship passes the squall and overtakes others that are within the limit of this opposing wind.

When strong winds are arrested by those from an opposite direction they are generally preceded by a heavy swell, which extends a great way before them.

Very black clouds, mixed with light clouds and fragments of black clouds below the others, having a rapid movement, accompanied sometimes by lightning and distant thunder, are the forerunners of a smart squall. Light clouds, without any definite form, the borders of which it is almost

impossible to determine, give, ordinarily, rain and a little wind.*

We are not here speaking of the gales and squalls, which we have already indicated when occupied with the localities where they occur.

Gales of wind frequently raise a sea very formidable to small vessels, and even for large ones. Small vessels, for their greater security, can use a drag, a method made use of by many captains and practiced by ourselves. This float, or drag, should be large enough to present sufficient resistance, and be immersed to a certain depth. A hawser should be made fast to the float and brought in forward, as low down as possible, veer the hawser, furl all sail, except a storm mizen, and point the yards to the wind. In this manner a vessel will keep head to sea, as if at anchor. For small vessels this method of riding out a gale is much safer than running before a heavy sea. This system is, in reality, but a floating anchor. In every case where a small vessel scuds in a gale of wind it is well to avoid the heavy seas, to reduce her headway, so as not to add the velocity of the impulsion of the waves to that of the ship. As Owen observes, a hawser may be veered out and allowed to float astern. He remarks that he has seen a hawser thus used divide the wave and prevent its breaking over the stern of the vessel.

Marine barometer.

The marine barometer is a most useful instrument, especially in high latitudes, where it indicates the advance of a gale. Before a storm there is generally a sensible fall of the level of the mercury. It is the same in the tropics when threatened with a hurricane. In low latitudes, generally the squalls which pass quickly have little effect on the barometer, and sometimes this instrument is not affected during these squalls. Within the tropics a marked fall of the barometer is only caused by the approach of a strong gale, and not always then, below 14° or 15° latitude.

In high latitudes, the movements of the mercurial column of the barometer are, as the winds, excessively variable. The mercury falls, in general, much before a storm, and rises before it is finished, sometimes even before the storm is felt, in proportion as the equilibrium of the atmosphere is re-established.

* Voyage of the *Beagle*, vol. ii, p. 49.

The mercury falls also considerably on the approach of a heavy rain. When the mercury is low the air is light and wanting in elasticity. It falls still lower when a storm threatens.

When the weather is fine and settled the mercury has a tendency to rise. This is also the case in severe cold. At sea the barometer generally rises with easterly winds and falls with those from the westward. It rises in the northern hemisphere with the wind from N. and falls with those from S. On the other hand, in the southern hemisphere it falls with northerly and rises with southerly winds. The oscillations of the barometer can be observed with more profit at sea than near the land, where the rarefaction and dilation of the air make its variations more irregular than in the open sea. Following a calm or extraordinary heat, particularly in winter, gales of wind are experienced, and this happens most generally when the temperature of the atmosphere is much elevated above its mean.

Atmospheric tides.

It is proper to observe, that in the open ocean, between the tropics, in settled weather, there is a flux and reflux in the atmosphere twice every twenty-four hours, resembling the tides of the sea; but these atmospheric tides depend upon the sun's influence and the rotation of the earth, and do not follow the motion of the moon. The rise and fall of the mercury in consequence of these tides is about six or seven hundredths of an inch in settled weather near the Equator, the high station happening about 11 a. m., and the lower about 5 a. m. and 5 p. m. The regularity of this flux and reflux of the atmosphere is obstructed by land, but in the ocean it prevails to 26° N. and S., and in fine steady weather it may be perceived as far as 30° or 32° N. or S.*

Note by the translator.

Although in the *General Examination of the Pacific Ocean* Captain DeKerhallet has discussed the winds, &c., of the Straits of Magellan, this route has been so much more frequented, and so much information regarding it collected of late years, that the translator has considered it desirable to introduce here an account of the winds, &c., in these straits, taken from the report of Captain Richard C. Mayne, C. B., commanding her Majesty's ship Nassau, (1868.) What has already been said, however, of the winds of Tierra del Fuego, will likewise apply to all the territory of Magellan:

* *Horsburgh's India Directory.*

"Westerly winds are the most prevalent throughout the year, and at the eastern end of the strait there is generally a strong breeze with heavy squalls between N. W. and S. W. A cloudy, overcast sky, and probably rain, while the wind is northward of W.; and usually clear bright weather, with the sun out, when the wind draws southward of W. The general course of the wind seems to commence at N. E. or N., with misty weather or rain, veering quickly to N. W. and freshening while the barometer falls. Between N. and W. it frequently remains two or three days, the weather clearing when it inclines to W., and mist or rain increasing and the barometer falling when it inclines northward. With this wind a decided rise in the barometer is a sure sign of a shift to S. W., which shift invariably takes place before the wind lulls for any time or fine weather can be expected. Winds. Strait of Magellan

"In summer the wind generally dies away from the S. W., but after uncertain durations from that quarter, and before the N. or N. W. wind begins again, an hour or so of light easterly or northeasterly wind will probably be registered, showing that the wind has gone round the right way, through the southeastern quarter. Later in the season, or as winter advances, the S. E. wind becomes more prevalent, and instead of the wind dying away at S. W. it will frequently vary between S. S. W. and S. E. for two or three days, sending a heavy swell into Possession Bay. Sometimes it continues round to E. or N. E., still blowing hard and with wet gloomy weather, not preceded by the interval of fine weather experienced on the coast before a gale comes on from the eastward.

"This veering round will, however, like the easterly gales on the coast, be found a rare occurrence. As a rule, the wind will be found stronger from the S. W., and the squalls heavier than from N. W., and no certain warning is given of this shift. Sometimes the barometer precedes it, but more generally accompanies it. Sometimes heavy banks of white cumulus clouds, having hard edges and appearing very rounded and solid, will be seen rising from the S. W. or southward, but this is more frequently the case when a S. W. wind is about to spring up from a calm or light air, than as indicative of a gale shifting to S. W. or S.

"The backing of the wind from S. W. to N. W. is always accompanied by a falling barometer, or its ceasing to rise,

as it does during the whole time it blows from S. W. The change of wind, however, usually accompanies the change in the barometer, and the mercury merely ceasing to rise may indicate the S. W. wind subsiding. If the wind backs from N. to N. E. the same dirty weather may be expected that is mentioned as usual when it draws round to the E. from the southward, and generally the seaman may be prepared for bad weather when the wind backs, even though the barometer does not fall.

"Northerly winds are often preceded by low flying clouds, with a thickly overcast sky, in which the upper clouds appear at a great height. The sun shows dimly through them with a reddish appearance, and with its edges so indistinct that it is impossible to take an altitude, often for hours, before a gale comes on. Sometimes, but very rarely, with the wind light between N. N. E. and N. N. W., a few days fine weather may occur. Each day of this must be gratefully received as it comes, for it cannot be predicted, and occurs sometimes with a high and at times with a low barometer.*

"Easterly winds are certainly more common, and the strait is on the whole less windy in winter (June, July, and August) than in summer; but when against this possible advantage is placed the cold, with the long nights and short days, this season is not likely to be preferred by the mariner in a vessel bound westward. Though beyond the limits of this chapter, it may be well to mention that ships getting as far as Cape Froward with a S. W. wind will generally find it N. W. on rounding the cape, as the wind follows the direction of the channel.

"Captain King, after remaining nearly a year in Port Famine, and a considerable time in the eastern part of Magellan Strait, came to the conclusion that the barometer could not be considered so unfailing a guide as in the lower and middle latitudes, and that 'although the rise and fall does sometimes precede the change, yet it more frequently accompanies it.' After two seasons careful observation, the writer coincides in this opinion, as far as the actual strait

* In December, 1867, the *Nassau* had several days of beautiful weather, with the barometer between 29.05 and 29.50, and then, after a few days' blow from S. W., another interval of fine calm weather, with the barometer ranging from 30.10 to 29.9°.

itself is concerned. It is probable that the difference of opinion expressed by Captains King and Fitzroy on the subject is to be attributed to the former having made the greater part of his observations in the strait, while those of the latter were made on the outer coasts of Terra del Fuego or Patagonia, free from the local influences of the narrow channels.

"It has already been said, when speaking of the shift of wind from the N. W. to S. W., that the barometer invariably rises with it, and the only rule which we can give as at all settled is, that a rising barometer precedes or accompanies a shift of wind from N. W. or W. to S. W., and that generally, if the mercury falls while it is blowing from S. W., the wind will back to N. W. again; but in both these cases, nine times out of ten, the two events will occur simultaneously. A table has been constructed from the meteorological journals of her Majesty's ship *Nassau*, kept during nearly ten months spent between Sandy Point and Cape Virgins in 1867–'68, some being in corresponding months of the different years, in the hope of being able to draw some practical conclusions from it, but in vain.

"The study might interest a scientific person, but, with the exception of that given above, no rule useful to the seaman navigating the strait could be found. It may be added that a meteorological journal, very carefully kept by Sr. Jorge C. Schythe during nine years' governorship at Sandy Point, has been examined with a like result. Captain King, after stating that after a fall of barometer with N. W. or northerly winds, a S. W. gale may be expected when it ceases to fall, adds, 'it frequently, however, falls without this change. In the month of June, at Port Famine, the barometer fell to 28.17, and afterward gradually rose to 30.5, which was followed by cold weather, in which the thermometer stood at 12° Fahrenheit.'

"It has been already remarked, when speaking of winds, that some of our finest weather occurred with a very low barometer, and it may be added that frequently the barometer has fallen so as to lead one to expect and prepare for a gale when nothing has come of it. It would be interesting to know whether anything occurred to account for such changes off Cape Horn, or in open sea at either end of the

strait, from which the high land and tortuous channels sheltered us.*

Barometer.

"Captain King gives the following table of mean temperature and pressure of the atmosphere at Port Famine in 1828:

1828.	Temperature.	Barometer.
	Fahr.	
February	51.1	29.40
March	49.4	29.64
April	41.2	29.57
May	35.5	29.30
June	32.9	29.28
July	33.0	29.37
August	33.2	29.28

"The same elements taken from the observations of the governor at Sandy Point above mentioned would give:

Months.	Number of years.	Thermometer.	Number of years.	Barometer.
	Mean.	*Fahr.*	*Mean.*	*Inches.*
January	9	54.80	4	29.55
February	9	54.40	4	29.63
March	10	48.05	4	29.62
April	8	44.10	4	29.53
May	8	40.40	4	29.61
June	8	35.40	4	29.62
July	7	35.40	3	29.64
August	7	37.40	3	29.66
September	7	42.40	4	29.60
October	9	47.30	4	29.70
November	9	50.70	4	29.54
December	9	53.20	4	29.60

"In coming southward from the tropics the gradual lowering of the mercurial column must not be forgotten. It has been estimated that a difference of half an inch exists between the mean in the tropics and that in the latitude of the strait.†

* The opinion of the late Admiral Fitzroy respecting the barometer will be found at page 136, part ii, of the *South American Pilot*, sixth edition. As already stated, it refers to the open coast, and has only been adopted here when it agreed with Captain Mayne's observations. The admiral spent but a short time in the eastern entrance of the strait.

† *Maury's Physical Geography of the Sea;* eleventh edition, p. 447, art. 833. See, also, 14th number of *Meteorological Observations*, published by Board of Trade.

"The following observations made in 1867 seem to show that this is equally true for the strait itself:*

Month.	Mean barometer observed at Rio de Janeiro.	Mean barometer observed at Sandy Point.	Difference.
July	30.243	29.256	.987
August	30.147	29.530	.617
September	30.137	29.808	.329
Mean			.644

Seasons.

"For making the passage from east to west round the Horn, Captain King was of opinion that the winter season is the most favorable,† and considers the frequency of easterly and northerly winds at that season a set-off against the long nights, with the chances of decks covered with snow and ropes frozen stiff. Whichever may be preferred for a sailing vessel rounding the cape, it has already been said that for a steamer in the Magellan Strait, with which alone we are now concerned, the summer is far preferable for going either way.

"Here, as elsewhere, the equinoctial months are the most windy, though the heaviest gales do not always occur at the equinoxes. March is very boisterous, and its gales are usually followed by some fine calm weather in April and May. Towards the middle of May the weather becomes sensibly colder, and the snow, which has been covering the summits of the hills perhaps for some time, will be observed to advance down the slopes; it, however, varies greatly. In March, 1867, the western mountains were covered with snow, and the first fall of snow at the east end was on 1st April. In March, 1868, there was much less snow on the western mountains, and none reached the level of the water till April 19th.

"The coldest weather is in June, July, and August; a mean of six years' observations gives June as the coldest month four times, July once, August‡ once. Even in these winter months, however, though there are occasional cold days, the general temperature at Sandy Point during June,

* These observations are reduced to 32° Fahrenheit. The mean difference *observed* was 0.744.

† *South American Pilot*, vol. ii, p. 218.

‡ Sr. Schythe's journal, and *Nassau's*.

July, and August, for several years, is about 36° Fahrenheit. With the advance of the vernal equinox the west winds increase again, and the equinoctial gales of September, like those of March, are usually succeeded by some fine weather in October and November. December, January, and February are the warmest, the mean temperature for several years for these months being 54°; the days are then long, there is some fine weather, and the sun when out has some power.

"Westerly winds, however, which often increase to violent gales and furious squalls with much rain in the western part, are frequent even throughout that season, which, as far as the mariner is concerned, carries with it less of summer than almost any part of the world. We say as far as the mariner is concerned, for to the eastward of Sandy Point the weather on shore is very fine, though rather windy, during summer; the temperature is pleasant, the air bracing and healthy. Indeed, during our two seasons there, we hardly ever had more than one or two men on the sick list, and those generally from accidents, though their work was hard, and the men much exposed, camping out, and constantly getting wetted through with salt water. The change between this and the western part of the strait and the northern channels is very marked in this respect. In these latter there were always eight or ten on the *Nassau's* sick list with colds, bronchitis, and rheumatism.

"It would seem that Admiral Fitzroy was unfortunate in having seen the sun so rarely while in those waters, for he says* 'that to endeavor to rate chronometers by equal altitudes would be a fruitless waste of time, in any other months than April, May, and June.' In 1866–'67–'68, equal altitudes were frequently observed in November, December, January, and February, and in fact during all the summer onths at Sandy Point, Dungeness, Direction Hill, and Gregory Bay. At Sandy Point, indeed, we hardly ever experienced any difficulty or delay in obtaining equal altitudes until June, when the sun was so low as to be available for a comparatively short time only on either side of noon.

"We think vessels would generally be able to rate their chronometers at Sandy Point; further westward it would be more difficult, though equal altitudes of the sun were

* *South American Pilot*, page 135.

CHART OF THE GENERAL WINDS IN THE ATLANTIC OCEAN

obtained at Sholl and Halt Bays and Island Harbor in March and April, 1868.

Fogs. "Fogs are of rare occurrence and short duration in the eastern part of the strait, though occasionally they set in very thick for a few hours, and with no warning, during calm weather. Dense fogs have, however, been known to last two or three days at Sandy Point in the winter months. Thick rainy weather is the ordinary condition of the western part.

Squalls. "Squalls blow with great force and suddenness all over the strait, making boat work very dangerous, and rendering it inadvisable to set light sails even when the weather seems most promising.

Thunder and lightning. "Thunder and lightning are very rare, indeed scarcely known, except in very bad weather, when violent squalls come from the S. and S. W., usually giving warning of their approach by masses of clouds.

"These storms are rendered more formidable by snow and hail of a large size."

We will now examine the currents of the Atlantic Ocean.

CHAPTER II.

GENERAL CURRENTS.

Two kinds of currents.

Two kinds of currents are distinguished; the one occasioned by the ebb and flow of the sea, which alternate, and are felt only a short distance from the coast; the others, on the causes of which philosophers are divided, are nearly constant in their direction and do not deviate, except near to the shores, which, laying in their route, present an obstacle to their usual course; these last, called *general currents*, are divided into cold and warm currents, according to the temperature of the waters which compose them. In generalizing, the observations on currents may be thus summed up—cold currents, directed from the poles toward the Equator on the west coasts of the continents; currents directed from E. to W. along the Equator; and warm currents directed from the Equator toward the poles on the east coast of the great continents. There has been found a cold current setting from the N. to the S. on the west coast of Europe and upon the northwest coast of Africa; a cold current from the S. to the N. on the southwest coast of the same continent. On the other hand, on the coast of Brazil a warm current is met with setting from the N. to the S.; also, a warm current which, turning through the Gulf of Mexico, passes the Bahama Channel and the length of the coast of the United States, and is known as the *Gulf Stream*, in the vast basin of the Atlantic Ocean, formed by the great longitudinal valley which separates the European and African continents from that of America. Such are the currents named *general currents*. We will treat only of these in this chapter.

Philosophers differ on the causes of these permanent or general currents. Some attribute them to the action of the trade-winds, while the greater number consider that they, as the winds, are occasioned by the calorific action of the sun and the rotary movement of the earth. Thus, they say, following this movement of rotation and the transfer of the polar waters toward the Equator, there should be formed under the Equator a current having an apparent direction

from the E. toward the W., as takes place with the wind from the same cause.

Now, such a current should necessarily produce an attraction of its lateral waters toward their eastern extremity, and on the other hand, a lateral reflux toward their western extremity; in other words, there is a flow of the polar waters toward the Equator on the west side of the great equatorial continents, and an efflux toward the poles on the eastern sides of the same continents.

Besides, the equatorial waters, on approaching the Equator, should, from their accelerated velocity of rotation and from the flow of the polar waters toward the Equator, take a direction from W. to E., as do, in the Atlantic Ocean, the Gulf Stream and the current traversing the Atlantic, running from the coast of Brazil toward the coast of Africa.

Equatorial currents.

Polar currents.

Tropical currents.

We call the *equatorial current* the current running from E. to W. at the Equator; we designate those *polar currents* which are directed from the poles toward the Equator on the west coasts of the continents, and *tropical currents* those directed from the Equator toward the poles on the east side of the continents.

The velocity of these currents varies at different points of their course; the greatest observed has been from sixty to one hundred and twenty miles in twenty-four hours. Their temperature is also higher or lower than that of the adjacent sea according to the heat of the sea where they take their origin.

We will now indicate the course and the limits of those currents in the Atlantic Ocean, giving their velocity and mean temperature. We will first discuss those of the North Atlantic Ocean and the equatorial current.

Equatorial current.

The equatorial current commences near the west coast of Africa in longitude 5° 20′ or 5° 50′ E. It extends entirely round the Island of Annobon; it runs parallel to the Equator between the parallels of 1° and 1° 30′ N. and those of 2° or 3° S. latitude; it soon spreads from N. to S., and though it passes but little to the N. of the parallel just mentioned, it sometimes reaches abreast of Cape Palmas as far as 2° 30′ N. and 5° S. latitude. The length of the Equator in the Gulf of Guinea it is tangent for a distance of over one thousand miles; that is, to the vicinity of the meridian of 11° or 12° of W. longitude, to another current running from W. to E., called *the current of the*

north coast of Guinea. This portion of the sea presents the remarkable phenomenon of two currents in contact, running with considerable velocity in opposite directions, and having a difference of temperature of 0°.8 or 0°.9 of Fahrenheit; so that according as a ship may be in the one or the other current in navigating to the east or the west, her speed is accelerated or retarded from forty to fifty miles per day, the velocity of these two currents in this locality. We will return hereafter to this important fact.

Advancing to the west on each side of the Equator, the equatorial current, arriving at 20° or 21° of W. longitude, throws into the northern hemisphere a branch of considerable volume, known as the northwest branch of the equatorial current, which runs as far as 20° N. latitude, spreading more and more, and is sometimes felt as far as 30° N.

At the same point it spreads more and more toward the south and runs thus for the distance of about three hundred miles, as far as Cape St. Roque, where it is divided into two branches. The north branch, which is the most considerable, forms the Current of Guiana and penetrates into the Caribbean Sea.

The south branch taking a direction parallel to the coast of South America at a considerable distance seaward, forms the current of the coast of Brazil.

Extent of the equatorial current.

The length of the equatorial current from the coast of Africa to Cape St. Roque is twenty-five hundred miles, and to its entrance into the Caribbean Sea four thousand miles.

Its width near its origin is one hundred and sixty miles, on the meridian of Cape Palmas three hundred and sixty miles, and it is four hundred and fifty miles before it divides.

Velocity of this current.

This current acquires its greatest velocity in the summer, and is at its least in the winter. Between the meridians of 5° E. and 8° W. longitude its mean is from twenty-five to thirty miles per day.

Between 8° and 14° W. longitude, toward the end of June and the commencement of July, it varies from forty-five to seventy-five miles; between 14° and 21° W., from forty-five to sixty miles; the mean velocity may be estimated at forty-six miles nearly in twenty-four hours.

Temperature.

The mean temperature of its waters is 75°, or from 3° 6 to 5° 4 above that of the ocean in different seasons.

The current running toward Cape St. Roque is unfavorable to ships going to the south to cross the line in 22° W. longitude.

The northwest branch of the equatorial current runs first to the N. W., then in a more northerly direction; this current is always felt as far as 18° N. latitude, and even at times as far as 30°. It is lost in the drift currents of the N. E. trades, to which it appears to give a northwesterly direction and increases their velocity. The breadth of this current at the point of separation is nearly two hundred miles, and more to the N. it is three hundred miles; its velocity to 10° N. latitude is from twenty to twenty-four miles per day, from there it decreases gradually. This current is of advantage to ships passing from the southern to the northern hemisphere.

Northwest branch of the equatorial current.

The movement of the waters toward the W., in the zone of which we have just spoken, in the vicinity of the equator, cannot be doubted. Different navigators, however, have met with, and that for several days, a current setting to the E. in this zone; among others the captains of the *Bayadère*, the *Zélée*, and the *Clorinde*, who have crossed those currents setting to the E. with a velocity varying from three-tenths to one mile per hour.

Disturbances observed in the equatorial current.

Such cases can, we think, be regarded as exceptions, and the currents mentioned as eddies or counter-currents to the limits of the general current. Some authors indicate the existence of a current running from the W. to the E., between the parallels of 8° and 10° N., which, they say, commences to be felt about the meridian of 53° W. and extends to the meridian of 26° W. On this first meridian its principal direction would be N. to N. N. E., and in proportion as it advances to the E. it becomes broader, its velocity increases to about the meridian of 38° N. and it takes a more easterly direction; that beyond the meridian of 38° W. its velocity decreases with the extension of its bed, and it becomes almost insensible on the meridian of 26° W. We point out this current, which might be named the *counter equatorial current*, to the researches of navigators.*

* Commander R. W. Shufeldt, U. S. N., then in command of the U. S. S. *Wachusett*, thus alludes, in his remark book, to this current: "Attention is called to the adjoining table, showing the rather remarkable coincidence between two passages of this ship, with reference to a counter-current setting strong to the eastward on the northern edge of the great equatorial current. It will be observed that the current was found between the same parallels and meridians at two different seasons of the year; that in both instances the water was warmer than on either edge of it; that in January the current was stronger and rather more south-

Drift currents.

We will now speak of the drift currents, which philosophers attribute to the winds blowing from the same direction during a longer or a shorter period.

The drift currents which owe their origin to constant winds, as the trades, are constant themselves, do not vary their direction, and have most always the same velocity. They are found in the Atlantic between the tropics, but are only considered regular between the parallels of 23° N. and 9° S. latitude, the space in which the trades blow regularly. The drift currents from these winds attain a mean velocity of from nine to ten miles in twenty-four hours.

Drift currents from prevailing winds are not constant in either their direction or velocity; they are found to the N. and S. of 32° latitude.

Current of Guiana.

The current of Guiana, which is a continuation of the equatorial current, runs the length of the lower coast of Guiana toward the Island of Trinidad; in the vicinity of the Equator it is crossed by the currents of the Amazon, which, carrying an immense body of water with great velocity to the ocean, forms a counter current and vast whirlpools. This, however, does not appear to exert any influence

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erly, owing, probably, to the greater strength of the winds in that month. On both occasions the wind was easterly, the current consequently setting against it:

United States Steamer Wachusett.

