CLOUD FORMS

According to the International System of Classification

SECOND EDITION

Prepared by the Weather Bureau Cloud Committee:

Benjamin C. Kadel, Chairman
Harry C. Frankfield
Franklin G. Tingley

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With the International Cloud Definitions together with introductory remarks and height-frequency diagrams
Prepared by the Weather Bureau Cloud Committee, April 1928

The earliest attempt to give names to the clouds appears to be that of Lamarck who, in 1801, recognized six forms to which he gave French names. His system does not seem to have been very widely used. In 1803 Luke Howard published his system, giving to the clouds Latin names, cirrus, cumulus, and stratus, and using compounds of these words and the name nimbus for intermediate forms.

Although a number of systems were later proposed, that of Howard had attained such widespread acceptance that it served as the basis for the nomenclature recommended for international use by a majority vote of the International Meteorological Congress at Munich in 1891. In 1894 a committee created by this Congress prepared an atlas illustrating the typical cloud forms, and adopted the international cloud definitions, which, with the few changes suggested at the International Meteorological Congress at Innsbruck in 1905, are here reprinted from the International Cloud Atlas, second edition, 1910.

The classification is based upon the form or appearance of the cloud; but it has been demonstrated by actual measurements that the form is largely dependent upon the height, the same form having its maximum frequency at nearly the same level at widely separated stations in Europe and America.

In the preceding edition of this publication, prepared in March 1924, diagrams showing cloud height frequencies at Blue Hill, Mass., were presented. In this revision diagrams are presented to show cloud height frequencies as determined at Washington, D.C. The diagrams are based upon theodolite measurements made in 1896 and 1897 by the United States Weather Bureau.\(^1\)

Cirrus were measured 1,339 times. The height of maximum frequency, both summer and winter, was between 9,000 and 10,000 meters. Of the 846 summer measurements, 470 were above the 10,000-meter level and 191 below the 9,000-meter level, whereas of the 503 winter measurements, 166 were above and 207 below these respective levels. The mean summer level was 10,380 meters, mean winter level, 9,840 meters.

Cirro-stratus measurements numbered 189 in summer and 162 in winter. These clouds differed but little in height from the Cirrus but were more uniformly distributed throughout the different levels.

Cirro-cumulus were measured 240 times in summer and 225 times in winter. The mean level of these clouds was slightly lower than that of the Cirro-stratus.

Alto-stratus occurred throughout a great range of levels in summer but a moderate range in winter. The greatest frequency of occurrence in summer was between the levels of 5,000 and 7,000 meters; in winter, between those of 4,000 and 6,000 meters.

Alto-cumulus measurements were 690 in summer and 340 in winter. In the former season the greatest frequency of occurrence was found between the 4,000- and 5,000-meter levels, while in the latter season it was found between the 2,000- and 3,000-meter levels.

As in the case of the other cloud forms the Strato-cumulus and Cumulus levels were found to be slightly higher in summer than in winter. The greatest frequency of occurrence of both these forms was found below the 3,000-meter level. The Cumulus tops exhibited a marked frequency at about 2,000 meters in summer and 1,800 meters in winter.

No separate classification of Nimbus was made.

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Cloud height measurements, Washington, D. C., May to September 1896 and April to June 1897. (8 months.)
Relative frequency at different heights indicated by width of figure. Cumulus tops plotted by 200-meter intervals, horizontal scale, 115 observations to the inch. Cumulus bases also plotted by 200-meter intervals, 46 observations to the inch. All other forms plotted by 1,000-meter intervals, 230 observations to the inch.
Cloud height measurements, Washington, D. C., October 1896 to March 1897. (6 months.)

Relative frequency at different heights indicated by width of figure. Cumulus tops and bases plotted by 200-meter intervals, horizontal scale 46 observations to the inch. Other forms plotted by 1,000-meter intervals, 230 observations to the inch.
INTERNATIONAL CLOUD DEFINITIONS

The following definitions are taken from the International Cloud Atlas, second edition (Paris, 1910):

1. Cirrus (Ci.). [1, 2, 3, 5, 6, 8, 27.]—Detached clouds of delicate and fibrous appearance, often showing a featherlike structure, generally of a whitish colour. Cirrus clouds take the most varied shapes, such as isolated tufts, thin filaments on a blue sky, threads spreading out in the form of feathers, curved filaments ending in tufts, sometimes called Cirrus ursinus, etc.; they are sometimes arranged in parallel belts which cross a portion of the sky in a great circle, and by an effect of perspective appear to converge toward a point on the horizon, or, if sufficiently extended, toward the opposite point also. (Ci.-St. and Ci.-Cu., etc., are also sometimes arranged in similar bands.)

