

## FOG, CLOUD, AND SUNSHINE.

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*Being the Sixth of a series of lectures on Meteorology in relation to Hygiene. Delivered May 10th, 1894.*

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It must be evident, to all who consider the matter carefully, that either of the subjects proposed for this lecture—Fog, Cloud, or Sunshine—would furnish abundant material sufficient for a lecture, without the aid of the other two; so that if those whom I address find many points neglected on which they would gladly have heard something, I trust that they will understand that the question of “time” is the only one which prevents me from dealing with them more fully than I would otherwise have done. I must ask my hearers, therefore, to leave to me the selection of the points on which I may touch, and also for their indulgence while I deal with them as fully as I can.

To begin—Fog, as we are about to consider it, is an aggregation in the lower stratum of the atmosphere, of myriads of minute particles of water, now pretty well known as “water dust.” Its most conspicuous effect is the obstruction of rays of light through the atmosphere—the obstruction varying in intensity with the fog’s density. It appears sometimes in a “wet” condition, moistening to a considerable extent bodies exposed to its influence, producing the sensation of exceedingly minute rain drops on the face, &c., and dropping from the boughs of trees as though they had been rained on; at other times it is in a comparatively dry condition—not damping, or scarcely damping, objects exposed to it, not producing the sensation of minute rain drops falling on the face, and not dropping from trees, &c., as the wetter fogs do. In large towns and cities a very dry modification is often observed, the causes of which are mainly local, but in all true fogs the basis of the phenomenon is the water dust extracted from the atmosphere, or introduced into it by some moist object.

Fog may be formed in various ways, *e.g.*, (1) by the contact of two air currents, the temperature of which when mingled is rather lower than that of their dew-point; (2) by a damp air current passing over some cold object (such as a cold river), when the colder object condenses into a shallow fog the vapour in the lower part of the air; (3) by the advent of a cold air current over relatively warm water, when the water discharges into the air vapour, which at its existing temperature the air is unable to hold in suspension, and which consequently assumes the form of fog. The most common way is by the rapid cooling of the earth’s surface by the radiation of its heat into space

during long, clear, quiet, nights, when the temperature falls below the dew-point; the air being still, its moisture is thus changed into fog, which appears first at the ground and gradually spreads upwards. Valleys are excellent localities in which this operation may be carried on, the air being kept very still by the surrounding hills, while the radiation of heat goes on interruptedly, both from the valley and the hill sides.

Now it has been shown by Dr. Aitken that an excess of vapour may exist in any given space, and appear in the form of heavy dew without the appearance of fog, provided the atmosphere be entirely free from particles of dust or smoke, but that the introduction of extremely minute dust at once brings about its condensation in the form of fog—the dust particles forming a series of nuclei, round which the water can collect. We might consequently expect that the smoke produced in large towns would turn them into positions peculiarly favourable for the development of fog, when the atmospheric conditions already referred to have been established. This is found to occur, and, as many or most, of our largest towns lie in river valleys, they are completely adapted to become fog-producing centres, and are for other reasons also, the localities in which the phenomenon is exhibited in its worst aspects. The mere term “London Fog” has earned for itself a most unenviable reputation, and most of our large cities are somewhat similarly notorious, but yield to the Metropolis as regards both frequency and intensity on account of its enormous size.

Let us now reconsider what are the atmospheric conditions favourable for the development of fog. They are still calm air, low temperature, a clear sky, and (some add) high barometric pressure. The last named, however, may probably be only incidentally present when the other features are secured, and take no active part in the fog-making. Of the two great weather systems which present themselves to us in nature (the Cyclonic and Anticyclonic) it is the latter which brings to us the requisite conditions, and this chiefly during the colder half of the year. In this system the pressure is high and uniform, the temperature low, the wind light or calm, and the sky clear. No sooner are such conditions established than the fog begins to appear—first in the large cities and towns, then in the lower parts of the country, and the longer the anticyclonic conditions last, the worse the fog becomes in the cities and towns which it covers. The chief qualities of dry (anticyclonic) fogs in towns are well known; they obstruct light to such an extent that on some occasions an object at from three to five feet distant is invisible even in daytime; they invade public buildings and private dwellings, and are apparently uninfluenced by the presence of even a bright fire, or high temperature in the room;

