INTERNATIONAL CLOUD ATLAS

Volume II

WORLD METEOROLOGICAL ORGANIZATION

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NOTE

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.

FOREWORD

With this new, thoroughly revised edition of Volume II of the International Cloud Atlas a key publication is once again made available for professional meteorologists as well as for a wide circle of interested amateurs. For meteorologists this is a fundamental handbook, for others a source of acquaintance with the spectacular world of clouds.

The present internationally adopted system of cloud classification is the result of work which started in the nineteenth century. The first studies on the topic were published by J. B. Lamarck (1802) and L. Howard (1803). The first attempt to use photography for cloud classification was made by H. Hildebrandsson (1879), in Uppsala, who prepared a cloud atlas of 16 photographs. The further development of this work, following the recommendation of an International Meteorological Conference which took place in Munich in 1891, resulted in the publication in 1896 of the first International Atlas, containing 28 coloured plates accompanied by definitions and descriptions of clouds and instructions on cloud observations in three languages (French, German, English). The first International Atlas, which was then adopted in almost all countries, was a great step forward in making internationally comparable cloud observations. This Atlas was reprinted in 1910, without substantial amendments. The subject of further refinement of cloud classification still remained to the fore, however, during the following decades. As a result the *International Atlas of Clouds and Study of the Sky, Volume I, General Atlas* was published in 1932 by the International Commission for the Study of Clouds. A modified edition of the same work appeared in 1939, under the title *International Atlas of Clouds and of Types of Skies, Volume I, General Atlas*. The latter contained 174 plates: 101 cloud photographs taken from the ground and 22 from aeroplanes, and 51 photographs of types of sky. From those photographs, 31 were printed in two colours (grey and blue) to distinguish between the blue of the sky and the shadows of the clouds. Each plate was accompanied by explanatory notes and a schematic drawing on the same scale as the photograph, showing the essential characteristics of the type of cloud.

When the World Meteorological Organization (WMO) came into being in 1951 in place of the non-governmental International Meteorological Organization, the First Meteorological Congress noted the need for a new International Cloud Atlas and referred the task to the Commission for Synoptic Meteorology. Within a relatively short time very substantial work was accomplished and the new Atlas was published in 1956 in two volumes: Volume I contained a descriptive and explanatory text on the whole range of hydrometeors (including clouds), lithometeors, photometeors and electrometeors; Volume II contained a collection of 224 plates (123 in black and white and 101 in colour) of photographs of clouds and of certain meteors. Each photograph in Volume II was accompanied by an explanatory text, to enable the pictures in Volume II to be understood without the detailed technical definitions and descriptions contained in Volume I.

The 1956 edition of Volume II has not been reprinted or revised until the preparation of the present edition. A revised version of

Volume I, however, was published in 1975 under the title *Manual on the Observation of Clouds and Other Meteors*. In the meantime there have been substantial advances in techniques of cloud photography and a growing requirement for more photographs taken at locations outside Europe.

In 1981 a WMO Informal Planning Meeting on Volume II of the International Cloud Atlas drew up a plan for the preparation of a new edition. It recommended the deletion of 26 black-and-white plates and eight in colour, and their replacement by 41 new colour plates selected from a large number of photographs received from various countries. The section containing illustrations of certain meteors was also expanded by the addition of nine more plates. The legends for the new plates selected by the Informal Planning Meeting were edited by the chairman of the meeting, Mr. R. L. Holle, of the U.S. National Oceanic and Atmospheric Administration, and those for the new plates in the section on meteors by Mr. C. S. Broomfield, of the U.K. Meteorological Office.

Later it became apparent that many of the original photographs of the 1956 edition had deteriorated with time to an extent excluding the possibility of their inclusion in the new edition. Moreover, it was felt that the geographical distribution of the photographs was still somewhat restricted and that the balance between the various sections could be improved. With the approval of the president of the Commission for Basic Systems, it was therefore decided to revise the Atlas extensively, bearing in mind the urgent requirement for the new edition, and Mr. Holle kindly agreed to undertake this complex task, including the soliciting at short notice of new photographs from specialists. The final editorial work was carried out by the WMO Secretariat. The result of the work, the present Volume II of the International Cloud Atlas, contains 196 pages of photographs, 161 in colour and 35 in black and white. Each illustration is accompanied by an explanatory text.

The excellent work of the consultants and the authorization willingly given by all contributors for publication of photographs in both the original volume and this new edition are gratefully acknowledged. Particular thanks are due to the printer, whose painstaking work permitted much of the original material to be conserved and blended harmoniously with the new contributions.

It is felt that this new edition of the Atlas, besides being a most valuable reference work for meteorologists and those working in aviation, in agriculture and at sea, will also be a fascinating addition to the amateur's bookshelf.

(G. O. P. Obasi)
Secretary-General

INTRODUCTION

The legend accompanying each picture consists of two parts. The first part relates directly to the illustration; it draws attention to important features, explains the identity of the cloud (genus, species or variety) and frequently gives an explanation of the coding. The second part supplies a short description of the synoptic situation.

Important features in the illustrations are referenced in the legends by numbers. Each number usually relates to two arrows, one on the right- or left-hand edge of the illustration and the other along the top. The place in the illustration to which a number refers is located at the intersection of imaginary horizontal and vertical lines along the shafts of the two arrows bearing the same number. Numbers in the text usually indicate only the most outstanding features and on many occasions similar, though less striking, features can be found in the illustration.

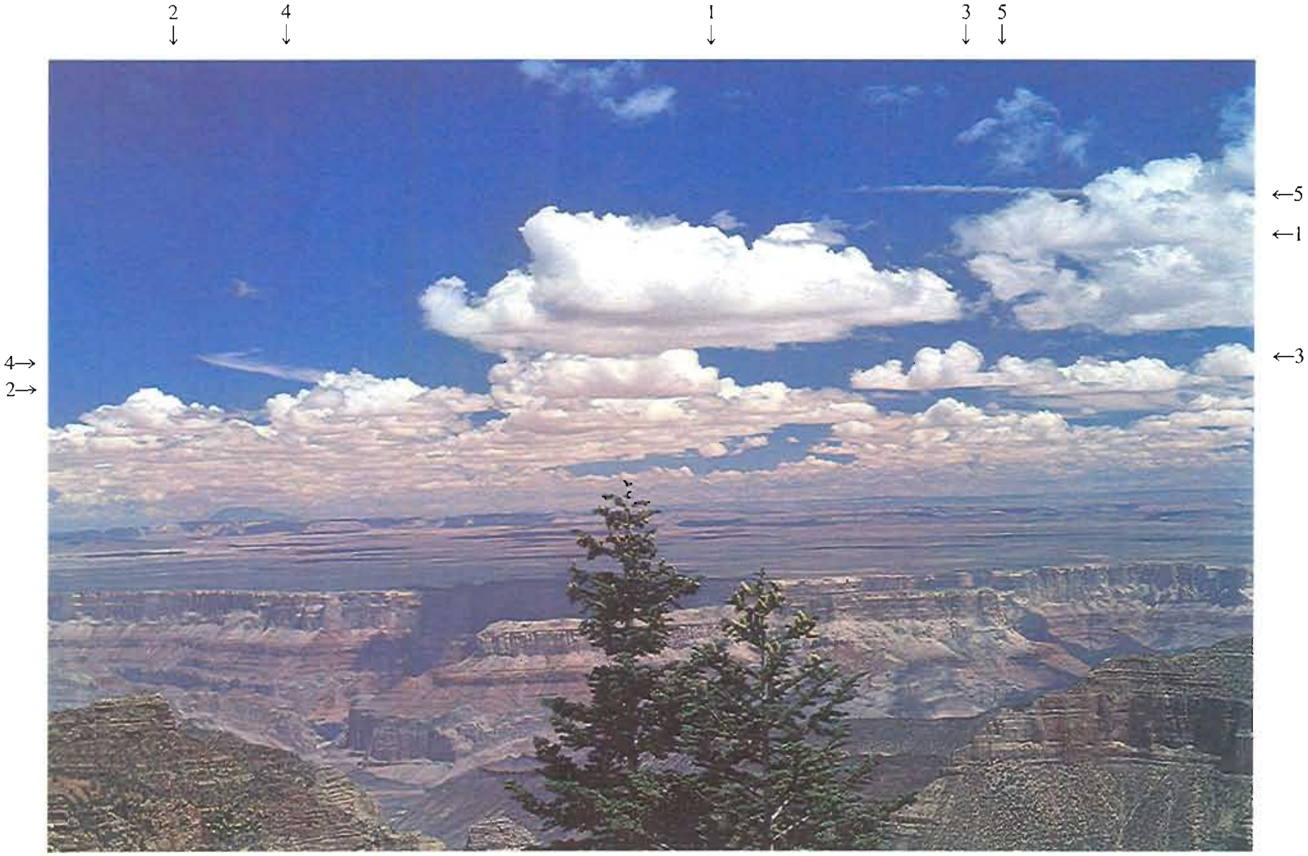
The name of the photographer, the place where the photograph was taken (station) and the date, time and direction are given where possible. The designations of geographical locations given are those which were valid when the photographs were taken. The time indicated is the local official time. In the case of photographs from aircraft, the altitude is also mentioned.

Usually the name of the most important cloud illustrated provides the heading of the legend; however, when other clouds are present in appreciable amounts, they are also indicated in the heading. In general, the sequence of the photographs within each of the five major sections corresponds to the listing of the definitions given in Volume I.

Code figures printed under the legends refer to the specifications given in the code tables for C_L, C_M, and C_H clouds when the clouds illustrated are seen from the Earth's surface. The sequence of code figures is always from the lower clouds to the higher clouds. The particular code figure for which the illustration provides an example is printed in heavier type.

An appendix listing the plates in the order in which they appear serves as a table of contents and at the same time assists the user in quickly finding the illustrations corresponding to the various code figures and different cloud forms.

CLOUDS AS SEEN FROM THE EARTH'S SURFACE



R. L. Holle, Grand Canyon (Arizona, U.S.A.), 18 August 1977, 1240 hours (towards E)

Cumulus humilis

A field of Cumulus humilis fills the sky at midday over the elevated dry plateau surrounding the Grand Canyon. All of the tops are flat (1) or are only very small and rounded (2, 3). Clear-cut horizontal bases are present everywhere. A few Cirrus fibratus streaks are visible at 4 and 5.
The Cumulus clouds began to form during the morning on an undisturbed dry day dominated by the diurnal cycle of heating. Only a few isolated Cumulonimbi formed toward sunset.

$$\mathbf{C_L = 1}, \quad C_M = 0, \quad C_H = 1$$

A. Viaut, Paris (France), 28 April 1952, 1305 hours (towards NE)

Cumulus humilis with haze

These Cumulus clouds are scattered; most of them are fairly dense masses with definite horizontal bases. Their vertical extent is small and they are consequently of the species humilis. In the vicinity of the main clouds there are some isolated fragments (1, 2). Haze veils the distant units.
The station was in old maritime polar air on the south-western margin of a cold upper low centred over the northern part of the Federal Republic of Germany, but far from any front and in a zone of weak surface pressure gradients. The winds at the surface were light N to NE, turning to NW aloft.

$\mathbf{C_L = 1}$, $C_M = 0$, $C_H = 0$

T. Bergeron, Ånn (Sweden), 14 July 1950, 1000 hours (towards ESE)

Cumulus humilis and Cumulus fractus

Most of these clouds are typical Cumulus humilis. They have distinct horizontal bases, generally shaded; their outlines are not very ragged, their tops are flattened as a whole and only slightly rounded in places. There are some Cumulus fractus (1, 2). The sky was observed in the western portion of a weak anticyclone which covered Finland and Sweden.

$\mathbf{C_L = 1}$, $C_M = 0$, $C_H = 0$

M. Mézin, Paris (France), 3 April 1948, 0901 hours (towards SE)

Cumulus mediocris and Cumulus fractus

Cumulus is the only genus present. Some of the clouds are in the form of tufts of cotton-wool (species fractus); others are better developed and exhibit the beginning of bulging growth, already appreciable in places in spite of the early hour (species mediocris). Wind and turbulence cause asymmetry of form and raggedness of outline.
The picture is typical for maritime polar air behind a cold front; winds at lower levels were WSW, fairly strong (8 to 12 m s^{-1} at the surface) and gusty. Thunderstorms with hail were observed in the same air mass.

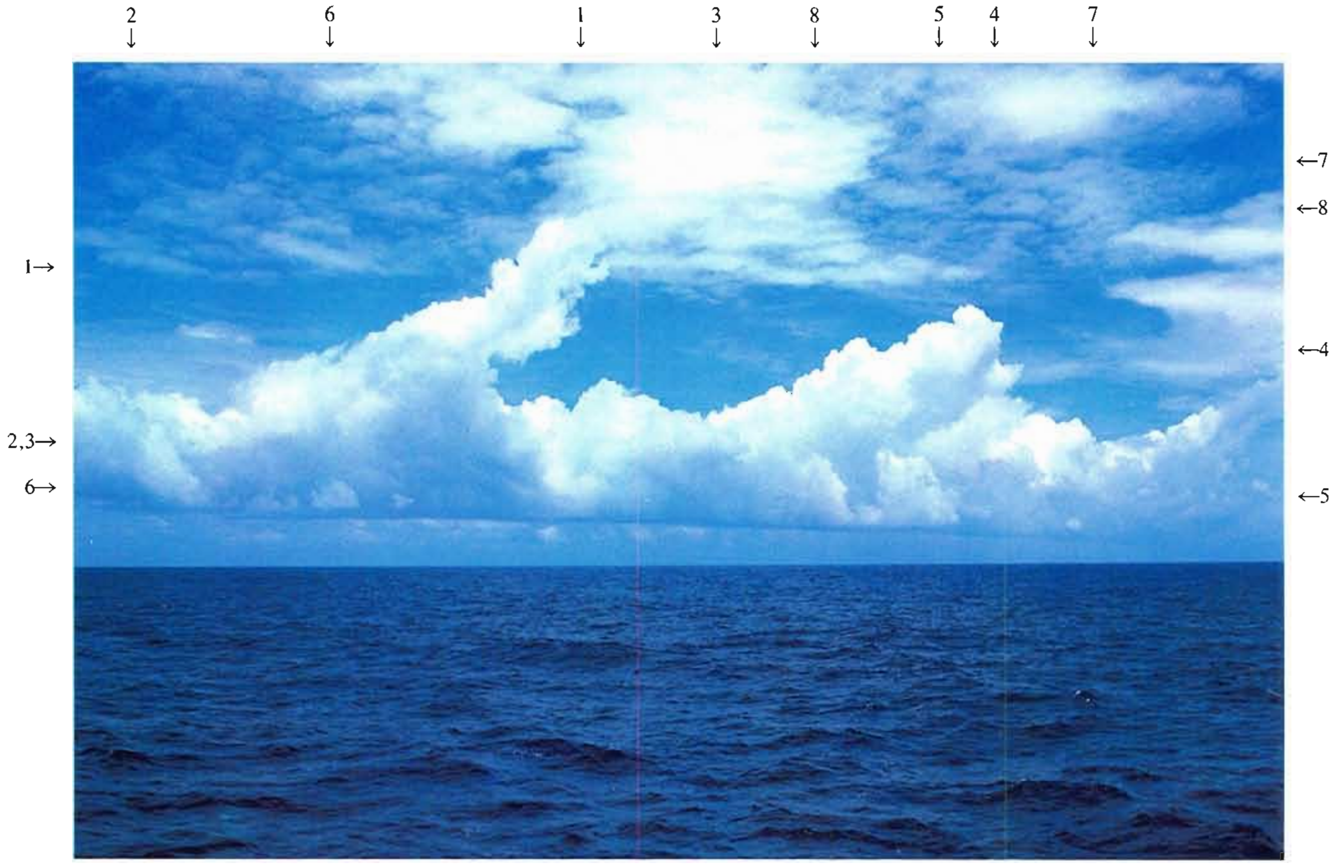
$\mathbf{C_L = 2}$, $C_M = 0$, $C_H = 0$

A. Viaut, La Rochepot (France), 7 September 1952, 0915 hours (towards N)

Cumulus congestus

Despite the early hour the vertical extent of these Cumulus congestus clouds is considerable, compared with their horizontal dimensions. Some units, somewhat torn and ragged, rise like towers leaning towards the right (1, 2), indicating a wind shear in the vertical.
The photograph was taken in a flow of fresh, unstable polar air skirting a strong Atlantic anticyclone.

$\mathbf{C_L = 2}$, $C_M = 0$, $C_H = 0$



W. P. Bowman, Atlantic Ocean (9° N, 22.6° W), 7 September 1974, 1315 hours (towards ESE)

Cumulus affected by wind shear. Altocumulus

This plate shows a good example of horizontal wind shear restricting the growth of Cumulus congestus as seen by the pronounced tilt of the Cumulus tower at 1. The Cumulus occurs in a continuous row consisting of the species congestus (1, 2, 3, 4), mediocris (5) and fractus (6), all with their bases at the same level. Altocumulus translucidus is seen at 7 and opacus at 8. The base of the latter is lower than the Altocumulus translucidus, but the layers are combined (duplicatus).
The photograph was taken during fair weather conditions of limited convective activity.

$\mathbf{C_L = 2}$, $C_M = 7$, $C_H = 0$

R. L. Holle, Long Key (Florida, U.S.A.), 17 September 1972, 1600 hours (towards SE)

Cumulus congestus, mediocris and fractus

Three species of cumuliform cloud are present in this illustration, photographed over a warm, tropical ocean. All have their bases at the same level (1). Cumulus fractus is seen at 2, Cumulus mediocris at 3 and Cumulus congestus at 4. The Cumulus congestus (4) is past its mature stage but its top continues to be sharply defined although falling rain makes the tower look diffuse. The rain can be seen reaching the sea at 5. Another tower, which has almost completely evaporated, is apparent at 6, with further congestus at 7. These clouds over the ocean do not show the well-defined hard tops as frequently as are seen over land.

The area was dominated by a low-level ESE flow with no disturbances in the region. The lack of significant wind shear through the depth of the cloud is indicated by the near-verticality of the main tower at 4.

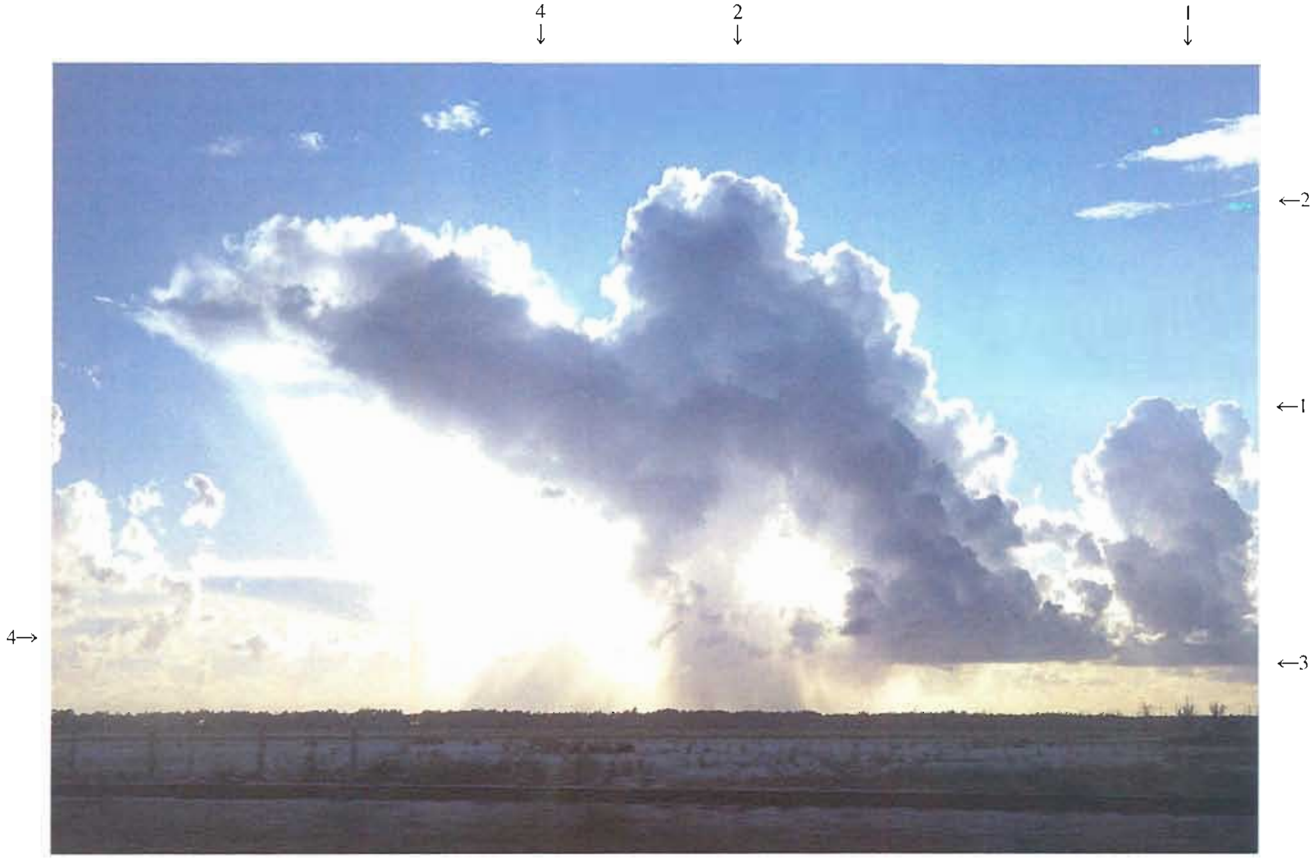
$\mathbf{C_L = 2}$, $C_M = 0$, $C_H = 0$

A. J. Aalders, North Atlantic Ocean (52° N, 20° W), 8 April 1951, 1637 hours (towards SSW)

Cumulus congestus praecipitatio, with haze

The huge cumuliform masses show in their upper parts some ragged outlines (visible especially at 1, 2), which indicate the beginning of dissolution. The cloud at the right is giving precipitation (3), and it could be considered as an intermediate stage between Cumulus congestus and Cumulonimbus calvus. However, as none of the cloud tops are flattened or show a fibrous texture, the clouds should be called Cumulus congestus praecipitatio rather than Cumulonimbus calvus and the coding should be $C_L = 2$ and not $C_L = 3$. Note the frayed, irregular appearance of the rainy base (4), the presence of Cumulus fractus (5) and the patches of Altocumulus at 6. Haze aloft is revealed by the shadows cast by the projecting cumuliform tops.
The station was in the rear of a depression over the North Sea area in a rather strong north-westerly current of maritime polar air.

$\mathbf{C_L = 2}$, $C_M = 6$, $C_H = 0$



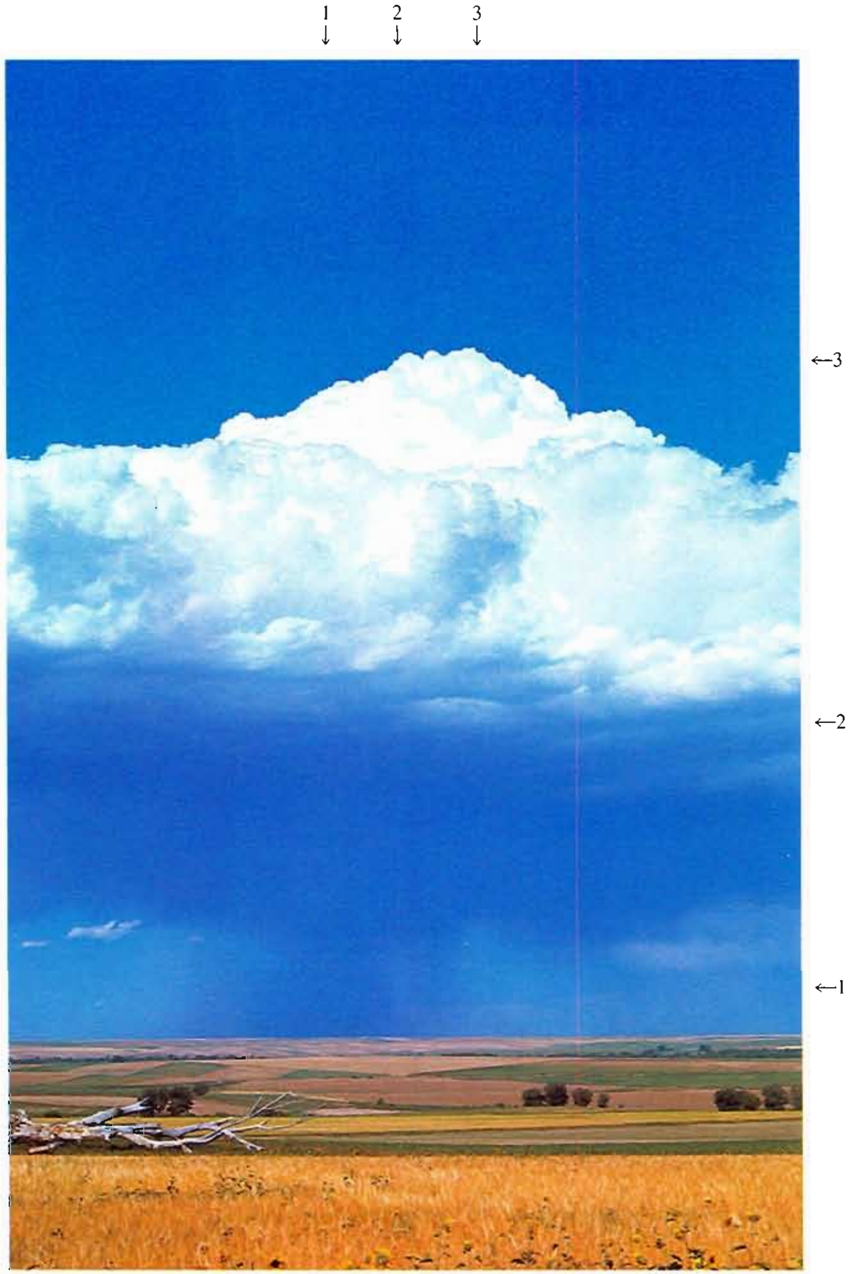
R. L. Holle, near Miami (Florida, U.S.A.), 26 August 1967, 1600 hours (towards W)

Cumulus congestus praecipitatio

The Cumulus clouds in this photograph show large vertical extent and hard tops. This is typical in the subtropics and tropics of this type of cloud which has been heated from land masses below. The tips (1, 2) have well-rounded towers, and the bases are well-defined and horizontal (3). The Cumulus on the right of the picture (1) has begun to grow tall, but is not yet producing precipitation. The cloud in the centre (2) is older, and precipitation can be seen falling from its base. The rain at 4 is from an older cloud which will soon dissipate.

The area was in the region of a low-level flow from the south-east, and a weak trough was located to the east of Florida. Winds gradually backed with height to ENE at 200 hPa, and the shear was responsible for the cloud tops leaning towards the left in the picture.

$\mathbf{C_L = 2}$, $C_M = 4$, $C_H = 0$



R. F. Reinking, Ault (Colorado, U.S.A.), 14 July 1965, 1400 hours (towards E)

Cumulus congestus praecipitatio

A column of rain (1) can be seen falling from the base of this Cumulus congestus cloud. The cloud is mature but shallow, and has an unusually high base (2). These features reflect the low humidity of the semi-arid high plains of eastern Colorado. The cloud top (3) appears hard and well-defined. Later the cloud glaciated as it moved eastwards.

The cloud formed in response to diurnal heating. A weak high-pressure circulation dominated the region.

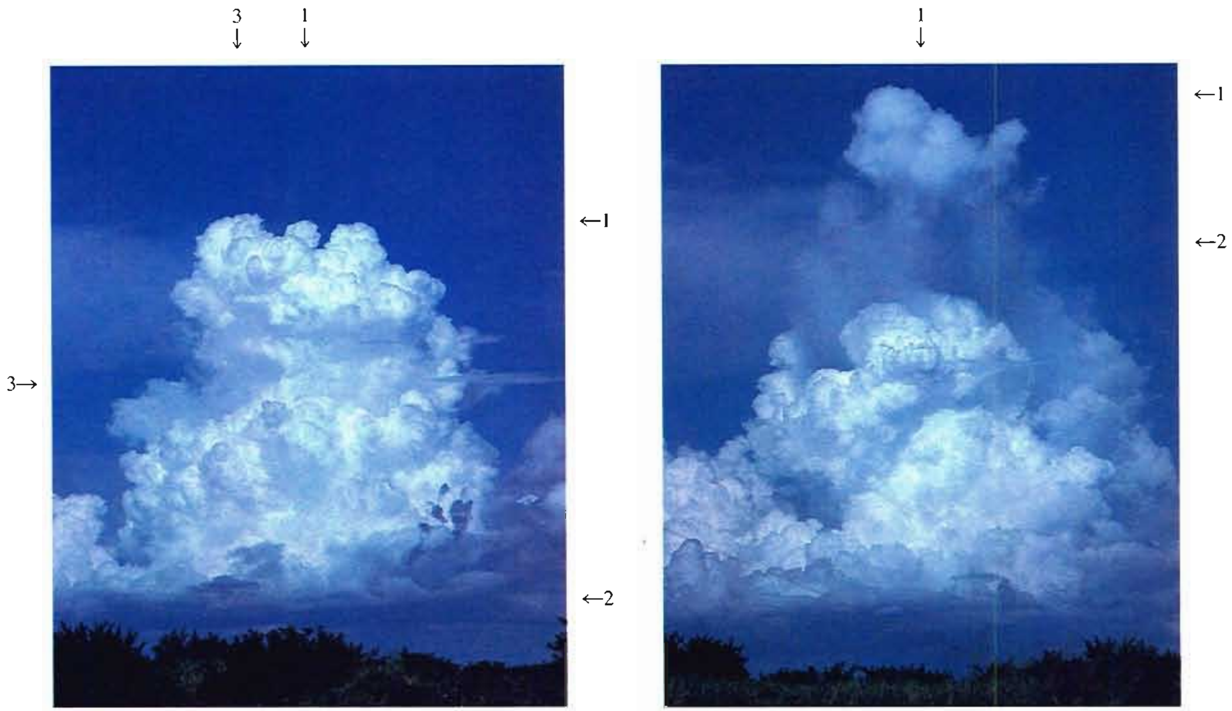
$\mathbf{C_L = 2}$, $C_M = 0$, $C_H = 0$

J. H. Golden, Miami (Florida, U.S.A.). September 1966, 1930 hours (towards W)

Cumulus congestus in a row

The Cumulus towers at 1, 2 and 3 all rise from a uniform cloud base. The cloud column at 1 shows some evidence of evaporation, but there are no cirriform features which would identify it as Cumulonimbus. The tallest tower (2) extends to a height of about 6 000 metres. These clouds are growing vertically over a tropical land mass and no precipitation is evident from the clear-cut, horizontal base (4). A Cumulonimbus calvus developed from these clouds soon after the photograph had been taken. Some of the cloud tops are inclined towards the right of the picture because of a vertical wind shear. Some patches of Altocumulus can be seen to the left of the tallest Cumulus tower.
The clouds were aligned SSW-NNE along a sea-breeze convergence line which had moved inland during the afternoon.

$\mathbf{C_L = 2}$, $C_M = 3$, $C_H = 1$



M. W. Maier, Clewiston (Florida, U.S.A.), August 1978, 1730 and 1740 hours (towards E)

Evaporating and precipitating Cumulus congestus

This Cumulus congestus cloud formed over a heated tropical land mass. In the first photo, the cloud has a number of bulging elements in the upper part (1) which show sharp outlines and resemble cauliflower heads. These features distinguish the cloud from Cumulonimbus calvus where the sproutings in the upper part are more or less indistinct and are flattened without sharp outlines. The cloud had grown rapidly from its dark, horizontal base (2). At 3 the cloud appears diffuse where its growth has passed through a dry or warmer layer.
In the second photo (which was taken ten minutes later), the cloud top (1) has grown even higher, but has become separated from the main body of the cloud at 2 as part of the cloud tower has evaporated. Precipitation, probably of small raindrops, can be seen falling at 2.
This sequence of pictures shows that the diffuse cloud patch in the first picture at 3 marked the beginning of the separation of the upper part of the cloud from the main body.