October, 1864.				Temp'e.		January, 1868.				Temp'e.	
Date.	Lat. N.	Lon. W.	Currents.	Air.	Water.	Date.	Lat. N.	Lon. W.	Currents.	Air.	Water.
	° ′	° ′	*Knots.*	°	°		° ′	° ′	*Knots.*	°	°
17	2 02	40 35	12 W.	82	80	2	2 06	39 22	36 WSW½W	80	77
18	3 09	42 08	12 W.	83	80	3	3 17	42 07	32 W. S. W.	83	79
19	4 56	43 48	22 W.	84	80	4	3 51	43 51	13 W. N. W.	85	80
20	6 51	44 54	17 N.E.byE.	84	83	5	4 26	44 29	17 E. ¾ S.	85	80
21	8 28	46 19	16 E.	85	83	6	5 34	44 50	59 E. by S.	82	80
22	9 25	47 38	12 S. E.by S.	84	85	7	6 02	46 30	44 S. ¾ E.	83	81
23	10 50	49 55	12 S. E.	82	80	8	7 30	48 28	15 S. E.	83	80
24	11 56	51 51	14 westerly.	84	80	9	9 12	50 17	18 N.E. byE.	82	79

The United States steamer *Hartford*, in September, 1865, from the latitude of 10° N., longitude 26°W., to the Equator in longitude 24° W., experienced an easterly current, varying from 1 to 1½ knots per hour, with a general set to the northward and eastward, and the water was found to be of a higher temperature than on either side of this belt.

on its direction; the waters of the river and current do not mix, and in traversing the current, the waters of the river may be recognized three hundred miles from its mouth.

A little to the south of Trinidad, the river Orinoco pours a large body of water into this current; the two directions making a very acute angle, the waters mix readily, and increase considerably the velocity of the current.

It then enters the Caribbean Sea through the channels between Trinidad and Martinique, where the Islands of St. Vincent, Santa Lucia, Grenada, Barbadoes, and Tobago are situated. It there takes the name of the Current of the Caribbean Sea.*

Current of the Caribbean Sea and Gulf of Mexico.

No constant currents have, as yet, been found in the Caribbean Sea; however, in the center of this sea, and in the vicinity of the islands which bound it on the N. and E., there are variable currents, which are most frequently directed toward the W. The general current runs along the coast of South America, more or less removed from the shore, and following its contour. Thus it is directed from the E. to the W. from the Island of Trinidad to Cape Aguja; from there it mounts toward the W. N. W. and N. W. as far as Cape Catoche, traversing the Gulfs of Darien, Nicaragua, and Honduras; when it describes a complete circle in the Gulf of Mexico, and takes the name of the General Mexican Current. After turning Cape Catoche, it is directed toward the W. on the bank of Campeachy, along the north coast of Yucatan; it descends then to the S. W., following the bend of the coast, as far as the meridian of 95° 10′ W. nearly; there it turns sharply to the N. N. E. as far as about the parallel of 25° 30′ N., and the meridian of 85° 40′ W., where it is directed toward the E., inclining to the S. in proportion as it advances toward the Tortugas in passing into the channel comprised between the Peninsula of Florida and the north of Cuba; this channel receives the principal branch of this current, the other and secondary branch of which produces near and to the north of Cape St. Antonio a current toward the S., and to the south of Cape St. Antonio, the current setting toward the E. and S. E., on the south side of the Island of Cuba. This last extends sometimes as far as the Isle of

* For the currents in the West Indies and Gulf of Mexico, see the *Manuel de la Navigation dans la Mer de Antilles, &c.*

Pines, and more to the S. between Cuba and Jamaica. It is remarked, that between these two islands and to t he west of Jamaica the currents are very variable.

The general current of the Caribbean Sea forms in this sea two counter-currents, a knowledge of which is very useful in the navigation of the coast of America; both run to the E. The first commences north of the parallel of San Juan de Nicaragua, and running along the coast, from which it extends from ten to twelve miles, is lost in the vicinity of Carthagena. The other current to the E., is found in the Gulf of Honduras, between the Bay of Honduras and Cape Gracias-a-Dios; it extends along the coast between the bay and cape to a distance of twenty-five to thirty miles from the land.

In the season of northerly winds, there is often found near the Mosquito coast and the west coast of the Gulf of Honduras a current setting to the S.

Near the west coast of the Gulf of Mexico, from the river of Coatzacoalcos as far as the Bay of Galveston, and in the open sea of this coast, in the space comprised between it and the general currrent of the Gulf of Mexico, the currents are variable and depend on the winds. They are directed to the W. and N. W. with the trade-winds, and attain a velocity of from one to two miles; with the winds from the N. they run to the S. and S. S. E. with a velocity of one to one and a half mile.

To the west of the Mississippi, between the Southwest Pass of this river and the Bay of Galveston, there is, the whole length of the coast, a strong current to the W. near the coast; at its off-shore limit, about forty or fifty miles from the land, it runs to the W. S. W. and S. W.

To the east of the Mississippi, the current is directed to the E., near the coast. At its off-shore limit it runs to the E. S. E. and S. E., and is lost in the general current.

Near the west coast of Florida, the currents are variable and depend on the winds. They run most frequently to the S.

Velocity of the current of Guiana and of the Caribbean Sea.

The velocity of the current of Guiana varies in its course, which is about five hundred and ninety miles, from ten to twenty-one and thirty-six miles per day, according to the locality; in the bed of the current it has been found to be four miles per hour, while near the coast it diminishes gradually to less than one-half mile per hour. The velocity of

the current of the Caribbean Sea, as a mean, is from one and a half to two miles per hour; it is particularly strong from January to March.

The temperature of the waters of this current has been observed to be 80°.6, and that of the Amazon, very near to the line of demarcation, also 80°.6. The line of separation of the waters of the current and the Amazon is N. W. $\frac{1}{2}$ N., and they are as well defined as if composed of two different fluids. The temperature of the seas of archipelagoes has, in general, been found, under the same parallel, higher than that of the open sea. It is considered, however, that the high temperature of the Caribbean is more due to the warm currents that penetrate it from the torrid zone, than from the increase of heat given to its waters by the continents which surround it. Temperature of this current.

We give the following remarks on the currents of the Windward Islands, deduced from a great number of observations, judging that they will be found useful in the navigation of the different passages among these islands. The direction which we assign to the currents being the mean, they should be regarded only as indicative. Currents should always be distrusted, as very variable near land so uneven as the Windward Islands, and influenced besides by the winds as to the velocity per day. We have cited those most frequently encountered, that they may be more readily comprehended, and have placed them in a tabular form:

Currents observed among the Windward Islands.

Localities.	Positions.	General current.		Observations.
		Direction.	Velocity in miles per day.	
Channel between Trinidad and Tobago	Middle	W	48	Accidental; current N.W. by W.; velocity 72 miles, with the ebb tide.
	South coast	W. N. W	48	
	North coast	W. S. W	48	
Island of Tobago	Northeast part	N. W. and N. N. W	40	
	Southeast part	N. W. and W. N. W	24	
	At sea to eastward	W. by S	43	
	At sea to westward	S. W. by W	12	
	To the northward	W. by S	12	
Channel between Trinidad and Grenada	Middle	W	24	
	North coast	W. by S. and W. ½ S	24	
	South coast	W. N. W. and W. by S	29	
Island of Grenada	To the west	W. S. W	29	
	To the southeast	W. by S	24	
	To the north	W. N. W	28	Between Grenada and the Grenadines.
The Grenadines	To the east, between the meridians of 60° 30′ and 59° 30′.	N. N. W	40	Accidental; N. N. W.; velocity 69 miles. In the channels of the Grenadines the direction of the current is W. N. W., and N. W. by W., 10 miles; the strongest is in the channel between Grenada and Cariacou, of 22 miles.
	To the southeast of group.	W. by S	10	
	To the northeast of group.	N. and N. N. E	33	
	To the west of the group	N. W	16	

Island of St. Vincent	To the south	W. N. W	12	To the W. in the offing from St. Vincent the current runs to the W. 19 miles.
	Northeast part	N. W	33	
Channel between St. Vincent and Barbadoes	Middle of channel, south side.	N. N. E	33	
	Middle of channel, north side.	N. W	18	
Island of Barbadoes	To the east	W		
	To the southeast	W		
	To the west	W. S. W		
	To the north	W. by S		Accidental; S. E. by E.
Channel between St. Vincent and Santa Lucia	Middle	W	30	Accidental; W. 72 miles, in May.
Island of Santa Lucia	Southwest part	N. W., W. S. W., and S. W.	33	To the W. and to seaward from Santa Lucia the current runs to the W. 19 miles.
	Northwest part	S. W	10	
	East coast	N. W. and N. W. $\frac{1}{2}$ W	18	
Channel between Santa Lucia and Martinique, (east entrance.)	Middle	N., N. by E., and N. N. W.	20	In May a current has been found to the N. N. E. 18 miles.
	South coast	N. W. $\frac{1}{2}$ W	18	
	North coast	N. and N. by E	28	This current follows the E. coast of Martinique.
Channel between Santa Lucia and Martinique, (west entrance.)		N., N. W., and N. N. W	19	The currents are very variable at this entrance.
Island of Martinique	To the west	N. W	30	Accidental; N. N. W. 55 miles; in January and May they have been found running to S. and S. W. 11 miles.
	To the southeast at sea	W. N. W	35	
	To east of the island, at sea	W	10	
Channel between Martinique and Dominica	East entrance	W	10	The same current in the open sea to the E.
	West entrance	N. W. and N. N. W	9	In the open sea to the W. it turns to W. by S
Island of Dominica	West coast	N. N. W	31	
	Southeast part	W. by S		

Currents observed among the Windward Islands—Continued.

Localities.	Positions.	General current.		Observations.
		Direction.	Velocity in miles per day.	
Island of Dominica—Continued.	Northeast part	W. by N	35	
Channel between Dominica and Marie Galante	Middle	W	35	
	South coast	W. N.W. and W. by N	35	
	North coast	W. by S	35	
Channel formed to the north by Désirade and Guadeloupe, to the south by Petite Terre, Marie Galante, and Isle des Saintes.	Middle	W. by S. and W. S. W	20	Accidental; W. N. W. and W. by N
Channel between Dominica and Guadeloupe	Middle	W. by S. and W. S. W	14	
Island of Guadeloupe	Southwest part	N. W	15	
	Northwest part	N. E	21	
	East coast	W	11	
Channel between Guadeloupe and Montserrat	Middle	W	18	
Channel between Montserrat and Antigua	Middle	N. and N. W		
Channel between Guadeloupe and Antigua	Middle	W. and W. S. W	18	
Channel between Antigua and Barbuda	Middle	N. W		
Channel between Barbuda, Nièves, and Saint Christophe.	Middle	N. W		To the E. and near St. Christophe there are at times currents setting to the S. S. E. with a velocity of 15 miles.
Channel between Montserrat and Nièves	Middle	W. and W. S. W	18	
Channel between St. Christophe and St. Eustache.	Middle	W		
Channel between St. Eustache and Saba	Middle	N. by W	21	

Island of Saba	To the west, at sea	W. ½ S		
Channel between St. Eustache and St. Barthélemy	Middle	N. W. and N. E	36	
Island of St. Barthélemy	To the west	N. N. W		
Channel between St. Barthélemy and St. Martin	Middle	N. E	36	We think that this current is exceptional; we only possess a single observation on this channel.
Channel between St. Barthélemy and Saba	East coast	N. N. W	24	
Channel between Anguilla and Sombrero	Middle	W	15	
Channel between Sombrero and Anegada	Middle	S. W		With the winds from N. E. the currents in the open sea run to the W.; with winds from S. E., near Anegada, they run to the N. W.
	South part	N. W. by W	16	
Channel between Anguilla, St. Martin, and St. Eustache on one side and the Virgin Islands on the other.	Middle	N. W	24	Very variable in the middle of the channel.
	West coast	W	22	
	East coast	W. by S	17	
Channel between St. Eustache and Santa Cruz	Middle	W	17	
Channel between Santa Cruz and the Virgin Isl'ds.	Middle	S. W. by W., and W. S. W.	12	
To the north of the Virgin Archipelago	In the offing	W. and W. S. W	8	

From the parallel of Santa Lucia to that of Anguilla, when a little in the offing to the east of the Windward Islands, the current runs to the W. S. W. and W., at a velocity of ten, eleven, and twelve miles per day. From the parallel of Anguilla to that of Anegada, it runs to the W. at a rate of eleven miles. To the west of the Windward Islands and of the meridian of 63° it is directed toward the W., varying to W. S. W. and W. N. W. Its mean velocity is thirteen or fourteen miles.

On the parallel of Martinique and Dominica, when between the meridians of 61° 10′ and 62° 10′ W., the current is often found setting to the N. W. Between Barbadoes and Trinidad, on the meridian of the first, the current sets to N. W. and N. N. W. at a rate of ten, of fifty-eight miles, and sometimes sixty-nine miles per day.

Gulf Stream or Florida Current.

The Gulf Stream or Current of Florida has its origin in the Gulf of Mexico, where its waters, having become heated, are directed across the Bahama Channel; leaving this strait they run to the northward and westward along the coast of Florida, and in latitude 31° N. take a direction nearly N. E., as far as Cape Hatteras. There, from the re-entering of the coast, the western limit of the current takes a more northerly direction, while its bed continues to run toward the N. E., until it encounters George's and Nantucket Banks, when its direction becomes E. A little after, in passing over the southern extremity of the Grand Bank of Newfoundland, it takes the direction E. 11° N., and keeps this direction between the parallels of 35° and 43° N. latitude, until it arrives at the meridian of 36° W. longitude; there it turns to the S. E. and to the S.; when, turning to the westward of the Azores, it is lost in the ocean.

Its warm waters have, however, sometimes been found on the west coast of Europe; they have been observed between the parallels of 44° 20′ and 39° N., among others by Franklin.

Extent and velocity of the Gulf Stream.

The Gulf Stream extends about three thousand miles from its origin to the west of the Azores; it traverses in its course 20° of latitude from the parallel of 23° to that of 43°. From observations made on this current, its mean velocity at the entrance of the Bahama Channel, at the Islands of Bemini, and as far as 31° N., would be seventy miles in twenty-four hours. A velocity of eighty miles in twenty-four hours was found between the parallels of 26°

and 27° N., when the wind was blowing from the N. with violence. At the outlet of the Straits of Florida abreast of Cape Florida, its rapidity resembles a torrent, and reaches at times one hundred and twenty miles per day. Its velocity decreases then gradually in its course toward the E.; between the meridians of 63° and 64° W. it is fifty-five miles per day, and on that of 40° 10′ W., it is not more than thirty to thirty-five miles.

The Gulf Stream diminishes very rapidly its velocity on turning to the S.; and to the west of the Azores and near these islands it is but ten miles per day.

The current is narrowest in the Florida Channel, between Cape Florida and the Islands of Bemini, which is a distance of thirty-four or thirty-five miles, nearly the whole of which is occupied by the current, and it has here a great velocity. About seven hundred miles to the northward and eastward of Cape Hatteras the breadth of its bed is estimated to be about seventy-five miles, and beyond this it enlarges considerably to the northward and to the eastward.

The end of August and the commencement of September are the periods when the Gulf Stream acquires its greatest velocity and its highest temperature, its minimum velocity and lowest temperature are in the month of February. In the month of October the current is much weaker than in September, its velocity varies according to the season. Near the coast of Cuba, at its southern limit, the Gulf Stream is generally weak; there exists here often, if not always, a counter-current, of which we will speak hereafter. On the meridian of Matanzas the great velocity of the current is nearly on the parallel of 24° N.; at the northern and western limits of the Gulf Stream, in its whole extent, the velocity observed is greater than at its southern and eastern limits, where, from its tendency to spread into the ocean and from eddies, its strength is diminished.

Counter-currents of the Gulf Stream.

On the north side of Cuba, as has been remarked, the current is weak, and near this coast there is found a counter current, which also exists on the southern and eastern limits of the Gulf Stream throughout its extent. On the opposite border of the Florida Channel along the Carysfort Cays there is also found a counter-current setting to the S. and to the W., according to the position occupied in the channel; the same counter-current exists on the north and west border of the Gulf Stream through its whole extent.

When the weather is good, a well-defined line appears to separate the principal from the counter-current near the Carysfort Cays; outside of this line the water ripples in some places and a strong chop is observed. The color of the sea varies in the counter-current, and it changes from a deep blue to sea green and to milk white in proportion as the Florida Reef is approached.

When the winds are regular and moderate, the force of the current in the Florida Channel is not extraordinary, but after a gale from the N. or N. E., and while it blows, the current and the counter-currents acquire a great velocity. The winds from N., N. E., and E. diminish the breadth of the bed of the stream, and its velocity becomes considerable when these winds blow from September to March. The winds from S. and S. E. have less tendency to increase the principal current, the bed of which increases and is less removed from the coast, from which it is separated by the counter-current which runs to the S.

The winds from N. W., W., and S. W. also spread the bed of the current on the border towards the ocean, which diminishes its velocity. Lastly, the phases of the moon also exert an influence on the Gulf Stream, though not in so great a degree as the winds, but combined it results that the shores of Florida and the Carysfort Reefs and Cays are inundated. When a gale from the N. happens at the full and change, under these circumstances the water has risen five and a half fathoms above its level.

The Gulf Stream, from the parallel of 26° to that of 28°, runs generally to the N., bending a little to the E., between those of 28° and 35°, the parallel of Cape Hatteras; at its western limit it runs to the N. and N. N. E. and to the N. E.; it is there arrested by the Bank of Soundings extending from the coast, and follows its contours, with different velocities according to the season. The limit of the current passes nearly forty miles from the coasts of Georgia and Carolina, and is nearer to that of Florida. The mean breadth of the bed of the current is about sixty miles, less near Cape Canaveral, more on the parallel of Cape Hatteras. In this locality the current has at times been found having a velocity of five miles per hour; its mean is three miles. The current then, instead of removing from the coast on arriving at the parallel of Cape Hatteras, approaches it between the parallels of 38° and 39°, as has

been already remarked, and its velocity is two and a half miles per hour. It then runs along the George and Nantucket Banks, which divert it to the E. N. E. and E. by N. After it has passed Cape Hatteras it runs to the N. N. E., and then to E. towards George's Bank, extending nearly to 40° latitude N. Its southern limit, taking the direction of N. N. E., cuts the parallel of 35° N. on about the meridian of 72° W. longitude, or one hundred and twenty miles E. by S. of Cape Hatteras.

Between the Bank of Soundings on the coast of the United States and the western limit of the Gulf Stream there is a space of about forty miles which is occupied by the cold counter-current, which runs S. by W. (principally during the months of winter, December to April) with a velocity of twelve miles per day. Between the meridians of 70° and 65° N., the northern limit of the current appears to be the edge of George's Bank, beyond which it turns toward N. E. by E. as far as the meridian of 65°, which it cuts; in the summer in the latitude of 41° N., and in winter much more to the southward. Its southern limit during the same season is nearly the parallel of 35°.

Between the meridians of 65° and 60°, the portion of the current between the Bermudas and Nova Scotia, it is found that the northern limit of the bed of the current attains the parallel of 41° 20′ in the longitude of 65°, and the parallel of 42° 15′ in the longitude 59° 40′. Its southern limit has not been exactly ascertained.

In the north part of the Gulf Stream, during the winter, from December to March, there are constant and heavy squalls, most frequently between N. and W., blowing obliquely to the bed of the current from Cape Hatteras to beyond George's Bank, and tending to give its waters a movement toward the E., at times so strong that it is impossible for a ship to approach the land, unless with a strong favorable wind. When the winds blow from S. and E., which is not common in these localities, the current approaches the coast, and in some places passes the edge of the Bank of Soundings, compressed, as it were, between the edge of the bank and the easterly wind, the breadth of the stream diminishes and its velocity increases proportionally. This fact is particularly remarked from the meridian of Block Island, the length of the edge of the Bank of Nantucket, and from there toward the George's; also, along the

coast of Georgia and a part of South Carolina. With the winds from W. and N. W., the bed of the current spreads many miles into the Atlantic Ocean.

From what has been said on the principal limits of the bed of the current and the changes of position which have been observed, it can be concluded that the counter-currents produced by the Gulf Stream undergo equal variations, and especially near its outer limits it is generally found that the counter-current takes a direction opposite to that of the principal current. Its velocity is increased in proportion to the force of the wind blowing from a direction opposite that of the Gulf Stream, while it is diminished and the counter-current disappears almost entirely when the wind blows from a direction following the principal current. In the last case the bed of the stream expands. The east portion of its current, between the meridians of 60° and 30° W., increases greatly its breadth; its direction is consequently very variable and its limits less defined. On the meridian of 60° its northern limit attains, in the summer, to 42° 15′. From there it passes over the southern part of the Bank of Newfoundland, and the current going to the E. N. E., and sometimes to the N. E. beyond the bank, its limit attains to the latitude of 44° 30′ N. on the meridian of 41° W. It is about this meridian that the limit of the Gulf Stream commences to descend toward the S. To the W. of the Azores, between the meridians of 40° and 30° W., in the winter, the northern limit of the current is 30′, or 1° less to the N. than during the other season. On the meridian of 60° W. it does not pass the latitude of 41° 30′ N.

The southern limit of this part of the Gulf Stream does not appear to be fixed. Most frequently it is found very variable, with a tendency towards the S., when the great volume of water to the N. advances to the E. In the principal current, during the month of August, its velocity varies from fifty to twenty miles per day. It decreases in going to the E.

As the month of August and the commencement of September are the periods when the velocity is the greatest, it is necessary to make a diminution in allowing for the other months.

On the meridian of 60° the width of the bed of the Gulf Stream is, at the end of summer, about three hundred and fifty miles. The drift currents of the trade-winds, which are found to the southward of the bed of the Gulf Stream, and,

in the vicinity of the Bermudas, run in a contrary direction to the Gulf Stream; and though very variable, are generally to the W. S. W. To the north of the Gulf Stream are found variable currents, eddies, and currents derived from prevailing winds.

The Gulf Stream is generally lost on entering that part of the Atlantic Ocean called by the Portuguese the Sea of Sargasso or Sargaçao, a name given to a species of *Fucus natans* very common in this part of the ocean; it is the marine plant commonly known as the *Gulf weed.*

This gulf weed occupies to the south of the Gulf Stream the space comprised between the parallels of 37° and 18° N. latitude and the meridians of 33° and 43° W. longitude. In this space is found at times lines of the fucus very thick and compact, at others it is dispersed and divided into small groups.

The Sargasso Sea may be regarded as bounded on the south by the equatorial current directed to the W.; on the east, by the currents running S. and coming from the north of the ocean; and on the north and west, by the Gulf Stream. Its extent from north to south is more than twelve hundred miles, and within these limits the sea or gulf weed is found in greater quantities than elsewhere. During the past sixty years it does not appear to have much changed its position. It may be stationary, or unable to leave the position it occupies, which, according to Rennel, would indicate in this locality a kind of depression of the level, as is remarked in whirlpools.

Some portions of this fucus are detached from the large masses and carried by the drift currents of the trade-winds toward the Virgin Islands, and toward Porto Rico, until they reach the current of the Caribbean Sea, which carries them to the west.

As a summary, we will say that the point where the greatest velocity of the Gulf Stream is found in August and September is about the latitude 37° 45′ N.; that the velocity of this current is very variable, and that the mean does not exceed three miles per hour.

The maximum temperature observed in the waters of the Gulf Stream has been 86°, which is 9° above that of the ocean on the same parallel; 10° further north it has been found 84°, having in this space fallen 2°; in 61° W. longitude it has been found 81° in the summer and 67° in the

winter; in 43° W. longitude, 75°; and in 38° W. longitude, 73°. The temperature thus appears to decrease with the velocity, but not as rapidly as the waters advance to the E.; for when they turn to the S. they retain still a high temperature.

In leaving the Bahama Channel the waters of the Gulf Stream have a deep indigo color, and their line of separation from the green waters of the Atlantic Ocean is perfectly appreciable for a space of a hundred miles.

N. E. branch of the Gulf Stream.

When the Gulf Stream turns to the S. E., to the north of the Azores, and about the meridian of 36° W., it throws off toward the N. E. a considerable branch, with a breadth of about six hundred miles, which ascends toward the pole, passing, in part, between Iceland and the Norwegian coast, and enveloping the Faroe Islands. The waters of this current are warm, and their temperature has been found to be 54° in the summer and 51° in the winter. Its direction is toward the N. E. There is but little information as to its velocity. (See Appendix, No. 2.)

This current is important to ships going from the West Indies, Norway, Denmark, or to points situated in the north of the North Sea.

Captain Dundas Cochrane thinks that the currents met in Baffin's Bay and Davis's Strait come from the Polar Sea, which bathes the coast of North America.

"All the expeditions made to this locality," says this officer, "and among others that of Captain Franklin, have shown regular currents setting from the Polar Sea toward Baffin's Bay. Captains Ross and Parry encountered them in the Polar Sea, and in this bay, having a velocity of three to four miles per hour. There is little doubt that between Hudson's Bay and Barrow and Lancaster Straits there are a number of channels traversed by rapid currents, which render their navigation both difficult and dangerous.