(I have known a room full of fog with the temperature artificially raised to 70° F.) Dry fogs also obstruct the free radiation of heat, so that while the sun's heat rays do not reach us from above, the warmth generated by the thousands of fires in the towns cannot escape freely into the higher parts of the atmosphere; the result is that during fogs the temperature within towns is often very many degrees higher than that registered in the suburbs where the sky is clear. Nor is this all, for fogs prevent the free escape of sulphurous and other vapours, emanating from chimneys, and putrescent matter from other sources, to the serious injury of the inhabitants, and of plants exposed to their influence. London and other large towns are at times for days together in a state of complete or nearly complete darkness, and often the air becomes so charged with soot, sulphur, and various other injurious matters, that the mucous membranes are affected to a serious extent, and people suffering from delicate membranes succumb in large numbers; others suffer seriously, but not fatally, and none fully escape discomfort. In the open country these conditions are not nearly so prevalent, and even within the urban districts, dwellers in the thinly populated parts suffer less than those in parts where the population is more dense and the position more central. It is the domestic fires which contribute the lion's share of the poisonous ingredients, and it has not yet been satisfactorily *proved* that the burning of so-called "smokeless" coal would do very much to ameliorate the evil.

The following Tables are compiled from Values given by the "Manchester Field-Naturalists and Archæologists' Society":—

TABLE 1.

Showing the maximum and minimum amounts of Sulphur found in the air at the Town Hall, Manchester, during each of the months, September, 1891 to August, 1892. [Expressed in milligrammes of  $S O_3$  per 100 cubic ft. of air.]

Months.	Max.	Min.	Means.
1891. September .....	2.7	1.0	2.0
October .....	6.8	1.2	3.4
November .....	14.0	2.9	6.2
December .....	20.5	3.4	10.1
1892. January .....	12.7	4.7	9.1
February .....	8.9	5.6	7.1
March .....	26.7	7.6	12.7
April .....	18.5	5.1	10.3
May .....	4.1	2.7	3.4
June .....	4.4	1.3	2.6
July .....	2.4	1.0	1.7
August .....	4.4	3.0	3.9
Means—all Months .....	10.5	3.3	{ 9.3 Nov. to April. 2.8 in the other 6 mons.

TABLE 2.

Showing from observations made at Owens College, Manchester, the amount of organic matter suspended in the air on the dates named. [Values are given according to the number of milligrammes of oxygen required to oxidize the organic matter in 1,000 cubic feet of air.]

Dates.	A*	B*	C*	Totals.	Weather.
1891. Sept. 16...	0.7	Nil.	Nil.	0.7	Dull.
Oct. 20...	0.8	0.4	1.3	2.5	Clear.
" 22...	3.0	3.2	0.8	7.0	Rather hazy.
" 24...	7.3	5.2	1.0	13.5	Light fog.
Nov. 6...	6.0	6.5	1.7	14.2	Do.
Dec. 21	14.6	5.2	8.2	28.0	Dense fog.
" 22	7.5	16.9	5.3	29.7	
" 23	17.1	14.3	9.3	40.7	
1892. July 30...	3.0	2.8	1.3	7.1	Gloomy.
Sept. 6-8	2.5	1.3	0.4	4.4	Hazy.

\* A=Highly putrescible matter; B=Less putrescible matter; C=Soot.

It is impossible in the limits here available to discuss these Tables fully; but it may be pointed out that the figures in Table 1 show, that in the months most subject to fog the objectionable inorganic matter discovered in the air increases rapidly. Table 2 shows that the putrescible matter also present is in much larger quantities in foggy than in clear weather.

The next Table points to the results of these conditions as they make themselves felt in the death-rate from Pulmonary diseases only. The figures represent the annual death-rate per 100,000 of the population, in the different quarters of the years named.

TABLE 3.

Dates.	Manchester.		Glasgow.	
	Least Populated Area.	Ancoats. (Densely Populated.)	Least Populated.	Densely Populated.
1890. 4th Quarter	132	430	For one Year.	1600
1891. 1st "	163	407		
2nd "	171	490		
3rd "	68	417		
4th "	132	340		
1892. 1st "	139	360	870	1600
2nd "	101	257		
3rd "	57	209		

These Tables referring to Manchester have been selected because we hear so much about London and its fogs, that many people seem to think that other large towns escape.

