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M.O. 233 (4th Edition)

AIR MINISTRY
METEOROLOGICAL OFFICE

CLOUD FORMS
ACCORDING TO THE
INTERNATIONAL CLASSIFICATION

The Definitions and Descriptions

APPROVED BY THE
INTERNATIONAL METEOROLOGICAL COMMITTEE

WITH
PHOTOGRAPHS OF CLOUDS
MAINLY FROM THE COLLECTION OF MR. G. A. CLARKE
OF THE OBSERVATORY, ABERDEEN

Issued by the Authority of the Meteorological Committee

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1939

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PHOTOGRAPHS OF CLOUDS

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The code numbers for reporting forms of cloud in meteorological telegrams are given in the Meteorological Observer's Handbook (M.O.191) Supplement No. 1, 4th edition, 1939 or in Form 2459.

CLOUD FORMS

ACCORDING TO THE INTERNATIONAL CLASSIFICATION

The Definitions and Descriptions approved by the International Committee, with Photographs of Clouds, mainly 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 Uppsala, Sweden; M. Léon Teisserenc de Bort, of Paris; and M. A. Riggenbach, of Zürich, Switzerland.

A classification was agreed on at the International Conference at Munich in 1891, and as a sequel the first edition of the "International Cloud Atlas" appeared in 1895. It has run through several editions since that date, the last appeared in 1910 and is now out of print.

After the Great War the need for a new Atlas was acutely felt and an International Commission for the Study of Clouds was set up in 1922, under the presidency of General E. Delcambre, the Director of the Office Nationale Météorologique de France, to undertake this work. An "Abridged edition for the use of observers" was produced in 1930, and the complete Atlas with separate editions having the text in French, English and German was published in 1932. The method of classification and the definitions of forms of cloud

adopted therein differ in certain respects from those of the Atlas of 1895. The following summary is based on Part I of the English edition :—

I.—TABLE OF CLOUD CLASSIFICATION

At nearly all levels clouds may appear under the following forms :—

- (a) *Isolated*, heap clouds with vertical development during their formation, and a spreading out when they are dissolving.
- (b) *Sheet clouds which are divided up into filaments, scales, or rounded masses*, and which are often stable or in process of disintegration.
- (c) *More or less* continuous cloud sheets, often in process of formation or growth.

Classification into families and genera

Family A : High clouds (mean lower level 6,000 m. (20,000 ft.)).*

- Form b 1. Genus Cirrus.
- 2. Genus Cirrocumulus.

Form c 3. Genus Cirrostratus.

Family B : Middle clouds (mean upper level 6,000 m. (20,000 ft.), mean lower level 2,000 m. (6,500 ft.)).

- Form a } 4. Genus Altopumulus.†
- Form b }

Form c 5. Genus Altostratus.

Family C : Low clouds (mean upper level 2,000 m. (6,500 ft.), mean lower level close to the ground).

- Form a } 6. Genus Stratopumulus.†
- Form b }

- Form c { 7. Genus Stratus.
- 8. Genus Nimbostratus.

Family D : Clouds with vertical development (mean upper level that of the cirrus, mean lower level 500 m. (1,600 ft.)).

- Form a { 9. Genus Cumulus.
- 10. Genus Cumulonimbus.

* It should be noted that the heights given are for temperate latitudes, and refer, not to sea level, but to the general level of the land in the region. In certain cases there may be large departures from the given mean heights, especially as regards cirrus, which may be found as low as 3,000 metres in temperate latitudes, and in polar regions even almost as low as the surface.

† Most altopumulus and stratopumulus clouds come under category b; but the varieties cumuliformis and particularly castellatus belong to category a.

II.—DEFINITIONS AND DESCRIPTIONS OF THE FORMS OF CLOUDS

1. **Cirrus (Ci.).**—Detached clouds of delicate and fibrous appearance, without shading, generally white in colour, often of a silky appearance.

Cirrus appears in the most varied forms such as isolated tufts, lines drawn across a blue sky, branching feather-like plumes, curved lines ending in tufts, etc.; they are often arranged in bands which cross the sky like meridian lines, and which, owing to the effect of perspective, converge to a point on the horizon, or to two opposite points (cirrostratus and cirrocumulus often take part in the formation of these bands).

2. **Cirrocumulus (Cc.).**—A cirriform layer or patch composed of small white flakes or of very small globular masses, without shadows, which are arranged in groups or lines, or more often in ripples resembling those of the sand on the sea shore.