2. Cirro-stratus (Ci.-St.). [4, 5, 6, 7, 8, 31.]—A thin, whitish sheet of clouds sometimes covering the sky completely and giving it only a milky appearance (it is then called Cirro-nebula) at other times presenting, more or less distinctly, a formation like a tangled web. This sheet often produces halos around the sun and moon.

3. Cirro-cumulus (Ci.-Cu.), Mackerel Sky. [7, 9, 10.]—Small globular masses or white flakes without shadows, or showing very slight shadows, arranged in groups and often in lines. [Small A-Cu. may also be “Mackerel Sky.”]

4. Alto-stratus (A.-St.). [4, 7, 11, 12, 16, 18, 23, 24, 29, 31.]—A thick sheet of a grey or bluish colour, sometimes forming a compact mass of dark grey colour and fibrous structure. At other times the sheet is thin, resembling thick Ci.-St., and through it the sun or the moon may be seen dimly gleaming as through ground glass. This form exhibits all changes peculiar to Ci.-St., but from measurements its average altitude is found to be about one-half that of Ci.-St. [Nonfibrous A.-St. is often undulated or festooned.]

5. Alto-cumulus (A.-Cu.). [12, 13, 14, 15, 16, 17, 22.]—Large globular masses, white or greyish, partially shaded, arranged in groups or lines, and often so closely packed that their edges appear confused. The detached masses are generally larger and more compact (resembling St.-Cu.) at the center of the group, but the thickness of the layer varies. At times the masses spread themselves out and assume the appearance of small waves or thin slightly curved plates. At the margin they form into finer flakes (resembling Ci.-Cu.). They often spread themselves out in lines in one or two directions.

6. Strato-cumulus (St.-Cu.). [17, 18, 19, 20, 21, 22, 23.]—Large globular masses or rolls of dark clouds often covering the whole sky, especially in winter. Generally St.-Cu. presents the appearance of a grey layer irregularly broken up into masses of which the edge is often formed of smaller masses, often of wavy appearance resembling A.-Cu. Sometimes this cloud-form presents the characteristic appearance of great rolls arranged in parallel lines and pressed up against one another. In their centers these rolls are of a dark colour. Blue sky may be seen through the intervening spaces, which are of a much lighter colour. St.-Cu. clouds may be distinguished from Nb. by their globular or rolled appearance, and by the fact that they are not generally associated with rain.

7. Cumulus (Cu.), Woolpack Clouds. [16, 23, 25, 26, 27, 28.]—Thick clouds of which the upper surface is dome-shaped and exhibits protuberances while the base is horizontal. These clouds appear to be formed by a diurnal ascensional movement which is almost always noticeable. When the cloud is opposite the sun, the surfaces facing the observer have a greater brilliance than the margins of the protuberances. When the light falls aslant, as is usually the case, the clouds throw deep shadows; when, on the contrary, the clouds are on the same side of the observer as the sun, they appear dark with bright edges.

True cumulus has well-defined upper and lower limits, but in strong winds a broken cloud resembling cumulus is often seen in which the detached portions undergo continual change. This form may be distinguished by the name Fracto-cumulus (Fr.-Cu.).

8. Cumulo-nimbus (Cu.-Nb.), the Thunder Cloud; Shower Cloud. [1, 27, 29, 32.]—Heavy masses of cloud rising in the form of mountains, turrets, or anvil-shaped, generally surmounted by a sheet or screen of fibrous appearance (false cirrus) and having at its base a mass of cloud similar to nimbus. From the base local showers of rain or snow (occasionally of hail or soft hail) usually fall. Sometimes the upper edges assume the compact form of cumulus and form massive peaks round which delicate “false cirrus” floats. At other times the edges themselves separate into a fringe of filaments similar to cirrus clouds. This last form is particularly common in spring showers.

The front of thunder clouds of wide extent frequently presents the form of a large are spread over a portion of a uniformly brighter sky.

9. Nimbus (Nb.), Rain Clouds. [30.]—A thick layer of dark clouds without shape and with ragged edges, from which steady rain or snow usually falls. Through the openings in these clouds an upper layer of Ci.-St. or A.-St. may be seen almost invariably. If a layer of Nb. separates up in a strong wind into shreds, or if small loose clouds are visible floating underneath a large Nb., the cloud may be described as Fracto-nimbus (Fr.-Nb.) ("Seud" of sailors). [Note that all rain clouds are not nimbus (nor Cu.-Nb.), but only those having the characteristics as defined. A.-St., St., and St.-Cu. frequently yield rain or snow, while precipitation occasionally reaches the ground from A.-Cu., Cu., and possibly others.]