$\mathbf{C_L = 2}$, $C_M = 4$, $C_H = 2$

T. Bergeron, Ånn (Sweden), 29 June 1945, 1427 hours (towards ESE)

Transition from Cumulus congestus to Cumulonimbus calvus

The clouds (1-2) show protuberances with fairly well-defined vertical or overhanging sides. The cloud at 3-4 is starting to lose its sharp outline, this being an indication of the transition from Cumulus congestus to Cumulonimbus calvus. At 5-6 the beginning of anvil formation can be discerned, but no fibrous appearance can yet be observed. In the distance (at 7), however, a virga is vaguely visible, presumably from an older cloud of the same type. The clouds are arranged in large bands (1-2, 8-9) probably parallel to each other, although owing to perspective they appear to converge.
In the same sky we see at 10 some fairly thin patches of Altocumulus, probably due to the spreading out of the upper parts of the convective clouds, and at 11 some Cumulus fractus.
The station lay in a weak northerly continental polar air stream between an anticyclone extending from Greenland to northern Scandinavia and a depression over the Baltic.

$\mathbf{C_L = 3}$, $C_M = 6$, $C_H = 0$

R. K. Pilsbury, Totland (Isle of Wight, U.K.), 18 September 1981, 1300 hours (towards NW)

Cumulonimbus calvus

A bank of Cumulonimbus calvus towers has become flattened at 1, 2, 3, 4 and 5 after losing their rounded tops. The coding is therefore $C_L = 3$. A line of thin Altocumulus at 6 is also apparent. A number of Cumulus lie along the main cloud bank and the bases of many others are visible beyond the base of the principal clouds.

A cold-front system connected to a complex depression north and west of Scotland had crossed the area in the early hours of the morning. Large Cumulonimbi and showers built rapidly behind the fronts in the deep cold air. At the time of this picture, however, the Cumulonimbus development had become less active.

$\mathbf{C_L = 3}$, $C_M = 3$, $C_H = 0$

R. L. Holle, Spanish Wells (Bahama Islands), 29 May 1978, 1500 hours (towards NW)

Cumulonimbus calvus praecipitatio and pannus

The tops of Cumulonimbus calvus are evident at 1, 2, 3 of the picture. The cumuliform tops have lost some of their sharp outlines but no distinct cirriform features are present. Being over the ocean, these clouds do not pass through their life cycle as rapidly as over land and few hard tops are present. Some Cumulonimbus congestus clouds are apparent at 4. Precipitation is falling from beneath nearly all the clouds, and shreds of pannus can be seen at 5.
A weak low-level trough was located in the area. Winds were from the east-north-east.

$\mathbf{C_L = 3}$, $C_M = 0$, $C_H = 3$

P. G. Black, Miami (Florida, U.S.A.), July 1966, 2000 hours (towards W)

Cumulonimbus calvus praecipitatio

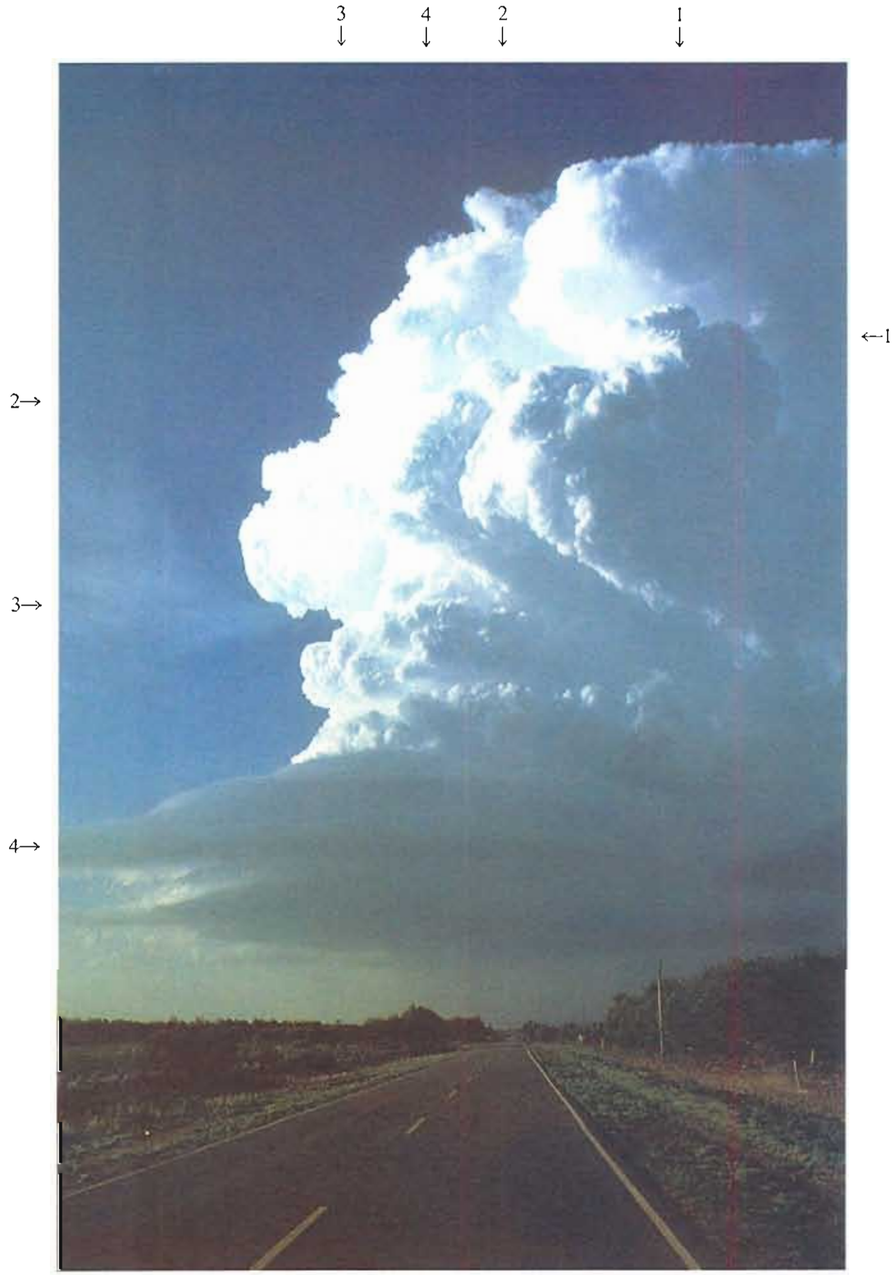
Several large cumuliform towers are situated in a group in this striking picture taken at sunset. Although these clouds are quite massive, they do not show many of the distinctive structural features of Cumulonimbus. However, the lightning at 1, 2, 3 leaves no doubt that the cloud should be classified as Cumulonimbus. Cloud-to-ground discharges are seen at 1, 2, and a portion of the same or a different flash is seen in the cloud at 3. Other less obvious clues are the somewhat flattened and smoothed top at 4 and the implication that the feature at 5 is part of a large cloud which is becoming diffuse and the top of which (out of the picture) is likely to be cirriform. Precipitation is falling at 6, 7.
The clouds were located about 20 kilometres from the coast and developed as a result of the sea breeze.

$\mathbf{C_L = 3}$, $C_M = 0$, $C_H = 1$

Cumulonimbus calvus

Explosively growing towers (1, 2) are feeding this severe thunderstorm along the dry line in western Oklahoma. Some tower tops curl around toward the back of the storm (3) and descend. The base of the SW portion of the storm is laminar (4), and is indicative of forced, stable, upward motion. This supercell storm moved northeast and produced large hail and a mesocyclone. The environment of the storm was characterized by strong vertical shear and a steep lapse rate.

$\mathbf{C_L = 3}$, $C_M = 0$, $C_H = 3$



H. Bluestein, Cheyenne (Oklahoma, U.S.A.), 20 April 1985, 1742 hours (towards N)

R. A. Keen, from summit (4196 m) of Grand Teton Mountain (Wyoming, U.S.A.), 11 August 1971, 1600 hours (towards SE)

Cumulonimbus capillatus praecipitatio

Cumulonimbus capillatus (1) over the semi-arid region of Wyoming is seen in this photograph. A tapering column of precipitation (2) is evident. The tapering is due to the evaporation of the precipitation as it falls through the dry environment so that very little reaches the ground. The precipitation probably consists of snow pellets above the apparent melting level (3). The symmetrical shape of the anvil (4) and vertical shaft of precipitation indicate that winds were light throughout the lower and middle troposphere.
The area was under the influence of a warm, high-pressure area in the middle troposphere.

$\mathbf{C_L = 3}$, $C_M = 0$, $C_H = 0$

R. K. Pilsbury, Bracknell (Berkshire, U.K.), 8 November 1972, 1600 hours

Stratocumulus cumulogenitus from Cumulus mediocris

A line of Cumulus mediocris (1) is being lit by the late afternoon sun, below the layer of Stratocumulus (2). The tops of these Cumuli, particularly at 3, 4, and 5, can be seen to be spreading into the Stratocumulus above, forming at an inversion level. A single Cumulus mediocris, with its top also spreading into Stratocumulus, can be seen at 6.

A cold front had moved southwards, and was lying along the English Channel some 125 km to the south. There was a strong ridge of high pressure building across the area as the upper-air situation rapidly stabilized.

$\mathbf{C_L = 4}$, $C_M = 0$, $C_H = 0$

R. L. Holle, Lake Gogebic (Michigan, U.S.A.), 21 August 1985, 0915 hours (towards NW)

Stratocumulus cumulogenitus from Cumulus mediocris

Cumulus mediocris (1) is located in a curved line across the photo. The Cumulus cloud at 2 has a rather hard base, but weakens with height as it reaches a stable layer. At 3, the vertical nature of the cloud disappears and it becomes diffuse, the cloud mass spreading into a horizontal Stratocumulus cloud. While none of the cumuliform clouds appear to rise above the stratiform layer, the Stratocumulus can be directly associated with the Cumulus because of the blue sky between cumuliform cloud groups.

The area was under the influence of a weak anticyclone, with light surface winds and a subsiding NW flow aloft.

$\mathbf{C_L = 4}$, $C_M = 0$, $C_H = 0$

R. K. Pilsbury, Lymington (Hampshire, U.K.), 31 October 1979, 1222 hours

Stratocumulus cumulogenitus with Cumulus mediocris

The tops of the Cumulus mediocris at 1, 2, and 3 have reached an inversion layer where the increasing westerly wind aloft has carried the tops forward as they spread into Stratocumulus cumulogenitus (4).
A cold front had moved across the area twelve hours earlier, and was lying 200 km to the east, with a ridge building up rapidly behind it.

$$\mathbf{C_L = 4}, \quad C_M = 0, \quad C_H = 0$$

G. Rouillon, Greenland (70° 55′ N, 40° 38′ W), 17 July 1951, 0200 hours (towards W)

Stratocumulus stratiformis opacus undulatus

The right half of the photograph shows a sheet of undulated Stratocumulus; the undulations are particularly well marked at 1 and 2. The margin (3-4) of the sheet is remarkably abrupt and ragged.
The picture was taken approximately 12 hours after the passage of an occlusion; a weak anticyclone was developing over central Greenland.

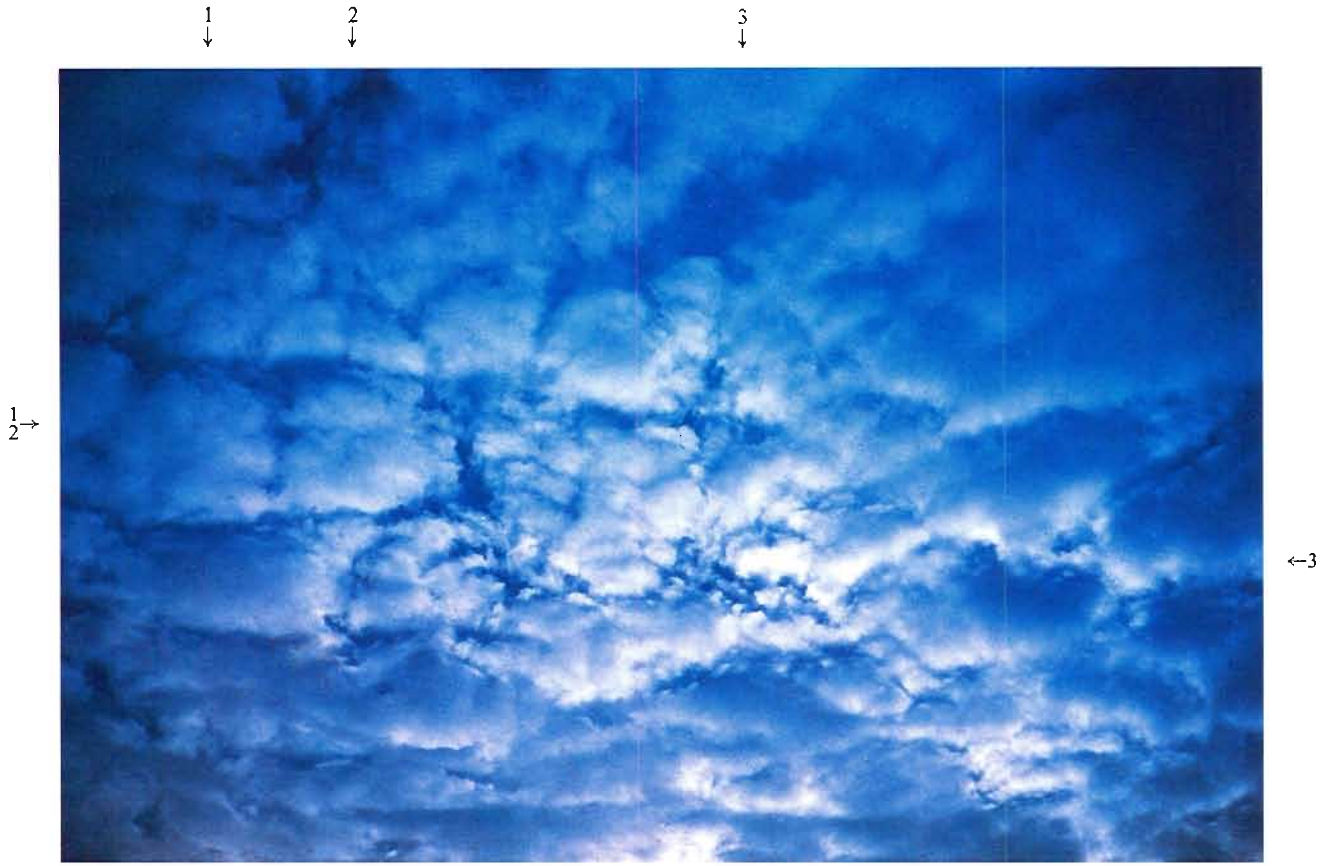
$$\mathbf{C_L = 5}, \quad C_M = 0, \quad C_H = 0$$

A. J. Aalders, Bussum (Netherlands), 18 January 1950, 1538 hours (towards S)

Stratocumulus stratiformis translucidus

This rather thin Stratocumulus consists of a layer of large, flat and irregularly shaped merged elements; it is therefore identified as species stratiformis. The greater part of the layer appears sufficiently translucent to reveal the position of the sun (variety translucidus). This is a typical example of winter Stratocumulus in polar continental air. There was a high-pressure area over the Baltic, and winds were ENE at the station. A marked inversion was observed at 1300 m.

$C_L = 5$, $C_M = /$, $C_H = /$

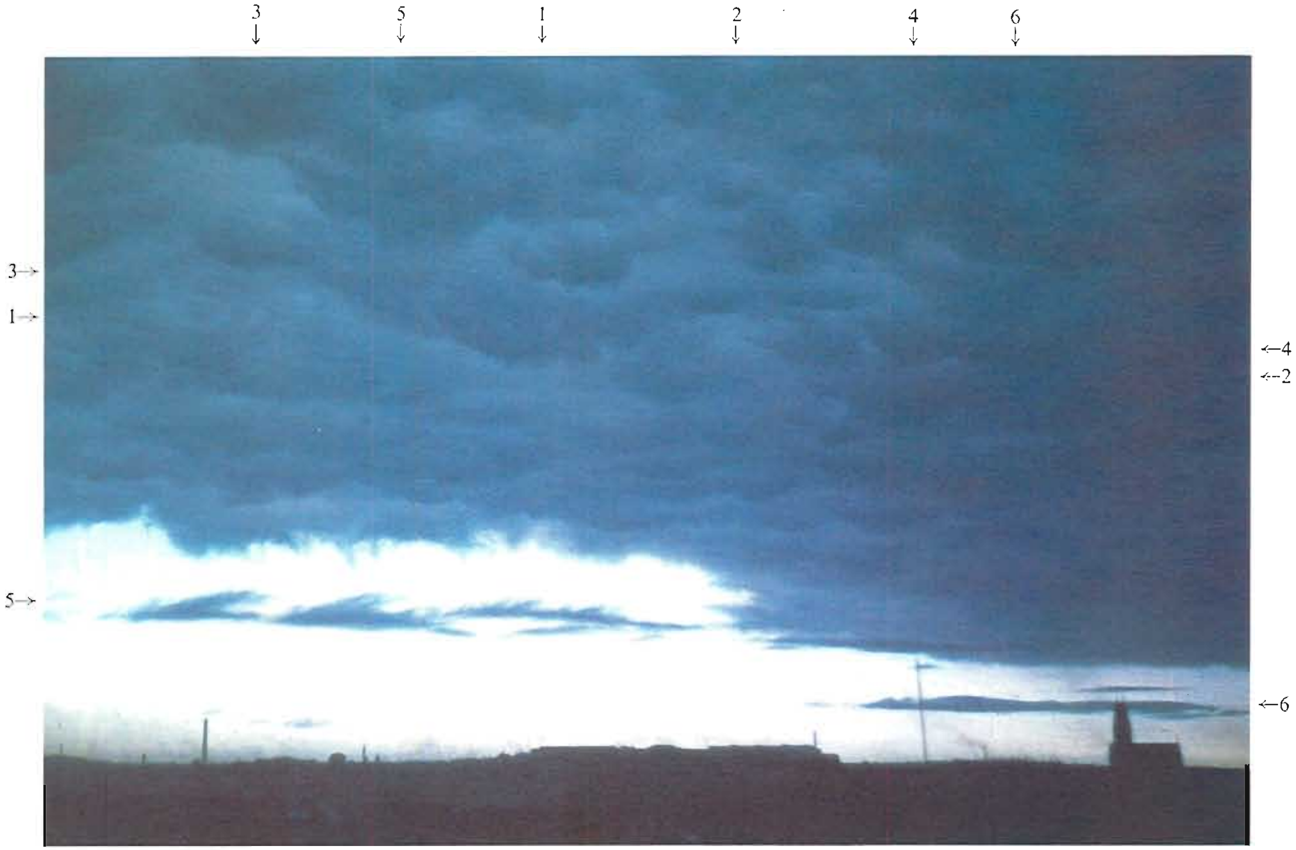


French Meteorological Service, Paris (France), 15 December 1949, 1056 hours (towards SSE)

Stratocumulus stratiformis translucidus perlucidus

The regularly arranged elements (1, 2) are large (especially at the upper right-hand corner), blurred, grey; most of them show shading. This cloud therefore, being rather low, belongs to the genus Stratocumulus, despite the smallness, whiteness and sharpness of outline of numerous fragments (3) into which the larger units seem to be breaking up. Almost everywhere the blue sky can be seen between the elements.
The station was near a warm-front-type occlusion moving towards the east-south-east and causing strong variations.

$\mathbf{C_L = 5}$, $C_M = 0$, $C_H = 0$

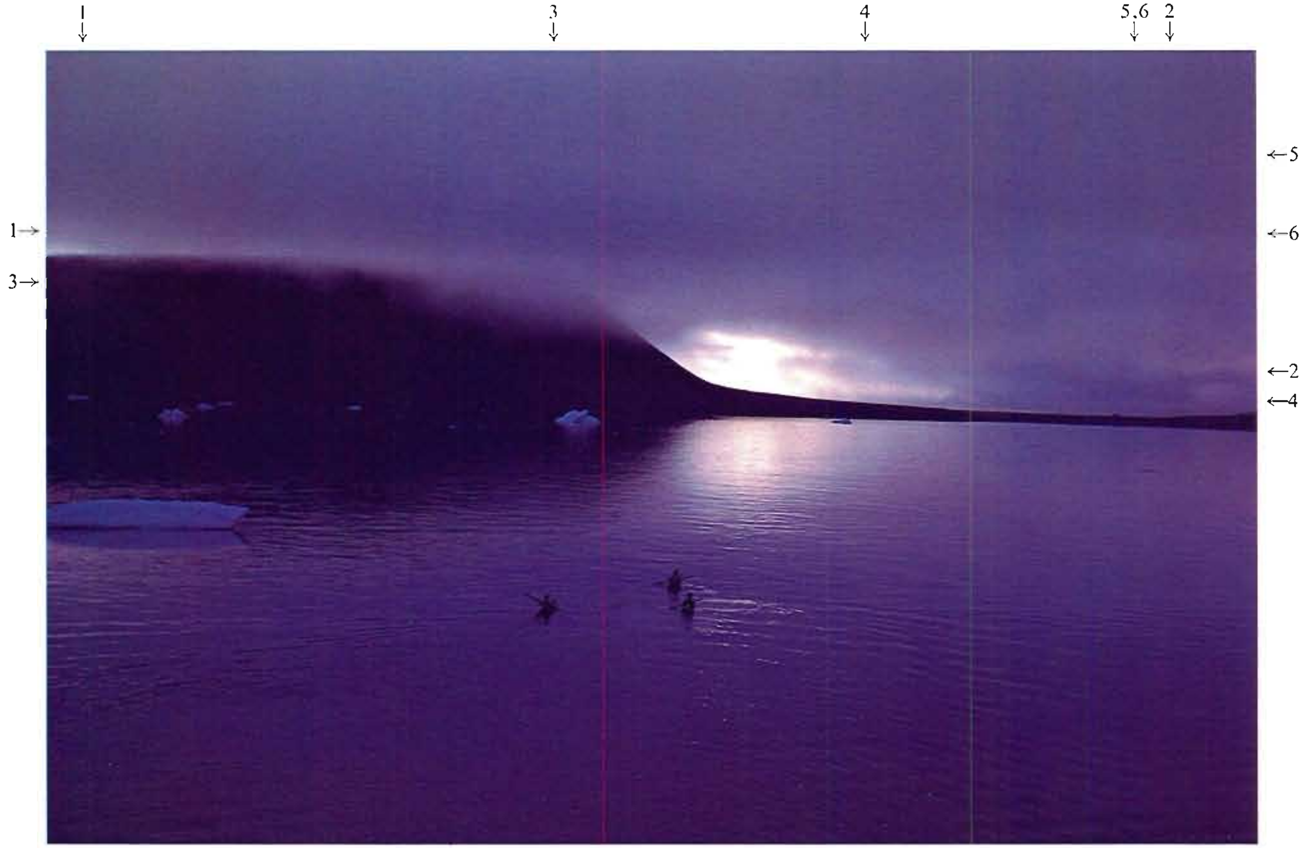


T. Bergeron, Stockholm (Sweden), 14 September 1944, 1403 hours (towards ENE)

Stratocumulus stratiformis opacus mamma and Stratocumulus lenticularis

A slate-grey layer of Stratocumulus covers most of the sky. There are fairly large, rounded units (1, 2), everywhere sufficiently opaque to blot out the sun (variety opacus). Several units (3, 4) have a shape suggesting udders (supplementary feature mamma). At 5 and 6 some lower patches of Stratocumulus lenticularis can be seen. The station was in the warm sector (close to the warm front) of the disturbance over northern Scandinavia.

$\mathbf{C_L = 5}$, $C_M = 0$, $C_H = 0$



F. A. Milan, Thule (Greenland), summer 1947

Stratus nebulosus undulatus

Owing to the purity of the air in this polar region the base (1-2) of the Stratus is clearly visible; it is low enough to conceal the top of the cliff (3). The height of the cloud base is not absolutely uniform; moreover the layer is definitely thinner near the horizon (4). Differences in optical thickness reveal very large indistinct rolls (5, 6) which indicate the variety undulatus.

$\mathbf{C_L = 6}$, $C_M = /$, $C_H = /$

R. L. Holle, Boulder (Colorado, U.S.A.), 20 February 1986, 1555 hours (towards SW)

Stratus nebulosus

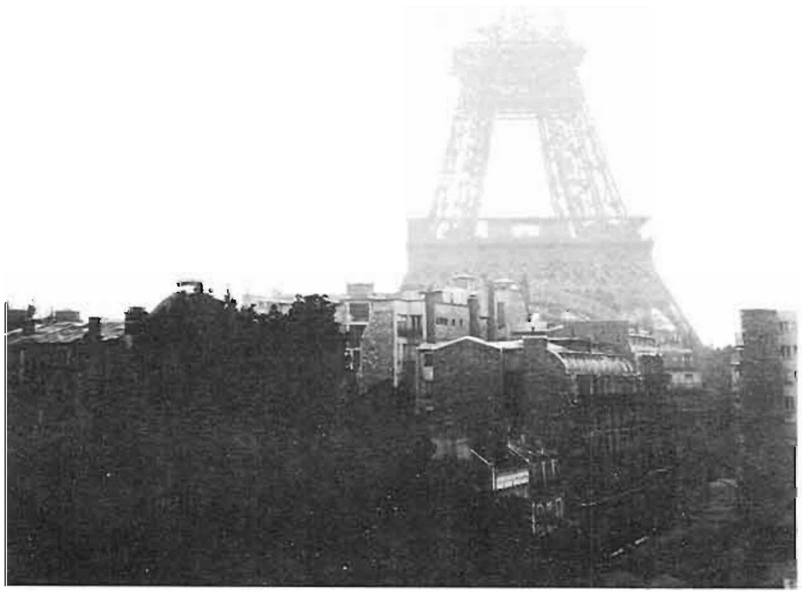
The layer of Stratus has a uniform base as it intersects the foothills at 1-2. Except for this feature, there is little structure to the cloud, besides the semi-transparent area at 3, where the sun is almost visible.
A cold front had passed through the area during the previous night leaving a light dusting of snow. The cold air layer had begun to dissipate during the afternoon.

$\mathbf{C_L = 6}$, $C_M = /$, $C_H = /$

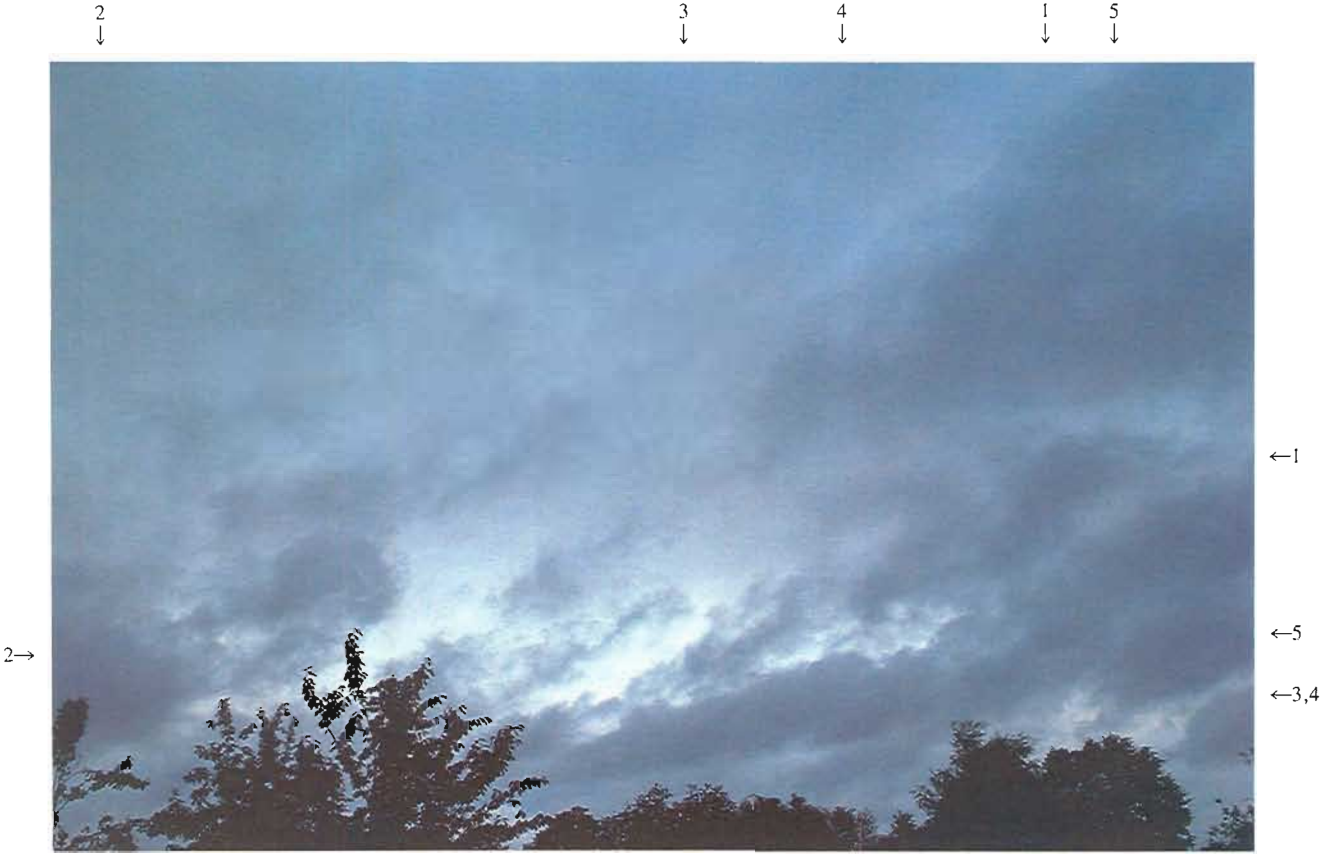
Stratus nebulosus

The cloud layer is completely uniform; its base, not very distinct, blots out the Eiffel Tower progressively, beginning with the second platform. Below the cloud the air is somewhat misty.
The station was in the warm sector of a disturbance centred over northern Scotland. The surface wind was light and from the south-west.

$\mathbf{C_L = 6}$, $C_M = /$, $C_H = /$



French Meteorological Service, Paris (France), 12 October 1944, morning (towards SSW)



R. K. Pilsbury, Totland (Isle of Wight, U.K.), 13 September 1975, 1530 hours (towards WSW)

Stratus fractus and Cumulus fractus (pannus) of bad weather below Altostratus opacus

Dark grey, ragged low cloud masses of Stratus fractus (pannus) are visible at 1 below an upper layer of Altostratus opacus. There are some rounded and darker Cumulus fractus (pannus of bad weather) at 2, 3, 4 and 5.

A vigorous depression had developed to the west of Ireland, and by this time was situated in the western approaches of the English Channel. The warm front was about 150 km south-west of this area, bringing extensive clouds and rain.

$\mathbf{C_L = 7}$, $C_M = 2$, $C_H = /$

M. Mézin, Paris (France), 4 April 1948, 1350 hours (towards NNW)

Stratus fractus and Cumulus fractus (pannus)

The sky is covered with low, ragged clouds, probably below Altostratus; there was no precipitation. The somewhat menacing appearance of these clouds identifies them as pannus, thus favouring the coding $C_L = 7$.
The station was situated in maritime polar air ahead of an occlusion which was moving rapidly eastward.

$\mathbf{C_L = 7}$, $C_M = /$, $C_H = /$

A. J. Aalders, Valkenburg (Netherlands), 24 May 1950, 1303 hours (towards NW)

Stratus fractus (pannus) and Cumulus fractus radiatus (pannus) under Nimbostratus

Dark, grey, ragged masses (1, 2) of Stratus fractus of bad weather (pannus) are seen against a lighter background of Nimbostratus (3, 4). Somewhat rounded and heavily shaded Cumulus fractus clouds of bad weather (pannus), clearly arranged in bands (5-6, 7-8), are present near the horizon.

The station was situated in a northerly flow of maritime polar air about 150 km behind a cold front. The upper flow, however, was from S to SW, 10-15 m s^{-1}, and disturbances moving with this flow had caused thundery showers during the preceding night and morning.

$\mathbf{C_L = 7}$, $C_M = 2$, $C_H = /$

R. K. Pilsbury, Bracknell (Berkshire, U.K.), mid-September 1973, 1800 hours

Stratocumulus stratiformis and Cumulus congestus

There is a high layer of Stratocumulus above 1, with its base just catching the evening sun. Below this layer are a number of Cumulus mediocris and congestus at 2, 3, 4, and 5 which are just reaching the layer of Stratocumulus but are not spreading into it.

$$\mathbf{C_L = 8}, \quad C_M = 0, \quad C_H = 0$$

R. L. Holle, Mitchell (South Dakota, U.S.A.), 24 August 1985, 1305 hours (towards NNW)

Stratocumulus stratiformis perlucidus and Cumulus mediocris

Long rows of Cumulus mediocris have formed across the picture (1, 2). They developed beneath an extensive layer of Stratocumulus over the region. The two layers are separate, however — for example at 3, where the Cumulus is not spreading out at the layer cloud. The coding, then, is $C_L = 8$ rather than $C_L = 4$, which would have been the case if Cumulus formed the Stratocumulus.

