M.O.233 AIR MINISTRY

METEOROLOGICAL OFFICE

CLOUD FORMS

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M.O.233 AIR MINISTRY

METEOROLOGICAL OFFICE

CLOUD FORMS

ACCORDING TO THE INTERNATIONAL CLASSIFICATION

DEFINITIONS AND DESCRIPTIONS APPROVED BY THE INTERNATIONAL METEOROLOGICAL COMMITTEE WITH PHOTOGRAPHS OF CLOUDS

SIXTH EDITION
(incorporating resolutions of Washington, 1947)

LONDON
HIS MAJESTY'S STATIONERY OFFICE
1949

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CLOUD FORMS

ACCORDING TO THE INTERNATIONAL CLASSIFICATION

In outline the classification of the clouds is based upon that originally put forward 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. Abercromby contributed a number of papers on the subject, laying stress upon the most important fact that the basic 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 an agreed international classification was adopted. 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 at the International Conference at Munich in 1891, and as a sequel the first edition of the "International Atlas of Clouds" 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 War of 1914–18 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 National 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.

In this Atlas a modification was introduced which was of very great importance. In the earlier Atlas the cloud had been considered as an entity rather than as a feature of the sky which should be considered in relation, not only to all the other clouds present, but also to the development in time. This involved some radical changes in the conception of how clouds should be viewed and some differences in the nomenclature of clouds. This conception has led to the international codes for reporting cloud types, and in

the Atlas an attempt was made to give in order examples not only of the basic classification but also of the sky types to which numbers are given in the reporting codes.

After the second World War, 1939–45, some amendments were made to the reporting codes at the twelfth Conference of Directors, held at Washington, D.C., in 1947.

In the present edition of " Cloud Forms " the plates are arranged on the basis of the new reporting codes. The description of each photograph and its relation to the international classification is printed beneath it.

The following summary of the international classification is based on Part I of the English edition of the " International Atlas of Clouds ".

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

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, Form b } 4. Genus Altocumulus.†

Form c 5. Genus Altostratus.

* 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 at any height where ice crystals can exist.

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

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

Form a, Form b } 6. Genus Stratocumulus.*

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.

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 (see C_H 1, C_H 2, C_H 3, C_H 4).

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 (see C_H 9).

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 altocumulus on the edges of altocumulus sheets.

3. Cirrostratus (Cs).—A thin whitish veil, which does not blur the outlines of the sun or moon, but gives rise to halos (see C_H 5, C_H 6, C_H 7, C_H 8).

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. Altocumulus (Ac).—A layer (or patches), composed of laminæ or rather flattened globular masses, the smallest elements of the regularly arranged layer being fairly small and thin, with or without shading (see C_M 3, C_M 4, C_M 5, C_M 6, C_M 9).

* Most altocumulus and stratocumulus clouds come under category b ; but the varieties cumuliformis and particularly castellatus belong to category a.

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** (see C_M 1, C_M 2, C_M 7).

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** (see C_L 4, C_L 5, C_L 8).

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** (see C_L 6).

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** (*see* C_L 7, C_M 2).

It appears as though feebly illuminated seemingly from inside. When it gives precipitation this 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** (see C_L 1, C_L 2).

When the cloud is opposite the sun the surfaces normal to the observer are brighter than the edges of the protuberances. When

Photo by the Office National Météorologique, Paris

Photo by G. A. Clarke

C_L 1 ⌓ **Fair weather cumulus.** The clouds look rather like cauliflowers. The bases tend to be flat and to be at a uniform level. They are scattered and have a flat and deflated appearance, even when convection is greatest in the early afternoon. Their horizontal extension is greater than the vertical. The words " fair weather " are not to be interpreted as a forecast ; they refer to the weather at the time, and imply that there is no evidence in the sky of precipitation at the time in the neighbourhood (C=8).

