
OBSERVATIONS

IN RELATION TO

CYCLONES OF THE WESTERN PACIFIC:

EMBRACED IN A

COMMUNICATION TO COMMODORE PERRY,

BY

WILLIAM C. REDFIELD.

INTRODUCTORY NOTE.

The following paper, prepared by the lamented William C. Redfield expressly for this report, may be looked upon as the very last offering to practical science of that eminent man, it having been finished but a few days prior to the illness which terminated his life.

It was my good fortune to enjoy for many years the friendly acquaintance of one, as remarkable for modesty and unassuming pretensions, as for laborious observation and inquiry after knowledge.

To him, and to General Reid, of the Royal Engineers of England, are navigators mainly indebted for the discovery of a law which has already contributed, and will continue to contribute, greatly to the safety of vessels traversing the ocean.

It is true, that subsequent writers, Piddington, Thom, Fryers, Sedgewick and Bosquett, as mentioned in the 1st volume of this work, have furnished additional information upon the subject, but to Redfield and Reid should be ascribed the credit of the original discovery of this undeniable law of nature, and its application to useful purposes; and there can be nothing more beautiful, as illustrative of the characters of these two men, than the fact, well known to myself, that, notwithstanding their simultaneous observations and discoveries in distant parts of the world, neither claimed the slightest merit over the other, but each strove to give to his co-worker in research the meed of superior success in the great object of their joint labors; and thus, without ever meeting, a strong friendship was formed between them, growing out of congenial aspirations for honorable fame, and mutual admiration of the generous and enlightened views exhibited by each other; and this enobling feeling was kept alive to the last by friendly correspondence.*

I recollect, when sent abroad by the government, in 1838, to visit the dock-yards and light-houses of England and France, I was favored with a letter of introduction from Mr. Redfield to his friend, then Colonel Reid,† and I could well judge, by the many attentions and valuable services rendered to me by that distinguished officer, and his verbal enquiries, how highly he valued the recommendation of a man whom he had never seen.

M. C. PERRY.

* The last letters of General Reid arrived too late to be opened and read by the deceased.

† Now General Reid, and Governor of Malta.

OBSERVATIONS

IN RELATION TO

THE CYCLONES OF THE WESTERN PACIFIC.

BY WILLIAM C. REDFIELD.

NEW YORK, *December 26, 1856.*

DEAR SIR: The return to the United States of the naval expedition placed under your command by our government, for special service in the Asiatic seas, has furnished much valuable information on various subjects of general interest and importance. Of these beneficial contributions, the numerous geographical and hydrographical examinations made by the officers of the squadron, and the observations made and collected in relation to the tempestuous cyclones of the Western Pacific, cannot fail to promote the interests of navigation and commerce. The latter portion of these materials, together with such other notices of the gales and typhoons of the China Sea and the North Pacific Ocean as are now at hand, constitute the subject of this communication.

Cyclone of July, 1853.—The steamships *Susquehanna* and *Mississippi* left the bay of Yedo, in Japan, on the 17th of July, 1853, steering a southwesterly course, with the barometer at 30 inches, which is quite above the mean height of this instrument in the summer season on that coast, and was caused, apparently, by the exterior atmospheric wave of the approaching cyclone. On the 18th, the barometer commenced falling, with the wind at E.S.E., and was accompanied on the 19th by a heavy swell from the southeast quarter, in latitude $31^{\circ} 14' N.$, longitude $135^{\circ} 03' E.$; the center-path of the cyclone, thus approached by the ships, being at the distance of about five hundred and fifty miles, as now estimated. On the 20th, the cyclonic wind had veered to the east, increasing in force, and with "very heavy sea." At 6 P. M., the barometer had fallen to 29.36; below which it did not subside. The *Mississippi*, after lying twenty-four hours with head to S.E., with no indications of a favorable change, was placed with her head to N.E., when the rise of the barometer was very apparent, as appears by the master's report. The *Susquehanna's* barometer, at 9 A. M. of the 21st, stood at 29.36; and from this time it continued to rise slowly, and the strength of the gale was found to abate. On the 24th, the *Mississippi* was in latitude $26^{\circ} 25'$, longitude $128^{\circ} 10' E.$, near to Lew Chew, with barometer at 29.60, and the cyclonic wind had veered to E.S.E. On the 26th, at Lew Chew, the wind had veered round to the southward, and the barometer rose to 29.74; and on the 27th and 28th, attained 29.80, the usual height for July in that region.