A cold front had passed over the area during the previous night. Moist low-level NW winds prevailed, and some cumuliform clouds developed under the influence of afternoon heating.

$$\mathbf{C_L = 8}, \quad C_M = 0, \quad C_H = 0$$

R. F. Reinking, Niwot (Colorado, U.S.A.), 10 June 1986, 1830 hours (towards N)

Cumulus and Stratocumulus with bases at different levels

A line of small Cumulus (1) is occurring simultaneously with higher-based Stratocumulus (2). Light but steady rain with large drops is falling under a light surface flow.
The region was dominated by cold upslope advection and lifting over the High Plains of Colorado.

$\mathbf{C_L = 8}$, $C_M = /$, $C_H = /$

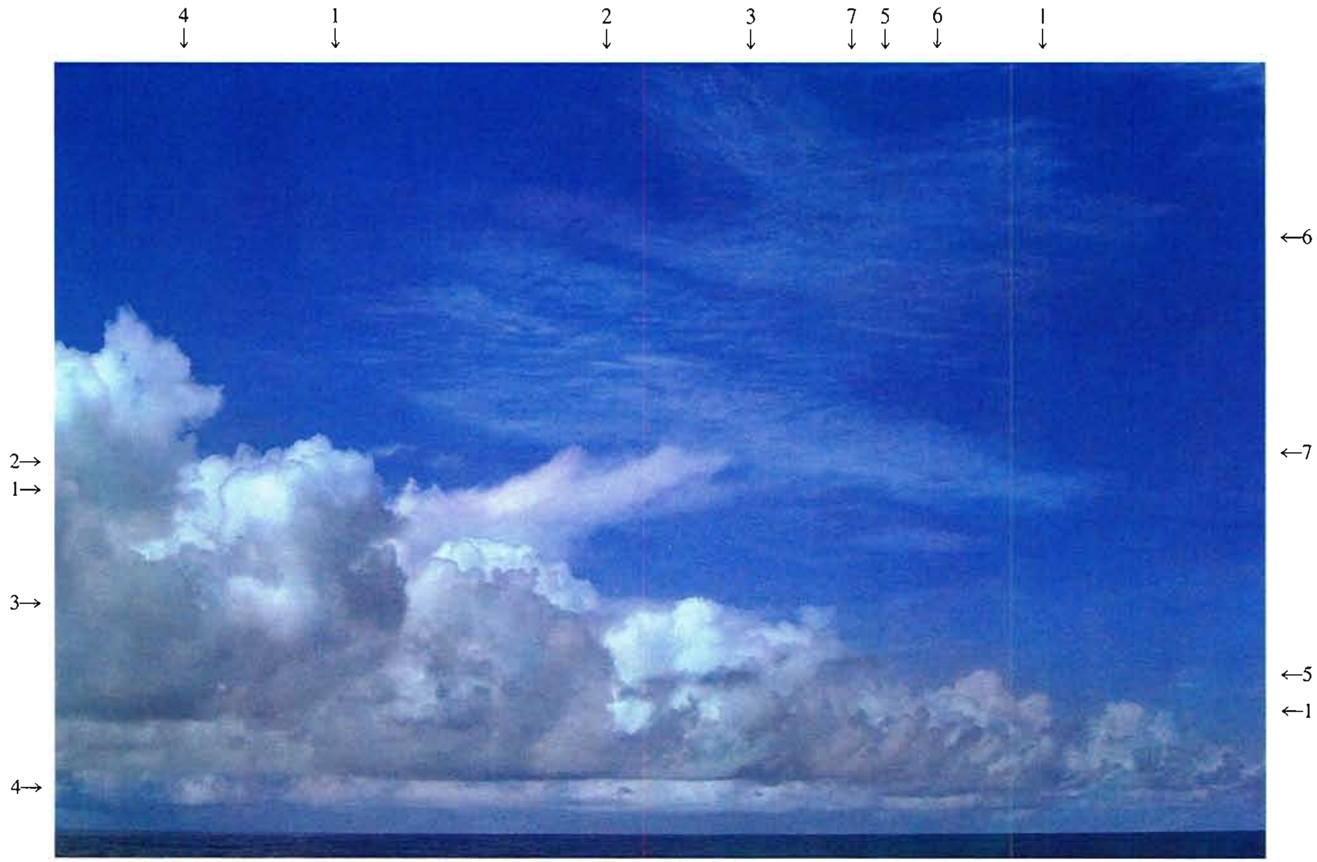
T. Bergeron, Stockholm (Sweden), 1 September 1943, 1600 hours (towards W)

Stratocumulus stratiformis opacus and Cumulus congestus

The dense Stratocumulus layer is sufficiently opaque throughout to be identified as Stratocumulus opacus. A somewhat wrinkled structure (1, 2) of its under-surface becomes vaguely visible as a result of the grazing twilight illumination. Cumulus clouds (3, 4) with distinct horizontal bases and large vertical bulges enter the upper layer. There are also some Cumulus fractus clouds (5).

The station was in a north-easterly flow of maritime polar air on the southern edge of a high centred over Spitsbergen.

$$\mathbf{C_L = 8}, \quad C_M = 0, \quad C_H = 0$$



R. J. Polavarapu, Atlantic Ocean (9° N, 22.5° W), 6 September 1974, 1015 hours (towards SSW)

Rows of Cumulus and Cumulonimbus of strong vertical development

This plate shows Cumulus and Cumulonimbus in organized lines. This is a typical arrangement found over ocean areas. Cumulus congestus is seen at 1, Cumulonimbus calvus at 2 and Cumulonimbus capillatus at 3. The bases are generally at the same level, except for the slightly lower base of the precipitating Cumulonimbus at 4. As is usual in the humid tropics, Cumulus fractus clouds are present around the edges of the larger clouds and appear in the photograph as darker elements (5). Cirrocumulus lenticularis undulatus is present at 6, but Cirrus fibratus intortus predominates at 7.
The photograph was taken during conditions of isolated showery activity.

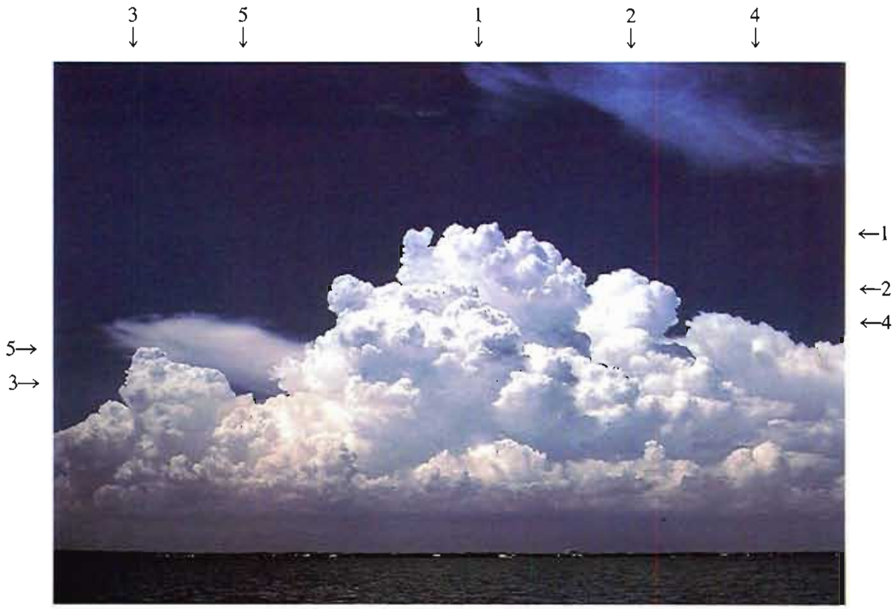
$\mathbf{C_L = 9}, \quad C_M = 0, \quad C_H = 1$

J. M. Brown, Coral Gables (Florida, U.S.A.), 23 August 1967, 0930 hours (towards S)

Isolated Cumulonimbus capillatus with Cumulus congestus and mediocris

The isolated tall, narrow Cumulonimbus capillatus in the centre of the picture is located just seawards of a long, narrow island about ten kilometres off the south coast of Florida. The cloud has a primary updraught region the top of which is near 1, but the updraught is composed of several surges seen at 2, 3 and 4. The cloud is leaning slightly to the south (away from the camera) due to a weak northerly shear in the lower and middle troposphere. Strong north-easterly winds in the upper troposphere have led to the spreading downwind of the glaciated upper section of the cloud to form an elongated anvil (5). Virga can be seen falling from the anvil at 6. This is undoubtedly ice because of the high altitude. Adjacent to the main cloud, the lifting of a moist, stable layer has produced a patch of Altocumulus stratiformis cumulonimbogenitus at 7. All other Cumulus in the picture range from mediocris to the largest congestus at 8.
An upper-tropospheric cold low located 400 kilometres to the south-east was responsible for a north-easterly airflow at upper levels. The lower tropospheric flow was weak from the east-south-east since the subtropical high-pressure ridge was orientated E-W well to the north of the area.

$\mathbf{C_L = 9}$, $C_M = 6$, $C_H = 0$



H. B. Bluestein, off the coast of Florida (U.S.A.), 28 August 1971, afternoon (towards W)

Cumulonimbus calvus pileus and Cumulonimbus capillatus

This pair of time-sequence photographs shows the development of Cumulonimbus from a vigorous mass of Cumulus congestus.

The large group of Cumulus congestus towers seen in the first photograph formed along the sea-breeze line inland from the coast of the Florida peninsula. Their hard tops with sharp outlines (1, 2, 3) are most striking. The flattened appearance of a distant top (4) indicates that it is turning to ice, thus classifying it as Cumulonimbus. The anvil of a more distant Cumulonimbus capillatus can be seen at 5.

By the time the second photograph had been taken the tower at 1 was displaying the characteristics of Cumulonimbus calvus. A pileus cloud had developed at 2, indicating that the tower was continuing to rise. The tops at 3, 4, 5 had not changed significantly since the first picture was taken, and the anvil structure (6) remained similar to the earlier view.

Although Cumulonimbus calvus dominates the second picture, the distant anvil at 6 determines the coding as $C_L = 9$.

The region was under the influence of undisturbed anticyclonic south-easterly flow at low levels. At higher levels winds were light, ranging from south to east. The upper winds were not strong enough to produce any tilt in the major new tower (1).

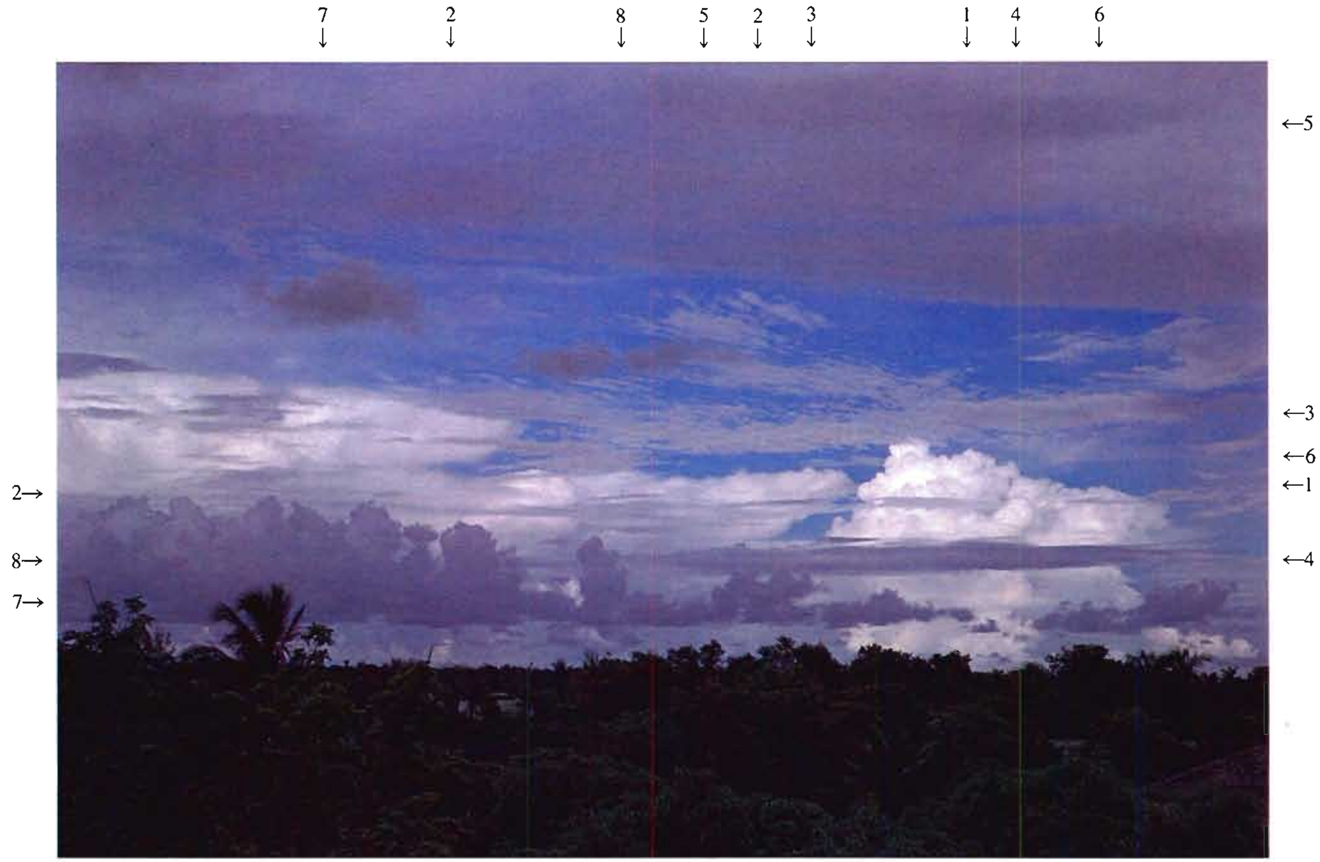
$\mathbf{C_L = 9}$, $C_M = 0$, $C_H = 3$

H. B. Bluestein, Sanibel Island (Florida, U.S.A.), 8 August 1971, morning (towards S)

Cumulonimbus capillatus incus

The drawn-out anvil (1) of this maritime Cumulonimbus is shearing off the mother cloud which extends above it at 2. Two other cirriform features at 3 and 4 are the remains of past convective towers of which the lower portions have evaporated and the upper portions turned to ice and blown downwind. A smaller Cumulonimbus capillatus (5) has started to form an anvil. The formation of multiple pulses within a long anvil such as at 1 occurs more often in the tropics and subtropics, in clouds evolving slowly over water in undisturbed conditions, than over land.
The area was dominated by a light south-westerly airflow at low levels, while a weak closed circulation was located several hundred kilometres to the north. At upper levels an easterly flow prevailed which caused the anvil to be sheared to the right of the photograph.

$\mathbf{C_L = 9}$, $C_M = 0$, $C_H = 3$

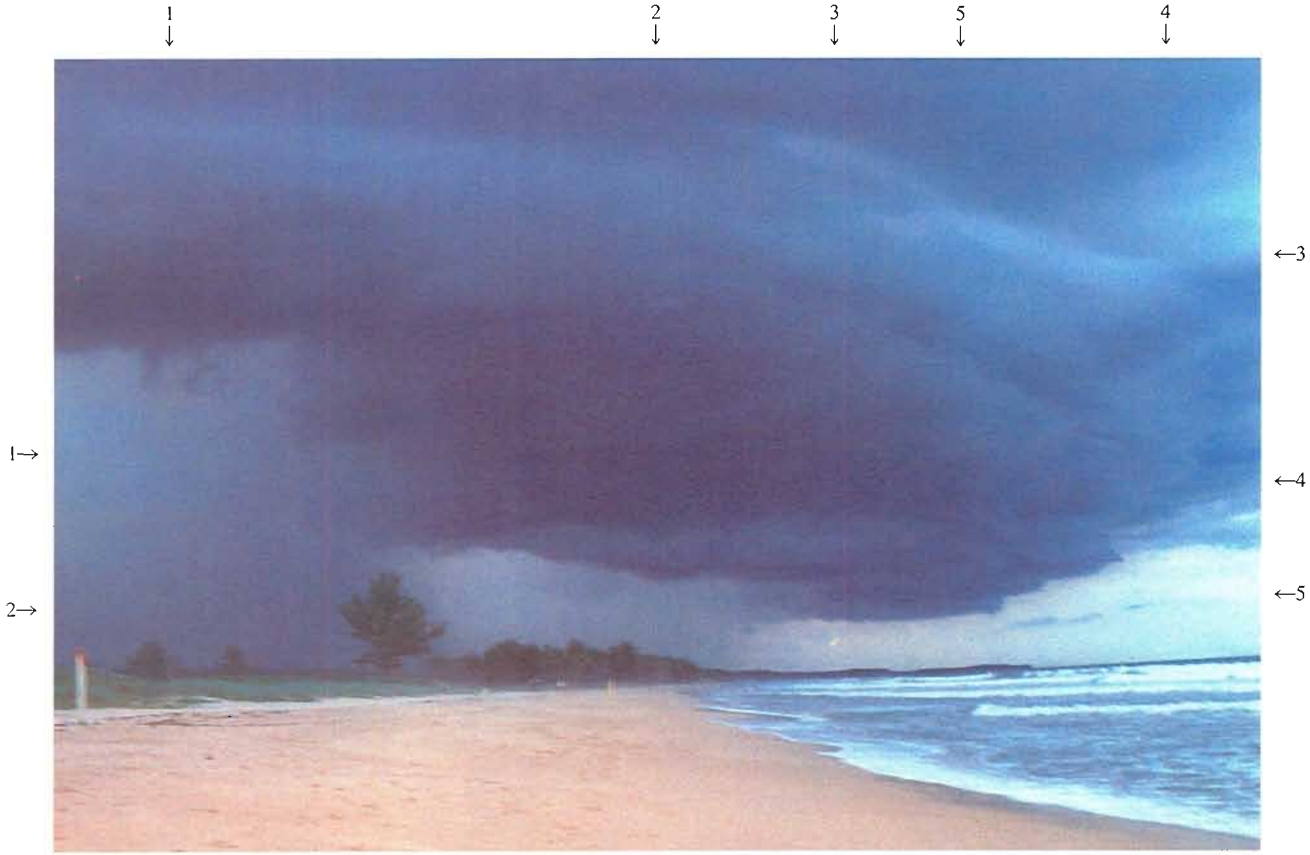


J. M. Brown, Miami (Florida, U.S.A.), 15 July 1967, 1530 hours (towards ENE)

Cumulonimbus, Altocumulus and Altostratus of weakly disturbed tropical conditions

The mixture of stratiform and cumuliform clouds depicted in this photograph is typical of weakly disturbed conditions in the tropics. Cumulonimbus calvus (1) and capillatus (2) are present with patches of Altocumulus stratiformis at various levels (3, 4). The uniform appearance of the cloud at 5 suggests Altostratus. A small element of Cirrus spissatus cumulonimbogenitus can be seen at 6. In the foreground, shaded by the Altostratus, is a band of Cumulus fractus, mediocris and congestus (7), beyond which stretches Altocumulus (8).
The axis of the east-west subtropical high-pressure ridge was several hundred kilometres to the north. Easterly flow extended through middle levels of the troposphere but became westerly at upper levels, as evidenced by the shape of the Cumulonimbus tops at 1. The presence of multiple layers of Altocumulus is evidence of high relative humidity in the middle troposphere. When a region is under the influence of a strong disturbance, frequently only Stratocumulus is visible, and the elements shown here are not apparent.

$\mathbf{C_L = 9}$, $C_M = 7$, $C_H = 3$



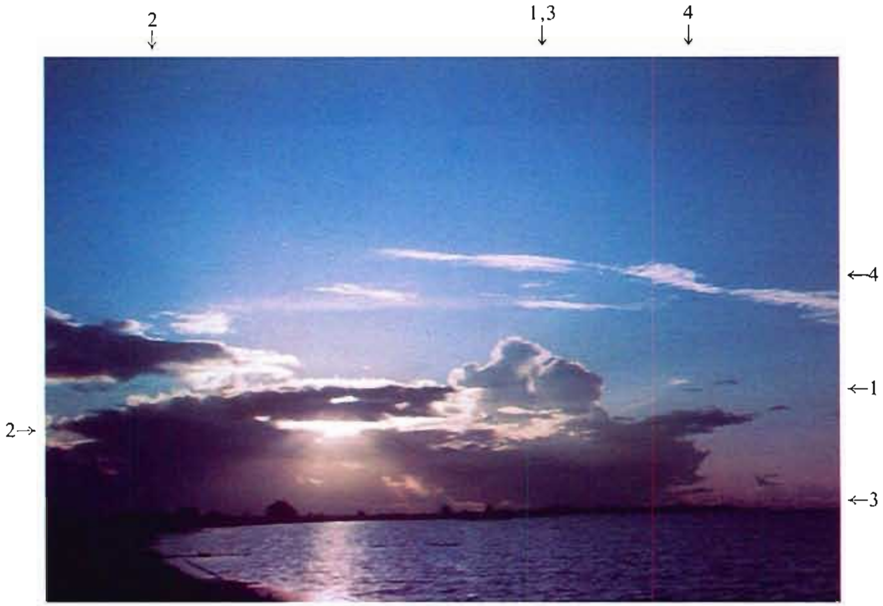
D. O. Blanchard, Jupiter Island (Florida, U.S.A.), 4 September 1978, 1330 hours (towards N)

Cumulonimbus capillatus praecipitatio arcus

Two columns of precipitation can be seen in this photograph; the nearer is at 1, with a more distant shaft at 2. The cloud is Cumulonimbus, which was moving slowly towards the right (E) of the picture. Ahead of the main cloud a curved arcus cloud extends from 3 to 4 on the near side of the rain columns, then on to 5 on the farther side. This area represents the leading edge of the outflow from the parent Cumulonimbus.

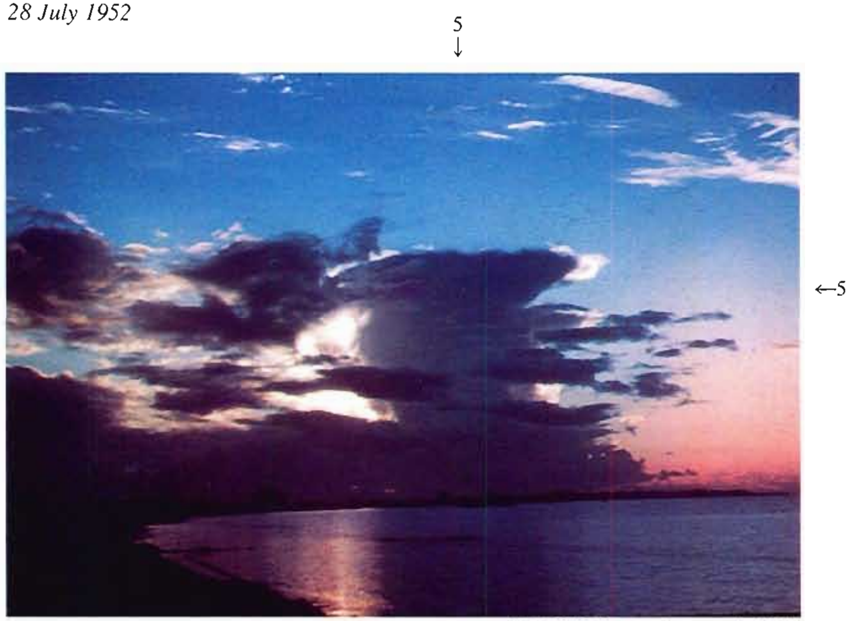
A NE-SW trough was moving slowly across the area, causing a south-westerly airflow in the lower troposphere. The Cumulonimbus and accompanying thunderstorm formed along the east coast of Florida, where a light east-south-east sea breeze developed at the surface.

$\mathbf{C_L = 9}$, $C_M = /$, $C_H = /$



A. J. Aalders, Naarden (Netherlands), 28 July 1952

(a) 1956 hours (towards NW)



A. J. Aalders, Naarden (Netherlands), 28 July 1952

(b) 2012 hours (towards NW)

Formation of a Cumulonimbus capillatus incus

The four photographs on pages 44 and 45 show the rapid formation of a Cumulonimbus cloud in maritime polar air associated with a low centred over the Heligoland area. In *(a)*, a strongly bulging mass (1) penetrates patches of Stratocumulus cumulogenitus (2). Beneath the cumuliform mass at 3, the horizon is very dark. Altocumulus cumulogenitus is present at 4.

$\mathbf{C_L = 3}$, $C_M = 6$, $C_H = 0$

In *(b)*, 16 minutes later, the mass, having continued its vertical development, seems to reach a stable layer and spreads out, forming at 5 an anvil with very dark shading.

$\mathbf{C_L = 9}$, $C_M = 6$, $C_H = 0$

Further development of a Cumulonimbus capillatus incus

The evolution of the Cumulonimbus on page 44 continues.
In *(c)*, 15 minutes after *(b)*, the cloud has approached the observer, while a wind shear in the vertical causes the tower to lean towards the left. There is a second anvil close behind the tower (1). Altocumulus fragments are still present at 2.

$\mathbf{C_L = 9}$, $C_M = 6$, $C_H = 0$

(c) 2027 hours (towards WNW)

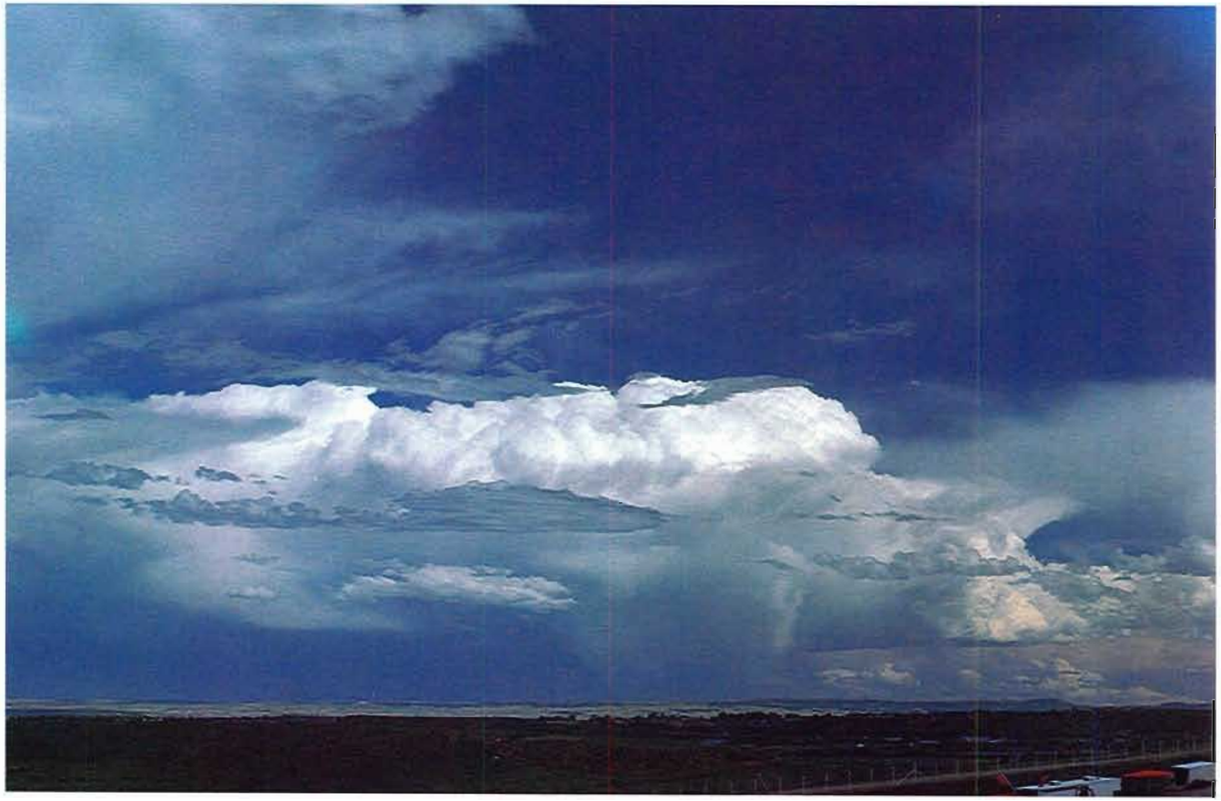
A. J. Aalders, Naarden (Netherlands), 28 July 1952

Finally, in *(d)*, disintegration starts in the upper part of the anvil, while clouds formed by lateral spreading (3) persist around the base.

$\mathbf{C_L = 9}$, $C_M = 6$, $C_H = 0$

(d) 2041 hours (towards WNW)

A. J. Aalders, Naarden (Netherlands), 28 July 1952



C. A. Doswell, Morrison (Colorado, U.S.A.), 26 July 1986, 1300 hours (towards SE)

Cumulonimbus capillatus incus

A complex of Cumulonimbus capillatus clouds with anvils is visible at 1 and 3 in different growth stages. The mature updraught at 1 has cumuliform updraughts restricted to the upper portion and streaks of precipitation falling at 2. The updraught at 3 is considerably younger, and is developing into an anvil left behind by a now-dissipated Cumulonimbus. The sharply-defined updraught bases at 4 and 5 contrast with the indistinct cloud base associated with the mature storm at 1. Patches of Cirrus, as for example at 6, are approaching the Cumulonimbus complex from the west, having been generated by thunderstorms over the mountains to the west. Numerous patches of suppressed Altocumulus (7) are scattered in the clear air behind the system. Distant Cumulus (8) shows some limited vertical growth.

The situation was typical of High Plains convection, since the axis of an upper-air ridge of high pressure moved eastwards, and unstably stratified air returned. A weak cold front had passed through Colorado two days earlier.

$\mathbf{C_L = 9}$, $C_M = 4$, $C_H = 3$

A. Viaut, Altkirch (France), 23 May 1950, 1400 hours (towards SW)

Cumulonimbus mamma

The main mass of a Cumulonimbus is towards the left of the picture. Mamma stand out in relief under the lower surface of the anvil.
The station was situated in an area of weak pressure gradients with thundery disturbances all over France. Thunder was heard when the picture was taken.

C_L = **9**. C_M = / C_H = /

H. Bluestein, Hennessey (Oklahoma, U.S.A.), 26 May 1985, 1923 hours (towards WNW)

Cumulonimbus capillatus with mamma in anvil

Pouches of mamma (1, 2) are illuminated by the setting sun (3). The mammatus clouds appear under the anvil north-east of a small cyclonically rotating Cumulonimbus (4). At the time of the photograph, two larger severe, cyclonically rotating storms were in progress to the north-east and east.
The Cumulonimbus formed along the dry line in an environment of weak to moderate vertical shear and steep lapse rate.

$\mathbf{C_L = 9}$, $C_M = 0$, $C_H = 3$

A. Viaut, Paris (France), 16 February 1951, 1525 hours (towards SSW)

Altostratus translucidus

The major part of this layer of Altostratus is sufficiently thin to reveal the position of the sun (variety translucidus). An occlusion was present 150 km to the west, moving eastwards in a general westerly flow.