I must pass on, however, to consider for a moment the more humid kind of fogs. These too obstruct the passage of rays of light through the atmosphere, but beyond this they and the drier

fogs appear to have no features in common. Their effect on the parts of the body exposed to them is, as before stated, almost like exceedingly minute droplets of rain, and during their continuance the water pours down from boughs of trees just as it does when rain is falling. Their temperature is decidedly higher than that of the drier fogs we have just been considering, they do not irritate the mucous membranes, but are liable to cause severe colds in those who are unduly exposed to them. Although they often appear at times when the general distribution of pressure is high and anticyclonic, yet it is commonly found that an exceedingly faint cyclonic circulation has been set up in the immediate locality where they are developed, and it is not uncommon to find this feature at the end of a long period of dry fog, heralding the breaking up of the conditions which have produced it. The matter is now under discussion by Mr. R. H. Scott, and it will therefore be only right for me to leave it for the present without further remark. The next Table (4) is from a paper read by Mr. Scott before the Royal Meteorological Society; it shows the number of foggy days reported at certain stations in the fifteen years 1876—90, and is the most complete record available.

TABLE 4.  
MONTHLY TOTALS OF FOGS, 1876—1890.

STATION.	Jan.	Feb.	Mar.	April	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Sumburgh Head .....	5	1	9	8	23	30	44	47	18	11	5	1
Stornoway .....	3	6	8	6	6	9	11	7	10	4	5	4
Wick ... ..	14	5	6	17	39	36	32	40	17	10	5	3
Nairn .....	6	1	5	7	6	16	7	8	14	2	3	2
Aberdeen .....	10	6	9	10	11	16	15	11	10	5	4	1
Leith .....	36	33	23	14	10	8	9	10	34	47	69	52
North Shields .....	45	33	33	21	29	21	9	28	54	54	49	68
York .....	73	32	16	8	4	0	0	8	23	51	62	69
Nottingham .....	57	34	34	9	0	4	2	18	52	72	47	62
Ardrossan .....	97	89	61	54	28	31	14	30	62	82	69	96
Donaghadee .....	10	2	3	3	2	14	13	8	17	11	8	2
Liverpool (Bidston) .....	50	34	22	8	5	7	4	16	22	45	45	51
Holyhead .....	35	37	24	23	18	19	17	16	18	23	9	23
Valencia .....	9	9	2	7	4	1	3	12	8	15	6	5
Roche's Point .....	24	14	17	15	17	37	22	30	23	15	16	25
Pembroke (St. Ann's Head) ...	45	40	41	25	41	55	54	38	41	15	25	26
Scilly .....	38	35	33	24	48	77	64	66	48	17	23	23
Hurst Castle .....	44	29	34	18	13	22	9	13	29	18	19	40
Dover .....	36	38	29	25	16	30	15	19	6	27	21	48
London .....	131	84	73	32	16	7	7	10	82	132	117	143
Oxford .....	103	58	42	15	3	1	2	10	61	87	101	116
Cambridge .....	18	10	4	3	1	0	0	3	4	13	14	26
Yarmouth .....	144	97	59	42	24	16	6	12	32	79	97	134
Totals .....	1033	718	587	394	373	457	359	469	685	835	819	1020

We cannot help seeing here, that in the colder months the E. and S.E. stations are much more foggy than those in the W. and N.W., as the former are influenced more by the Continental anticyclones than the latter; but in the summer months the W. and S.W. stations have the largest number, under the influence of the Atlantic anticyclones which then approach our S.W. coast somewhat closely.

We come now to the question of clouds. Fog may be looked upon as raw material, clouds are the fully developed, or "manufactured" articles. That there is a vital difference between fogs and clouds I am quite satisfied, but this is hardly the place, even if there were the time, to enlarge on this part of the subject.

It may nevertheless be noted that it is only while the fog lies in contact with the earth that it is sheet-like in form, that as soon as it "lifts" it assumes a form (when it assumes any definite form at all) which approximates to the cumulus rather than the stratus form, and that frequently it disappears speedily by evaporation, much the same as the steam from the funnel of a locomotive engine disappears even when the air is fairly damp.

