

opinions; that we must be prepared to receive fresh ideas from our new views of the action of intense heat on gases and meteorites.

I have only one point to add to my own observation (at two, not ten, minutes past six, as misprinted), that the object, when nearest, presented through its length (but rather below than above) a remarkable "boiling" appearance (as seeds in a capsule), while the edges appeared smooth and quiet.

The Rookery, Ramsbury, February 20 ALFRED BATSON

Aurora

A NEWSPAPER paragraph that has come under my notice describes "a strange phenomenon" seen at Brixham on Thursday morning at 1.30—the 15th instant is to be inferred from the date of the paper. It would seem to have been an aurora—yet another example of exceptional auroral activity attendant on the passage of large sun-spots, as there was a spot of importance approaching the sun's central meridian at the time. Any definite information concerning this particular manifestation, or indeed aurora generally near the date in question, appears worthy of a place in your journal. The sun-spot maximum is passing—perhaps past—and such opportunities should not be lost.

February 24 F. B. E.

DIURNAL VARIATION OF THE VELOCITY OF THE WIND ON THE OPEN SEA, AND NEAR AND ON LAND<sup>1</sup>

DURING the three-and-a-half years' cruise of the *Challenger*, ending with May, 1876, observations of the force and direction of the wind were made on 1202 days, at least twelve times each day, of which 650 days were on the open sea, and 552 days near land. The observations of force were made on Beaufort's Scale, (0-12) being the scale of wind-force observed at sea. The five oceans have been examined separately, viz., the North and South Atlantic, the North and South Pacific, and the Southern Ocean, and thereafter the results grouped together. The mean diurnal periodicity in the force of the wind on the open sea and near land respectively is shown on Fig. 1, where the figures on the left are Beaufort's Scale, and those on the right their equivalents in miles per hour. The solid line represents the mean force on the open sea, and the dotted line the mean force near land.

As regards the open sea, it is seen that the diurnal variation is exceedingly small, showing only two faintly-marked maxima about midday and 2 a.m. respectively. On examining, however, the separate means for the five oceans, no uniform agreement whatever is observable among their curves. The slight variations which are met with are different in each case, not one of the maxima or minima being repeated at the same hours in more than two of the five oceans. It follows, therefore, that the force of the winds on the open sea is subject to no distinct and uniform diurnal variation. The difference between the hour of least and that of greatest mean force is less than a mile per hour.

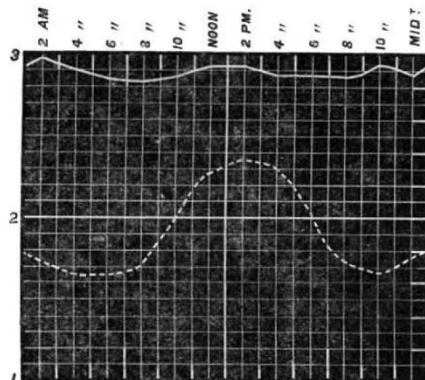
Quite different is it with the winds encountered by the *Challenger* near land, where the observations of the force of the wind give a curve as pronouncedly marked as the ordinary diurnal curve of temperature. The minimum occurs at 2 to 4 a.m., and the maximum from noon to 4 p.m., the absolute highest being at 2 p.m. The curve constructed for each of the five oceans, from the observations near land, gives one and the same result, viz., a curve closely agreeing with the curve of diurnal temperature.

The 650 daily observations on the open sea give a mean velocity of 17½ miles per hour, but the 552 near land give a velocity of only 12½ miles per hour. The difference is greatest at 4 a.m., when it amounts to up-

wards of 6 miles an hour, but is diminished as the temperature rises, till at 2 p.m. it is less than 3 miles an hour.

At Mauritius, which is situated within the south-east trades, the minimum velocity of the wind is 9.7 miles per hour, occurring from 2 to 3 a.m., from which hour it rises to the maximum 18.5 miles from 1 to 2 p.m., the influence of the sun being thus to double the wind's velocity. At Batavia, situated in a region where the mean barometric gradient is much smaller, the differences are still more decided. From 1 to 6 a.m., 85 per cent. of the whole of the observations are calms, whereas from noon to 2 p.m. only 1 per cent. are calms. In all months the minimum velocity occurs in the early morning, when the temperature is lowest, and the maximum from 1 to 3 p.m., when the temperature is highest. At Coimbra, the mean maximum hourly velocity in summer is five times greater than the minimum velocity, whereas in winter it is only about a half more. At Valencia, in the south-west of Ireland, one of the stormiest situations in western Europe, the three summer months of 1878 gave a mean hourly velocity of 13.3 miles per hour, the minimum oscillating from 10 to 11 miles an hour from 9 p.m. to 6 a.m., and the maximum exceeding 16 miles an hour from 11 a.m. to 5 p.m. The absolutely lowest hourly mean was 10 miles at 11 p.m., and the highest 18 miles at 1 p.m., the velocity about midday being thus nearly double that of the night. The results of observa-

FIG. 1.



tions at many other places might be added to these, including those published by Wild, Hann, Köppen, Hamberg, and others, which go to establish the fact that the curves of the diurnal variation of the velocity of the wind generally conform to the diurnal curves of temperature. The curves of the diurnal variation are most strongly marked during the hottest months. The maximum velocity occurs at 1 p.m., or shortly thereafter, being thus before the maximum temperature of the day (occurring therefore at the time when insolation is strongest); and the minimum in the early morning, when the temperature falls to the lowest, or when the effects of terrestrial radiation are at the maximum. The rule appears to hold good with all winds, whatever be their direction, as shown by Hamberg. The exceptions to this rule are so few, and of such a nature, that they are in all probability attributable to causes more or less strictly local.

With respect to cloud, Hann has pointed out that for a number of places the mean maximum hourly velocity is 102 per cent. above that of the minimum with clear skies; 77 per cent. with skies half covered with clouds; and 50 per cent. with skies wholly covered. At Vienna, however, these rates of increase are, for clear skies, 101, and half-covered skies, 66 per cent., whereas when the sky is overcast the variation becomes irregular and but faintly marked. Hann has also examined the Vienna observations of the wind on those days when the velocity

<sup>1</sup> Part of this article is abridged from a forthcoming volume of the "Reports" of H.M.S. *Challenger*, by permission of the Lords Commissioners of H.M. Treasury.