In general cirrocumulus represents a degraded state of cirrus and cirrostratus both of which may change into it. In this case the changing patches often retain some fibrous structure in places.

Real cirrocumulus is uncommon. It must not be confused with small altopumulus on the edges of altopumulus sheets.

3. **Cirrostratus (Cs.).**—A thin whitish veil, which does not blur the outlines of the sun or moon, but gives rise to halos. Sometimes it is quite diffuse and merely gives the sky a milky look; sometimes it more or less distinctly shows a fibrous structure with disordered filaments.

4. **Altopumulus (Ac.).**—A layer, (or patches) composed of laminae or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without shading. These elements are arranged in groups, in lines or waves, following one or two directions and are sometimes so close together that their edges join.

The thin and translucent edges of the elements often show irisations which are rather characteristic of this class of cloud.

5. **Altostratus (As.).**—Striated or fibrous veil, more or less grey or bluish in colour. This cloud is like thick cirrostratus but without halo phenomena; the sun or moon shows vaguely, with a faint gleam, as though through ground glass. Sometimes the sheet is thin with forms intermediate with cirrostratus (altostratus translucidus). Sometimes it is very thick and dark (altostratus opacus), sometimes even completely hiding the sun or moon. In this case differences of thickness may cause relatively light patches between very dark parts; but the surface never shows real relief, and the striated or fibrous structure is always seen in places in the body of the cloud.

6. **Stratocumulus (Sc.).**—A layer (or patches) composed of globular masses or rolls; the smallest of the regularly arranged elements are fairly large; they are soft and grey, with darker parts. These elements are arranged in groups, in lines, or in waves, aligned in one or in two directions. Very often the rolls are so close that their edges join together; when they cover the whole sky—on the continent, especially in winter—they have a wavy appearance.

7. **Stratus (St.).**—A uniform layer of cloud, resembling fog, but not resting on the ground.—When this very low layer is broken up into irregular shreds it is designated fractostratus (Fs.).

8. **Nimbostratus (Ns.).**—A low, amorphous and rainy layer, of a dark grey colour and nearly uniform; feebly illuminated seemingly from inside. When it gives precipitation it is in the form of continuous rain or snow.

But precipitation alone is not sufficient criterion to distinguish the cloud which should be called nimbostratus even when no rain or snow falls from it.

There is often precipitation which does not reach the ground; in this case the base of the cloud is always diffuse and looks “wet” on account of the general trailing precipitation, *virga*, so that it is not possible to determine the limit of its lower surface.

9. **Cumulus (Cu.).**—Thick clouds with vertical development; the upper surface is dome shaped and exhibits rounded protuberances, while the base is nearly horizontal.

When the cloud is opposite to the sun the surfaces normal to the observer are brighter than the edges of the protuberances. When the light comes from the side, the clouds exhibit strong contrasts of light and shade; against the sun, on the other hand, they look dark with a bright edge.

True cumulus is definitely limited above and below; its surface often appears hard and clear cut. But one may also observe a cloud resembling ragged cumulus in which the different parts show constant change. This cloud is designated fractocumulus (Fc.).

10. **Cumulonimbus (Cb.).**—Heavy masses of cloud, with great vertical development, whose cumuliform summits rise in the form of mountains or towers, the upper parts having a fibrous texture and often spreading out in the shape of an anvil.

The base resembles nimbostratus, and one generally notices *virga*. This base has often a layer of very low ragged clouds below it (fractostratus, fractocumulus).

Cumulonimbus clouds generally produce showers of rain or snow and sometimes of hail or soft hail, and often thunderstorms as well.

If the whole of the cloud cannot be seen the fall of a real shower is enough to characterise the cloud as a cumulonimbus.

As compared with the specifications set out in the first International Cloud Atlas (reprinted in former editions of this handbook) the most important new features are the omission of “nimbus” and the inclusion of the new type “nimbostratus”.

In addition to *families* and *genera* which suffice for the broad classification of cloud forms, the new International Atlas also recognises *sub-genera*, *species*, *varieties* and *casual details* to which distinguishing latin adjectives are applied for purposes of more precise differentiation.

For details of these sub-classifications reference should be made to the Atlas. It is proposed, in this handbook, to refer only to the varieties which are already so well known that their names have come into general use. These are distinguished by the adjectives “cumuliformis,” “lenticularis,” “castellatus” and “mammatus.”

