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AIR MINISTRY.  
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CLOUD FORMS

According to the  
INTERNATIONAL CLASSIFICATION.

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The Definitions and Descriptions

APPROVED BY THE  
INTERNATIONAL METEOROLOGICAL COMMITTEE  
IN 1910.

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WITH AN

Atlas of Photographs of Clouds

SELECTED FROM THE COLLECTION OF MR. G. A. CLARKE  
OF THE OBSERVATORY, ABERDEEN.

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*Issued by the Authority of the Meteorological Committee.*

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## ATLAS OF CLOUD FORMS.

- PLATE I. Type 1.—Stratus (St.). Level sheet of low cloud below 3,000 feet.
- PLATE II. Type 61.—Fracto-stratus (Fr. St.). Ragged Stratus. Drifting masses of low cloud.
- PLATE III. Type 2.—Nimbus (Nb.). Shapeless cloud with ragged lower edge and rain falling, base below 7,000 feet.
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- PLATE XIII. Type 93.—Cirro-cumulus (Ci. Cu.). Higher than *alto-cumulus*. Mackerel sky; layer of small cloudlets in waves.
- PLATE XIV. Type 73.—Alto-cumulus-lenticularis (A. Cu. lent.). Almond-shaped banks of cloudlets at *alto-cumulus* level.
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- 1.—Cloud Photographs from an Aeroplane Mammato-cumulus.  
Compound lenticular mass of Cirro-cumulus with the underside illuminated.

## CLOUD FORMS

### ACCORDING TO THE INTERNATIONAL CLASSIFICATION.

The Definitions and Descriptions approved by the International Meteorological Committee in 1910, with an Atlas of Photographs of Clouds selected from the Collection of Mr. G. A. Clarke, of the Observatory, Aberdeen.

The international classification of cloud-forms is based upon the four fundamental types of the classification proposed by Luke Howard at the beginning of the 19th Century, namely, **cirrus**, the thread-cloud; **cumulus**, the heap-cloud; **stratus**, the flat cloud or level sheet; and **nimbus**, the rain-cloud. The details of a more precise classification occupied the attention of meteorologists in many countries during the latter part of the century, among whom were specially prominent our own countrymen, the Rev. Clement Ley and the Hon. Ralph Abercromby. A book by Mr. Clement Ley entitled "Cloudland" is well known to meteorologists. Mr. Abercromby contributed a number of papers on the subject, laying stress upon the most important fact that cloud-forms are not peculiar to special localities or latitudes, but are the same for all parts of the world. Both these gentlemen unfortunately died before the classification was settled. The other meteorologists who were specially active in this work were Professor H. H. Hildebrandsson, of Upsala, Sweden; M. Léon Teisserenc de Bort, of Paris; and M. A. Rigggenbach, of Zurich, Switzerland.

In 1891 the International Conference at Munich recommended the following classification of clouds elaborated by Messrs. Abercromby and Hildebrandsson:—

- (a) Detached clouds with rounded upper outlines (most frequent in dry weather).
- (b) Clouds of great horizontal extent suggesting a layer or sheet (suggestion of wet weather).

A.—Upper Clouds: average altitude, 9,000 metres (30,000 feet).

- (a) 1. Cirrus.
- (b) 2. Cirro-stratus.

B.—Intermediate Clouds: between 3,000 metres and 7,000 metres (10,000 feet and 23,000 feet).

- (a) { 3. Cirro-cumulus.
- 4. Alto-cumulus.
- (b) 5. Alto-stratus.

C.—Lower Clouds: below 2,000 metres (7,000 feet).

- (a) 6. Strato-cumulus.
- (b) 7. Nimbus.



D.—Clouds of diurnal ascending currents,

- (a) 8. Cumulus: top, 1,800 metres (6,000 feet); base, 1,400 metres (4,500 feet).
- (b) 9. Cumulo-nimbus: top, 3,000 metres to 8,000 metres (10,000 feet to 26,000 feet); base, 1,400 metres (4,500 feet).

E.—High Fogs under 1,000 metres 3,300 feet).

10. Stratus.

N.B.—The equivalents in feet of the heights given in metres are only roughly approximate.

After Abercromby's death, at the request of the International Meteorological Committee in 1894 a Cloud Atlas was prepared by Messrs. Hildebrandsson, Riggenbach and Teisserenc de Bort and published in 1895, with excellent illustrations in photochromotype executed at Zürich. It was naturally very acceptable to meteorologists in all countries, and the number of copies was soon exhausted. In 1905 the International Meteorological Conference at Innsbruck requested Messrs. Hildebrandsson and Teisserenc de Bort to prepare a new edition, making at the same time some suggestions for the improvement of the classification and definitions. Among these suggestions the following should be noted because it indicates a special type of cloud. "Certain cloud forms which are particularly frequent on days of sirocco, mistral or föhn, have an oval shape and occasionally show irisation. These cloud forms are to be described by the term *lenticularis*, e.g., *cumulus lenticularis* (cu. lent.), *stratus lenticularis* (st. lent.). A plate illustrating this cloud form should be included in the Cloud Atlas."

These lenticular, lentil-shaped or almond-shaped clouds have attracted some attention in recent times. They have a peculiar outline. In many cases they are very suggestive of an airship, and are perhaps the clouds in "Hamlet" which are "very like a whale" (Plate XIV). In others the inner part of the cloud becomes very thin, or disappears, so that the shape looks like a large horse-shoe as seen from beneath at a great distance (Plate XV). Photographs of typical specimens have been secured by Mr. G. A. Clarke at Aberdeen, and by Captain Cave at Ditcham Park. At the Meteorological Office there is a very fine specimen of a stereophotograph, with a wide base, of one of horse-shoe-shape, which shows admirably the detail of the structure of curled wisps which form the cloud. The photographs and eye-observations show that the bank of clouds which keeps its position with little apparent change is really composed of a mass of cloudlets, forming and drifting into the cloud-bank with the wind at one side drifting away from it and dissolving at the other. Thus the stationary appearance of the cloud-bank is illusory as regards the wind. The wind blows *through* the cloud-bank, which is formed by the massing of the drifting cloudlets. The cloudlets belong apparently to the type of alto-cumulus or cirro-cumulus, not to the massed clouds, stratus or cumulus, as suggested by the Conference. The example inserted in the new edition of the Cloud Atlas is cirro-cumulus-lenticularis. The relation of this cloud to *sirocco*, which is a southerly wind in front of an advancing depression of the Mediterranean Sea, or to the *föhn*, which is the continuation of the same wind on the northern side of the Alps, or to the *mistral*, which is a dry wind from the North-West on the French Mediterranean coast, has not been investigated.

