## THE RED SKIES.

THE remarkable atmospheric phenomenon which has recently attended sunrise and sunset, has attracted great attention not only from the general public, but from scientific men, who have endeavored to give a satisfactory explanation of it. Similar appearances have been noted in former years; but they have been of limited extent, and attributable to local causes. The distinguishing characteristics of the present manifestation are its enormous extent, since it has been observed over nearly the whole earth, its persistence, and the fact that the times of its first appearance have varied in different countries, thus suggesting a progressive motion.

In the United States the reports of observers of the signal-service show that its earliest appearance was in October. At Pensacola, Fla., on the 8th, the phenomenon was observed at both sunrise and sunset. Near the middle of the month it was noted along the southern border from southern California to the Gulf of Mexico. At the close of the month it was observed in great brilliancy in the southern and south-western states. In the more northern portions of the country, during October, the sunsets were characterized by unusual brilliancy; but the peculiar 'afterglow' which marked the later appearances was not noted. In the early part of November the phenomenon was still observed on a few days in the south and west; but after the 20th it appeared in its full beauty over nearly the whole country. In New England, the Atlantic, Gulf, and central states, the lake region, the north-west, and along the Pacific coast, the phenomenon was observed, beginning at various dates after the 21st, according to the weather conditions of the different localities. The 27th was the date in which the appearance was first especially marked in the eastern states. Since that date, to the end of the year 1883, the skies have been characterized by the same brilliancy, whenever the weather conditions have been favorable to its observation; the 27th and 28th of December revealing the appearance in the eastern section of the country to a marked degree.

The sky seems to have had essentially the same characteristics wherever the phenomenon has been observed. In Europe and America, however, if we may judge from the published descriptions, the green or blue appearance of the sky has been less noticeable than in India, where the earliest observations were made. In this country the 'afterglow' has been ruddy, with at times an orange or greenish tint. The observer at Memphis, Tenn., under date of Oct. 30, writes, "For more than one hour after sunset there was in the west a segment of red light, whose intensity and brilliancy appeared equal at all points in the segment. The position (altitude?) of the segment was about 30°, azimuth 45° to 120°." On Oct. 31 the appearance was similar, "except that in the north-east quarter of the segment a few converging bands, apparently dark, entered the segment from a clear sky. While no stars were visible in the illumined part of the segment, they were visible in all other parts of the sky, and also in the bands, which, it appears, were dark in contrast." At Washington, on Dec. 29, a ruddy arch arose in the early morning, and was about 25° high an hour and ten minutes before sunrise. Soon after, the usual twilight arch appeared, also of a ruddy tint; and the two were seen simultaneously, the former losing its outline, and growing paler as it became tranfused over the sky. During the day, the material causing the appearance was plainly visible as a white haze surrounding the sun to a distance of about 30°. At sunset on the 27th and 28th the phenomena were as at sunrise, but in reverse order, the secondary glow lasting an hour and three-quarters after sunset. While the glow at the end of December is perhaps not as intense in color as when first seen a month earlier, it is the same in other respects. It has been described in profuse detail in the daily press; and several English magazines, notably *Nature*, have devoted much space to it.

Three different hypotheses have been advocated to explain the phenomenon, assigning its cause to aqueous vapor, meteoric and volcanic matter respectively. It is undoubtedly atmospheric, and due to the presence of some matter in unusual quantities. The persistence of the phenomenon, and its great extent, are objections to the view that it is due to aqueous vapor. There would certainly have been, ere this, extensive precipitation, were aqueous vapor the cause; but reports indicate nothing abnormal in the rainfall. Moreover, the glow has been most noticeable when the air has been driest: it has been a characteristic of the cold, dry weather, which attends areas of high barometric pressure. In addition, the spectroscope has confirmed the indications of the psychrometer. The pocket-spectroscope shows a very weak rain-band, and a strong development of the bands designated by Piazzi Smyth as $\alpha$ and $\delta$, and ascribed by him to 'dry air,' the

latter known especially as the 'low sun-band.' The same result has been obtained in England and in America. A careful examination of the spectrum with a powerful grating spectroscope, made at sunset on Dec. 28, showed that the aqueous lines were feeble; and the spectrum, at its disappearance, was much farther extended towards the green than is usual in a clear sky. From all these considerations, it seems that the hypothesis of an excess of aqueous vapor in the atmosphere is not tenable.