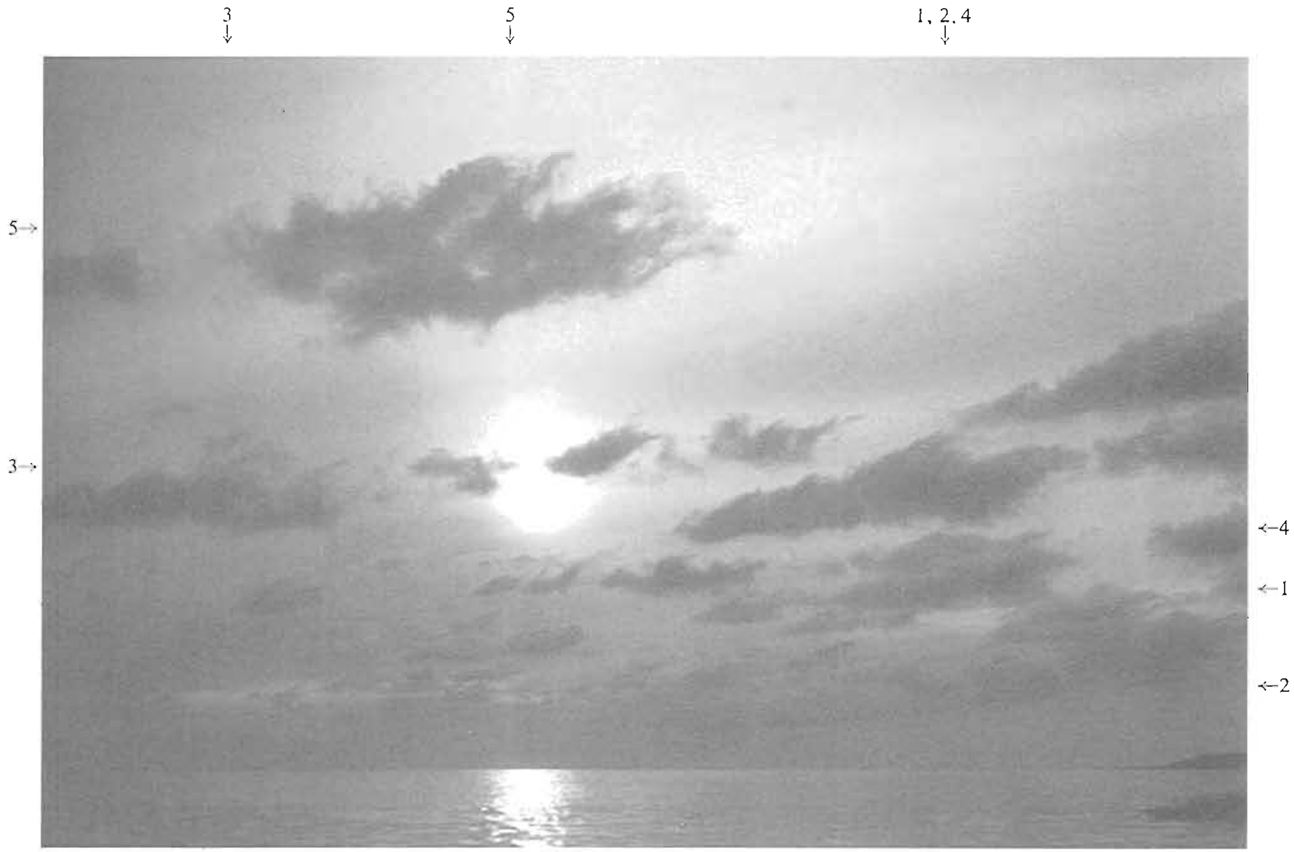
$C_L = 0$, $\mathbf{C_M = 1}$, $C_H = /$

R. Beaulieu, Paris (France), 17 October 1950, 0940 hours (towards SE)

Altostratus translucidus

This very uniform layer of Altostratus is differentiated from Stratus of rather similar appearance by the haziness of the spot (1) where the sun is.
The station was 300 km ahead of a warm front, associated with a disturbance coming from the west.

$C_L = 0$, $\mathbf{C_M = 1}$, $C_H = /$



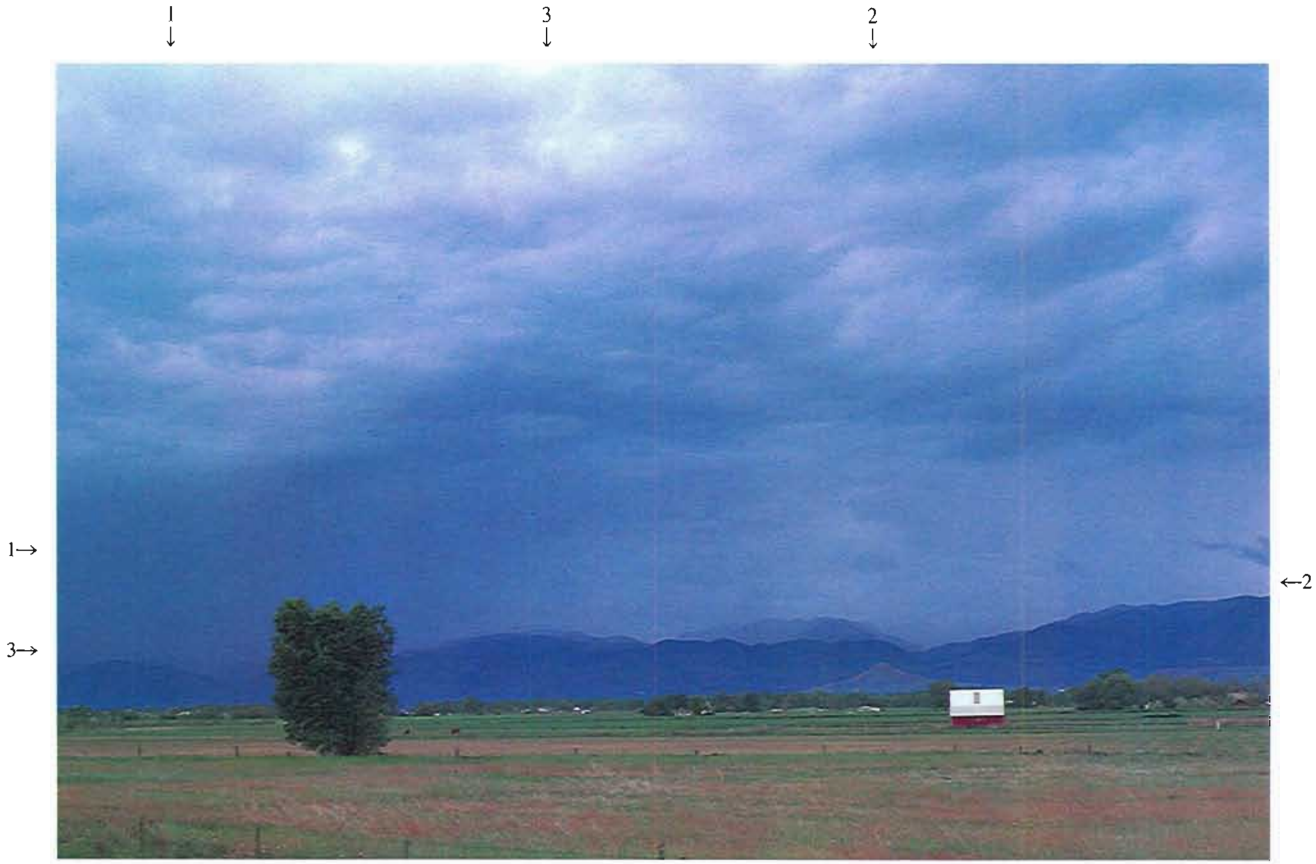
A. J. Aalders, Naarden (Netherlands), 22 May 1952, 0526 hours (towards W)

Altostratus translucidus and Cumulus fractus

The major part of this Altrostratus is sufficiently translucent to reveal the position of the sun. The appearance of the layer as a whole is more or less fibrous; differences in opacity produce darker bands which cross the sky. At low level, dark clouds lit from behind are present. They show more or less horizontal bases (1, 2) and slightly rounded tops (3, 4) and are intermediate between Cumulus humilis and Cumulus fractus. A particularly good example of Cumulus fractus is seen at 5. One might be inclined to code these lower clouds as $C_L = 1$; however, the presence of the Altostratus and the fact that not much day-time convective activity is to be expected in the early morning make the coding $C_L = 7$ more appropriate.

The station was situated in a weak north-north-easterly current in the south-east segment of an anticyclone extending from the Atlantic to central Norway. A weak disturbance in this flow passed the Netherlands during the morning.

$C_L = 7$, $\mathbf{C_M = 1}$, $C_H = /$



R. F. Reinking, Niwot (Colorado, U.S.A.), 4 June 1986, 1653 hours (towards W)

Nimbostratus

A dense, dark layer cloud is raining at the left (1) and in the distance (2). The Nimbostratus cloud is sufficiently dense to cover the sun and all other cloud layers that may be above it.
Cold, upslope advection was lifting the air over the rising terrain of the High Plains of Colorado and above the foothills of the Rocky Mountains (3).

$C_L = 0$, $\mathbf{C_M = 2}$, $C_H = /$

R. K. Pilsbury, Bracknell (Berkshire, U.K.), 24 January 1972, 1350 hours (towards N)

Nimbostratus with Stratus fractus

A layer of Nimbostratus covers the sky and completely hides the sun. Below this layer are a few patches of Stratus fractus at such locations as 1, 2 and 3. Rain is falling at the time of the picture.

A cold front had passed over the area earlier in the day, but a wave forming to the south-west had brought a return of middle cloud and rain for a time.

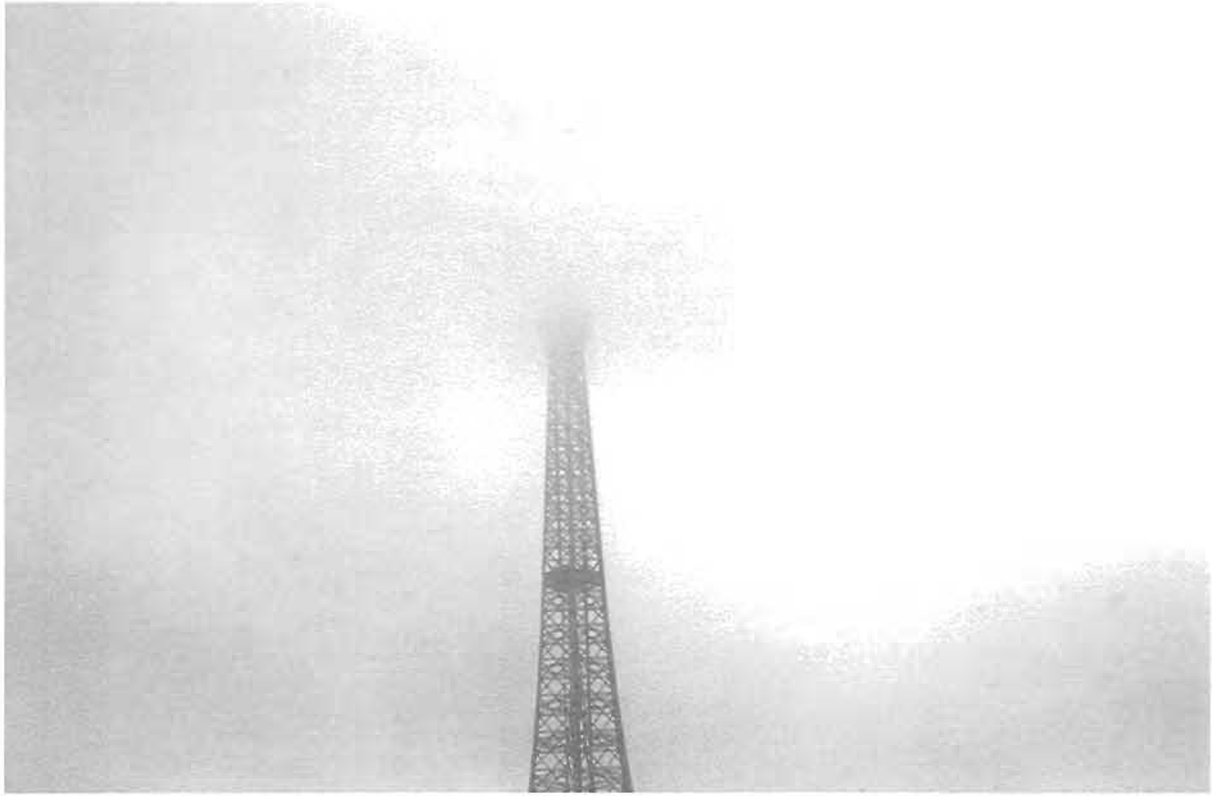
$C_L = 7$, $\mathbf{C_M = 2}$, $C_H = /$

R. L. Holle, Waterloo (Indiana, U.S.A.), 19 August 1985, 0705 hours (towards ENE)

Nimbostratus with Altocumulus stratiformis

A large, raining cloud area is located at the top of the picture (1), extending for a large distance to the south. This dark, diffuse Nimbostratus cloud is raining lightly at its edge at 2. In the distance is found blue sky (3), where the Nimbostratus gives way to scattered layers of Altocumulus stratiformis and possibly some Cirrus.
The photo was taken on the north edge of a large rain area associated with a stationary E-W front.

$C_L = 0$, $\mathbf{C_M = 2}$, $C_H = /$



A. Viaut, Paris (France), 18 March 1952, 1000 hours (towards SSW)

Nimbostratus

Some differences in opacity appear in this very low layer of Nimbostratus, which partly hides the top of the Eiffel Tower. The station was situated to the south-east of the centre of a cold upper low. A weak surface low was centred over Biscay with a quasi-stationary warm-front-type occlusion extending from Ireland to southern France.

$C_L = 0$, $\mathbf{C_M = 2}$, $C_H = /$

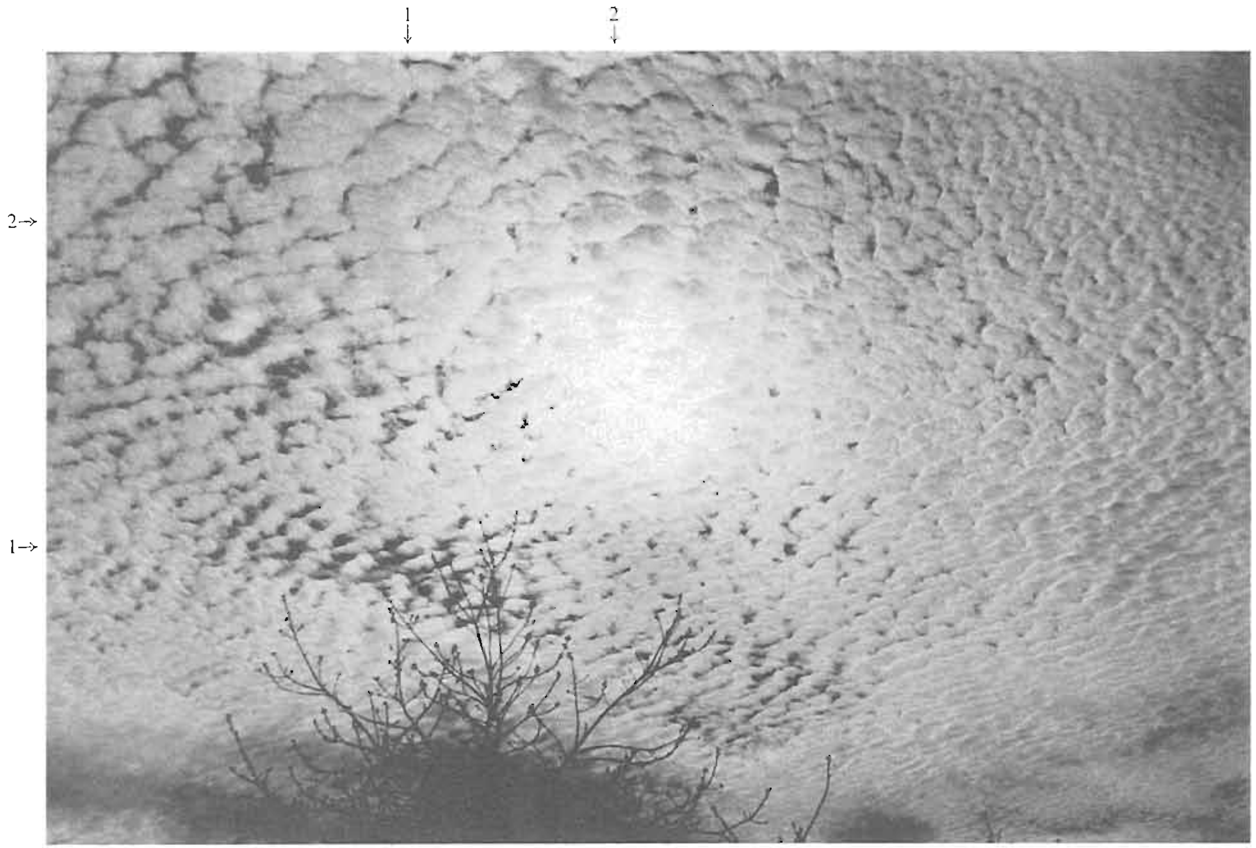
R. L. Holle, Tucson (Arizona, U.S.A.), 21 January 1984, 1615 hours (towards W)

Altocumulus translucidus

A single layer of Altocumulus is present in this view. While the cloud type covers the sky, there are numerous breaks (1, 2) between Altocumulus elements, which range from thin (3) to thick (4). The clouds were not progressively invading the sky; had this been so, the coding would have been $C_M = 5$.

The Altocumulus clouds spread over southern Arizona during the afternoon as a weak short wave moved to the north of the region.

$C_L = 0$, $\mathbf{C_M = 3}$, $C_H = 0$

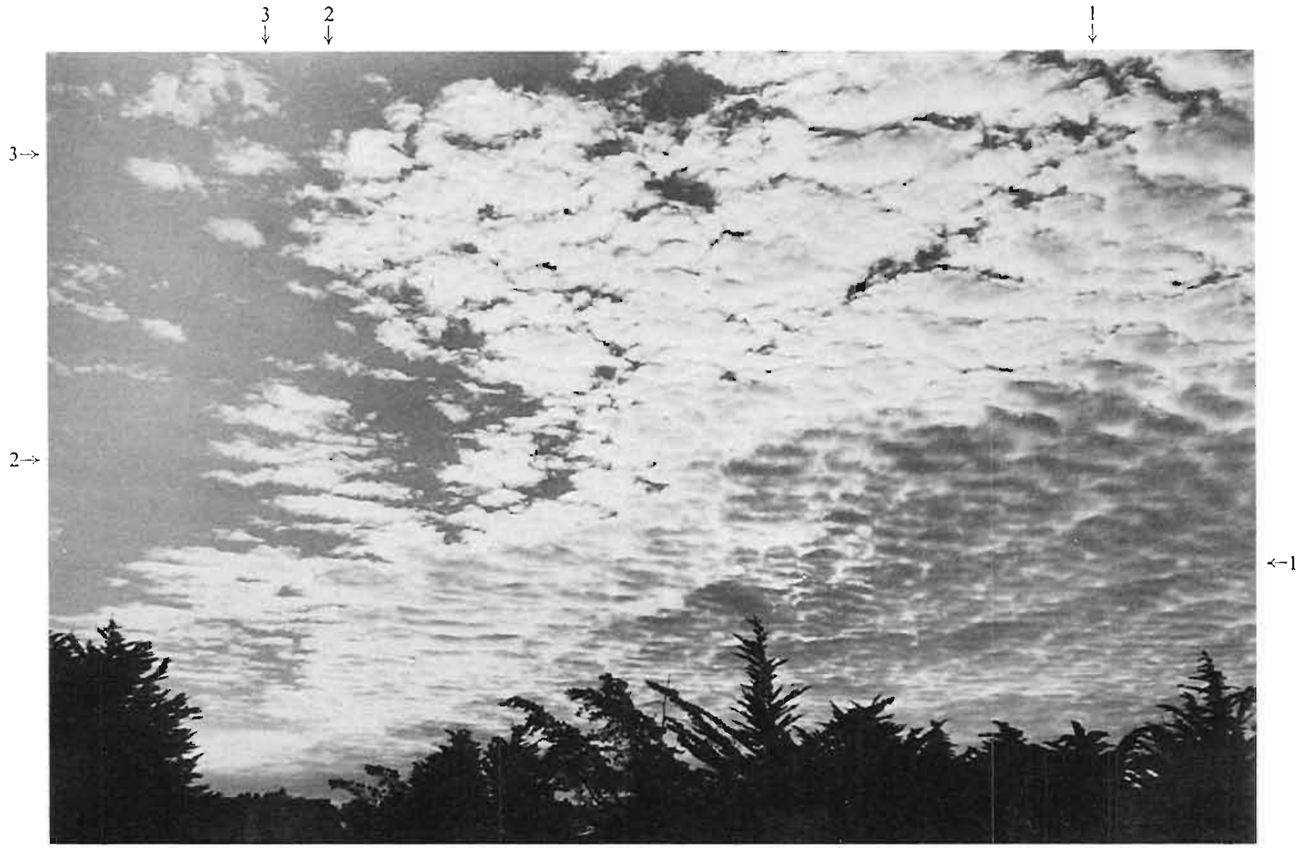


A. J. Aalders, Bussum (Netherlands), 18 April 1943, 1553 hours (towards WSW)

Altocumulus stratiformis translucidus perlucidus

The regular and extensive layer of Altocumulus is composed of elements, either well detached from one another (1) or more closely assembled like pieces of a mosaic (2). The sky is visible everywhere between the elements, except near the horizon (variety perlucidus); the cloud layer is sufficiently translucent, almost everywhere, to reveal the position of the sun (variety translucidus).
The station was in the warm sector not far from the warm front of a depression travelling from south of Iceland to central Norway.

$C_L = 0$, $\mathbf{C_M = 3}$, $C_H = 0$



L. Buffault, Jard-sur-Mer (France), 8 August 1950, 1910 hours (towards WNW)

Altocumulus stratiformis translucidus perlucidus

A sheet of lightly shaded white to dark-grey elements, showing the chief characteristics of Altocumulus: regularly arranged laminae, merged at 1, detached at 2, ragged at 3. The layer is of variety translucidus as one may assume that it would be possible to determine the position of the sun through most of it. The clouds were not progressively invading the sky and the coding is therefore $C_M = 3$ rather than $C_M = 5$.
A disturbance was centred off Ireland and the station was about 300 km ahead of its warm front, which was undergoing rapid frontolysis.

$C_L = 0$, $\mathbf{C_M = 3}$, $C_H = 0$

B. Colman, Denali National Park (Alaska, U.S.A.), 26 May 1984, 1245 hours (towards SSE)

Altocumulus lenticularis

Numerous small Altocumulus patches are seen in the photograph. At 1 a pile of smooth lens-shaped elements is visible. Three apparent waves are defined by the fibrous elements with crests at 2, 3, 4. The wave signature is also seen in the Cirrus at 5. A vigorous short-wave trough was approaching from the west, the local area experiencing an increasing SW flow at all levels (right to left in the photograph).

$C_L = 2$, $\mathbf{C_M = 4}$, $C_H = 1$

J. M. Brown, Boulder (Colorado, U.S.A.), 3 December 1979, 1200 hours (towards WNW)

Altocumulus lenticularis duplicatus with Cirrostratus fibratus

Altocumulus lenticularis is shown at two different levels (1, 2) against a background of Cirrostratus fibratus. Duplicatus structure is evident at 3. The Continental Divide of North America, obscured by a smooth, föhn wall cloud of laminar appearance (4, 5), is 30 km to the west. This cloud is partially shaded by the Altocumulus above, accounting for its variation in apparent brightness. A downstream rotor cloud with cumuliform top is visible at 6, partially obscuring the föhn cloud.
The flow at mountain-top level (about 4 000 m) was from the north-west at about 15 m s^{-1}, increasing to 25 m s^{-1} at 9 000 m above mean sea-level.

$C_L = 5$, $\mathbf{C_M = 4}$, $C_H = 7$

L. Buffault, St. Brice (Seine-et-Oise, France), 25 August 1950, 1758 hours

Altocumulus lenticularis radiatus

The lower part of the picture shows many cigar-shaped Altocumulus patches, with on the whole fibrous, but not silky, extremities. The wavy band (1-2), brilliantly lit from the side, shows superimposed layers, four of which are clearly distinguishable at 3, and it has a flat, horizontal and greyish base. Similar clouds were seen at the same time at Tours and Rennes, 200 and 300 km from the place of observation.

A weak Atlantic depression extended from Cape Finisterre to Cornwall and a strong upper current from the south-west was crossing the Pyrenees. There was strong instability, with thunderstorms over southern and western France.

$C_L = 0$, $\mathbf{C_M = 4}$, $C_H = 0$

A. H. Boujon and R. Pommier, Adélie Land (Antarctica), 10 January 1951, 0600 hours (towards NW)

Altocumulus lenticularis undulatus radiatus and Cirrostratus

The lenticular patch (1-2) consists of fairly small, lightly shaded, whitish elements. In places (3-4) the elements are aligned in sinuous files, which give the cloud a wavy appearance (variety undulatus); there is also a banded structure (variety radiatus). Near the horizon are banded Cirrostratus (5 and 6) and a thin and particularly straight band of coastal Stratocumulus (7-8). The station was on the margin of a depression.

$C_L = 5$, $\mathbf{C_M = 4}$, $C_H = 5$

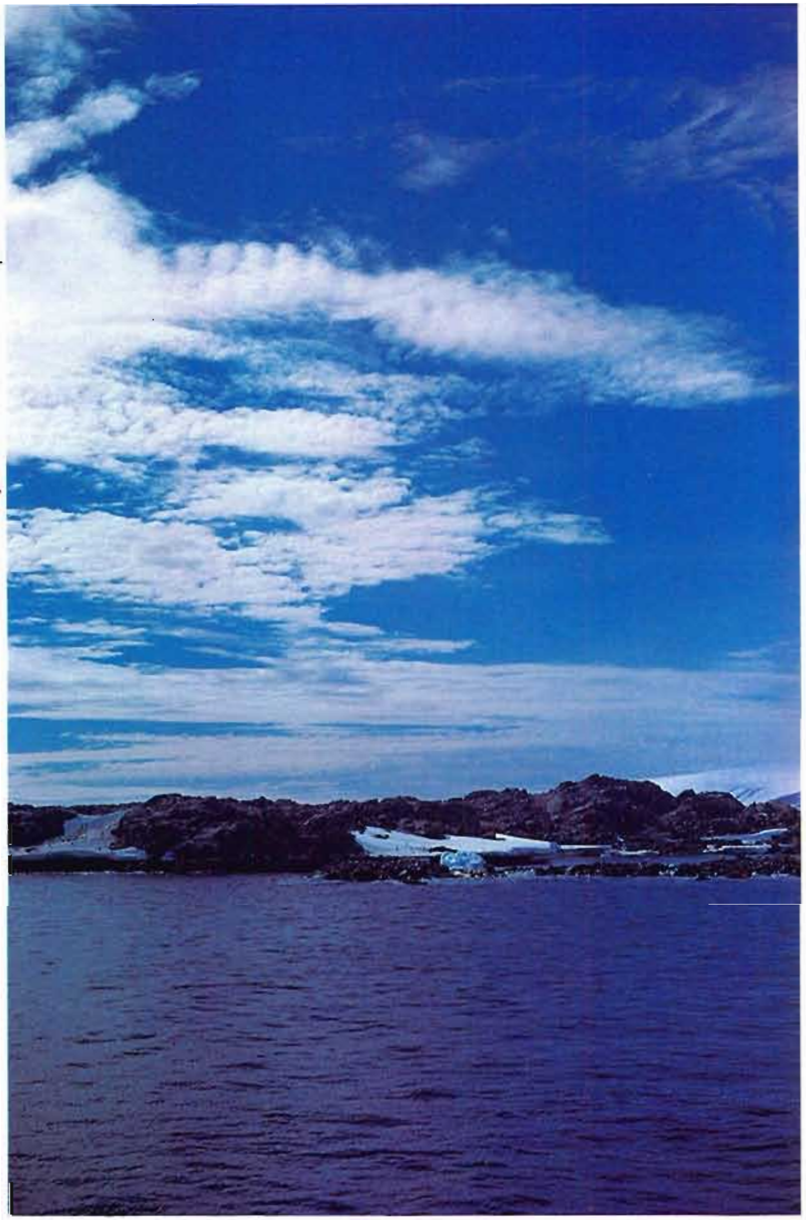
J. M. Brown, Boulder (Colorado, U.S.A.), 6 December 1979, 1515 hours (towards S)

Altocumulus lenticularis

The large patch at 1 is an example of a mountain-wave cloud at a great height (estimated 8 000 m above ground), hence it is very probably composed primarily or entirely of ice particles. These clouds are suggested also by the rather fibrous structure of this and of the more extensive Altocumulus lenticularis mass (2) at a greater distance but at the same level. The clouds are classified as Altocumulus because of the very marked shading evident in much of the cloud. The elongated structures in this cloud mass clearly suggest wave motion. The patch of Cirrus fibratus at 3 is also wave-induced, but lacks clear lenticular appearance. The N-S oriented Continental Divide of North America is located 30 km to the west. A jet contrail (4) and a small patch of Stratocumulus (5) are also present.

The flow aloft was from the north-west, increasing from 20 m s^{-1} near mountain-top level to 35 m s^{-1}, with strong anticyclonic shear, at 9 000 m above mean sea-level.

$C_L = 5$, $\mathbf{C_M = 4}$, $C_H = 1$



A. H. Boujon and R. Pommier, Adélie Land (66° 49′ S, 141° 25′ E), 4 February 1951, 2300 hours (towards SE)

Altocumulus lenticularis undulatus radiatus

The sky is barred with more or less smooth patches, many of them of lenticular shape, and composed of lightly shaded rounded elements, in continual transformation, dispersed (1, 2) or aligned (3) in waves (variety undulatus). The cloud system as a whole also shows a banded structure (variety radiatus). The Altocumulus, consisting of water droplets, has a pale, almost yellowish, shade which contrasts with the brilliant whiteness of nearby snow (4).

There was a cold front 400 km north-west of the station.

$C_L = 0$, $\mathbf{C_M = 4}$, $C_H = 0$

G. A. Clarke, Aberdeen (Aberdeenshire, U.K.), 29 October 1927, 1510 hours

Altocumulus lenticularis

Some of the lenticular patches are darkly shaded in their central parts (1, 2) and show no detailed structure; others are without shading and consist partly of small rounded elements (3). The lenticular shape of the Altocumulus is most probably due to stationary waves, caused by orography. Above the Altocumulus there are some filaments of fine Cirrus (4) and a thin veil of Cirrostratus extending down to the horizon.

The sky was observed in maritime polar air with fresh SW winds, 500 km ahead of a warm-front-type occlusion.

$C_L = 0$, $\mathbf{C_M = 4}$, $C_H = 6$

M. Bonnet, Amsterdam Island (Indian Ocean 37° 50′ S, 77° 34′ E), 8 April 1952, 1835 hours (towards NE)

Altocumulus lenticularis and Stratocumulus

In this photo, taken by moonlight, the characteristic form of the Altocumulus lenticularis (1-2), its fibrous fringes and its subdivision into smaller elements are clearly seen. Stratocumulus patches of varying thickness occupy the rest of the sky. Some banks in the lower part of the picture (3-4) are without a fibrous fringe and have the form of twisted rolls, again vaguely of lenticular shape, probably as a result of orographic waves. The Stratocumulus patch at the top of the picture (5-6) is much lower and has blurred outlines, the latter feature presumably being due to movement of the cloud during the relatively long time of exposure.

The station was on the southern side of the Indian Ocean anticyclone centred at 32° S, 79° E, and therefore on the northern border of disturbances moving from WNW towards ESE between the parallels 45° and 60° S.