Upon two examples of this type of cloud Mr. Clarke remarks as follows: "Very often the intermediate clouds of the cirro-cumulus, alto-cumulus and strato-cumulus types may be seen massed together in long oval or torpedo-shaped sheets. These are termed *Lenticular* clouds, from the resemblance of their form to that of the cross-section of a lens. These *lenticular* masses are found sometimes detached but at other times cover the sky in dense sheets at several different levels, and are generally seen when the wind is blowing from some point in the south-west quadrant. The following conditions are found to accompany their appearance:—(1) The sky, when visible, is usually of a very intense blue colour; (2) the barometer is exceedingly unsteady, rising and falling jerkily at very short intervals of time; (3) the wind is usually strong or high and of a very gusty character, and in addition there is a periodic rise and fall in its average velocity. At times the lower clouds, such as *Cumulus* and *Stratus* are seen to assume a somewhat similar form in *quiet* weather, but in such cases the conditions above-mentioned will be absent."

That clouds similar to those associated with mistral or föhn are to be found in south-westerly winds at Aberdeen, where there are mountains to the south-westward, and over the South Downs at Ditcham Park, points perhaps to the orographical influence of the land surface upon the currents of the upper air, and it seems desirable to have a definite class to which such clouds can be referred.

The new edition of the Cloud Atlas was issued in 1910, and the definitions and descriptions of cloud forms are as follows:—

[The translation into English has been altered in certain respects from that which appears in the English version of the introduction to the International Cloud Atlas, in order to represent more closely the original French.]

### International Definitions and Descriptions of Cloud Forms.

1. \**Cirrus* (Ci.).—Detached clouds of delicate appearance, fibrous (threadlike) structure and feather-like form, generally white in colour. Cirrus clouds take the most varied shapes, such as isolated tufts of hair, i.e., thin filaments on a blue sky, branched filaments in feathery form, straight or curved filaments ending in tufts (called *cirrus uncinus*), and others. Occasionally cirrus clouds are arranged in bands, which traverse part of the sky as arcs of great circles, and as an effect of perspective appear to converge at a point on the horizon, and at the opposite point also if they are sufficiently extended. Cirro-stratus and cirro-cumulus also are sometimes similarly arranged in long bands. Plate XVI.

2. \**Cirro-Stratus* (Ci.-St.).—A thin sheet of whitish-cloud; sometimes covering the sky completely and merely giving it a milky appearance; it is then called *cirro-nebula* or *cirrus haze*; at other

\* It may be noted that the outline of the sun is visible, and his rays cast a shadow in spite of the presence of clouds of this type, unless the clouds and the sun are both low down on the horizon.



times presenting more or less distinctly a fibrous structure like a tangled web. This sheet often produces halos round the sun or moon. Plate XVII.

3. **\*Cirro-Cumulus (Ci.-Cu.).—Mackerel Sky.**—Small rounded masses or white flakes without shadows, or showing very slight shadow; arranged in groups and often in lines. French, *Moutons*—German, *Schäpfchen-wolken*. Plate XIII.

4. **Alto-Cumulus (A.-Cu.).—Larger rounded masses, white or greyish, partially shaded, arranged in groups or lines, and often so crowded together in the middle region that the cloudlets join.** The separate masses are generally larger and more compact (resembling strato-cumulus) in the middle region of the group, but the denseness of the layer varies and sometimes is so attenuated that the individual masses assume the appearance of sheets or thin flakes of considerable extent with hardly any shading. At the margin of the group they form smaller cloudlets resembling those of cirro-cumulus. The cloudlets often group themselves in parallel lines, arranged in one or more directions. Plate XII.

5. **Alto-Stratus (A.-St.).—A dense sheet of a grey or bluish colour, sometimes forming a compact mass of dull grey colour and fibrous structure.** At other times the sheet is thin like the denser forms cirro-stratus, and through it the sun and the moon may be seen dimly gleaming as through ground glass. This form exhibits all stages of transition between alto-stratus and cirro-stratus, but according to the measurements its normal altitude is about one-half of that of cirro-stratus. Plate XI.

6. **Strato-Cumulus (St.-Cu.).—Large lumpy masses or rolls of dull grey cloud, frequently covering the whole sky, especially in winter.** Generally strato-cumulus presents the appearance of a grey layer broken up into irregular masses and having on the margin smaller masses grouped in flocks like alto-cumulus. Sometimes this cloud-form has the characteristic appearance of great rolls of cloud arranged in parallel lines close together. (Roll-cumulus in England, **Wulst-cumulus** in Germany.) The rolls themselves are dense and dark, but in the intervening spaces the cloud is much lighter and blue sky may sometimes be seen through them. Strato-cumulus may be distinguished from Nimbus by its lumpy or rolling appearance, and by the fact that it does not generally tend to bring rain. Plate X.

7. **Nimbus (Nb.).—A dense layer of dark, shapeless cloud with ragged edges from which steady rain or snow usually falls. If there are openings in the cloud an upper layer of cirro-stratus or alto-stratus may almost invariably be seen through them.** If a layer of nimbus separates in strong wind into ragged cloud, or if small detached clouds are seen drifting underneath a large nimbus (the "**Scud**" of sailors), either may be specified as **fracto-nimbus (Fr.-Nb.)**. Plate III.

\*It may be noted that the outline of the sun is visible, and his rays cast a shadow in spite of the presence of clouds of these types, unless the clouds and the sun are both low down on the horizon.

8. **Cumulus (Cu.) (Woolpack or Cauliflower Cloud.)—Thick cloud of which the upper surface is dome-shaped and exhibits protuberances while the base is generally horizontal.** These clouds appear to be formed by ascensional movement of air in the daytime which is almost always observable. When the cloud and the sun are on opposite sides of the observer, the surfaces facing the observer are more brilliant than the margins of the protuberances. When on the contrary, it is on the same side of the observer as the sun it appears dark with bright edges. When the light falls sideways, as is usually the case, cumulus clouds show deep shadows. Plate IV.

True cumulus has well-defined upper and lower margins; but one may sometimes see ragged clouds—like cumulus torn by strong wind—of which the detached portions are continually changing; to this form of cloud the name **Fracto-Cumulus** may be given. Plates V and XVII.

