

be limited to a simple communication of the more interesting results obtained by us from August 17 to September 22.

On reaching the summit of the Pic du Midi (2877 metres), where the barometer maintains a mean height of 538 mm., everything presents itself to the observer as if the density of the veil formed above him by the atmosphere were diminished by about a third. The aerial region left behind him being unquestionably the most charged with mist, dust, and aqueous vapour, he may expect to find at once more light and less diffusion. Thus, during the mornings of September 19 and 20, by masking the sun with a screen held at some distance, and exploring the surrounding space with a small spectroscope with an aperture of 0.02 m., we were able to observe the planet Venus at a distance of 2° from the solar disk. We could even subsequently distinguish it with the naked eye. But what most surprised us was the marvellous definition at this station. The limb of the sun projected on the slit of a spectroscope showed a spectrum with a boundary as sharp as if produced by a punching machine. We can positively state that we never elsewhere saw anything similar either at Nice, in Italy, Algeria, or even Upper Egypt. We should add that this complete absence of undulation was noticed only in the morning. After the slopes of the mountains had been exposed for several hours to the heat of the sun, the undulations were produced as they are everywhere else, and even became excessive for the rest of the day.

During clear nights, using a telescope with an aperture of 0.16 m., and a reflector by Henry of 0.20 m., we found the perfect definition observed in the case of the sun in the morning reproduced in the case of the moon, planets, and stars. Under such conditions observations of extreme precision could certainly have been obtained.

For the study of solar physics we had set up the horizontal telescope and the large spectroscope which we usually employ. On observing the solar spectrum at a favourable moment, it seemed streaked in its entire length with a considerable number of fine lines, some bright, others dark, at a mean distance of 3" of arc from each other. They certainly belonged to the solar image, for they followed all its displacements, and they could have arisen from the granulations of the photosphere alone. Under the same conditions, that is, when the images were perfectly still, the hydrogen bands C and F had no longer any sort of continuity, but seemed formed of distinct bright and dark fragments, of the same magnitudes as the intervals between the lines.¹ This phenomenon was observed not merely at certain times and places, but constantly over the whole surface of the disk. We feel satisfied that the chromosphere presents a system of granulations analogous to that of the photosphere. The two systems thus superimposed become separated in the spectroscope, yielding, one a continuous, the other a linear, spectrum, and blending together in the telescope as on a photographic proof. If this chromosphere, thus rendered visible on the full disk, happened to be traversed by a protuberance, the band C increased in luminosity and for a greater length. By giving sufficient breadth to the aperture, we were then able to observe the protuberance itself, as when on the edge, although naturally with less brilliance, and foreshortened. Nor is this the first instance of protuberances thus observed on the full disk. On this subject the delicate observations of Young and Tacchini are well known. But instead of being accidentally visible, instead of being produced only under special circumstances, as for instance in the neighbourhood of a spot or on the bridge of a spot in process of segmentation, these phenomena were constant for us with varying degrees of intensity, and under the sole condition of using an image entirely free from undulations.

These phenomena referred to by Messrs. Thollon and Trépid were observed and recorded in England under exceptionally fine atmospheric conditions during the last sunspot maximum.

The observations made outside the edge of the solar disk were no less pregnant with results. We know that in the spectrum of the chromosphere there are eight lines always visible under ordinary conditions. On the Pic du Midi, during the five days when we were able to make our records at favourable moments, we saw the number of these bright lines always visible increased to over thirty in the portion of the spectrum which is comprised between D and F. Here we subjoin a table of the wavelengths of these lines:—

5533.6	5273.2	5204.8	5122.6
5525.8	5258.9	5199.5	5114.4
5469.9	5254.3	5196.9	5112.1
5361.5	5252.2	5183.0	5087.0
5324.3	5248.8	5172.0	5029.8
5318.7	5233.9	5168.3	5017.9
5292.4	5225.6	5166.7	4983.6
5283.1	5207.4	5147.0	4923.0
5275.0	5206.8	5130.2	4882.9
			4854.2

It will be seen that, at the altitude at which our observations were made, an approach was made to the conditions prevailing during a total eclipse.

