THE DAMLY EVENING TRUNCHAPH ... PHILADELPHIA, TUPEDAY, DECEMBER 31, 1867.

TORNADOES.

BY RICHARD A. PROCTOR, B. A., F.R.A.S., AUTHOR OF "BATURN AND ITS SYSTEM," STC.

The inhabitants of the earth are subjected to agencies which-beneficial, doubtless, in the long run, perhaps necessary to the very emistence of terrestrial races-appear, at first sight, energetically destructive. Such are-in order of destructiveness-the hurricane, the earthquake, the volcano, and the thunderstorm. When we read of earthquakes, such as those which overthrew Lisbon, Callao, and Riobamba, and learn that one hundred thousand persons fell victims in the great Sicilian earthquake in 1663, and probably three hundred thousand in the two earthquakes which assailed Antioch in the years 526 and 612, we are disposed to assign at once to this devastating phenomenon the foremost place among the agents of destruction. But this judgment must be reversed when we consider that earthquakes-though so fearfully and suddenly destructive both to life and property,-yet secur but seldom compared with wind storms, while the effects of a real hurricane are gearcely less destructive than those of the sharpest shocks of earthquake. After ordi-mary storms, long miles of the sea-coast are strewn with the wreeks of many once gallant ships, and with the bodies of their hapless crews. In the spring of 1866 there might be seen at a single view from the heights near Plymouth twenty-two shipwrecked vessels, and this after a storm which, though severa was but trifling compared with the hurricanes which sweep over the torrid zones, and thence, scarcely diminished in force, far north sometimes as our own latitudes. It was in such a hurricane that the Royal Charter was wrecked, and hundreds of stout ships with her. In the great hurricane of 1780, which commenced at Barbadoes and swept across the whole breadth of the North Atlantic, fifty sail were driven ashore at the Bermudas, two line-of-battle ships went down at sea, and upwards of twenty thousand persons lost their lives on the land. So tremendous was the force of this hurricane (Captain Maury tells us) that "the bark was blown from the trees, and the fruits of the earth destroyed; the very bottom and depths of the sea were uprooted-forts and castles were washed away, and their great guns carried in the air like chaff; houses were razel, ships wrecked, and the bodies of men and beasts lifted up in the air and dashed to pieces in the storm"-on account, however, which (though doubtless faithfully rendered by Maury from the authorities he consulted) must perhaps be accepted cum grano, and especially in reference to the great guns carried in the air "like chaff."

In the gale of August, 1782, all the trophies of Lord Rodney's victory, except the "Ardent," were destroyed, two British ships-of-the-line foundered at sea, numbers of merchantmen nnder Admiral Graves' convoy were wrecked, and at sea alone three thousand lives were lost.

But, quite recently, a storm far more destructive than these swept over the Bay of Bengal. Most of our readers doubtless remember the great gale of October, 1864, in which all the ships in harbor at Calcutta were swept from their anchorage, and driven one upon another in inextricable confusion. Fearful as was the loss of life and property in Calcutta harbor, the destruction en land was reater. A vast wave swept for miles over the surrounding country, embankments were destroyed, and whole villages, with their iumoved through the air, whirled onwards like a cloud of feathers, and passing, disclosed a wide space filled with broken trees, naked stumps, and heaps of shapeless ruins, which marked the path of the tempest."

THE DAILY EVENING

If it appeared, on a careful comparison of observations made in different places, that these winds swept directly along those tracks which they appear to follow, a comparatively simple problem would be presented to the meteorologist. But this is not found to be the case. At one part of a hurricane's course the storm appears to be travelling with fearful fury along the true storm- ; at another less furiously directed across the storm-track; at another, but with yet diminished force, though still fiercely, in a direction exactly opposite to that of the storm-track.

All these motions appear to be fairly accounted for by the theory that the true path of the storm is a spiral-or rather, that while the centre of disturbance continually travels onwards in a widely extended curve, the storm-wind sweeps continually around the centre of disturbance, as a whirlpool around its vortex.