In Behring Strait there are the voyages of Cook, or rather of Clerke and of Kotzebue, also the recent Russian expedition commanded by Captain Vasillief. These different navigators have found currents setting to the N., to the N. E., and to the E. N. E.; the observations of the last mentioned are the most conclusive. On the coast of Kamtchatka he found the currents setting to the E. N. E. so strong, thirty miles beyond Icy Cape, that he hesitated to advance further, fearing that he might not be able to effect

his return, as he regarded wintering in these frozen regions as imprudent if not dangerous. (See Appendix No. 2.)

"All the authors, all the philosophers, as well as those who have made researches in this matter, admit that there is a current penetrating into the Polar Sea from the Pacific, by Behring's Strait, at least during the autumn, and a current returning from the Polar Sea by Baffin's Bay. The arctic current is attributed to this cause. The currents observed by Captain Franklin are confirmed by this fact, that in the localities in question the drift-wood is all carried to the west of the capes or promontories on the coast, which is a proof that in these regions there are no currents running to the W."

These remarks of Captain Cochrane explain in a satisfactory manner the currents which descend from Baffin's Bay and Hudson's Strait, and set to the S. with considerable velocity.

Arctic current.

The arctic current is supposed to take its rise in the frozen regions which surround the pole; from thence it descends along the west coast of Greenland as far as Cape Farewell. It is divided at this cape into two branches; the one, returning to the N. along the west coast of Greenland, as far as about the parallel of 66°, is lost in the Current of Baffin's Bay; the other diverges toward the S. W., and mixes with the waters of the Hudson's Bay Current, which descends through the different straits in this part of the Polar Sea situated to the north of America. The name of *polar current of America* would be better adapted to this current, we think, than the one given to it at present.

The Current of Hudson's Bay arriving at the north point of Newfoundland, is divided into two branches; the one penetrates the Straits of Belle-Ile, the other passing over the Newfoundland Bank, where its waters mix with those of the arctic current. Near the east coast of this island this current, discharging into the ocean, appears to have a predominant direction to the S. W., and a velocity, at times, of two miles per hour; however, it varies according to the force and direction of the wind. The current along the east coast of Newfoundland turns Cape Race, and is directed towards the W., following the south coast, until it meets the current from the Gulf of St. Lawrence. The point of meeting of these currents is a little to the west of the Island of Saint-Pierre and Miquelon.

Current of Hudson's Bay. Straits of Belle Ile.

Captain Bayfield has remarked that the branch of the Hudson's Bay Current which penetrates the Straits of Belle-Ile, follows at first the direction of this strait, and is directed toward the Gulf of St. Lawrence. This is confirmed by the ice transported by this current during the summer in spite of the prevailing winds from S. W. As far as Mecatina, and sometimes to the vicinity of the east point of Anticosti, its velocity becomes greater, with a succession of winds from the N. E.; then it attains in the strait a velocity of forty-eight miles per day, and thirty or forty miles further to the west it diminishes gradually as the current enters the larger extent of the gulf. Its velocity, however, is generally less than that indicated above, and when the winds from S. W. prevail, it is almost insensible. To the east of Davis's Strait, many observations show that the prevailing current is to the E. Many bottles thrown in the sea by Captains Ross and Parry have been found on the coast of Ireland, and on the shores of the islands west of Scotland. (See Appendix No. 2.)

Current Bay of Biscay.

Although to the west of the Azores the current of the Gulf Stream turns partly towards the S., there exists between this archipelago and the coast of Europe a general movement of the waters from W. to E. This is the current known to seamen as the *Current of the Bay of Biscay.* This current, whether produced by the warm waters of the Gulf Stream, or by the cold streams running from the poles towards the Equator, is a question as yet unsettled.

The strength of the Current of the Bay of Biscay appears to be very variable, it has been observed to be at times from ten to fourteen miles in twenty-four hours. It has been met with twenty-four miles per day.

On the parallel of Cape Finistère, the Current of the Bay of Biscay, which varies in direction principally from E. S. E. to S. E., is divided into two branches; one forms the Rennel Current, the other the current of the coast of Portugal.

Rennel current.

The Rennel Current, which bears the name of the learned major who first observed it, is directed toward the E., in the vicinity of Cape Finistère; it runs along the north coast of Spain, it then mounts to the N. along the west coast of France. In this locality it commences to be felt thirty or forty miles off the coast and has a breadth of fifteen or twenty miles. Its velocity has been found to be one-half

to two-thirds of a mile per hour; it is, however, very variable, following the direction and force of the winds; it has often been found one mile per hour. To this current is attributed the loss of many ships in making the land about the Channel. It enlarges more and more in going to the north. On the parallel of Brest it extends eighty miles from east to west, and its direction is nearly N. W.; it runs from the Bay of Biscay, passes to the west of Ushant, fifteen or twenty miles from this island, traverses the entrance of the Channel and is directed to the west of the Scilly Islands; at the opening of the Irish Sea it throws one branch into this sea, the principal branch being directed toward Cape Clear, running to the W. N. W. or W., and is lost near the meridian of 18° W. in the polar current of Northern Africa.

Current of the coast of Portugal. Current of the Strait of Gibraltar.

The second branch of the Current of the Bay of Biscay, called the *current of the coast of Portugal*, is directed from Cape Finistère toward the S. S. E. and S. E.; along the coast, at the parallel of Cape St. Vincent, its direction becomes S.E., and in descending toward the S. it bends to the E. more and more until it reaches the entrance to the Strait of Gibraltar, toward which, from the meridian of 18° W., are directed all the waters from Cape St. Vincent on the north to Cape Cantin on the south, to form the current of the Strait of Gibraltar, which carries the waters of the ocean to the Mediterranean.

The velocity of the current of the coast of Portugal has been found to be from twelve to twenty-four miles per day; it is, however, very variable, according to the prevailing winds, their force and duration. On this coast, then, this current should be distrusted, particularly in winter, with strong winds from the W., and the coast be kept at a sufficient distance.

It is necessary, also, in the Bay of Biscay to pay great attention to the Biscay Current, as also to that of Rennel; these two currents gain additional force in proportion as the winds from W., variable from N. W. to S. W., have blown a length of time or with violence; it will be prudent in this case to keep always a lookout for the land of the Channel, and in leaving the Bay of Biscay to double Cape Finistère well to seaward. The Bay of Biscay presents this important fact, that while in open sea and to the southward the waters are directed towards the E., E. S. E., and S. E., which is proved by the great number of bottles found near

Bayonne and the basin of Arcachon; the waters of the interior near the coast of France run toward the N. and N. W. to find an exit.

Polar current of Africa and current of the north of Guinea.

The polar current of North Africa rises in that portion of the sea situated to the north of the Azores, and nearly on the parallel of Cape Finistère. It is directed to the S., and the principal bulk of its waters passes to the east of this archipelago, then to the west of Madeira, while between Cape St. Vincent and Cape Cantin all the mass of waters, as far as the longitude of 18° W., is directed to the N. E. and S. E., toward the Strait of Gibraltar, in which they are ingulfed as in a funnel.

From Cape Cantin to Cape Bojador, between the meridian of Madeira and the coast of Africa, it is oftenest directed to the E. S. E., but with this direction, in this locality, it does not extend more than one hundred and fifty or one hundred and eighty miles from the coast. More in open sea it runs to the S. and S. S. W. From the Canaries to Cape Verd its direction is generally from S. to S. S. W.; at Cape Verd it turns some degrees to the E. of S., following the coast of Africa, and it takes the name of *the Current of Northern Guinea*, at the parallel of Cape Palmas.

Its western limit, at the parallel of Cape Verd, is between the Island of Sal and San Nicolas, then between the Island of Mayo and Santiago, of the Cape Verd Archipelago; its direction is from S. to S. W., as through nearly all this limit from its source as far as this point.

At the parallel of Cape Mesurado its direction becomes E. S. E. and even E. in the open sea, while at a little distance from the coast it is S. E. as far as Cape Palmas; there its direction is E. in the open sea; then E. N. E. and E. S. E. to the bight of the Gulf of Benin; it runs then in contact with the equatorial current, and after turning Princes Island its waters probably mix with those of the equatorial current.

Extent of the current of Northern Guinea.

The breadth of the Current of Northern Guinea varies according to the season. On the parallel of Cape Palmas it extends to seaward about one hundred and eighty miles, that is, about as far as 12° W. longitude, and occupies the space comprised between the parallel of 2° 30′ N. and the coast of Guinea. It has on the meridian of Cape Palmas a breadth of about one hundred and fifty miles, but to the east and in the Gulf of Benin it attains a much more con-

siderable breadth, about three hundred miles from north to south. Neither this nor the equatorial current is felt in the vicinity of St. Thomas, the latter not until a little to the west of this island, in longitude 5° 50′ E.

Velocity of the polar current of North Africa.

The velocity of the polar current of North Africa near its origin and abreast the coast of Portugal is about twelve miles per day; abreast the coast of Africa it varies between sixteen and ten miles, as far as Cape Palmas.

Velocity of the Current of Northern Guinea.

The velocity of the Current of Northern Guinea is the greatest from June to September. To the east of Cape Palmas, at this period, it has been found from forty to fifty miles per day. Abreast of Cape Three Points it is about thirty-four miles; it then diminishes, and in the Gulf of Benin it bends from the E. toward the S.

Temperature of this current.

At the Cape Verd Islands the temperature of the waters of this current is from 7° to 9° below that of the waters of the ocean in this vicinity; it rises with rapidity as it goes S. In the Gulf of Guinea the temperature has been observed at 84° in the middle of the current and from 83° to 82° at its southern limit, in contact with the colder waters of the equatorial current; it is 79° to 81° in its northern part and in the vicinity of the coast.

This current is of great importance in the navigation of the west coast of Africa.

Such are the general currents in the North Atlantic Ocean, the remainder of which is occupied by drift currents, the principal of these, as we have already said, is that directed toward the W. and S. W. from the effect of the N. E. trade-winds.

NORTH ATLANTIC OCEAN.

Table of the comparative mean velocities of the currents in this hemisphere in twenty-four hours.

	Miles.
Equatorial Current	46
Current of Guiana	30
Gulf Stream	35
Drift Current of the N. E. trades	10
Rennel Current	18
African Current of Northern Guinea	20

From the numerous bottles thrown into the sea it appears that in the Atlantic Ocean the waters have a movement from W. to E., for, from the observations made on this sub-

ject by the learned hydrographic engineer Daussy, all that have arrived have been found on the coasts of Europe, and not one has been reported on the coast of America. The wind necessarily should be considered in the route of these bottles toward the continents; but by this only a movement of the upper strata of the waters would be indicated. The solution of the great question of the currents of the North Atlantic lies in the study of the currents and the temperature of the waters of the Strait of Gibraltar; are the waters carried by the ocean to the Mediterranean warm or cold? Do they supply those brought from the Gulf Stream, or those which, coming from the regions of the north, descend along the coast of Africa? This is the scientific question long proposed, but not as yet completely solved.

We will indicate the currents of the South Atlantic:

Current of Brazil.

We have already spoken of the Current of Brazil, the south branch of the equatorial current dividing at Cape St. Roque. It extends two hundred and fifty or three hundred miles from the coast of South America, and spreads into the ocean 6° or 7°. The space between the coast and the current is occupied by other currents, receiving their direction from the alternate winds from S. E. and N. E. The waters of the Current of Brazil are traversed by those of the Rio de la Plata, which can be recognized two hundred miles to seaward of its mouth. These waters, however, do not appear to exert any considerable influence on the Brazil Current, which, in this locality, is divided probably into two branches; the most considerable turns to the E., and forms the traverse current of the South Atlantic Ocean; the other branch, directed to the S., forms a current which, though very weak, is sometimes experienced as far as the entrance of the Strait of Magellan.

Velocity of this current.

The mean velocity of this current at its point nearest approaching the Equator is about twenty miles per day.

Currents of the coast of Brazil.

We have said that between the coast of Brazil and the current just mentioned alternate currents are found, occasioned by the periodic winds which blow on this coast; the strength of these currents depend on the force of the winds, and are accordingly very variable. From March to September, the season of the winds from S. E. to E. S. E., the currents mount toward the N.; from September to March, with the winds from N. E., variable to E. N. E., they descend toward the S. In these general directions, however,

will be found many variations due to the contour of the coast, these currents are not felt more than one hundred and fifty to one hundred and eighty miles from the coast, and are of great importance to navigators of this locality.

Current of Cape Horn.

The Current of Cape Horn is constantly directed from the Antarctic and the Pacific Oceans into the Atlantic. Its general direction is E. N. E. and N. E.; whatever may be the prevailing winds on the east coast of America, it is directed to the N. E. and surrounds the Falkland Islands. At certain seasons it keeps its course to the N. E. as far as the parallel of 48° or 49° S. latitude, and it is probable that it mixes its waters with the traverse current of the South Atlantic, of which we will speak.

In the vicinity of Tierra del Fuego this current has been observed to have a mean velocity of from twelve to fifteen miles in twenty-four hours. In the latitude of 57° S., and longitude of 72° W., it has been found thirty-five miles per day. In the vicinity of the coast its mean velocity would be about twenty-four miles in twenty-four hours, while between Cape Horn and Staten Island, in latitude 55° S., its direction is N. 51° E., and its velocity fifty-six miles.

Temperature.

This current advances to the N., and coming in part from the Antarctic Sea has a temperature much lower than that of the waters of the adjacent ocean.*

Traverse current of the Atlantic.

The portion of the ocean occupied by the traverse current, which sets from the coast of Brazil toward the Cape of Good Hope, is still imperfectly known. It is believed to be formed in a great measure by the tropical current of the coast of Brazil, but this is not positively known. It advances with great rapidity toward the E., passing to the south of the Cape of Good Hope at the distance of one hundred and fifty to one hundred and eighty miles; it then penetrates the Indian Ocean, where it is traced two thousand miles beyond the cape, where it forms the current of the south and west coasts of Australia. This traverse current is very favorable for ships going by the east to the East Indies and in the Pacific Oceans.

Current of Cape Agulhas, or of the Cape of Good Hope.

The Current of Cape Agulhas, or of the Cape of Good Hope, is formed by two other currents coming from the Indian Ocean, the principal of which, directed toward the S., descends the Mozambique Channel along the coast of Africa;

* See *General Examination of the Pacific* relative to the Current of Cape Horn.

the other coming from the sea, situated to the south of Madagascar, is the southwest branch of the equatorial current of the Indian Ocean.

These two Indian currents unite a little to the south of Port Natal, where they take a more southerly direction, along the edge of the Agulhas Bank, then, instead of passing entire, as has been supposed, into the Atlantic Ocean, the great part of its waters return by a counter-current into the Indian Ocean, mixing with the traverse current of the Atlantic Ocean, of which we have spoken. After the Bank of Agulhas has checked its course to the W. this counter-current is called "the counter-current of the Cape of Good Hope," or "the traverse current of the Indian Ocean."*

Polar current of the South Atlantic.

The other portion of the waters of the Current of Cape Agulhas returns in the Atlantic Ocean along the west coast of Africa for nearly its whole extent. This branch is called "the polar current of the South Atlantic," or "the South Atlantic Current."

Breadth of the Agulhas Current.

At the point of reunion of the currents which form it, opposite Cape Recife, the Agulhas or Cape of Good Hope Current has a breadth of ninety to one hundred miles; its velocity in some parts is sixty and as much as one hundred miles per day.

Temperature of this current.

Outside the Bank of Agulhas its temperature has been observed to be 70°, which is 9° above the temperature of the ocean. Near the edge of the bank it has been found 68°, 8° above the temperature of the ocean.

On the same bank the temperature of the water has been found 5°.4 below that of the surrounding ocean.

Breadth of the counter-current of the Cape of Good Hope.

The counter-current of the Cape of Good Hope attains at times a breadth of from two hundred and ten to two hundred and forty miles.

South Atlantic polar current.

The polar current of the South Atlantic, which, as we have said, is the only branch of the Current of the Cape of Good Hope which penetrates into the Atlantic Ocean, turns the Cape of Good Hope. It extends eighty to one hundred miles to seaward, and passes to the north of the traverse current of the Atlantic Ocean. Abreast the Cape of Good Hope it increases considerably, and extends about one hundred and fifty to one hundred and sixty miles. It runs, then, toward the N., spreading more and more, and empties into the equatorial current. Its principal direction is

* See general examination of the Indian Ocean.

N. W. Opposite to the Cape of Good Hope, and nearly in its latitude, it receives a branch which appears to proceed from the traverse current of the Atlantic Ocean.

Velocity of this current.

The mean velocity of this current has been found to be sixteen miles per day in its principal direction of N. W.; it meets in its course the waters of the River Congo, which, though running with much force, do not appear to have any marked influence upon its direction, the meeting currents deviating from this current but at a small angle. Its waters, as those of the Amazon, do not mingle, and for a distance of two hundred miles the water of the Congo can be recognized by its color.

Temperature of this current.

In the vicinity of the Cape of Good Hope the temperature of the waters of this current is 66°.9, 3°.06 above that of the ocean. On the parallel of 30° S. latitude it is only 64°.4.

Current of Southern Guinea.

From St. Paul de Loando the current runs the length of the coast of Africa, nearly N. W.; arriving at Cape Lopez one portion is detached from the main current, and takes a more northerly direction. Running along the coast of the Gaboon as far as the Gulf of Biafra, it is lost in the eddies of the equatorial current; this current should be named the "*Current of Southern Guinea.*"

Its principal direction is N. N. E. and N. E. near the coast; sometimes N. W. more in the offing and near the islands of the Gulf of Biafra.

Limit of this current.

The limit of this current to seaward appears to be further to the east than Prince's Island.

Velocity.

Its velocity, as a mean, is ten miles per day, though it attains often twenty-four miles. It is, however, very variable, and sometimes scarcely felt. Currents are found setting to the south in this part of the Gulf of Guinea; but this is only exceptional.

Temperature.

The temperature of the current of Southern Guinea, at the limit near the coast of Gaboon, has been found to be 77°, and in the middle of the current 77° and 78°.8. It is then higher by 5° or 7° than the waters of the equatorial current. A knowledge of this current is useful to vessels bound to the Gaboon.

Such are the currents of the South Atlantic Ocean.

Drift currents of the S.E. trades.

The vast space of sea which forms the center of the South Atlantic Ocean is occupied by the drift current of the S. E. trade-winds, the most decided directions of which are W. to S. W. and S. S.W., changing as its waters approach the

exterior current of the coast of Brazil, into which it empties, to return again to the E. by the traverse current of the Atlantic Ocean.

SOUTH ATLANTIC OCEAN.

Table of comparative mean velocities of the currents of the southern hemisphere in twenty-four hours.

	Miles.
South Atlantic Current	15
Current of Brazil	20
Traverse Current of the Atlantic	15
Current of Cape Agulhas	80
Counter-current of the Cape of Good Hope	30
Drift current of the S. E. trades	10
Current of Southern Guinea	10


N° 2.
60
50
30
A

CURRENTS
in the
ATLANTIC OCEAN.

*North and South Atlantic Oceans, 50° N. to 50° S.**

Zones.	Means.		Maxima.				Minima.				Extreme range.		Approximate number of observations.
	Specific gravity at 62° E.	Temperature.	Specific gravity.	Longitude W.	Temperature.	Longitude W.	Specific gravity.	Longitude W.	Temperature.	Longitude W.	Specific gravity.	Temperature.	
NORTH.													
Degrees.		°		*Degrees.*	°	*Degrees.*		*Degrees.*	°	*Degrees.*		°	
50 to 40	1.0260	57.5	1.0304	30 to 40	79	30 to 40	1.0099†	St. Lawrence.	32	50 to 60	.0205	47	4,000
40 to 30	1.0271	67.0	1.0323	20 to 30	81	40 to 50	1.0239	30 to 70	49‡	60 to 70	.0084	32	2,300
30 to 20	1.0274	75.0	1.0312	40 to 50	85	70 to 80	1.0235	30 to 40	58	20 to 30	.0074	27	2,100
20 to 10	1.0270	77.8	1.0313	20 to 30	83	20 to 30	1.0198§	20 to 30	64	17 to 20	.0115	19	2,000
10 to 0	1.0257	80.4	1.0318	20 to 30	84	20 to 30	1.0206‖	50 to 60	74	20 to 30	.0112	10	3,000
SOUTH.													
0 to 10	1.0270	77.4	1.0308	30 to 40	84	10 to 20	1.0159	10 to 12	69	10 to 12	.0149	15	2,400
10 to 20	1.0272	73.0	1.0311	30 to 40	83	30 to 40	1.0247	30 to 40	90	10 to 12	.0064	23	2,100
20 to 30	1.0271	69.4	1.0318	30 to 40	83	30 to 40	1.0196	Rio.	56	20 to 30	.0122	27	2,600
30 to 40	1.0265	62.3	1.0312	30 to 40	80	30 to 40	1.0185	20 to 10	45	0 to 10	.0127	35	3,700
40 to 50	1.0260	51.2	1.0293	30 to 40	66	20 to 10	1.0226	20 to 10	33	0 to 10	.0067	33	1,400

* Findlay, *South Atlantic*, p. 124.

† Near the entrance of the St. Lawrence River, and affected by fresh water.

‡ 33° is said to have been met with near the American coast in January.

§ After much rain. Her Majesty's steamer *Boscawen*.

‖ The ship *Victory*, while trading on the African coast, found the specific gravity lower on several occasions: 1.0164, 1.0130, 1.0129, 1.0167.

In a log kept by Admiral Sir Frederick Grey himself, on the coast of Africa, there is the following passage: "At the surface of the water after we anchored, the stream of brown Congo water prevailed generally, while at a depth a little below, the green salt water was seen, and the variations in density, (by hydrometer,) 1.0247, 1.0248, 1.0241, 1.0202, depend on the eddies which sometimes brought up the water from below." At bottom, temperature 72°, density, 1.0252; at surface, temperature, 75°.9, density, 1.0202.

CHAPTER III.

NAVIGATION IN THE ATLANTIC OCEAN.

As a general rule, in the navigation of the great seas of the globe, the necessity is recognized of entering the zone of the trade-winds when going from E. to W., and of keeping without this zone when navigating from W. to E.* In the one case it is desirable to reach this zone as quickly as possible; in the other, to leave it as soon as possible.

Having indicated the prevailing winds and currents which are met with in the Atlantic Ocean, we will now speak of the routes which should be taken to utilize the one and the other.

Routes to the ports of Archangel or Onega.

In going from the south of Europe to the ports of Archangel or Onega, situated in the White Sea, the route will depend on the port of departure. The North Sea should be traversed when starting from ports situated on its borders; or, if leaving the ports of the west of France, of Portugal, or Spain, pass to the westward of the British Islands.

In every case, whether coming from the North Sea or from the ocean, it is advised† to obtain a good departure from Balta, the N. E. point of the Shetlands. Captain Ramage says that in starting from England this is a good precaution, but it should be taken with a view to verify the route to that point rather than as a necessity for the continuation of the voyage, as it often happens that these islands, hid in the fog, cannot be well recognized. The islands of Faroe can be made, especially when coming from the ocean. In every case soundings should be frequently taken when in the vicinity of either of these groups of islands.

On the route from thence to Cape North, every opportunity for observing the variation of the needle should be taken advantage of, as this is very important in these localities. On arriving at Cape North a drift to the westward of the reckoning is generally found, which is attributed to the current setting to the W. or to the S. W. This may be due, however, in a great measure to errors in the magnetic variation, or to both of these causes combined.

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* We speak principally of navigation under sail.

† Purdy's *Memoir descriptive*, &c., page 80.

To the west of Cape North there are two clifts, high and perpendicular, the one at forty-two miles, the other twenty-one miles from the cape; these clifts are often taken for Cape North, or for the cape called the Nordkyn, which is thirty-nine miles to the eastward. These two clifts are very uniform in appearance, and when known are a very useful point of departure for the cape. The land which separates these clifts appears irregular and resembles a succession of islands of about one-half the height of the clifts themselves.

When abreast of the second clift, Cape North bears nearly S. E. by E. eighteen miles distant. This cape is comparatively low, level on its summit, and recognizable as the only land which presents a tabular form.

Cape North may, besides, be known by three remarkable islets detached from the coast, named the Mother and Daughters. The Mother, which is in the center when bearing about S. eighteen miles distant, appears between the two little islets, a little more elevated than the coast behind it; its upper extremity is of a conical form, with a flat summit; its appearance is different, however, viewed on different bearings.

In doubling Cape North keep at a moderate distance from the land, as in its vicinity it is frequently calm. Cape Nordkyn is thirty-nine miles from Cape North; between these two capes the two great bays of Parsanger and Laxa are situated. The land near Cape Nordkyn is high, and when abeam of it, at the distance of eighteen miles, Cape North appears comparatively low and flat, as we have remarked above.