Photo by the Office National Météorologique, Paris

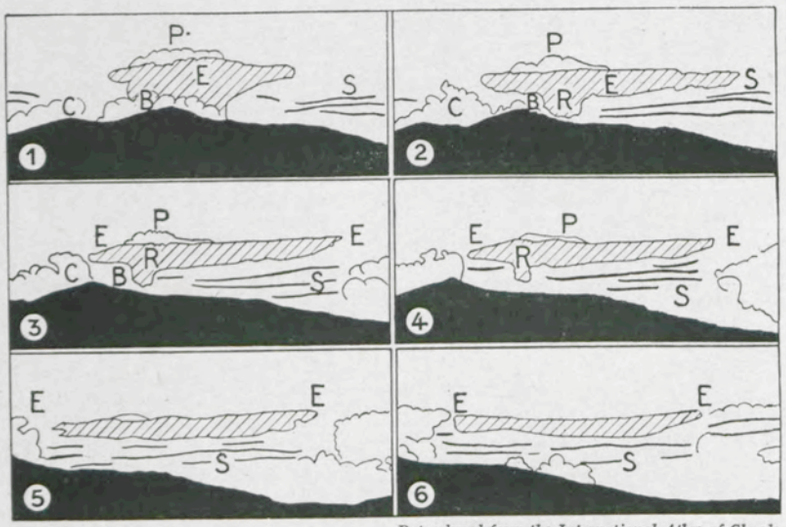
Photo by the Meterologisch-Magnetisches Observatorium, Potsdam

$C_L 2$ ⛆ Towering cumulus. The difference between these and the fair weather cumulus is that the tops of the clouds instead of remaining rounded (and apparently quiescent) begin to bulge upwards and " rising heads " appear. These can be seen clearly in both pictures. Their edges are still well defined and are not softening at the top into cirrus cloud. In the upper picture there is a patch of thick lenticular cirrostratus. This originated from the anvil of a cumulonimbus (see C_L 9). If this cumulonimbus were still in the sky, the code figure would be 9 and not 2, even though a large amount of cumulus without anvil were present (C=8).

Photo by C. J. P. Cave

Photo by F. W. Baker

$C_L 3$ ⛆ Cumulonimbus without anvil. Distinguished from C_L 2 by the fact that the tops are beginning to acquire a fibrous appearance and by showers falling from the base, as seen in the upper photograph. The tops are however definitely not cirriform or anvil-shaped and the type is therefore C_L 3 not C_L 9 (C=9).



Reproduced from the International Atlas of Clouds

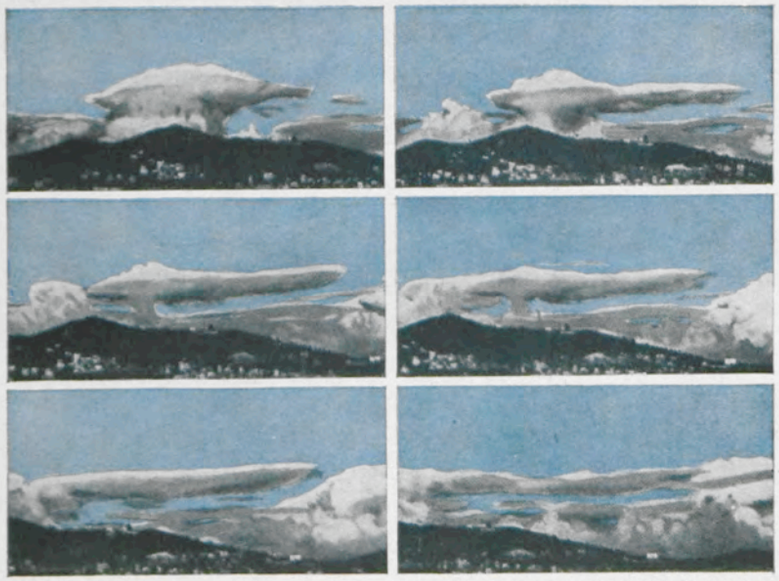


Photo by the Fundació Concepció Rabell, Barcelona

$C_L 4$ **Stratocumulus** formed by the spreading out of cumulus. This cloud is formed in two ways : (*a*) during the day when there is a stable layer or an inversion which the convective cumulus clouds reach and cannot penetrate ; (*b*) in the evening when convection weakens, with or without an inversion above the cumulus. It is most common in the evening (C=6).