9. **Cumulo-Nimbus (Cu.-Nb.) the Thunder Cloud; Shower Cloud.**—Great masses of cloud rising in the form of mountains or towers or anvils, generally having a veil or screen of fibrous texture (false cirrus) at the top and at its base a cloud-mass similar to nimbus. From the base local showers of rain or of snow, occasionally of hail or soft hail, usually fall. Sometimes the upper margins have the compact shape of cumulus or form massive heaps round which floats delicate false cirrus. At other times the margins themselves are fringed with filaments similar to cirrus clouds. This last form is particularly common with spring showers. The front of a thunderstorm of wide extent is frequently in the form of a large low arch above a region of uniformly lighter sky. Plates VI, VII and VIII.

10. **Stratus (St.).—A uniform layer of cloud like fog not lying on the ground.** Plate I. The cloud layer of stratus is always very low. If it is divided into ragged masses in a wind or by mountain tops, it may be called **Fracto-Stratus**. Plate II. The complete absence of detail of structure differentiates stratus from other aggregated forms of cloud.

The following remarks are added in the international atlas as instructions to observers.

(a) In the daytime in summer all the lower clouds assume, as a rule, special forms more or less resembling cumulus. In such cases the observer may enter in his notes "**Stratus- or nimbus-cumuliformis.**"

(b) Sometimes a cloud will show a mammillated surface and the appearance should be noted under the name **mammato-cumulus**. Plate IX.

(c) The form taken by certain clouds particularly on days of sirocco, mistral, föhn, etc., which show an ovoid form with clean outlines and sometimes irisation, will be indicated by the name **lenticular**, for example: **cumulus lenticularis, stratus lenticularis (Cu.-lent., St.-lent.)**.

(d) Notice should always be taken when the clouds seem motionless or if they move with very great velocity.



The illustrations in colour in the Cloud Atlas, twenty-nine in all, comprised:—

Four examples of cirrus,	Two of cumulus,
One of cirro-stratus,	One of fracto-cumulus,
One of cirro-cumulus,	Four of cumulo-nimbus,
Two of alto-stratus,	One of mammato-cumulus,
Two of alto-cumulus,	One of stratus,
Two of strato-cumulus,	One of fracto-stratus,
Three of nimbus,	One of cirro-cumulus lenticularis,
One of fracto-nimbus,	One additional alto-cumulus,
One of tufted cirrus.	

The Atlas is now unfortunately again out of print, and, in consequence of the war, it is not likely that a reprint can be obtained. In order to meet immediate requirements, a number of photographs have been selected from Mr. G. A. Clarke's collection and are reproduced here as a provisional atlas of cloud-forms.

It includes two specimens of lenticular cloud banks, one at the alto-cumulus-level and the other at the cirro-cumulus-level. Plates XIV and XV. A definition of this peculiar form of cloud is necessary. It may be put into the following words.

**11. Lenticular Cloud Banks.**—Banks of cloud of an almond or airship shape, with sharp general outlines, but showing, on close examination, fretted edges, formed of an ordered stucture of cloudlets similar to alto-cumulus or cirro-cumulus which is also seen in the bank itself when the illumination is favourable. Sometimes the body of the cloud bank is dense, and the almond shape is complete, fore and aft, but sometimes the bank thins away from the forward edge to clear sky within, so that the bank presents the appearance of a horse-shoe seen in perspective from below at a great distance. The bank appears nearly or quite stationary, while the cloudlets move rapidly into it at one side and away from it at the other.

Although we have at present no illustrative plate we may add a description of a form of cloud to which Clement Ley gave a separate name.

**12. Alto-Cumulus-Castellatus.**—"Little miniature cumulus rising in many heads from a more or less compact layer of alto-cumulus." "Not a very common cloud in these latitudes but sometimes seen in summer, and when coming from a westerly or south-westerly point is almost always a sign of the approach of shallow depressions which bring thunderstorms."\*

**NOTE.**—The Code Numbers printed under each illustration are the numbers to be used for clouds of the type illustrated in telegraphic reports of the form of cloud. The scale adopted for these reports is as follows:

Code Number.	Type of Cloud.
1	Cirrus
2	Cirro-stratus
3	Cirro-cumulus
4	Alto-cumulus
5	Alto-stratus
6	Strato-cumulus and Mammato-cumulus
7	Nimbus
8	Cumulus (and Fracto-cumulus)
9	Cumulo-nimbus
10	Stratus (and Fracto-stratus)

\*Captain C. J. P. Cave, R.E. The Form of Clouds. Q.J. Roy: Met: Soc. Vol. XLIII, p. 68. 1917.

This second edition of "Cloud Forms according to the International Classification" is a reprint of the first with the addition of an appendix which contains a collection of photographs of clouds from an aeroplane, by Captain C. K. M. Douglas. These photographs were published in Part IV of the Manual of Meteorology.

In the first edition the following notes were added to the introduction by Sir Napier Shaw, F.R.S.

### Cloud Types.

In making a cloud Atlas it has always been customary to begin with the highest clouds, viz., *cirrus* and *cirro-stratus*, and gradually to let our view descend to the surface, where we find the only form of cloud actually known to many of us by practical experience of its interior, namely, fog or mountain-stratus. The learner or inexperienced reader may find it easier to proceed the other way, and starting from the fog, with which he is familiar, pass to the consideration of stratus, and nimbus, with which he has also a working acquaintance, to cumulus, which is the first cloud to prompt an answer to the question of its origin and development, and so on to the cloud forms—some ordered, some irregular—of the upper regions of the air, about the formation and structure of which we know little.

It should be noticed in this connection, that the problem presented to those who classify clouds is of a dual character. There are first the forms of individual clouds, *stratus*, *nimbus*, *cumulus*, and *cirrus*, while the other forms are really aggregates, or groups of clouds or cloudlets, arranged sometimes in a continuous mass, sometimes in rows or waves, not infrequently in double or even triple sets of waves. There are all sorts of gradations, from the dappled mackerel sky of *cirro-cumulus* to the *alto-cumulus*, with a dense central portion and separate clouds on the margins, the irregular masses of *strato-cumulus*, and finally the continuous *stratus* which is to be found at various different levels—low, intermediate, and high. We can hardly exclude the continuous stratus itself from consideration as a group or aggregate, because when it thins it breaks up into detached clouds.

