

still look back on the work accomplished by Prof. Rudolf Wolf as a germ from which their work had developed, and as a monument of pains and industry. In his death, besides a true friend, we lose a thorough devotee to science, and we can ourselves mourn with his friends who say, "Und heute stehen seine Freunde aus allen Gauen des Vaterlandes trauernd am offenen Grabe, der Erde die sterbliche Hülle eines Mannes übergebend dessen geistige Grösse, persönliche Bescheidenheit und herzlichste, oft aufopfernde Liebenswürdigkeit allen die ihn gekannt haben unvergesslich bleiben wird." W. J. L.

CLOUD PHOTOGRAPHY.

LA NATURE recently printed an article by M. A. Angot on the methods he has been employing in order to obtain the excellent photographs of clouds exhibited at the Paris Physical Society at the beginning of last year. The following is a free translation of the article:—

It is well known that ordinary photographic plates are most sensitive to blue and violet rays; hence the blue background of the sky acts, in general, nearly as much upon the plates as the white parts of clouds, which are thus rendered almost or entirely indistinguishable upon the photograph. It is possible, however, easily to obtain views of an interesting effect when, on a background of blue sky, large clouds pass before the sun. The edges of the clouds are then lit up to such an extent that they make much stronger impressions upon the sensitive plate than the sky itself; the remainder of the cloud is, on the contrary, dark, grey or black, and does not come out as well as the sky. To obtain an accurate picture under these conditions it is necessary to develop with great care; or better, to use a dilute pyro developer—a few drops of bromide of potassium solution and very little pyro to begin with; the development is then slowly carried on with the addition of carbonate of soda, and pyro is only added again towards the end if the plate lacks clearness.

This method ceases to give good results when it is applied to ordinary clouds, and becomes altogether useless for cirrus clouds. But these are precisely the clouds the study of which is most interesting; they are composed not of water vapour, but of ice-needles; and their forms and movements are closely connected with changes of weather. Cirri are the most difficult to photograph because, being farther from us than other kinds, they are less brilliant; and further, when they are seen, the sky is very frequently pale blue in colour, or covered with a milky veil, which diminishes the contrast.

Numerous plans have been proposed to photograph cirrus clouds. The first consists in photographing from the summits of high mountains, but that method is not within the reach of everybody. At such places the sky is, in general, much darker, and the clouds are better seen upon the background, so that excellent photographic images can be obtained without special devices. Another method has been proposed by Prof. Rigggenbach, and appears to have some advantages. It consists in photographing the sky, using a diaphragm so small and giving an exposure so short that only a trace of the cloud-image

appears after development. The plate is then intensified, and the image brought out by means of bichloride of mercury and sodium sulpho-antimoniate. This method, however, has little to commend it. In the first place, intensification is always inconvenient and destroys details, and further, the sodium salt very rapidly deteriorates, so there is always a risk of the plates being spoiled by becoming a very intense yellow colour, or being covered with a metallic deposit.

Prof. Rigggenbach has suggested another and a better method, which is found to give excellent results. The method is based upon the fact that the blue light of the sky is partially polarised, whilst the light of clouds does not possess the same property. If, therefore, a convenient analyser (a Nicol's prism or black glass inclined at 55°) is placed in front of the lens of the camera, only a portion of skylight is obtained, while the light of the