From the known law which governs the cyclones in the northern hemisphere it results that these observations, as made by a single ship, are quite sufficient to show that this gale was a great cyclone, and was moving in the direction which is common in the lower latitudes; that it

was of great superficial extent; and that the position of these ships was far to the right of the path pursued by the axis of the gale. It is equally apparent that it belonged to a class of gales which are distinguished by the sluggish rate of their geographical progression. All this was manifested by the persistence of the easterly winds; by the slow and graduated effect of their cyclonic action, as seen in the fall and subsequent rise of the barometer; and by the gradual veering of the winds towards the south, as the cyclone passed off. It has sometimes happened that a ship placed in a similar position in a cyclone, has run in nearly a direct course parallel to its path, for several days, without any considerable change in the direction of the storm wind. Hence it has been inferred, erroneously, that the gale was not a cyclone. A better knowledge of the cyclones will enable the mariner to avoid this error.

But we have further knowledge of the great extent and slow progression of this storm, obtained from direct observations in the adjacent parts of the Pacific ocean. The *Saratoga*, which left Yedo bay with the steamships, bound for Shanghai, on a track more northerly than was pursued by the steamships, encountered in like manner the heavy sea and strong winds from the eastward; and on the 21st was hove to, in latitude $29^{\circ} 1'$, longitude $129^{\circ} 37'$; and likewise on the 23d and 24th, near latitude $30^{\circ} N.$, longitude $124^{\circ} E.$, and was off Saddle island, near the mouth of the Yang-tsz river, from 27th to 30th, having then southeasterly winds, with squalls and continued bad weather. The barometer reached its lowest point, 29.60, at noon of 24th, in latitude $29^{\circ} 28'$, longitude $128^{\circ} 17'$, with the wind at E.N.E., and afterwards veering to S.S.E., as with the steamships. We have no observations made nearer to the right border of the cyclone.

Next in order of the gale's progression, we have the observations found in the master's report of the United States store-ship *Supply*, then lying at Napha, Lew Chew islands, latitude $26^{\circ} 12' N.$, longitude $127^{\circ} 43' E.$, a position much nearer to the center-path of the cyclone. His tables show the maximum of the anterior barometric wave to have reached Napha as early as noon of the 12th, when the barometer stood at 30.02 inches; from which time to the night of the 17th, it slowly subsided to 29.84, with winds from the eastern board. On the 18th the wind had become strong, with an increasing fall in the barometer. On the 19th and 20th the gale blew from the northeast quarter, with increasing violence; and in its greatest force from the northward on the 21st. At 3 A. M. of this day the barometer had subsided to 28.88; and to 28.82 at noon, with a slight reaction at evening. At 3 P. M. of 22d it had settled to 28.74, its lowest point, from which it had only risen to 28.83 at midnight, with improving weather. On the 23d and 24th the wind veered through east to southeast, and the barometer rose more rapidly. It reached 29.80, the July mean of the region, on the 20th, when the wind had veered to south, with no further traces of the departing cyclone. The fall and rise of the barometer at Napha, as also with the other vessels, was not entirely gradual, but with very moderate fluctuations of some hours continuance, as is more or less common under other wide-spread cyclones. The gale, though of much violence at Napha, was not of the greatest intensity of hurricanes. It was observed by the officers "that even when the wind was piping loudest—when the water was whirled violently by in perfect sheets—the scud moved overhead at a remarkably slow rate, and the upper layer of clouds seemed scarcely to be stirred at all;" thus showing the very limited elevation of the superior surface of the cyclone. Its axial center, when near these islands, probably bore south from Napha near noon of 22d, at a distance which I now estimate at about eighty miles.

In further tracing its approach to the western limits of the Pacific, we have the log-book of

the United States store-ship *Caprice*, Lieutenant Wm. L. Maury, bound from Shanghai to Lew Chew. At 8 A. M., July 17, the *Caprice* left the mouth of Woo-sung river, and stood down the Yang-tsz river. Barometer at noon 29.71 inches, its maximum for this period. Anchored during the night, with a heavy ground swell from S.E. July 18th, barometer at noon 29.67. P. M., working out of the river with wind at S.E.; barometer at midnight 29.62; force of wind 2; and a heavy swell from S.E.

July 20.—Pleasant, and wind veers from E.S.E. to N.E. by E. with gradually increasing strength, 3 to 4; with very heavy swell from S.E. to E.S.E. Latitude at noon, $31^{\circ} 33' N.$, longitude $123^{\circ} 18' E.$; in 18 fathoms water. Weather still pleasant, with good breezes. At 6 P. M., barometer 29.42; took in sail and prepared for a gale; barometer rising to 29.50.

July 21.—Commences pleasant, with fresh breezes from N.E. by E., increasing, and heavy sea from E. At 10 A. M., gale at N.E. by N., force 7; barometer 29.40. Noon, latitude $29^{\circ} 30' N.$, longitude $124^{\circ} 42' E.$ 5 P. M., gale N.E.; barometer 29.35; at midnight 29.34.