It seems not unreasonable to suppose that the upper regions of the atmosphere have received from some source an accession of light matter which reflects the sunlight. Of the two suggested sources, — meteoric dust encountered by the earth in its progress, and volcanic matter projected to an enormous height, — either would be a satisfactory explanation. The former would seem in itself the more reasonable, were there not in this instance special considerations which give additional weight to the latter. Both of these hypotheses have been independently suggested by various writers. Mr. Ranyard advocates the meteoric view in *Knowledge* for Dec. 7, and Mr. Lockyer the volcanic theory in the London *Mail* of Dec. 10, and current numbers of *Nature*. English scientific men have shown great interest in this investigation; but few references to it have been made, as yet, in the publications of other countries.

It will be of interest to classify the dates at which the atmospheric phenomenon has been earliest observed in different countries. The following table contains a list of the dates and countries, with the approximate distance and direction of each country from the Straits of Sunda, in which occurred the tremendous volcanic outburst of Aug. 26. It should be noted, that, while the dates given have been collated from the best evidence at hand, there is a possibility that they may be too late in some cases, either from the fact that earlier observations have not been reported, or were not made owing to unfavorable weather: they must therefore be taken as only approximately accurate. A few have been derived from general statements in which the exact dates were not mentioned.

This table has been derived mainly from English periodicals and from the records of the U. S. signal-service. The important references to New Ireland and the Hawaiian Islands were received by letter from Mr. S. E. Bishop of Honolulu, who has also obtained from shipmasters the information that the phenomenon has been extensively seen on the Pacific Ocean since Sept. 1. It is also reported from China, but no date is assigned.

| Date. | Country. | Distance and direction from Straits of Sunda. |
|---|---|---|
| 1883. | | *Miles.* |
| Aug. 28 | Rodrigues | 3,000 S.W. |
| 28 | Mauritius | 3,500 S.W. |
| 28 | Seychelles | 3,500 W. |
| 30 | Brazil | 10,500 W. |
| Sept. 1 | Gold Coast | 7,500 W. |
| 1 | New Ireland | 3,000 E. |
| 2 | Venezuela | 12,000 W. |
| 2 | West Indies | 12,000 W. |
| 2 | Peru | 13,000 W. |
| 5 | Hawaiian Islands | 7,000 N.E. |
| 8 | Southern India | 2,000 N.W. |
| 8 | Ceylon | 2,000 N.W. |
| 15 | Southern Australia | 3,000 S.E. |
| 15 | Tasmania | 4,000 S.E. |
| 20 | Cape of Good Hope | 6,000 S.W. |
| Oct. 8 | Florida | 13,000 N.W. |
| 19 | California | 9,500 N.E. |
| 20 | Southern United States | 11,000 N.E. |
| Nov. 9 | England | 7,500 N.W. |
| 20 | Turkey | 7,000 N.W. |
| 21 | United States | 11,000 N.E. |
| 25 | Italy | 7,000 N.W. |
| 26 | France | 7,500 N.W. |
| 28 | Germany | 7,000 N.W. |
| 30 | Spain | 8,000 N.W. |
| 30 | Sweden | 7,500 N.W. |

An examination of this table shows at once the wide-spread character of the phenomenon, and its progressive motion. It is impossible not to conjecture a connection with the volcanic eruption in the Sunda Straits, by which, on Aug. 26, the island of Krakatoa disappeared wholly from the face of the earth. The terrible nature of this outburst can hardly be realized: the sky was darkened for several days, the noise was heard two thousand miles, magnetic disturbances were noted, the tidal wave was distinctly felt at San Francisco, and the atmospheric disturbance was sufficient to cause marked barometric fluctuations, which were noted by the barographs on the continent, in England and America, for several succeeding days. Coincidence in dates is not a proof of a connection between the atmospheric and the volcanic phenomena; but it is certain that the former were first observed near the scene of the latter, and that similar atmospheric effects have been heretofore recorded over limited areas in connection with volcanic outbursts. Assuming the origin of the atmospheric effects to be the volcanic eruption, the table shows an extremely rapid progression in both an easterly and a westerly direction, — the former over the Pacific Ocean, the latter over the Indian and Atlantic oceans, to South America and the West Indies. Mr. Lockyer considers that the latter continued westward to the Hawaiian Islands, and does not regard an eastward pro-