" The time from the beginning to the end of the series shown is 20 minutes. 1. It is clear that the top of the cloud that is growing out is of the rounded cumulus type (B) without any cirriform parts. The spreading out has been at (E) and the head of the cumulus has penetrated the extension at (P). 2. (P) has developed a little, but (B) is decreasing and (E), which is increasing in extent, is beginning to separate off, so that the extreme base of the cloud (R) is now seen. 3. (P) grows smaller, (B) has completely settled down and is detached at (R), while (E) is still developing in extent. 4. (P) has completely settled down, (R) is melting away, (E) is completely independent. 5 and 6. There is no longer any trace of (P) or (R) while (E) is fully formed : notice the pendant shreds of cloud on the lower surface. On all the photographs other bands of stratocumulus may be seen in the distance which are being drawn out into stratus ; they probably originated in the same way."

Photo by C. J. P. Cave

Photo by G. A. Clarke

$C_L 5$ **Stratocumulus** not formed by the spreading out of cumulus. The individual cloud masses may be detached and more or less lenticular in shape as in the upper photograph, or close together in a continuous (or nearly continuous) layer. Stratocumulus is often a dark cloud particularly in winter, but it may be fairly light—usually when it is at a fairly high level (C=6).

Photo by the Office National Météorologique, Paris

Photo by G. A. Clarke

C_L 6 — **Stratus.** The upper illustration shows the type of stratus often associated with winter anticyclones. The cloud shows distinct undulations and is not very low, as the top of the tower (1,000 ft.) is clear of cloud. The lower picture shows the typical structureless low stratus frequently seen in hilly country (C=0).

Photo by G. A. Clarke

Photo by F. W. Baker

C_L 7 --- Ragged low clouds of bad weather. These low clouds, collectively known as **fractonimbus,** often show up very dark against the relatively lighter background of altostratus or nimbostratus. The lower picture shows typical scud (fractostratus) below a background of nimbostratus; the upper picture shows, perhaps, a less typical example but nevertheless one in which the ragged low clouds are the predominant features (C=0).

Photo by F. W. Baker

Photo by G. A. Clarke

C_L 8 ⧖ **Cumulus and stratocumulus.** The base of the cumulus is lower than that of the stratocumulus, distinguishing C_L 8 from C_L 2 or C_L 4 (C=8 and C=6).

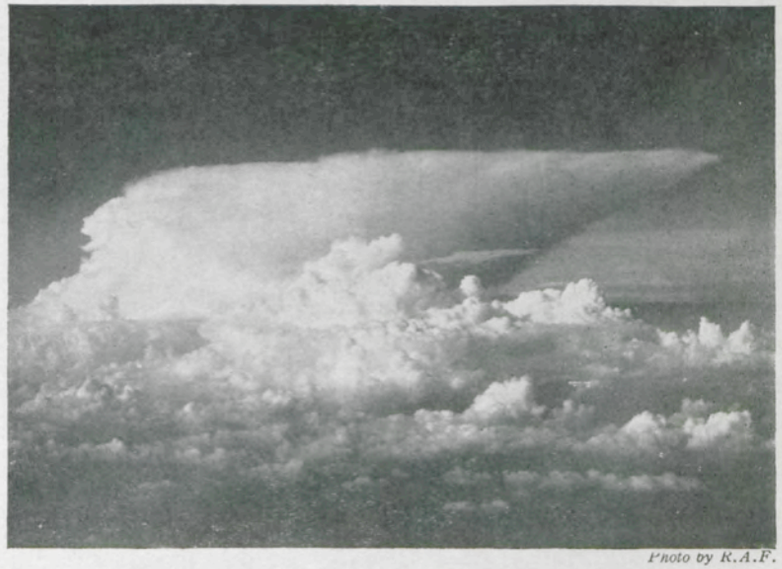


Photo by R.A.F.