I have arranged the photographs according to these ideas, and in numbering the types I have adopted the following scheme of enumeration:—

#### TYPES OF SINGLE CLOUD FORMS.

The figure 1 means	stratus.
" " 2 "	nimbus.
" " 3 "	cumulus.
" " 4 "	cirrus.

#### TYPES OF CLOUD GROUPS.

The figure 5 means	clouds in ordered groups of middle height between 7,000 feet and 25,000 feet.
" " 6 "	ragged clouds drifting in detached masses or irregular groups.
" " 7 "	lenticular groups; almond-shaped or horse-shoe-shaped banks of cloudlets, generally between 10,000 feet and 25,000 feet.



## OTHER TYPES.

The figure 8 means portions of a cloud-mass having a peculiar structure.

„ „ 9 „ the highest forms of clouds.

The combination of two figures gives the appropriate number for the types which appear in the international classification, and are illustrated in the Atlas.

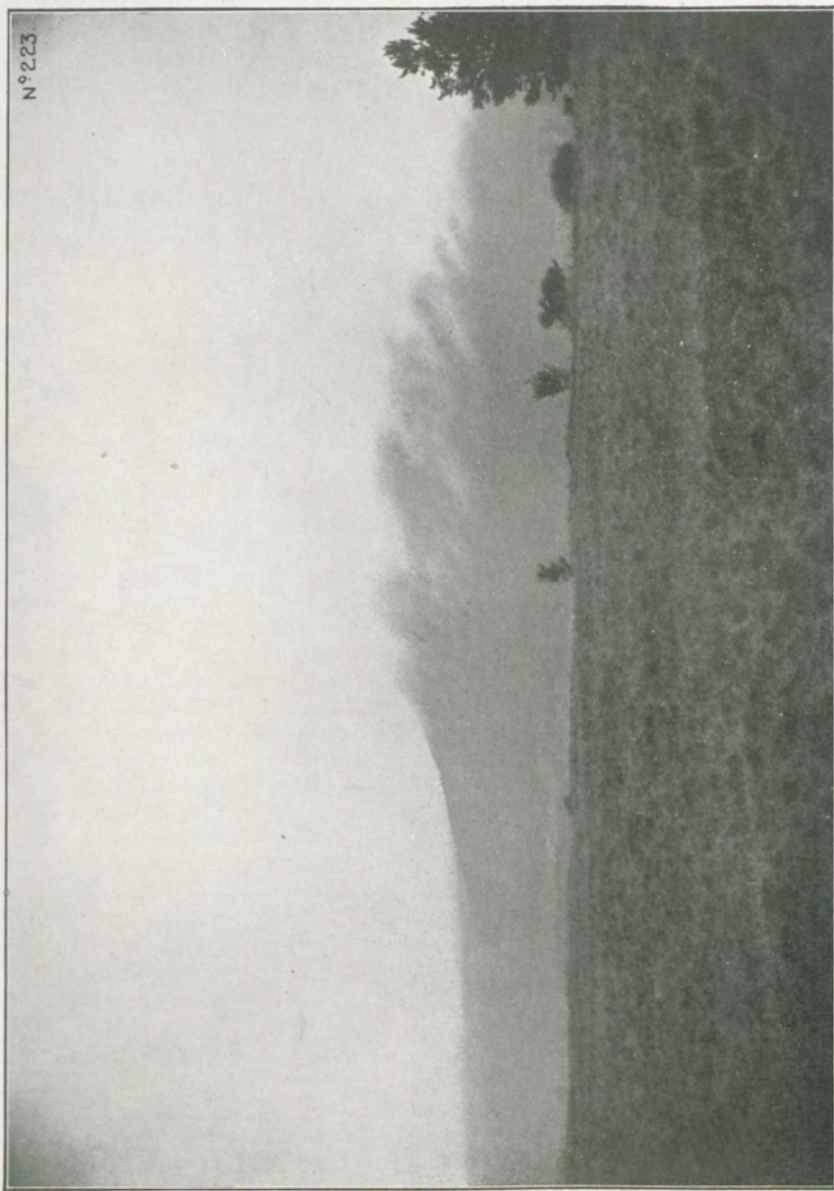
A word must be added about *cirrus*. It is generally understood to be not only a cloud of thread-like structure, as its name implies, but at the same time a very high-cloud, its normal height being about 9 kilometres, or nearly 30,000 feet. No doubt the best and most durable examples are to be found at those great heights, but from personal observation and from the consideration of many observations by Mr. Clarke, I think it must be allowed that thread-like clouds, indistinguishable in appearance from wisps of true cirrus, may be found at much lower levels just as the so-called false cirrus is formed at various heights. Captain C. K. M. Douglas, from close observation in an aeroplane, expresses the opinion that false cirrus, or, in other words, thread-like structure, is always attributable to clouds formed of ice crystals, and if that be the properly distinctive characteristic of the thread-like structure, it only hampers our conception of the atmospheric processes if we assume all clouds which show that structure to be at a very high level. The form is really suggestive of the formation of cloud by some special physical process, such as the reduction of the pressure of a mass of air which contains exceptional quantity of water vapour in streaks or wreaths. It is better, therefore, to regard cirrus as being a special form of cloud which may be developed in suitable circumstances at any level where ice crystals can form, and where a reduction of pressure, in consequence of external changes, may occur; this may be any region beyond the four-kilometre level in our latitude. Consequently, I give a separate number 4 to cirrus as a cloud of thread-like structure, and another number 9 to the highest clouds, so that the clouds that we are accustomed to call "true cirrus"—that is, thread-like clouds in the region of 9 kilometres height—are designated by the composite number 94.

The information given here is concerned almost entirely with the identification of cloud forms which is only the first step in the meteorological study of clouds. It should be noted that in the year 1896—97, known among meteorologists as the international cloud-year, observations were made on an international basis of the height and the velocity of motion of all the typical forms of cloud at the following observatories:—Bossekop (Norway), Upsala (Sweden), Pavlovsk near Petrograd (Russia), Potsdam (Germany), Trappes near Paris (France), Toronto (Canada), Blue Hill near Boston and Washington, D.C. (U.S.A.), Allahabad (India), and Manilla (Philippine Islands). A very instructive summary of these and other observations of clouds is given in Chapters IV and VII of *Les bases de la météorologie dynamique* par H. H. Hildebrandsson et Léon Teisserenc de Bort. According to the discussion of the heights of clouds at Potsdam, clouds tend to favour the following levels (the heights are in metres) 500, 2,000, 4,300, 6,500, 8,300, 9,900. These heights are however, only general means. They vary from one station to another and are also subject to diurnal and seasonal variations.