gression at all; but the later evidence from the Pacific shows that the phenomenon was seen several thousand miles east of Java on Sept. 1. This extremely rapid progression has been mentioned as an objection to the volcanic theory, but it is not impossible to believe in its truth; and we know little or nothing of the motions of the higher strata of the atmosphere. Besides, it is not necessary to reckon from Aug. 26, the date of the volcanic catastrophe; for the volcano had been in eruption since May 20, and the steamship Siam, on Aug. 1, in latitude 6° south, longitude 89° east, sailed for more than forty miles over floating pumice. There seems also to be a well-marked southern progression, though the dates for Australia and Tasmania are probably too late.

It is difficult, however, to trace with certainty a progression northward. The October appearances in the United States, and the November appearances in the United States and Europe, if the result of the August eruption, show a rate of progress very much slower than that in an easterly or westerly direction. There seems also to be a gap in the dates; for, with the exception of the three dates in October, there is a September group covering a large territory, and a similar group in November over a different territory. The October records, which are all in the United States, are definite, but few in number. During this month, and up to the 20th of November, there was a well-marked brilliancy in the sunrise and sunset colors over a large portion of the United States, but it did not possess the marked intensity which seemed to suddenly begin after the 20th. It is possible that the sudden increase in the latter part of November, which was noted both in America and in Europe, was due to the arrival over these countries of the volcanic matter which had been moving slowly northwards for ten weeks; and the October appearances may have been either the sequel of the progression towards the West Indies in September, or the forerunner of the later, more marked appearances.

Another explanation, in consonance with the volcanic hypothesis, may be given. The eruption in the Sunda Straits is not the only volcanic outburst of great intensity which has recently occurred, though it has been better known because occurring in an inhabited region. Meagre accounts have been received of a great outburst in Bering Sea, to which brief allusion was made in *Science*, No. 46. The October weather review of the signal-service contains a letter from Sergeant Applegate, the observer at Unalashka, Alaska, in which he says, referring to some sand which fell in a rain-storm of Oct. 20, —

> "This sand is supposed to have come either from the Mukushin, or the new volcano adjacent to Bogoslov. The former is at a distance of about nineteen miles south-west, but for years has only issued forth smoke or steam. The latter is a new one, which made its appearance this summer, and burst out from the bottom of Behring Sea. It has been exceedingly active, as it has already formed an island from eight hundred to twelve hundred feet high. According to the report of Capt. Anderson, the discoverer, who sails one of the company's vessels, and who went within two thousand yards of it, it presents a most magnificent sight. The fire, smoke, and lava are coming out of many crevices, even under the water-line. Large bowlders are shot high in air, which, striking the water, send forth steam and a hissing sound. Bogoslov is about sixty miles from here, in a west direction. The new volcano is about one-eighth of a mile north-west of it."

This makes the position of the volcano, latitude, 54° north; longitude, 168° west. The San Francisco *Chronicle* of Nov. 23 contains a more detailed report, but adds nothing essential to the above description. As this extensive eruption has been taking place for some months, it is not improbable that the atmosphere has received a large accession of volcanic material from this source also; and possibly to this cause may be due, at least in part, the appearance of the sky in November.

It would seem as if an examination of the dust particles brought to the earth by rain or snow would furnish final proof as to the source of the matter causing the phenomenon, provided that it is not wholly above the influence of the descending precipitation. The force of gravity would certainly eventually bring to the earth portions of the material. It is not uncommon for meteoric matter to be found in the analysis of freshly-fallen snow; and an anonymous writer in the *New-York herald* of Dec. 29 implies that the late snows have given indications of meteoric matter. This, if verified, would tend to confirm the truth of the meteoric theory; but results of quite a different character are announced in *Nature* for Dec. 20, which has been received since this article was begun. An analysis of fresh snow, made by Mr. McPherson in Madrid, Spain, revealed the presence of "crystals of hypersthene, pyroxine, magnetic iron, and volcanic glass, all of which have been found in the analysis lately made at Paris of the volcanic ashes from the eruption of Java." Similarly a microscopic examination of the sediment from a violent rain-storm on Dec. 13 was made at Wageningen, Holland, by Messrs. Beyerinck and Dam, and compared with a sample of ash from Krakatoa.