July 22.—Gale N.E.; heavy sea from E. and N.E.; 3 A. M., barometer 29.27; 5 A. M., N.E. by E., increasing; 9 A. M., force 9; barometer 29.27; sea running from N.E., and rapid gale scud flying over. Noon, latitude D. R. $28^{\circ} 46'$; longitude, chron., $124^{\circ} 49'$. 1 P. M., gale E.N.E., force 10; 3 P. M., barometer 29.25'; squalls and rain. At 7 P. M., gale E. by N., 10; ship was hove-to; strong gales and high sea; rapid scud flying overhead.

July 23.—Lying-to throughout; a high and regular sea from E.N.E., with rapid scuds flying. 3 A. M., barometer 29.22; 9 A. M., gale east, 10; barometer 29.25. Noon, latitude D. R. $28^{\circ} 30' N.$, longitude, chro., $124^{\circ} 26' E.$; 3 P. M., barometer 29.23; 5 P. M., gale E. $\frac{1}{2}$ S., force 11; 9 P. M., gale E. by S.; barometer 29.23; spoon drift flying over the ship.

July 24.—Lying-to throughout; gale E. by S., force 10; high scud flying to westward with great rapidity. 3 A. M., barometer 29.22; 7 A. M., 29.20; 9 A. M., gale E.S.E.; barometer 29.18. Noon, latitude D. R. $28^{\circ} 26' N.$, longitude, chro. $124^{\circ} 47' E.$; 1 P. M., gale S.E. by 10 E., force 11, with heavy squalls of wind and rain, with irregular sea; 3 P. M., barometer at its minimum, 29.16; heavy cross sea, and spoon-drift flying over the vessel; sky overcast with clouds, passing over slowly to the westward; 5 P. M., barometer 29.18, clouds sluggish; 7 P. M., gale S.E., less severe; barometer 29.24; 11 P. M., barometer 29.27; clouds occasionally breaking, and passing to N.W.

July 25.—3 A. M., gale S.E. by S, force 8; barometer 29.25; squally, with light rain. 5 A. M., force 7; barometer 29.28. 9 A. M., gale increasing; rainy and squalls; barometer 29.32; sea moderating. 11 P. M., gale 8; barometer 29.34. Noon, latitude D. R. $28^{\circ} 51'$, longitude D. R. $124^{\circ} 03'$; gale S. E. 8. 3 P. M., gale S.S.E. 7, with cross sea; barometer 29.37. 9 P. M., gale S.S.E. 6; sky brightening to northward and patches of blue sky to S.E., and overhead.

July 26.—Wind strong at S. E. by S., force 6; barometer 29.50; scud passing to northward; sea from S.S.E. 9 A. M., a heavy and cross sea rising; barometer 29.52. Noon, latitude $29^{\circ} 31'$, longitude $125^{\circ} 16'$; in 40 fathoms water. P. M., wind and sea increasing, with heavy squalls; clouds [scud?] passing rapidly to N.W. At 5 P. M., gale still S.E. by S, force 8; barometer 29.49. Ends moderating, (7); barometer 29.51.

July 27.—At 5 A. M., gale S.E., 7; barometer 29.52; squalls increasing. 8 A. M., gale S.E. $\frac{1}{2}$ E., 8; scud low and thin, passing to northward; sea from southward, increasing. Noon, latitude D. R. $28^{\circ} 55'$, longitude D. R. $124^{\circ} 16'$; barometer 29.53; heavy squalls and rain; nimbus clouds passing to N.N.W. At 7 P. M., wind S.S.E. (6); barometer 29.55.

July 28.—1 A. M., strong winds (6) from S.S.E.; barometer 29.54; sea moderating. At 7

A. M., increasing to gale (7) from S.E. by E. ; barometer 29.56 ; noon same, with high, irregular sea ; barometer 29.58 ; latitude 29° , longitude $124^{\circ} 37'$; P. M., wind S.E. by S. (6) ; barometer 29.56—29.58. Ends with strong winds from S.E. and squalls.

July 29.—7 A. M., gale S.E. (7) ; barometer 29.55 ; low scuds flying to northward ; high and irregular sea from S.S.W. Noon, latitude D. R. $28^{\circ} 09'$, longitude D. R. $123^{\circ} 22'$; in 45 fathoms water ; barometer 29.56 ; gale S.E. by S. (7) ; scud flying to northward. At 3 P. M., gale S.S.E. (7) ; barometer 29.52. 6 P. M., strong gale (9) and squally, with rain and heavy sea. At 11 P. M., gale moderated to 5 ; barometer 29.58.