## Atlas of Photographs of Clouds

Selected from the Collection of  
Mr. G. A. CLARKE, of the Observatory, Aberdeen.





Code No. 10. Stratus (St.). Level sheet of low cloud : below 3,000 ft.

**Stratus (St.).**—A uniform layer of cloud like fog, but not lying on the ground.

The complete absence of details of structure differentiates stratus from other aggregated forms of cloud.

The line of the lower surface of the cloud, which is all that can be seen in a photograph of stratus, is partially interrupted in Plate I by the mountain, the top of which is hidden by the cloud. The line can be carried by eye horizontally across the mountain from the tree on the right-hand side to the shoulder on the left, almost parallel to the line of the foreground, which is very nearly horizontal.

(16987)



Code No. 10. Fracto-stratus (Fr. St.). Ragged stratus : drifting masses of low cloud.

**Stratus.**—The cloud layer of stratus is always very low. If it is divided into ragged masses in a wind or by mountain tops, it may be called Fracto-Stratus.





**Nimbus (Nb.)**—A dense layer of dark, shapeless cloud, with ragged edges from which steady rain or snow usually falls.

In Plate III the cloud-type to be represented is shown in the right-hand half of the picture with an extension to the left of the upper part. The light region of the lower part on the left consists of upper cloud, and is the sort of sky that can be seen through gaps or openings in a sheet of nimbus. Heavy rain is shown falling in two showers, one behind the final, which projects from the bottom of the picture, the other at the right-hand of the base of the picture.

Little patches of white "scud" are shown against the dark extension of the nimbus to the left.

Code No. 7. Nimbus (Nb.). Shapeless cloud-base below 7,000 ft., rain falling.



**Cumulus (Cu.)** (Woolpack or Cauliflower Cloud).—Thick cloud of which the upper surface is dome-shaped and exhibits protuberances while the base is generally horizontal. These clouds appear to be formed by ascensional movement of air in the daytime which is almost always observable.

When the light falls sideways, as is usually the case, cumulus clouds show deep shadows.

Code No. 8. Cumulus (Cu.). Detached cloud with flat base at mean height 4,500 ft., and domed top at mean height 6,000 ft.





CODE NO. 8. Fracto-Cumulus (**Fr.-Cu.**). Ragged cumulus in drifting groups (4,000 to 6,000 ft.).

**Cumulus: Fracto-Cumulus.**—True cumulus has well-defined upper and lower margins; but one may sometimes see ragged clouds, like cumulus torn by strong wind, of which the detached portions are continually changing; to this form of cloud the name Fracto-Cumulus may be given.

In the photograph the way the smoke of the chimney is blown is a good indication of the character of the day.

**Cumulo-Nimbus**—The Thunder Cloud — Shower Cloud. — Great masses of cloud rising in the form of mountains, or towers, or anvils, generally having a veil or screen of fibrous texture (false cirrus) at the top, and, at its base, a cloud-mass similar to nimbus. From the base local showers of rain or of snow, occasionally of hail or soft hail, usually fall. Sometimes the upper margins have the compact shape of cumulus, or form massive heaps round which floats delicate false cirrus.

Plate VI gives an example of Cumulo-nimbus with the upper margins in compact form, but there are no floating wisps of false cirrus shown in the picture, unless the small dark cloud half-way up on the extreme right of the picture represents one. Such detached cloudlets are so characteristic of cumulo-nimbus that the combination used to have the name "cumulo-stratus," which is used by Abercromby, but is not now recognised as a separate cloud form.



CODE NO. 9. Cumulo-Nimbus (**Cu.-Nb.**). Mountainous mass reaching from about 10,000 to 25,000 ft.



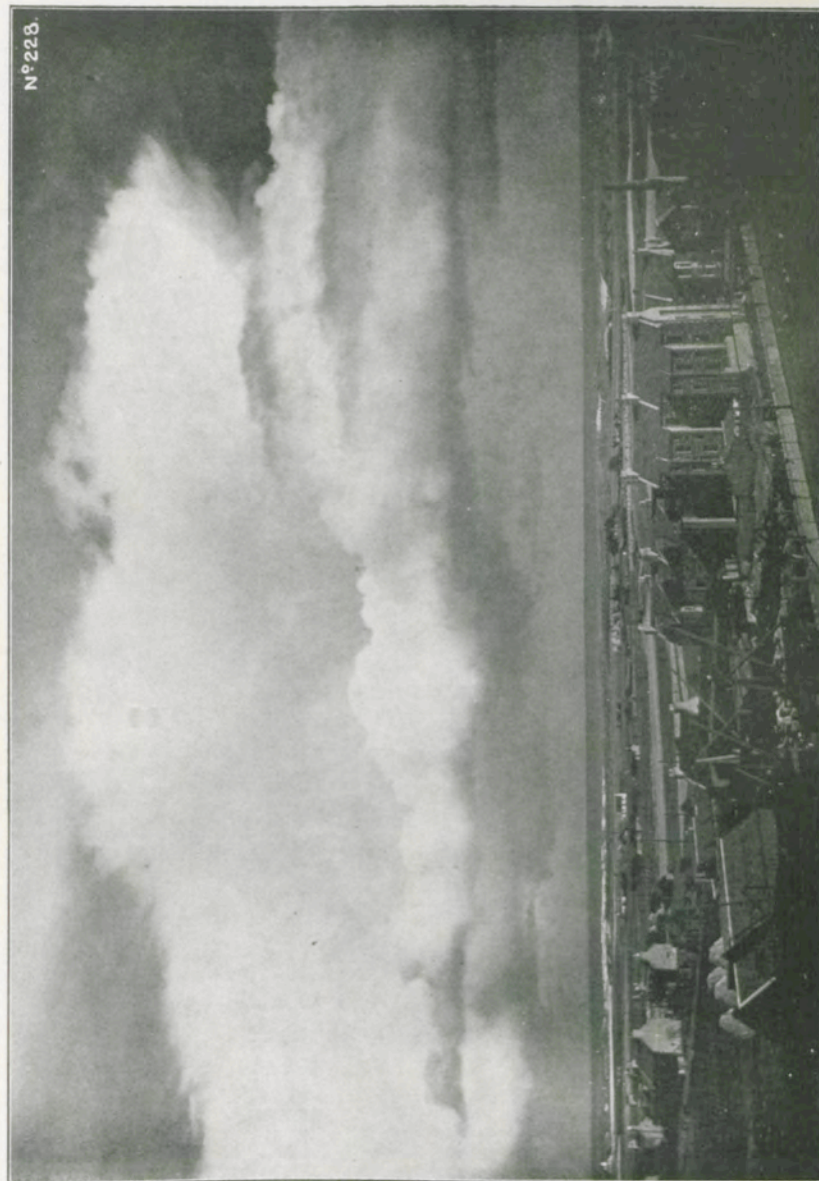


CODE NO. 9. Cumulo-Nimbus (Cu. Nb.). Thunder cloud with large "anvil" of false cirrus.

