

4. "Although the Conference is of opinion that, as far as the general scope of meteorological inquiry goes, the same form of register should be supplied to merchant ships as to men of war, it declares it will be most desirable that, besides the regular observations, a more extended scale for scientific inquiry should be adopted on board ships of war, as in such cases there is a large number of suitable officers, as well as more means for carrying on the service. As examples of observations which are of importance for the development of Maritime Meteorology, over and above the regulations embodied in the scientific instructions given to Naval expeditions for the special purpose of the advancement of science, the following suggestions may be enumerated:—

(a) "Possibility of carrying out accurate observations on the velocity of the wind by anemometers at sea.

(b) "Possibility of employing rain-gauges satisfactorily at sea.

(c) "Observations with Regnault's and other hygrometers, and experiments on the best mode of observing wet and dry thermometers, and the best position to place them in on board ship.

(d) "Currents at the surface and at depths to be observed with great minuteness, with the special object of defining their limits.

(e) "The comparison of various instruments, among which are expressly mentioned that of aneroids with mercurial barometers. It is further deemed very desirable that frequent comparisons should be instituted between the instruments used at sea and meteorological stations on shore in various countries.

(f) "Deep-sea soundings and temperatures, with specimens of water.

(g) "The collecting of information on Ocean Meteorology at outlying stations.

(h) "The furnishing of synchronous observations at oh. 43m. G. M. T., in accordance with the suggestion and request of the United States Signal Office."

VI.—DISCUSSION.

Can general suggestions be thrown out as to the most profitable mode of discussing the observations?

That it is desirable that every Institution should publish the observations and results in such a manner that every foreign institute can incorporate them with its own observations and results in the easiest way possible; that is, by preserving the number of observations, together with any means derived from them, for single square degrees.

That it is further desirable that, whatever charts be published, the results for single square degrees should be published in a tabular form.

That it seems desirable for the use of the sailor that each chart should have reference to only one element, or, at least, only to elements closely related to each other.

VII.—SUBJECTS OF INQUIRY.

To what extent can a division of labour, as regards subjects of inquiry, be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

That the division of labour, as regards investigations, can only be carried out by mutual agreement between the several institutions; and each institution should announce to other institutions what investigations it proposes to undertake.

It is very desirable that such divisions of labour should be effected.

VIII.—SAILING DIRECTIONS.

In how far are purely practical investigations, such as the preparation of sailing directions, admissible for a scientific institution?

That the sailor wants the result of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best.

It was resolved, that Capt. Toynbee's remarks on the programme should be printed in full, with extracts from the remarks of other gentlemen, should they contain important suggestions.

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee on Luminous Meteors, by Mr. Glaisher.

—The appearance of meteors noticed in published journals, and otherwise ascertained by the committee during the past year, include some striking examples of such remarkable exhibitions, discussed and investigated very ably by astronomers, as well as of others passing almost unobserved excepting by accidental gazers. A few such large meteors were doubly observed in England. Some have been visible in the day-time, while many other large and small fire-balls have been described to the committee, of which it is to be regretted that notices have hitherto only reached them from single observers. The months in which these phenomena have been most abundant were September, December, and January last, April, June, and again quite recently, the last few days of July and beginning of August of this year. The report contains descriptions of the brightest of these meteors, and an account of Prof. Galle's calculations and inquiries regarding the real cause of two large meteors which passed over Austria on the 12th and 19th of June last, with the probable path that he assigned to them. If a mass of burning sulphur found on the ground immediately after the disappearance of the latter meteor is not considered presumably meteoric, no occurrence of a fall of aërolites, as far as the committee is aware, has taken place during the past year.

The annual star-showers have been watched for with the usual attention of observers in correspondence with the committee; and the results of their combined observations are described, with accounts of some other occasional star-showers, at some length in the descriptive part of the report. Although little important information was thus added this year to our present well-known star-showers of January, April, and October, and the cometary meteor showers of November 14 and 27, connected with Tempel's and with Biela's comet, all of which, in spite of very favourable weather for their observations, were this year most remarkable by their non-appearance; yet the fluctuating intensities of these showers at their successive periodic dates are an important element to record; and in the case of the star-showers of August 10 and December 12 of the past year, the watch was at least attended with more positive success. Duplicate observations of meteors were obtained in them, and the general centre of divergence of each of these two meteor-currents was pretty exactly ascertained. Bright meteors were more frequent on each of these two nights than is at all usual in ordinary exhibitions of those showers. It will be found among these observations that the return of Biela's meteor-shower on the 27th of November last disappointed expectation, and the small extent and rapid departure of that meteor-cloud from the earth's neighbourhood is clearly shown by its visibility as a star-shower only for a single year.