To resume. The observations we were able to make on the Pic du Midi during the five weeks of our sojourn on its summit justify us in concluding that science will gain much by the completion of the astronomical station begun by the directors of the Paris and Pic Observatories. Here we should have a permanent establishment always open to *savants* wishing to undertake special researches. To mention those points only towards which our attention was mainly directed, we are of opinion that good opportunities would here be found of furthering the solution of many problems connected with solar physics and the spectral analysis of the stars.

THE WHEAT HARVEST OF 1883

THE public must be somewhat puzzled with the divergent opinions of authorities upon the yield of the wheat crop of the present year. On the one side, for example, stands Sir John Lawes with his accurate balances and wonderful wheat field, which experience has taught him usually proves a fair criterion of the yield of the English crop. On the other side is arrayed a somewhat formidable party, which we may take as well represented and led by the very able article in the *Times* of Saturday last, headed "The Result of the Harvest." To put the matter briefly, there is a difference of opinion as to whether we have reaped an average crop or an under-average crop of wheat. And there is also a good deal of difference in opinion as to what an average crop is. The point of greater interest no doubt to us is whether we have just secured an abundant harvest or not. It is a point of very great importance not only intrinsically but as a matter of opinion. If business men believe that our national wealth has been recently increased by an unusual augmentation of our food supply, they may make this opinion a basis for enterprise or speculation. If the opinion which prompted them to action should prove a false one, the results would be inflation, panic, and loss. It is therefore very essential that public opinion should be guided in a right direction upon this important point. Any person who has read our leading newspapers carefully upon the subject of harvests for a series of years will probably have observed a tendency to over-estimate production. The prospect is usually depicted *couleur de rose*, and the public is congratulated upon its harvest prospects, while practical farmers remain in doubt as to the yield of their cornfields. Of one thing we may be certain—that wheat needs heat. The average temperature of our islands is scarcely suitable to the wheat plant, which is rightly viewed as somewhat exotic in its requirements. A slight elevation above the sea-level, or a slight decrease in solar heat, invari-

ably lowers the yield of wheat. Properly read with regard to its distribution throughout the season, the temperature of the summer months ought to guide us to a judgment with regard to the probable yield of wheat. It is the same with regard to wine. Good wheat and good wine years run together. 1868, 1870, and 1874 will probably all continue to be remembered as good wine years, and they are well known as among the best wheat years of the present half-century. In judging as to the effects of temperature upon the wheat crops, we must not only take average temperature but fluctuations between night and day. A single cold night may do incalculable damage, and a few cold days at blooming time may do much to blight a wheat-grower's prospects. Those who watch the weather closely will usually lay the foundation of a sound judgment upon wheat prospects. We require, first, a good seed time; second, a dry March; third, a hot June, July, and August. So much for the weather. We require also a good "plant," *i.e.* plenty of young wheat plants uniformly scattered over the surface. The growing crop must be fairly free from those unaccountable visitations known as "blights," both insect and vegetable, and if we can secure these good conditions we reap a good wheat crop. Let us then endeavour to apply these rules to the actual state of things during the months between seed time of 1882 and harvest of 1883, and let us glance at the various opinions expressed as to the yield of wheat for the present year in the light of these facts. First, then, we passed through a period of incessant rainfall during the time when farmers usually sow their wheat. A worse seed time we have rarely experienced. Constant rain and destructive floods were the characteristics of October, November, January, and February last. Now we owe to Sir John Lawes, in a great measure, the knowledge of the fact that a wet winter washes out that element of fertility which of all is the most important, namely, the nitrates. Here then we have to record a very wet winter, in which seeding was interrupted and nitrates were washed through into the drains and subsoil, and that to an unusual degree.

The consequence was that in the spring a thin plant was the rule upon all stiff soils. After this the wheat improved under the influence of a singularly fine spring, and farmers rejoiced in the opportunity afforded them to get on with their root cultivation. Unfortunately this state of things did not last. At the most critical period for the wheat crop summer forsook us. The nights became bitterly cold in June, and a continuation of wet weather set in which lasted almost up to harvest. Accompanying this untoward state of affairs were blights, and the ears became greatly affected with wheat-midge, smut, and ear-cockle, so that wheat-growers became sensible that their main crop was in extreme danger of ruin, and that before the papers began to publish their estimates.