And here a remarkable circumstance attracts our notice, the consideration of which points to the mode in which cyclones may be con-ceived to be generated. It is found, by a careful study of different observations made upon the same storm, that cyclones in the northern hemisphere invariably sweep round the onward travelling vortex of disturbance in one direction and southern cyclones in the contrary direction. If we place a watch-face upwards upon one of the northern cyclone regions in a Mer-cator's chart, then the motion of the hands is contrary to the direction in which the cyclone whirls; when the watch is shifted to a southern cyclone region, the motion of the hands takes place in the same direction as the cyclone motion. This peculiarity is converted into the following rule-of thumb for sailors who encounter a cyclone, and seek to escape from the region of flercest storm :- Facing the wind, the centre or vortex of the storm lies to the right in the northern, to the left in the southern hemisphere. Safety lies in flying from the centre in every case save one-that is, when the sailor lies in the direct track of the advancing vortex. In this case, to fly from the centre would be to keep in the storm-track; the proper course for the sailor when thus situated is to steer for the calmer side of the storm track. This is always the outside of the C, as will appear from a moment's consideration of a spiral curve traced ont by a cy-clone—he will probably escape unscathed. There is, however, this danger, that the stormtrack may extend to or even slightly overlap the land, in which case scudding before the gale would bring the ship upon a lee shore. And in this way many gallant ships have, doubtless, suffered wreck.

The danger of the sailor is obviously greater, however, when he is overtaken by the storm on the inner side of the storm- -. Here he has to encounter the double force of the cyclonic whirl and of the advancing storm-system, instead of the difference of the two motions, as on the outer side of the storm-track. His chance of escape will depend on his distance from the central path of the cyclone. If near to this, it is equally dangerous for him to attempt to scud to the safer side of the track, or to beat against the wind by the shorter course, which would lead him ont of the storm- on its inner side. It has been shown by Colonel Sir W, Reid that this is the quarter in which vessels have been most frequently lost.

But even the danger of this most dangerous quarter admits of degrees. It is greatest to its sources, and piled up the wat where the storm is sweaping round the most height of thirty feet in the Gulf of M curved part of its track, which happens in about latitude twenty-five or thirty degrees. In this case, a ship may pass twice through the vortex of the storm. Here hurricanes have worked their most destructive effects. And thus it happens that sailors dread, most of all, the part of the Atlantic near Florida and the Bahamas, and the region of the Indian Ocean which lies south of Bourbon and Manritius.

the shores of Western Europe. In the Indian Ocean there is the "south-equ current," which sweeps past Mauriti Bourbon, and thence returns toward east. In the Chinese Sea there is the equatorial current, which sweeps roun East Indian Archipelago, and then a into the Japanese current. There is a current in the Bay of Bengal, flowing th the region in which, as we have seen, o are commonly met with. There are oth currents besides these, which yet br cyclones. But we may notice two peties in the currents we have named. flow from equatorial to temperate region secondly, they are all "horse-shoe curr So far as we are aware, there is but one current which presents both these per ties, namely, the great Australian co between New Zealand and the eastern of Australia. We have not yet met wit record of cyclones occuring over the Aus current, but heavy storms are known to in that region, and we believe that whe storms have been studied as closely storms in better known regions, they found to present the true cyclonic cha Now, if we inquire why an ocean of travelling from the equator should "storm-breeder," we shall find a ready a Such a current, carrying the warmth of tropical regions to the temperate zone duces, in the first place, by the mere diff of temperature, important atmospher turbances. The difference is so grea Franklin suggested the use of the ther ter in the North Atlantic Ocean as a means of determining the longitude, sin position of the Gulf Stream at any given almost constant.

But the warmth of the stream itself is only cause of atmospheric disturbance. the warm water vapor is continually and, as it rises, is continually condense the steam from a locomotive) by the air round. "An observer on the m says Captain Maury, "would, on a v day, be able to trace out by the mist air the path of the Gulf Stream throug sea."

But what must happen when vapor densed? We know that to turn wate vapor is a process requiring-that is, up-a large amount of heat; and, conv the return of vapor to the state of wat free an equivalent quantity of heat amount of heat thus set free over th Stream is thousands of times greater that which would be generated by the who supply annually raised in Great E Here, then, we have an efficient cause wildest hurricanes. For, along the w the Gulf Stream, from Bemini to the Banks, there is a channel of heated-t rarefied air. Into this channel denser atmosphere on both sides is co ally pouring, with greater or less strengt when a storm begins in the Atlantic, it makes for this channel, "and, reaching it. and follows it in its course, sometime tirely across the Atlantic." "The so points of America and Africa have w themselves," says Maury, "the name stormy capes,' but there is not a storn in the wide ocean can out-top that rages along the Atlantic coast of America. The China seas and the Pacific may vie in the fury of their gale this part of the Atlantic, but Cape Hor the Cape of Good Hope cannot equal certainly in frequency, nor, do I beli fury." We read of a West Indian st violent that "it forced the Gulf Stream The ship Ledbury Snow attempted to r storm. When it abated she found herself high up on the dry land, and discovered that