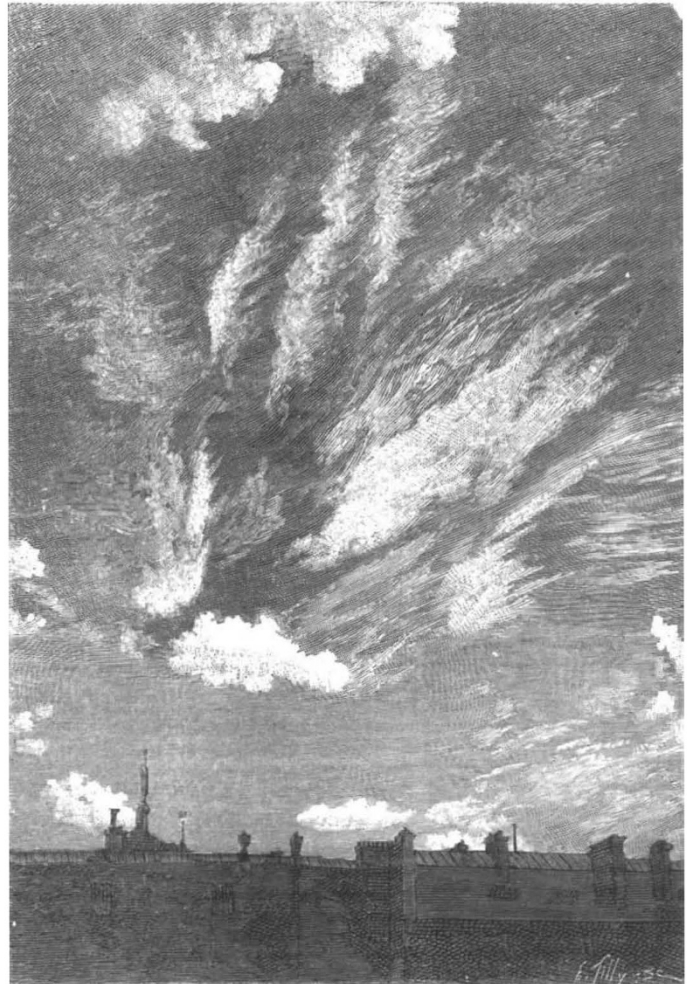


FIG. 1.—Cirrus Cloud preceding a Storm (March 31, 1892).

clouds remains unaltered, and the increased contrast renders it an easy matter to obtain a good picture. But at the same time, this method possesses inconveniences. The proportion of polarised light is far from being the same in all parts of the sky; hence it is not possible to photograph clouds in any direction. Moreover, many photographers object to the complications which are

involved in the introduction of an analyser in front of the lens of the camera.

There is still another method, unquestionably the most simple one, and the one which, at the same time, gives the best results: it is the employment of coloured screens. In front of the lens of the camera is placed a screen which transmits yellow and green rays, but is opaque to blue and violet rays. The light of clouds is rich in yellow and green rays; hence a large proportion of it is able to traverse the screen, and act upon the photographic plate, while, on the other hand, the blue background of the sky emits very little yellow light; in fact, the proportion of rays of this refrangibility decreases as the blue colour increases in depth, so its action upon the sensitive film is considerably diminished or altogether obviated. The only inconvenience of this method is that yellow and green rays have very little

now to have almost been abandoned. But this difficulty has been practically overcome by the production of the orthochromatic or isochromatic plates of commerce, which are sensitive to yellow and green light.

M. Angot finds that the best brands of plates for use in cloud photography are the Lumière orthochromatic and Edwards' isochromatic. Other brands have been tried, but none gave better results than these. As to the yellow screen, the best is obtained by placing a cell having parallel faces, about five or seven millimetres apart, in front of the lens, and filling it with an almost saturated solution of bichromate of potash to which a few drops of hydrochloric or sulphuric acid have been added. A mixture of saturated solutions of bichromate of potash and copper sulphate in the proportion of three of the former to one of the latter may also be employed. In either case the cell is hermetically sealed, and it can easily be fixed in front of the lens or behind it in the bellows of the camera.

Evidently it would be simplest to use a screen of coloured glass, and, as a matter of fact, certain glasses give as good results as the cell containing one of the above-mentioned solutions. But most yellow glasses are quite inadequate for the purpose. It is to be hoped that coloured-glass manufacturers will soon make a glass which will transmit exactly the same rays as the solutions. It will be a good thing to have a series of glasses of graduated tints; the clearest to serve for very bright white clouds standing out boldly upon a fine blue sky, while the darkest could be used for faint clouds when the blue colour of the sky is not so pronounced. The time of exposure must, of course, be increased as the glass used is increased in tint.