Let us proceed to consider the two main classes of cloud as they appear in nature, and see what we can find of interest and value in them. Starting first with those of the "Cumulus" type, we find that they consist of a heap of water particles, piled up like masses of cotton wool, rising from a horizontal base. The variations in its colour (white, dark, or silver edged) depend wholly on their position with regard to the Sun or Moon—the darker portions being those which are thrown into shade by its other parts, or by some other cloud coming between them and the source of light, while the lighter and often brilliant portions are those which reflect the rays of the sun or let these rays pass through from behind. The upper edges of the true *cumuli* are rounded and sharply defined, but the base is looser and more horizontal. These clouds may be small, and appear in detached portions drifting over the sky, or they may be piled in vast masses to a great height, and in this form are best observed when hanging far away on the horizon, in enormous heaps, which sailors say indicates a shift of the wind to the quarter in which the bank is observed. To such banks the term "piled cumuli" has sometimes been applied. On other occasions, and notably in thundery weather, portions of these banks rise up like enormous turrets, above the general mass, and change their form rapidly; and at all times the cumuli form objects of great beauty, and reflect the rays of the light from the Sun and Moon with ever varying effect. As a rule the smaller cumuli are fine weather clouds, but it often happens

that the larger masses undergo a change in their upper parts which assume a *cirri-form* structure; and when this occurs, or when the upper portion of the cloud unites itself with a layer of stratus cloud in its neighbourhood, the cumulus becomes changed into the "cumulo stratus," of Luke Howard. It has recently become usual to call this variety "cumulo nimbus," as heavy passing showers fall from it, accompanied frequently by thunder and lightning. The illustration presented on the screen leads to the conclusion that a thunder shower was in progress at the time the photograph was taken, as some high electric strati are seen above the cumulus bank, and the "breaking off" of the upper surface of the cumulus is of a very decided character. Should this process of disintegration be continued, the cumulus is steadily reduced in size, becomes *cirri-form* all round, and in no way resembles the cloud in its earlier stages; inexperienced observers have in fact been known to call such clouds "low cirrus." The bases of cumuli are often observed at about 3,000 feet above the earth's surface, while their summits rise many thousands of feet upwards and pierce the strata of higher cloud-forms, yet to be described. More commonly however, the bases of the clouds appear at a higher level, and it may be taken as a rule that the higher the altitude of the base, the smaller is the vertical measurement, or thickness, of the cloud, so that it is at last hard to distinguish between such clouds and certain others of the *stratus* type; in this condition the term "*strato-cumulus*" is now commonly applied to the form. The above are the main characteristics of the cumuli.

We have now to consider that class of cloud whose distinctive feature is that they assume the form of sheets, or layers, in contradistinction to the massed or heaped form of the cumuli. Sheet-clouds are known under the general term of *Stratus*, and appear at various elevations from a few, to many thousands of, feet. Many observers include even ground fog among them: even if this were correct the fogs have already been dealt with at great length in this lecture and time forbids our dealing with them any further. There are, however, many physical reasons why surface fog should not be looked upon as a "cloud" at all, and still more why it should not be classed among the *strati*.

Now *stratus* clouds while ever maintaining their sheet-like character appear nevertheless in a variety of detail as to internal structure. Sometimes they are seen as a continuous sheet covering the whole sky, sometimes in detached and somewhat rounded masses, or cloudlets, which as a vast flotilla pass over the sky; still further the cloudlets themselves vary greatly in form, and may be usually arranged in classes, each

of which has its own significance. Sometimes these clouds rise in turret-like form from a horizontal base, and sometimes they are "cirriform" or hair-like in structure. I cannot show you pictures of the *continuous* form because it presents no distinctive texture which can be photographed. It is merely a vast uniform canopy of cloud, varying greatly in height. Now it is the "anticyclonic stratus," which often envelopes our skies in winter during long continued quiet weather and easterly winds, then as the thin film of ice particles, called "cirrus haze" floating at an altitude of many thousands of feet, causing Solar and Lunar Halos, and often so thin that the solar rays passing through are sufficiently strong to throw a well defined shadow of objects which stand on the earth's surface. At intermediate heights it forms a canopy which often precedes rain, and which when united with some other varieties, forms the "*strato nimbus*," or cloud of continuous rain. On a screen, however, if we throw a photograph of a low form of stratus, separated into detached masses through which the light of the sun steals and behind which his image is reflected in the sea, the type will be readily detected. This is the form which usually appears at the same level as the strato-cumulus already referred to, and you will observe that it is of considerable density and the horizontal measurements of the various cloudlets are large. In other cases we meet with the stratus in a thinner and higher form, the "cirro-cumulus" of most authorities, and the "mackerel sky" or "sheep sky" referred to in general conversation. In these the cloudlets are distinctly thinner than in those previously mentioned; a large portion appears white from the sun's light having pierced it, but there are still well-defined "shadows" in each cloudlet. Sometimes the cloudlets are elongated considerably into a form resembling the section of a double convex lens, and are hence termed by the Rev. W. C. Ley, "lenticular" stratus, while others appear like rather dense masses of sea-weed or heavy feathers and may be called "cirriform"-stratus or cirro-stratus.