Cumuliformis.—Various types of clouds, particularly cirrus, altocumulus and stratus may in certain circumstances assume a rounded appearance resembling cumulus. The adjective “cumuliformis” is added to the name of the cloud to indicate this condition (e.g., stratus cumuliformis). (See Plate XVII(b).)

Lenticularis.—Groups of cirrocumulus, altocumulus and stratocumulus, sometimes show an ovoid form with sharp edges, resembling the cross-sections of a lens. The adjective “lenticularis” is added to the name of the cloud to indicate this structure (e.g., altocumulus lenticularis). (See Plate XVI(b).)

Castellatus.—Added to the name altocumulus to indicate the turreted or crenellated appearance sometimes assumed by individual cloudlets of middle height, usually in summer. (See Plate XVII(a).)

Mammatus.—The lower surface of certain cloud sheets sometimes forms pouches or breasts. This structure is distinguished by the adjective “mammatus” or the prefix “mammato,” e.g., “cumulonimbus mammatus.” (See Plate XV.)

Hints on the classification of clouds.—The problem presented to those who classify clouds is of a dual character. There are first the forms of individual clouds, stratus, 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 cirrocumulus to the altocumulus, often with a dense central portion and separate clouds on the margins, the irregular masses of stratocumulus, and finally the continuous strata which are 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.

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 XVI). 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. 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 and 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 altocumulus or cirrocumulus. Upon two examples of this type of cloud Mr. Clarke remarks as follows:—"Very often the intermediate clouds of the cirrocumulus, altocumulus and stratocumulus 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-sections 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."

The term "mammatus" was formerly associated exclusively with cumulus but mammatus structure is frequently observed on the under surface of an anvil of so-called "false cirrus" (now called cirrus nothus) projecting from a mass of cumulonimbus. A structure to which the name mammatus is appropriate, though differing somewhat from the typical form, is also sometimes seen beneath sheets of stratus and altostratus. The characteristic "cumulonimbus mammatus" illustrated in Plate XV (a) has a peculiar heavy and ominous appearance.

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 Km., or nearly 30,000 ft. No doubt the best and most durable examples are to be found at those great heights, but thread-like clouds, indistinguishable in appearance from wisps of true cirrus, may be found at much lower levels just as the cirrus nothus

is formed at various heights. C. K. M. Douglas, from close observation in an aeroplane, expresses the opinion that masked 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 resembles trails of falling precipitation, and it is possible that the fall of the particles relative to the air (itself often rising) tends to produce a fibrous structure in the cloud. Ice crystals are much larger than most water particles (other than rain-drops) and tend to fall faster and further without evaporating. Clouds which are definitely fibrous have a considerable vertical extension, but in cold weather they may exist entirely below 4 Km. Very thin delicate layers of cloud (often high) may sometimes appear wisp-like, especially under the influence of perspective, but this structure is different from the true fibrous type. These delicate layers often show iridescence when near the sun or moon, indicating that they are almost certainly not composed of crystals.

PHOTOGRAPHS OF CLOUDS

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

PHOTOGRAPHS OF CLOUDS

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

Stratus (St.).—A uniform layer of cloud, resembling fog, but not resting on the ground.

In its most typical form, stratus shows no details of structure when observed from the ground. In this example the cloud hides the top of a hill and the line of the lower surface of the cloud can therefore be observed, passing round the hill from behind the tree on the right to the slope on the left.



Stratus (St.). Level sheet of low cloud : 500-2,000 ft.



Fractostratus (Fs.). Ragged stratus. Drifting masses of low cloud.

Stratus (St.).—In this example the cloud is seen in the form of ragged masses, to which the name Fractostratus is applicable.

Nimbostratus (Ns.).—A low, amorphous, and rainy layer of a dark grey colour and nearly uniform. When it gives precipitation it is in the form of continuous rain or snow. The usual evolution is as follows : a layer of altostratus becomes thicker and lower until it becomes a layer of nimbostratus. Beneath the latter, as in the case here illustrated, there is usually a development of ragged, very low cloud (fractocumulus or fractostratus) which may eventually fuse together and obscure the nimbostratus.

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Nimbostratus (Ns.) Low, rainy layer of dark grey cloud, nearly uniform : 500-2,000 ft.