From Cape Nordkyn in going to the White Sea, keep a moderate distance from the coast to avoid the calms which often exist near high land; if at the commencement of the season, (the middle of the spring or the commencement of the summer,) and the wind is from the westward, try to sight the Seven Islands, or rather the Island of Nagel, in order to pass inside the banks of ice, which drift at this season from the White Sea, driven some miles from the coast by the currents of the river; these, swelled by the melting snow, carry to the sea a large volume of water, and form near the coast a passage by which, with prudence and care, Sweet Nose can be reached without danger and without encountering many obstacles. It will be then possible to

enter and remain securely in the Bay of Sweet Nose (Sviatoi-Noss) until the drift ice has passed its northern point and opened a passage towards the south.

In keeping too far away from the land a risk would be run of either penetrating into the bank or being surrounded by immense quantities of ice. The greatest danger is run under these circumstances from the strain the ship has to support, as also the difficulty of extricating her from these banks.

When before Sweet Nose, to guard against the fog, so frequent in these localities, stand towards the Bank of Knock-John, keeping the lead going until soundings are struck on the bank; then follow its western edge, if the wind is ahead, bear away to the southward, tacking between the shore and the western edge of the banks until its southern extremity is attained. The tacks toward the coast should not be extended inside of fifteen fathoms, and those toward the bank not within ten fathoms, until arriving at the pitch of Cape Orlov, (Orloge Nose.) From this cape steer to pass the Three Islands, which can be known by the rocks surmounted by crosses placed near their eastern side, and by the narrow mouth of the River Ponoi, opening between two high clifts; from these islands steer for the Island of Sosnova, (or Cross 1;) it is at this island, which can be recognized by the number of wooden crosses placed on it, that the last departure is taken. From this island to Point Cat Nose, or Blue Nose, the route is nearly S. S. W., but in the spring there is frequently a strong current setting to the E. towards the Gulf of Meshen, (or Mezene;) it will be preferable to run at first a little more to the westward, then steer directly for Cat Nose.

If on the route you meet with any ice it will be best to approach the coast of Lapland. When obliged to beat it is also best t keep on that coast where the tides are more favorable than on that of Archangel.

On approaching Archangel, after passing the Cape of Cat Nose, (called also Winter Hills,) run parallel to the coast in keeping it at a little distance, until on the meridian of Point St. Nicholas; in this position await a pilot for the port.

If, instead of going to Archangel, Onega is the port of destination, from Cross Island steer for Cape Onega, allowing for the current setting to the E. by steering a little more to the W. than the direct route. Cape Onega is high

and covered with little trees, it will be known besides by the little Island of Rovestra, which is opposite to it and very high; it has a tower, and here the pilots for Onega are taken.

From Rovestra steer toward Point Orlotsna-Volock, which is high; to the south of this point is the anchorage and village of Puzlackta; the shelter is here good and it is frequented by ships which arrive too early in the season to go to Archangel; keep then a moderate distance from the coast and run parallel to it; double the point, which is quite projecting and forms a peninsula called Kimenskoi or Kisminiskoi; the course then toward Onega will be about S. E. by S. in following the coast. The little Island of Purr-Luda or Ponade-Kio can be passed to the eastward or to the westward. Fronting the entrance of the River Onega is the islet of Kio, and inside the bar two others, the islets of Shakloui. If it is wished to pass to the west of Purr-Luda, bring these two islands in one, on a bearing of S. E. ½ E., which leads to the entrance of the river.

Tides on the coast of Lapland and in the White Sea.

To the east of Cape North, the flood runs to the S. E. and to S. S. E. the length of the coast as far as Cape Orlov. In the Bay of Tana, at full and change, high water is at 3h.; at Ward-huus, at 4h.; at Kilduin, at 7h. 30m.; in this last locality the tides fall two and a quarter to two and three-quarters fathoms; at Three Islands high water takes place at 11h. 30m., it falls two and a half fathoms; the establishment at Cross Island is 4h. 15m.; at Cat Nose, 3h. 30m.; between these two points the flood sets to S. W. by W.

On the bar at Archangel, the establishment is 6h. and 7h. 30m. in the port. Between Cape Onega and Onega, the flow runs the length of the coast toward S. E. by S. at the rate of two miles per hour, the tide falls one and one-eighth fathoms. We have considered that these indications of the tides might be useful to seamen going to the White Sea.

Routes from Europe to North America.

In the routes from Europe to North America it has generally been considered that the further north the port of departure, the greater the chances of a quick passage.

At the commencement of the year.

In the commencement of the year, it is recommended to keep to the north of the parallel of 46° or 47° N. latitude, until in about the longitude of 35° W.; then to descend to the parallel of 43° N., and keep on or near the parallel without going further to the northward, particularly in approach-

ing the coast of North America, in order to pass well to the south of Sable Island, a dangerous sand-bank which cannot be too carefully avoided. In following this route, the northern limit of the Gulf Stream is avoided, and from the Bank of Newfoundland the arctic current, setting to the S. W., is taken advantage of. This route answers for the ports of Nova Scotia, New Brunswick, or the northern ports of the United States.

Toward the end of the year.

Toward the end of the year, a route further to the north than the former is advised. In leaving Europe, steer to the N. W. until in the latitude of 55° N., and when on the meridian of 26° W., steer to the southward to cross the Banks of Newfoundland in latitude 46°; then keep sufficiently to the southward to pass about sixty miles south of Sable Island, when steer for the port of destination.

In these routes, it is particularly recommended never to pass to the north of Sable Island, on account of the frequent fogs in these localities, and the strong current setting to the S. W., which exist in its vicinity, the effects of which cannot be calculated.

Route from Europe to Newfoundland or to the Great Bank.

In viewing the chart of the Atlantic Ocean, it is seen that from the entrance of the English Channel to Newfoundland the direct route is nearly W. 4° S.; that to Cape Sable (Nova Scotia) it is about W. 9° S. Generally it is not possible to make these routes direct, and there is less difficulty and less time employed in following the curve. Under all circumstances, the best route is that to the northward. In starting from the channel and steering to the N. W. it is probable that the winds will be found blowing less directly from the W., and will be less contrary than in a lower latitude in proportion as you advance toward Davis's Strait, and in the end the currents and winds are favorable. Thus, in going from France to Newfoundland, it will always be advantageous to make the northern route. The rule which we lay down is founded on the remark made in England, that ships starting from Scotland always arrive sooner at Newfoundland than those sailing from the Channel. A well-known fact, besides, is that in the spring and summer the currents set generally from the entrance of Hudson's Bay, and from Davis's Strait toward the Atlantic Ocean the proof of the existence of these currents is the icebergs and fields of ice which are met with on the banks of Newfoundland from the month of May to that of August. We repeat, there is

then an advantage in going to the north on sailing from Europe.

The route which should be followed in going from Europe to Newfoundland is nearly the same as we have above indicated for the route to the ports of North America during the first months of the year; that is, to keep above the parallel of 46° or 47° until about the meridian of 37°, then a more southerly course can be made to reach the parallel of 45°, in order to avoid the icebergs, for which a good lookout should be kept; keep about the parallel of 45°, but not to the southward of it, to the edge of the Great Bank. On this route, it is particularly between the parallels of 60° and 40° N. and between the meridians of 30° and 60° W. that a lookout should be kept for icebergs descending from the north towards the south. It is generally toward the month of April that the fishermen of the Great Bank leave Europe; some start earlier. The Banks of Newfoundland are frequently covered with thick fog, which, from the spring to the month of December, lasts sometimes eight or ten days without interruption, and is often so dense that it is impossible to see a distance of sixty-five feet; this fog resolves itself into rain upon the sails and rigging and falls drop by drop upon the deck. It is frequently calm with a heavy swell, and a continual fear is felt of being run down by some vessel or taken by the current on some bank, a double danger with no means of avoiding it, from the impossibility of perceiving objects at any distance.

To these drawbacks should be added those occasioned by the currents which prevail in the vicinity of Newfoundland. They are often very strong and very irregular, setting at times toward the land, at times toward the offing; little confidence can be felt in those localities; in addition to this, the current coming from the N. along the coast of Labrador detaches, towards the spring, immense fields of ice, which are taken to the south, and thus add another danger to those occasioned by the fog. Some of these masses ground in depths of from forty to fifty fathoms; others are carried into the sea, where they are sometimes met with three hundred and seventy-five and three hundred and ninety miles from the coast. Fortunately this floating ice is most generally indicated, even in the haze and fog, by the brilliant and white reflection which it produces in the atmosphere

above the position which it occupies, and by the noise of the breakers upon it.

The vicinity of icebergs can be known, besides, by the intense cold existing for a great distance around them. These icebergs are preserved a long time, and are met even in the month of August. The approach to the Great Bank is known by the sea birds which fly in troops from its edge. On this edge the bottom is of fine whitish sand speckled with black.

Route to the island of St. Pierre.

Ships going to St. Pierre, an island situated to the south of Newfoundland, should, on leaving Europe, steer as we have directed above, then, when they have attained the meridian of 52° W., keeping on the parallel of 45° N. latitude, they will steer W. N. W., which will take them on Green Bank in soundings of about fifty-three fathoms. Continuing their course, when they reach the meridian of 55° 20′, in the latitude 45° 35′ the depth increases suddenly from fifty-three to eighty-eight fathoms, making twenty miles more on the same course, the depth diminishes again to forty-five, varying to thirty-five fathoms; from this make twenty miles more on the same course, then steer directly for the Island of St. Pierre; in steering thus it will be nearly impossible to miss it.

Looking on the chart of the Great Bank of Newfoundland it will be seen that the difference in the soundings which we have given are produced by the ditch of deep soundings which separates Green Bank from St. Peter's Bank. This ditch extends from north to south between the meridians of 55° and 55° 20′ of W. longitude and the parallels of 45° 10′ and 46° 10′ N. latitude, its length is about sixty miles; its center is situated nearly in the latitude of 45° 52′ and longitude 55° 10′. It is an excellent mark when going to the Island of St. Pierre or to the Gulf of St. Lawrence, and a sure means of rectifying the position when observations cannot be obtained, which happens often in these localities, where the fog is so frequent. In seeing the depth increase suddenly the sounding should not be discontinued; some captains, in ignorance of this ditch, stop sounding as the depths increase to the west of Green Bank, and believe themselves at the entrance of the Gulf of St. Lawrence; this error causes them to run too long to the north and puts them on the coast to the east of Cape Race, or on the rocks of Newfoundland.

Route to the Gulf of St. Lawrence.

In going to the Gulf of St. Lawrence, after passing to the south of the Virgin Rocks, which are on the Great Bank, and then to the south of the Island of St. Pierre, a course should be steered half-way between Newfoundland and Cape Breton Island, recollecting what has been said in a preceding chapter upon the winds in these localities. It should be further remarked that on the south coast of Newfoundland, to the west of Fortune Bay, the ports are little known, and there are many rocks at their entrance, which cannot be seen in foggy weather, which is the most prevalent on this coast.

Currents on the Great Bank of Newfoundland and its vicinity.

It appears that on the north part of the Great Bank of Newfoundland the current is found setting to S. S. W., while on its southern part it sets to the N. E., and that these currents form in mingling eddies, which are very irregular; the mean velocity of these currents is from eight to ten miles per day, but sometimes they are found twenty-four and even thirty miles; this also takes place in the localities of the Gulf of St. Lawrence. Thus in the vicinity of the Island of Breton the waters of the river St. Lawrence are directed toward the S. W. On the south coast of Sable Island, with the winds prevailing from S. and S. W. the current runs strong to the E. as far as the extremity of the Northeast Bar; this current then meets the branch of that which, leaving the St. Lawrence, passes Cape Breton and sets strongly to the S. S. W. near the Northeast Bar of Sable Island, especially in April, May, and June. The waters of these currents mix, and it is possible that the Gulf Stream, which, on the parallel of 42° 30′ runs to the N. N. E., modifies the direction of the current of the St. Lawrence, setting to the S. S. W. and forces it to take a direction more to the W.

The current from the Gulf of St. Lawrence runs most frequently toward the S. E., if it is not opposed by winds from the E., when it takes sometimes the contrary direction. It should be said, however, that the winds in the gulf, and even in the open sea, have such an influence on the currents, that no precise statement of them can be made.

It will be seen, after what we have said, how much the currents should be distrusted on the Great Bank and in the Gulf of St. Lawrence. They produce in the movement of the waters in the offing of this island constant variations,

which often cannot be appreciated from want of observations and foggy weather. The greatest care and prudence should therefore be observed in this dangerous navigation.

Currents near the coast of Newfoundland.

Near the east coast of Newfoundland, the current from Hudson's Bay sets to the S. S.W. and S. as far as Cape Race; it turns this cape and is directed to the W. along the southern coast as far as the Islands of St. Pierre and Miquelon. Near these islands it meets: 1st, the branch of the Hudson's Bay Current, which, having traversed the Straits of Belle Ile and turned the western extremity of Newfoundland, is directed toward the E. along its southern coast; 2d, the general current of the Gulf of St. Lawrence, setting usually to the S. S. E. and to E. S. E.

It is no doubt owing in a great measure to these so variable currents that so many ships are lost on the south coast of Newfoundland in the vicinity of Cape Pine. In fact, the ships which leave the Gulf of St. Lawrence are at first drifted to the east, then to the west, until they have passed to the east of the meridian of the Islands of St. Pierre and Miquelon. Then, with calms or light and head winds, they are carried insensibly to the west of their reckoning; and if without observations, which is frequently the case on account of the fogs, it results that, calculating on being to the eastward of Cape Race, and being in reality to the westward of it, in steering toward the north they are thrown on the coast at the moment when they suppose themselves in the open sea.

It is even probable that on the meeting of the two currents running from different directions along the coast of Newfoundland, the one from the W. may annul that from the E., which comes from the Gulf of St. Lawrence, or may give it a northerly direction.

After the indications we have given, too much vigilance and care cannot be observed in navigating near the shores of this island; for, in addition to the fogs which hide the land, one has to strive against the winds, the currents which are much influenced by them, and at last against the dangers which may result from encountering icebergs, drifted by these currents.

General observations on making the land of the Bermudas.

In foggy weather, or in the night, the Bermudas should be approached with the greatest caution. To prevent being drifted unawares upon the reef, a good lookout should be kept by day for the land and Gibbs's Light-house, which

from the offing resembles a ship under sail, and at night to get hold of the light as soon as possible.

The establishment of the light has necessarily diminished the danger in making the land; nevertheless, there are still many precautions to take in running for this island.

In running on the parallel of the Bermudas, with a favorable wind, if the land is not seen before night, and it is thought to be near, a vessel in this position should not be hove to, especially with a fresh breeze, as she might be drifted by currents, the existence of which are probable, their direction and force depending on the prevailing winds. In this case, if it is desired to await the day, it will be better to make short tacks under easy sail; otherwise, to make the light.

The islands are generally very low, and cannot be seen far from the deck of a small vessel; besides, in the summer season thick fogs are frequent and add to the difficulty of making the land, unless the latitude is well ascertained.

Soundings should be taken frequently from the time that the ship is supposed to be near the land. The greater number of shipwrecks which have occurred on this island have been from a neglect of this precaution.

Making the land from the west.

Ships destined for the Bermudas from the ports of the United States, or coming from the West Indies by the Bahama Channel, should steer much to the S. of the direct route, and even to the S. S. E., until in a latitude three or four miles south of Cape Hatteras; make then S. E. by E. until on the parallel of 32° or 32° 5′ N. latitude. Crossing the Gulf Stream in its greatest breadth, and where it would set principally to the E., will be thus avoided, and it will be crossed where its direction affects the latitude more than the longitude, which is important for vessels which navigate by dead reckoning.*

In making to the southward and steering S. E. by E., you will make the islands twelve or fifteen miles west of their longitude and get hold of the light.

The prevailing winds in this zone of the Atlantic being from the W. and N. W. in the winter, and from the S. W. in summer, it results that nearly all ships going to these islands make the land from the W., and place themselves on about 68° W. longitude, from whence they steer directly

* *Blunt's Coast Pilot.*

to the E. Without being a general rule, this manner of making the land has become almost general, and is that adopted particularly by merchant vessels.

The parallel of 32° 8′ N. being three miles to the south of all the dangers to the southwest of the island, appears to be the best to follow in making the land to the west. It is necessary however, on this route, to keep always in mind that there is probably a current occasioned by the prevailing wind. Thus with the wind at N. W., the parallel of 32° 8′ N. can be taken; if it is at S. W. that of 32° 2′ N.*

When the winds are adverse or the weather very foggy, before making the land it will be prudent in the night not to go further north than the parallel of 32° 4′, or that of 32° 5′ N., † and if the wind turns to the S. W., that of 32° should not be passed. When certain of the position, either of the parallels mentioned can be taken according to circumstances, and steer to the east; thus Wreck Hill will be made, a remarkable conical hill, with a volcanic appearance. It should bear to port, as should also Gibbs's Hill, the light-house on which can generally be seen before the land.

With these two points the position can be rectified, and if the light-house only is seen, it must be recollected that the reefs which are on the west of the Bermudas extend to westward of the light-house at least twelve miles, and the soundings are too close to the edge of the reef to give sufficient warning. They should not be approached until the light-house or Gibbs's Hill bears N. E. by N.‡

* Blunt and other instructions, indicate in the same case, the parallel of 32° 5′ N. The route on the parallel of 32° 2′ would pass the meridian of Gibb's Light, at a distance from it of thirteen miles. The light is plainly visible at this distance. The light can then be seen fixed before and after the flashes, which cannot be done at a greater distance. This remark is important. It is understood that the parallel to be chosen should depend on the prevailing winds, their force, and the probable time that they have been blowing, up to the day of making the land. From this may be derived the current against which it is necessary to guard. We think, however, that when the latitude is certain, the parallel of 32° 2′, or that of 32° 3′ are those which should be preferred, when there is a good breeze from the S. W., or when making the land at night.

† The currents which run to the N. E. are at times very strong in the vicinity of the Bermudas, and ships leaving America are drifted, as a mean, one hundred and fifty miles to the eastward of their tracks.

‡ Blunt, Purdy, Thomas Leon.

With this bearing you can run depending on the land, and when the light-house or Gibbs's Hill is on with Wreck Hill, or in the night when the light bears N. W. by N., you will be abreast of the southwest breakers, the only danger to be feared on the south side of the island. It extends one and half miles from the south point of the Island of Bermuda.*

After passing this bearing a short distance haul up along the coast of the island, keeping one or one and a half miles from it.* Run thus as far as Castle Harbor, and until St. David's Head bears N. or until Cape Garnet and Cape St. David are on the same line running along the coast. Do not go inside of ten or eleven fathoms during the day, and twelve to thirteen fathoms at night.

When to the southeast of Castle Harbor heave to for a pilot, and if at night make a night-signal and hoist a light to show your position. When hove-to be careful not to drift to leeward, as the current generally runs towards the E.; with the pilot on board he will take the vessel to Murray's anchorage, the harbor or road of St. George's, as may be desired. By day, if pressed for time, or if the pilot does not come off, you can pass round the reefs after having passed the island on the southeast side of Castle Harbor, double St. David's Head, outside which the reefs stretch about three-fourths of a mile, and anchor in nine or ten fathoms in St. George's Road.

To take this anchorage, which we would only advise during the day, when not wishing to await a pilot, (which will not always be prudent,) it will be necessary, as in all other anchorages of the Bermudas, to be guided by the eye in selecting an anchorage where the ground is not foul. The clearness of the water and the white color from the sand, indicate plainly the places where the anchor can be dropped without risk.

Making the land to the east.

In going from any port of Europe to the Bermudas, steer directly for the island as long as the wind is favorable. Should it become contrary, instead of working to windward it will be desirable to run to the south and take the N. E. trades, keeping in them sufficiently long to enable you on running to the northward to cut the parallel of 32° 8′ N. in

* Blunt, Purdy, Thomas Leon.

the longitude of 67° 40′ W.* The land will then be made to the west, as above.

If the wind is favorable during the whole route, the land can be made to the east as well as to the west; running for the island place the ship between the parallels of 32° 15′ and 32° 4′ N. latitude. This route will lead a few miles to the south of St. David's Head.†

In making the land at night be careful not to go to the north of the last-mentioned parallel, in order to keep within sight of the land and the light. If on the route for making the land to the east the wind becomes contrary, there is a fog, haze, or bad weather, you should, more especially at night, not go to the north of the parallel 32° or 32° 4′ N., and if then you get to the westward the land can be made to the west, as before directed.

We terminate these remarks on the Bermudas by counseling navigators never to seek the anchorage during the night unless the weather is sufficiently clear to admit of their constantly knowing their position by bearings, until the pilot comes on board.

Routes from Europe to the United States.

In the route from Europe to the ports of the United States, it is necessary to avoid the bed of the Gulf Stream, for in event of a calm or a contrary wind the current would sweep you rapidly to the E. In going then to any of the northern or central ports of the United States, follow the routes heretofore directed, passing to the south of Sable Island to the east of the banks of St. George and Nantucket, and from there navigate in the current which sets to the S. near the coast of the United States, keeping sufficiently near the coast to avoid entering the Gulf Stream. By navigating thus, the passage to New York, the Delaware, and the other ports situated to the south of these will be much shortened.

* Blunt.—It appears to us that the distance to the W. of the island given for cutting the parallel of 32° 8′ N. is too great, and that 66° 40′, or 65° 40′, would be sufficiently far to the west. This places you one hundred and six, and forty-six miles to the westward of the group. If the weather is good and the ship furnished with chronometers, we would advise making the land to the eastward, and to leave the N. E. trade when in a position for reaching the parallel indicated for making the land to the east.

† It appears to us that there is less danger always in making the land to the east than to the west, and in reality there is nothing in favor of the latter but the wind generally blowing from the W., which is more favorable and permits a more direct route.

At any rate, if it is desired to cross this current in going to the west it should be done as rapidly as possible.

There is another route through the trade-winds which, although the distance to be run is greater, appears to us preferable in case the wind is not fair, and when destined for the southern ports of the United States; for if the time employed in a passage is in direct ratio to the distance, it is in inverse ratio of the speed with which the ship goes from the point of departure to that of her destination.

On leaving Europe, if the winds are not favorable for making a direct route to the United States, we believe that it will be more advantageous to run to the S. or S. W., according to the prevailing wind, and get in the trades as soon as possible. The best route for reaching the zone where they blow, is that between the Azores and Madeira, and between Madeira and the Canaries, avoiding the passage between the latter and the coast of Africa; for in the proximity of this coast the winds change their direction and lose much of their force.

Once in the region of the trades, make the route most suitable for reaching the port of destination, only taking the precaution in crossing the Gulf Stream and making the land to be about thirty-six miles to windward of the port of destination.

It is very frequent that this passage can be made without descending to the trade-winds, especially in the forty or fifty days which follow the equinoxes, when the wind is frequently at N. E.; so that ships starting at this time can make the route by the high latitudes. However, if during the passage head-winds are encountered, it will be better to go south for the trades than to beat against these winds.

In the spring, summer, and autumn, the seasons when the N. E. trades extend to the parallels of 28° to 30° N. latitude, the route through the trades will be very advantageous, particularly when destined for the southern ports of the United States.

Finally, if the winds permit, in going from the ports of Europe to those of the United States, a west course is the one to be followed; if the winds do not permit, in the season of the equinoxes, take that nearest to it. In every other case, preference should be given to a course between south and west to reach the trade-winds.

The mean of the passages from Liverpool to New York

made by the packet ships in six years is forty days.* The following may be cited as fine passages: The *Charlotte* made two voyages from Bremen to New York in thirty-three and twenty-eight days; the *Alexander*, from the Weser to New York, was twenty-seven days; the *Clementine*, from Bremen to Baltimore, was twenty-nine days.† On the return we find the following: The *New York*, from New York to Liverpool, in less than fifteen days; the *Mary Catherine*, from Charleston to Liverpool, in nineteen days; the *Marmion*, in eighteen days between the same ports.‡

Routes from the ports of the United States to Europe.

On the return from the ports of the United States to Europe, the currents which set to the S. near the coast should be crossed as quickly as possible, the Gulf Stream entered, and steer to the N. to get out of its influence, as in the region which it occupies there is much bad weather and a liability to hurricanes in the months of July, August, September, and October. In the other months, it is our opinion, that with a good ship the course of the Gulf Stream should be followed, which will much shorten the passage. When on the meridian of 38° W. longitude, steer to pass to the N. of the Azores, and from thence, according to the winds, follow the course for the port of destination. On this route one is greatly favored by the winds from W., variable to S. W. and N. W. The mean of all the passages made during six years by the New York packet ships was twenty-three days, but the passage has been made in nineteen, eighteen, and even in fifteen days.

The same passages, made by steamers of that time, give the following results:§

From east to west.