These forms of the *Stratus* are (as a rule) composed of water particles and are responsible for those burrs and coronæ which appear from time to time round the sun and moon, but as we go still higher—say to 20,000 feet or more—we come to the still thinner clouds of precisely similiar structure, but composed of ice particles, and constituting the "high cirro-cumulus," the true cirrus (mare's tails), and the cirrus-haze forms, being thin they appear white as the solar rays pass through them, or cream-coloured when seen through haze. These are the clouds which produce halos, parhelia and paraselenæ, and they are the highest forms known.



Dr. Mill, in the second of this course of lectures, explained that the effect of vapour and clouds was to "temper" the heat and cold of the earth, and remarked that their effect in so doing is very great. He showed that while vapour in the air may be likened to the sheet and blanket of a bed, the clouds are like the Eiderdown quilt which kept the sleeper quite warm, although the temperature of the air in his room might be changing greatly. There is however another effect to which I would draw attention. Thin clouds are like the glass in a conservatory: the rays of "luminous-heat" pierce them and warm the earth, but the "dark-heat" which the earth reflects cannot get away again through them into space, and in this way we often find that at the close of a fine warm bright spell of weather in summer, we have a rather cloudy day with shade temperature far in excess of that of the brighter days which preceded it, and at the same time an oppressiveness beyond anything that can be accounted for by any change that may have taken place in the humidity or electrical condition of the air.

In passing from the stratus clouds at low to those at high levels, we find a law the same as that observed with clouds of the *cumulus* type, viz. the higher the cloud the thinner it is found to be, until in the highest regions the beautiful gossamer threads of the finest cirri alone are found, and beyond them cloud is unknown.

The reason is obvious. The earth, with its vast ocean surface, is the source of all the vapour out of which the cloud-forms are developed; some (of the *cumulus* type) are formed at the head of the columns of vapour as they rise slowly but directly from the earth, and, as it has been beautifully put, form the capitals of the pillars of vapour as they ascend from the earth; others, of the stratus type, are apparently due to large quantities of vapour, hurried from the earth to the higher regions in a cyclonic swirl, and thence carried out in the sheet-like form, as the ascending current spreads out towards the tops of the anticyclones by which it is fed. Naturally, therefore, from this cause and from the differences of temperature, the lower will be the thicker and denser varieties, the upper thin and transparent.

Reference must be made very briefly to the *mammato cumulus* and *mammato stratus* clouds observed from time to time. The former is often called the "pocky" cloud because it hangs down like large "pockets" from a horizontal base; at other times the pockets are small, and the appearance of the sky resembles more nearly that of a vast mushroom bed inverted—the mushroom heads being downwards. The Royal Meteorological Society has an excellent photograph of such a cloud. In the case of the *mammato stratus*, the *mammæ* are

still smaller, and the cloud has an appearance akin to that of the surface of boiling wax. I have repeatedly observed that they appear in that part of the country where Westerly winds are about to veer to N.W. But we must now not pursue the consideration of these matters further.

Once above the cloud level we come into the region of Bright Sunshine, and this brings us to the next subject with which I have to deal. By Bright Sunshine I mean those direct rays of sunlight which, escaping the clouds and fogs of our atmosphere, reach the earth's surface with strength sufficient to enable them on passing through a certain form of lens to leave a trace by burning, or scorching, on a carefully prepared strip of cardboard placed at the proper focal distance in the rear of a certain form of lens. The first instrument designed to record Bright Sunshine by burning was that invented by Dr. Campbell, and used for a long time in Whitehall. In it the solar rays passed through a spherical lens, placed within a wooden bowl. The heat rays burned these bowls, each of which was exposed for six months, into a series of furrows, in the manner shown by a specimen exhibited, kindly lent me by the Meteorological Council. The record is exceedingly interesting, but the difficulty of comparing the various bowls made it desirable to introduce something giving a clearer record. Professor (now Sir George Gabriel) Stokes soon devised a frame which should hold the necessary lens and cards, and I now show the instrument as it is in use at a large number of stations in the British Islands, and a modification of it made by Mr. Casella, of Holborn Bars.