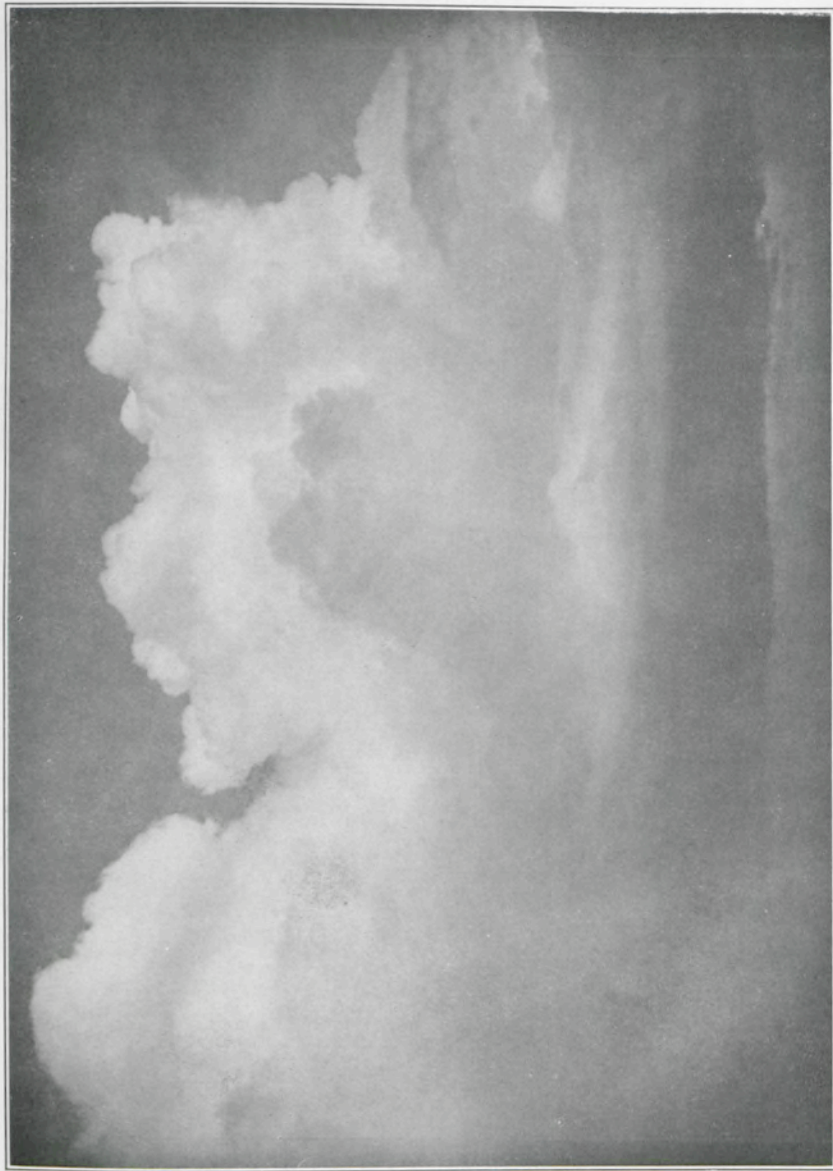
Cumulus (Cu.). Detached cloud with flat base and rounded top. Height of base usually 2,000-5,000 ft.

Cumulus (Cu.).—Thick clouds with vertical development; the upper surface is dome-shaped and exhibits rounded protuberances, while the base is nearly horizontal. When the light comes from the side, the clouds exhibit strong contrasts of light and shade; against the sun, on the other hand, they look dark with a bright edge, the “silver lining.”

Cumulus (Cu.).—True cumulus is well defined with hard and clear-cut outlines; but one may also observe as in this photograph clouds belonging to the same system in which the outline is ragged and changing rapidly. To such clouds the name fractocumulus (Fc.) is applied.



Fair weather cumulus (Cu.) and some fractocumulus (Fc.).