	The longest time. *Days.*	The shortest time. *Days.*
Passages of the *Great Western* from Bristol to New York	21½	13
Passages of the *Royal William* from Liverpool to New York	21½	18½
Passages of the *Liverpool* from Liverpool to New York	18½	16

* Hodgson's *Letters on North America*, vol. ii, p. 345.

† Journals of ships of commerce of the Hanse Towns.

‡ *Liverpool Journal*, January, 1824.

§ *American Almanac Repository of Useful Knowledge*, 1841.

	The longest time. *Days.*	The shortest time. *Days.*
Passages of the *British Queen* from Portsmouth to New York.....	20½	14
From west to east.		
Passages of the *Great Western* from New York to Bristol	15	12
Passages of the *Royal William* from New York to Liverpool.....	17½	14½
Passages of the *Liverpool* from New York to Liverpool.....	17½	13¾
Passages of the *British Queen* from New York to Liverpool.....	22½	13½

The regular line of steamers between Liverpool and Boston, via Halifax, made the passage in fourteen days, leaving the 3d and 18th of each month. Another regular line of steamers between Havre and New York made the passage in twenty-five to thirty days, leaving the 1st, 8th, 16th, and 24th of each month.

In 1840 a line of steamers, carrying the mail between Liverpool and Halifax, was established; in 1842 the mean of their passages from east to west was thirteen days six hours, that of the return voyage eleven days five hours.

Routes from Europe to the West Indies and Gulf of Mexico.

In leaving Europe for the ports of the Caribbean Sea or the Gulf of Mexico, as soon as in the Atlantic, ships should direct their course to the southwest, in order to reach the region of the N. E. trades as quickly as possible.

On this part of the route the coast of Africa should not be approached too closely, as the currents near it run obliquely toward the coast, and the winds also take a direction more toward the W. If it is necessary to go as far as the Canaries to find the trades, pass to the west of this archipelago.

Once in the trades, if going to the Windward Islands, steer directly for the point of destination, in keeping, from the month of May to the month of December, as long as possible on the parallel of 19° or 20° N. latitude. From December to June, on the contrary, a lower parallel should be followed. In approaching the Caribbean Sea the currents should be considered, particularly if a ship is navigating by dead reckoning, which will always place the position by account to the east of the true position, so that if navigating by

dead reckoning it would be well to add twelve miles a day to the run made to the west, as an allowance for current.

If the ship is destined for the larger islands of the West Indies or for the Gulf of Mexico, enter the Caribbean Sea by the passage between Guadeloupe and Antigua, or between St. Martin and Anguilla. This is invariably the entrance preferred in going to St. Thomas, Porto Rico, Port au Prince, Kingston, Havana, Tampico, Vera Cruz, and New Orleans.

In the season of the trades, from March to September, the passage can be made to the north of the Virgin Islands and Great Antilles, and through the Old Bahama Channel. This route, though shorter than the preceding, appears to us in reality less advantageous, from the many dangers and difficulties which it presents.

Those destined for La Guayra, Porto Cabello, Carthagena, or any of the ports of Venezuela, generally enter the Caribbean Sea by the channel between Santa Lucia and St. Vincent, or that between Grenada and Tobago.

Route from the United States, or from the Bermudas, to the West Indies and Gulf of Mexico.

In leaving the United States or the Bermudas for the Windward Islands, a course should not be steered directly for these islands, but first get to the eastward in running S. E. if the wind permits, or by working to windward in the variable winds, until sure that in traversing the trade-winds you will be able to fetch to windward of that one of the islands to which you are destined, even should the trades be at E. S. E. or S. E.; besides this the current setting to the W. should be taken into account; this current is general, and has a velocity of at least twelve and sometimes twenty-four miles per day.

In going to the Great Antilles follow the same directions, and pass to the north or south of the Great Antilles according to the season, whether of hurricanes or that of N. winds. In the latter case you will enter the Caribbean Sea by the Mona Passage, or by the one of those to the northward of Santo Domingo (Silver Cay, Turk's Island, Caicos, or Crooked Island Passages) which may appear most suitable. Crooked Island Passage is taken by preference by those going to the Gulf of Mexico or the Havana.

In leaving the United States for the Havana or the Gulf of Mexico you can also pass through the Northwest Providence Channel, and on reaching the Florida Channel, keep along the western edge of the Great Bahama Bank, or, if

not drawing too much water, cross it, as also the Salt Cay Bank, and, passing along the north side of Cuba, make Havana. You can, besides, by taking the Crooked Island Passage, reach Havana through the Old Bahama Channel. We only point out, however, this route.*

Routes from Europe to Guiana.

In leaving Europe the general route from November to July will be to take the most direct line to the parallel of 10° N., between the meridians of 44° and 46° W., so as to cross the belt of calms to the westward of its greatest breadth, the most difficult point of crossing. When on the parallel of 10° keep a point or a point and a half more to the south than the direct route, to balance the current, which in general runs to the N. W., so as to place you on the parallel of 3° or 3° 30′ about one hundred and fifty miles from the land; then run to the west to nine or ten fathoms of water, to recognize the land.

From the month of July to November the following route might be adopted from preference, and often with advantage: Pass about four hundred and fifty miles to the west of the Cape Verd Islands, then steer to the south, cross the zone of variable winds and reach the S. E. trades, which at this season are found as far as 5° or 6° and even 7° or 8° N. of the Equator; having these winds steer to the west, keeping between the Equator and the parallel of 3° 30′ N. until striking soundings in seven or eight fathoms.

Routes from the West Indies to Europe.

In leaving the Windward Islands for Europe the ordinary route is between Guadeloupe and Montserrat, from thence with the winds from E. to N. E. run to the north, always on the starboard tack, to get as soon as possible out of the zone of the trade-winds. On reaching the variable winds follow the directions given on the route from the United States to Europe.

In leaving Jamaica it is customary to pass through the Windward Passage, between this Island, Santo Domingo, and Cuba, then, according to the prevailing wind, take any one of the Bahama Island Passages, when, by running on the starboard tack, you will pass through the trade-winds as quickly as possible.

In the season of the northerly winds (principally from November to February) the passage can be made by dou-

* For these routes see *Le Manuel de la Navigation dans la Mer des Antilles*, chap. viii.

bling Cape St. Antonio and passing through the New Bahama Channel.

If going from Jamaica or Cuba to the Windward Islands the same route is to be pursued as that in leaving the Caribbean Sea, by one of the passages to the northward of Santo Domingo, or by the New Bahama Channel; from thence run to the north to get out of the trades, and work sufficiently to the eastward to fetch to the east of the Windward Islands.

Ships which leave La Guayra, Porto Cabello, or Cumana, for Europe, leave the Caribbean Sea by the Mona Passage, formed by the Islands of Santo Domingo and Porto Rico; from this keep to the north, so as to cut the parallel of 40° N. between the meridians of 28° to 33° W., nearly. Leaving Santa Marta, Carthagena, or ports more to the westward, the Caribbean Sea can be left by the Windward Passage, or by the New Bahama Channel. This last seems to us preferable.

Ships leaving the Virgin Islands or Porto Rico make directly to the north on the starboard tack, to get as soon as possible out of the region of the trade-winds, and follow nearly the same route as in departing from the Great Antilles for Europe or for the Windward Islands.

Leaving Cuba, or the Gulf of Mexico, ships enter the Atlantic Ocean through the Bahama Channel, and steer toward the northeast to leave the Gulf Stream. The route then is east, passing to the south of the Bermudas, and cutting again the Gulf Stream in the vicinity of the Azores.

We have passed quickly over the navigation in the Caribbean Sea and Gulf of Mexico, having given in detail the navigation of these two seas in the *Manuel de la Navigation dans la Mer des Antilles, &c.*, to which we would refer navigators who may be anxious to make it a study.

Following, is some general information on the passages from Europe to the West Indies and Gulf of Mexico and the return:

Going.

From the mouth of the Elbe to Havana, fifty-nine days.
From Hamburg to La Guayra, fifty days.
From Brest to Santo Domingo, forty-six days.
From Havre to Vera Cruz, forty days.
From Brest to Martinique, twenty-seven days.

The longest passages have been forty-six days. The shortest twenty-seven and twenty-eight days. In fourteen voyages from the ports of Brest, Lorient, and Rochefort to this island the mean is thirty-two days.

Returning.

From Havana to the mouth of the Elbe, forty-nine days.

From Kingston to Brest, thirty-two days.

From Havana to Gibraltar, forty-seven days.

From Vera Cruz to London, forty-two days.

From Guadeloupe to Brest, thirty-seven and twenty-eight days.

From Port au Prince to Brest, twenty-nine days.

From Martinique to Brest, thirty days.

From St. Thomas to Hamburg, generally, forty-five days.

A voyage has been made in thirty-six days by a Prussian ship, the *Elizabeth Louise*, Captain Kasten.

There is a regular line of steam packets between Southampton and Tampico, by way of the West Indies. Their trips are made as follows:

Going, forty-six days, touching at Funchal, Barbados, Grenada, (with a branch for the Small Windward Islands and St. Thomas, La Guayra, Trinidad, and Demerara,) from Grenada to Jacmel, Kingston, Havana, and Tampico, leaving twice a month, returning from Tampico via Nassau and the Bermudas.

There is also from Havre to the Havana a regular line of steam packets, which make the direct route in thirty or thirty-five days by the Old Bahama Channel.

Routes from Europe to the ports of South America.

Ships leaving Europe for the ports of South America, as Rio Janeiro or Buenos Ayres, should run between south and west to reach as soon as possible the N. E. trade-winds, passing between the Azores and Madeira, and Madeira and the Canaries and to the west of the latter, if no stoppage is to be made there. From thence steer to cross the Equator after passing the zone of variable winds near this great circle.

Where the equator should be crossed.

For a long time it has been the rule to cross the line in from 18° to 20° W. longitude. Numerous facts* have proved that it is preferable to cross the line in from 23° to

* The routes made by the packets to Brazil, the mean of their passages to Rio Janeiro being from thirty to thirty-five days.

28° W. In fact, the zone of variable winds is narrower between these meridians than toward the coast of Africa, and ships often pass, without experiencing calms from the N. E. to the S. E. trade-winds, the change taking place in a squall. As to the fear of being drifted to the W., and toward Cape St. Roque, by the equatorial current, it appears that this has been much exaggerated, and that, on the other hand, the trades in this locality blow much more from the E., which would not indicate any difficulty in doubling Cape St. Roque. A general remark may be made, that the winds in the open sea, on the coast of Brazil, blow nearly perpendicular to the coast, principally from the month of October to March. During this period, then, one can approach the land without fear, the winds being generally from N. E. to E. N. E., and the current near the coast running from the N. toward the S.; thus, as we have said, the route will be most easy. From March to October, on the contrary, the winds blow from E. to E. S. E., and the current near the coast running from S. towards the N. it will be preferable, bound to Rio Janeiro or Buenos Ayres, to keep one hundred and twenty or one hundred and fifty miles from the land in the general current of the coast of Brazil, and to pass to the west of the Island of Trinidad. Ships bound round Cape Horn, whether they come from Rio Janeiro, Buenos Ayres, or elsewhere, should approach the coast of Patagonia, and keep within at least one hundred miles of it, to avoid the heavy sea raised by the winds from the W. which prevail, and also to turn to advantage the variations of the winds on this coast; they will pass between the Falkland Islands and Tierra del Fuego, and, generally, to east of Staten Island, the Straits of Le Maire being often difficult to pass.*

Route from South America to Europe.

In leaving the ports of South America for Europe, the routes to be taken depend on the latitudes of the ports.

Ships leaving the ports of Brazil situated to the north of Point Olinda, can in general take the starboard tack, double the coast, and steer directly to the N.

Those leaving the ports of Brazil situated to the south of this point, are forced often to take the port tack and run to the southward to get clear of the coast. Sometimes the winds from N. E. oblige them to continue on this tack for twelve or fifteen days, and to run to the southeast or south-south-

* *Instructions on Patagonia*, by King.

east as far as the parallel of 28° or 29°, and even to 32° S. latitude. Keep on this tack until you reach the meridian of 30° W., or work to windward as far as the same meridian, so that on going on the starboard tack you will be nearly certain of doubling the Island of Trinidad. In proportion as you go to the north you are assisted by the winds hauling to the E., and it is very rare that you cannot on this tack pass to the eastward of Fernando de Noronha, and cross the line between the parallels of 28° and 33° W. longitude. From thence, traverse the zone of variable winds, which is generally narrow to the west of the meridian of 28°, and continue on the starboard tack with the N. E. trades, until on the parallel of 30° N. latitude.

When without the trades steer for the port of destination, passing either inside or to the north of the Azores.* After what has been said there can be no difficulty in making the routes from the ports of Brazil, when leaving ports more to the south or coming from Cape Horn; the westerly winds prevailing in that zone will facilitate the route as far as the zone of the S. E. trades.

From fifteen passages made from different ports of Europe to Rio Janeiro, the mean duration of the voyage was fifty days. Many voyages have been made from the west coasts of France and England in from forty to forty-two days. The packets from England to Rio Janeiro made the passage in thirty-five days.

Going.

From Brest to St. Catherine, seventy-seven days.

From the Strait of Gibraltar to St. Catherine, fifty-three days.

From Havre to Maranham, forty-three days.

From Marseille to Rio Janeiro, sixty-five days.

From Bordeaux to Cape St. Augustine, forty-five days.

From Bordeaux to Cape St. Antoine, sixty-four days.

From Rio Janeiro to St. Catherine, six days.

From Brest to Montevideo, fifty-seven days.

From Brest to Cayenne, thirty-one days.

From the ports of Europe to Cape Horn, the mean, eighty-two days.

* For more ample details see the *Pilote du Brésil*, by Admiral Baron Roussin.

Regular lines of steamers.

From Havre to Pernambuco, making the route direct, from forty to forty-five days, touching at Bahia, Rio Janeiro, and Buenos Ayres.

From Rio Janeiro to Buenos Ayres seven days.

From Falmouth to Buenos Ayres, fifty days, touching at Funchal, Santa Cruz, (Teneriffe,) Bahia, and Rio Janeiro.

Returning.

From Montevideo to Rio Janeiro, eleven days.

From Rio Janeiro to Cherbourg, fifty-eight days.

From Rio Janeiro to Brest, forty-eight days.

From ports of the north of the coast to Europe, the mean of the voyages were from thirty-three to thirty-seven days.

From Montevideo to Havre, eighty three days.

From Maranham to Havre, sixty-five days.

From Cape Horn to Rio Janeiro, eighteen days.

From Cape Horn to Europe, seventy-three days.

Regular line of steam packets.

From Rio Janeiro to Havre direct, the voyage was forty-eight to fifty days. Departure every twenty days.

These data are sufficient to give a general idea of the voyages from Europe to the coast of South America.

We will now speak of the routes from the ports of Europe to that portion of the coast of Africa situated to the north of the Equator.

Routes from Europe to the ports on the coast of Africa, north of the Equator.

Navigators leaving Europe, taking their departure from the ports of the Channel, or those of the Bay of Biscay, should call to mind what has been said concerning the currents in these localities. After doubling Cape Finistère, according to the season, thirty-five or sixty miles to the westward, steer between south and southwest, avoiding a too near approach to the coast of Portugal, especially during the winter, so as to pass either to the east or to the west of Madeira, or to make the Canaries, as is generally customary with ships bound for the coast of Africa.

One may pass indifferently either to the west of these islands or between them, there being no dangers in the channels which are not apparent and close to the shore.

I have traversed each of them, and the channel which appears to me the most desirable, when passing through

the archipelago without stopping, is that formed by the Islands of Palma and Hierro on the west, and Gomera on the east.

In the other channels, after clearing them to the south it is rare not to experience calms under the lee made by the high islands, with a heavy swell which is very trying to the masts. This is especially the case with the winds from N. to N. E., which, divided by the islands into two currents, do not again join in a common direction until a considerable distance to the southward of them.

In the months of November and December it is preferable, with bad weather, to pass entirely to the westward of these islands for fear of gales from the S. E., which in that season are frequent.

If it is desired to touch at the Canaries, the best anchorage is that of Palmas in the Grand Canary. This town offers more resources than that of Santa Cruz, in Teneriffe, and in its bay one can make sail at any time, which is not the case at Santa Cruz—an anchorage resorted to from custom, and a very dangerous one in a S. E. gale.

Routes from the Canaries to any point north of Cape Palmas.

In leaving the Canaries, if bound to St. Louis, Gorée, &c., the course will be S., S. by W., or S. S. W., according as you may pass to the westward or through the channels of the group.

After passing the parallel of 19°, that of the southern extremity of Arguin Bank, keep gradually from the south toward the east, making allowance for the polar current of the N., in which you should keep, making St. Louis a little to the north of its parallel: in going to Gorée make Cape Verd.

If bound to points more to the south than Gorée, the Gambia or Sierra Leone, for example, or to a point on the coast of Liberia, the route as far as Cape Verd would be the same; for it is generally made, except when touching at the Islands of Cape Verd. At any rate, if it is not desired to make either of these points, it will be better to pass nearer to Cape Verd than to the archipelago, as the breezes are more established and fresher on the coast.

From Cape Verd the navigation becomes in a measure local; easy with the winds from N. E. in the fine season, difficult with those from the S. W. during the winter.

Routes for the north coast of Guinea.

Ships bound to the trading stations on the north coast of Guinea, to the islands of the Gulf of Biafra, or to the

Gaboon, after passing Cape Verd, will descend as far as Cape Palmas, either with favorable winds from October to May, or with head-winds principally during June, July, August, and September, when they blow from S. W., W. S. W., W., and W. N. W., interrupted by calms. In this season it is well to keep three hundred miles from the coast.

Then direct the course so as to pass in sight of Cape Palmas, or, at most, not over sixty miles from it. At this distance the Current of Northern Guinea will be taken, which is only a prolongation of the polar current of Northern Africa, directed toward the E. and E. N. E. from 13° or 14° of longitude.

Before reaching the parallel of Cape Palmas, as we have said, the prevailing winds are from S. W. to W. S. W.; winds and currents will then be favorable for reaching any of the points of Northern Guinea, but in this route, one should not descend further to the south than 2° N. latitude, so as not to encounter the equatorial current setting to the W. Thus, as soon as the parallel of Cape Palmas is reached, which can be passed in sight, if bound to the Ivory Coast, the Factories, or the Slave Coast, you can navigate at any distance from the land, but always to the northward of 2° N. latitude. The best mode of navigating on this coast is to keep it in sight, about ten to fifteen miles distant at the most, and to approach it within one or two miles when thirty or forty miles to the west of the point of destination.

In estimating the route, the velocity of the current, which is twenty or thirty miles per day, should be considered, for it is very necessary to make the land well to the west of the point of destination, and guard against passing to the eastward of it.

If going to the islands of the Gulf of Biafra, or to the Gaboon, after doubling Cape Palmas, steer to the east, keeping between the parallels of 2° and 3° N. latitude as long as possible, according to the island you wish to make, then cross obliquely the space between 2° N. and the Equator, and run to windward of the port of destination, in order to make it from the south. Follow the same directions for the islands in the Gulf of Biafra. In the vicinity of these islands, the Current of the Southern Guinea sets to the N. E., and at times to N. N. E.; the winds will also be found from S. S. W., hauling sometimes to S. on approaching the Equator.

In going from Prince's Island to the Gaboon you traverse the Current of Southern Guinea, which runs to the N. E. and to the N. W., and sometimes to the N.; it is necessary, then, to make the land to the south of the river, to counterbalance the effects of the current. In the bight of the Gulf of Biafra the currents are variable, although as high as Fernando Po, and between that island and the coast, they run most frequently to the E. N. E. and to the N. E. If, then, it is wished to descend to the south from these localities, it will be necessary to work to windward a short distance from the coast of Gaboon in order to profit by the alternate breezes and the diminished strength of the current, and to take advantage of the tides. The Current of Northern Guinea, in times past, was the bugbear of navigators, who supposed that once within the gulf, there was no exit, except with the greatest difficulty.

Routes for returning from east to west in the Gulf of Guinea.

When leaving a point to the east of the north coast of Guinea for a point on the same coast situated to the west, it is necessary to run on the starboard tack a sufficient distance to get out of the current of Northern Guinea, enter the equatorial current, and, according to the season of the year, cross the line and pass to the south, in order to get the winds from the S. to the S. S. W.; then take the port tack, keeping well to the west of the point of destination, to counteract the effect of the Current of Northern Guinea, which will be again felt in 2° N. latitude.

If this tack is not sufficient to make sure of making the coast to the west of the point of destination, make another stretch in the latitude of 2° N., and run on the starboard tack until sufficiently to the west to return to the coast with certainty. In this manner, a few days will take you to your destination. Some vessels, which have tried to beat along the coast of Northern Guinea, have been thirty or forty days from Cape Coast Castle to Grand Bassam, and have been forced to give up beating thus to the west. However, during the rainy season, and while the harmattan blows, from October to January, the currents near the coast are reversed and run at times to the W., or they are insensible. Then you can work to the west very near the north coast of Guinea.

In leaving the Island of Fernando Po, it is necessary to tack along the coast of the Gaboon to make use of the variations of the breezes and the tides, and accordingly

keeping but a short distance from the shore, until sufficiently to the southward to reach easily the equatorial current. In leaving Prince's Island, with the wind from S. W., take the starboard tack and keep on this tack as long as the vicinity of the coast will permit, then take the port tack to run out of the Gulf of Guinea. If it is desired to eave it after reaching the Equator on the starboard tack, you can keep on this circle or to the south of it on the other tack, with the winds from S. to S. S. W. and sometimes S. S. E., steering to the west until you attain the meridian of Cape Palmas; and if going to the northern hemisphere, after thus running along the Equator, commence running to the north at from 17° to 28° W. longitude, then steer according to the point of destination.

Thus in returning to Europe it will be preferable not to leave the Equator or steer to the north until in 23° W. longitude, and then take the same route as indicated for returning from Brazil to Europe; but if near the Equator winds from W. and N. W. are encountered, which is frequently the case during the winter, from May to September, then run to the northward in 17° or 18° W. longitude, and pass between the Cape Verd Islands and the coast of Africa; to the northward of the Cape Verd Islands the N. E. trades will be taken, with which run on the starboard tack. If it is desired to return to a port on the coast of Africa, Sierra Leone, Gambia, Gorée, or St. Louis, commence to ascend to the north in longitude 16° or 18° W. and beat between the meridians of 22° and 28°, to avoid entering the bed of the polar current of Northern Africa, until on the parallel of the Bissagos; this last route will be particularly favorable from May to September, the winter season. Lastly, if returning to the United States or to the West Indies keep to the north from the meridian of 28° or 33° W. longitude.

Favorable season to leave the Gulf of Guinea.

The most favorable season to leave the Gulf of Guinea is from May to December; at that season it is rarely necessary to cross the line, the winds from S. S. E. are sometimes well established at this period, and they come to the northward of the Equator; but from December to May it is preferable to cross the line and keep at least in 0° 30′ or 1° S. latitude. In following the directions given above a few days will take you out of the Gulf of Guinea. To recapitulate, in entering the Gulf of Guinea pass near Cape

Palmas and keep in the Current of Northern Guinea, between the coast and the parallel of 2° or 3° N. latitude. In leaving the Gulf of Guinea, as a general rule, whatever may be the point of departure on the coast, you should maneuver so as to reach the Equator by the most direct route; from May to December keep on the Equator or even a little to the northward of it. In the other months it is well to keep to the south of it, in 0° 30′ or 1° S. latitude, keep thus as far as the meridian of 16°, 17°, or 23°, &c., of W. longitude, according to the port of destination.

We will now give some of the passages from Europe to places in Northern Africa.

Going.

The mean from ports of the north of Europe to Madeira, fifteen days.

From the Strait of Gibraltar to Madeira, four or five days.

From ports of the north to the Canaries, sixteen days.

From the Strait of Gibraltar to the Canaries, seven days.

From ports of the north to the Cape Verd Islands, twenty days.

From ports of the north to St. Louis, eighteen days.

From ports of the north to Gorée, twenty days.

From ports of the north to Gambia, twenty-four days.

The navigation along the coast of Africa to the south of St. Louis depending on the seasons, the duration of the voyage is very variable; thus, in the fine season the mean from Gorée to Prince's Island is about twenty-eight days, and in the winter generally from thirty-six to thirty-eight days.

Returning.

From Prince's Island to Gorée, thirty-eight to forty days.

From Gambia to Gorée, three to four days.

From Gorée to St. Louis, five to seven days.

From St. Louis to Brest, thirty to forty days.

This voyage has been made in twenty-four and in twenty-two days.

Routes from Europe to ports on the coast of Africa south of the Equator.