This feeling among wheat-growers was quite general, as they knew that empty ears could not lead to full measures. Examination of the ears just before harvest showed clearly that small and shrivelled grains were only too common, and that many of the florets were barren. Accordingly crops were valued low, and the results from the threshing machine are bearing out the wisdom of these low valuations. As to Sir John Lawes' estimates, based on the experimental field at Rothamsted, no one knows better than Sir John that this coincidence between his average yield and that of the country generally must be liable to be upset by local disturbances. As a criterion of the harvest Sir John Lawes' field may be useful, but certainly cannot be infallible. A local frost, a local hail-storm, a local loss of plant, or faulty cultivation, must be always liable to affect any field and rob it of its general average character when compared with the harvest of millions of other acres. All this is simple truth, and in this season we are inclined to think that Sir John's field "told a flattering tale." The opinion of the writer of the

present article is based, first, upon the meteorological conditions to which the wheat crop was exposed during its growth. Secondly, upon his own experience as a grower. Thirdly, upon information obtained from other growers, and from observation and reading.

He has come to the conclusion that the wheat crop of 1883 is below an average, and will be disappointing to the grower. Not only was the crop subjected to many bad conditions during its growth, but a large proportion of it was badly harvested, and is now in wretched condition. If we are not deeply disappointed with the 20 to 26 bushels of wheat per acre which our own liberally treated crops are yielding of *marketable* corn, it is because we have never expected more since those frosty nights of last June, when we resigned our hopes of a good wheat crop. The subject is almost too long for treating in a single article, and we must leave it here. If space had permitted, we should have entered upon the question as to what constitutes an average crop of wheat—a point upon which we appear to be in a state of great ignorance, unless we are to believe that an average which thousands of our best farmers have not been able to touch for the last ten or twelve years is that of the entire country with its millions of badly cultivated acres. This we cannot admit, and after a careful study of the estimates made as to average yield in various counties, we are driven to the same conclusion as that of the writer to the *Times* last Saturday, namely, that little reliance is to be placed upon them. Average, over-average, and under-average are somewhat vague terms, and difficult to fix. We can, however, base an opinion upon the fact that cheerless, cold, and wet summers that are unfavourable for fruit, bees, and vines, or even to pleasure parties, lawn tennis, and picnics, are not going to be favourable to wheat-growers. We have not touched upon barley and oats, but are prepared to allow that circumstances have been more favourable towards these crops than towards the most important cereal.

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ON A NEW METHOD OF SINKING SHAFTS IN WATERY, RUNNING GROUND

WHEN an attempt is made to sink a shaft in very watery deposits of gravel, sand, and mud in the ordinary way—that is, by digging out the solid matter by hand and pumping the water to keep the bottom dry—it is found that, after a certain depth has been reached, the current of water which flows up through the bottom brings solid matters along with it as fast as they can be removed, and further downward progress is then completely arrested. Under these circumstances it is necessary to resort to certain special methods of sinking, two of which have been hitherto employed with more or less success. According to one of these methods the shaft-lining consists of an air-tight iron cylinder fitted with an air-tight cover. When the excavation is continued below the natural level of the water, compressed air is forced into the interior of the shaft so as to drive back the water and leave the bottom dry. The workmen can then stand in the bottom and remove the solid matter by hand as easily as if the ground had been naturally free from water. The lining sinks downward as its lower end is laid bare, and is lengthened at the top as required. The pressure of the air is gradually augmented as the depth increases, but unfortunately this process cannot be carried beyond three atmospheres without prejudicially affecting the health of the workmen. When the depth of the watery running ground surpasses the limit represented by a pressure of three atmospheres, it is necessary to resort to the second method. In this case the water is allowed to stand at its natural level in the shaft, and the solid matters are removed from the bottom by a revolving dredger. The lining or casing consists of a cylinder of masonry or iron