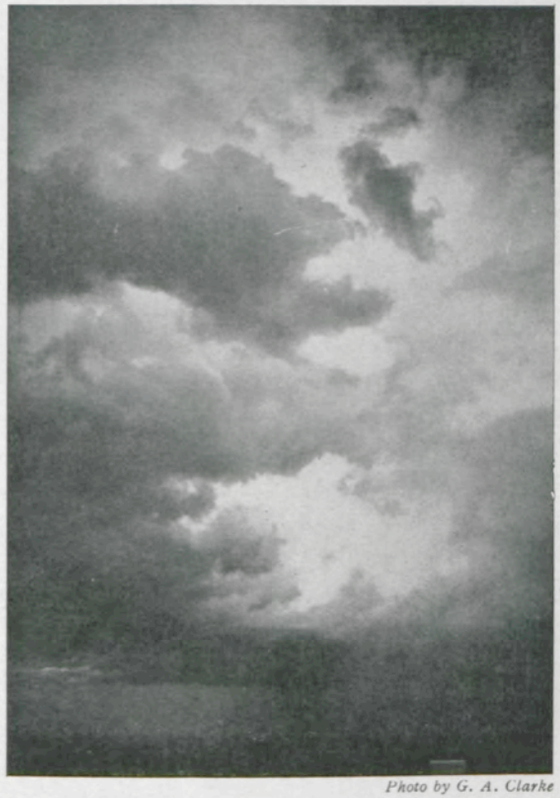


Photo by G. A. Clarke

C_L 9 ⧖ **Cumulonimbus with anvil.** Ragged low clouds of bad weather are often present as in the lower example. The anvil-shaped mass of cirriform cloud, which is exceptionally well seen in the upper photograph, may be hidden from a near-by observer by lower parts of the cloud mass. It is important therefore to keep a close watch on the sky to ensure accurate differentiation between C_L 3 and C_L 9 (C=9).

Photo by G. A. Clarke

$C_M 1$ ⌒ Typical **altostratus (thin).** This is a darkish veil usually covering the whole sky, though not always. It looks rather like a thinly fogged photographic plate. The sun or moon appears as though shining through ground glass and does not cast a shadow. Halo phenomena are not seen in altostratus. A sheet of this cloud resembles thick cirrostratus (see $C_H 7$) from which it is often derived (C=5).

Photo by G. A. Clarke

$C_M 2$ ⌒ Typical **altostratus (thick)** (C=5) (sun and moon invisible) or nimbostratus (C=7). The sun and moon are generally hidden or are indicated only by the lighter colour of one part of the cloud. Typical thick altostratus can be formed either by a thickening of thin altostratus or by the fusing together of the cloudlets in a sheet of altocumulus. The picture illustrates an example rather on the thin side; in many cases the lightness will be less evident or will not appear at all.

Photo by G. A. Clarke

$C_M 3$ ∪ Single layer of **altocumulus or high stratocumulus.** Altocumulus often looks like sheeps' fleeces. This type generally forms a single layer; it is fairly regular, and of uniform thickness, the cloudlets always being separated by clear spaces or lighter gaps; the cloudlets are neither very large nor very dark. This layer is generally fairly persistent, it does not change or disappear quickly. Cases of altocumulus which are so dense that the waves do not show lighter parts should be reported as $C_M 7$ (C=4).

Photo by G. A. Clarke

$C_M 4$ ∽ **Altocumulus** in isolated patches—often lenticular. The cloudlets may be as small as cirrocumulus, but lenticular altocumulus shows delicate colouring (irisation). Where this is so, the clouds are often scattered over the sky quite irregularly and may be at different levels. Though individually they may be changing, the amount of cloud over the whole sky generally remains about the same (C=4).