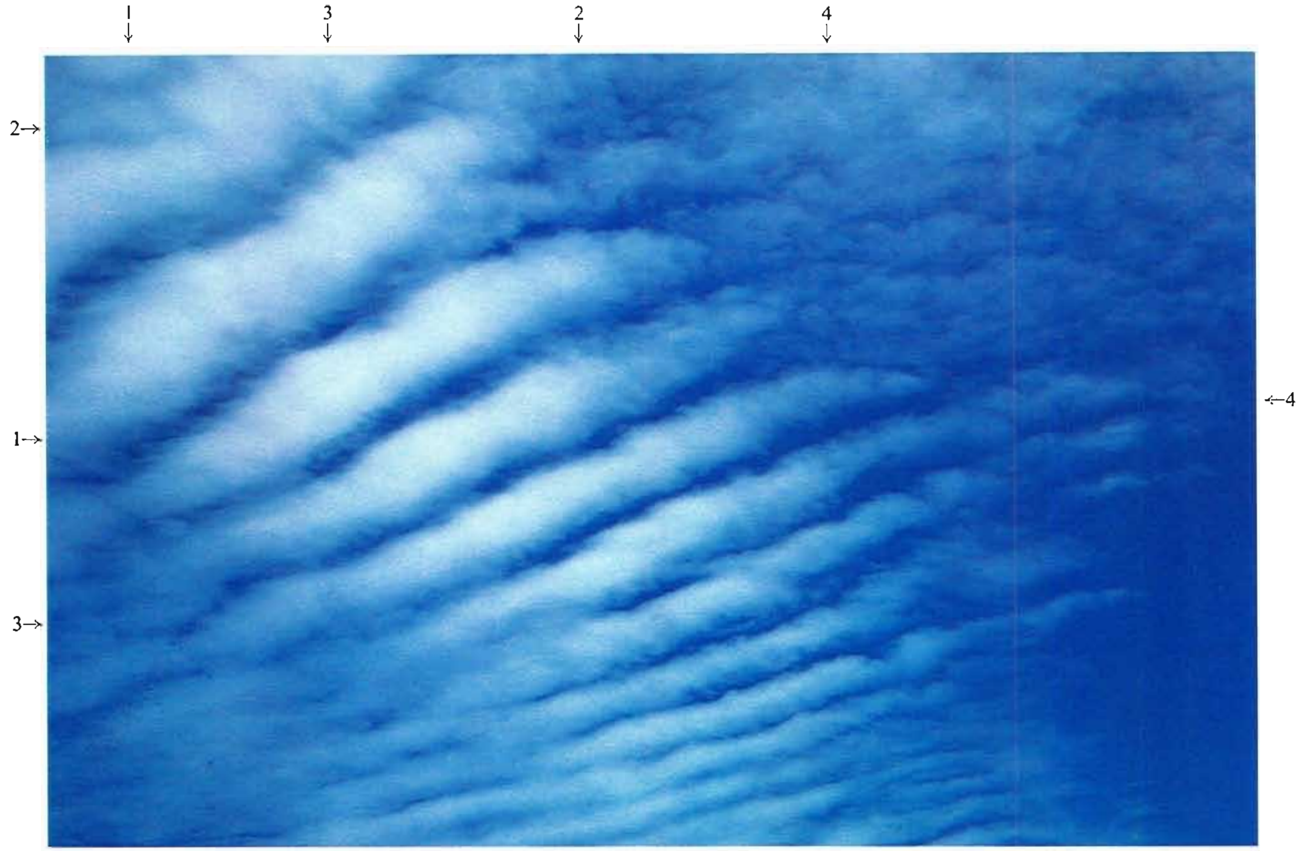
$C_L = 5$, $\mathbf{C_M = 4}$, $C_H = 0$

A. Simon, Cairo (Egypt), 17 November 1943, 1302 hours (towards WSW)

Altocumulus stratiformis lacunosus

In view of the appreciable size of the elements (1, 2, 3) the genus is identified as Altocumulus. The variety lacunosus is indicated by the presence of more or less circular holes (4, 5) through which the sky can be seen. The sharply defined holes suggest downward motion and it may be surmised that the cloud as a whole is continuously changing. The station was in the southern segment of a weak depression.

$C_L = 0$, $\mathbf{C_M = 4}$, $C_H = 0$



A. Viaut, Saint-Palais-sur-Mer (France), 22 July 1950, 1108 hours (towards NNE)

Altocumulus stratiformis perlucidus undulatus

The cloud layer is made up for the most part of fairly large rolls (1-2, 3-4), roughly rectilinear and parallel. Clear sky is visible between the rolls (variety perlucidus). The clouds were progressively invading the sky.
The photograph was taken in a maritime polar air mass between a cold front and an occlusion, both of thundery character.

$C_L = 0$, $\mathbf{C_M = 5}$, $C_H = 0$

French Meteorological Service, Paris (France), 15 December 1949, 0903 hours (towards ESE)

Altocumulus stratiformis translucidus undulatus

The Altocumulus layer is composed of fairly large elements having the appearance of irregular rolls (1), the relief of which is particularly accentuated by the grazing illumination. In spite of the heavy shading, the cloud belongs to the variety translucidus, as it may be surmised that the position of the sun, visible at 2, would be revealed through the major part of the layer. Some Cirrostratus nebulosus is observed at 3.

The layer of Altocumulus tended to thicken and it had invaded the sky progressively with the approach of a warm-front-type occlusion which was 100 km to the west-north-west and passed over the station at 1115 hours.

$C_L = 0$, $\mathbf{C_M = 5}$, $C_H = 8$

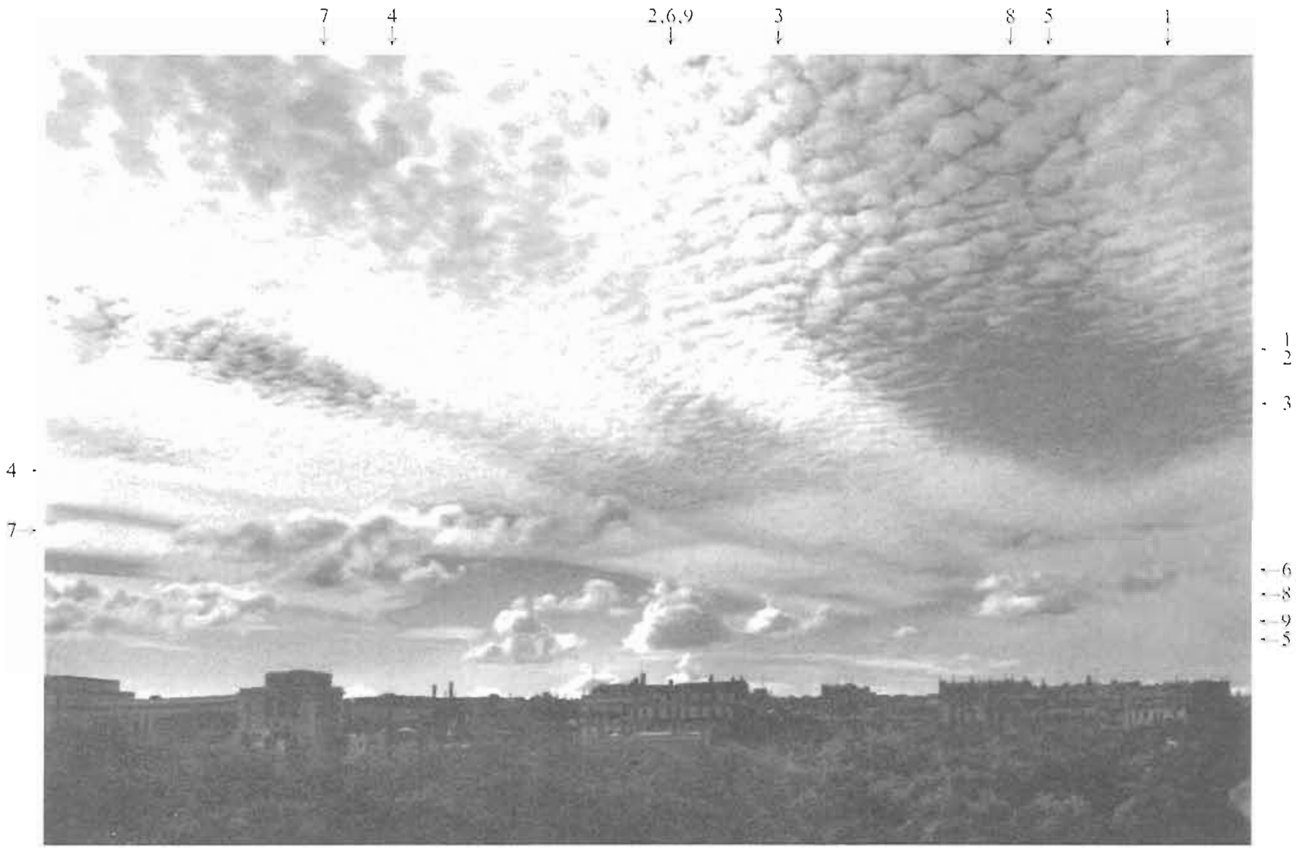
L. Buffault, Carnac (France), 30 July 1950, 0631 hours (towards SE)

Altocumulus stratiformis undulatus translucidus perlucidus radiatus

This layer of Altocumulus is clearly translucent (variety translucidus). Numerous intervals between the elements (1, 2) also permit the sky to be seen (variety perlucidus). The presence of elongated elements, almost parallel to one another (3, 4), indicates the variety undulatus; there is also a banded structure (variety radiatus) across the picture (5-6, 7-8). The layer was rapidly invading the sky; in the direction in which the picture was taken, there is still an opening at 9.

The station was in a maritime polar warm-air mass, about 100 km ahead of a cold front moving W-E which produced scattered thunderstorms at the end of the morning and later. The winds were SW-WSW up to 6 km.

$C_L = 0$, $\mathbf{C_M = 5}$, $C_H = 0$



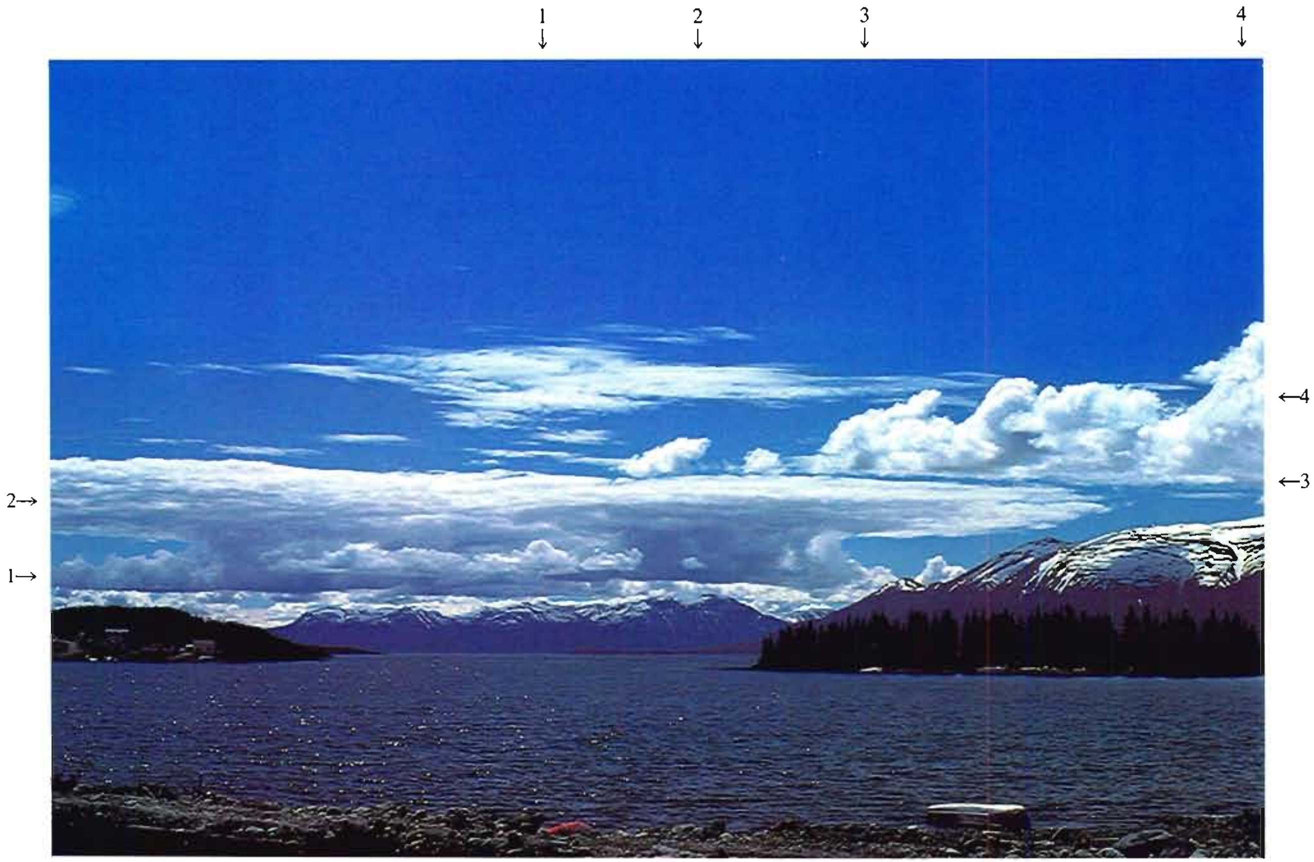
French Meteorological Service, Paris (France), 2 August 1946, 1600 hours (towards W)

Altocumulus stratiformis undulatus radiatus translucidus perlucidus

The Altocumulus clouds were invading the sky progressively. The translucent layer consists of elements some of which are merged; others are separated by clear spaces. At various places (1, 2), the cloud elements are arranged in small rolls (variety undulatus). Elongated patches (3, 4), which seem to converge towards point 5, indicate the variety radiatus. At 6 some fused Altocumulus lenticularis are observed. Under the Altocumulus there are some Cumulus fractus (7), Cumulus humilis (8) and Cumulus mediocris (9).

The picture was taken in maritime tropical air, about 300 km from the advancing cold front of a depression centred north of Scotland and moving south-eastwards.

$C_L = 2$, $\mathbf{C_M = 5}$, $C_H = 0$

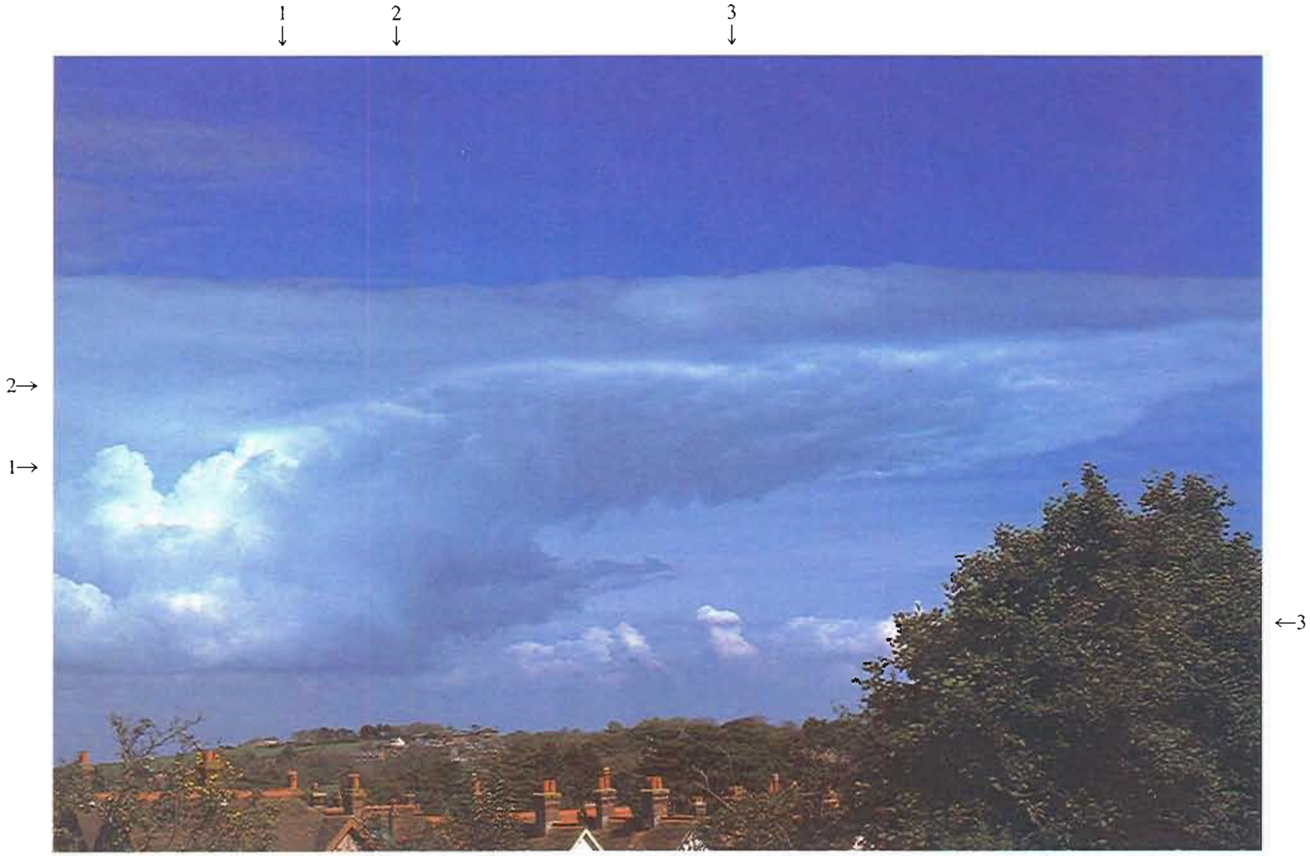


B. Colman, Atlin (British Columbia, Canada), 29 June 1977, 1130 hours (towards SSW)

Altocumulus cumulogenitus with Cumulus congestus

The cluster of Cumulus clouds (1), approximately 20 km down the lake, has reached a stable layer with the vertical growth completely stopped. The Altocumulus cumulogenitus is clearly seen spreading out from the summits of the parent Cumulus (2). The Altocumulus cumulogenitus appears fairly thick and opaque near its source and is visibly thinner near the edges (3). The Cumulus clouds in the right foreground (4) have recently formed and have not yet reached the stable layer.
The station was in a post-frontal SW flow. The cold upper-level trough had passed the station to the east, weak ridging occurring to the west.

$C_L = 2$, $\mathbf{C_M = 6}$, $C_H = 0$



R. K. Pilsbury, Lymington (Hampshire, U.K.), 7 September 1975, 1210 hours (towards NE)

Altocumulus cumulogenitus formed by Cumulus congestus

The Cumulus congestus cloud at 1 has its top reaching, and spreading into, the Altocumulus layer at 2. The Cumulus congestus at 3 have formed well inland to the north-east, but have not reached the inversion level.
The nearby congestus (1) formed on the sea-breeze front caused by the onset of a southerly sea breeze meeting the light NW flow of the ridge, and the top was carried well to the south-east by the upper NW flow.

$C_L = 2$, $\mathbf{C_M = 6}$, $C_H = 0$

A. Viaut, near Tarbes (France), 24 July 1951, 1705 hours (towards SSW)

Altocumulus cumulogenitus

The principal patch of Altocumulus (1) resulted from the spreading out of the top of a moderately developed Cumulus (2). Patches of Altocumulus (3, 4) on the margin of the main patch are disintegrating. At 5 a whitish sheet, constituting the top of a Cumulonimbus capillatus, can be seen.

The station was situated in a northerly flow of polar air on the eastern side of a high over the Bay of Biscay.

$C_L = 9$, $\mathbf{C_M = 6}$, $C_H = 0$

T. Bergeron, Rundhögen (Sweden), 10 July 1945, 2130 hours (towards NNW)

Altocumulus stratiformis opacus

The grazing illumination makes the relief of the sheet of Altocumulus opacus, which covers the right half of the photograph, particularly evident near the horizon, where ripples and waves (1, 2) can be seen. At a lower level, at 3, a patch of Stratocumulus is observed, apparently formed out of the convective clouds which developed during day-time but subsided during the evening.

A quasi-stationary front, with an Altostratus-Nimbostratus system, oriented NNW-SSE, was lying over Sweden. The station was situated exactly at the western margin of the withdrawing cloud system, which at the place of observation had degenerated into Altocumulus.

$C_L = 4$, $\mathbf{C_M = 7}$, $C_H = 0$

A. J. Aalders, Blaricum (Netherlands), 1 November 1953, 1605 hours (towards WSW)

Altostratus translucidus above Altocumulus stratiformis perlucidus

The higher cloud layer consists of a rather featureless grey veil of Altostratus through which the sun is seen as through ground glass; apparently no part of the veil is of sufficient optical thickness to obscure the sun (variety translucidus). Over most of the picture there are medium-sized units of a lower Altocumulus sheet; through breaks between the elements the higher Altostratus can be seen (variety perlucidus). Some Altocumulus elements have a more or less lenticular shape.
A rapidly deepening depression was centred over Ireland, with a strong south-south-easterly current over the Netherlands. An occlusion of cold-front character, lying over eastern England and moving towards the Netherlands, caused some rain during the following night.

$C_L = 0$, $\mathbf{C_M = 7}$, $C_H = 0$

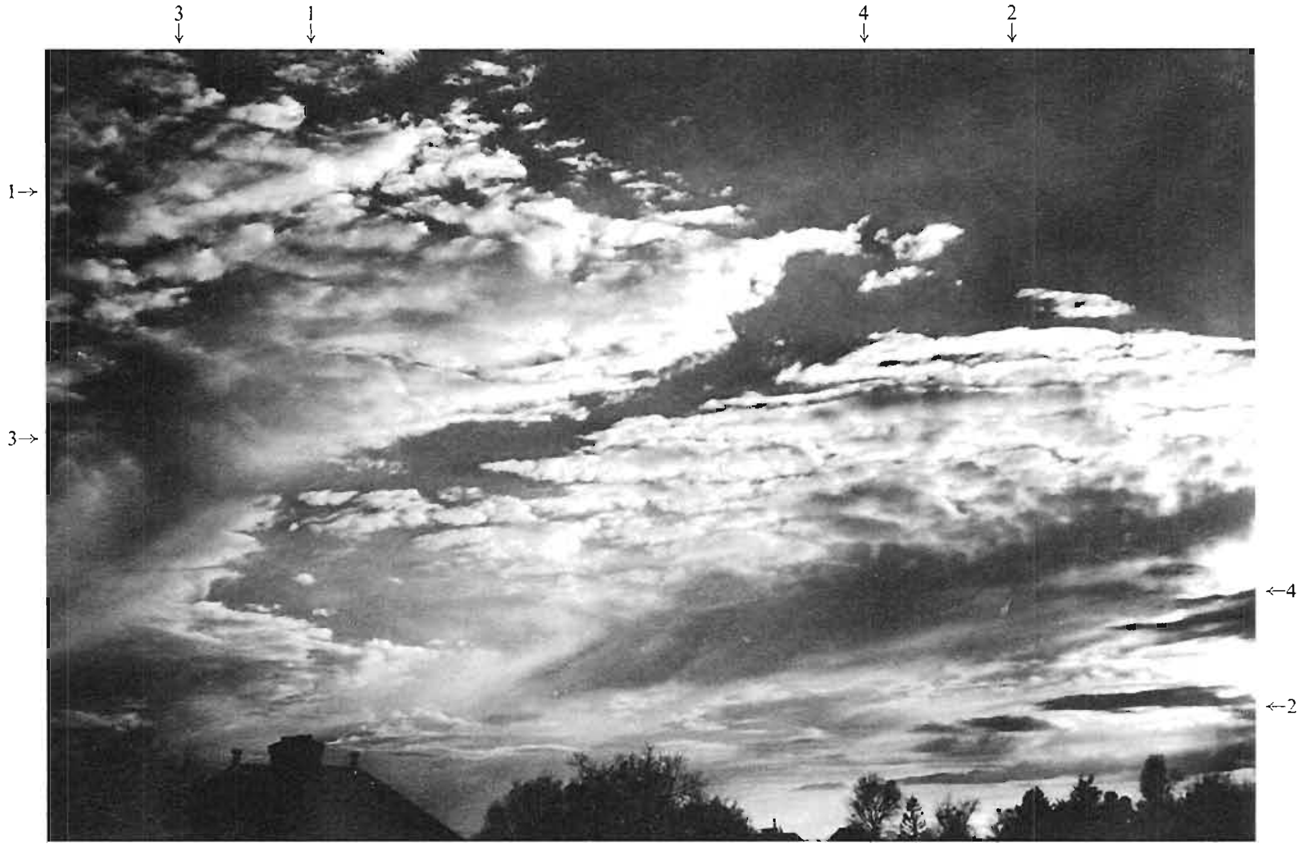
A. J. Aalders, Oud Loosdrecht (Netherlands), 16 September 1950, 1840 hours (towards W)

Altostratus undulatus radiatus translucidus

The general fibrous appearance of the layer and its considerable range of luminance identifies the cloud as Altostratus. The greater part of the layer is sufficiently thin to reveal the position of the sun (variety translucidus). The long streaks radiating from a point outside the picture to the right indicate the variety radiatus. In view of the fact that there is also a more detailed waved structure, the cloud may also be considered as belonging to the undulatus variety. Near the horizon, particularly at 1, elongated elements of Altocumulus can be seen, which make it necessary to select code figure $C_M = 7$.

A ridge of high pressure had dominated the weather, but at the time the picture was taken the pressure was falling, the wind backing and the cloudiness increasing with the approach of a very active disturbance (originally a tropical cyclone) over the British Isles (compare with p. 109).

$C_L = 0$, $\mathbf{C_M = 7}$, $C_H = /$



A. J. Aalders, Bussum (Netherlands), 20 April 1941, 1950 hours (towards W)

Altocumulus with virga

There are Altocumulus clouds at different levels. This is clear at 1 where the wave patterns show different directions and at 2 where there are darker units below a higher sheet; the correct coding is therefore $C_M = 7$. From the denser portions (3, 4) of the cloud masses, striated to smooth virga trail towards the left.
The station was in a region of rising pressure in the rear of a trough associated with a depression far to the north-west.

$C_L = 0$, $\mathbf{C_M = 7}$, $C_H = 0$

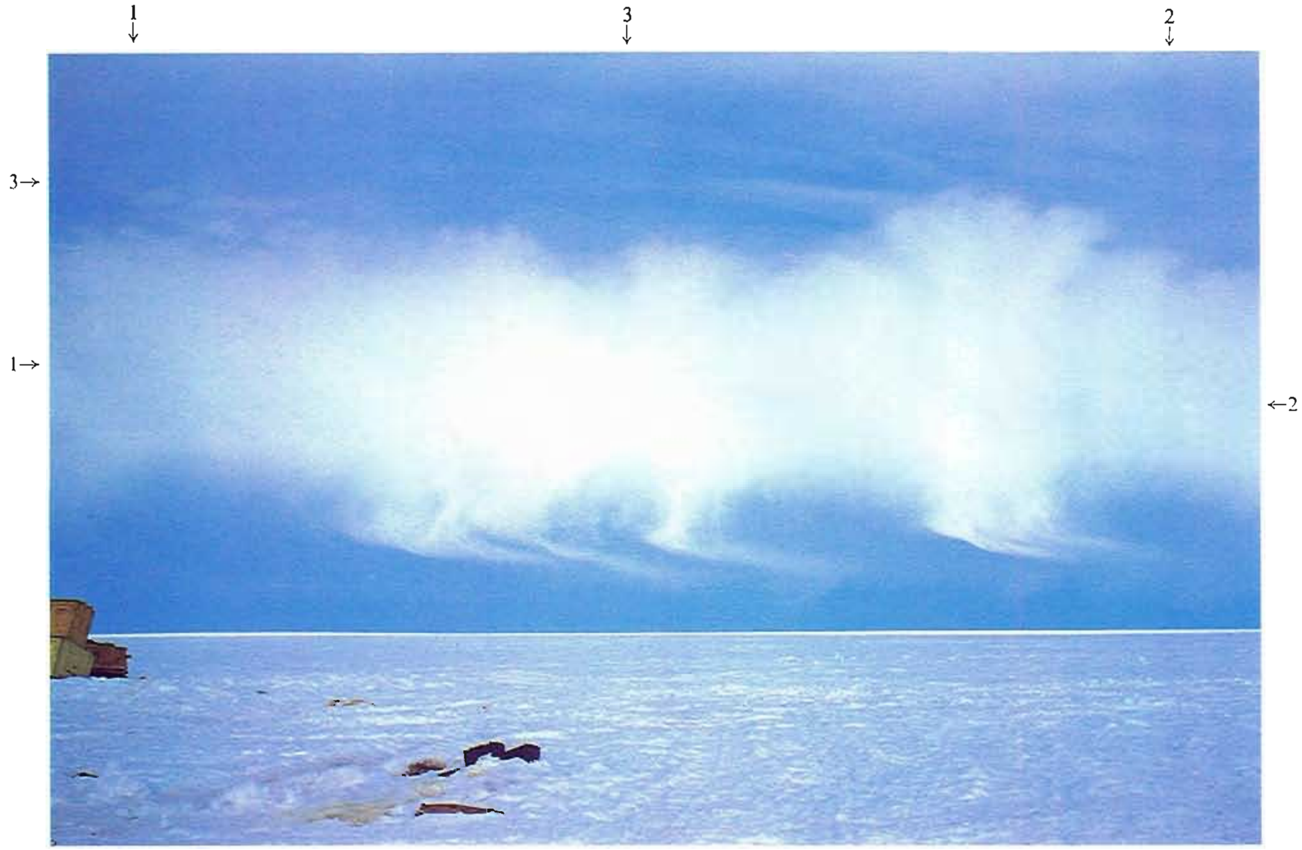
C. A. Doswell, Erick (Oklahoma, U.S.A.), 20 May 1974 (towards E)

Altocumulus castellanus with Cumulus congestus

An extensive area of Altocumulus castellanus is shown in concentrations at 1 and 2. Other clouds include Altostratus, and a Cumulus congestus at 3, which is dissipating.

The flow pattern was weak south-westerly at 500 hPa, with a weak short-wave trough approaching from the west. These clouds were in moist, unstable air ahead of a dry line located about 100 km to the west. Later in the afternoon, a major severe thunderstorm developed just ahead of the quasi-stationary dry line.

$C_L = 2$, $\mathbf{C_M = 8}$, $C_H = 1$



P. Stahl, Greenland (69° 41′ N, 48° 15′ W), altitude 1595 m, 11 June 1951, 0630 hours (towards W)

Altocumulus castellanus with virga

The principal mass (1-2) belongs to the genus Altocumulus; its upper part has a flocculent appearance (species castellanus). From this mass, notably from the parts having rounded tops, fall snowy virga of remarkable whiteness, which, curved by the wind, suggest Cirrus uncinus. Above the mass of Altocumulus, Cirrus fibratus (3) can be seen. The station was on the western margin of a strong anticyclone centred over Greenland, in a flow of maritime polar air from south to south-east.

$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 1$

C. A. Doswell (Central Oklahoma, U.S.A.), 27 April 1974 (towards NW)

Altocumulus castellanus

An extensive patch of Altocumulus castellanus is seen at 1, with a smaller, more distant patch at 2. These clouds are in the warm sector of developing extratropical convection, seen in the early afternoon.
Later in the day, a line of thunderstorms developed farther west and moved through the area.

$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 0$

P. Stahl, Greenland (69° 41′ N, 48° 15′ W), altitude 1595 m, 11 June 1951, 0505 hours (towards NW)

Altocumulus stratiformis and Altocumulus floccus with virga

The Altocumulus is at two levels. The clouds (1-2) at the higher level are in a sheet (species stratiformis), consisting of rather small rounded elements arranged in files, so that towards the horizon there is a resemblance to undulatus. Below this sheet there is Altocumulus floccus, consisting of large tufts (3, 4), denser and distinctly whiter than the blue grey of the higher layer; from the tufts fall virga of snow, which evaporates before reaching the ground. Note at 5 the whiteness of an element which contrasts strongly with the rest of the sky. The presence of Altocumulus floccus calls for the coding $C_M = 8$.
The station was on the western margin of a strong anticyclone centred over Greenland, in a flow of maritime polar air from between south and south-east.

$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 0$

C. J. P. Cave, Petersfield (Hampshire, U.K.), 5 August 1923, 1530 hours (towards NE)

Altocumulus floccus

The cloud elements have the form of small tufts and clearly show a cumuliform appearance. Some of them (1, 2) resemble Cumulus fractus in their compactness and in the absence of a horizontal base. Most of the elements are ragged and scattered (3); a few (4) look like white balls without shading. Near the horizon the elements are in staggered lines (5).
A small thundery trough of low pressure was situated over western England and Brittany with a flow of maritime polar air from the south-west over southern England.

