SCIENCE

NEW YORK, JULY 31, 1891.

THE UPPER STRATA OF THE ATMOSPHERE.

At a meeting of the Geographical Society of Berlin on May 2, 1891, Professor Förster read a paper on "The Upper Strata of the Atmosphere," a report of which is given in the Proceedings of the Royal Geographical Society for July. Professor Förster began by saying that the earlier conceptions of the height of the earth's atmosphere were based mainly upon observations as to the duration of the twilight, and as to the extent to which the light of the heavenly bodies was refracted. On the basis of such observations, the height of the atmosphere was estimated at from forty to fifty miles; it was not, however, by any means thought that, above these altitudes, there were no other strata belonging to the earth, but only that the density of the latter was too small for them to produce the optical effects just specified. The discovery of a means of determining the existence of such extremely thin strata beyond a height of fifty miles dates from the end of the eighteenth century, when attempts were first made to measure, according to Chladni's principles, the heights at which the first illumination of falling stars takes place.

A specially comprehensive investigation with reference to these heights was carried out at the instance of the Berlin Observatory in August, 1867, by means of simultaneous observations in the neighborhood of Berlin, with the result that not one of the altitudes at which illumination commences, and which were measured with sufficient accuracy, was found to exceed practically a hundred miles. These results, however, possess only a relative value, being valid only for the falling stars of the month of August, the so-called Perseides; for it is evident that illumination will arise earlier or later, and at different altitudes, according to the varying velocities with which the small heavenly bodies penetrate the atmosphere. Illumination will take place earliest in the case of those falling stars which move in a directly opposite direction to the movement of the earth, which travels at about nineteen miles per second. These heavenly bodies, possessing a velocity of their own of about twenty-six miles per second, consequently enter the earth's atmosphere with a velocity of forty-five miles; while in the case of those bodies which tend to be overtaken by the earth in their movement round the sun, the velocity can, in the most extreme case, only be equal to the difference between the two velocities above-mentioned, viz., seven miles.

The altitudes at which extinction, that is to say, the almost complete dissolution of these heavenly bodies, commences, vary very much, because the rapidity of the extinction is dependent upon the size and composition of the bodies themselves. The Berlin observations of 1867 gave for this an average height of about fifty miles. From these observations as to falling stars it is also supposed that the boundary between the strata which participate in the earth's movement and those which resist it should be fixed at least at some miles higher than a hundred miles. It is here also that the bodies become heated prior to their illumination.

The polar lights extend to still greater altitudes; their height, at the time of their greatest development, when they are visible as far as the tropics, would be from 300 to 375 miles, while in the polar regions they spread themselves, as a rule, at a height of only a few miles, indeed quite close to the earth's surface. But there remains the question whether at those altitudes there are still strata which follow the movement of the earth round the sun; for it is possible that the phenomena of the electric glow, which the polar lights may be considered to be, radiate from the earth into the heavens, follow also the earth's movement round the sun, but at the same time extend beyond the strata belonging to the earth into the strata of extremely rarefied gases, which in all probability fill up the space between the planets and the sun. This space may be designated as the "Himmelsluft," and is not to be confounded with the so-called "ideal medium," viz., ether, in which luminous phenomena are supposed to occur.

Evidence in support of the existence of such a "Himmelsluft" is to be found in the conditions existing on the sun, which are gradually becoming more completely known. On the sun, gases are continually being developed and given off as the result of explosive processes as well as of the dissolution and volatilization of the numerous small meteoric bodies which are incessantly hastening to the sun. Further, the movement of Encke's comet, which, in its return, occurring in periods of twelve hundred days, remains longest in the vicinity of the sun, has furnished important evidence of the obstructive effect of a so-called "Himmelsluft." The movements of other comets and of the planets have not yet afforded evidence of such an influence, but it must be borne in mind that the perceptibility of such an effect depends not only on the density, which increases towards the sun, but also on the proportion which the surface of the heavenly body in question bears to its mass. This proportion is very much greater in the case of comets than in the case of planets, and may also in one comet be much greater under certain conditions than in others.

Indications of the counter-influence of the relatively quiet "Himmelsluft" as compared with the earth, which rushes through it with a velocity of about nineteen miles per second, can be recognized in the highest strata in the case of the movements of the luminous tails and clouds of light which many falling stars and fireballs leave behind them along their flying course, that is, when these remain visible for some minutes. The changes of position and form, which proceed apparently very slowly in these luminous forms, due regard being paid to their great height and distance from the observer, are supposed to be executed with a velocity of more than sixty yards a second. The movements which take place in these meteoric tails are, according to all appearances, not so simple that they can be explained merely as being the result of the highest strata being left behind in consequence of the velocity with which the observer on the earth's surface is being whirled along, and which at the equator amounts to seventeen miles a minute, and at our latitudes to about eleven miles a minute. The very considerable alterations of form which these tails undergo in shift-

ing their position, point to very complicated conditions of movement. But the counter-influence of "Himmelsluft," as compared with the movement of the earth round the sun, is a necessary consequence, not only of the movements in the highest strata of the atmosphere, but also of the effects of pressure, which could not remain unnoticed in the case of very delicate barometrical measurements. If the daily period of fluctuation of the atmospheric pressure were not influenced by so many different factors, — for example, by the daily warm period and, theoretically at least, by a certain operation of ebb and flow caused by the sun and the moon through their powers of attraction in the atmosphere as well as in the ocean, and perhaps also by the electrical conditions of the atmosphere, — there must be, at that time of day at which a given station arrives, in consequence of the earth's rotation, on the front side of the mighty "vessel" which transports us round the sun with a velocity of nineteen miles a second, a somewhat greater atmospheric pressure. This time of day is, as a rule, between midnight and midday.