Photo by Lindenberg Observatory

$C_M 5$ **Altocumulus** in bands (increasing). In this type either the bands are great elongated masses, sometimes appearing rather dark, often of a roughly lenticular shape, or the ordinary altocumulus waves are crossed by blue lanes, so that they appear like bands (with the waves across the bands). An essential feature of this type is that the sky becomes more and more covered. Often the layer thickens up as in the photograph or has another layer of cloud lower and darker forming beneath it (C=4).

Photo by G. A. Clarke

$C_M 6$ **Altocumulus** formed from the spreading out of cumulus. Cumulus clouds of sufficiently great vertical development may undergo an extension of their summits while their bases may gradually melt away. The process is similar to that of C_L 4 but at a higher level. The cloud which looks anvil-shaped must not be confused with C_L 9 (C=4).

Photo by the Office National Météorologique, Paris

$C_M 7$ (*a*) Double-layered **altocumulus.** The higher layer includes the very lightly shadowed tessellations and ripples. The lower layer of typical altocumulus is strongly shaded (C=4).

Photo by F. W. Baker

$C_M 7$ (*b*) Thick opaque layer of **altocumulus** (C=4).

Photo by C. J. P. Cave

$C_M 7$ (*c*) **Altocumulus** associated with **altostratus.** Different types are comprised in this section. There may be two definite layers of altostratus and altocumulus or the altocumulus may be thickening into altostratus by the cloudlets fusing together or altostratus may break up into altocumulus (C=4 and C=5).

Photo by G. A. Clarke

$C_M 8$ **Altocumulus castellatus.** The character common to the types of altocumulus C_M 8 is vertical development, a turret or a dome shape. These clouds are often the precursors of thunderstorms. Altocumulus castellatus is composed of small cumuliform masses with more or less vertical development, either detached or forming a band as in the above example (C=4).

Photo by C. J. P. Cave

$C_M 8$ **Altocumulus floccus.** The cloudlets are of ragged appearance without definite shadows and with the rounded parts slightly domed. There are often pronounced trails (*virga*) of cirriform appearance, as in the above example (C=4).

Photo by the Office National Météorologique, Paris

$C_M 9$ **Altocumulus** in several layers generally associated with fibrous veils and a chaotic appearance of the sky. The sky has a disordered, heavy and stagnant appearance. It is very complex with patches of medium cloud more or less fragmentary, superposed, often badly defined and giving all the transitional forms between low altocumulus and the fibrous veil (C=4).

Photo by the Fundació Concepció Rabell, Barcelona

$C_H 1$ — **Fine cirrus** not increasing. Wisps of cloud at a very high level; they may be scattered over a large part of the sky but the amount does not increase noticeably either in time or in any particular direction.

The clouds do not collect into sheets and bands, and there is no tendency for the elements to fuse together into masses of cirrostratus. The cirrus cloud whose strands end in an upturned hook or tuft must not be included in this class but in C_H 4 (C=1).

Photo by G. A. Clarke

$C_H 2$ — **Dense cirrus** in patches or twisted sheaves. Cirrus of this type is more " woolly " in appearance than C_H 1 and is possibly, but not certainly, the debris of the upper part of cumulonimbus (C=1).