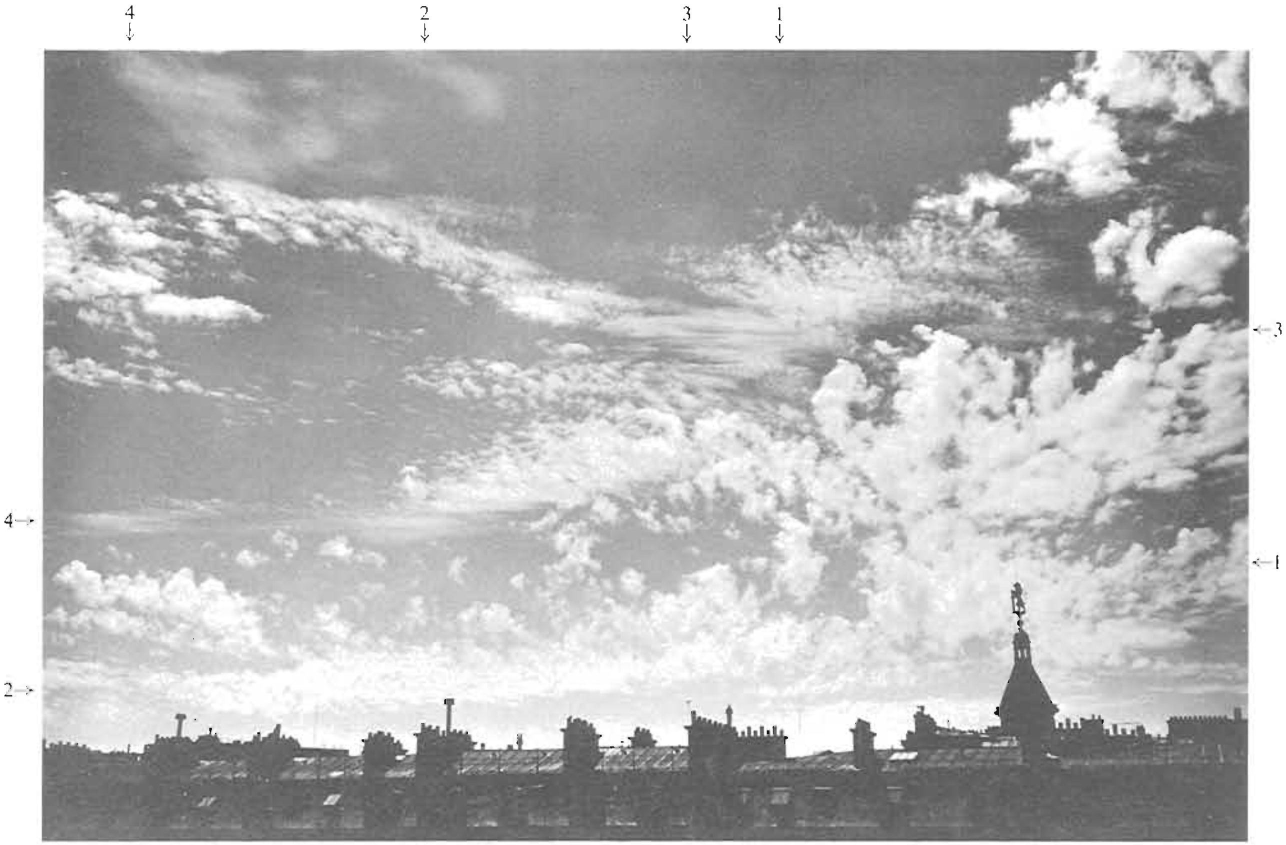
$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 0$

D. J. O'Connell, New York (U.S.A.), 28 November 1943, 1300 hours

Altocumulus floccus

Although most of the cloud elements have ragged margins and resemble roughly spherical masses of cotton-wool, their cumuliform appearance is still pronounced with sharp outlines here and there (1, 2) in the upper parts. This circumstance, and the fact that definite shading is visible, places the clouds in the genus Altocumulus and not Cirrus, although the latter may finally evolve from it. The hazy whiteness in the centre of the picture is probably due to virga. The station was on the southern margin of a depression centred over the Gulf of St. Lawrence in a very unstable continental polar air mass, with westerly winds up to the level of the Altocumulus.

$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 0$



French Meteorological Service, Paris (France), 13 July 1950, 1005 hours

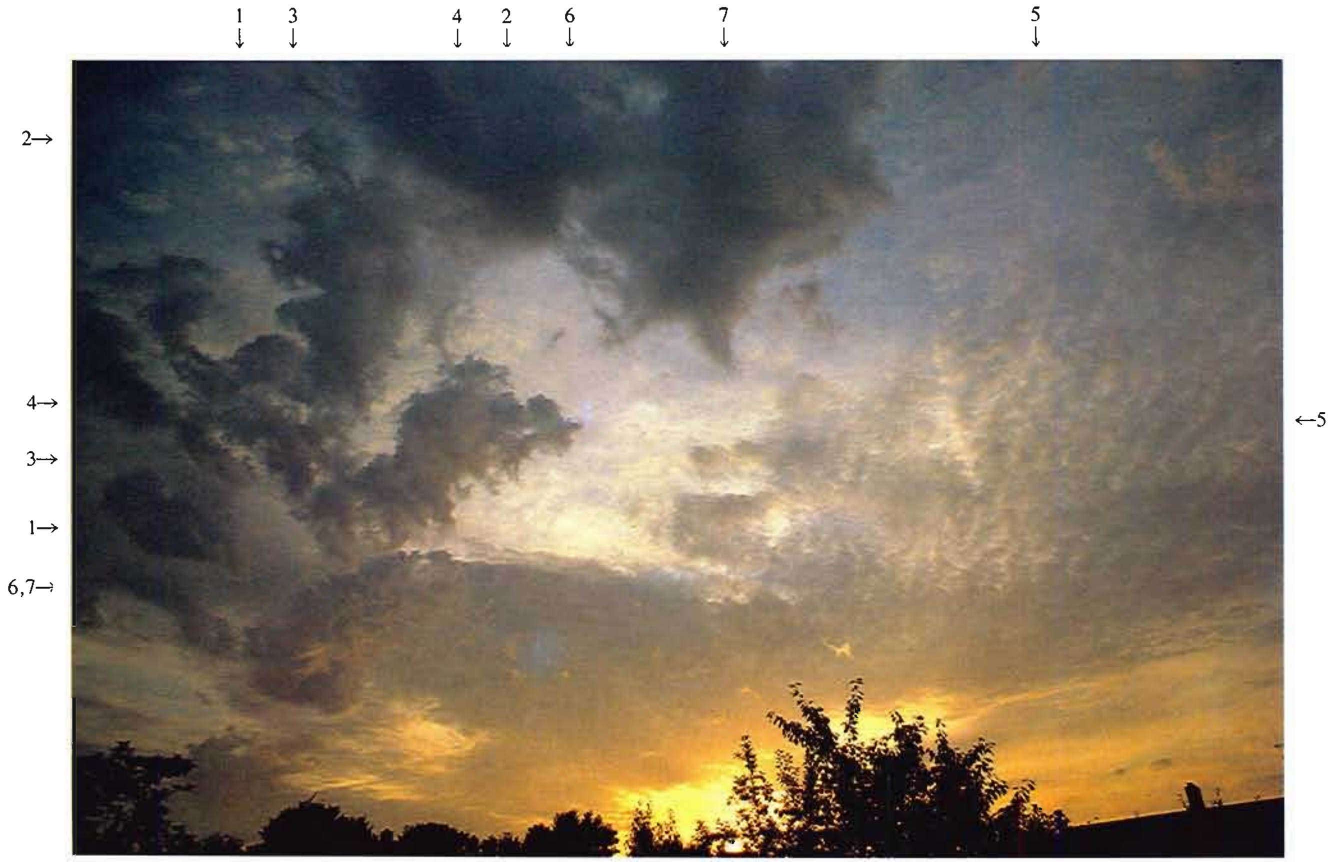
Altocumulus floccus, castellanus and lenticularis

The major part of the picture is occupied by isolated small tufts (1) of cumuliform appearance which are Altocumulus floccus; there are also some clouds of the species castellanus, their common base being distinguishable for instance at 2. Altocumulus lenticularis is present at various places (3, 4).

It is not unlikely that the initial condensation took place in the form of lenticularis, then cumuliform sproutings may have developed from the lenticular base, thus forming castellanus, and finally the floccus formed as a result of the disappearance of the base.

A small anticyclone was breaking down simultaneously with the entry of a weak maritime flow over the continent. Thunderstorms, first observed in the south-western part of France, spread over the whole country.

$C_L = 0$, $\mathbf{C_M = 8}$, $C_H = 0$



R. K. Pilsbury, Bracknell (Berks., U.K.), 24 June 1971, 2115 hours (towards NW)

Chaotic sky

Clouds at many levels are present. Cumulus fractus at low levels lies diagonally across the sky at 1-2 and 3-4. There is an extensive Altocumulus floccus cloud at 5, becoming dense at 6, and signs of castellanus at 7. Above all these cloud types can be seen an extensive layer of Cirrostratus.

Pressure had been very slack over the British Isles and France on the previous day, with an ill-defined frontal system over France. A depression moved to the west of Scotland on this day, its warm front over eastern Ireland inducing an unstable southerly flow over southern England.

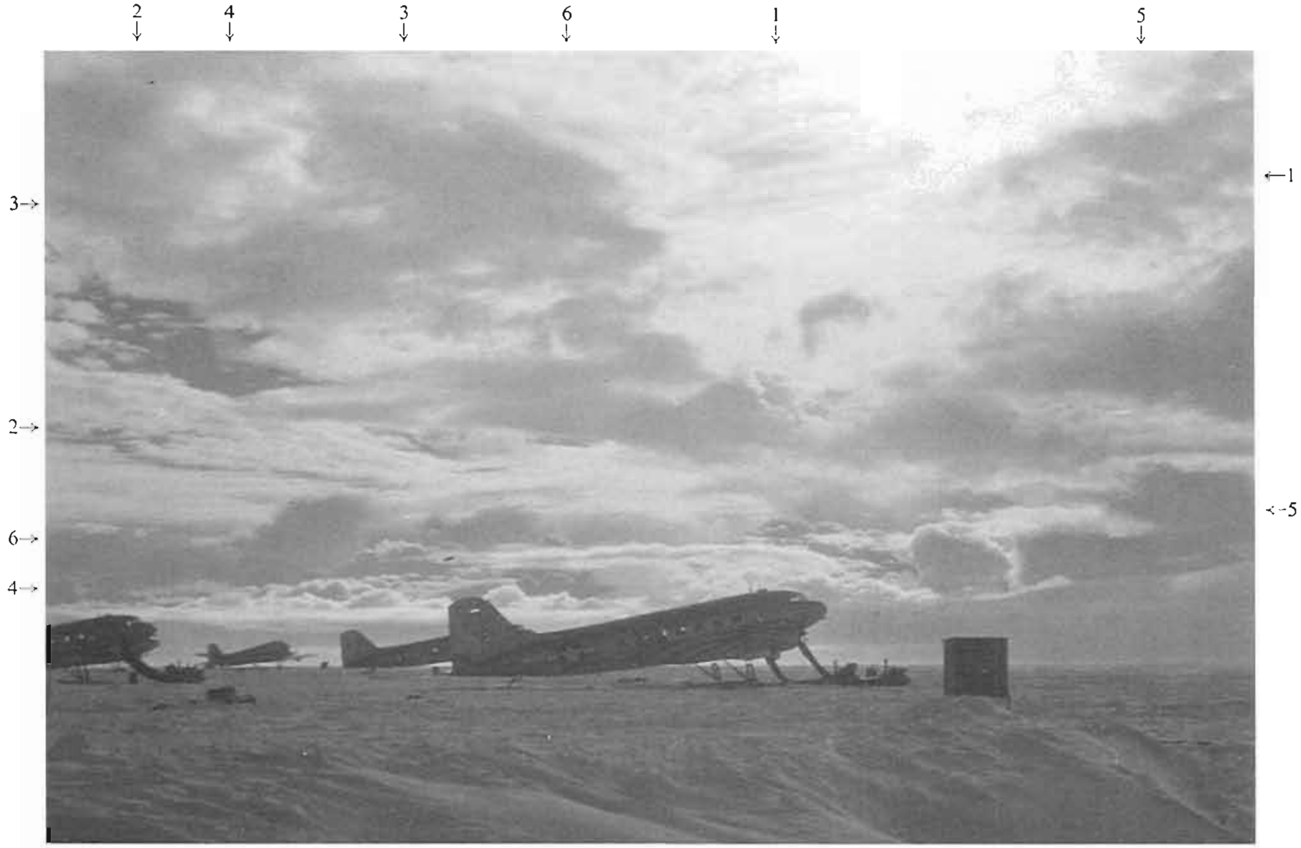
$C_L = 1$, $\mathbf{C_M = 9}$, $C_H = 8$

A. Viaut, La Tranche-sur-Mer (France), 13 August 1952, 1802 hours (towards SE)

Chaotic sky

Clouds of different shapes at various levels and rather irregularly scattered make this a chaotic sky. The Altocumulus clouds at 1 and 2 are turreted and rise from a common base (species castellanus); the Altocumulus at 3 are more or less isolated tufts (species floccus). In the upper part of the picture there are patches (4, 5) of Altocumulus stratiformis translucidus.
A shallow depression was approaching from Spain, causing a weak easterly flow with widespread thunderstorm activity over southern France.

$C_L = 0$, $\mathbf{C_M = 9}$, $C_H = 0$



B. C. Haynes. Bay of Whales (Little America, Antarctica). 11 February 1947. 0100 hours (towards E)

Chaotic sky

The picture shows a chaotic sky with clouds of significant vertical development. At (1) there is a high, dense, fibrous veil, with shadings, apparently a large patch of Cirrus spissatus. Altocumulus, in patches of irregularly shaped elements with different opacities and at various levels, covers the greater part of the picture area (2, 3). A line (4-5) of Cumulus and Cumulonimbus is visible under the Altocumulus; these convective clouds, illuminated from behind, are strongly shaded. At 6 a patch of Stratocumulus cumulogenitus is visible.
A cold front had passed the place of observation a few hours earlier.

$C_L = 3$, $\mathbf{C_M = 9}$, $C_H = 2$

R. A. Keen, Boulder (Colorado, U.S.A.), 11 July 1983, 1000 hours (towards SW)

Cirrus fibratus and Cirrus uncinus

Some nearly straight Cirrus fibratus elements are present at 1 and 2. Most of the Cirrus filaments, however, are topped with small tufts (3, 4) and are therefore uncinus.
A cold front had passed on the previous day; surface winds were light on this day. Winds were SW at 20 m s^{-1} at 250 hPa, as the area was under a weak SW jet associated with a stationary trough 600 km to the west.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 1}$

R. K. Pilsbury, Cowes (Isle of Wight, U.K.), 17 July 1982, 1500 hours (towards N)

Cirrus uncinus and Cirrus fibratus

The Cirrus hooks prominent at 1 and 2 are of the variety uncinus, while the thread-like patch of cloud at 3 is Cirrus fibratus. Below 4 are patches of high Stratocumulus.

An extensive anticyclone to the south-west of the British Isles had a ridge extending to Denmark. A weak and diffuse front was drifting south-eastwards towards southern England, and the only effect it gave was patches of Cirrus and the high Stratocumulus to the north.

$C_L = 5$, $C_M = 0$, $\mathbf{C_H = 1}$

Cirrus uncinus and Cirrus fibratus

The sky is nearly filled with Cirrus uncinus (1, 2, 3) and Cirrus fibratus (4) elements. A patch of more distinct, almost cumuliform, Cirrus is seen at 5, which appears to be at a slightly lower level than the other clouds.
Central Oklahoma was on the northern side of an elongated ridge of high pressure aloft.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 1}$

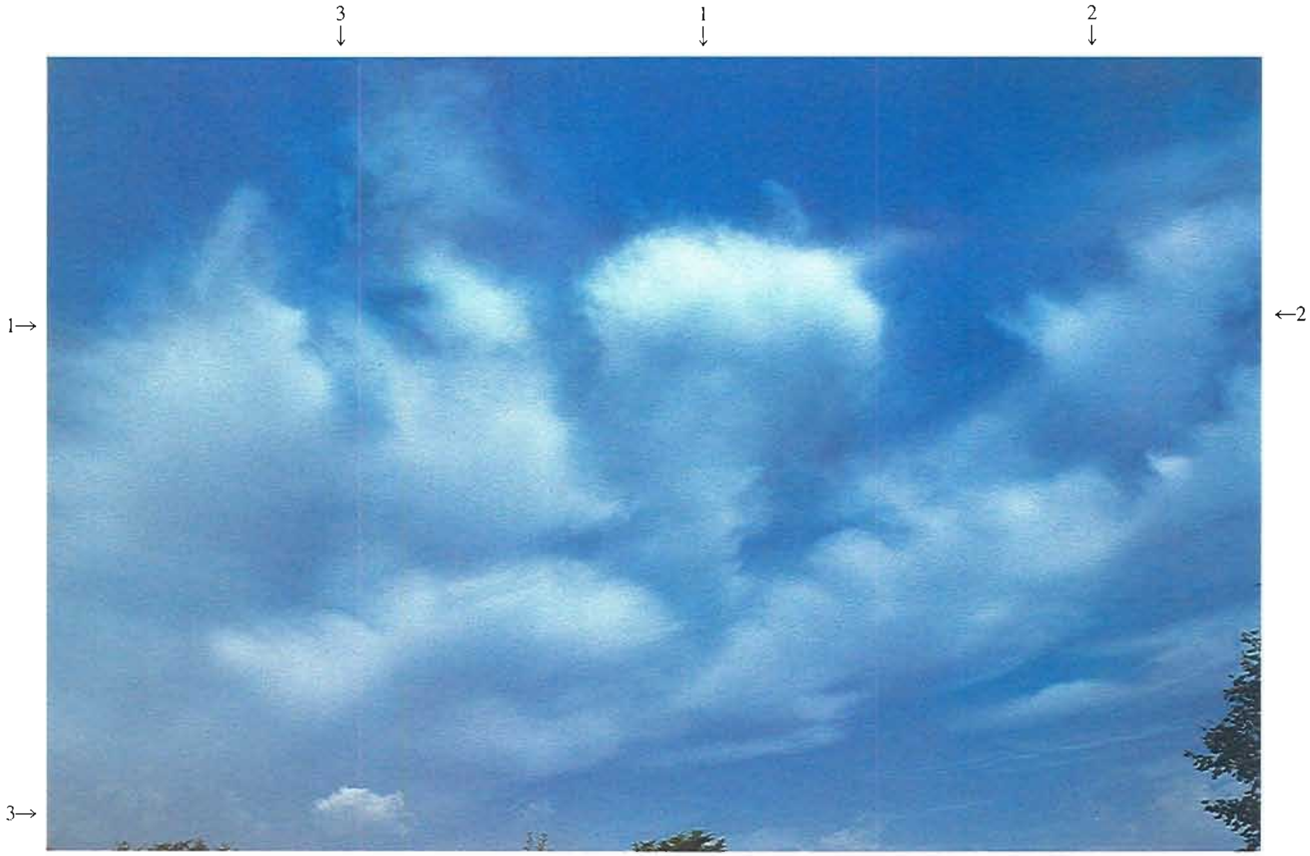
C. A. Doswell, Norman (Oklahoma, U.S.A.), December 1973, 1700 hours (towards W)

P. Taft, Albuquerque (New Mexico, U.S.A.), 11 September 1950, 1253 hours

Cirrus fibratus vertebratus

The principal cloud (1-2) suggests the form of a fish skeleton of which the flocculent masses (3, 4) form the spinal column and the filaments, arranged on either side, constitute the ribs. There is an isolated patch of Cirrus fibratus at 5.
The place of observation was in tropical air, south of a precipitating warm front on the western edge of a mass of polar air.

$C_L = 0, \quad C_M = 0, \quad \mathbf{C_H = 1}$

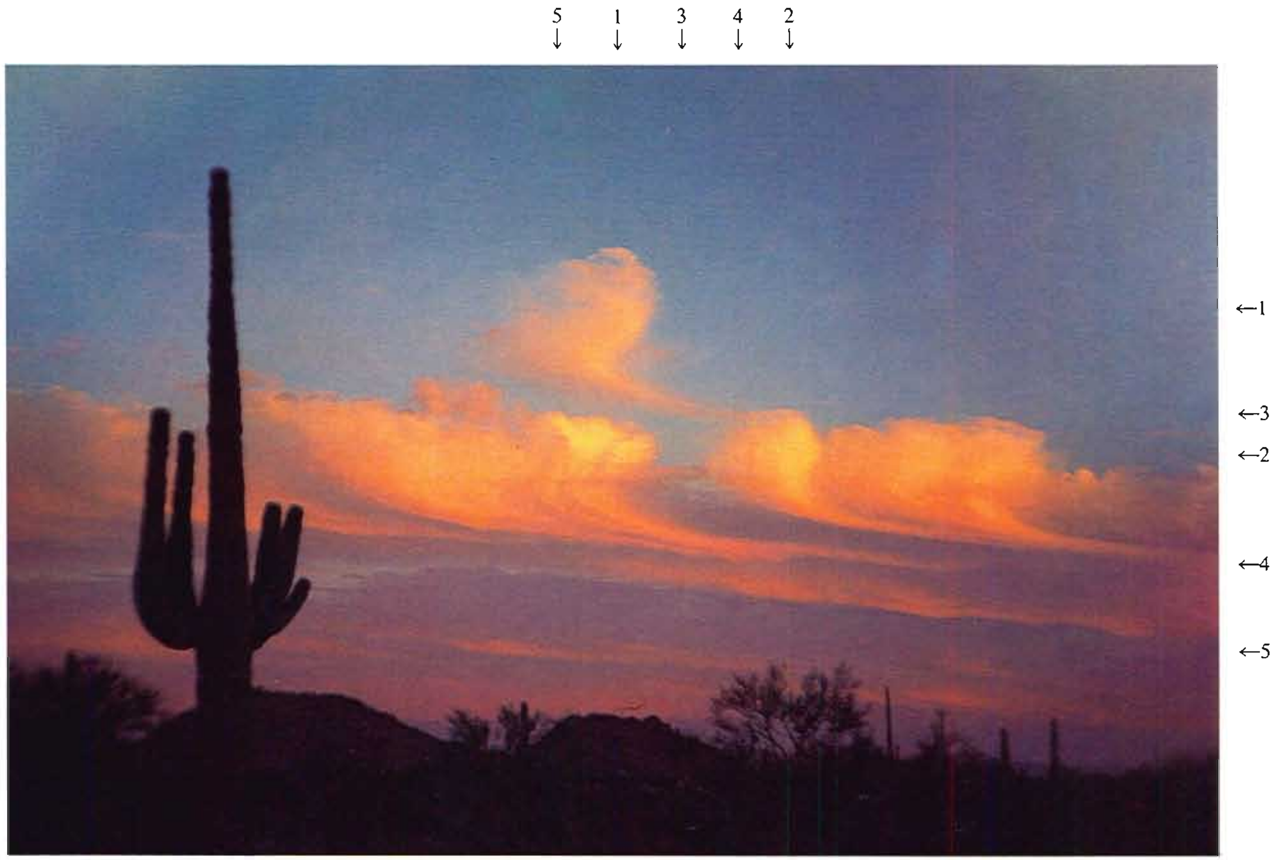


R. K. Pilsbury, Christchurch (Hampshire, U.K.), 25 October 1978, 1100 hours (towards W)

Cirrus spissatus with virga

These patches of Cirrus are very dense, and are therefore of the species spissatus. From below the patches at 1 and 2, there is a little virga trailing back in the lighter winds below the Cirrus level. The top of a Cumulus congestus, unrelated to the Cirrus, is visible at 3.
A stationary front was lying NW-SE about 300 km to the north-east, with an anticyclone building to the south-west.

$C_L = 2$, $C_M = 0$, $\mathbf{C_H = 2}$



R. A. Keen, Ajo (Arizona, U.S.A.), 20 October 1981, 1700 hours (towards SE)

Cirrus floccus

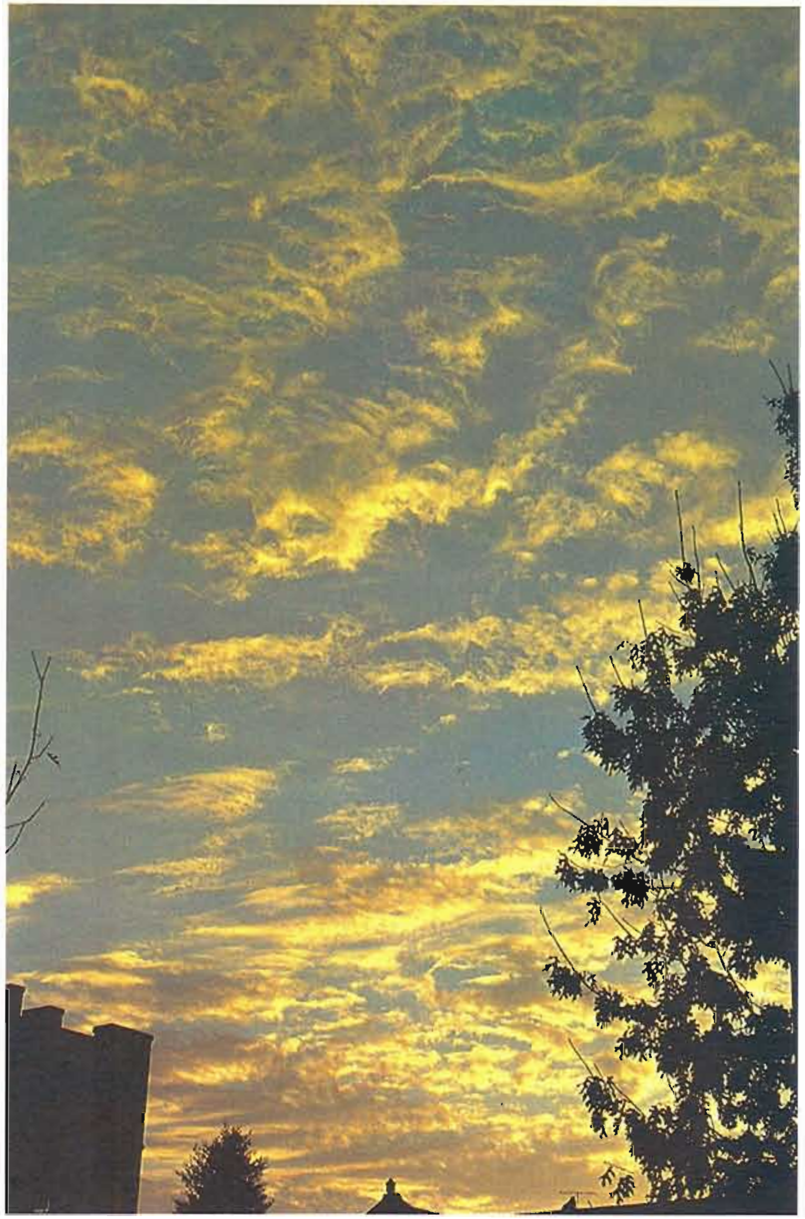
The Cirrus has the appearance of cumuliform tufts (1, 2) that are trailing streamers of falling ice crystals (3, 4), and therefore the Cirrus is classified as floccus. More distant floccus at 5 is mostly in the shadow of the foreground clouds.
Winds aloft were SW due to a stationary trough about 200 km to the west. Winds increased from 10 m s^{-1} at 500 hPa to 25 m s^{-1} at 250 hPa, all from the south-west. Thus, there was SW vertical shear, and the ice-crystal fallout trailed from the Cirrus tufts. Surface winds were light.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 2}$

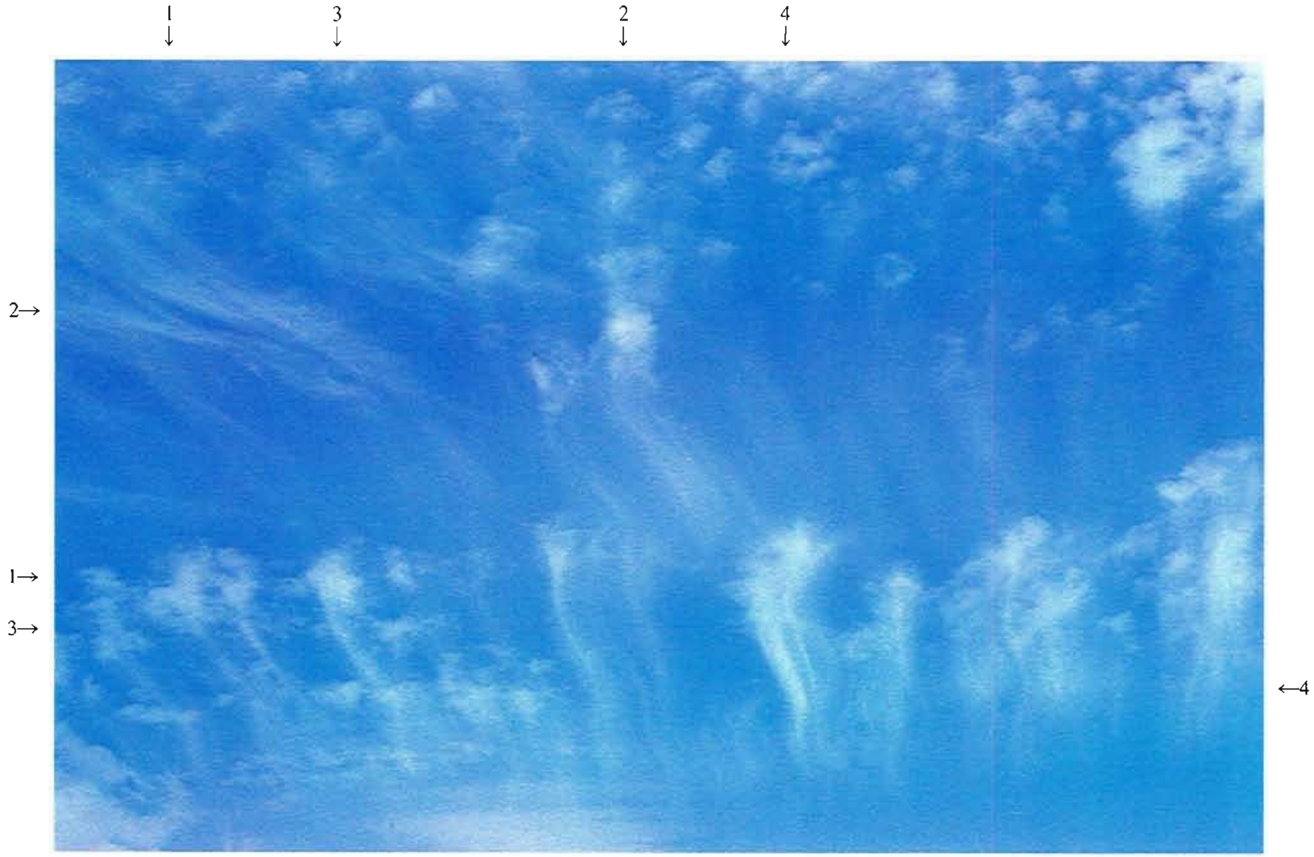
Cirrus floccus

Flocculent elements with soft, fibrous outlines are seen at 1. The elements at 2 are characterized by hard outlines, but appear to be at the same level as the more fibrous elements at 1. A patch of banded Altostratus (3) is seen low in the sky.
Central Oklahoma was on the northern side of a quasi-stationary ridge of high pressure aloft.

$C_L = 0$, $C_M = 1$, $\mathbf{C_H = 2}$



C. A. Doswell, Norman (Oklahoma, U.S.A.), January 1974, 1700 hours (towards SW)



A. Viaut, La Tranche-sur-Mer (France), 25 August 1952, 1418 hours (towards E)

Cirrus floccus with virga and Cirrocumulus floccus

Rounded tufts without shading and some of them very white (1, 2) are producing "showers" of ice crystals (3, 4) which the wind deforms into irregular filaments. Several of the elements appear to have a breadth of more than one degree and therefore cannot be called Cirrocumulus floccus but must be called Cirrus floccus.
The photograph was taken in a maritime polar air mass, north of a small depression in the Bay of Biscay.

$C_L = 0, \quad C_M = 0, \quad \mathbf{C_H = 2}$

C. A. Doswell, Palo Duro Canyon (Texas, U.S.A.), 28 June 1975 (towards SW)

Cirrus spissatus cumulonimbogenitus with Cumulus congestus

A dissipating Cumulonimbus (1) has left a small patch of Cirrus and is showing some remnant precipitation at 2. Other Cumulus (3) and Cumulus congestus (4) are forming along a N-S escarpment across the Texas Panhandle.
The area was in a south-easterly low-level flow ahead of a dry line. Later in the day, a much stronger Cumulonimbus developed just ahead of the eastward-moving dry line near this location.

$C_L = 2, \quad C_M = 0, \quad \mathbf{C_H = 3}$

Formation and dissipation of Cirrus spissatus cumulonimbogenitus

The four photographs on pages 98 and 99 show the formation of Cirrus spissatus by several Cumulonimbus along the east shore of the large inland Lake Okeechobee under easterly low-level flow. When the updraughts moved from the heated land to cooler water, they weakened and the upper portions persisted until only Cirrus remained.

(a) 1052 hours (towards WNW)
R. L. Holle, Pahokee (Florida, U.S.A.), 15 August 1973

In (*a*) the upper cirriform remains of a small Cumulonimbus have persisted in the ice form (1), while the water-droplet cloud beneath it has nearly disappeared at 2. On the left at 3, the top of the Cumulus updraught is beginning to become fibrous, indicating the formation of a new Cumulonimbus. Rain is falling at 4 from this cloud body. Another small Cumulus congestus has become detached from its lower cloud body at 5. Cumulus mediocris are seen across the horizon at 6.