The routes from Europe to the ports of Africa, situated to the south of the Equator, are very different, according to the latitude of the ports; the routes of which we will speak have been called the *great route* and the *little route.*

Great route. The great route is that which is followed in going to the Cape of Good Hope, and in general for all the ports situated to the south of Cape Negro.

Little route. The little route is that made by ships bound to ports situated to the north of Cape Negro. However, the great route is equally followed by many ships going to the same ports.

The ships which make the great route on leaving Europe will follow at first the directions we have given for the routes from Europe to Brazil; they will accordingly cross the line between 23° and 28° W. longitude; from thence, profiting by the S. E. trades, they will take the port tack and make a course toward the Island of Trinidad; they will pass to the west of this island, and traversing the zone of the S. E. trades they will endeavor to reach the westerly winds and cross the current of the Southern Atlantic, setting to the E.; they will then direct their course toward the Cape of Good Hope, so as to cross the parallel of 30° S. in nearly 18° W. longitude. In following the route just given, ships have been only fifty days from the Channel to Cape Town.

Navigate in a similar manner to reach the points on the west coast of Africa situated to the north of Cape Negro; that is, after having crossed the line between 23° and 28° W. longitude, take the port tack with the S. E. trade-winds, keep on this tack so that in going on the starboard tack you will be able to fetch to the south of the port of destination, in order to counteract the effect of the polar current of Africa setting to the N. W. along the south coast of this continent; but if bound to Benguela, Angola, or to Loango, or more generally to a point situated to the north of Cape Negro, the route can be modified and in general shorter passages made.

On leaving Europe steer to take the trade-winds as quickly as possible; pass then either to the east or west of Madeira, to the west of the Canaries, or through the channels formed by these islands; from there steer to pass to the west of the Cape Verd Islands if in the winter, from June to September. In the other months you can pass between this archipelago and Cape Verd in approaching the cape nearer than the islands, because near the continent the winds from N. E. and N. N. W. are fresher and better established in this season. Whatever route may be adopted,

after passing to the south of the parallel of Cape Verd, you will navigate along the coast of Africa, keeping one hundred and eighty to two hundred and forty miles from it until on the parallel of the Bissagos; from there steer for Cape Palmas. You can pass near Cape Palmas in sight of it, or at sixty miles distance, and traverse the Gulf of Guinea on the starboard tack; this board generally will lead to Cape Lopez, and often to the south of the Island of Annobon; then go on the port tack, but do not make the tack too long to the westward, to guard against falling into the equatorial current; return then to the starboard tack to reach the S. W. winds, which are prevalent and alternate from the sea and land, principally from the month of January to September, in the zone comprised between the coast and a line joining the Cape of Good Hope and Cape Palmas; then beat close to the land to profit by these winds. The sea breeze prevails in the day from 10 or 11 in the morning, blowing from W. S. W. to S. W., and the land breeze during the night from S. E. to S.

Thus the tacks should be combined so as to be near the coast when the land breeze commences blowing, and well in the offing in the morning to take the sea breeze; for this the tacks should not be more than thirty miles, so as not to lose the advantage of this variation of the breezes, and to be able to anchor if it falls calm. The bottom is of mud, or sand and mud.

This navigation is precisely similar to that which can be made on the coast of Senegambia, in the northern hemisphere; but here it is upon a coast of greater extent.

This navigation is particularly favorable from January to September. During the bad season, in the latitude of Cape Lopez, sharp, sudden squalls are sometimes experienced, but they are generally of short duration.

Routes from Europe to the islands of the South Atlantic.

In going from Europe to the islands of the South Atlantic, vessels, from bad navigation, have taken a hundred days. We will make some remarks which we consider useful.

Route for Ascension. Route to the east.

From Europe bound to Ascension, try to reach, as quickly as possible, the N. E. trade-winds; steer then to pass between the Cape Verd Islands and the Continent, or to the west of the Cape Verd Islands; from there steer to double Cape Palmas, and sight it if possible. On losing the N. E. trade-winds, make as much as possible to the south,

to traverse the zone of variable winds, without passing to the westward of the meridians of 8° or 9° W.

On approaching the limits of the S. E. trade-winds, in the vicinity of Cape Palmas, or even to the north of that cape, will be found, nearly always, winds from the S. W., and sometimes from W. S. W.; with these take the starboard tack, and the line can generally be crossed in 6° or 5° W. longitude, often even more to the east, if the currents of the Gulf of Guinea are taken advantage of.

The route which we have already indicated, in going to the islands of the Gulf of Biafra, can be used, and it appears to us the most advantageous by keeping on the parallel of 2° N. to get sufficiently into the Gulf of Guinea, and to cross the line in 0° or 1° E. longitude, running on the starboard tack. As soon as the prevailing winds from S. to S. E. are taken, run on the port tack, and on this board the Island of Ascension will be often made without a long and fatiguing voyage.

Western route. In going to Ascension by the western route pursue the same course, nearly, as in going to Brazil. After having crossed the Equator between the meridians of 23° and 28° W., with the S. E. trade-winds, take the port tack, and run on this tack until in a position to reach to the east or to the south of Ascension, by heading E. or E. N. E. on the starboard tack. If, however, the winds are from the E., which is not frequent, it will be necessary to work to the east, profiting by all the variations of the wind, and making long boards to the south.

Route to St. Helena. There are also two routes from Europe to St. Helena. From the position of this island in the strength of the S. E. trade-winds, it cannot be made from the north until a considerable distance is run to the east or west, to bring it under the lee.

The length of the voyage will generally depend on the time taken to cross the zone of variable winds of the Equator. The season then will determine which of the two routes should be pursued. That to the west is always possible; that to the east is only recommended in the months of November, December, January, February, and March, the period, as we have said, when the zone of the variable winds of the Equator is comparatively narrow.

Route to the east. The route to the east, in the months cited above, will be the same as that for going to Ascension, only longer tacks should

be made toward the coast of Africa until headed off by the wind. When on the other tack St. Helena will generally be reached, and more promptly on this route than that to the west. But when the sun has a great northern declination the eastern route is very uncertain, and that to the W. is preferred. However, it may be said that a good sailer and a ship that holds a good wind may take the eastern route at any season.

Western route.

After crossing the line between 23° and 28° W., take the port tack, running toward the coast of Brazil, and keep on this tack until the Island of St. Helena can be made to the south or east when heading on the starboard tack east or east-northeast, according to the winds. If the winds become contrary, it will be necessary to beat, when, after running on the port tack as long as possible, take the starboard tack to the eastward; when near the coast of Brazil take again the port tack, and strive to get out of the S. E. trades and into the variable winds, where you can make to the east with the westerly winds; then traverse the zone of the trade-winds on the starboard tack, running to the northeast or east-northeast to make St. Helena to the south or east.

The currents in the vicinity of St. Helena are weak, and even in making the land to windward there would be little trouble in reaching the anchorage, except at the epoch of the full and change, when the current setting to the N. W. increases in force.

The mean of the voyages from Europe to the Cape of Good Hope, taken from a great number, is ninety days. Horsburgh, in the *Anna*, made it in sixty-seven days. This is one of the shortest which has been made. A steamer from England has taken fifty-nine days to the Cape of Good Hope.

The mean of voyages from Europe to St. Helena is about sixty days. The steam packet, from London to Australia, touching at Teneriffe and the cape, takes one hundred and fifty days to reach her destination.

Routes from Ascension and St. Helena to points on the south coast of Africa.

St. Phillip of Benguela being the most southerly point which can at times be reached in one stretch, we will choose it in going from Ascension to the coast of Africa, south of the Equator, as it will readily be seen that any point situated to the north of this can be more easily reached. On leaving Asension, take the starboard tack and do not pass to the north of the parallel of 4° S. latitude, in order not to fall

into the great westerly current, and do not make too long tacks to the south if the wind does not permit you steering S. 35° E.; this, however, depends somewhat on circumstances. It is possible that some tacks will have to be made in order not to pass the limits indicated, but it often happens that the passage is made on the same tack, as in general the winds on approaching the coast of Africa haul to the S. W. and at times to the W. S. W. It will be necessary in going from St. Helena to shape a course a little to the southward of the point of destination, on account of the polar current of the South Atlantic.

In general, and notwithstanding the opinions of many authors who advise, on leaving these islands, to run first on the port tack to the southwestward, when going to ports on the coast of Africa, situated as high as St. Phillip of Benguela, take the starboard tack in leaving these islands and make for the point of destination, making allowance for the current, the mean velocity of which is fifteen miles per day, setting to the N. W. and W. N. W. But if leaving Ascension or St. Helena for a point more to the southward, the Cape of Good Hope for example, it will be then necessary to take the port tack to run to the southward and toward the coast of America, and follow the directions heretofore given for the routes from Europe to the Cape of Good Hope, when in the southern hemisphere.

Routes from Africa to the islands of Ascension and St. Helena.

The routes from the ports of Africa to Ascension and St. Helena have been indicated in the routes from ports north of the Equator; they are the same as from Europe to Ascension, whether the great or little route be taken. In going from a point on the coast of Africa situated to the southward of these islands, the winds and currents are favorable, and the only precaution is to make them to the south rather than to the north.

Routes returning from the ports of the north coast of Africa to Europe.

In speaking of the navigation of the Gulf of Guinea, we have indicated the routes in leaving this gulf for Europe. After having attained the longitude of 23° W., by running to the south of the Equator, run to the north on the starboard tack and cross the zone of the N. E. trades; on reaching the zone of the variable winds, steer to pass to the north of the Azores or through the channels formed by these islands. If the point of departure is situated to the north of Cape Palmas, go to the westward with the S. W. winds prevailing in these localities, pass the zone of variable winds

as quickly as possible; and then on the starboard tack with the N. E. trade-winds run to the north. On leaving the ports of Senegambia, Gambia, Gorée, or St. Louis, in the fine season, with the winds from N. E. and N. N. E., take the starboard tack until within the zone of variable winds. The routes mentioned are generally made to the west of the Azores. On two different occasions in the months of May and June I have passed to the east of the Azores, and made fine passages, one in thirty-two and the other in twenty-four days from St. Louis. The return route from points on the west coast of Africa situated to the south of the Equator, can be readily deduced from the route from the Cape of Good Hope to Europe.

Route from the Cape of Good Hope to Europe.

In doubling the Cape of Good Hope from the Indian Ocean, if in the fine season, the land may be approached without fear, and a northerly course taken as soon as the cape is doubled. But if in winter, that is, from June to September, before steering north it will be prudent to run to the west one hundred and twenty or one hundred and fifty miles from the land, in order not to be placed on a lee shore by the gales from W. or N. W., which are very frequent at this season.

After doubling the Cape of Good Hope in the fine season, that is, from October to April, keep nearly for St. Helena, passing a short distance from it either to the east or west. From St. Helena keep N. W. by N., about, passing twelve or thirteen miles to the east or west of Ascension, and from thence cross the line between 23° and 28° W. The route then will be that before given for returning to Europe. In doubling the cape between the months of May and September, keep off the coast, as we have already said, and get sufficiently to the westward, to have nothing to fear from the N. W. or S. W. gales; get into the zone of the S. E. trades and cross the line between 26° and 28° W. In this season, from a great number of voyages, the mean has been from the Cape of Good Hope to Europe, about seventy days.

The mean from the cape to St. Helena, fifteen days; the mean from St. Helena to Ascension, six days; there is another route recently taken which may be followed in going from the Cape of Good Hope to Europe, which is, to follow the coast of Africa at a short distance from the cape as far as the Equator. The winds on this coast prevail during the year from S. S. E. to S. S. W.; this passage can be quickly

made. Cross the line in 17° or 18° W., and either pass between the Cape Verd Islands and the coast, and from there, running on the starboard tack, take the route followed from Senegal to Europe. This route may be advantageous in certain cases, principally when the line is crossed from May to September, the period when, from the vicinity of the coast to beyond the Cape Verd Islands the winds are from the W., varying to the S. W. and N. W. We have not sufficient information on this route to say whether it will be found generally advantageous. We limit ourselves by pointing out how it may be followed, as it was a short time since by Captain Le Sieur de Ville-sur-Arce, on returning from India.

Routes from North America to the north coast of Africa.

In going from the ports of North America to the coast of Africa, north of the Equator, the route is nearly the same as that to be followed in going to Europe; only when sufficiently to the east to reach the port of destination, steer for that point, traversing obliquely the region of the N. E. trades.

Route from the ports of North America to the west coast of South Africa, or to the east coast of South America.

In going to ports of Africa situated to the south of the Equator, shape a course to traverse obliquely the zone of the N. E. trades, cross the line between 23° and 28° W., and adopt one of the routes already indicated for the west coast of southern Africa or the east coast of South America, as may be.

Route for returning from the coast of Africa to North America.

We will only indicate the route from the Cape of Good Hope to the ports of North America, as from it all the others can easily be deduced.

Starting from the cape from October to April, the winds will generally be found prevailing from the S. E., and the direct route will be that heretofore indicated in returning to Europe, as far as crossing the line in about 28° W, longitude; from thence pass to the west of the Penedo de San Pedro, and shape a course with the trade-winds, which blow generally from E. to E. N. E., a sufficient distance to windward of the Windward Islands, this route, as is seen, offers no difficulty.

From the month of March to September, on account of the frequency of N. W. gales during these winter months, keep at once sufficiently off the coast to have nothing to fear from gales from this quarter; traverse then the zone of the S. E. trades obliquely, and cross the line in 33° W. longitude. In this season it is preferable to cross the line

on this meridian rather than to the east of it,* it is also preferable to pass to the east of the Bermudas if bound to Nova Scotia, rather than to the west of them, for at this season winds from the eastward are often found in this locality.* It is a rule very generally adopted to pass to the east of the Bermudas, from the middle of March to the month of October, in going to any of the ports of North America situated to the north of New York. From the different routes we have given in this chapter, it will be easy to deduce all which can be made from any point to another in the Atlantic Ocean. We have, in this book, brought together nearly all the most important observations which are of service to navigation, and have given to mariners the information most useful for directing them in the navigation of the Atlantic Ocean.

Although all the facts given are the results of numerous observations, it should not be inferred that under every circumstance they will be found the same.

There is nothing more subject to variations than the winds and currents which we have discussed.

The seaman should make it a constant study, in order, under all circumstances, to take advantage of the general facts as presented, and modify the routes as exceptions to the general laws here indicated arise.

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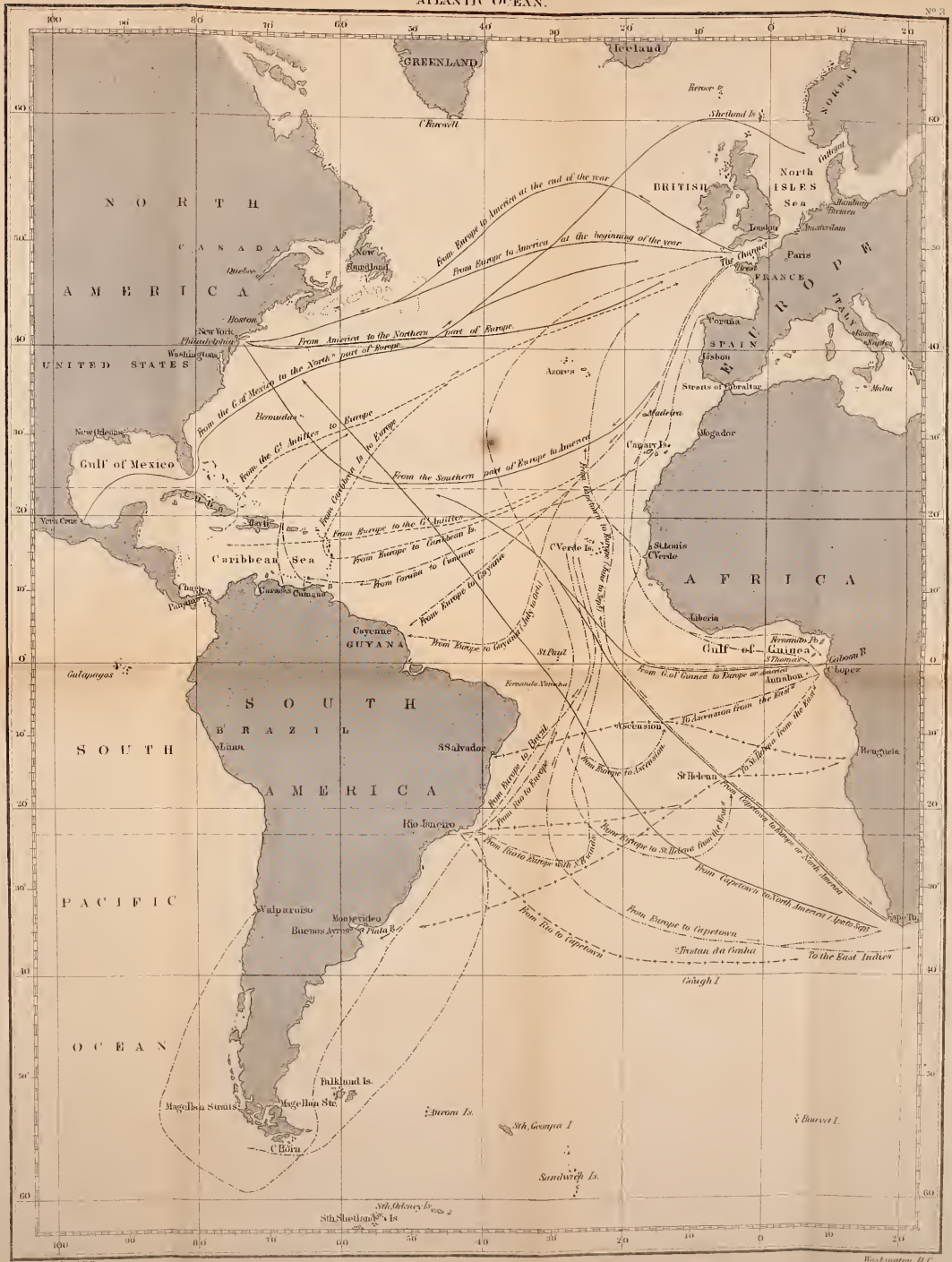
* Amases Delano.

CHART
of the
PRINCIPAL ROUTES
in the
ATLANTIC OCEAN.




40
30
C. Farewell
Quebec Portland to Glasgow and Liverpool 2770 M.
2898 M.
New York to Liverpool 3040 M.
Liverpool 3627 M.
Southampton
Spanish West India to Cadix
Cape Verde Is.
St. Paul
Fernando de Noro
Pernambuco
Bahia
Trinidad


NORTH
AMERICA
UNITED
STATES
EUROPE
AFRICA
SOUTH
AMERICA
Gulf of
Mexico
Caribbean Sea
GUYANA
Gulf of Guinea
C. Farewell
N. Foundland
Sable I.
Bermudas
Cape Verde Is.
Canary Is.
Madeira
Azores
Trinidad
Fernando de Noronha
St Paul
Ascension
St Helena
Tristan da Cunha
Falkland I.
S. Georgia
PRINCIPAL STEAM ROUTES
IN THE
ATLANTIC OCEAN

APPENDIX No. 1.

NAUTICAL DIRECTIONS TO AVOID HURRICANES.

From motives which it would be useless to mention, we had not intended to give in this work the nautical directions for endeavoring to escape the violence of hurricanes.

Having received many inquiries on the subject, and its omission in the *General Examination* having been commented on, thanks to the obliging kindness of M. Keller, we have been able to supply the deficiency. Not only has this learned hydrographic engineer authorized us to take from his memoir of 1847* the nautical directions which he published at that time, but he has furnished us with an extract from a memoir much more extended on the same subject. This last memoir of M. Keller (of which we have before made mention) is yet unpublished, and we cannot too warmly thank the author for the readiness with which, for the general benefit of navigators, he has been pleased to communicate to us that portion of it which is to them of the greatest importance.

DE KERHALLET.

EXTRACT FROM THE MEMOIR OF M. KELLER, PUBLISHED IN 1847.

We will recapitulate for each hemisphere the nautical directions for attempting to avoid the violence of hurricanes, and to facilitate their application by navigators threatened to be enveloped by these storms.

IN THE NORTHERN HEMISPHERE.

Hurricanes of West Indies, Cyclones of India, Typhoons of the China Sea.

"If the wind hauls by the compass to the right, or in accordance with the movement of the hands of a watch, you are in the dangerous semicircle of the tempest, and, whatever may be the latitude, you should heave-to on the starboard tack; or, if the force of the wind is not too great, stand on close-hauled on the starboard tack.

* Hurricanes, Tornadoes, Typhoons, and Tempests, &c.

"If, on the contrary, the wind hauls by the compass, to the left, or in an opposite direction to the movement of the hands of a watch, you are in the manageable semicircle of the tempest; and, if the sea is not too heavy, you should run with the wind on the starboard quarter; or, if the sea is too heavy, heave-to on the port tack."

IN THE SOUTHERN HEMISPHERE.

Hurricanes in the Channel of Mozambique, Island of Bourbon, &c.

"If the wind haul by the compass to the left, or in a direction opposite to the movement of the hands of a watch, you are in the dangerous semicircle of the tempest, and, whatever be the latitude, you should heave-to on the port tack; or, if the storm is not too heavy, stand on close-hauled on the port tack.

"On the contrary, if the wind hauls by the compass to the right, or in accordance with the movement of the hands of a watch, you are in the manageable semicircle of the tempest; and, if the sea is not too heavy, run with the wind on the port quarter. If the sea becomes too heavy, heave-to on the starboard tack.

"We will further add that after having experienced a hurricane in less than 26° S., or 30° N. latitude, you should not for some days steer toward the Pole, to avoid again encountering the branch of its path the furthest removed from the Equator; for although the velocity of its movement exceeds greatly that of a ship, yet the latter may describe the chord which joins two points of the curve of the hurricane, in the same time employed by the meteor to run over the arc of this chord.

"This precaution would be superfluous in the hurricanes of the Gulf of Bengal, and in the typhoons of the China seas, for these seas only extend to 30° N. latitude, and only contain a limited and sensibly rectilineal portion of the general path of hurricanes, which spend themselves on the land when directed toward the N. W.

"These practical directions are independent of the latitude; they apply to all the routes of typhoons, and assure escape in the right direction when this is possible."

EXTRACT FROM AN UNPUBLISHED MEMOIR OF M. KELLER, RELATING TO MANEUVER IN HURRICANES, CYCLONES, TYPHOONS, AND TEMPESTS.

"The gyratory movement of hurricanes determines the tack.

"The movement of translation decides the course a ship should take.

"In the northern hemisphere the gyratory movement is opposite to the movement of the hands of a watch, and in the southern hemisphere it is in the same direction as that movement.

"The gyratory movement being invariable in each hemisphere, the tack upon which a ship should be placed is equally invariable. It is the starboard in the northern hemisphere and the port in the southern hemisphere.

"The movement of translation of the hurricane determines for both hemispheres.

"1. In the dangerous semicircle, the course close-hauled, as long as the barometer falls, and with the wind free when it rises.

"2. In the manageable semicircle, the course with the wind on the quarter as long as the barometer falls, and with the wind free when it rises.

"The dangerous semicircle being to the right of the path of the center in the northern hemisphere and to the left in the southern hemisphere, the course of escape, that is to say, the route which should be pursued to increase the distance from the center of the hurricane, will be known, if it is known on which side of the path of the center of the hurricane the ship is placed; now the side is indicated by the variation of the wind by the compass, produced by the change of place of the center of the storm.

"If in looking in the eye of the actual wind, the wind as it hauls blows from the right, the ship is to the right of the path of the center. If, on the contrary, the wind as it hauls, blows from the left of the actual wind, the ship occupies a position to the left of the path of the center; after this, the route to be pursued to increase the distance from the center, depends exclusively on the variation of the wind.

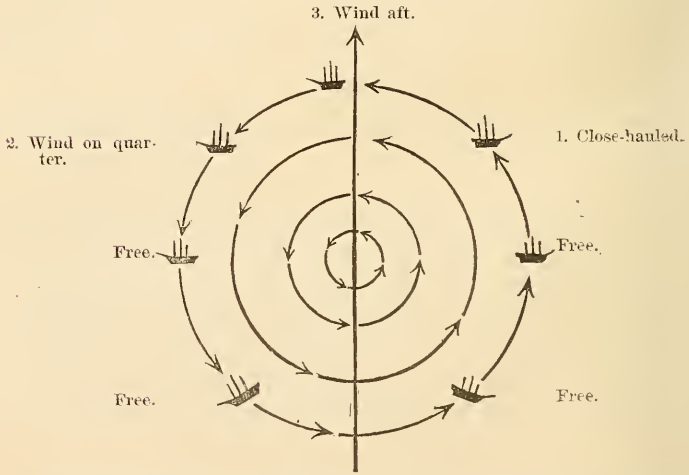
"This variation should be observed hove-to, in order that it be the result of the change of the base of the cyclone, and not the change of position of the ship; besides, it should correspond to a fall of the barometer, a distinctive mark of

the actual penetration of the ship into the body of the hurricane.