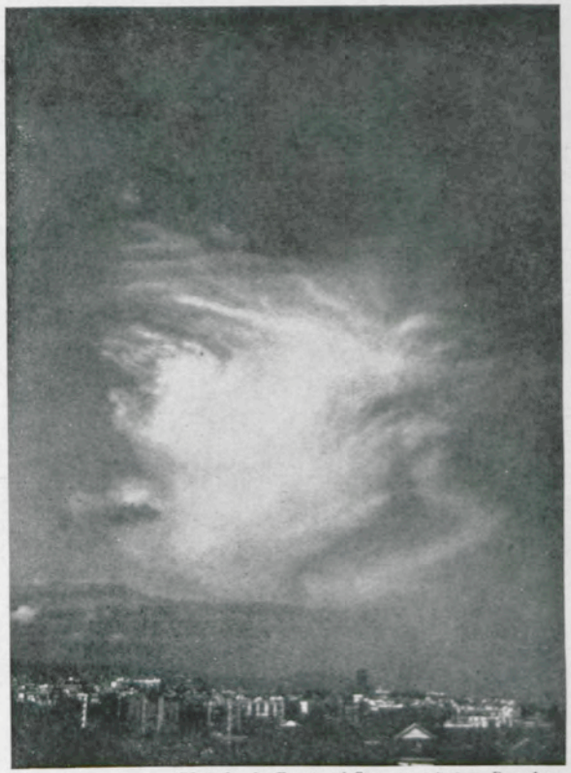


Photo by the Fundació Concepció Rabell, Barcelona

$C_H 3$ — **Cirrus, often anvil-shaped,** usually dense, which is known to be either the remains of the upper part of a disintegrated cumulonimbus or part of a distant cumulonimbus the rest of which is not visible at the time of observation (C=1).

Photo by the Fundació Concepció Rabell, Barcelona

$C_H 4$ — **Hooked cirrus.** This type of cirrus, which is in the form of streaks ending in a little upturned hook or in a small tuft, increases in amount both in time and in a certain direction. In this direction it reaches to the horizon, where there is a tendency for the cloud elements to fuse together, but the clouds do not pass into cirrostratus (C=1).

Photo by G. A. Clarke

$C_H 5$ **Cirrus or cirrostratus** increasing ; still below 45° altitude ; often in polar bands. Sheet of fibrous cirrus partly uniting into cirrostratus, especially towards the horizon in the direction where the cirrus strands tend to fuse together ; the cirrus is often in a herring-bone formation or in great bands converging more or less to a point on the horizon. In this class is also included a sheet of cirrostratus which does not cover the sky and is below 45° altitude (C=2, or 1 if cirrus predominates).

Photo by G. A. Clarke

$C_H 6$ **Cirrus or cirrostratus** increasing and reaching above 45° altitude ; often in polar bands. The definition of this type is the same as the previous one, with the exception that the cloud reaches more than 45° above the horizon. (*Note.*—Altitudes if not measured instrumentally are deceptive ; it is common to over-estimate a point in the sky. A point at 30° altitude will appear to be about 45° altitude.) (C=2, or 1 if cirrus predominates.)

Photo by G. A. Clarke

$C_H 7$ **Veil of cirrostratus** covering the whole sky, either (*a*) a thin uniform nebulous veil, sometimes hardly visible, sometimes relatively dense, always without definite detail, but producing halo phenomena round the sun and moon ; or (*b*) a white fibrous sheet, with more or less clearly defined fibres, often like a sheet of fibrous cirrus from which indeed it may be derived (C=2).

Photo by G. A. Clarke

$C_H 8$ **Cirrostratus** not inceasing and not covering the whole sky. This is a case of veil or sheet cirrostratus reaching the horizon in one direction but leaving a segment of blue sky in the other direction ; this segment of blue sky does not grow smaller, otherwise it would be reported as C_H 5 or C_H 6. Generally the edge of the sheet is clear-cut and does not tail off into scattered cirrus (C=2).

Photo by G. A. Clarke

$C_H 9$ **Cirrocumulus** predominating, and a little cirrus. Cirrocumulus is a wavy type of " mackerel " sky with a delicate fine structure. Cirrocumulus is not to be confused with small altocumulus. There must be either evident connexion with cirrus or cirrostratus, or the cloud observed must result from a change in cirrus or cirrostratus.

Cirrocumulus may occur with any of the types C_H 1 to C_H 8 (C=3)

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** (see C_L 3, C_L 9).

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.

III.—PRINCIPAL VARIETIES OF CLOUDS

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. Among the most important of these sub-classifications are those 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).