It was found that "both the sediment and the volcanic ash contained, (1) small, transparent, glassy particles; (2) brownish, half-transparent, somewhat filamentous little staves; and (3) jet black, sharp-edged, small grains resembling augite. The average size of the particles observed in the sediment was of course much smaller than that of the constituents of the ash. These observations fortify us in our supposition, expressed above, that the ashes of Krakatoa have come down in Holland."

These analyses certainly tend to confirm the volcanic hypothesis, though it is interesting to note that some of the substances found by Mr. McPherson are also characteristic of meteoric matter. The evidence thus far accumulated seems to point positively to the truth of the volcanic hypothesis. The opponents of this view dwell upon the improbability of so much matter being thrown up to such a great height, and of its remaining so long a time in the atmosphere. But the magnitude of the Java eruption has certainly not been overrated; and the amount of material thrown into the atmosphere from this source alone is probably sufficient to account for the observed effects. If we add the amount from the Alaskan volcano, there is less reason to doubt the ability of the hypothesis to account for the quantity of material required. The objection on the ground of the persistence of the phenomenon has been met by Messrs. Preece and Crookes on electrical grounds. If the matter thrown up is charged with negative electricity, it would be repelled from the earth, and its particles would repel each other, thus causing the rapid dissemination of the material in the atmosphere, and its retention for an indefinite period. The decline of brilliancy has been slow during the time it has been observed in this country. In the Hawaiian Islands it is still a marked phenomenon, after a lapse of several months. We may therefore expect that for some time to come we shall observe it under favorable weather conditions, but that it will gradually become less prominent until it is known only as a fact of past history.

W. UPTON.

Washington, D.C., Jan. 1, 1884.

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## *WHIRLWINDS, CYCLONES, AND TORNADOES.*[1]—VII.

WE are now prepared to consider and explain the actual distribution and motion of cyclones.

The limitation of violent cyclones to the ocean is natural enough: the level surface of the sea allows a great accumulation of warm, moist air before the upsetting begins, and permits the full strength of the winds to reach a very low altitude. On land the air never waits so long as it may at sea, before upsetting; it never becomes so moist; and, when in motion, the inequalities of hill and valley hold back the lower winds by friction. On land the strong part of the cyclone is relatively higher than at sea, as the records of mountain observatories show; and we know less of it.

No violent cyclones are known to have occurred within four hundred miles of the equator. Here, — where the air is warm, quiet, and heavily charged with moisture; where heavy, quiet rains are frequent; where the conditions which have been mentioned as essential for starting a cyclone are of common occurrence, — cyclones are nevertheless unknown. They occur often enough, however, in the embryonic form of thunder-showers, but they never reach the adult stage; and this must be because at the equator the deflective effect of the earth's rotation is zero, and the inrushing winds are allowed to move directly toward the low-pressure centre and fill up the depression, instead of increasing it by their deflection and their centrifugal force. From this we learn, that, while warmth and moisture may be sufficient to begin a cyclone, they alone cannot maintain it. There would be no violent cyclones if the earth stood still.

It might be inferred from this that cyclones should increase in frequency and intensity as we recede from the equator toward the poles, for in the higher latitudes the earth's deflective force is known to increase. It is true that storms are much more frequent in high latitudes than near the equator; and this is very likely due to the greater ease with which moderate indraughts are here deflected so as to produce a central baric depression. But the more intense storms are all within thirty or thirty-five degrees of the equator, because, in more polar latitudes, the air is not warm or moist enough to co-operate effectively with the deflective forces, and produce violent winds. It has already been explained that a rising column of moist air cools more slowly than one of dry air; and on this there was shown to depend much of the greater energy of oceanic storms over that of desert whirls. It should now be added, that, of two ascending currents of saturated air, the warmer will rise much more vigorously than the cooler: hence the warm, saturated air of the tropical sea breeds hurricanes, cyclones, and typhoons of greater strength than the

[1] Continued from No. 45.