LAW OF STORMS.

By the Right Revd. Bishop Bromby, D.D.

[*Read 14th October*, 1879.]

In 1874 I had the honour of reading a paper to this Society upon the Law of Weather and Storms. I then stated that my principal object, in the interests of our merchants and sailors, was to induce others on land, or on ship-board, to register observations, which, when collated with those reported in other countries in the Southern Hemisphere, might lead to some general and useful results. It is now assumed that a circular storm, to use the definition of Buchan, is simply the variation of the atmosphere attempting "to flow in upon a central area of low pressure in an in-moving spiral course." I stated that the rule for determining the *approach* as well as *direction* of the storm had been in somewhat rough and familiar language laid down by Ballot, "If you stand with your back to the wind, the barometer will be lower on your left hand than on your right." This, however, only describes storms in the other hemisphere—the W. India hurricanes, and the typhoons of China, which move from right to left, *i.e.*, in a direction contrary to the movements of the hands of a watch. A man looking eastward in the British Isles, and finding that the barometric pressure at the north of Scotland is, say, $\frac{1}{2}$ inch less than on the south of England, may look out for a westerly gale. In our Tasmanian waters I believe it will generally be found that a storm arises from a conflict between an easterly and westerly wind, the easterly being always found to flow on the polar side of the westerly. It should be borne in mind also that the direction of the force of the wind does not depend upon the height of the barometer, *i.e.*, upon the barometric pressure at the station where the storm occurs, but upon the difference of barometric pressure over a given distance. I stated in my last paper that the force of a wind was regulated by the distance between the station where the storm is felt from the point where at that moment the barometric reading was the lowest, so that if that distance was small the force of the storm would be in the same proportion more violent. This opinion has been questioned among American authorities.

The atmosphere, like the ocean, is one great fluid, and phenomena need to be noted in order to connect effects in

one portion of the earth with cases which occur in another. A very little science suffices to qualify the observer, excessive heat leads to excessive evaporation, in consequence of diminished atmospheric pressure, and excessive evaporation leads to storms. We need to note observations all over the world that we may discover how far causes in one country, and even in one hemisphere, affect the climate in another. If, again, there be a periodicity in the weather, and weather storms, is that periodicity raised by the return of the maximum frequency of the sun-spots? Let every society like this continue to register its observations in the service of science and of the mercantile marine.

I have now to do with a short report of one of our own Local Storms. The paper I refer to was read during the time of the visit of the American ship "Swatara." Captain Chandler, a scientific and intelligent observer, heard or read my paper. A few months after his departure from this port he favoured me with a communication of his experience of our waters on his way to New Zealand, which has, therefore, a special interest to ourselves. I will, with this introduction, read his short description of what he believes to have been a true cyclone, confirming my previous impressions of what we might expect of the behaviour of this class of storms in our Southern Hemisphere.

The real causes which produce the cyclones of India and China are but little understood. They are, however, clearly connected with the monsoons.

The ablest observers and writers upon physical geography have doubted whether rotatory storms are really ever met with in the South Pacific Ocean. Such a conclusion has probably been too hastily drawn. We have, indeed, no such grand land ovens as are found in the deserts of North Africa and Asia, to interfere with the north-east trade winds, yet we have our hot Australian continent to influence our prevailing south-east trades winds. We have but to remember the origin of the typhoons of China, and the other storms of the Indian Ocean, which have their origin in the effect of the solar heat upon the plains of Asia, and we may expect to meet with results on a smaller scale in our Australian sea. It is true that the monsoons, to which the storms and typhoons of the Northern Hemisphere are related, arise from the interference with the trade winds, while the southern portion of Australia, and all Tasmania and New Zealand lie far outside the influence of S.E. trade winds; but for all that New Zealand and Tasmania lie in the great trade current of a westerly wind, blowing from Cape of Good Hope to Cape Horn. The monsoons of India and China, together with their dependent storms, are the effect of the diversion

of the N.E. trade winds on the northern side of the equator, being sucked in northwards, or even N.W.-wards, towards the heated deserts of Asia. The S.E. trade winds, no longer kept at bay by a belt of a neutral calm, seize the opportunity of crossing the line. Those N.E. trade winds, being already drawn to the heated land, have taken a southerly direction, and the S.E. trades on the S. side of the Equator, and which have now crossed the Equator, and are at the same time losing gradually their easterly character in consequence of the diminished effect of the different diurnal motion of the earth, unchecked by any belt of calm, and meeting with less resistance, are drawn into the general conflict. It has been assumed that (I quote from memory) "there are, on the polar side of the S.E. trade winds, no great plains, except in Australia, upon which the rays of the sun in the summer can play with force enough to rarefy the air sufficiently to materially interrupt these winds in their course," *i.e.*, to make a monsoon of them. This may be true, but the cyclones experienced at the Mauritius are, I imagine, close to the conflict between the trade wind force and the force which impels the air towards the over-heated deserts of Australia. Australia is small, compared with Asia, but if the smallest coral island interferes, as we know it does, with the course of a prevailing wind it would be absurd to doubt the powerful effect which a large continent like Australia, a portion of which lies within the tropical regions, must exercise beyond the usual currents of wind, whether they be the south or the S.E. trade winds, on the polar edges of which the Mauritius stands on (or on a smaller scale), producing a contest between our own steady western trade winds and the indraft produced by the heated continent of Australia in summer.