July 30.—Clouds breaking, clear to E. and S.E. ; strong breezes S.S.E. to S.E. ; clouds cumulo-stratus and nimbus, passing to N.N.W. At noon in 43 fathoms ; latitude 29° N., longitude $124^{\circ} 30'$ E. ; heavy sea from S.E., and swell from S.S.W. ; barometer 29.55 to 29.61.

July 31.—Strong breezes (6) from southward ; heavy swell from S.S.W. At noon under double-reefed topsail and foresail ; latitude D. R. $28^{\circ} 19'$, longitude $124^{\circ} 17'$; barometer ranging between 29.57 and 29.63.

August 1.—Fresh breezes, force 5, moderating to 4 ; heavy swell from S.S.W. Noon, latitude $28^{\circ} 35'$, longitude $125^{\circ} 09'$, in 50 fathoms. Barometer rises from 29.62 at 1 A. M. to 29.69 at midnight, or nearly to the same point as at the commencement of this very extended period of cyclonic action.

The phenomenon thus presented may be regarded as of much scientific and practical interest. It does not appear that the *Caprice* was at any time nearer to the axis of the cyclone than about one hundred and fifty miles. The greatly prolonged influence of the cyclone upon her barometer was nearly equable ; its movement being unusually steady during its successive gradations. The entire range of the barometer during a period of seventy-two hours, from 3 A. M. of the 22d to same hour of 25th, was scarcely more than one-tenth of an inch, or between 29.27 and 29.16 inches. The lowest depression occurred about 1 P. M. of the 24th, and probably indicated the nearest approach of the cyclonic axis, as it passed the ship. Its nearest approach to the *Supply*, at *Lew Chew*, appears to have been about 3 P. M. of the 22d, which is earlier by seventy hours. Hence, the rate of the advance of the cyclone, in this period, for the distance of little more than two hundred nautical miles, appears to be *only three nautical miles per hour*.

The earlier progress of this storm may have been at a faster rate, as has been shown in other cyclones, while moving westward toward the places of their northwardly recurvation. The minimum of the barometer, when properly observed, is believed to furnish more exact evidence of the actual progress of the storm than is afforded by the specific direction and changes of the winds, particularly in a wide spread cyclone.

The entire absence of any winds other than from the eastern board, with the several ships, would perhaps lead many navigators and meteorologists to infer that this gale was not a cyclone, but a direct wind, moving in the manner of a great current ; and such inference might seem confirmed, on finding that these conditions must have extended over a breadth of track equal to about ten degrees of latitude. Yet, we might well inquire whether any gales, *other than cyclones*, are ever found to blow with great strength on the broad ocean. But the characteristic movements of the barometer and the coincident changes in the direction and strength of the winds, as also the advanced action and the subsequent changes in the direction of the heavy swell, which often ran in a course different from the winds, as blowing at the several ships, are quite sufficient to establish the cyclonic character of this extensive and slowly advancing gale. Moreover, the direction and strength of the winds with the steamships on the 20th and 21st, was

such that, according to the above inference, the same should have reached the Caprice, and the coast of China, in about eight hours; and yet some fifty or sixty hours are found to have elapsed before this geographical translation had fully taken place.

Although the cyclonic character of this gale is thus fully established, we have still another important series of observations, obtained by the officers of the squadrom from the British schooner *Eament*, procured from the log-book by Lieut. Wm. L. Maury, which show us a portion of the northerly winds of the cyclone as *veering by the west* to southwest and south, in the *inner portion of its left hand quadrants*. The following is the abridged log, with the old system of nautical dates reduced to civil time:

The schooner *Eament*, H. D. Brown, commander, from Hong Kong towards Woo-sung, was standing through the Formosa channel, and on the afternoon of July 21, had moderate breezes from the northern quarter, with fine weather.

July 22 begins with light breezes from N.N.W. and fine; heading N.E. by N.; steady breeze and cloudy; 11 A. M., in all studding sails, and braced sharp up. At noon, latitude D. R. $25^{\circ} 30' N.$, longitude by chronometer $120^{\circ} 46' E.$; barometer 29.40. P. M., moderate breeze from N.N.W., and heavy sea from N.E. Midnight, pitching very heavily, and gale increasing; double reefed the foresail; barometer 29.39. [Off the north end of Formosa, heading up north-eastward, and approaching the center path of the storm.]

July 23.—1 A. M., gale still N.N.W.; split inner jib; vessel's course falling off from N.E. to E.N.E., and gale increasing; 10 A. M., Agincourt island bearing S.S.W., distant five miles. Noon, barometer 29.20; strong gale from N.N.E.; 4 P. M., gale increasing, close reefed foresail and mainsail; aneroid falling rapidly. Midnight, strong gale and heavy rain; aneroid 28.50; vessel pitching heavily. [Between Formosa and the Madjico-sima group.]