**Cumulo-Nimbus.**—Plate VII shows a cloud of this type, very suggestive of thunder, which is completely covered or veiled by a great "anvil" of false cirrus. Smaller, but probably growing, clouds of the cumulus type are shown on the line of the lower surface of the cumulo-nimbus.

The cloud was advancing towards the spectator. Note the smoke of the distant chimney.

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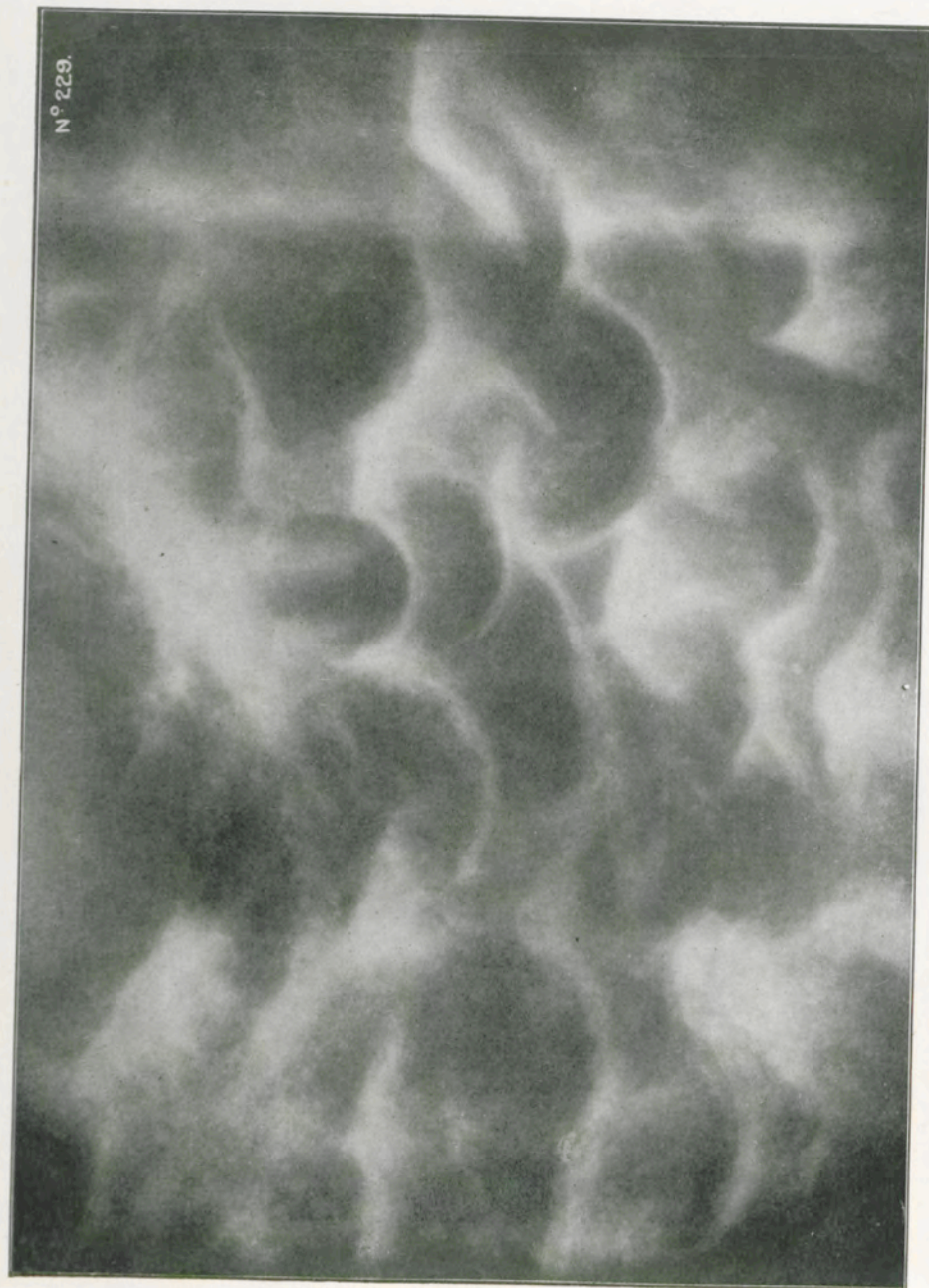


CODE NO. 9. Cumulo-Nimbus (Cu.-Nb.). Shower-cloud—hail and rain at sea, false cirrus fringing the top.

**Cumulo-Nimbus.**—At other times the margins themselves are fringed with filaments similar to cirrus clouds. This last form is particularly common with spring showers.