"The indications of the approach of a hurricane being a heavy swell, a steady fall of the barometer and an increasing violence of the wind, as soon as these are observed a ship should reduce sail and be hove-to, on the starboard tack in the northern hemisphere, and the port tack in the southern hemisphere, without taking into consideration the direction of the waves, in order to escape the center of the storm and be in a position to execute, at once, such ulterior maneuvers as the variation of the wind, observed while hove-to, may determine. A résumé of these maneuvers is given in the following:

MANEUVER IN HURRICANES IN THE NORTHERN HEMISPHERE.

Northern hemisphere, starboard tack.



"Being hove-to on the starboard tack, barometer falling:

"1. If the wind haul by the compass to the right, or in the direction of the movement of the hands of a watch, the ship is to the right of the path of the center, in the dangerous semicircle, and should run close-hauled on the starboard tack and keep this course until the barometer rises and then run free.

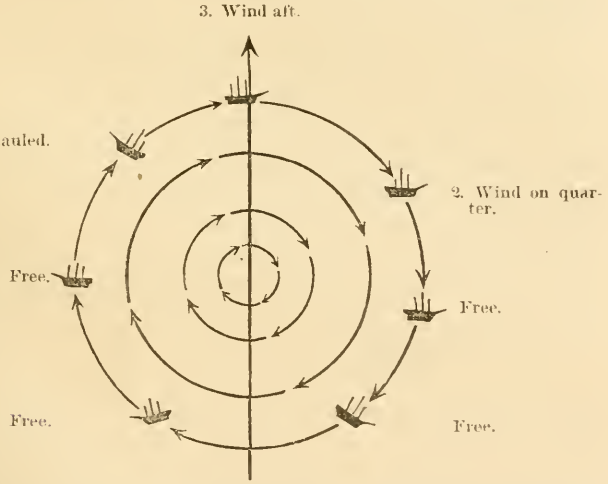
"2. If the wind hauls by the compass to the left, or contrary to the movement of the hands of a watch, the ship is

to the left of the path of the center, in the manageable semicircle of the cyclone, and should run with the wind on the starboard quarter, and maintain this compass course during the ulterior changes of the wind until the barometer rises; from this time shape a course free.

"3. If the wind as noted when hove-to does not change its direction during the progressive fall of the barometer, the ship is in the path of the center, and should run with the wind aft and keep the same compass course on the starboard tack until the barometer rises; from this moment a course free should be maintained to the end of the storm."

MANEUVER IN HURRICANES IN THE SOUTHERN HEMISPHERE.

Southern hemisphere, port tack.



"Being hove-to on the port tack, the barometer falling:

"1. If the wind hauls by the compass to the left, in a direction contrary to the movement of the hands of a watch, the ship is to the left of the path of the center, in the dangerous semicircle; she should run close-hauled on the port tack and preserve this course until the barometer rises, and then shape a course with the wind free.

"2. If the wind hauls by the compass to the right in accordance with the movement of the hands of a watch, the ship is to the right of the path of the center, in the manageable semicircle of the storm, and should run with the wind on the port quarter and maintain this compass course during

the ulterior changes of the wind until the barometer rises; when shape a course free.

"3. If the wind, observed when hove-to, does not change its direction during the progressive fall of the barometer, the ship is in the path of the center and should run before the wind, and keep the same compass course on the port tack, until the barometer rises, a course with the wind free should be constantly maintained until the end of the storm.

"These directions relative to maneuvers in hurricanes in the two hemispheres differ from those of page 19 of our memoir on hurricanes, tornadoes, typhoons, and tempests, as the maneuvers advised by Reid, in his recent work, *The Progress of the Development of the Law of Storms*, page 27, differ from those recommended in the two editions of his first work, *The Law of Storms*, which has been extolled by Piddington, Thom, &c.

"The latter work advised heaving-to on the port tack in the manageable semicircle of hurricanes in the northern hemisphere, and on the starboard tack in the southern hemisphere, in order to avoid the danger of being taken aback in the shifts of wind. But this maneuver having the grave disadvantage of pushing the ship toward the center and precipitating her into a danger more certain and more formidable, Reid, struck by this disadvantage, advises at present to renounce this mode, and in all cases to take the starboard tack in the northern hemisphere and the port tack in the southern hemisphere.

"We are entirely of this opinion, which simplifies the maneuvers in reducing them to a question of direction and placing the tack out of the case, the more so as the course with the wind on the quarter and the wind aft being substituted in the recent directions for hove-to on the opposite tacks in the manageable semicircle of hurricanes, ships need not fear being taken aback, for the shifts of wind are never so great at the commencement of a hurricane as to pass from aft forward.

"On the other hand the variation of the wind arising from the ship penetrating the base of the hurricane is greater in a given time as the penetration is greater, or as the velocity of the translation of the hurricane is greater. Now, this velocity keeping back the wind from the manageable semicircle, the wind there is more feeble according to the

rapidity with which the hurricane advances in its path, thence, the greatest variation in the direction of the wind which could be feared would be only from a wind comparatively light and by no means formidable, and if, on the contrary, the wind is strong it varies but little, because the velocity of the translation is feeble, and then there is no danger of being taken aback; although in this case the violence of the wind in the manageable semicircle differs but little from that in the dangerous semicircle.

"We will add that the maneuver, wind aft, involves a great reduction of sail, to manage the ship almost under bare poles if the wind is very violent, in order to reduce the speed of the ship and the impetus which she communicates to the waves, which would be likely to comb over aft if the speed were too great. It is always better to run the risk of shipping a few seas than to remain stationary, on all courses, except that, with the wind aft, it is necessary to make sail, otherwise the ship would be at the mercy of the waves."

That navigators may judge of their maneuver by the state of the sea, we will show the direction of the predominant wave on the different courses prescribed.

DIRECTION OF THE PREDOMINANT WAVE ON THE DIFFERENT COURSES.

In the northern hemisphere, starboard tack.

The ship being hove-to on the starboard tack:

On the course prescribed free, the predominant wave is on the starboard quarter.

In the dangerous semicircle:

On the constant course, close-hauled, the wave is on the starbord beam.

In the manageable semicircle:

1st. Wind aft ..... the wave is on the port quarter.
2d. Wind on quarter .. the wave is aft.
3d. Wind free ..... the wave is on the starboard quarter.
4th. Close-hauled ..... the wave is on the starboard beam.

In the southern hemisphere, port tack.

The ship being hove-to, port tack:

On the course prescribed free, the predominant wave is on the port quarter.

In the dangerous semicircle.

On the constant course, close-hauled, } the wave is { on the port beam.

In the manageable semicircle:

1st. Wind aft.....
2d. Wind on quarter..
3d. Wind free .....
4th. Close-hauled.....
} the wave is {
on the starboard quarter.
aft.
on the port quarter.
on the port beam.

"According to the foregoing, the most unfavorable direction of the wave is that of close-hauled in the dangerous semicircle, but on this route, the ship being supported by the wind, the rolling is not likely to affect the spars; the pitching will be moderate, and the helmsman must watch the waves and strive to avoid the shock of the heavy seas. This course should not be abandoned, for it is the only one by which to avoid future peril, and the skill of the helmsman may meet the present danger. The danger here mentioned should never make the mariner neglect the rules laid down. He should follow them at all hazards, whatever may be the state of the sea, for certainly his situation will become more dangerous the longer he delays to execute the maneuver which alone can secure his safety, by removing from the center of the hurricane."

The following is a résumé, for the two hemispheres, of the practical directions already given.

GENERAL REPRESENTATION OF THE MANEUVER IN HURRICANES, TYPHOONS, AND TEMPESTS.

As soon as a progressive fall of the barometer and increasing violence of the wind indicate the approach of a hurricane, all the necessary precautions should be taken; heave-to, so as to remain, as nearly as possible, stationary, or at least making very little progress, in order to observe the wind during the first depression of the barometer and to decide from it the course for escape, as follows:

In the northern hemisphere, starboard tack:

The starboard tack should be taken equally in heaving-to at first as for the course of escape.

If, when hove-to, the barometer falling, the wind has not changed its direction, run with the wind aft, and keep this original compass course.

If the wind hauls to the left, run with wind on quarter, and keep this original compass course,

If the wind hauls to the right, run close hauled and keep this course,

until the barometer rises.

From this moment, and as long as the wind is violent, follow the course free on the starboard tack.

In the southern hemisphere, port tack :

The port tack should be taken equally in heaving-to at first, as for the course of escape.

If, when hove-to, the barometer falling, the wind has not changed its direction, run with the wind aft, and keep this original compass course.

If the wind hauls to the left, run close-hauled, and keep this compass course,

If the wind hauls to the right, run with wind on the quarter, and keep this original compass course,

until the barometer rises.

From this moment and as long as the wind continues violent, follow the course free on the port tack.

"These practical rules are general and independent of all conjecture upon the direction, the velocity, or the radius of the storm; they reduce the maneuver to a question of courses, the tack being constant and invariable in each hemisphere; they should be executed strictly, without any thought of the direction of the wave, for being influenced by the state of the sea might cause a false maneuver; they are treated of at a greater length in the work which will be hereafter published, to support them, and justify the confidence of seamen.

"In this work we will exhibit the great variety of direction in the paths of hurricanes observed in the same latitudes, and often in the same localities, to demonstrate the necessity of directions, independent of any particular direction of the hurricane, and to prove to navigators how great the danger would be were they to regulate their maneuvers by rules founded on a single conjectured direction, indicated in

advance. On the other side to confirm our own instructions we will give the list of numerous vessels which, from having executed maneuvers different from those we have laid down for each case, have become more involved in the storm and been seriously damaged.

"KELLER,

"*Ancien Élève de l'École Polytechnique,*

"*Ingénieur Hydrographe de la Marine.*"

APPENDIX No. 2.

MEMOIR ON THE CURRENTS OF THE ATLANTIC OCEAN, BY M. IRMINGER, CAPTAIN IN THE DANISH NAVY, AND AIDE-DE-CAMP-GENERAL OF HIS MAJESTY THE KING OF DENMARK.

Notwithstanding the progress of navigation, which at this day extends to every point of the ocean, sufficient attention has by no means been accorded to the currents of the sea, which can, with propriety, be named the arteries of the terrestrial globe, as, in passing through the different zones, they bestow heat on the frigid and refresh the tropical regions. Although a system for the surface currents of the sea is in some measure established, they have been but imperfectly examined; as to the currents of the depths of the ocean nothing is known.

Nevertheless, as it is known that the currents below the surface of the sea are very different in their direction from those of the surface currents, it having been observed that icebergs, with deep bases, move with considerable rapidity against the wind and surface current.

It may be believed that the submarine as well as the surface currents pass with regularity through the different zones, and that they are united by a reciprocal dependence. It is, then, desirable that the greatest possible number of observations be sought on the currents existing in the depths of the ocean. When a certain number has been collected, giving the direction of these currents, with their temperature, &c., a system can certainly be established. It should be admitted that they are probably much more constant than the currents of the surface, upon which the influence of the winds, the tides, the melting of the ice in high latitudes, the waters which debouch from the great rivers, the storms and tempests, which heap up the water on isolated points, and, finally, the different pressures of the air, are so many causes of perturbation.

When I set out in 1847, with the brig of war *L'Aigle*, for the coast of Guinea and the West Indies, by the kind assistance of Professors Orsted and Forchhammer, I obtained

the instrument of M. Aimé for determining submarine currents. It was made by the optician Nissen, at Copenhagen. The observations that were made during the voyage with this instrument proved that it was perfectly adapted to practice, as its mechanism is so simple that it can be repaired by any good maker of instruments. The weight suspended to the instrument, in our experiments, was always twenty pounds.

To obtain a good result it is necessary that the vessel is stationary while the instrument is lowered into the sea. If the depth is too great to anchor the sea should be calm, and there should not be any surface current; for if, during the trial, the ship drifts, the line attached to the instrument not being vertical, the observation would lose its exactness.

Although the vessel was not furnished with lines of sufficient length for great depths, I will give, nevertheless, some of my observations made during rare moments of calm, in localities where I was desirous of examining the direction of the submarine current.

The 14th of September, 1847, calm; in sight of Madeira, latitude 31° 58′ N., longitude 17° 12′ W. The *Indicator of the direction of the current*,* the name which I have given to this instrument, was lowered to a depth of 632 meters, (2,054 feet.)

Attached near the instrument was a self-registering thermometer, encased in a cylinder of solid metal, on which was screwed a lid, also of metal, of the same thickness, to guard the thermometer against the force of the submarine pressure. The following temperatures (deduced from those found by the author with the thermometer of Réamur) are given for Fahrenheit:

Temperature of the air in the shade on deck, 76°.1; at the surface of the water, 73°.4; at the depth of 2,054 feet, 51°.8.

The instrument indicated that the direction of the current at the above depth was W. S. W., (true.) After careful observations no surface current could be perceived for from 7h. of the morning until 5½h. in the afternoon; the vessel had been carried hardly two miles to the E., and the line attached to the instrument was perpendicular.

* The instrument of M. Aimé, constructed to give the direction of submarine currents.

The surface current in this locality is generally directed toward the coast of Africa. The indicator of the submarine current showed that the mass of the lower water was directed toward W. S. W., (true.) To persons more versed than myself in such matters I would submit the following hypothesis: It is known that the volume of water which debouches from Davis's Strait is such that it frequently brings into the Atlantic enormous masses of ice, veritable mountains, descending below the latitude of Newfoundland, and as far as the Gulf Stream, whose waters, heated the whole length of the coast of Mexico, are much lighter than its own, could it not be supposed that becoming a submarine current from this cause, the current of the north continues to the S. by passing under the breadth of the Gulf Stream, and that in approaching the south of Europe and the north of Africa the direction of the coasts of these continents obliges it to bend toward the west in the locality where this observation was made.

More numerous observations on submarine currents will demonstrate whether these suppositions are true or not.

The 17th of March, 1849, calm; latitude 25° 4′ N., longitude 65° 41 W. The indicator was lowered with the thermometer to a depth of 920 meters, (2,990 feet.) It required fifteen minutes to descend, and sixteen and a half to come up. At this depth the instrument indicated that the current run to the N. W. The temperature in the shade on the deck, 79°; at the surface of the water, 76° 4′; at 2,990 feet depth. 45° 8′.

In order to assure myself of the reliability of the instruments I sent them down immediately again to the same depth; the direction of the current and the temperature were found identically the same.

In making these observations I always allowed the instrument to arrive at the required depth, and remain a certain time before letting fall the lead weight, to be sure that the movement of the needle, which without doubt must be considerable during the descent, had entirely ceased.

Similar observations at different points and at different depths would lead us to a more exact knowledge of submarine currents, and although those only at the surface of the sea at the present have a practical interest for the seaman, it nevertheless appears to me probable that repeated observations on submarine currents, as to their direction and

temperature, may in time become of practical utility, considering that perhaps they may teach the route and the causes of the annual migration of the whale and numerous species of fish,* which, without doubt, is intimately connected with the currents, for these take to them the nourishment which the whale seeks, as much at the depths of the ocean as on its surface.

If the interest which such observations merit could induce seamen to make them, a great point would be gained. In a calm they would serve as a distraction on board of vessels of war, where the number of men admit of the apparatus being hoisted without fatigue to any.

In the foregoing I have said that the currents of the surface are exposed by exterior influences to deviation from their usual track; and as I have frequently noticed that my observations differ much from those indicated in the descriptions of currents, I add a table of those which I have found during a voyage made in 1847 to Guinea and the West Indies, in order to prove to what irregularities the fixed currents may be subject.

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* My honorable friend, Professor Eschricht, requested me when I left Copenhagen in the brig of war *Eagle* to observe the direction taken by the whales which we might see during the voyage. I in consequence noted carefully in my journal each time they were met with and the direction followed by them. Although I have met these cetacea frequently during similar voyages, I was surprised to see often, from the 21st to the 27th of September, between the latitude of 15° N. and 11° N., and longitude 23° and 26° W., troops of whales, sometimes composed of many hundreds, traveling always with great rapidity toward the N. and N. E., and most frequently N. N. E. In these localities the temperature of the water at the surface was 82°.6 to 84°.2 Fahrenheit, a temperature higher by 4°.5 than the ordinary under this parallel.

Navigation of the brig of war Eagle from Guinea to the West Indies in October and November, 1847.

Date at meridian.	Temperature of the air.		Temperature of the sea at the surface.		Height of barometer.	Latitude observed.	Longitude observed W. of Greenwich.	Direction of the wind.	Force.	Current in twenty-four hours.	
	Mean.	Difference with the maximum.	Mean.	Difference with the maximum.						Direction.	Drift, in miles.
	°	°	°	°	*Inches.*	° ′	° ′				
October 27	78	3.6	77	0.4	29.9	Road of Christiansborg.		S. W	3		
28	76.3	1.6	77	1.1	29.9	4 29 N.	0 04 W.	W	2	N. E	7
29	79.7	4.8	78	1.1	29.9	3 47	0 13 E.	S. W. by W	2	N. E. by E. ½ E	16
30	78	1.2	79.1	0.0	29.9	3 17	0 30	W. S. W	1	N. E. ½ E	9
31	79.7	3.4	80	1.2	29.8	2 31	1 00	S. W	2	E. by N	8
November 1	78.6	3.4	80.8	1.1	29.9	2 30	0 39	S. W. by S	2	N. W. ½ N	9
2	78	2.3	79.1	0.4	29.9	1 27	0 45	S. W	3	N	8
3	78	3.4	79.1	0.0	29.9	0 53	0 26	S. W. by S	2	N. N. W. ½ W.	7
4	77	3.4	79.1	1.1	29.9	0 18	2 40 W.	S. S. W	3	N. N. E	6
5	76.3	0.4	76.3	1.1	30	0 02	5 05	S. S. W	3	N. ½ W	12
6	75.2	3.4	75.2	1.1	30	0 24 S.	7 04	S. by W	3	N. N. W. ½ W.	13
7	77.7	1.1	76.3	1.2	30	0 49	10 53	S	1	N. E. ½ E	24
8	75.2	0.4	76.3	2.1	30	1 11	14 11	S. by E	4	E. by N	18
9	76.3	3.4	77	1.2	30	0 3 N.	16 50	S. E. by S	3	N. E. by E	7
10	77	3.4	77	1.1	29.9	0 43	19 41	S. E	3	N. N. W	15
11	76.3	2.1	78.6	1.1	30	1 00	25 03	S. E	3	N. ½ W	17
12	78.2	2.1	79.1	1.2	29.9	1 57	26 30	S. E. by E	4	N. by W	22
13	79.1	3.4	80.8	1.4	29.9	3 46	28 53	E. S. E. and S. W	3	N. by E. ½ E	4
14	79.7	4.5	81.5	0.4	29.8	5 08	30 28	E	2	N. W. by N	4

Navigation of the brig of war Eagle from Guinea to the West Indies, &c.—Continued.

Date at meridian.	Temperature of the air.		Temperature of the sea at the surface.		Height of barometer.	Latitude observed.	Longitude observed W. of Greenwich.	Direction of the wind.	Force.	Current in twenty-four hours.	
	Mean.	Difference with the maximum.	Mean.	Difference with the maximum.						Direction.	Drift, in miles.
	°	°	°	°	*Inches.*	° ′	° ′				
November 15..	79.1	2.7	81.5	0.4	29.8	6 13	31 07	S. S. E. and N. N. E....	Squalls	E. by N.....	4
16..	79.1	2.1	80.8	2.1	29.8	7 01	31 12	E. squalls and thunder.	variable.	E.½ N.....	23
17..	78.6	3.4	80.8	1.2	29.9	8 57	32 52	E.....	....do....	S. E. by E.....	13½
18..	76.3	2.7	80.4	1.4	29.9	10 47	35 00	N. E	4	E	0
19..	78	2.3	80.4	1.1	29.9	11 53	37 53	E. N. E.....	4	S. E.....	7
20..	77.8	1.2	79.7	0.4	29.9	12 51	41 25	E. N. E.....	4	N. ½ W.....	10
21..	78	1.2	80.8	0.4	30	13 46	44 36	E.....	4	N. E	1½
22..	77.4	3.4	79.7	0.4	30	14 25	47 45	E. N. E.....	2 to 3	N.....	1
23..	77.5	2.1	80.8	0.4	30	15 04	51 15	E.....	3	N. W. by N...	14
24..	77.4	1.1	80.8	0.0	30	15 48	54 57	E. by N.....	6	N.....	10
25..	78	1.4	79.7	0.0	30	15 57	58 10	E.....	5	N. E. by E....	15
26..	79.1	1.4	81.5	0.4	30	16 44	61 02	E.....	4	*E. by S.....	16

* In sight of Point Antigua of Guadeloupe, bearing S. by W.

This shows that from the 5th November, inclusive, to the time of sighting the Island of Guadeloupe, we had experienced a current of one hundred and forty-four miles, setting N. 30° E., a mean of 6.55 miles in twenty-four hours.

I would remark that the vessel was provided with excellent chronometers. We had daily observations for latitude and longitude, in which we placed all confidence. The courses were steered with the greatest care, and the direction of the current was calculated from the difference of position between the observations and the dead reckoning.

It is seen by the table that the direction of the current of Northern Guinea, from the 27th to the 31st of October, at which time we should have expected to have been without its influence,* was N. 60° E., with a rate of 9.7 miles per day. The instructions indicate a current to the E. of from fifteen to thirty miles per day.†

In beating back along the coast of Guinea, from Quitta to Accra, a distance of about eighty-five miles, with a fresh wind from W. S. W., nearly a head-wind, we were from the 14th until the 15th, at 10h. in the evening, and were convinced that not only we had no current against us, but, contrary to general observations, we had been carried, during twenty-four hours, six miles to the west. This current toward the west is, without doubt, unusual;‡ but it is not improbable, for the vessel was beating in close proximity to the coast, and there, as everywhere near the limits of considerable currents, a counter-current may exist; yet, at anchor on different parts of the coast, I have never discovered any.

The table shows that on the 5th November the current set nearly W. The ship was then in a position where, by running west, it could be expected to profit by the equatorial current without interruption; and, as this current comes from the S., and from colder regions, I had no doubt of

* Purdy, *Atlantic Ocean.*

† In Rennel's excellent work on the currents of the Atlantic Ocean, it is stated that the current of Northern Guinea has a breadth of one hundred and eighty miles, which accords perfectly with the table, seeing that the 31st of October, at noon, the ship was nearly one hundred and eighty miles to the south of the coast of Guinea.

‡ We have in the *Manuel de la Navigation de la Côte d'Afrique* indicated these changes of the general current, which take place in the rainy season, and while the harmattan blows.—(DeK.)

finding it so, as the temperature of the water had fallen to 76°; but, contrary to the directions, I found, on the following days, that the current set toward the E. instead of the W.

Rennel cites, among the perturbations which take place in the great equatorial current, that, in 1816, Sir James Yeo, in a voyage from Guinea to the West Indies, found no current between the Equator and 1° 30′ S. latitude, from the meridian of 0° to that of 15° W. longitude, although four other vessels, in the same locality and during the same month, had experienced a current which set toward the W. at the rate of twenty-two and even sixty-three miles per day.

The table indicates that I found on the 6th, 7th, and 8th of November, in the localities in question, a current which differs still more from those ordinarily encountered, than the currents found by Sir James Yeo, inasmuch as it set, in four days, N. 48° E. forty-one miles, a mean of 13.7 miles per day to the N. E., while, in these localities, it sets nearly always, with considerable velocity, to the W.

I cannot explain this remarkable direction of the current in this region, except by admitting that the current of the Equator (and perhaps this may be common in this season, though the directions do not mention it) had been carried more than ordinary toward the south, and that we had navigated in the eddy formed at its northern limit; for the temperature of the sea proved sufficiently that we were in a mass of cold water, which should come from the south and regions less heated by the sun.

I traversed, from preference, during the remainder of my voyage across the Atlantic, the route where the instructions and the charts indicated favorable winds and currents. Nevertheless, contrary to my expectation, I reaped no advantage from current, for, from the 5th of November, when I believed that I was within the influence of the equatorial current, to the 26th of November, when we made Guadeloupe, (in which time the vessel had run about 3,500 miles,) the current had carried us one hundred and forty-four miles N. 30° E., and though, in comparison with the distance run, this cannot be considered considerable, it is not the less extraordinary, for, generally, the current on this route is favorable, setting to the W.

To find, if it were possible,* a reason for these currents so different from those usually met with, it would be necessary to compare the logs of ships which have traversed the Atlantic at this period, but as these are not within my reach I can only cite facts. Little is known as yet of the currents of the arctic division of the Atlantic Ocean.