$C_L = 9, \quad C_M = 0, \quad \mathbf{C_H = 3}$

(b) 1057 hours (towards WNW)
R. L. Holle, Pahokee (Florida, U.S.A.), 15 August 1973

In (*b*), five minutes later, the clouds have continued to mature and dissipate. The Cumulonimbus on the left (7) has become more fibrous at the top, and the smaller congestus on the right (8) has started to dissipate.

$C_L = 9, \quad C_M = 0, \quad \mathbf{C_H = 3}$

Further formation and dissipation of Cirrus spissatus cumulonimbogenitus

In (*c*), six minutes later, the Cumulonimbus on the left has begun to turn entirely to ice on top at 1 with virga at 2. The congestus on the right has almost completely disappeared with very little cirriform structure remaining (3), indicating that it was composed mainly of water.

$C_L = 9$, $C_M = 0$, $\mathbf{C_H = 3}$

(c) 1103 hours (towards WNW)
R. L. Holle, Pahokee (Florida, U.S.A.), 15 August 1973

Photo (*d*) was taken after another five minutes, or 16 minutes after the first photo (*a*). The Cumulonimbus on the left (4) has now assumed an appearance similar to that of the older Cirrus cloud at (5) in the first photograph. A new congestus tower is beginning to grow at 6, but it will also dissipate rather quickly as did these nearby clouds in this sequence.

$C_L = 9$, $C_M = 0$, $\mathbf{C_H = 3}$

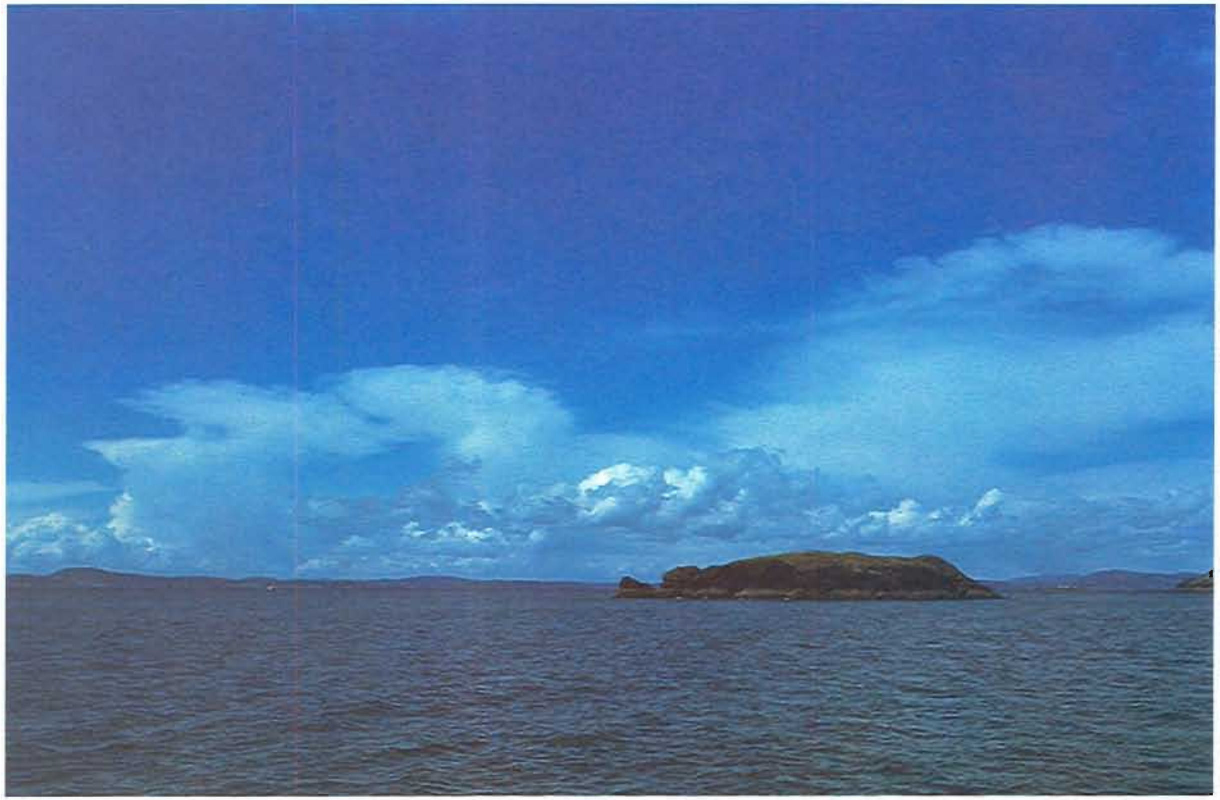
(d) 1108 hours (towards WNW)
R. L. Holle, Pahokee (Florida, U.S.A.), 15 August 1973

C. A. Doswell, Boulder (Colorado, U.S.A.), 29 June 1984 (towards NNW)

Cirrus spissatus cumulonimbogenitus with virga

The patch of Cirrus at 1 had its origins in weak showers from Cumulonimbus that developed early in the afternoon over the Front Range of the Rocky Mountains to the left (W). This shower is in the process of dissipation, and some light precipitation continues to fall as virga at 2. Other Cumulus congestus are located over the mountains at 3.
A weak ridge of high pressure was present aloft, with relatively low moisture content but a high lapse rate, typical of summer convection in Colorado. Another cycle of convection developed later in the afternoon.

$C_L = 2$, $C_M = 0$, $\mathbf{C_H = 3}$



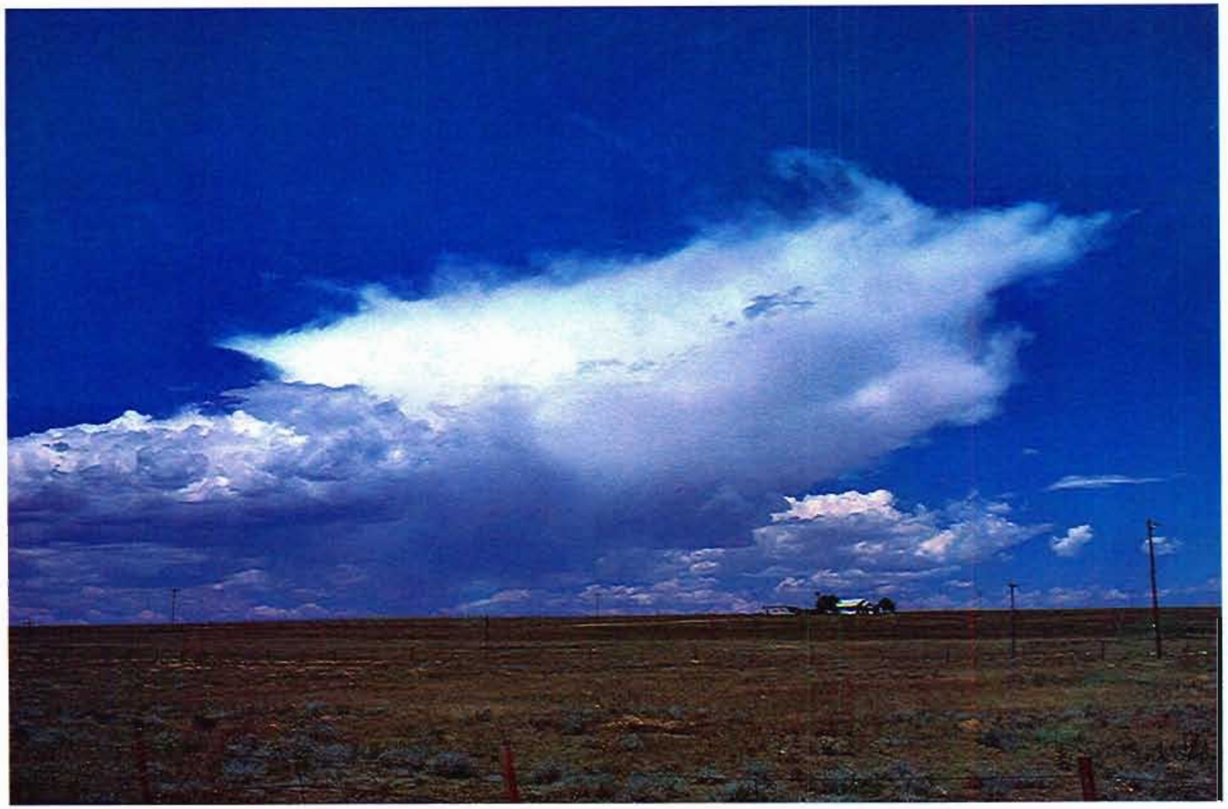
M. A. LeMone, near Deception Pass (Washington, U.S.A.), April 1970, 1500 hours (towards W)

Cirrus spissatus from Cumulonimbus

Several Cumulonimbus are in different stages of development in the photograph, the younger clouds (1) having a smaller anvil than the more widespread one (2) of the older clouds. The anvil at 3 is Cirrus spissatus cumulonimbogenitus, since it is detached from visible convection, but is clearly derived from convection, as are the other clouds visible at this time. Small Cumuli are seen at 4.

The Cumulonimbus were probably developing over the Olympic Peninsula and Vancouver Island to the west, supported by instability created by cold advection aloft.

$C_L = 9$, $C_M = 0$, $\mathbf{C_H = 3}$



S. M. Holle, Des Moines (New Mexico, U.S.A.), 30 July 1977, 1130 hours (towards NE)

Cirrus spissatus cumulogenitus with virga

This Cumulonimbus cloud has been almost completely converted from its earlier water-droplet form to an ice cloud. The fibrous upper part at 1 extends nearly to the base of the visible cloud, where a small area of updraught is visible at 2. Virga is nearly reaching the ground at 3 in this dry atmosphere.
The region was under the influence of dry lower levels and strong diurnal heating in the afternoon.

$C_L = 9, \quad C_M = 0, \quad \mathbf{C_H = 3}$

R. K. Pilsbury, South Cambridgeshire (U.K.), 3 November 1978

Cirrus uncinus with Cirrostratus

Tufts of Cirrus, above 1, are moving rapidly from lower right to upper left in a strong NW current aloft. Some tufts have hooks (2), and all have long trails below. As is often the case, the Cirrus in the distance above the setting sun appears to merge into Cirrostratus (3) and has thickened and lowered to Altostratus opacus near the horizon (4).
The increasing Cirrus heralded the approach of a fast-moving warm front to a depression 1500 km to the west.

$C_L = 0$, $C_M = 2$, $\mathbf{C_H = 4}$

H. B. Bluestein, Norman (Oklahoma, U.S.A.), 9 October 1977, early afternoon (towards N)

Cirrus uncinus radiatus

The Cirrus elements have a variety of shapes in this view. Cirrus uncinus at 1 shows the filaments terminating in hooks and tufts. Other portions of the cloud field have small patches (2) and streaks (3) which appear to converge toward the horizon in the lower left of the picture. The Cirrus is progressively invading the sky; no Cirrostratus is apparent, however, thus the coding is $C_H = 4$.
The location was under a strong (70 m s^{-1}) westerly jet. At low levels, a ridge axis was nearby, with cool NW winds to the east and a dry, southerly return flow to the west.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 4}$

J. H. Conover, Milton (Massachusetts, U.S.A.), 24 July 1948, 1850 hours (towards SW)

Cirrus uncinus

The characteristic appearance of uncinus is clearly visible. Some elements have the shape of a hook (1, 2); others are surmounted by a fairly dense tuft, elongated obliquely into a more or less tenuous fibrous trail (3, 4). On the whole, all trails are fairly parallel, but at some places (5) isolated trails are superposed in a more or less tangled network. Disturbances had been passing the station from the west along the northern border of the Bermuda anticyclone. The warm front of a new approaching depression was at a distance of 500 km.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 4}$

A. Viaut, Paris (France), 15 February 1951, 1610 hours (towards W)

Cirrus uncinus radiatus

The cloud elements have a fibrous structure as a whole, visible particularly at 1; as at 2, each major element is hooked at its upper (left) end, indicating that the Cirrus belongs to the species uncinus. In addition, the elements are fairly well aligned in bands (radiatus), which converge to a radiant point on the right, beyond the field of the picture. Owing to perspective, the clouds are close together near the horizon, but the filament structure is still clearly recognizable and it would not be correct to code the cloud system, which is invading the sky from west-south-west, as $C_H = 5$. The station was in maritime polar air, far in advance of an occlusion moving from the west-north-west. Up to the level of the Cirrus the winds were west-south-west.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 4}$

A. J. Aalders, Bussum (Netherlands), 30 December 1948, 1555 hours (towards SW)

Cirrus fibratus duplicatus

Cirrus fibres, white, more or less delicate, almost straight and silky in appearance, stretch in two main directions (1-2, 3-4) and are apparently arranged in two superposed layers (Cirrus fibratus duplicatus). Near the horizon the Cirrus clouds seem to agglomerate owing to the effect of perspective, but the filament structure is still discernible and even at 5-6 the sheet cannot yet be considered as Cirrostratus. The cloud system was progressively invading the sky and thickening as a whole. There is a flat patch of very low clouds in the distance near the horizon (mainly on the right-hand side of the photograph) and fragments (7) presumably related to it are seen in the foreground. It is very likely that these clouds are Stratus fractus of bad weather (surface wind 13 m s^{-1}).

From a depression north of Scotland, a cold front extended via the North Sea and England towards the south-west, with a wave forming south of Ireland. Pressure was falling rapidly over the Netherlands.

$C_L = 7$, $C_M = 0$, $\mathbf{C_H = 4}$

A. H. Boujon and R. Pommier, Port-Martin (Adélie Land, Antarctica), 25 December 1950, 0830 hours (towards NW)

Cirrus uncinus and Cirrostratus

The clouds are at two levels. The Cirrus, at the higher level, has a very thin filament structure (1, 2) with hooks (3, 4), so that the species is uncinus rather than fibratus. The cloud element at 4 verges on the variety intortus. The lower level is represented by patches of Cirrostratus (5, 6). The cloud system was invading the sky progressively. The station was at the border of a depression, the active part of which was to the north-west over the Antarctic Ocean.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 5}$

A. J. Aalders, Oud Loosdrecht (Netherlands), 16 September 1950, 1811 hours (towards W)

Cirrus and Cirrostratus thickening into Altostratus (with Altocumulus)

At the top of the picture (1), thin and somewhat fibrous Cirrus clouds merge with the thin, partly white sheet of Cirrostratus which occupies most of the photograph. This Cirrostratus merges at the bottom of the picture with a dark grey sheet of Altostratus which is partly striated and partly uniform. Projected against the Cirrostratus are some small- to medium-sized Altocumulus elements (2-3), dense enough to look dark.

A ridge of high pressure had dominated the weather, but at the time the picture was taken the pressure was falling, the wind backing and the cloudiness increasing with the approach of a very active disturbance (originally a tropical cyclone) over the British Isles (compare with pages 77 and 111).

$C_L = 0$, $C_M = 7$, $\mathbf{C_H = 5}$

C. A. Doswell, Norman (Oklahoma, U.S.A.), September 1976, 1500 hours

Cirrostratus

A sharply defined Cirrostratus edge extends from 1 to 2, with a pronounced band of optical thickening extending from 3 to 4. The Cirrostratus has passed overhead, and is moving into clear air. The sky therefore has a continuous veil of Cirrostratus more than 45 degrees above the horizon without being entirely covered, hence the coding $C_H = 6$.
A strong short-wave trough was approaching Oklahoma from the west.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 6}$

A. J. Aalders, Bussum (Netherlands), 17 September 1950, 0629 hours (towards ESE)

Cirrus fibratus and Cirrostratus

Clouds of the higher *étage* are invading the sky very slowly from the west. The cloud sheet now photographed in an easterly direction has advanced only slightly since the previous evening (compare with pages 77 and 109). The leading edge (1-2) has almost reached the eastern horizon. From there, Cirrus clouds, consisting of fibrous elements (fibratus), extend upwards in the picture, approximately to 3-4, where a continuous veil of Cirrostratus begins; this veil extends through the zenith to the western horizon. Thin, medium-sized, non-fibrous elements of Altocumulus are observed at the top of the picture (5-6).
A ridge of high pressure had dominated the weather, but since the previous evening pressure had been falling owing to the approach of a very active disturbance (originally a tropical cyclone) from the direction of the British Isles.

$C_L = 0$, $C_M = 3$, $\mathbf{C_H = 6}$

1
↓

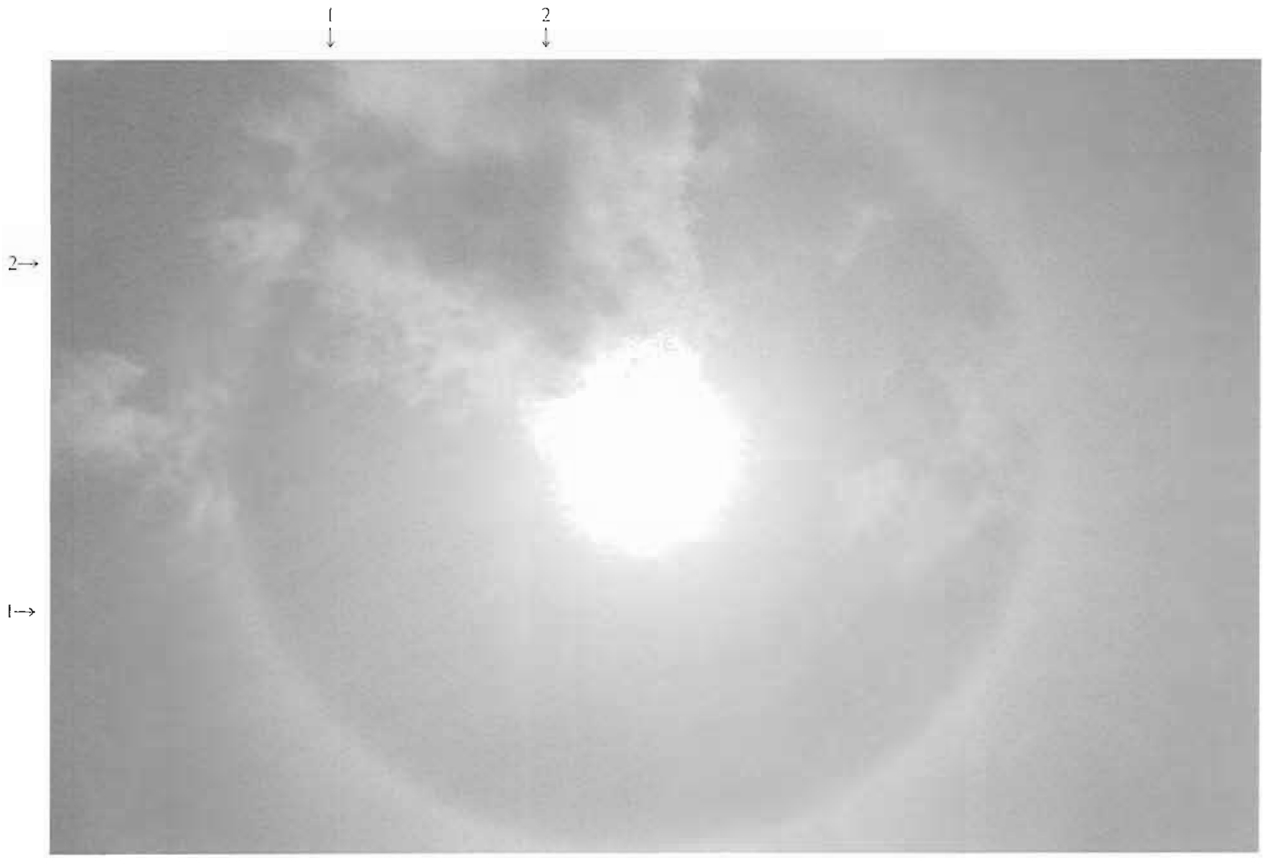
2→  ←1

H. B. Bluestein, Boulder (Colorado, U.S.A.), 10 January 1985, morning (towards SE)

Cirrostratus nebulosus

The sky is covered with a thin layer of Cirrostratus. The only indication of this thin but widespread layer is provided by the parhelion at 1 that is being produced by the sun, located just off the left side of the photograph at 2.
The location was in the lee of the Rocky Mountains in an undisturbed, moderate NW flow.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 7}$



R. L. Holle, Dakar (Senegal), 8 August 1974, 1000 hours

Cirrostratus translucidus fibratus

A uniformly thin veil of Cirrostratus covers the sky. It is sufficiently thin to show the sun's position, but illustrates its existence distinctly by the 22° halo surrounding the sun. Around 1, the fibrous nature of the cloud layer is shown faintly by an irregular pattern of curved filaments. The light of the sun is strong enough to cause shading variations in the Cumulus fractus at 2. The photo was taken in an area of extensive cloudiness to the east of a low-level vortex that had passed to the west-north-west across Dakar during the previous night.

$C_L = 1$, $C_M = 0$, $\mathbf{C_H = 7}$

H. B. Bluestein, Dillon (Colorado, U.S.A.), 5 January 1978, afternoon (towards W)

Cirrostratus fibratus

A thin veil of Cirrostratus covers the sky. Some striations in the Cirrostratus are visible as fibratus across the sky, as for example at 1. Darker, thicker striations are apparent from 2 to 3.
The clouds are located near the southern edge of a short-wave trough moving through the north-west of the U.S.A. The flow is moderately strong from the west, north of the main jet.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 7}$

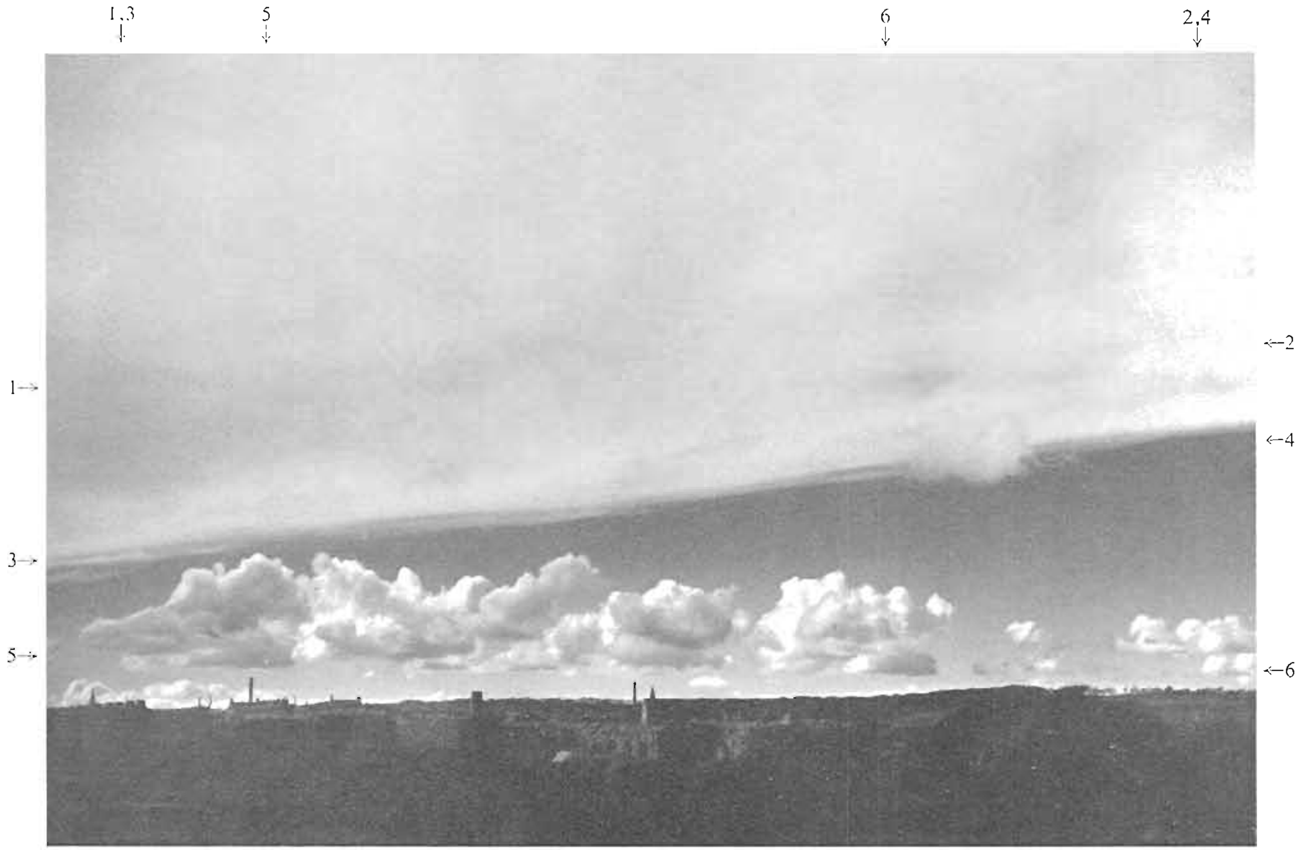
A. Viaut. Bruges (Belgium). 26 August 1951. 1616 hours (towards NW)

Cirrostratus fibratus with Altocumulus castellanus undulatus

After the passage of an occlusion the Cirrostratus fibratus, which covers the greater part of the sky, is decreasing, which calls for the coding $C_H = 8$. Under the main cloud layer, there are patches of Altocumulus (1, 2, 3, 4) of elongated form and broadly parallel to one another. The bulges at 5 and 6 indicate a convective character and presumably (note the shading) more such bulges are arranged on the common, slightly ragged bases, so that the clouds are properly called castellanus.

The occlusion was to the east of the point of observation, and had given rise to an intensive thunderstorm one hour before the photograph was taken.

$C_L = 0$, $C_M = 8$, $\mathbf{C_H = 8}$



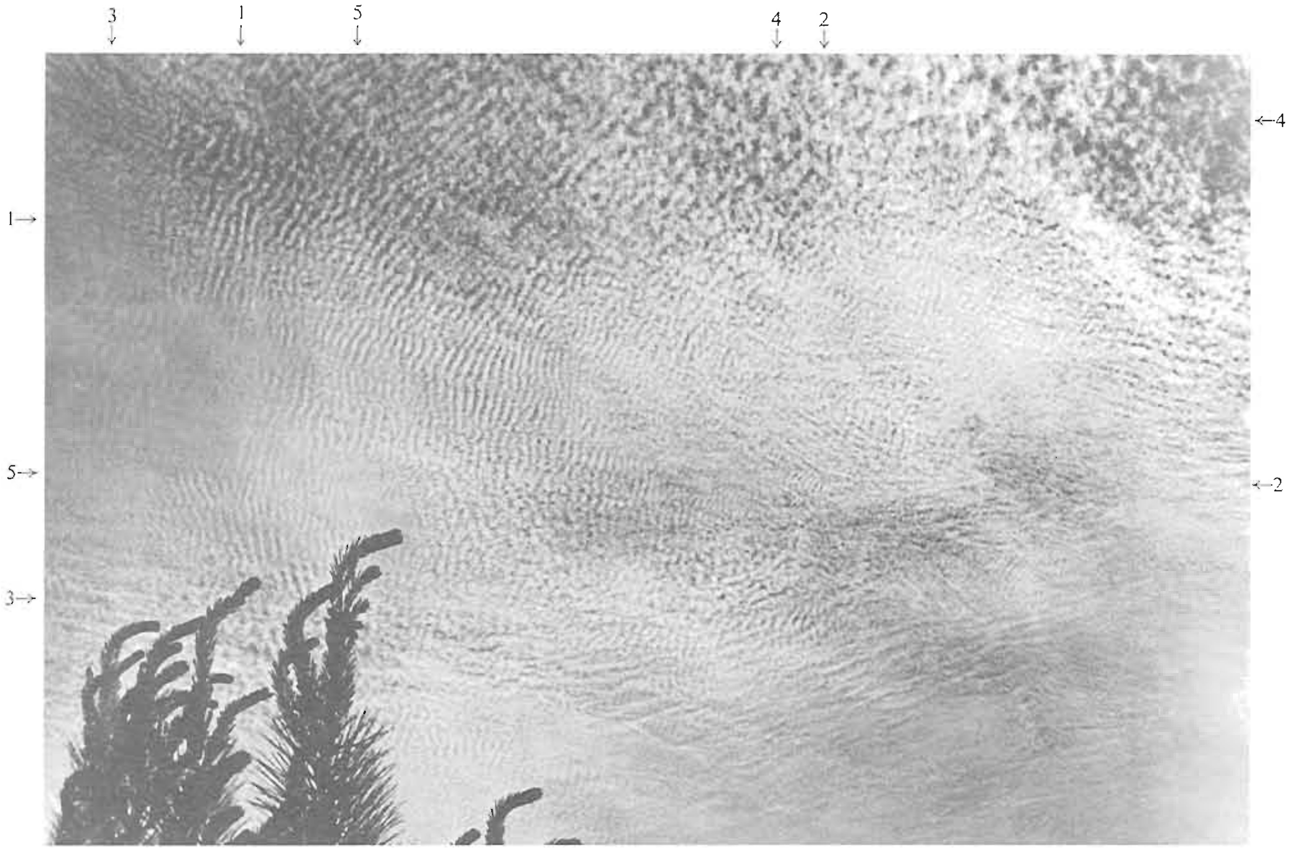
G. A. Clarke, Aberdeen (Aberdeenshire, U.K.), 1 April 1917, 1230 hours (towards W)

Cirrostratus nebulosus

A sheet of Cirrostratus (1-2) showing no structural details extends from the sharply outlined border (3-4) to the opposite horizon. The clear sector remains almost constant, which means that direction of motion of the sheet is parallel to the border. Some scattered Cumulus with moderate vertical extent have formed in the clear sector; they are seen in profile projected against the sky (5, 6).

The station was on the northern edge of a perturbation of the polar front, which, moving from the west, crossed Wales and England.

$C_L = 2$, $C_M = 0$, $\mathbf{C_H = 8}$



D. S. Hancock, Bognor Regis (Sussex, U.K.), 9 June 1935, 1358 hours (towards S)

Cirrocumulus stratiformis undulatus

The plate shows a typical example of Cirrocumulus, forming a nearly continuous extended layer (stratiformis). It has fine or very fine ripples (1 and 2), rounded elements more or less aligned in files (3), a lacunosus aspect (4) and also some fairly uniform areas (5).
The station was in the forepart of a thundery disturbance advancing from the south-west.

$C_L = 0, \quad C_M = 0, \quad \mathbf{C_H = 9}$

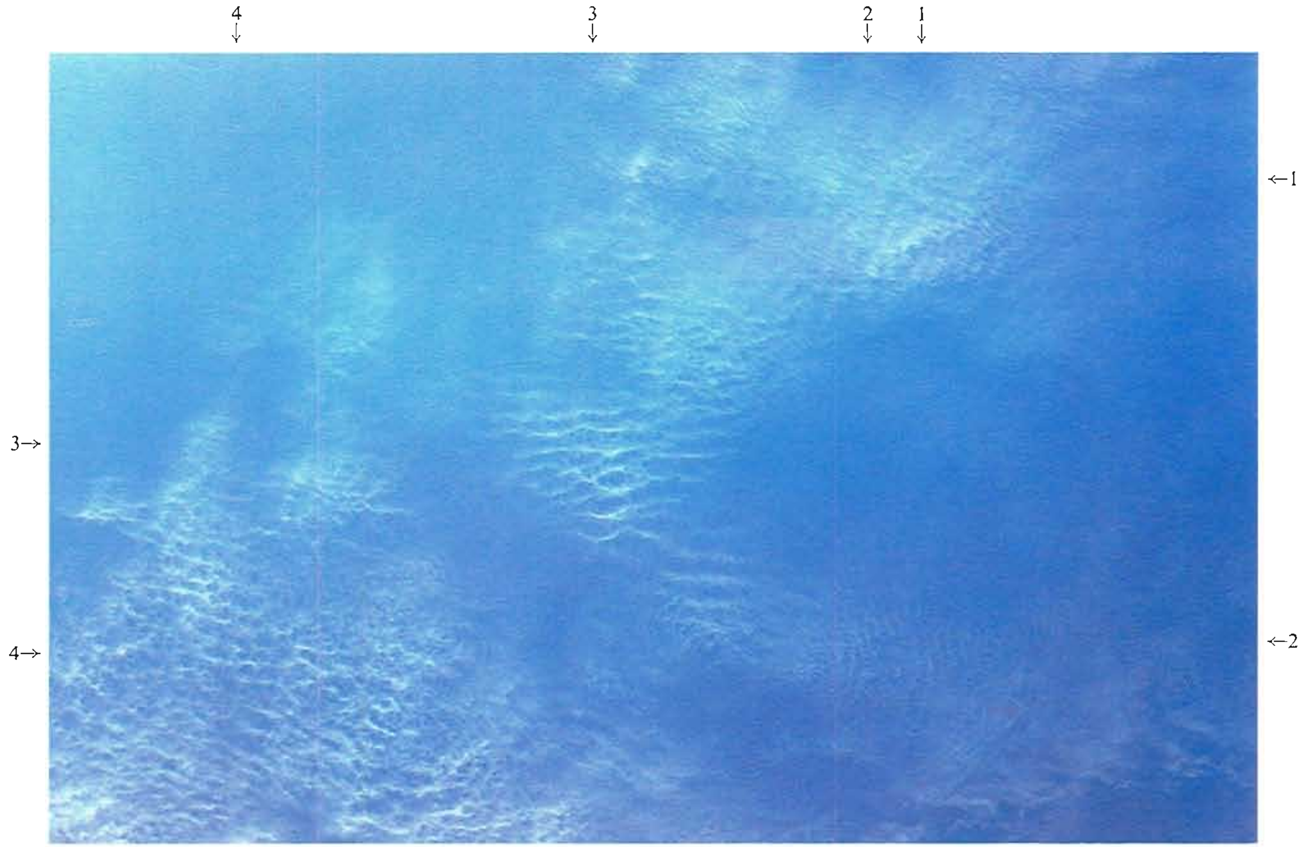
A. J. Aalders, Amsterdam (Netherlands), 19 May 1952, 1220 hours (towards SW)

Cirrocumulus stratiformis lacunosus

This extensive cloud sheet belongs, on account of its fineness and whiteness, to the genus Cirrocumulus. Small rounded elements without shading (1, 2) and ripples (3, 4) are visible almost everywhere. The lacunosus structure is evident from the numerous holes (5, 6). As often occurs in Cirrocumulus, some Cirrus fibratus (7) is merged with the patches.