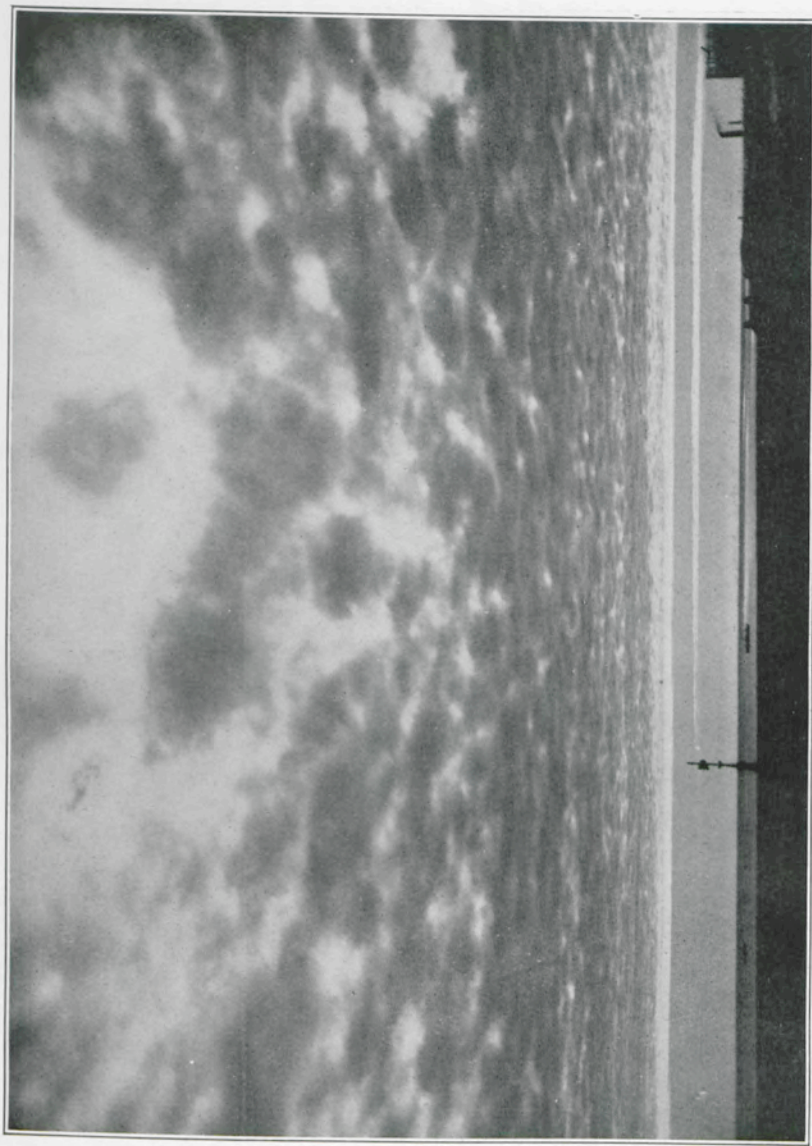
Cumulonimbus (Cb.). "Thunderstorm cloud" without "anvil." Height of base usually 2,000-5,000 ft.

Cumulonimbus (Cb.).—Heavy masses of cloud, with great vertical development, whose cumulonimbus summits rise in the form of mountains or towers, the upper parts having a fibrous texture and often spreading out in the shape of an anvil. This example shows in the lower left-hand corner a *virga* or trail of precipitation, but the upper parts are quite hard and clear cut.



Cumulonimbus (Cb.) with large "anvil" of cirrus nothus (cumulonimbus cirrus).