The duplicate observations described in former reports have been reduced at the request of the committee by Mr. T. H. Waller, whose report of these calculations is added, and whose conclusions of their real heights and velocities are without doubt very accurate and complete.

The publication of Capt. Tupman's observations of shooting stars in the Mediterranean during the years 1869-71, with the list of radiant points obtained from them and shown on a pair of charts accompanying them by Capt. Tupman, is now brought to a close, and the catalogue and charts have been sent to astronomers and correspondents of the committee in England and abroad, and in America, and discussions of these in foreign scientific journals have appeared, showing the important light in which the appearance of this valuable new meteor catalogue has been regarded. Its principal part, the comparative catalogue of his meteor-showers with those of other observers, and the charts on which they are projected, are presented in this report, with Dr. Schmidt's similar catalogue (the remaining two principal meteor-shower lists, of which no account has yet appeared in these reports), thus placing before readers of recent volumes of these reports all the material contributions to this branch of meteoric astronomy that have yet been made.

They are summed up in a very concise catalogue at the end of this report by Mr. Greg, who has selected, to corroborate such observations already published in his former lists, the greater

part of Dr. Schmidt's and Capt. Tupman's observations, and has included them with his own former collection, thus forming a very extended catalogue founded on all the similar work of his contemporaries and predecessors, and omitting but few genuine meteoric showers, chiefly in the southern hemisphere, which have only been observed by Dr. Neumayer in Australia.

Following the method of Dr. Weiss, viz. to calculate the radiant points of those comets of early and recent times whose orbits are believed to pass near the earth, a list of such comets for both the northern and southern hemispheres is annexed to Mr. Greg's catalogue, and the cases where they corroborate each other are pointed out. Many important and well-known comets are found to have meteor-showers as their present representatives, as would, perhaps, be still more apparent if more reliable orbits of comets could be used; but the coincidences are, however, numerous enough and sufficiently exact to render desirable the further cultivation of cometary astronomy by the help of star-shower observations.

Report on Isomeric Cresols, by Dr. Armstrong.—Little has been done by the committee during the past year. *Para* and *ortho* cresols have been obtained from ordinary cresylic acid, but it has not been with certainty determined whether the *meta* cresol is likewise present, or whether these are the sole constituents of this substance.

Report of the Committee for the Utilisation of Sewage, by Prof. Corfield.—The committee has been unable, from want of funds, to carry on the quantitative experiments as they would have wished. Of the total nitrogen supplied to the farms during the year March 25, 1873, to March 24, 1874, 37.7 per cent. was recovered in the crops, during the preceding year 41.7 per cent. was recovered, while during the first year of the experiments the nitrogen recovered amounted to 26 per cent. The committee will be enabled, through the liberality of a gentleman, to carry on their investigations during another year.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

On the Construction of a perfectly Achromatic Telescope, by Prof. G. G. Stokes.

At the meeting of the Association in Edinburgh, in 1871, it was stated that it was in contemplation actually to construct a telescope by means of discs of glass prepared by the late Mr. Vernon Harcourt, which should be achromatic as to secondary as well as to primary dispersion. This intention was subsequently carried out; and the telescope, which was constructed by Mr. Howard Grubb, was now exhibited to the Section. The original intention was to construct the objective of a phosphatic glass containing a suitable percentage of titanic acid, achromatised by a glass of terborate of lead. The percentage of titanic acid was so chosen that there should be no irrationality of dispersion between the titanic glass and the terborate. As the curvature of the convex lens would be rather severe if the whole convex power were thrown into a single lens, it was intended to use two lenses of this glass, one in front and one behind, with the concave terborate of lead placed between them. It was found that provided not more than about one-third of the convex power were thrown behind, the adjacent surfaces might be made to fit, consistently with the condition of destroying the spherical as well as the chromatic aberration. This would render it possible to cement the glasses, and thereby protect the terborate, which was rather liable to tarnish. At the time of Mr. Harcourt's death two discs of the titanic glass had been prepared, which it was hoped would be good enough for employment, as also two discs of terborate. These were placed in Mr. Grubb's hands. On polishing, one of the titanic discs was found to be too badly striated to be employed; the other was pretty fair. As it would have required a rather severe curvature of the first surface and an unusual convexity of the last to throw the whole convex power into the first lens, using a mere shell of crown glass behind to protect the terborate, Prof. Stokes thought it more prudent to throw about one-sixth of the whole convex power into the third or crown-glass lens, though at the sacrifice of an absolute destruction of secondary dispersion, which by this change from the original design might be expected to be just barely perceptible. Of the terborate discs, the least striated happened to be slightly muddily from some accident in the preparation; but as this signified less than the striae, Mr. Grubb deemed it better to employ this disc. The telescope exhibited to the meeting was of about