| Ocean there is the "south equatorial | FINANCIAL. | FINANCIAL. | SHIPPING |
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| "," which sweeps past Mauritius and n, and thence returns towards the | TREASURY DEPARTMENT | BANKING HOUSE | STEAM TO LIVERPOOL, CALLING |
| In the Chinese Sea there is the north | | | The Inman Line, sailing SEMI-W EERLY, carrying the United States Main, CITY OF LON DON Saturday, January 4 |
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| a Japanese current. There is also the in the Bay of Bengal, flowing through ion in which, as we have seen, cyclones | OP | JAYCOOKE & CO. | The Tomati Line, smiling SEMI-WEERLY, carrying the United Scient Maila, CITY OF 10N100N |
| monly met with. There are other sea- s besides these, which yet breed no | and the second discount of the second s | 02 and 114 So. THIRD ST. PHILAD'A. | First Ca bin 100 100 Steernge 100 London 100 Steernge 10 London 100 100 100 100 100 100 100 100 100 10 |
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| path of the Gulf Stream through the | | BOUGHT OR CASHED IN GOLD AT BEST . MARKET RATES, BY | nort on Naturday Taomars 4 |
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| air. Into this channel the atmosphere on both sides is continu- uring, with greater or less strength, and | | SMITH, RANDOLPH & CO., | THE PHILADELPHIA AND SOUTHERN MAIL STEAMSHIP COM |
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habitants, swept away. Fifty thousand souls, it is believed, perished in this fearful hurricane.

The gale which has just ravaged the Gulf of Mexico adds another to the long list of disastrous hurricanes. As we write, the effects produced by this tornado are beginning to be made known. Already its destructiveness has become but too certainly evidenced.

The laws which appear to regulate the generation and the progress of cyclonic storms are well worthy of careful study.

The regions chiefly infested by hurricanes are the West Indies, the southern parts of the Indian Ocean, the Bay of Bengal, and the China seas. Each region has its special hurricane season.

In the West Indies, cyclones occur principally in August and September, when the outheast monsoons are at their height. At the same season the African southwesterly monsoons are blowing. Accordingly there are two sets of winds, both blowing heavily and steadily from the Atlantic, disturbing the atmospheric equilibrium, and thus in all probability generating the great West Indian hurricanes. The storms thus arising show their force first at a distance of about six or seven hundred miles from the equator, and far to the east of the region in which they attain their greatest fury. They sweep with a north-westerly course to the Gulf of Mexico, pass thence northwards, and so to the northeast, sweeping in a wide curve (resembling the letter U placed thus =) around the West Indian seas, and thence travelling across the Atlantic, generally expending their fury before they reach the shores of Western En-ope. This course is the storm-track (or storm- as

we shall call it.) Of the behavior of the winds as they traverze this track, we shall have to speak when we come to consider the peculiarity from which these storms derive their names of "cyclones" and "tornadoes."

The hurricanes of the Indian Ocean occur at the "changing of the monsoons." "During the interregnum," writes Maury, "the fiends of the storm hold their terrific sway." Becalmed, often, for a day or two, seamen hear moaning sounds in the air, forewarning them of the coming storm. Then, suddenly, the winds break loose from the forces which have for awhile controlled them, and "seem to rage with a fury that would break up the fountains of the deep.

In the North Indian seas hurricanes rage at the same season as in the West Indies.

In the China seas occur those fearful gales known among sailors as "typhoons," or "white squalls." These take place at the changing of the monsoons. Generated, like the West Indian hurricanes, at a distance of some ten or twelve degrees from the equator, typhoons sweep in a curve similar to that followed by the Atlantic storms around the East Indian Archipslago, and the shores of China to the Japanese Islands.

There occur land storms also, of a cyclonic character, in the valley of the Mississippi. "I have often observed the paths of such storms," says Maury, "through the forests of the Misminsippi. There the track of these tornadoes is called a 'wind road,' because they make an avenue through the wood straight along, and as clear of trees as if the old denizens of the forest had been cleared with an axe. I have seen trees three or four feet in diameter torn up by the roots, and the top, with its limbs, lying next the hele whence the root came." Another writer, who was an eye-witness to the progress of one of these American land-storms, thus speaks of its destructive effects. "I saw, to my great astonishment, that the noblest trees of the forest were falling into pisces. A mass of branches, twigs, foliage, and dust

