THE MODERN LAW OF STORMS; PHILOSOPHICAL SOCIETY OF WASHINGTON, BULLETIN VOL. XI, PP.173- 189; HURRICANES IN THE BAY OF NORTH AMERICA

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THE

MODERN LAW OF STORMS.

BY

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THE MODERN LAW OF STORMS.

By the term "Law of Storms" is meant, as sailors understand it, a code of rules or directions for manœuvring a vessel so as to avoid the centre, or most dangerous portion, of a storm, and, as a secondary consideration, to take advantage of its favorable winds to prosecute the voyage. To a landsman it is difficult to appreciate the many and varying considerations that enter as factors in this question. Here on land our position is fixed; we take storms as they come, and make the best of it. It is hardly once in a lifetime that an approaching storm threatens us with danger to life or limb, and all that is required of the average individual is to "know enough to go in the house when it rains." Moreover, the great weather bureaus that are now established in the leading civilized nations, although a natural and legitimate growth, have a certain tendency, like other great monopolies, to crush out individuality, especially anything that may look like opposition. At sea, however, the case is widely different. The navigator is thrown upon his own resources entirely. He must decide from his own unaided observations whether a storm is approaching, and, if so, whether it is likely to be of dangerous severity. He must then, first of all, try to avoid the most dangerous regions of the storm-field, allowing a fair margin for safety; to do this, he has to consider the character of his vessel, the amount of sea-room he has for manœuvring (that is, the lay of the land, considered with reference to the winds and currents to be expected), the bearing and distance of the storm-centre, and the size, severity, velocity, and track of the storm. Secondly, he has to decide how he can best profit by the approaching storm to continue his voyage; to do this, he must understand the general character of the wind system, the probable track of the storm relative to his vessel's track, and the character of wind and weather following. Thus the law of storms is a very different thing to the practical navigator from what it is to the meteorologist, and in this article I shall confine my attention wholly to the practical side of the question.

It is rather astonishing, at first thought, to see how apparently slight are the modifications that the progress of the past fifty or sixty years has made in the old law of storms, as discovered by Redfield and enforced by Reid, Piddington, Thom, and other early writers. The

essential features of the old law were as follows: A hurricane is a "revolving storm,"—that is, a whirlwind (as opposed to a "straight-line gale," where the wind blows from the same compass-point over a large region, and for a long time); the rotation of the whirlwind is *against* watch-hands in the northern hemisphere, and *with* in the southern; the storm, whirling about a centre, has also a progressive motion along a parabolic track, westward in the tropics, receding gradually from the equator, and, finally, moving eastward in higher latitudes. Upon these general considerations—soon acknowledged to be very important facts, or, at least, very close approximations to the truth—a simple code of rules was based for the guidance of navigators, differing in the two hemispheres according to the different conditions of rotation and progressive motion. The first and most obvious rule is that the centre, or most dangerous portion of the storm, lies in a direction at right-angles to the direction of the wind at any position in the whirl; this is the well-known "eight-point rule." Next comes the rule regarding the tack upon which a vessel ought to lie-to in order to ride out the storm,—that is, let it pass over her with as little danger as possible. It is very difficult for any one to appreciate the importance of this question unless he can realize vividly the tremendous force of wind and sea in a hurricane, the sudden and terrific shifts of wind, the danger a vessel is in when taken aback, and, finally, the difficulty—impossibility, in most cases—of wearing ship (in order to change the tack) when once caught in such a storm. The rule is to lie-to on the *coming-up* tack,—that is, the tack on which the vessel will come up to the wind as it shifts, and not get taken aback. The great value of this rule is that it is so simple and universal in its application, and that there are so few exceptions. The conditions are such that if the wind begins by shifting to the right, say, for example, from east to east-south-east, and the vessel lies-to on the right, or starboard, tack, the next shift will also be to the right, say to southeast, almost invariably,—that is, the wind will continue to shift aft and not come out ahead. The best example of the results that may follow a failure to observe this rule is the disaster that befell Rodney's fleet and prizes—in all some ninety-two vessels—off the Grand Banks in 1782: all preparations for bad weather were made and the fleet hove-to, but on the *wrong tack;* frigates, prizes, and convoy were dismasted, sunk, scattered, abandoned; every man-of-war but one foundered, and more than three thousand lives were lost. The other rules of the old law of storms follow directly, you may say, from these two, together with the facts already mentioned concerning the circular character of the storm and its progressive motion along a curved track. Thus, If it be known from the appearance of the weather, sea, etc., that a revolving storm is approaching, and the wind freshens but remains steady in direction, it follows that the vessel is directly on the track of the storm, and that

she should square away and run before the wind, keeping her compass-course (when the wind begins to shift) until obliged to lie-to, when she should lie-to on the coming-up tack, as before.