Immediately after this instrument came into use, other inventions were brought forward to record, not so much the heating as the lighting power of the solar rays, and dependent on the intensity of the actinic rays. Two—and the chief ones—were designed by Mr. J. B. Jordan of the Home Office—one a very simple and cheap instrument, consisting of a cylinder carrying sensitized paper and perforated in two places by slits, through which the sun's rays could reach the interior: the other (the "Twin" recorder) more complex and expensive, giving a straight trace, on two separate pieces of paper which have to be joined after the "setting" of the trace is completed. It was found that these gave a record in excess of that of the "burning" recorders, but as a portion of the photographed record was faint, the simple process of washing it for "fixing" got rid of a great deal of the surplus, and the permanent record of the two instruments then agreed fairly well. Thus those who want the longer record may get it by measuring the trace before fixing, while those who wish for a record approximating more nearly to that of the Campbell-Stokes

instrument leave the measurement until the "fixing" is accomplished. For about fourteen years sunshine recorders have been at work, and in a publication called "Ten Years of Bright Sunshine" the Meteorological Office has placed before the world the monthly values for all the stations from which it was able to obtain the records. I have prepared two maps on which I have plotted the results of these observations. The maps give the mean number of hours recorded in the months of June and December during these years. That for June, the month in which the sun attains his greatest northern declination, shows that the sunniest parts of the kingdom are the Channel Islands, the Southern and Eastern parts of Ireland, and the Western, Southern, and South-eastern coasts of England. All these regions receive on an average more than 200 hours of bright sunshine in this month, and Jersey gets about 234, or more than 7 hours a day. Going northward, the record decreases to a mean of about 180 hours over the North-western and North-eastern districts, and naturally the large towns lag still further behind, Glasgow coming in with only 159 hours, Leicester 152, and Central London with 163. In the most favoured positions these numbers may seem fairly large, and yet at none of them is the record as much as one-half that of the interval during which the sun is above the horizon. The coasts are more sunny than the inland districts, the plains more than the hills. The map for December, when the sun is furthest south, shews that the mean number of sunshine hours has fallen to rather below 60 even in the most favoured parts of the kingdom (which, by the way, are still the Western and Southern coasts); in Leicester the number is only 28, at Glasgow 15, Greenwich 19, and the central parts of the City of London about 4. The difference between the coast and the inland values is increased in favour of the coasts, which at all seasons of the year are much more sunny than the inland counties. It would be interesting and indeed valuable if we could compare values for hills and valleys—some with towns, some without—we cannot yet, but doubtless this is a matter which, like the failings of most things in their infancy, will be set right by time. At present we can but speculate on the result of such a comparison with the probability that in most cases the hill tops would be the brighter on account of the fog in the valleys.

Of the hygienic properties of Sunlight, little need be said even if there were time. The cheering invigorating influence of bright sunshine is seen and felt by all, and has been recognised for so long, that even Solomon wrote, that a "good and pleasant thing it is to see the Sun." Plants and animals alike

rejoice in its presence, while in the absence of sunlight all beings become puny and weakly. Still we may have too much of a good thing—and over exposure to bright sunshine in tropical regions is the cause of diseases of the eye, especially in the regions covered by white sand or snow. We cannot, however, help rejoicing that recent investigation has brought out the fact that sunshine is a marvellous disinfectant, and its effects in destroying or rendering innocuous (if not actually useful) the microbes of certain diseases is beyond anything that could have been conceived. How far this discovery may modify the theories of medical treatment of some diseases, it is not within my power, my province, or my time to inquire—but the more intimate our knowledge of the distribution of the prevalence and of the intensity of bright sunshine becomes, the better shall we all be for it.

There is yet another important service that clouds can render—one of which Meteorologists in particular are glad. They enable us to detect the movements of the upper currents of the air in a manner that nothing else does. You will see at once that if we can but ascertain the altitudes at which the different varieties of clouds float in our atmosphere, we can by careful observation ascertain the movements of the upper currents, and thus solve many of the difficulties which confront us when we endeavour to discover the laws regulating the circulation of the wind in the different atmospheric systems. High level stations are very valuable, but then the hills introduce many complications by throwing the air currents out of their natural course. Balloons fail us just at the time when they are most wanted, but clouds often lend us their aid, and a good deal has already been done in utilizing their indications as aids to the forecasting of weather. Unhappily the lower clouds often conceal the upper, or render the detection of their movements very difficult, but Meteorologists have long ago learned, not merely that “half a loaf is better than no bread,” but that a very small “crust” is often a great blessing, and that nothing which contributes to our knowledge of the laws of nature is to be despised.

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