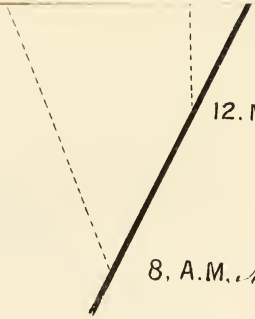
A great Dutch authority, Jansen, says that "in the South Pacific, and in the South Atlantic, so far as I know, rotatory storms are never known—these seas have no monsoons." I think this statement is not borne out by the short account with which Capt. Chandler has favoured me. We are happily free from those hurricanes with which the E. Indies and the Mauritius are familiar, and which are, in spite of their terribleness, blessings of compensation, and of which we ourselves stand in less need, but I am disposed to think that the same laws in the same economy of nature has produced rotatory storms, which, though unconnected with local monsoons blessing the land, should not be ignored by our shipowners, and the captains of our mercantile marine. As the presence of land, which is the proper home of man, is the chief ultimate cause of storms, we look for far greater calmness in the Southern Hemisphere, from the relative

scarcity of land. There is less need for Nature to take violent measures for equalising the temperature and dispersing her water-treasures over thirsty continents, but we look out for storms in the neighbourhood of Cape Horn, and we meet them in our South Australian seas. We may not yet, and may never fully, comprehend the nature of these great forces which restore the equilibrium that has been disturbed, but without the help of the monsoons. I think that this description given us by Capt. Chandler seems to point to a cyclone of diminutive dimensions. It has been laid down as a characteristic of a cyclone that its centre bears about eight points from the direction of the wind on the port side, in the Northern Hemisphere, and on the starboard side in the Southern Hemisphere. Since, however, "the spirally increasing movement of the wind" has been regarded as the true character of a cyclone, it is said that the true position should be 2 or 3 points ahead of the position assumed by the old rule. If we examine the ship's course as indicated in Captain Chandler's drawing, we shall find that the behaviour of the ship was such as to establish the true character of the storm he met with between our homes and New Zealand. It establishes, moreover, my theory that the storms between ourselves and New Zealand come from a conflict between the W. and E. winds, or rather combination, the W. trade wind being drawn in summer to Australia, and the E. or S.E. rushing after it. The subject deserves very careful observation, and it would be well for nautical science if our intelligent captains would register and forward to the Royal Society all the observed phenomena of cyclonic disturbance, noting the rate of movement, and the place and time of their occurrence. The more carefully and frequently such observations are made, at the present time, when the alphabet of weather prophecy is being mastered, the more trustworthy will be the prophecies and the warnings in the future, involving fewer failures, for the guidance and the preservation of our sailors and fishermen.

The science of weather predictions is making, I hope, sure but slow progress. The greatest care should be exercised. *False* prophecies, trusted to, entail great loss of time and money to the fishing fleet; *true* ones, despised, may entail the loss of the fleet itself.

The following is the communication received from Captain Chandler:—

"On the morning of Nov. 9th, 1874, from the appearance of the weather, the action of the barometer, and the change in the wind, I felt fully convinced that the ship was in the south-east quadrant of a light cyclone, and I at once pro-