2½ in. aperture, and 28 in. focal length, and was provided with an objective of the ordinary kind, by which the other could be replaced, for contrasting the performance. When the telescope was turned on to a chimney seen against the sky and half the object-glass covered, in the case of the ordinary objective, vivid green and purple were seen about the two edges, whereas with the Harcourt objective there was barely any perceptible colour. It was not, of course, to be expected that the performance of the telescope should be good, on account of the difficulty of preparing glass free from striae, but it proved to be quite sufficient to show the possibility of destroying the secondary colour, which was the object of the construction.

On Cyclone and Rainfall Periodicity in connection with the Sunspot Periodicity, by Charles Meldrum.

The catalogue of cyclones experienced in the Indian Ocean, from 1847 to 1873, submitted last year, indicated that during this period the number of cyclones in the space between the equator and 34° S. lat. and the meridians of 40° E. and 110° E. are much greater in the years of maximum than in the years of minimum sunspot frequency.

It will now, and in subsequent reports, be shown that not only the number of cyclones, but their duration, extent, and energy, were also much greater in the former than in the latter years, and that there is a strong probability that this cyclonic fluctuation has been coincident with a similar fluctuation of the rainfall over the globe generally.

The present communication is confined to the twelve years 1856-67, comprising a complete sunspot cycle.

With regard to the cyclones of the Indian Ocean, the investigation is based upon the extensive collection of observations made by the Meteorological Society of Mauritius on the assumption that the observations are so numerous that no cyclone of any considerable extent or violence can have escaped detection.

A chart has been prepared for noon on each day of the period during which a cyclone lasted. The chart shows the positions of the vessels, the directions and force of the wind, the state of the weather and sea, &c. In this way the position of the centre of the cyclone is ascertained for each day; then, by examining the several charts, the duration, extent, &c. of the cyclone are determined.

The number of cyclones thus examined for the twelve years is 113, and their tracks have been laid down on six charts.

The total cyclonic area in 1860 and 1861 was about twelve times greater than in 1856 and 1857, and nearly eight times greater than in 1867; in short, all the factors were greater in the years of maximum sunspot frequency. It is evident from the table that the cyclonic area increased rapidly from 1858 to 1860, and diminished slowly from 1861 to 1866. The registers for the years 1856, 1857, 1866, and 1867 have been examined with special care in order that nothing might be omitted; and, to give the utmost possible weight to those years, every instance of even an ordinary gale has been taken into account. In 1856 there was no great hurricane at all, and the same may be said of 1857, 1866, and 1867. From the chart for 1866 it will be seen that in April of that year there was a number of small cyclones. The south-east trade-winds and north-west monsoon were in collision for a considerable time, and several cyclonic eddies of short duration were formed.

If we could obtain good values of the mass of air in motion and the velocity of the wind, it would probably be found that the ratios of cyclonic energy were greater than those of cyclonic area, for in the maxima years the cyclones were much more violent than in the minima years. Assuming the mass to be nearly proportional to the area, and the velocity of the wind in a strong gale to be 55 miles, in a whole gale 70 miles, and in a hurricane 85 miles an hour, the amount of cyclonic energy in 1860 was about eighteen times greater than in 1856, the squares of the velocities being as three to five.

Although the results are necessarily rough approximations, yet the fact that the number and violence of the cyclones of years of maximum sunspot were far greater than in the years of minimum sunspot is beyond all doubt.

When a great hurricane takes place in the Indian Ocean, the disabled ships are obliged to put into the nearest port, and the newspapers in their shipping intelligence announce the arrival of the vessels, the dates and localities of the bad weather, and the amount of damage sustained. For upwards of twenty years the *Commercial Gazette* of Port Louis has published all arrivals of vessels and all maritime events which have been reported by them. Considering, then, the geographical position of Mauritius,