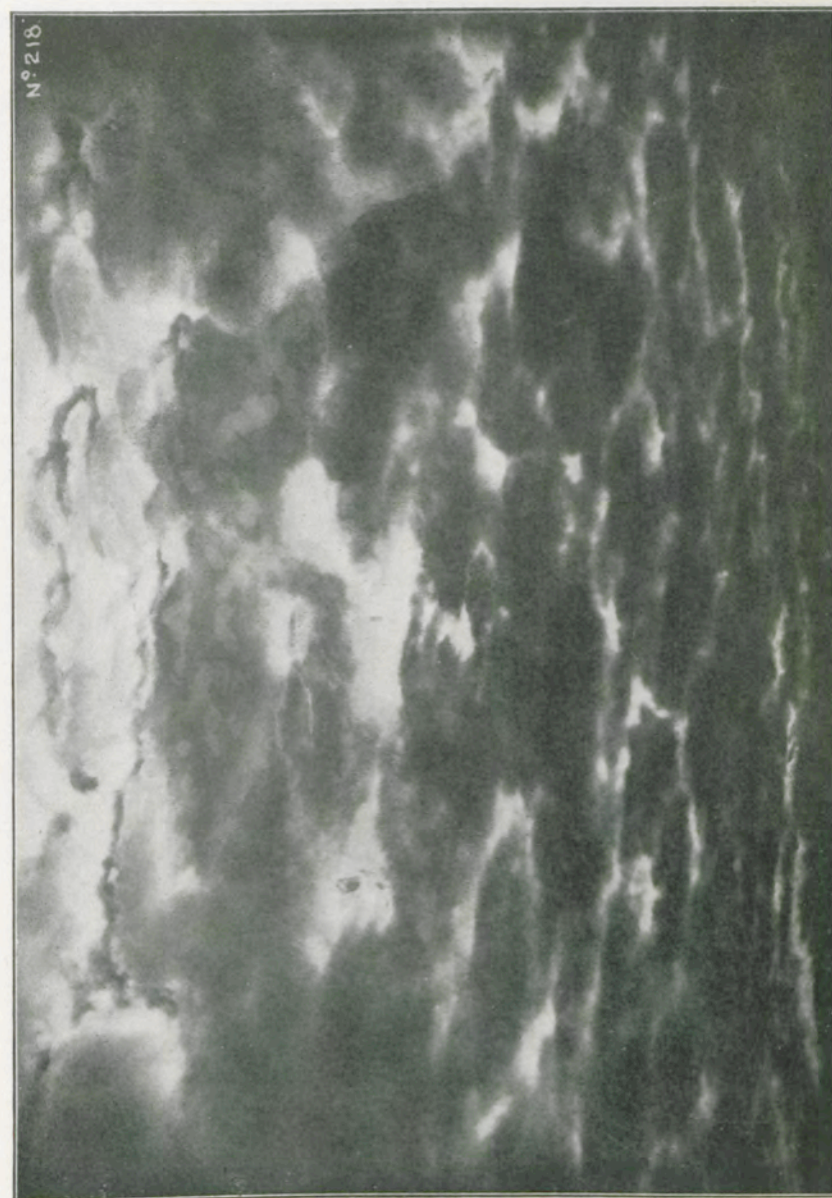
Plate VIII shows a typical example of a spring shower-cloud. There is a line of growing cumulus in front and a heavier bank of cumulo-nimbus behind, which is fringed with false 'cirrus' the thread-like structure of which is shown on the underside of the projection on the right, and on the upper surface of the middle protuberance, and on the left near the edge of the picture.





**Mammato-Cumulus or Festoon Cloud**—Sometimes a cloud will show a mamillated surface, and the appearance should be noted under the name mammato-cumulus. It is often called the festoon cloud, and the name is very appropriate for the example reproduced in Plate IX.

CODE No. 6. Mammato-Cumulus (**M.-Cu.**). The last stage of Cumulo-nimbus.



**Strato - Cumulus (St.-Cu.).**—Large lumpy masses or rolls of dull grey cloud, frequently covering the whole sky, especially in winter. Generally strato cumulus presents the appearance of a grey layer broken up into irregular masses and having on the margin smaller masses grouped in flocks like alto-cumulus.

Strato-cumulus may be distinguished from Nimbus by its lumpy or rolling appearance, and by the fact that it does not generally tend to bring rain.

CODE No. 6. Strato-Cumulus (**St.-Cu.**). Layer of clouds in irregular order below 7,000 ft.





**Alto-Stratus (A.-St.).**—A dense sheet of a grey or bluish colour, sometimes forming a compact mass of dull grey colour and fibrous structure. At other times the sheet is thin like the denser forms cirro-stratus, and through it the sun and the moon may be seen dimly gleaming as through ground glass. The dim gleam of the sun is well shown in Plate XI. There is very little structure in alto-stratus that will show in a photograph. The fragments of dark cloud of irregular shape shown in Plate XI are probably fracto-stratus at a very much lower level.

CODE No. 5. Alto-Stratus (A.-St.). Sheet at middle height, between 10,000 and 25,000 ft.



**Alto-Cumulus (A.-Cu.).**—Larger rounded masses, white or greyish, partially shaded, arranged in groups or lines and often so crowded together in the middle region that the cloudlets join. The separate masses are generally larger and more compact (resembling strato-cumulus) in the middle region of the group, but the denseness of the layer varies and sometimes is so attenuated that the individual masses assume the appearance of sheets or thin flakes of considerable extent with hardly any shading. At the margin of the group they form smaller cloudlets resembling those of cirro-cumulus. The cloudlets often group themselves in parallel lines, arranged in one or more directions. Plate XII shows all the characteristic features of alto-stratus set out in the international definition.

CODE No. 4. Alto-Cumulus (A.-Cu.). Layer of large Cloudlets in waves at middle height.





CODE No. 3. Cirro-Cumulus (Ci.-Cu.). The Mackerel Sky. The highest form of Cloudlets in waves : 20,000 to 25,000 ft.

**Cirro-Cumulus (Ci. Cu.).**  
(Mackerel Sky).—Small rounded masses or white flakes without shadows, or showing very slight shadow, arranged in groups and often in lines. French : *Moutons*. German : *Schäfchen-wolken*.

**Lenticular Cloud Banks.**—Banks of cloud of an almond or air-ship shape, with sharp general outlines, but showing on close examination fretted edges formed of an ordered structure of cloudlets similar to alto-cumulus or cirro-cumulus, which is also seen in the bank itself when the illumination is favourable.

In Plate XIV the best examples of the lenticular shape are to be dimly seen very low down in the picture. The nearer clouds show the fretted structure in their edges more and more until the one at the top of the picture shows little else : the sharp outline is no longer noticeable.



CODE No. 4. Alto-Cumulus-lenticularis (A.-Cu.-Lent.) Almond-shaped banks of cloudlets at the alto-cumulus level.





CODE No. 3. Cirro-Cumulus lenticularis (Ci.-Cu.-lent.). Horse-shoe-shaped banks of cloudlets at the cirro-cumulus level.

**Lenticular Cloud Bank**— Sometimes the body of the cloud bank is dense and the almond shape is complete, fore and aft, but sometimes the bank thins away from the forward edge to clear sky within, so that the bank presents the appearance of a horse-shoe seen in perspective from below at a great distance. The bank appears nearly or quite stationary, while the cloudlets move rapidly into it at one end and away from it at the other.

Two, probably three, horse-shoe shaped clouds may be traced in Plate XV having their points towards the right of the picture and streamers steadily passing away to the left. The fretted structure of the cloud is hardly visible in the photograph, though there are suggestions of it on the left at the top.