One other point regarding the old law of storms, and this, like the law of the coming-up tack, is as important to-day as it was fifty years ago: the storm disk is divided, for convenience of reference, into two semicircles, called, respectively, the manageable (or navigable) and the dangerous semicircle. Subsequent reflection and research have, to be sure, added somewhat to the value and force of these terms, but this only confirms the value of their original signification. In preparing data regarding West Indian hurricanes for Hydrographic Office publication No. 86 (Caribbean Sea and Gulf of Mexico; Washington, 1888), I defined the dangerous semicircle as follows, referring, of course, to northern hemisphere storms:

> "When the storm is moving to the westward, that portion lying north of the track is the dangerous semicircle, and while moving in a northerly direction, the portion to the eastward is the dangerous semicircle. In other words, the right-hand semicircle is by far the more dangerous portion of the storm, and for three reasons: First, because the progressive motion of the storm along its track (about seventeen miles an hour) increases the velocity of the wind in this semicircle, while decreasing it by the same amount in the other semicircle; secondly, because both wind and current tend to carry the vessel directly in front of the storm, and if obliged to scud she will run into still greater danger; and, finally, because this is the side towards which the track is liable to recurve at any moment."

Without going into the history of the development of these important laws in the hands of the numerous writers who have, at various times and among various nations, sought to verify, extend, and complete them for the benefit of commerce, let me advance at once to what I have called, in the title of this article, the modern law of storms. By this I mean to cast no discredit upon the old, but to consider briefly the few thoroughly well-established modifications of and additions to these laws that have already become a permanent and essential part of the code, and must be so recognized in treatises on navigation, examinations for officers' licenses, and courts of admiralty.

No reference to this subject would be complete at the present day without mention of and acknowledgment to Hon. Ralph Abercromby, the eminent English meteorologist who has made a specialty of this practical side of the question, and to whom the thanks of every meteorologist and practical navigator are due for his masterly and exhaustive researches. His knowledge is not that of books and theories alone, but in the prosecution of studies regarding the handling of ships in hurricanes he has made a tour of the world, visiting every hurricane region of the globe with but one exception, and that, unfortunately, a very important exception, the West Indies. He has thus met the leading local authorities, talked with them regarding their views and the local peculiarities of their storms, consulted and studied their

original and unpublished data, and, armed with a thorough knowledge both of the scientific and practical sides of the question, has given us a most important and valuable *résumé* of the best modern practice. It is rather an amusing fact that during his extended tour of the world he did not have the good fortune (as he puts it) to encounter a single hurricane, much as he desired to do so. After reviewing the subject very thoroughly, Abercromby gives his conclusions as follows, comparing his revised rules with the old ones:

"It will be remarked:

"1. That the rule for finding approximately the bearing of the vortex is modified and improved by the addition of indications derived from clouds; but that still the position of the vortex cannot be determined nearly so accurately as was formerly supposed.

"2. That the great rules of the 'laying to' tacks remain unaltered.

"3. That the greatest improvement is in recognising the position and nature of the belt of intensified trade wind outside the true storm field of a cyclone, where a ship experiences increasing wind without change of direction, with a falling barometer. The old idea that such conditions show that a vessel is then necessarily on the line of advance of a hurricane is erroneous. She may, but she need not be; and under no circumstances should she run till the barometer has fallen at least $\frac{4}{10}$ths inch.

"4. There are certain rules which hold for all hurricanes; but every district has a special series, due to its own local peculiarities.

"Finally, no one should blame the master of a ship for not following the established rules without the closest investigation, for, as Piddington says, 'absolute rules are all nonsense,' and much depends upon the capabilities of a ship and on the ever-varying conditions of a heavy cross sea."

It will thus be seen how apparently slight are the modifications that the experience of half a century has made in the sailor's law of storms. But although these modifications are apparently slight, they are really of very great importance, and very often, in critical cases, may turn the scales between safety and disaster. For a full discussion of the subject, both as to general rules for all hurricanes (both hemispheres) and special rules for each hemisphere and particular regions (notably the South Indian Ocean), I cannot do better than refer the reader to Abercromby's paper in the *Journal of the Scottish Meteorological Society* (Third Series, No. VI.). Within the limits of this article I can only touch very briefly upon what I regard as points of especial importance.

First, then, regarding the bearing of the centre of a hurricane, as estimated by means of observations at a single ship or station.

Here a decided advance seems to be the general recognition of the early indications of an approaching hurricane. No doubt individual navigators were thoroughly posted in this matter years ago, but at present the symptoms are so well known and so clearly stated in all works on the subject that every one must be familiar with the leading facts, applicable alike to hurricanes in every ocean, whether north or south of the line. Let me quote from the "Pilot Chart of

the North Atlantic Ocean," where these important general rules are printed every month, and thus kept conspicuously before the navigator:

"*Earliest indications:* Barometer above the normal, with cool, very clear, pleasant weather; a long, low ocean swell from the direction of the distant storm; light, feathery cirrus clouds, radiating from a point on the horizon where a whitish arc indicates the bearing of the centre.