July 24.—1 A. M., blowing a hurricane from N.N.E., with high sea; at 11 A. M., split the foresail. At noon gale less violent; weather looking very unsettled; 1 P. M., wind W.N.W., and moderate, with dirty looking weather and high sea; aneroid 28.30, and still falling; at 3 P. M., calm! [Vessel on southern edge of the axial area of the cyclone.] At 3.30 P. M. wind increasing, and bearing to S.W.; vessel labors heavily; 5 P. M., gale S.S.W.; 5.30, blowing a hurricane; split fore trysail; 6 P. M., hurricane from south, increasing; scudding under bare poles; very heavy seas; aneroid 28.14. [Vessel behind the storm's centre, and running across the rear of the vortex.] At 7 P. M., gale S.S.E.; 8 P. M., hove-to under bare poles; gale S.E. At 10 P. M., less wind, with heavy rain; set fore staysail and the close reefed fore and mainsails; midnight, strong gale.

July 25.—4 A. M., less wind; aneroid rising; 8 A. M., strong wind and high sea; 9.30, shipped a heavy sea; split foresail; vessel heading N.E. at noon, with strong gale and heavy sea; aneroid 28.00 [?] and [barometer?] 29.51; P. M., gale strong from S.E., and thick weather; vessel running N.E.; rolling and pitching heavily; 6 P. M., strong breezes and thick weather; aneroid 29.40; midnight, same winds and weather.

July 26.—At 4 A. M., less wind; set foresail, close reefed; 8 A. M., set squaresail; course N.; rolling heavily. Noon, strong breezes, with heavy sea; aneroid 29.52; P. M., fresh gale from S.E., and heavy sea; 7 P. M., strong winds and dirty weather; double reefed the foresail; midnight, less wind.

July 27.—4 A. M., fresh breezes and squally; course W.N.W. At 9.30 A. M., saw Video, bearing W.N.W. $\frac{1}{2} N.$, distant 8 miles. [Position of this island, latitude $30^{\circ} 07'$, longitude $122^{\circ} 46' E.$] At noon, aneroid 29.63.

It is here seen that in the Formosa channel the cyclonic wind had set in on the 21st, settling to N.N.W. at midnight, at the distance perhaps of 90 miles *to the left* of the line on which the axis of the storm was approaching; but pushing northeastward, in order to clear Formosa and the small islands, the vessel was steered almost directly for the approaching vortex, and thus changed her wind from N.N.W. to N.N.E., the proper anterior wind on the path of the gale's axis. When this axis had passed the vessel, she was then enabled to run on her desired course, before the southwesterly and southerly winds, thus crossing the axis path into the second right hand quadrant of the gale, and thus bringing the wind to the southeast quarter.

The axis path of the gale, as indicated by the foregoing reports, is found on the annexed storm chart for the north Pacific ocean, marked (A).

To what limits this cyclone might be traced on the left or southerly side of its path we are unable to determine. In regard to the entire breadth of its path, it appears by the report of sailingmaster Conover, "that on 26th and 27th of July, it blew most terribly upon the coast from Hong Kong to Shanghai; scattering and wrecking the unwieldy Chinese junks, and sending many a poor fisherman to his long home." Its further course over the great alluvial plain of China and the adjacent waters of the Yellow Sea, and the subsequent recurvation of its path to the northward and eastward, are not likely to be determined by direct observations.

The phenomena of this great cyclone are fruitful of instruction, both to mariners and meteorologists, and present many points of practical interest, which cannot be dwelt upon in the limits of this communication. It may be noticed, however, without regard to the slow rate of progression, that the phases of the barometer and winds which were presented in the extensive region on the right side of the axis path, are in perfect accordance with those which are found in the right hand quadrants of the great cyclones which so often sweep over the United States and the north Atlantic ocean, in pursuing their northeasterly course. Thus, as we have already seen, during the W.N.W. progression in the lower latitudes, the true winds of the cyclone, in its two right hand quadrants are chiefly from the *eastern* board, and veering *to the right* towards the south in the progress of the storm; and on reaching the higher latitudes, in consequence of the inversion in the course of progression, the winds of these two right hand quadrants come mostly from the *western* board, and are still found veering *towards the right*, by west towards the north, as the cyclone moves onward over the places of observation. Such cases are constantly presented during the greater part of the year; and our navigators in crossing the Atlantic have great experience of the truth of this position.

CYCLONES AND MONSOONS.

It is doubtless important that the nautical reports which we have already noticed should become available for the better guidance and security of oceanic commerce. For it often happens that seamen are too slow in recognizing the cyclonic character and conditions of the gales which they encounter, and many disasters have resulted from this neglect.