			N by E	6 to 7	29·58
„	8 p.m.	40	N E by N	6 x 7	29·56
				6 x 8	29·50
„	12 Mid.	32	E N E	7	29·52
Nov. 10,	4 a.m.	30	E by S	4 to 5	29·45
„	8 a.m.	36	S E by S	8	29·49
„	12 m.	47	S by E	7	29·58
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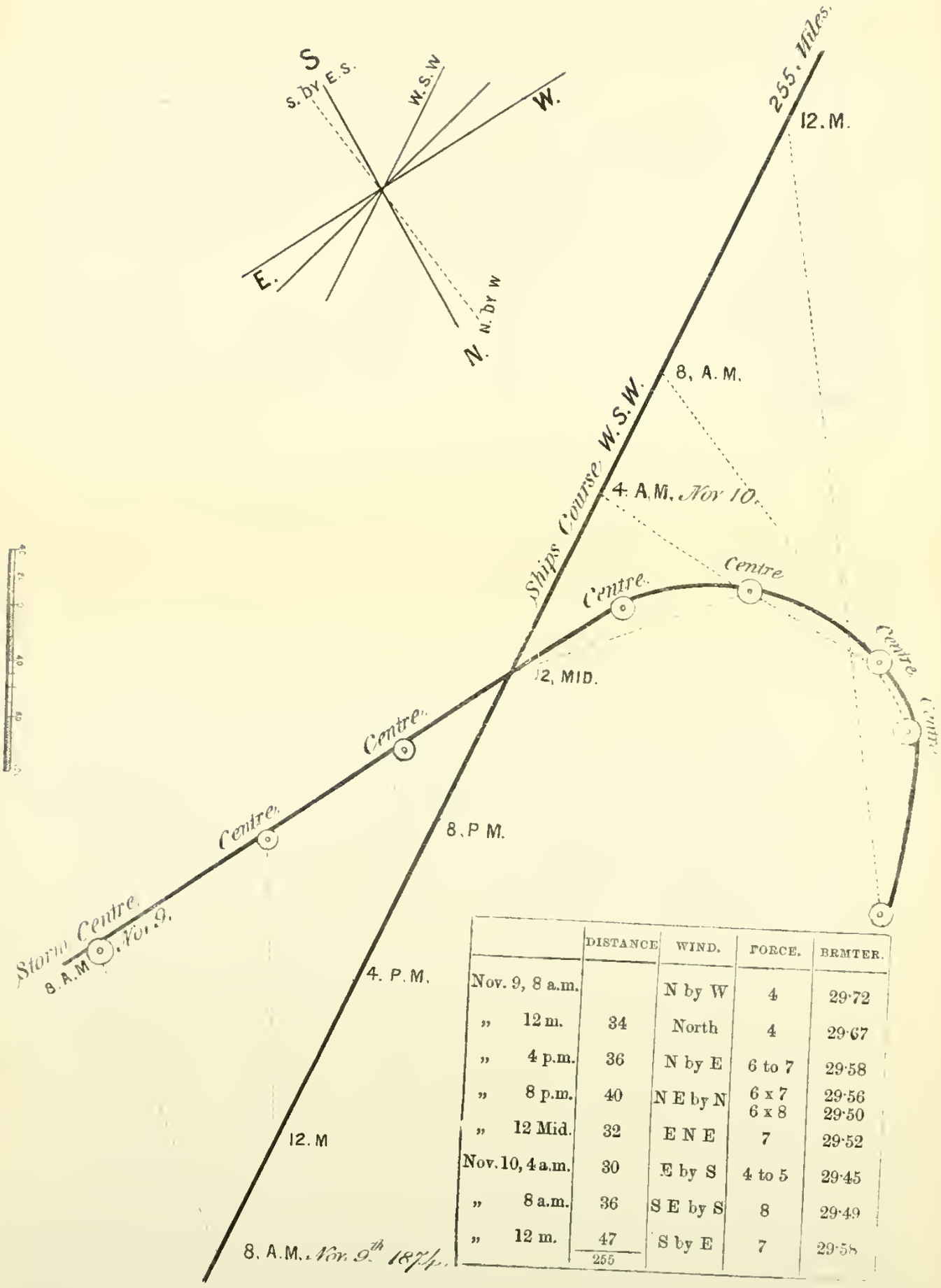

	DISTANCE	WIND.	FORCE.	BRMTER.
Nov. 9, 8 a.m.		N by W	4	29·72
„ 12 m.	34	North	4	29·67
„ 4 p.m.	36	N by E	6 to 7	29·58
„ 8 p.m.	40	N E by N	6 x 7 6 x 8	29·56 29·50
„ 12 Mid.	32	E N E	7	29·52
Nov. 10, 4 a.m.	30	E by S	4 to 5	29·45
„ 8 a.m.	36	S E by S	8	29·49
„ 12 m.	47	S by E	7	29·58
	255			

jected the accompanying chart, estimating the distance of the cyclone centre at seventy miles. At 12, meridian, my convictions were verified, but, to be certain, I reduced the speed of the ship from ten knots to eight, as we were increasing the force of the wind from hour to hour, up to noon, showing our approach to the centre. From noon to 4 p.m. the wind moderated, showing that the centre was going away from us. Having the cyclone centre now thoroughly established, I determined to make as much on our course as possible, and gave all the sail the ship could safely bear, viz., close-reefed topsails and close-reefed fore sail. At 8 p.m. the storm centre had crossed our bow, and was well to the northward; but the chart will explain itself better than any words of mine. I simply wish to show that I made 255 miles on my course in a cyclone, whereas, if I had not been convinced of the fact of its being a cyclone, I would probably have hove to. The path of the centre of the storm is not as well defined as some cyclones that occur in the Northern Hemisphere, because the prevailing winds between New Zealand and Tasmania are from the westward; and when this cyclone centre bore at right angles to the wind at 12 m. on the 10th, it came in contact with the prevailing westerly wind, and the battle must have been fierce, but the west wind conquered and dispersed the cyclone. This is simply a theory. I was told that cyclones did not blow in this latitude, but I think they occur in almost every quarter of the globe. This one was encountered about mid-way between New Zealand and Tasmania, on the 10th and 11th of November, 1874."