"*Unmistakable signs:* Falling barometer; halos about the sun and moon; increasing ocean swell; hot, moist weather, with light variable winds; deep red and violet tints at dawn and sunset; a heavy, mountainous cloud bank on the distant horizon; barometer falling more rapidly, with passing rain squalls."

The value of such early warning is of course very great, and all the more so if considered in connection with the probable path of the storm, as indicated by special experience or researches regarding the storms of the particular ocean where the vessel may be. A steamer can readily alter her course and avoid the storm, even though it require a wide détour; a sailing vessel is often unable to do so, owing to the light variable winds that she is liable to encounter; but she can at least make all preparations, and, by watching carefully every change of bearing of the distant cloud bank, be ready for instant and decided action when the winds of the cyclone itself first reach her. Nothing could be more graphic and interesting, as illustrating the unmistakable character of these early indications of the approach of a hurricane, than the many reports that are sent in to the Hydrographic Office by masters of vessels. The following may be quoted, by way of illustration: Captain Taylor, of the British ship "Argus," encountered a typhoon off the coast of China last August, and in his report he states as follows: "For two days previous the weather was hot and sultry, with calms and light variable winds. The wind at night had a hot and oppressive feeling. A swell rising from the southeast, and gradually increasing until very heavy. August 21, 4 P.M. (lat. about 27° N., long. 124° E.), a dense bank arose in the east-southeast, and the sky had altogether a troubled appearance, light olive-colored clouds scudding very low, with great speed. The barometer previous to this had kept very steady; it now fell. At sunset the sky had a fearful appearance,—a heavy blue-black cloud at an altitude of 10° to 15° above the horizon, having thin edges tinged with a deep crimson border, as if bound by a ribbon of that color, and in the southeast the sky was a lurid red, casting a reflection on the sails and over the water, which at that time was calm, with a heavy swell."

Again, take the case of the St. Thomas-Hatteras hurricane of last September: hundreds of vessels off our coast and about Bermuda noted the long, low ocean swell from the southward, increasing day by day, overspreading the entire western Atlantic, rolling in upon the sandy beaches from Florida to Long Island and breaking upon the granite ledges at Newport and along the coast of Maine and Cape Breton. Captain White, of the American schooner "Ada Bailey," was ninety

miles north-northeast from Hatteras, September 2, and at that early date noticed a heavy swell heaving in from east-southeast, evidently from the great hurricane that only reached St. Thomas the following day. That it really came from this distant storm is evidenced by many other reports, and by his own journal of subsequent dates, "September 3, lat. 37° 07′ N.; long. 74° 21′ W., a long and heavy swell from east; weather looking very bad. September 4, no wind; temperature of air, 84°; very heavy swell from east-southeast. September 5, lat. 37° 20′ N.; long. 72° 38′ W., calms; a long and heavy swell from south-southeast; every appearance of a hurricane."

Here was a vessel within a short distance of Hatteras, watching, by means of her own unaided observations, the slow but steady and unmistakable approach of this great hurricane *six days* before it reached the coast, and actually a week, to a day, before it finally secured recognition by the display of a cautionary signal for the benefit of commerce! At first thought it would seem to be a good idea for vessels to signal to the shore and communicate early warnings of approaching storms, rather than the reverse; but the fact is that a skilled observer can so easily detect the approach of a hurricane and estimate its severity and track that, with half a dozen well-selected stations along the coast, it ought to be impossible for one to approach us without several days' warning. The *state of the sea*, for example, is a very important indication, and this might well be reported by all our coast stations and charted on the daily weather map, as is done already in England and France.

I may well refer here, between the earliest indications of a cyclone's approach and its actual arrival, to certain statements that I made in an article on Tropical Cyclones that appeared in this magazine last June (republished in the *Revista General de Marina*, Madrid, and the *Nautical Magazine*, London), based principally upon the long experience of Padre Viñes, of Havana. These considerations do not appear in Abercromby's paper, although, in my opinion, they might well do so. First, as to the size and character of the approaching storm: "Soon the beautiful feathery cirrus clouds appear: if somewhat faint and opalescent in tint, fading gradually behind a slowly thickening haze or veil, the approaching storm is an old one, of large area; it is coming, perchance, from the Cape Verde Islands, and has crossed the entire ocean on its westward journey. If the cirrus plumes are of snowy whiteness, projected against a clear blue sky, it is a young cyclone just growing into its full strength and fury,—an overgrown tornado." Also the following, as a guide to the character or severity of the storm,—whether or no it has reached the stage when it fully deserves the name of a hurricane: "I have already referred to the marked character of the atmospheric circulation that is specially indicative of a tropical cyclone, and this is one of the most important things to look out for. The whole thing may be very easily appreciated by