Remarkable Clouds at High Altitudes.

By Prof. CARL STØRMER.

BETWEEN 1871 and 1892 some very remarkable clouds were seen both in England¹ and in Norway. These clouds, which before dawn or after sunset were characterised by their brilliant prismatic colours, were especially studied by the late Prof. H. Mohn.² Visual observations in England in 1885, and by Prof. Mohn in 1892, made it very probable that their altitude was exceptionally great, but no certain conclusion could be drawn from these visual observations.

I saw these clouds in the year 1890 and made very careful observations of their forms and colours, but after 1892 I did not see them at all in spite of a very careful watch. It was not until Dec. 27, 1926, that I saw them again. That afternoon I was unable to determine their height, but some days later, on Dec. 30, I succeeded in taking two pairs of simultaneous photographs of them from my two aurora stations, Bygdø and Oscarsborg. The measurement and calculation

of these photographs gave heights between 26 km. and 30 km. above the earth.³

On Jan. 13 of this year the clouds were again seen,

FIG. 1.—Nacreous clouds to the west, seen from Oslo.

FIG. 2.—Photograph taken from Oslo.

both in the early morning and in the evening. I was fortunate enough to have my two stations, Oslo and Oscarsborg, in action immediately after sunset, and a long series of more than ninety simultaneous photographs were taken from both stations. These give unique material for determining the exact height and situation of these remarkable clouds.

I myself conducted the photographic work from the astronomical observatory, and simultaneous photographs were taken in Oscarsborg by my assistant Hafnor by orders over the telephone. My assistant in Oslo was Tveter.

The best photographs were taken so late that the stars were visible, which allowed us to measure and calculate the height and situation of the clouds in the same manner as I have done in the case of the aurora borealis.⁴ In fact, the clouds remained luminous until three hours after sunset.

¹ See NATURE, vol. 33, pp. 220 and 486.

² "Perlemorskyer," *Christiania Videnskabselskabs Forhandlinger* for 1893, and "Irisierende Wolken," *Meteorologische Zeitschrift*, March 1893.

³ "Photogrammetrische Bestimmung der Höhe von irisierende Wolken (Perlmutterwolken) am 30. Dec. 1926." *Geofysiske Publikasjoner*, vol. 5, No. 3. Oslo, 1926.

⁴ *Geofysiske Publikationer*, vol. 1, No. 5. Oslo.

FIG. 3.—Photograph taken simultaneously with the preceding one (Fig. 2), from Oscarsborg.

Fig. 1 is from a photograph taken from Oslo just after sunset, through a red filter on panchromatic plates. The most luminous parts shone in beautiful colours like mother-of-pearl.

One of the best pairs of simultaneous photographs was taken at 16 h. 40 m. 30 s. G.M.T. to the west. Fig. 2 and Fig. 3 are reproductions of the photographs taken from Oslo and Oscarsborg. The colours had then disappeared, but the clouds were still visible among the stars. In the photographs the star Atair is seen near the centre, ζ Aquilæ to the right, and the constellation Delphinus up to the left.

Along the outlines of the clouds we have chosen fourteen points, the positions of which are seen on the diagram Fig. 4.

As the distance separating the aurora stations is about 27 km., the parallax was great, which gave a very trustworthy determination of height.

The result was as follows :

Point.	Height.	Point.	Height.
1	25.3 km.	8	24.3 km.
2	25.6 "	9	23.4 "
3	26.1 "	10	24.5 "
4	25.1 "	11	23.1 "
5	24.8 "	12	23.0 "
6	22.4 "	13	23.9 "
7	24.3 "	14	22.3 "

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Thus we have the same order of altitude as the clouds photographed on Dec. 30, 1926.

As Prof. Mohn had already found, these remarkable clouds are associated with an atmospheric depression to the north of Oslo, giving typical Föhn from the mountains in the west and north with high temperature and clear weather. In this way it has been possible to have a view upwards through a cyclone in that part which is generally obscured by clouds and rain. It may be possible that the iridescent or nacreous clouds are much more common over the ascending part of a cyclone, but that they are in general invisible, except in the case where a Föhn makes that part transparent so that the nacreous clouds can be seen.

The preparation of the whole material obtained may give a good deal more information about these remarkable clouds.

FIG. 4.—The clouds as seen from Oslo are shown by complete lines and as seen from Oscarsborg by dotted lines; corresponding points have the same number. For each star two directions are marked: The vertical circle and the great circle through the star and the point K where the direction Oslo to Oscarsborg meets the sky (direction of parallax). On these directions are marked the height above the horizon and the angle between the direction of the star and of the point K.