Lenticularis.—Groups of cirrocumulus, altocumulus and stratocumulus sometimes show an ovoid form with sharp edges, resembling the cross-section of a lens. The adjective " lenticularis " is added to the name of the cloud to indicate this structure, *e.g.* altocumulus lenticularis (see C_M 4).

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 C_M 8).

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.

A few other Latin adjectives will be found appended to the code specifications. They are sufficiently well defined by the preceding text, or in the descriptions of the illustrations.

IV.—REMARKS 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 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 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 ". 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. G. A. 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 stratocumulus and altostratus. The characteristic " cumulonimbus mammatus " 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 marked 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 raindrops) 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.

V.—CODES

For the purpose of reporting clouds for synoptic observation the following codes are used :—

Code for form of low cloud (C_L) (Code 11)

Code figure	*Specifications*
0	No stratocumulus, stratus, cumulus or cumulonimbus clouds.
1	Cumulus with little vertical development and seemingly flattened (Cu humilis).
2	Cumulus of considerable development, generally towering, with or without other cumulus or stratocumulus, bases all at the same level (Cu congestus).
3	Cumulonimbus with tops lacking clear-cut outlines but distinctly not cirriform or anvil shaped, with or without cumulus, stratocumulus, or stratus (Cb calvus).

Code for form of low cloud (C_L) (Code 11)—*continued*

Code figure	*Specifications*
4	Stratocumulus formed by the spreading out of cumulus; cumulus also often present (Sc cumulogenitus or Sc vesperalis). Since the spreading out of the scattered parcels of air that have been warmed by the surface may take place as in Sc vesperalis as soon as the condensation level is reached, observers are warned that, though cumulus may normally have been seen earlier, the formation of a particular piece of Sc vesperalis may not come from a cumulus.
5	Stratocumulus not formed by the spreading out of cumulus.
6	Stratus or fractostratus or both, but not fractostratus of bad weather.
7	Fractostratus and/or fractocumulus of bad weather (" scud ") usually under nimbostratus. By " bad weather " is meant the conditions usually prevailing before, during or after precipitation.
8	Cumulus and stratocumulus other than those formed by the spreading out of cumulus, with bases at different levels.
9	Cumulonimbus having a clearly fibrous (cirriform) top, often anvil shaped, with or without cumulus, stratocumulus, stratus or " scud " (Cb capillatus).

Code for form of medium cloud (C_M) (Code 12)

Code figure	*Specifications*
0	No altocumulus, altostratus or nimbostratus clouds.
1	Thin altostratus (semi-transparent everywhere) through which the sun or moon would be seen dimly as through ground glass (As translucidus).
2	Thick altostratus or nimbostratus. Through portions of the sheet the position of the sun or moon may be indicated by a light patch (As opacus or nimbostratus).
3	Thin (semi-transparent) altocumulus; cloud elements not changing much; at a single level.
4	Thin (semi-transparent) altocumulus in patches (often almond or fish shaped); cloud elements continually changing and/or occurring at more than one level.
5	Thin (semi-transparent) altocumulus in bands or in a layer gradually spreading over the sky and usually thickening as a whole: it may become partly opaque or double-layered.
6	Altocumulus formed by the spreading out of cumulus (Ac cumulogenitus).
7	Any of the following cases:— (*a*) double-layered altocumulus, usually opaque in parts, not increasing (Ac duplicatus); (*b*) a thick (opaque) layer of altocumulus, not increasing; (*c*) altostratus and altocumulus both present at the same or different levels.
8	Altocumulus in the form of cumulus-shaped tufts or altocumulus with turrets (Ac castellatus or Ac floccus).
9	Altocumulus of a chaotic sky; generally at different levels; dense cirrus in patches is usually also present.