In the Asiatic seas, as elsewhere, the judgment of the navigator is often misguided by the loose and inaccurate statements which are found in various authorities. Thus, it is said that gales or hurricanes rarely occur in these seas, except at the equinoxes, or at the changes of the monsoons. These assumed axioms are greatly erroneous, as the inspection of the storm charts may suffice to show.

The actual relations of the cyclones to the monsoons and local winds of the Asiatic seas are of much interest, and merit a careful examination. It is quite remarkable that these monsoons

should be found to have little, if any, control or influence as regards the regular courses and developments of the cyclones. This may show the predominancy of cosmical laws and influences over the apparently opposing conditions which are so extensively presented by these alternating winds.

The extent of the westerly monsoons, parallel to and on both sides of the equator, appears to be far greater than has been recognized by most writers. In the northern hemisphere these counter winds of the true trades extend from the east coast of Africa, near longitude 45° E., to at least longitude 175° E., in the central Pacific. The proper trade wind appears to consist of a comparatively thin stratum of aerial current moving upon the ocean surface, and is distinguished by its inclination towards the equator. On this stratum there is ordinarily imposed another current, probably of greater depth and volume, into which the trade wind ultimately merges, and which also moves westward while in the trade-wind latitudes, but generally inclines from the equator, as is shown by the rain clouds and squalls which it carries, and by the direction of translation imparted to the cyclones which it embodies. This important wind-current, so little recognized by most writers, frequently alternates with, or displaces, the true trades; and still more frequently it replaces the westerly monsoon, as a surface wind, to the east of Sumatra. Thus, the "southwest monsoon" of the China sea and the western Pacific, and which extends to the shores of Japan, is very commonly displaced from the surface by the main current of southeasterly wind, especially to the eastward of Sumatra. Thus, the "southwest monsoon" of the China sea and the western Pacific, and which extends to the shores of Japan, is very often displaced from the surface by the subsidence of the main current of southeasterly wind, more especially in the regions near the Asiatic coast.

UNIVERSALITY OF THE LAW OF STORMS.

The law of rotation and progression in storms, as developed on the Atlantic ocean, which was substantially discovered by the present writer in September of the year 1821, is essentially cosmical or world-wide in its origin and application. This soon became apparent in examining the accounts of gales which are found in the voyages of Cook, Vancouver, and others, in the several oceans and climatory zones of our globe. Hence, the polar relations of the phenomena presented are necessarily changed in the southern hemisphere, where, in all our relative comparisons, south must be substituted for north; east and west remaining the same.

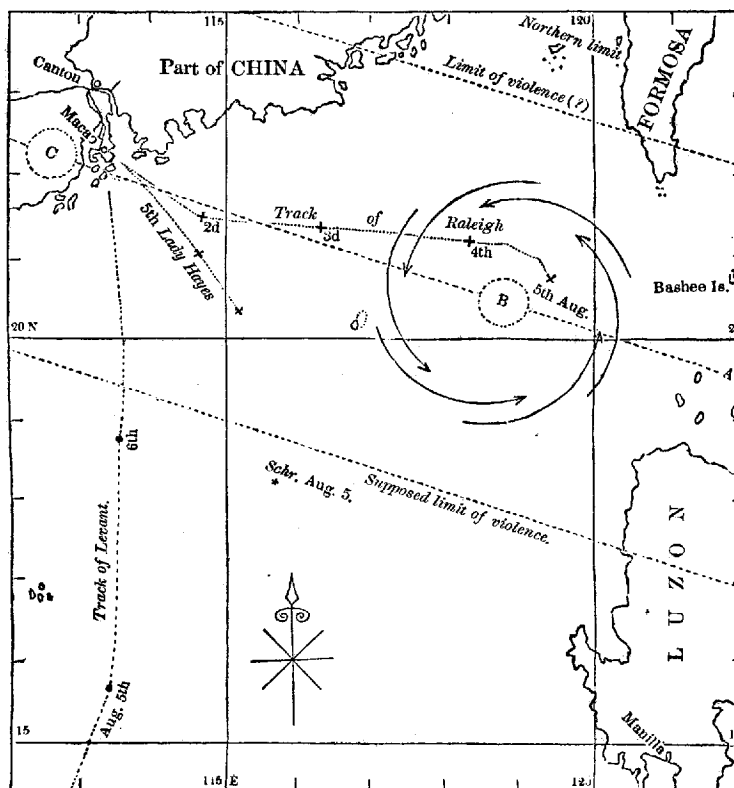
This similarity of polar relations in the winds of the two hemispheres, and the corresponding influence on the barometer, which are shown by the opposite cyclonic changes of these winds, are virtually recognized in P. P. King's account of his surveying expedition in the southern hemisphere about the year 1826, as is seen in his sailing directions. The more complete and satisfactory evidence of this cosmical system, or law, of cyclonic action, which is derived from a series of extended geographical observations in the paths of storms in the southern hemisphere, has since been furnished in the several works of Reid, Thom, and Piddington. The latter author has also investigated many storms of the sea of Bengal and the Indian ocean, and has noticed various gales, or typhoons, of the China sea. Some of the following notices may serve to increase our knowledge of Asiatic storms, and those of the Pacific ocean, north of the equator:

CYCLONES OF THE CHINA SEA.

A cyclone of moderate intensity was experienced by the *Mississippi*, then flag-ship of the expedition, from the 2d to the 4th of August, 1854, in the harbor of Cum-sing-moon, near

Macao. The wind was from N.E., veering through E. to S.E., S., and S.S.W. Barometer at lowest, 29.26 inches, on the 3d. These phases of the wind show the ship to have been under the two right-hand quadrants of the cyclone.

I have placed on the chart the track of a cyclone encountered by the American ship Panama in the China sea in October, 1831, which storm had previously passed over the Philippine Islands, and was very destructive at Manila. Also, the track of the cyclone of her Majesty's ship Raleigh, encountered near the Bashee Islands in August, 1835, and which afterwards visited Macao and Canton with great violence. A sketch showing its path of progression on the 5th and 6th of August is here subjoined.



It appears from the ship's log-book, as published by Colonel Reid, that the Raleigh sailed from Macao Roads on the 1st of August, on the track shown in our sketch, which had been prepared before the publication of his work. On the 4th the ship met with northeasterly and northerly winds, accompanying a fall of the barometer, and which increased to a heavy typhoon from N.N.E., veering to N.E. and E.N.E. Barometer at 8 A. M., 29.60; noon, 29.45; 8 P. M., 29.36; and midnight, 29.04, with typhoon increasing. August 5, at 3 A. M., the typhoon had veered to E.S.E., still increasing in violence; barometer 28.50, and falling. At 5 A. M., typhoon blowing from S.E. At 6.30, barometer falling from 28.30 to 28.20; commenced throwing the guns and shot overboard. At 8 A. M., still increasing. At 9.30 A. M. the ship went over. At 9.30 the masts and bowsprit went by the board and the ship righted, with four feet water in the hold; latitude $20^{\circ} 44'$, longitude $119^{\circ} 18' E$.

It will be seen by the veering of the wind that the Raleigh was on the right side, which is here the northerly side, of the center-path of the cyclone, and was very near to the vortex of the gale when it passed the ship, as is shown by the great fall of the barometer and the intensity

of the storm at that period. At 1 P. M. of the 5th the typhoon was blowing from S.S.E., and had moderated a little. From 6 to 7 P. M., more moderate; but strong gusts of wind, with a heavy sea, from the southward.

At Macao the typhoon was experienced in great force eighteen to twenty hours *later* than with the Raleigh. Of a valuable series of observations, thirty-four in number, which were taken of the barometer at Macao during the passage of the cyclone, the lowest was 28.08 inches, at 1.20 A. M. of the 6th of August. This great depression shows the centre, or vortex, of the cyclone to have passed near to Macao.

At Canton, on the right of the center-path, and about sixty miles north of Macao, the gale began with northerly winds on the evening of the 5th, and continued through the night and the next day. Its violence is said to have been greatest about 2 A. M. of the 6th. At midnight of the 5th the barometer had fallen to 29.37 inches. Its further fall, later in the night, was unnoticed; but at 5 A. M. it had again risen to 29.34 inches, which, respectively, is 0.23 inches and 0.32 inches higher than the two corresponding observations at Macao. The wind, during the typhoon, veered from N., through N.E., to S.E., and at 8 A. M. of the 7th the barometer had risen to 29.94 inches.

The American ship *Lady Hayes* left Macao Roads before the gale set in, and first encountered it about thirty-five miles from land, being on the *left* side of the line pursued by the storm's center. An attempt was made to return to port; which having failed, the ship, from noon of the 5th, was run off S.E. by E. under all the sail she would bear, and thus was meeting the gale in its approach, the wind then blowing at north, with a tremendous swell from the eastward. At 4 P. M. it was blowing in severe gusts, and the ship was becoming unmanageable. About 8.30 P. M. the wind began to veer to the west, but continued to blow as hard as ever till midnight, and drew round to the south, when it moderated a little. It continued to blow hard from that quarter until noon of the 6th. Had the wind veered eastward, as with the Raleigh and at Canton, it is likely the ship would have been driven ashore among the islands.