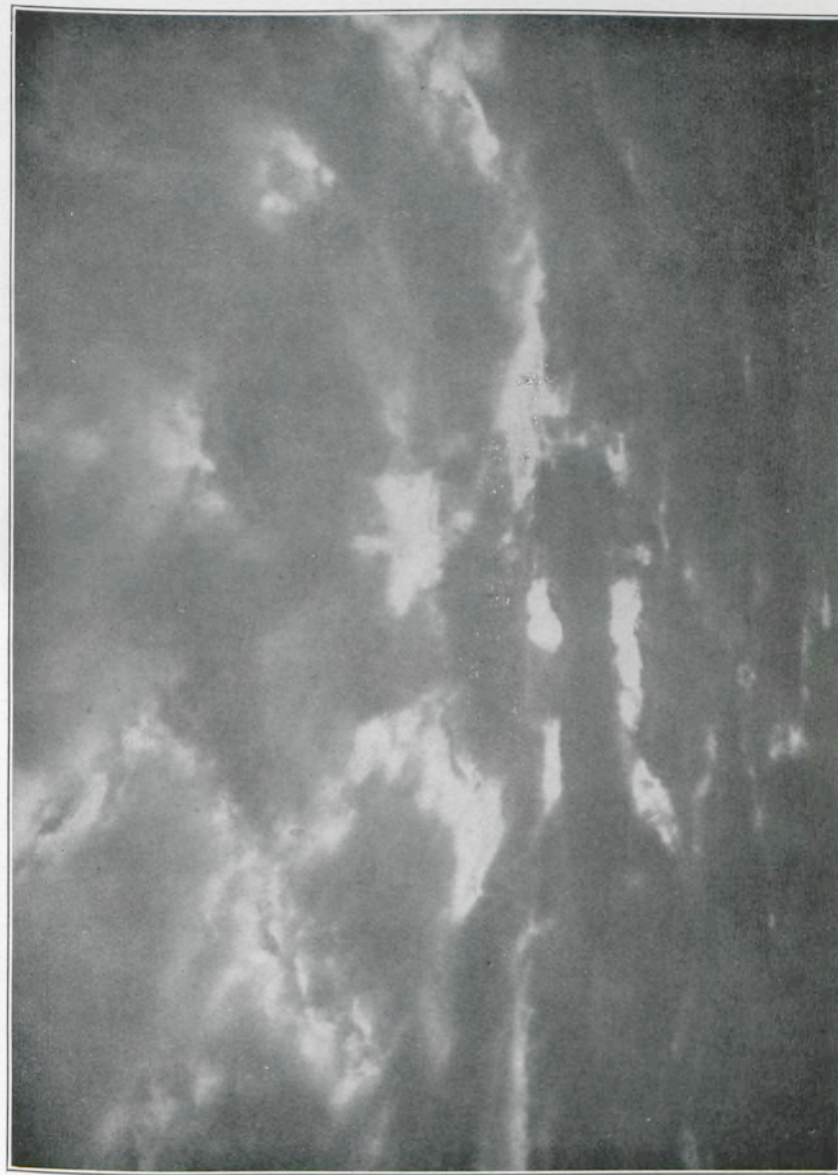
Cumulonimbus (Cb.).—This photograph of a mass of cumulonimbus advancing towards the spectator, shows a remarkably perfect example of the "anvil" formation of the upper parts referred to in the definition. These upper parts are of cirriform structure and were formerly distinguished by the name "false cirrus." The modern name, as given in the International Atlas of Clouds is cirrus nothus (cumulonimbus cirrus).



Stratocumulus (Sc.). A layer of large cloudlets at a relatively low level (1,500–4,500 ft.).

Stratocumulus (Sc.).—A layer (or patches) composed of globular masses or rolls; the smallest of the regularly arranged elements are fairly large; they are soft and grey, with darker parts.

In this example the cloudlets are of soft and irregular form. Note the uniformity of height as revealed by the sharp lower edge of the sheet seen against the clear sky. There is no sharp distinction between the higher forms of stratocumulus and the lower forms of altocumulus, but the heavy shadows seen in this example indicate that it should be classified as stratocumulus.



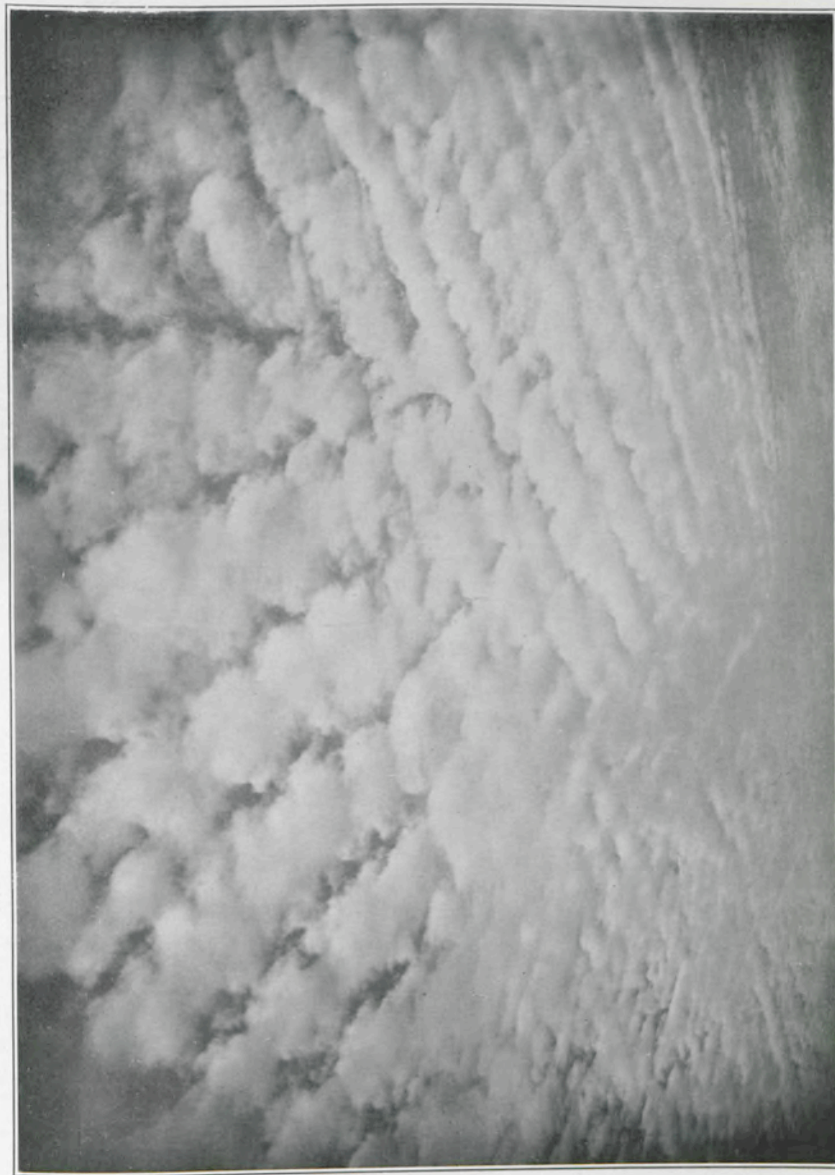
Stratocumulus (Sc.). Lumpy clouds forming a layer at a low level.