To show how important it is that captains should understand the theory of cyclones in both hemispheres, we shall here relate the manner in which Captain J. V. Hall escaped from a typhoon of the Chinese seas. About noon, when three days out from Macao, Captain Hall saw "a most wild and uncommonlooking halo round the sun." On the afternoon of the next day, the barometer had commenced to fall rapidly; and though, as yet, the weather was fine, orders were at once given to prepare for a heavy gale. Towards evening, a bank of cloud was seen in the southeast, but when night closed the weather was still calm and the water smooth, though the sky looked wild, and a seud was coming on from the northeast. "I was much interested," says Captain Hall, "in wa ching for the commencement of the gale, which I now felt sure was coming. That bank to the southeast was the meteor (cyclone) approaching us, the northeast scud the outer northwest portion of it; and when at night a strong gale came on about north, or north-northwest, I felt certain we were on its western and southwestern verge. It rapidly increased in violence; but I was pleased to see the wind veering to the northwest, as it convinced me that I had put the ship on the right track-namely, on the starboard tack, standing, of course, to the southwest. From ten A. M. to three P. M. it blew with great violence, but the ship, being well prepared, rode comparatively easy. The barometer was now very low, the centre of the storm passing

to the northward of us, to which we might have been very near had we in the first part put the ship on the larboard tack." But the most remarkable point of Captain

Hall's account remains to be mentioned. He had gone out of his course to avoid the storm, but when the wind fell to a moderate gale he thought it a pity to lie so far from his proper course, and made sail to the northwest. "In less than two hours the barometer again began to fall and the storm to rage in heavy gusts. He bore again to the southeast, and the weather rapidly improved." There can be little doubt that but for Captain Hall's knowledge of the law of cyclones, his ship and crew would have been placed in serious jeopardy, since in the heart of a Chinese boon a ship has been known to be thrown on her beam ends when not showing a yard of CHITVES.

If we consider the regions in which the cyclones appear, the paths they follow, and the direction in which they whirl, we shall be able to form a guess at their origin. In the open Pacific Ocean (as its name, indeed, implies) storms are uncommon; they are unfrequent also in the South Atlantic and South Indian Oceans. Around Cape Morn and the Cape of Good Hope, heavy storms prevail, but they are not cyclonic, nor are they equal in fury and frequency, Maury tells us, to the true tornado. Along the equator, and for several degrees on either side of it, cyclones are also unknown. If we turn to a map in which ocean currents are laid down, we shall see that in every "cyclone region" there is a strongly marked current, and that each current follows closely the track which we have denominated the storm-C. In the North Atlantic we have the great Gulf Stream, which sweeps from equatorial regions into the Gulf of Mexico, and thence across the Atlantic to

she had let go her anchor among the treetops on Elliott's Key."

By a like reasoning we can account for the cyclonic storms prevailing in the North Pacific Ocean. Nor do the tornadoes which rage in parts of the United States present any serious difficulty. The region along which these storms travel is the valley of the great Mississippi. This river at certain seasons is considerably warmer than the surrounding lands. From its surface, also, aqueous vapor is con-tinually being raised. When the surrounding air is colder, this vapor is presently condensed, generating in the change a vast amount of heat. We have thus a channel of rarefied air over the Mississippi valley,, and this channel becomes a storm-track like the corresponding channels over the warm ocean-currents. The extreme violence of land-storms is probably due to the narrowness of the track within which they are compelled to travel. For it has been noticed that the fury of a sea-cyclone increases as the range of the "whirl" diminishes, and vice versa.

There seems, however, no special reason why cylones should follow the stormone direction rather than in the in We must, to understand this, other. recall the fact that under the torrid zones the conditions necessary to the generation of storms prevail far more intensely than in temperate regions. Thus the probability is far greater that cyclones should be generated at the tropical than at the temperate end of the storm- c. Still it is worthy of notice, that in the land-locked North Pacific Ocean true typhoons have been known to follow the storm-track in a direction contrary to that commonly noticed."

The direction in which a true tornado whirls is invariably that we have mentioned. The explanation of this peculiarity would occupy more space than we can afford. Those of our readers who may wish to understand the origin of the law of cyclonic rotation should study Herschel's interesting work on Meteorology.

The suddenness with which a true tornado works destruction was strikingly exemplified in the wreck of the steamship San Francisco. She was assailed by an extra tropical tornado when about 300 miles from Sandy Hook, on December 24, 1853. In a few moments she was a complete wreck. The wide range of a tornado's destructiveness is shown by thisthat Colonel Reid examined one along whose track no less than 110 ships were wrecked, orippled, or dismasted .- Temple Bar.

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