10. Stratus (St.). [31, 32.]—A uniform layer of cloud resembling a fog but not resting on the ground. When this sheet is broken up into irregular shreds in a wind, or by summits of mountains, it may be distinguished by the name Fracto-stratus (Fr.-St.). [St. may be undulated or festooned, even though “uniform.” Its evident low height (under 1,000 meters) distinguishes it from nonfibrous A.-St.]
1. Cirrus becoming detached from thunderstorm top

2. Dense, bunched cirrus, probably of thunderstorm origin
Tortosa, Spain. Elbro Observatory.
3. Tufted cirrus, similar to (2) but thinner

Mount Wilson, Calif.  F. Ellerman.

4. Cirro-stratus and fibrous alto-stratus such as originate from thunderstorm tops

Orient, L. I., N. Y.  W. S. Davis.
5. Cirrus (top half of picture) and cirro-stratus (bottom half)

6. Cirrus merging into cirro-stratus: Not infrequently a sky aspect subsequent to (2) or (4)
7. Cirro-stratus and alto-stratus, with cirro-cumulus and alto-cumulus tops, characteristic of overflow from intense cyclones. The shadowy parts are alto-stratus, and the larger rounded tops, alto-cumulus

Tortosa, Spain.  

8. Cirrus (the detached portions) and cirro-stratus, from evaporation of such clouds as (7)

Atlas Photographique des nuages.  

J. Loisel.
9. Cirro-cumulus, overhead
Mount Wilson, Calif.  E. E. Barnard.

10. Cirro-cumulus, with tufted cirrus
Mount Wilson, Calif.  F. Ellerman.
11. Thin, undulated alto-stratus forming above a layer of fog or stratus. (Such thin A.-St. is distinguishable from Ci.-St. by its grayness, or, if near the sun or moon, by its diffraction colors, e.g., corona, iridescence)
Mount Wilson, Calif. F. Ellerman.

12. Thin alto-stratus (lower right) transforming to growing alto-cumulus, which becomes merged into dense alto-stratus (lower left). Compare small A.-Cu. with Ci.-Cu. in (9) and (10)
Tortosa, Spain. Ebro Observatory.
13. Undulated alto-cumulus, locally more or less scaly


14. Small alto-cumulus (note shadows: compare (9) and (10)). (Even if there are no shadows, the presence of coronas or iridescent colors near the sun or moon distinguish such small A.-Cu. from Ci.-Cu.)

15. Alto-cumulus, somewhat ragged


16. Turreted alto-cumulus. Tall cumulus below. (Turreted A.-Cu. usually grow up from a base of thin, usually undulated A.-St.)

Mount Wilson, Calif.  F. Ellerman.
17. Strato-cumulus or alto-cumulus, photographed from an altitude of about 1,750 meters. These same clouds would be called strato-cumulus by an observer nearer to them and alto-cumulus by an observer farther from them (as at sea level).

Mount Wilson, Calif.

F. Ellerman.


Tortosa, Spain.

Ebro Observatory.
19. Strato-cumulus rolls, with strong east wind at surface. (Taken looking south)
Orient, L. L., N. Y.

20. Ragged strato-cumulus rolls at 800 meters altitude in NW. wind in winter. Inset:
Same clouds viewed from height of 1,100 meters
Payne Field, Miss.

W. S. Davis.

P. W. Etkes.
21. Strato-cumulus or alto-stratus sheet, slightly mammilated, fed by overflow from local strato-cumulus below. Characteristic of moderate N. to NE. wind in autumn

Blue Hill, Mass.  

C. F. Brooks.

22. Strato-cumulus, evaporating scaly type. (Such clouds evolve in the process of evaporation of sheets like those in (20) and (21.).) (Note two airplanes)

Park Field, Tenn.
23. Cumulus and strato-cumulus below, thin alto-stratus above

24. Lenticular alto-stratus: Upper, standing clouds topping south wind; lower left, standing cloud in lee of Mount Washington during NW. gale; lower right, conditions unknown
25. Cumulus

Topeka, Kans.  
W. M. Lyon.

26. Cumulus rolls. (Such clouds when they mark the front of an arriving wedge of cool air may develop thunderstorms locally)

Over Columbia River, near Portland, Oreg.  
C. A. Gilchrist.
27. Cumulo-nimbus, just grown from cumulus. Note the start of streaks of falling snow (cirrus) from portions of the top on right
Mount Wilson, Calif.  F. Ellerman.

28. Low cumulo-nimbus, and cumulus, characteristic of spring
29. Anvil top of cumulo-nimbus (upper). Mammato alto-stratus on underside of cumulo-nimbus overflow in vicinity of tornado (lower)

Atlas photographique des nuages.  
Bartlesville, Okla.  
J. Loisel.  
L. C. Twiford.

30. Nimbus, with fog or stratus below

Mount Wilson, Calif.  
F. Ellerman.
31. Fracto-stratus (right), under alto-stratus and cirro-stratus, apparently from local thunderstorms

Mount Weather, Va.

A. J. Henry.

32. Stratus clouds at two levels; one practically on the ground

Mount Weather, Va.

A. J. Weed.