Code No. 1. Cirrus (Ci.). Mares' tails with tufted ends (Cirrus-uncinus) often at about 30,000 ft.

**Cirrus (Ci.).**— Detached clouds of delicate appearance, fibrous (threadlike) structure and feather-like form, generally white in colour. Cirrus clouds take the most varied shapes, such as isolated tufts of hair, *i.e.*, thin filaments on a blue sky, branched filaments in feathery form, straight or curved filaments ending in tufts (called cirrus uncinus), and others.





CODE Nos. 2 & 8. At top—Cirro-Stratus (Ci.-St.). Uniform sheet of very high cloud, 30,000 ft.; at bottom, Fracto-cumulus (Fr.-Cu.). A string of ragged cumulus at about 6,000 ft.

**Cirro-Stratus (Ci.-St.)**—A thin sheet of whitish cloud, at times presenting more or less distinctly a fibrous structure like a tangled web; at others, merely veiling the blue of the sky by a milky appearance; in the latter case a special name of **cirro-nebula** or **cirrus haze** is given. This sheet often produces halos around the sun or moon.

The example photographed in Plate XVII is one of the denser types of cirro-stratus. It occupies a little more than half the picture, measuring from the top downwards; the lower part of the picture shows a belt of blue sky below, or more strictly, beyond the cirro-stratus, and in the space between the ground and the upper cloud are strings of drifting cumulus irregular enough in shape to be called fracto-cumulus. As these clouds probably have their crests not higher than 6,000 feet, we must imagine a vertical space of nearly 25,000 feet between the two forms of cloud contained in the picture.

## APPENDIX.

### EDDY CLOUDS: FIGURES 1—6.

Photographs of Cloud-Sheets from Aeroplanes  
with Remarks based upon Notes contributed by

CAPTAIN C. K. M. DOUGLAS, R.A.F.

(Reprinted from Part IV of the Manual of Meteorology).

Nos. 1, 2, 3, 4, *Sheets of strato-cumulus cloud in ripples, waves or rolls.*

Examples 1, 2 and 4 were taken on the same day, August 15th, 1918; the first, at 1,700 feet, in the early morning about 7h., and the other two in the evening at 18h. when the cloud-sheet of the morning had worked upwards and developed a much more turbulent appearance. The tops of the rolls were then at 5,000 feet. The clouds were formed in a light northerly wind on the eastern side of an area of high pressure lying over the English Channel.

The third example shows a cloud-sheet with tops at about 4,000 feet formed in a fresh westerly wind at 7h. 30m. on August 17th, 1918.

“These clouds are accompanied by eddy-motion within and below them which keeps up a supply of water-vapour from below. It is the expansion and cooling of this water-vapour as the air carrying it gets diffused up by eddies that causes the clouds. Similar cloud-sheets are common at all heights up to 20,000 feet. The turbulence reduces the temperature at the cloud-level and there is often a rise of temperature above it.” It was only 1°F. in the first example but in the latter examples of the same day when the cloud was several thousand feet higher it had increased to 8°F.

Nos. 5 and 6. *Low Clouds of Lenticular Type.*

“These clouds are of interest as they represent a type rather similar to those shown in Plate XIV. They were, however, at a much lower altitude, about 2,500 to 3,000 feet at their upper surface. They were accompanied by very little turbulence and occurred in a stable layer, the temperature being 53°F. at 2,000 feet and 50°F. at 4,000 feet.” The normal lapse of temperature between these levels is between 5° and 6°F. The peculiarity of the lenticular clouds which have the smooth, gently rounded form so well imitated by the long wreaths or “sastrugi” of examples 5 and 6 is that they seem to be the loci where cloudlets are persistently formed and move independently of the general motion of the cloud-bank. The banks in this case lay in North and South lines and moved from SSW. Comparing their forms with the diagrams of wave-motion in Figure 1 of Chapter IX it is impossible to resist the suggestion that these long banks may represent waves, which are stationary or nearly so, across the current of air which forms the wind. On this occasion there was a wind at 7,000 feet from WSW., while the surface-wind was from the South. Northern France was under the northern margin of an extended anti-cyclone and there was a stationary “low” centred off the Hebrides. (7h. 30m. August 8th, 1918).



EDDY CLOUDS: FIGURE 1.



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1. Flat sheet of cloud at about 1,700 feet, in rolls or waves of strato-cumulus advancing towards the observer. August 15th, 1918, about 7h.

EDDY CLOUDS: FIGURE 2.



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2. The same layer of clouds as No. 1 at a greater height in the evening of the same day. Strato-cumulus in rolls and hummocks with tops at 5,000 feet advancing from the North (obliquely from the right towards the observer facing North-west) with sunlight from the West. The sun is out of the picture on the observer's left. August 15th, 1918, 18h.

Note the clearer belt beyond the strato-cumulus, over the English Channel, and the bank of clouds on the horizon over England.

EDDY CLOUDS: FIGURE 3.



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3. Strato-cumulus clouds about 4,000 feet with high clouds in another layer above, probably alto-stratus which is generally at 10,000 feet or higher. August 17th, 1918, 7h. 30m.

EDDY CLOUDS: FIGURE 4.



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4. Another view of the cloud sheet represented in No. 2 on the opposite page looking East with the sun behind the observer. The lines of cloud are moving obliquely away from the observer from the foreground on the left to the background on the right. August 15th, 1918, 18h.

Note the more turbulent appearance of the evening clouds represented in Nos. 2 and 4 as compared with the morning clouds represented in Nos. 1 and 3.



EDDY CLOUDS: FIGURE 5.



5. A vast field of long strips or bands of cloud, nearly parallel, with smooth and lightly rounded upper surfaces in the form of "hogs-backs," like wreaths of drifted snow (sastrugi).

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EDDY CLOUDS: FIGURE 6.



6. Another part of the cloud-sheet, No. 5, viewed to NE. against the light showing an eruption of cumulus heads in the middle distance. Overhead is another cloud-sheet at 7,500 feet of which the margin is seen at the top of the picture. August 8th, 1918, 7h. 30m.

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The bands of cloud lay roughly North and South. The wind at their level was from SSW. The form suggests wave-motion across the bands from W. to E.

A RIPPLE-MARKED SQUALL-CLOUD.



(From photograph by Mr. G. A. CLARKE).

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7. Compound lenticular mass of cirro-cumulus. September 12th, 1916, 18h. 10m. Showing under-surface with rippled structure illuminated by a ray of sunlight from the setting sun.



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