In the polar regions the state of affairs is a little more complicated. In these zones an observer can, during the winter, for a longer or shorter period, according to the geographical latitudes, remain on the front side of the earth, while in summer he finds himself turned over on to the back of the earth, viz., on that side which is away from the direction of movement. In lower latitudes the mercury in the barometer must always stand higher during the morning hours than during the rest of the day. In consequence of the collective effect of the various factors which influence the daily period of the pressure of the atmosphere, the result is a very complicated one.

Within the last five or six years a group of phenomena has arisen, which is of the greatest importance in considering the problem of the conditions in the upper strata of the atmosphere. The last of the series of phenomena connected with the Krakatoa eruption are the so-called luminous clouds, which have since that time been observed during the night in the summer months on both hemispheres at a height of about fifty miles. These clouds consist obviously of the smallest molecules of water, which have been projected to their highest point, and which during the summer nights have reflected down upon us from that great height the direct rays of the sun. The long duration of this phenomenon makes it a very remarkable one. During the last two years, for which very accurate photographic determinations of altitude are available, the average height of these clouds has not altered. This can only be explained if we suppose the existence in those altitudes of an opposing force, which nearly overcomes the influence of gravity, in consequence of the giving off of electricity.

In the last few years not only has the density of this collection of matter been very materially lessened, but its geographical and periodical distribution over the different regions of the globe has become more restricted and regular. In Germany these clouds have, during the last three years, only been seen between the end of May and the end of July, towards the north, at a distance of from 310 to 435 miles; on the southern hemisphere, at the southern extremity of America, only during the local summer (December), and then towards the south. It may, therefore, be supposed that this collection of the smallest molecules travels every year from one polar zone of the earth to the other, so that it is found just over that hemisphere where summer is at its height. This periodical movement would be completely unintelligible if the counter-influence of the "Himmelsluft" on those high strata of the atmosphere which participate more or less entirely in the rotation of the earth on its axis and round the sun, did not furnish an explanation. In consequence of the inclined position of the earth's axis, and of the counter-effect of the "Himmelsluft," there occurs from June to December a disposition, reaching its maximum in September, on the part of those strata, to travel from the northern to the southern hemisphere; while from December to June the reverse is the case. It is calculated that for such a periodical journey from pole to pole an average velocity in the north and south direction, or *vice versa*, of only little more than a yard a minute is necessary, a rate which is quite insignificant when compared with the velocity of nineteen miles a second, with which the relatively quiet "Himmelsluft" operates on the upper strata of the atmosphere which move with the earth.

Extensive investigations and measurements are still needed in order to arrive at a result in this matter, and it is only by means of the fullest co-operation of numerous observers in all parts of the world that the necessary data for this purpose will be obtained.

MILK FROM TUBERCULOUS COWS.

ACCORDING to a report by United States Consul Ryder of Copenhagen experiments have been resumed in Denmark towards elucidating the question whether milk from tubercular diseased cows, even in such cases where the udder was not affected with tuberculosis, can be the means of communicating infection. In these experiments the investigation was made in all with the milk from twenty-one diseased cows, with which forty guinea-pigs were inoculated. It had been intended that two guinea-pigs should be inoculated from each sample; but in two cases, owing to the number of these animals having fallen short, only one guinea-pig could be employed, from two to three cubic centimetres of milk being used on each occasion. The milk samples were taken by the veterinary surgeon of the cattle market, the cows being milked by him and the milk caught up into small bottles. The veterinarian selected only such cows as, on examination during life, could be classed by him as suffering in a high degree from tuberculosis; and in every case the udder and chest intestines of the animals were afterwards sent for examination, so as to obtain full assurance of the correctness of the diagnosis, as well as to ascertain the extent of development of the disease. The inoculated guinea-pigs were kept in isolated cages in such manner that only the two which had received milk from the same cow came into contact with each other. Three of the guinea-pigs were killed by rats, fortunately, however, at such distance of time (24 or 25 days) after inoculation that the inoculated tuberculosis must have shown itself had it been present. Two others died of casual (not tuberculous) lung disease after the lapse of a month and a half and two months, having no sign whatever of tuberculosis.

The results obtained from these inoculations are that milk from seventeen of the examined cows had no influence in producing tuberculosis in the guinea-pigs, while the milk from four of the cows showed itself to be communicative of infection; but in three of these cases, on examination of the udder most minutely, this could scarcely be considered in a perfectly sound state. In the one case two small tumors were found of about the size of a pea; in the two others, o the size of a hazel-nut; but in all the cases, with a sligh