The two illustrations here given are reduced copies of two of M. Angot's negatives. The originals are eighteen centimetres long by thirteen wide.

Fig. 1 was obtained on March 31, 1892; it shows some patches of cumulus cloud, and an extremely remarkable sheaf of cirrus which preceded a violent storm by two hours. The second illustration (Fig. 2) shows a form intermediate between cirrus, properly so called, and cirro-cumulus, observed on February 19, 1893. Both these pictures were obtained by means of Lumière orthochromatic plates, with a cell containing a solution of potassium bichromate and copper sulphate, and a wide angle lens having a focal length of 0.160 metres. The aperture was cut down by means of a diaphragm of about one-twentieth the focal length, and the time of exposure for Fig. 1 was three-quarters of a second, and one-half a second for Fig. 2. The usual developers may be employed, but pyrogallic acid was used by M. Angot on account of the latitude of exposure it permits.

As photography is being widely used in the future to increase our knowledge of clouds, it is recommended that the date and hour of exposure be written upon each picture. M. Angot's photographs are a sufficient testimony of the excellence of his method of work, and their multiplication in different parts of the world would considerably extend our knowledge of cirrus clouds, and very probably prove of use in forecasting weather.

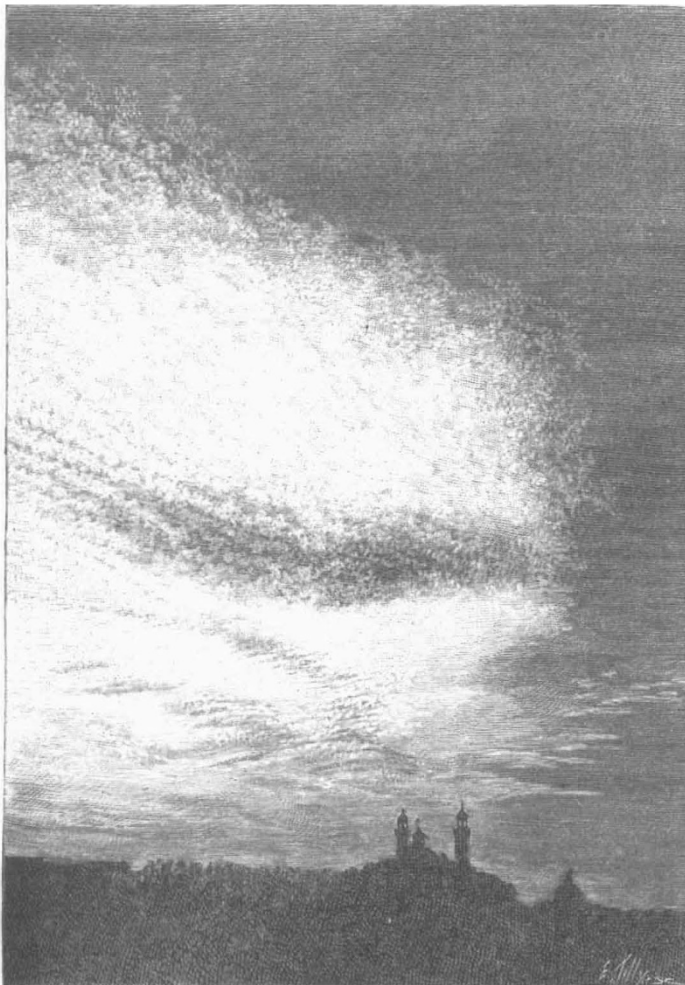


FIG. 2.—Cirrus and Cirro-cumulus (February 19, 1893.)

action upon an ordinary photographic plate. Under these circumstances it would be necessary to give a very long exposure, which is impossible in cloud photography on account of the movements of the objects and the rapid changes of form. It is probably for this reason that coloured screens, which were adopted in the earliest stages of cloud photography, appear