The cause of this want of knowledge is probably owing to the zone being seldom visited, and to the frequent storms, blowing from one direction and the other, altering the direction of these currents; moreover, the fogs and cloudy weather are insurmountable obstacles to obtaining the observations for establishing currents. It results that it is more difficult in these regions than under a lower latitude to arrive at a result which merits confidence. It is, however, known from indisputable facts that a current coming from S. W., passing between Iceland and the Shetlands, has its course across the Atlantic as far as the Arctic Sea.†

In order to examine this current I have examined the journals of many of our vessels of war which have gone latterly to Iceland, particularly those of the *Droning-Maria*, in 1834; the *Naiade*, in 1834; the *Mercury*, in 1845; the *Saint Croix*, in 1846; the *St. Thomas*, in 1847; the *Diana*, in 1850; the *Saga*, in 1851, &c. From my own observations on the one side, and on the other by the aid of many kind friends, I have been able to obtain numerous observations on the temperature of this part of the Atlantic Ocean. That the result of these observations could be more readily seen I entered some of them on a chart, joined to this memoir; in order to prevent confusion I have not given a arger number. The observations made in the voyages to Greenland were furnished me by Captain Holboll and by Lieutenant Ulrich, of the royal navy.

The vessels of war above cited have at different periods.

* We have indicated perturbations of the same kind in the equatorial current, as also one running to the E., which appears to be permanent in the space comprised between the N. W. branch of the equatorial current and the current of Guiana; it is this current to the E. in which Captain Irminger has navigated, and the observations of the preceding table are of the greatest interest, in that they confirm those already made by M. Lartigue and by Captain Montravel on the current to the E., which we have designated the *counter equatorial current*.—De K.

† See N. E. branch of the Gulf Stream.

from the month of April to September, navigated eighty-seven days between the meridian of the Island of Fairhill and that of 18° 10′ W., and between the parallels of 58° and 66° N. latitude. In these localities I have often found that the current was very irregular; but the mean of the observations during this period gives a current of 2.4 miles per day, setting to N. 52° E.

From the meridian of 17° 40′ W. longitude, (which is about that of the south point of Iceland,) between the parallel of 62° N. latitude and the south coast of Iceland, as far as Cape Reikianes, the mean of the currents for thirty-two days was 1.9 miles per day, setting to the northward and westward.

To examine if the currents in this space between Fairhill and Iceland had an equal velocity, I have divided it into four parts; the result obtained is as follows:

In the first division, comprised between the parallels of 59° 30′ and 61° 30′ N. latitude and the meridians of 2° and 6° W. longitude, the mean of the currents observed during seventeen days gives a rate of 7.7 miles per day, setting to the N. 72° E.

In the second division, comprised between the parallels of 60° and 62° N., and between the meridians of 8° and 10° W., the mean of the observed currents during eleven days gives a rate of 2.5 miles per day, setting N. 60° E.

In the third division, comprised between the parallels of 60° 30′ and 62° 30′ N. latitude, and the meridians of 10° and 14° W. longitude, the mean of the observed currents during twenty-five days gives a rate of $\frac{8}{10}$ of a mile per day, setting N. 32° E.

In the fourth division, comprised between the parallels of 61° and 63° N. latitude and the meridians of 14° and 18° W. longitude, the mean of the observed currents gives a rate of 3.1 miles per day, setting to N. 47° E.

Between Fairhill and Greenland the weather did not permit the collection of many observations, more especially for the determination of longitude; hence the direction and strength of the currents could not be calculated with the desired accuracy; however, it was found, in the month of April, between the meridians of 32° and 39° W. longitude, and the parallels of 57° and 59° of N. latitude, from the difference between the latitude observed and that estimated, that the mean difference to the N. during thirteen days was

3.2 miles per day. In the month of September, between the parallels of 60° and 58° N. latitude and the meridians of 43° and 9° W. longitude, there was a difference to the northward of five miles.

From the observations we have collected, it can be stated, 1st. That the temperature of the sea between the meridian of Fairhill and that of about 30° W. longitude, does not vary much on a line drawn to Cape Farewell. But to the west of the meridian of 30° the water becomes gradually colder as the coast of Greenland is approached. 2d. That the sea in the spring is not colder near the southern part of Iceland than it is at Fairhill, although the position of Iceland is many degrees further north; while near the Shetlands the temperature is a little higher in summer, or at the commencement of autumn, than it is near to Iceland. 3d. That the temperature of the sea is in general 2° to 3° colder in the spring than at the commencement of autumn.

In many voyages made in the beginning of May, it was found that the water in the northern part of the North Sea was colder by 2° and more than the sea which extends to the west of the Shetlands, while later in summer their temperature was more uniform.

From the 19th of June to the 13th of July, 1844, I found that the temperature about the Faroe Islands, and in the channels formed by these islands, was never below 49°, or above 51° Fahrenheit.

The daily observations made in 1846 and 1847, which were communicated to me by M. Moller, show that the temperature near Thorshavn was, at a mean:

For October, 1846....	48°.4	For March, 1847.....	43°.5
For November, 1846 .	47°.3	For April, 1847	43°.5
For December, 1846..	42°.9	For May, 1847	46°.2
For January, 1847 ...	42°.9	For June, 1847	48°.6
For February, 1847 ..	41°.0		

In the month of December the winds from N. and N. E. prevail at the Faroe Islands, and bring an intense cold; this is probably the cause of the increased coldness of the water during this month. The atmosphere has, without doubt, had more influence on the water of the Bay of Thorshavn, which is well closed, and the depth less than the sea. But as the Faroe Islands are situated nearly half way between the Shetlands and Iceland, the observations made near the

port of Thorshavn will give an approximate idea of the temperature of the sea in these localities during the above mentioned months, though the temperature of the water at great depths should be considered as more constant than those observed near the shore of Thorshavn.

It appears, moreover, that the current which is directed to the N. E. between Iceland and the Shetlands is divided into two belts, indicated by a difference of temperature of one or two degrees; their limits, however, are not always the same.

In mentioning these belts of water of different temperatures, I should observe that between the parallels of 40° and 45° N. latitude, and between the meridians of 40° and 50° W. longitude, there is always a great difference in the temperature of the sea. In the same places where at times the temperature is 8°.8 to 9°.4 below the ordinary temperature of the ocean,* at other times it is found that the warm current of the Gulf Stream preserves a temperature of many degrees above the ordinary temperature of the ocean. These variations are produced, without doubt, by the current of Davis's Strait.† If this current is very rapid, the northern limit of the Gulf Stream retrogrades toward the south, while in the opposite case it advances more to the north. In the same localities are frequently met mountains of ice, which nearly every year come from Davis's Strait,‡ and contribute much to lower the temperature of the sea.

Admitting that the great body of water which runs to the N. E., between Iceland and the Shetlands, comes from the localities indicated above,§ where the temperature of the sea is very variable, it can be readily believed that they exert as much influence on the temperature of the sea between Iceland and the Shetlands as the removal of the limits of the Gulf Stream. It is impossible, in the space comprised between Iceland and the Shetlands, to give the boundary which separates the warmer from the colder belt

* Rennel, p. 244, 248.

† Rennel, p. 207.

‡ A vessel in January, 1818, was inclosed in the ice during twenty-nine days, and was drifted a distance of three hundred miles E. S. E.—Rennel, p. 245.

§ See observations on the velocity of the Gulf Stream, in the *New Archives of Navigation*, p. 191, by Captain Irminger.

of water, as these belts are carried more toward the east or west, according as the currents and masses of ice coming from Davis's Strait influence more or less the limits of the Gulf Stream and the temperature of its waters.

Some experienced mariners, who, for a number of years have been occupied between Spitzbergen and Jan Mayens Island, in the whale and seal fishery, have informed me* that nearly in the longitude of the Shetlands, between those islands and the parallels of 63° and 64°, they have often seen in the sea discolored spots, by means of which, on their return, they were able to determine their longitude. Nearly in the same parallels of latitude, when nearer the meridian of the Shetlands than to that of Norway, the bird called the Jan-Van-Gent, (the Gannet,) known by all those who have navigated the north of the Atlantic, is frequently met with, while it is rarely seen when nearer to the meridian of Norway than to that of the Shetlands.

When it is considered that the vessels occupied in the whale fishery cruise often for months among the ice, under a parallel where a degree of longitude is not more than four or five miles, that the observations for position on board these vessels are generally confined to the latitude, it can be understood that they may have frequently considerable errors in their longitude, unless, from time to time, they make the land. It is then natural that the captains of these vessels should observe with particular attention the least change in the color of the water, the appearance of birds, the direction of their flight, &c., indications superfluous to those who, by exact observations, are confident of their position. Thus the experience acquired by these mariners, from many years of navigation in these localities, has convinced them that the indices of which we have spoken inform them, on their return from the Icy Sea, whether they are to the east or west of the route followed.

Similar observations, made by practical men, should not be despised. It is not unlikely that the spots in the sea result from the intermingling of the water of the current coming from S. W. with that coming from the Icy Sea, a meeting which probably takes place in the localities indicated.

It is also possible that these same currents bring the food which certain sea birds prefer, for it is extremely rare that

* Among others, the skillful Captain Kitelsen, who commanded on the coast of Greenland a vessel of Glückstadt.

the Gannet is found to the eastward of the meridian indicated above.

In the preceding I have mentioned the current which, near to the south coast of Iceland and to the west of the meridian of 18° W., is directed toward Cape Reikianes, bearing northwest westerly from Iceland, between 64° 15′ and 65° 50′ N. latitude, and between 23° 51′ and 25° 48′ W. longitude, the mean of observations made for five days in May and June, 1846, gives a current of 4.8 miles per day setting to the N. 15° W. During a considerable sojourn on the west coast of Iceland, I have often had evidence that the current directed toward the N. predominates considerably, which is a fact generally known to the fishermen.

It is found that the temperature of the water in the road of Reikiavik, from the 30th of May to the 16th of June, has been, at the mean, 47°.5; from the 1st to the 14th July, 53°.4, and from the 11th to the 31st, 51°.6; while the temperature of the sea near the west coast of Greenland, which is opposite to Iceland, generally varies but from 34° to 36° Fahrenheit.*

In the Bay of Patrix, which is above 65° 30′ N. latitude, distant hardly a degree from the polar circle, the temperature of the sea from 18th to 23d of June was 47°.1.

From the high temperatures we have mentioned, and the direction of the current, it can be inferred that the one which comes from the S. continues its course by rounding Iceland to the west. To determine how far it goes toward the N., I give the following:

June 23, 1846, at 6 p. m., the brig of war *St. Croix*, Captain Svenson, being in latitude 65° 54′ N., longitude 25° 05′ W., the temperature was 49°.1.†

The 24th of June, at 6 a. m., latitude, 66° 22′; longitude, 26° 13′; temperature, 35°.6; loose ice to northeast.

At 9 a. m., latitude, 66° 30′; longitude, 26° 14′; temperature, 32°.2.

At meridian, latitude, 66° 17′; longitude, 25° 39′; temperature, 37°.6.

At 4 p. m., latitude, 65° 53′; longitude, 25° 11′; temperature, 46°.4.

* *Voyage of Exploration on the East Coast of Greenland*, by Captain Garha, p. 152.

† This high temperature has been found but once.

At 8 p. m., latitude, 65° 38′; longitude, 24° 47′; temperature, 47°.5.

During the time the brig was in the cold current, there was no observation from which its direction could be calculated; but from numerous facts it is known that the current of the Icy Sea runs in the direction of W. and S. W., toward the coast of Greenland.*

This sudden change of the temperature indicates clearly the limits of the warm current. This limit, from the observations cited, is found to be where the northwest part of Iceland ends.

In this locality the current which comes from the Icy Sea arrests the warm current in its course toward the N. It is possible that it may be thus turned, and that then it is directed toward the W., along the southern limit of the current of the Icy Sea, until it is entirely wasted.

From the temperature of the sea between Cape Farewell and Iceland, and the northerly direction of the current, of which mention has been made, it is probable that a current to the N. exists in the greater portion of the channel which separates Iceland and Greenland, excepting where the current of the Icy Sea is strongest, and opens for itself a route to the S., along the east coast of Greenland.†

The warm current which runs toward the N., in rounding Iceland on the west, makes the temperature on the west

* *Currents near Iceland*, by Captain Irminger; *New Archives of Navigation*, 1843, page 199.

† Many experiments have been made by throwing bottles into the sea to find the direction of the current. Although the indications are quite uncertain, they may contribute to throw some light on this subject; but much would be added to their value if the bottles used were sufficiently thick and heavy to allow only a very small part of their surface to float above the level of the water. They would thus escape the influence of the wind and only follow the current. I will, however, cite some examples of bottles which, though thrown into the sea in the localities south of Iceland, where the winds prevail from W., have followed a direction approaching to north, from which it can be concluded that the current was more W. than N., otherwise they would have been drifted toward the E. Rennel mentions the following, p. 338: A bottle from the *Hekla*, Captain Parry, thrown in 56° 36′ N. latitude, and 25° 45′ W. longitude, the 13th October, 1820, was found the 6th or 7th of March, 1821, on the coast of Iceland, (Southern Barlwick.) Another bottle from the *Rising Sun*, Captain Bennett, thrown in 50° 32′ N., and 26° 40′ W.; and a third by the *Cranie* of Leven, thrown in 56° N. and 16° 30′ W., were both found on the coast of Iceland.

coast of Iceland comparatively mild, and no ice is found in the Bay of Faxe. If this current did not exist, the ice which extends off Spitzbergen, and which is always forced to the southwest, along the coast of Greenland, would bring up on the coast of Iceland, particularly with the fresh winds from W., and would fill the bays and gulfs.

Then its climate would probably not differ from that of the east coast of Greenland, which the cold renders almost uninhabitable. The ice there is so heaped up that the coast is always inaccessible. There are on the sea-coast enormous barriers of ice, which often extend far into the offing. Very heavy weather from the west can alone break this barrier and remove it a little from the coast; but as soon as the storm ceases the ice closes in again.*

Carried by the current of the Icy Sea, the ice, especially in the spring, extends often more than twenty miles below Cape Farewell; the current then doubles this promontory in running into Davis's Strait. It does not generally run to the N. above the 64th parallel of latitude. It runs toward the W. in the straits, and there it is united, without doubt, with the current which from Hudson's Bay† and the west part of Davis's Strait is directed to the south along the coast of Labrador. It contributes to drift the ice, which is thus taken toward the south from Davis's Strait to Newfoundland, and further into the Atlantic, where it is often an obstacle and a great danger to vessels navigating between Europe and North America.

When cruising in different climates, where the temperature of the sea and air is observed, one is struck with the concordance between the two temperatures.

I have already mentioned that I have found, during the month of September, 1847, between the parallels of 15° and 11° N. and the meridians of 19° and 21° W. the temperature of the sea varying from 82°.6 to 85°.2. In these localities the atmosphere is always heavy and disagreeable and the temperature 83° to 86°; eight days after, in latitude 4° N. and between 5° and 10° W. longitude, the temperature of the sea was only 74°.8 and we had an agreeable temperature not exceeding 75°; that is 9°.5. cooler, although we were from 7° to 11° nearer the Equator.

It is to the warm current of the south, of which we have

* *Voyage of Graah*, page 154. †Rennel, page 248.

already spoken, which flows along the west coast of Iceland to which we must attribute the relatively mild temperature of Reikiavik, the mean of which is 39°, while that of Gothaal, situated nearly in the same latitude as Reikiavik, is 34°.8 Fahrenheit, and that of the east coast of Greenland, along which descends the arctic current, is almost uninhabitable from excessive cold, although situated some degrees to the south of Reikiavik.

A little to the south of the Newfoundland Banks, where the current from Davis's Strait meets the Gulf Stream,* it cannot but be remarked, in working to windward during the winter, that it is exceedingly cold on the boundary of the Gulf Stream, when in the middle of its bed the temperature is mild and the air humid.

Sir Philip Brok cites, among other facts, that in the years 1811 and 1813, while navigating during the winter between the north and south limits of the Gulf Stream, in 39° or 40° N. latitude, he found that the thermometer marked 79°.1 in the middle of the bed of the current.†

Many similar examples could be cited, but by reference to the chart where the isothermal lines are traced, the influence that the currents have on the climate can more readily be seen.

The general currents, the cold as well as the warm, constantly fed by the arrival of masses of water of the same temperature, preserve their temperature (whether higher or lower than that of the sea which surrounds them) in traversing large tracts of the ocean, and they refresh or warm the atmosphere far from the regions of their origin.

A remarkable proof of the circular path of these masses of water is the quantity of tropical productions which are frequently carried to shores far to the northward; many species of mimosa are found on the coasts of Norway,‡ Faroe Islands, Iceland, and of Greenland, where also wood is frequently found; this wood thrown upon the shore is

* After the Gulf Stream has run a distance of about two hundred miles to the N. E. from the Strait of Florida it still preserves a temperature of 7° to 10° higher than the ordinary temperature of the ocean during the summer, and its velocity is one mile per hour. (Rennel, page 152.)

† Rennel, pages 181, 182.

‡ *Description of Currents by Sandmor in the district of Bergen*, p. 138; it is there mentioned that sometimes cocoanuts are thrown on the coast.

of the greatest utility to the inhabitants, deprived as they are of forest vegetation.

Torn by inundations from the borders of rivers, these trees are carried by the stream to the ocean; the lighter species, even after drifting a long time, continue to float, and this is the reason why the greater part of the wood thus collected is composed of different species of the fir tribe. Generally it is only the trunks, with a portion of their roots, which are thus found, the branches having been taken away.*

On the north coast of Beata, a small inhabited island situated to the south of Santo Domingo, I saw, in 1849, a large quantity of floating wood, among it some trees of a species unknown in the West Indies.

From the circular route of the currents it is probable that the specimen of wood that I found on the shore of this island arrived from the southern portion of the globe, and that whatever follows that route, if not arrested by some coast, is drawn into the current of the Gulf of Mexico, then, by the Gulf Stream, across the Strait of Florida, and lastly toward the north.† Thus, perhaps, at times, a tree, a native of New Zealand, or of some other place of the southern hemisphere, may be landed on the coast of Iceland, or other shores of the far north.

In the Islands of Faroe it frequently happens that wood in considerable quantities is drifted near to Kirkehoe, situated in the southern part of the Island of Stromo.

In 1844 I saw there a pine, the trunk of which, three feet above the roots, measured five feet four inches in circumference. The proprietor of the place informed me that wood drifted here often in February and March, and he calculated that the profit which he derived from it annually was as great as that derived from a field, which brought him $25 to $34. I learned, however, that this floating wood did not arrive latterly in such large quantities as in times past.

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* *Description of the Currents by Sandmor, &c.* In vol. vii, p. 419, among the dangers of Banca Strait, drift-wood is mentioned. I. R. Welsted, in his voyage, (*Nach der Stadt der Kalifen,*) p. 8, states that he encountered much drift-wood in the Persian Gulf. In the *Scientific Voyages of Darwin*, p. 242, it is related that large quantities of drift-wood are thrown on the shores and channels of Tierra del Fuego.

† The ship *Tilbury* was burned near Santo Domingo; her mainmast was drifted to the west coast of Scotland. Rennel, p. 348, and Berghaus, vol. i, 1837, p. 562.

Many trees are thrown on the coast of Iceland, principally on that of the north, and are landed to the westward of Point Langanoes, near the plain of Melrak, between the North Cape and Adelvig.

I have often understood from the inhabitants that a part of this wood was cedar, although it is possible that trees of this species may be drawn into the Gulf Stream and then follow the same route as the mimosas. It is not probable; on the contrary, I am of opinion that a great part of the wood thrown upon the coast of Iceland is the larch, taken to the Icy Sea* by the rivers of Siberia. Being carried in this sea by the current running to the W., it reaches Iceland,† Greenland, &c., passing Spitzbergen. As its color is reddish, it is confounded with the cedar. Further, it is proved that the larch, after remaining some time in water, takes a reddish tint; it is this color, in my opinion, which has caused the two to be confounded. In the Islands of Faroe I have never seen other than pines, and they informed me there that nearly all the wood cast upon their coast was white. This is an excellent proof that the red wood drifted upon the shores of Iceland is not the cedar, for if it were, trees of the same species would frequently be found on the shores of the Islands of Faroe. It is very probable that the greatest part of the floating wood which is thrown upon these coasts comes from the rivers of America, and that it is carried to the Gulf of Mexico by the Mississippi; from there, by the Gulf Stream, and then by the current which exists between the Shetlands and Iceland, toward the Icy Sea. Drift-wood in rivers is an obstacle and serious danger for navigation. It is probable that the forests in the vicin-

* *The North of Siberia*, by Wrangel. In this work he states that the larch tree in Siberia is black on the north side of the trunk, and red on the side turned to the south. There are large forests of these on the shores of the rivers; among others those of the Lena, p. 308. Among the great number of larches and aspens on the coast between the Lena and the Indigirka it is seldom that pine and fir trees are met with.

† I have seen in 1834, on the farm of Geitarkard, situated in the north part of Iceland, near the river Blanda, some window shutters made of the remains of a ship, the *Margarithe*, the name being painted on them. This ship had navigated between Glückstadt and Greenland, and a few years before had been abandoned a short distance from Spitzbergen; some time after, her hull was drifted on shore near the mouth of the Blanda.

ity of the rivers of North America are considerably thinned, as much on account of the great quantity of wood consumed by the numerous steamers plying on these rivers as by the great clearings made by the colonies established on their borders. It would not appear to me strange that the annual diminution of the drift-wood, as remarked at the Islands of Faroe, might be a consequence of the destruction of forests formerly extending to the shores of the rivers mentioned, and it might be supposed that the number of trees thrown upon the coast of the islands, &c., of the Northern Ocean would in the future become less and less.

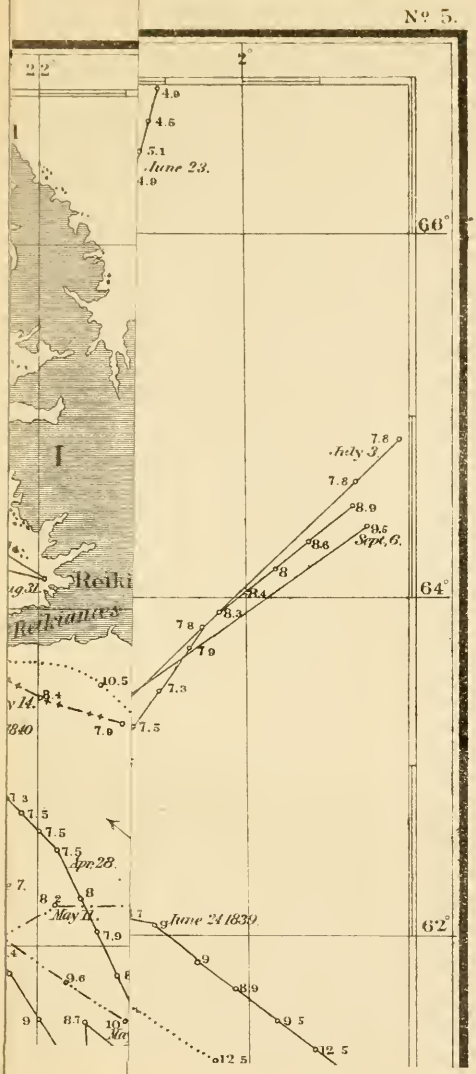
№ 5.
22°
2°
66°
64°
62°
Reikiavik
Reikianes
June 23.
July 3.
Sept. 6.
May 14.
1840
Apr. 28.
May 11.
June 24 1839.

CHART
OF THE
TEMPERATURES AND OBSERVED CURRENTS
between
The Shetland Islds and Greenland,
by Capt. Irminger.
Danish Navy.

The temperature given in the chart is the mean of all the daily observations (Celsius Scale)

Together with the work of Capt. Irminger is published an extract of the chart of temperature observed on board the "Recherche" during a voyage to Norway.

The arrows indicate the direction of the currents.

In regard to the observations of the "Recherche" the figures show the temperature observed at the different hours

- Sept. & Oct from Greenland to Denmark 1845.
- " " " " 1846
- May, from Denmark to Greenland 1845
- May, Track of the "Flora" 1845
- May, Track of the "Flora" 1846
- May, Tracks of the "Mercurius" 1846
- Aug. & Sept. Track of "La Sainte Croix"
- Tracks of "La Recherche"

GREENLAND

C. Farewell

C. Nord

Grimsey

Breede Bay

Faxa Bay

Reikiavik

Reikianes

ICELAND

Ferroe

Shetland Is.

Orkney Is.

SCOTLAND

Long.s West 26° from Green.ch 22 18 14 10 6 2

Engraved by H. V. Evans.

Washington D.C.

ALPHABETICAL INDEX.

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