Stratocumulus (Sc.).—A typical example of low, heavy stratocumulus. The individual cloudlets are of considerable size, are at a uniform height and appear to be of small vertical thickness.



Altostratus (As.). A level sheet of intermediate height (6,500-20,000 ft.).

Altostratus (As.).—Striated or fibrous veil, more or less grey or bluish in colour. The disc of the sun or moon can usually be seen through altostratus and coronae may be observed. Altostratus is readily distinguished from cirrostratus (the dense forms of which it sometimes resembles) by its lower apparent height and by the fact that it gives rise to no halo phenomena. Owing to the absence of definite details of structure altostratus is difficult to illustrate by a photograph, but this picture, in which there are a few small patches of lower cloud, gives a good idea of its normal appearance.



Altocumulus (Ac.). A layer of cloudlets of intermediate height (6,500-20,000 ft.).

Altocumulus (Ac.).—A layer (or patches) composed of laminae or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without shading.

The illustration shows a typical example in which the cloudlets are arranged in a fairly regular pattern with numerous clear interstices. In other cases the cloudlets may be widely separated and may show a turreted structure indicating considerable vertical development (Ac. castellatus, Pl. XVII a); or they may be arranged in bands. A special case of the latter structure is Ac. lenticularis' (see Pl. XVI b).



Cirrocumulus (Cc.). A high layer of small cloudlets associated with cirrus (20,000-40,000 ft.).