A three-masted schooner encountered the gale on the 5th of August in latitude $18^{\circ} 2' N.$, longitude $115^{\circ} 50' E.$, but no particulars are given.

Captain Dumaresq, of the American ship *Levant*, arrived at Lintin on the 7th, having made a fine run from the southward under the later and more outward winds of the cyclone, which had veered from S.W. by W. on the 5th to S.S.W. and S. on the 6th, with strong breezes, heavy squalls, and rain—ending in fine weather. At 11 A. M. of 6th had heavy squalls, with rain in torrents. Took in all studding sails, royals, and topgallant sails, and double-reefed the topsails, partly from an apprehension of falling too near the land the following night. The track of the *Levant* is seen on the sketch, as obtained from the ship's log-book and the private journal of Captain Dumaresq, which he has kindly placed in my hands.

From the data to which I have now alluded, the course of this storm appears to have been $N. 72^{\circ} W.$, and its rate of progress is estimated at about seventeen nautical miles per hour. It is fully apparent that its axis of rotation passed to the northward of the *Lady Hayes*, and southward of the Raleigh and of Canton, and the anchorages near Macao, and nearly on the line A B C, as designated on the sketch.

If circles, having a radius equal to about one hundred and sixty nautical miles, be drawn around the two points B and C, these will severally comprise the areas of principal violence in this hurricane at the two periods of 9 A. M. of the 5th and 2 A. M. of the 6th of August, respec-

tively. But the more moderate forces of the cyclone must have extended very far beyond these approximate limits.

A more extended notice of this storm may be found in my communications to the American Journal of Science, and the London Nautical Magazine, published in January, 1839, in which I have also comprised accounts of various other cyclones of great violence which have passed over the China sea, and the regions near Canton and Formosa, in different years. The tracts of some of these are well illustrated by the typhoon of the Raleigh. I omit, therefore, the close grouping which their delineation would require on the chart.

On the southern coast of China the semi-annual changes of the monsoons are found to occur in April, and about the end of September, varying somewhat in different years. Typhoons often cross the China sea, more commonly from May to October, on routes corresponding in direction to those of the hurricanes of the West Indies and the lower latitudes of the Atlantic, and with like characteristics. That inquiring old voyager, Dampier, states that on the coast of Tonquin the typhoons are expected in the months of July, August, and September. It will be noticed that these are also deemed to be hurricane months in the lower latitudes of the Atlantic, east of Yucatan, and that no special connexion with the periods of change in the monsoons is indicated. Dampier says that in these typhoons "the wind comes on fierce, and blows very violent at N.E. twelve hours, more or less. When the wind begins to abate, it dies away suddenly, and falling flat calm, it continues so an hour, more or less, when the wind comes about to the S.W., and it blows and rains as fierce from thence as it did before from the N.E., and as long." A better description of the phenomena of a violent cyclone, on its centre path in the lower latitudes, and before its recurvation, could hardly be given.

CYCLONE OF THE ANNIE BUCKMAN, IN FEBRUARY, 1853.

Among the valuable collections of the Expedition is an extract from the log of the American barque Annie Buckman, Henry Barber, commander, and furnished by him to Lieutenant William L. Maury. It will aid in dispelling the error that typhoons and hurricanes are only periodical in their occurrence in the torrid zone.

At noon of February 3, 1853, the Annie Buckman, sailing for Canton, was in latitude $12^{\circ} 30' N.$, longitude $129^{\circ} 16' E.$, several degrees east of the Philippine islands, with the barometer at 29.75, and a double-reefed topsail breeze from the N.E. quarter. In the period between this date and the 9th the vessel was subject to a very violent typhoon, during which both the direction of the wind and the course of the vessel went round the compass, by the north, west, and south, to the N.E. quarter on the 9th. At noon of this day the barque was in latitude $18^{\circ} 09' N.$, longitude $127^{\circ} 25' E.$, barometer 29.80. Of the few entries given of the barometer the lowest was 29.25, at 4 p. m. of February 7th; wind then from the westward, and increasing soon after to its greatest violence.

Captain Barber states that in twenty years navigation, in all oceans, he had not encountered a hurricane so violent. Its path is indicated on the chart.

Bonin Islands.—These islands, according to Commander Hammet, of H. M. ship *Serpent*, are subject to typhoons, but he states they are not frequent.

In October, 1853, the United States ship *Plymouth*, belonging to the Japan Expedition, was lying in Lloyd's Harbor, where on the 25th she encountered a typhoon, in which an officer and a boat's crew, then absent from the ship, were lost. According to the report of the acting master to Commodore Perry, it commenced with squalls of wind from E.S.E., under which the