Code for form of cirrus cloud (C_H) (Code 13)

Code figure	*Specifications*
0	No cirrus, cirrocumulus or cirrostratus clouds.
1	Filaments or strands of cirrus, scattered and not increasing (often " mares' tails ") (Ci filosus).
2	Dense cirrus in patches or twisted sheaves usually not increasing, possibly but not certainly the remains of the upper part of cumulonimbus (Ci densus).
3	Cirrus, often anvil shaped; either the remains of the upper portions of cumulonimbus or part of a distant cumulonimbus the rest of which is not visible (Ci nothus). If there is doubt as to the cumulonimbus origin or association, Code C_H 2 should be used.
4	Cirrus (often hook shaped) gradually spreading over the sky and usually thickening as a whole (Ci often Ci uncinus).
5	Cirrus and cirrostratus, often in bands converging toward the horizon, or cirrostratus alone; in either case gradually spreading over the sky and usually thickening as a whole, but the continuous layer not reaching 45° altitude.
6	Cirrus and cirrostratus, often in bands converging toward the horizon, or cirrostratus alone; in either case gradually spreading over the sky and usually thickening as a whole, and the continuous layer exceeding 45° altitude.
7	Cirrostratus covering the whole sky.
8	Cirrostratus not increasing and not covering the whole sky; cirrus and cirrocumulus may be present.
9	Cirrocumulus alone or cirrocumulus with some cirrus or cirrostratus, but the cirrocumulus being the main cirriform cloud present. Cirrocumulus may be present in $C_H=1$ to $C_H=8$.

Code for form of significant cloud (C) (Code 10)

Code figure	*Form of cloud*
1	Cirrus (Ci)
2	Cirrostratus (Cs)
3	Cirrocumulus (Cc)
4	Altocumulus (Ac)
5	Altostratus (As)
6	Stratocumulus (Sc)
7	Nimbostratus (Nb)
8	Cumulus (Cu) or fractocumulus (Fc)
9	Cumulonimbus (Cb)
0	Stratus (St) or fractostratus (Fs)

Examples of each code figure are given in this book, with brief notes about the clouds shown in the photographs, and also the plotting symbol which represents the cloud on the synoptic working charts used by forecasters.

It is clear from the descriptions of the code figures given under the various photographs that to describe the sky at a station at a

particular time logically and completely it is not enough merely to know the type of clouds present; for example altocumulus appears in seven code figures and cirrus in nine. The code figures, as the descriptions show, are not so much a dry statement of the types of clouds in the sky, as a general indication of the structure and evolution of the visible sky as a whole. For example C_M 9 is a thundery sky; in thundery conditions degenerate cloud forms are seen which are difficult to classify, but the thundery look of the whole sky is apparent at once and without any doubt.

The detailed analysis of the individual clouds should follow and not precede the observations of the sky as a whole. If the observer gets used to this course he will find in a short time that the different types of sky, low, medium and high, corresponding with the code, will seem just as "live" as the typical cloud forms, and it will be just as easy to identify a type of sky as the form of a cloud.

To make an observation of cloud it is necessary to do more than survey the sky while walking to the instrument enclosure. The aspect of the sky is continually changing. It is relatively rare for the observer to see typical clouds of one type; in most cases he will find he has difficulties at the time of observation if he has not taken the trouble to watch the evolution of the sky since the last observation. If, however, he has been able to keep it in view he will often be able to refer an indefinite type of sky, or a particular cloud to a previous formation which was typical and easy to identify. Moreover the specification of many of the code figures depends on evolution. If two figures seem to be equally applicable, the observer should in general select the higher figure rather than the lower, but he must remember that if cumulonimbus cloud is present the figure for C_L must be reported as either 3 or 9.

The observer must remember that it is only when he does his job properly that the forecaster is able, from his and other observers' reports, to get a correct picture. It is the task of the forecaster to become instinctively aware of the aspect of the sky associated with the code figures (and plotted symbols), so that the arrangement of the symbols on the map will convey a picture to his mind of the whole skyscape. This can only be accomplished by long practice. The first step is patient observation and the deliberate classification of skies.

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