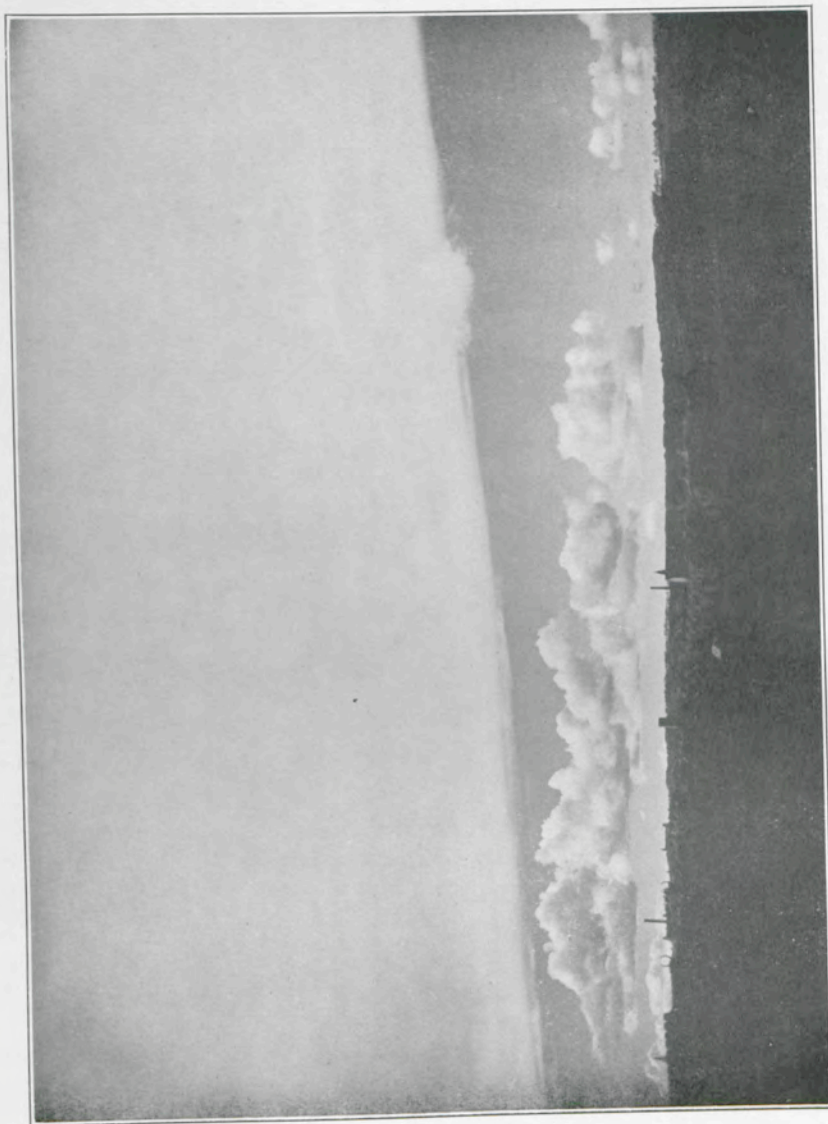
Cirrocumulus (Cc.).—A cirriform layer or patch composed of small white flakes or of very small globular masses, without shadows, which are arranged in groups or lines, or more often in ripples resembling those of the sand on the sea shore. As compared with altocumulus, the structure of cirro-cumulus is exceedingly delicate and there is an obvious association with cirrus, as illustrated in this plate. In other examples, the cloudlets may be larger and more widely separated. In the cloud aggregates the lenticular structure may occur (cirrocumulus lenticularis, Plate XVI a).



Cirrus (Ci.). Wisps or filaments of high cloud (20,000-40,000 ft.).

Cirrus (Ci.).—Detached clouds of delicate and fibrous appearance, without shading, generally white in colour, often of a silky appearance.

The photograph illustrates the general characteristics included in the definition, but cirrus appears in the most varied forms. These include hair-like tufts, straight filaments with hooked or tufted ends, branched filaments in feathery form and many others.



Cirrostratus (Cs.). Thin sheet of very high cloud, 20,000-40,000 ft. (cumulus below).

Cirrostratus (Cs.).—A thin whitish veil which does not blur the outlines of the sun or moon but gives rise to halos. Sometimes it is quite diffuse and merely gives the sky a milky look; sometimes it more or less distinctly shows a fibrous structure with disordered filaments.

In this illustration the cirrostratus sheet, of a rather dense type, occupies rather more than the upper half of the picture. Below, a number of small cumulus clouds are seen against the clear sky.

Cirrostratus is distinguished from altostratus by its more tenuous appearance and by the fact that halos are observable in cirrostratus alone, never in altostratus.



(a) **Cumulonimbus mammatus (Cb. mammatus).**—A typical example of mammatus cloud, a low cloud whose lower surface shows numerous udder-like structures, suspended from the main sheet.



(b) **“Mammatus” structure in a cloud of intermediate height.**—Though reaching its most typical development in the cumulonimbus mammatus cloud, the mammatus structure is sometimes observed in clouds at higher levels, *e.g.*, on the underside of the cirrus nothus projecting from cumulonimbus. In this illustration a rather ragged mammatus structure is seen in a cloud of intermediate height.

PLATE XVI

(a) *Cirrocumulus lenticularis*.

(b) *Altocumulus lenticularis*.—Two examples of cloud aggregates exhibiting the structure connoted by the adjective “lenticular” (“lenticularis”). The individual cloudlets are fused together into groups the general shape of which resembles the cross-section of a lens.



(a) *Altocumulus castellatus* (turret cloud).—This special form of altocumulus is relatively infrequent. The individual cloudlets resemble miniature cumulus, are usually widely separated and appear brilliantly white against a deep blue sky. When seen low down on the horizon the appearance is that of many heads of small cumulus rising from the main sheet.



(b) *Stratus cumuliformis*.—An example of cumulus-like structure occurring in stratus cloud. The adjective “cumuliformis” is of general application and is added to the name of the cloud when a tendency to assume the shape of cumulus is observed.

1. HANDBOOKS, TEXT-BOOKS, TABLES—*cont.*

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