This sky was associated with an old cold front which passed over the area slowly from the north-east. The front caused a temporary increase of cloudiness but no precipitation.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 9}$

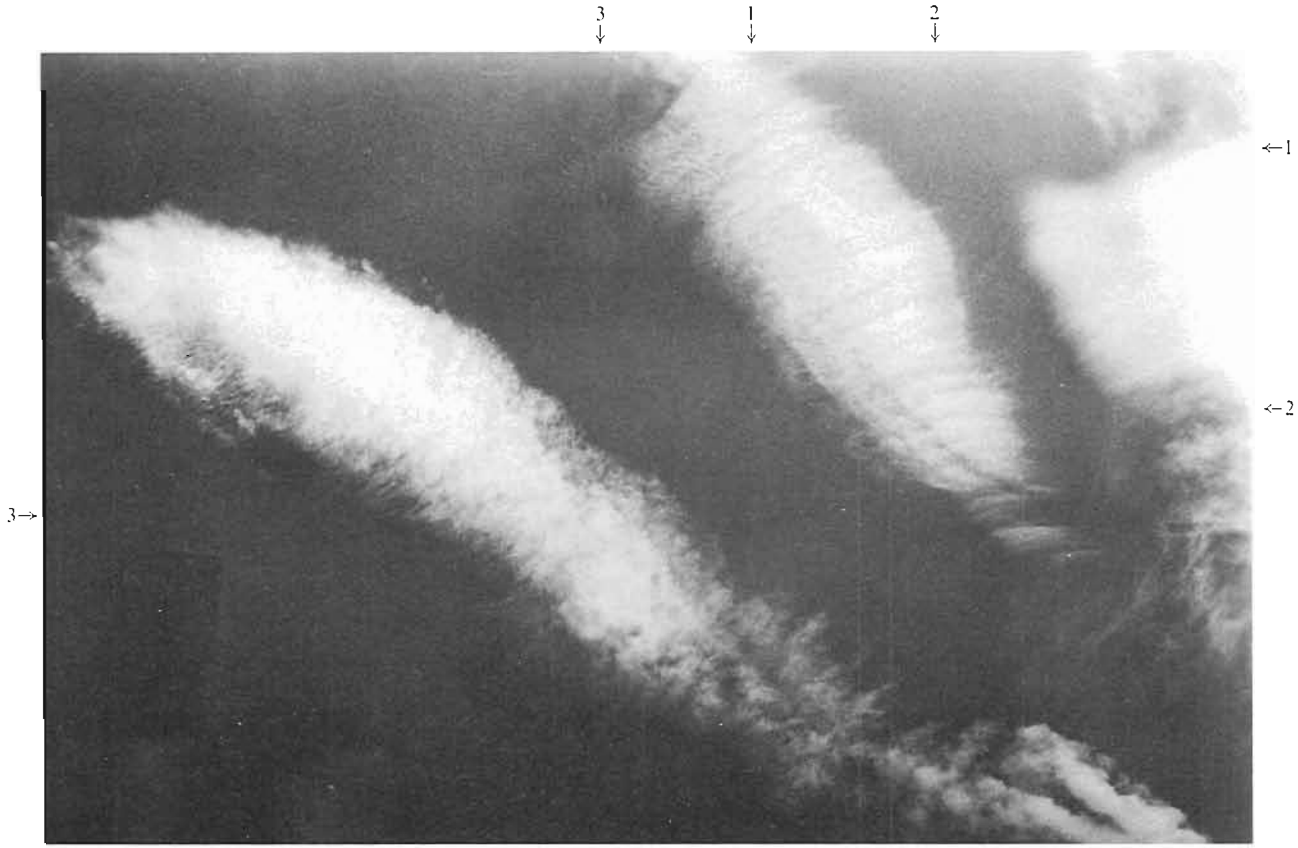


H. H. Larkin, Elma (New York, U.S.A.), 16 July 1949, 0842 hours (towards E)

Cirrocumulus stratiformis undulatus lacunosus

The major part of this Cirrocumulus sheet (species stratiformis) clearly shows (1, 2, 3) an undulated structure (variety undulatus). More or less round holes with fringed edges are visible in the cloud patch at 4. Cloud elements and clear spaces have a structure suggestive of a net or honeycomb.
The station was about 200 km north of an approaching warm front oriented W-E.

$C_L = 0$, $C_M = 0$, $\mathbf{C_H = 9}$



J. Mondain, Aspe Valley (France), 25 July 1938, 1030 hours (towards E)

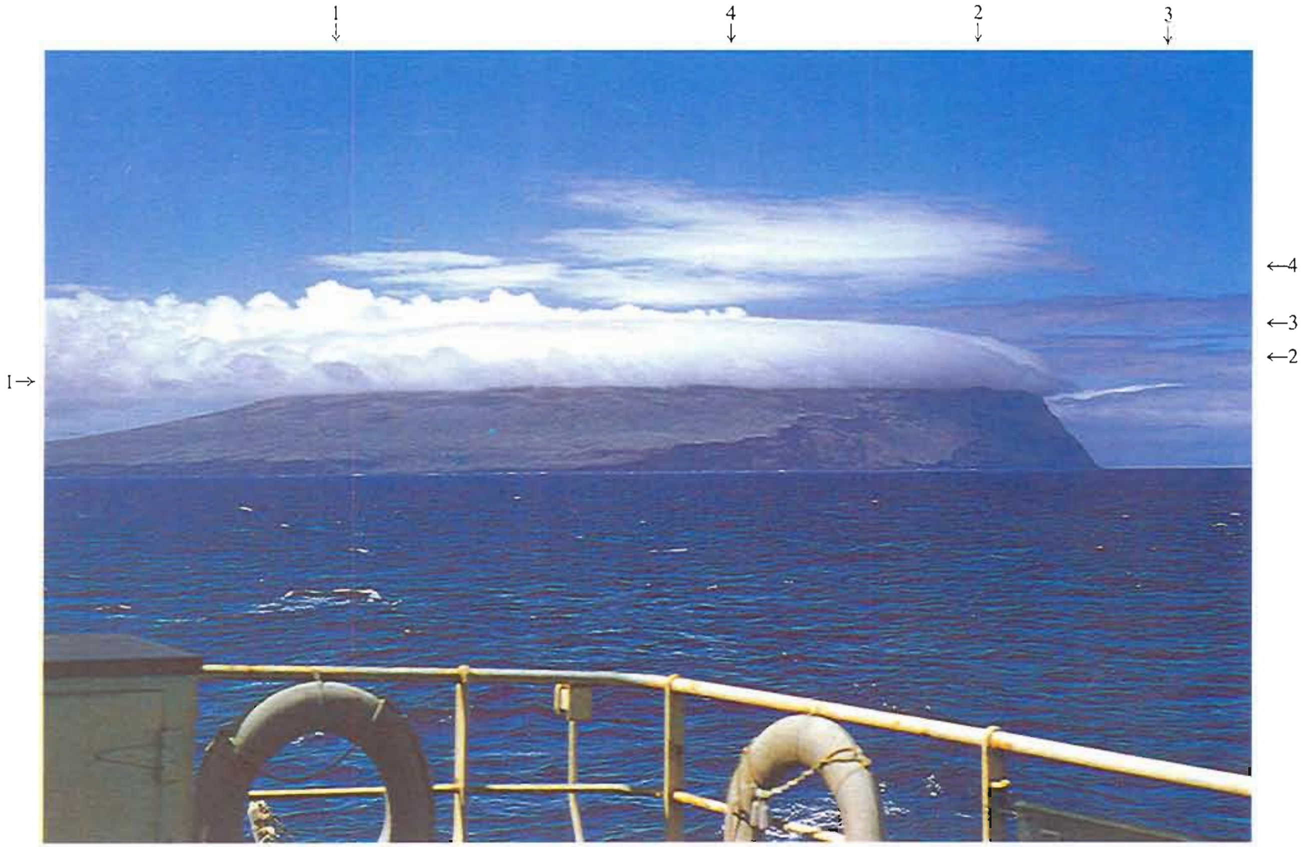
Cirrocumulus lenticularis

The clouds are characterized as Cirrocumulus by their whiteness, the absence of shading and the presence of fine ripples (1, 2) and small rounded elements (3). The patches have a shape which suggests more or less broadly that of a spindle or of a lens seen in profile.

Over central and southern France a low-pressure area (heat low) was developing in the maritime tropical air.

$C_L = 0, \quad C_M = 0, \quad \mathbf{C_H = 9}$

OROGRAPHIC CLOUDS



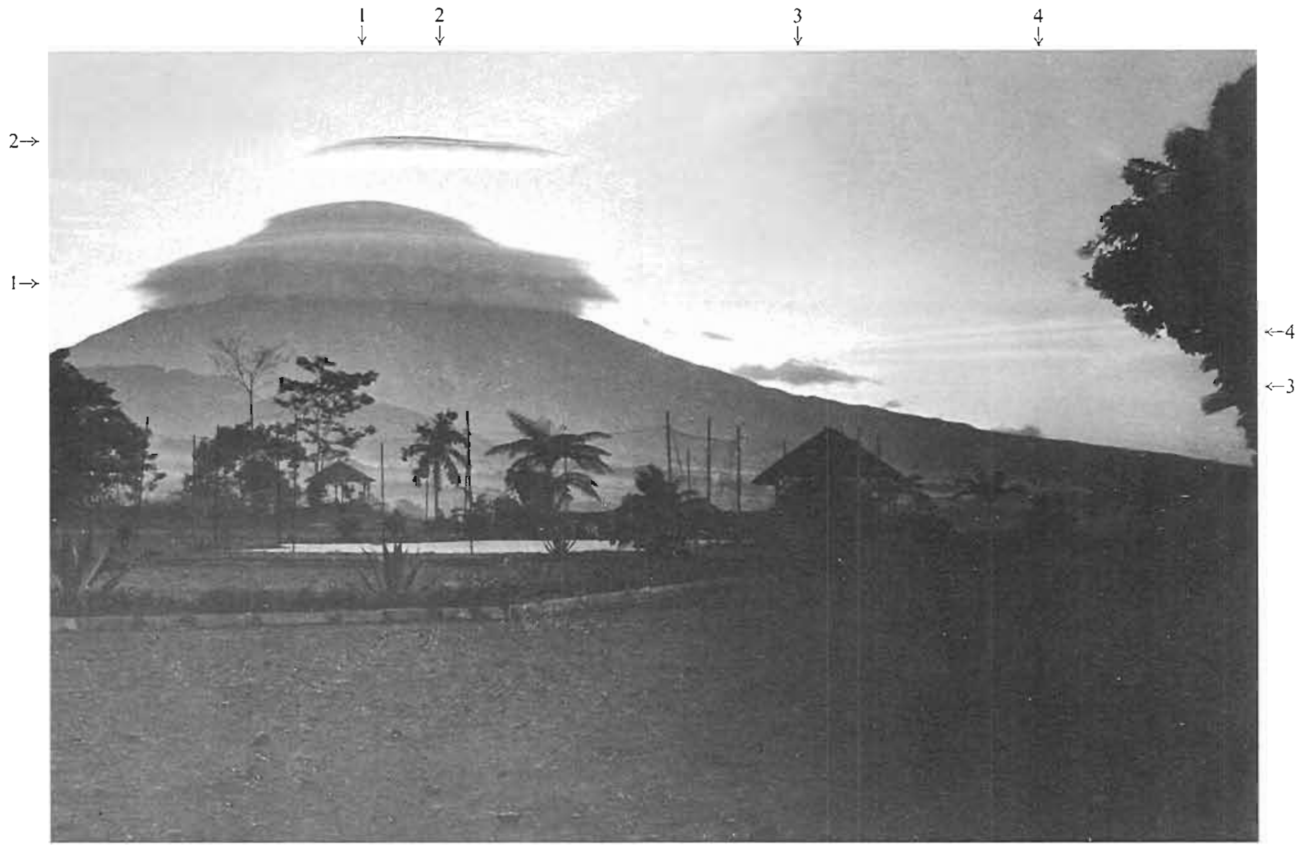
P. de Martin de Viviès, Amsterdam Island (37° 45′ S, 77° 25′ E), 6 February 1951, 0730 hours (towards S)

Conjoined orographic clouds

The patch of orographic Stratocumulus (1-2) has its base at 600 m and its upper surface at 1000 m. Cumuliform bulges emerging from this patch indicate some instability. Note that on the windward side (2) the base is particularly sharp and the bulges are not present, in contrast to the leeward side (1), where the bulges are conspicuous. Fibrous patches of lenticular Stratocumulus (3) and Altocumulus (4) are also present.

The picture was taken on the southern edge of an anticyclone centred over the 30th parallel. North-westerly surface winds brought somewhat unstable modified cold air over the island.

$C_L = 5$, $C_M = 4$, $C_H = 0$



S. W. Visser, Wonosobo (Java, Indonesia), 25 February 1924, 0615 hours (towards E)

Orographic cloud (cap)

The cloud mass (1) around the top of the volcano Sumbing, which is about 2500 m above the surface of the tennis-court in the foreground, is composed of a pile of numerous thin sheets. Each sheet has the shape of a cap. The mass appears stationary: actually, condensation in the west monsoon on the windward side (left side of the picture) and evaporation on the leeward side are constantly going on. Altocumulus lenticularis also due to forced ascent of air is seen above the top, at 2. The picture shows, in addition, some lower Stratocumulus at 3 and some Cirrus fibratus at 4.

$C_L = 5$, $\mathbf{C_M = 4}$, $C_H = 1$

1→  ←1

J. M. Brown, Boulder (Colorado, U.S.A.), 11 May 1979, 0700 hours (towards WNW)

Cumulus fractus

Cumulus fractus at 1 is topping and partly obscuring the Continental Divide of North America (elevation about 4000 m above mean sea-level). These clouds are the eastern limit of a patch or layer of Stratocumulus lying over valley areas west of the N-S mountain range.

This Stratocumulus was at the top of cool, moist air remaining from a deep marine polar air mass which had invaded the area a few days earlier. The air mass above was quite dry. Broad-scale airflow at mountain-top level was from the north-west at about 10 m s^{-1}.

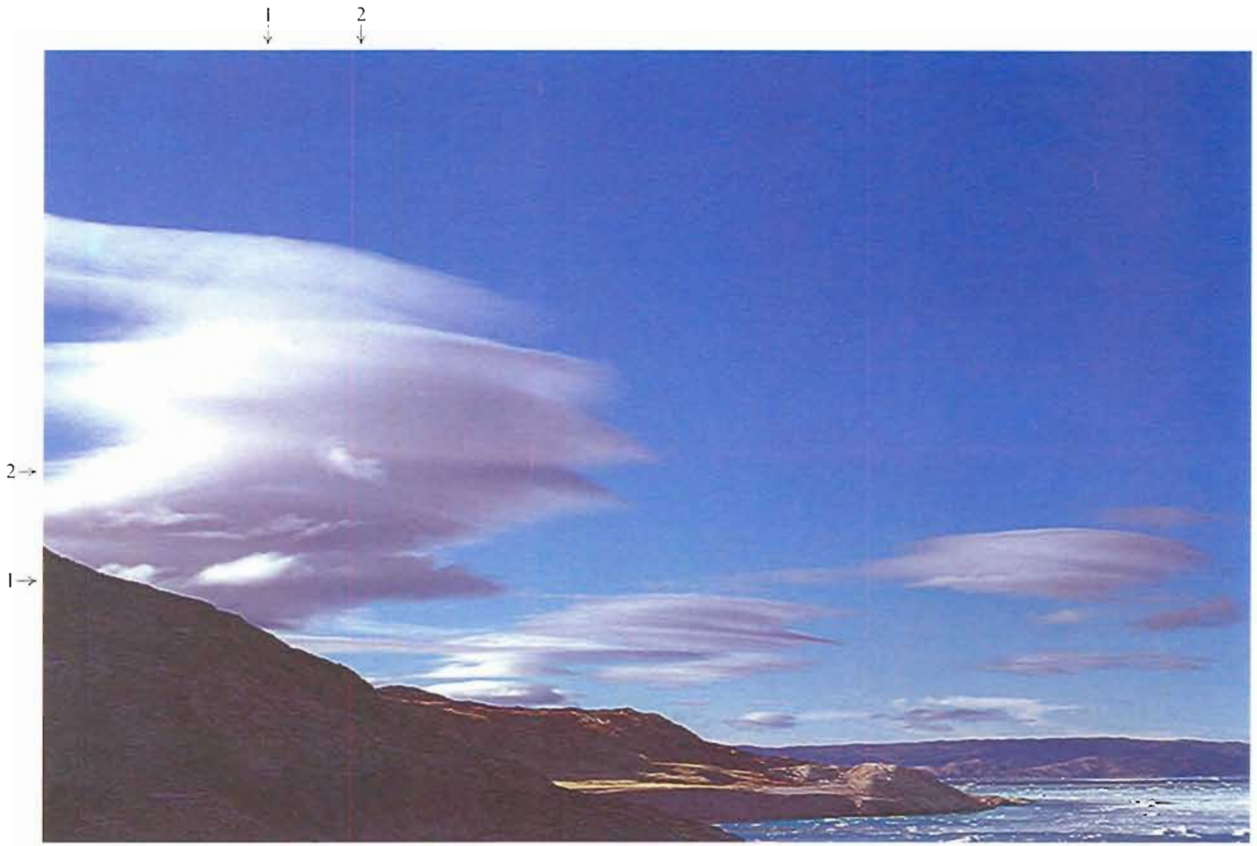
$$\mathbf{C_L = 1}, \quad C_M = 0, \quad C_H = 0$$

C. S. Patterson, Bishop (California, U.S.A.), 16 February 1952, 1415 hours (towards S)

Föhn wall, rotor clouds and orographic Altocumulus lenticularis

The föhn wall on the right (1-2) is on the crest of the Sierra Nevada mountains. Westerly winds with speeds of 25 m s^{-1} were sweeping across the range, causing a wave on the lee side, made visible by the lenticular Altocumulus (3); cumuliform rotor clouds are present at 4.

$\mathbf{C_L = 2}$, $\mathbf{C_M = 4}$, $C_H = 0$



P. Stahl, Greenland (69° 45′ N, 50° 16′ W), 23 September 1951, 1500 hours (towards SW)

Orographic Stratocumulus and Altocumulus (wave clouds)

Except for some Cumulus fractus at 1 and 2 and near the horizon, all cloud patches show a lenticular form with fibrous margins. The darker clouds, being rather heavily shaded, belong to the genus Stratocumulus; the lighter clouds are Altocumulus. A foliated structure is visible in various places. These typical orographic clouds are often observed on the west coast of Greenland, with wind blowing from the inland ice towards the sea.

On this particular day there was a high over east Greenland, while pressure was relatively low over Baffin Bay and the Davis Strait. At the station, the sea-level wind was light from the south-east, the temperature relatively high (10°C) and the relative humidity low (30 per cent).

$\mathbf{C_L = 8}$, $\mathbf{C_M = 4}$, $C_H = 0$

J. M. Brown, Boulder (Colorado, U.S.A.), 25 January 1984, 1000 hours (towards W)

Cumulus fractus and Altocumulus lenticularis

The Continental Divide of North America, 30 km to the west, is obscured by a föhn wall (1), which is the eastern edge of an extensive layer of Stratocumulus over a valley west of the Continental Divide. The föhn wall is shaded by the Altocumulus lenticularis opacus, the western edge being at 2 to 3. This Altocumulus was associated with a vertically propagating mountain wave. Aircraft measurements indicated that the base of the Altocumulus was at 350-400 hPa, and the top near 250 hPa. Surface winds at the time of the photo were westerly, gusting to 15-20 m s^{-1}. Broad-scale airflow at the height of the Continental Divide (about 4 000 m) was from WNW at 12 m s^{-1}.

$$\mathbf{C_L = 1}, \quad \mathbf{C_M = 2}, \quad C_H = 0$$

A. Viaut, Geneva (Switzerland), 25 September 1952, 1345 hours (towards E)

Orographic Stratocumulus

Beneath a veil of Cirrostratus which had recently thickened and which covered the whole sky when the picture was taken, there are patches of rather dark orographic clouds (1, 2). They are of elongated lenticular shape with ends either frayed, as at 3, or irregularly saw-toothed, as at 4. The height of the lenticular clouds is between 500 and 1 500 m. On account of their low height and dark appearance they should be called Stratocumulus rather than Altocumulus. Cumulus fractus clouds are also observed (5).

This photograph was taken in maritime tropical air about 200 km in advance of a cold front with which the Cirrostratus was associated. The Stratocumulus were formed in the brisk westerly current (12-15 m s^{-1}) blowing over the mountain ridges, oriented SW-NE, visible in the picture.

$\mathbf{C_L = 8}$, $C_M = 0$, $C_H = 7$

J. M. Brown, Boulder (Colorado, U.S.A.), 19 June 1979, 1200 hours (towards SW)

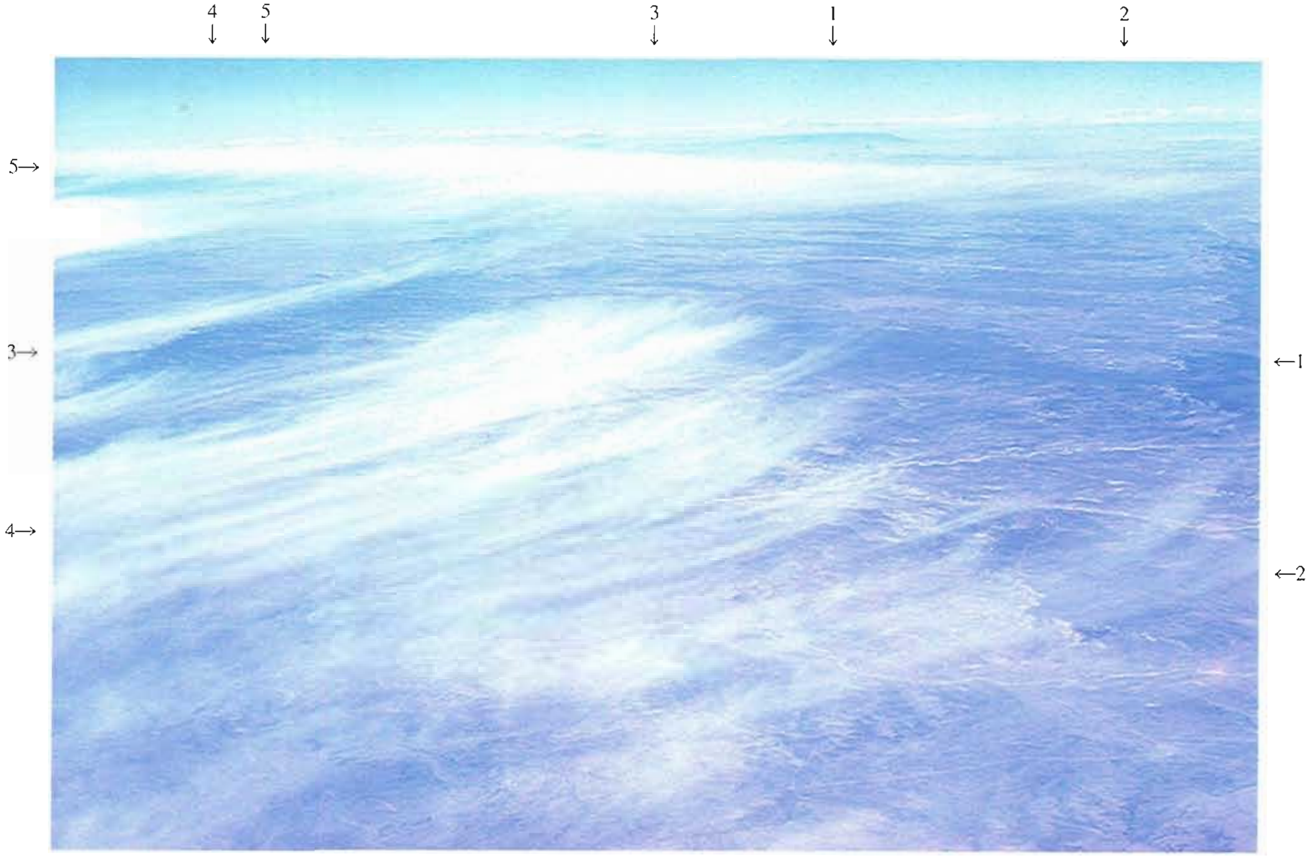
Cumulus fractus, Cumulus humulis and Altocumulus

Cumulus fractus and humilis at 1 and 2 are shown in an ill-defined band. These are associated with a rotor downstream of the Continental Divide of North America, which is oriented N-S 30 km to the west of the photo location. Cumuli associated with the next downstream rotor are visible at 3 and 4. Altocumulus produced by a vertically propagating mountain wave is visible at 5 and 6. This cloud lacks a lenticular appearance, appearing rather to be turbulent.

Surface winds at the time of the photo were occasionally gusting as high as 25-30 m s^{-1} from the west (downslope). A major upper-tropospheric trough was centred over the area and moving eastward. The broad-scale flow at the level of the top of the Continental Divide was from WNW at 12-15 m s^{-1}.

$\mathbf{C_L = 1}$, $\mathbf{C_M = 4}$, $C_H = 0$

CLOUDS AS SEEN FROM AIRCRAFT



R. L. Holle, above north-western part of New Mexico (U.S.A.), at 9500 m, 25 January 1981, 1400 hours (towards W)

Cirrus terminating in hooks and tufts

This illustration depicts a single layer of the species uncinus. The nearly-white, delicate filaments terminate at the top in small hooks (1, 2) or tufts (3). Long trails streak away behind the tops in parallel lines (4). The Cirrus is thin enough to allow the underlying arid terrain to be seen through most of the clouds. Cirrus in the distance (5) appears to be more dense, but this is due to perspective, as the cloud elements are similar to the ones in the foreground.

The photograph was taken 800 km west of a cold front which had passed through the region the previous day. Winds were strong, westerly, at the aircraft's flight level.

A. J. Aalders, above the North Sea, close to the coast of the Netherlands, at 3 000 m, 19 July 1949, 1621 hours (towards W)

Continuous mainly stratiform cloud layer

The layer of Altocumulus, altitude of top 2 900 m, stretching from the aircraft to the horizon, is penetrated in places (1) by tops of Cumulus congestus.

There was a ridge of high pressure over the British Isles and pressure was low over southern Scandinavia. The aircraft was flying in a north-westerly current of polar air, rather unstable in the lower layers, but with a marked inversion at flight level (—5.5°C at 2 900 m, —2.0°C at 3 100 m). Isolated showers were observed at the surface.

Capt. W. Kunikawa, All Nippon Airways, over the sea north-east of Shionomisahi (Japan), at 6000 m, 14 August 1978, 1400 hours

Lenticular Altocumulus with Cumulus and Cirrostratus

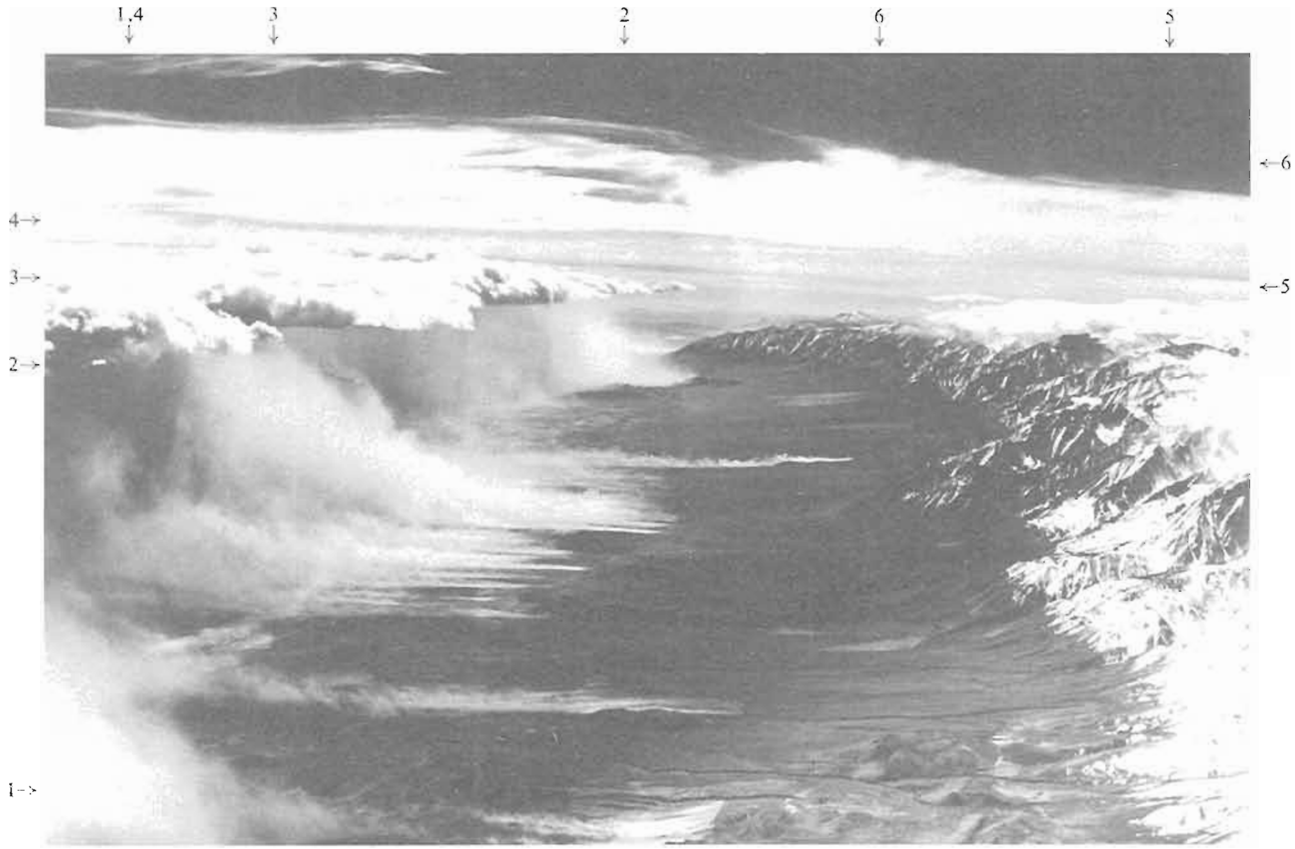
This picture shows Altocumulus lenticularis which has formed on the leeward side of the Kii Mountains. Several individual lens-shaped cloud elements can be seen one above the other at 1, 2, 3. These clouds are frequently observed over mountainous or hilly regions where they form at the crests of stationary waves in currents of moist air. They may sometimes envelop a mountain peak. Altocumulus lenticularis may occasionally be produced by relatively small ridges over low land. The illustration also shows the bulging tops of Cumulus congestus (4) and a layer of Cirrostratus nebulosus (5).

A surface ridge of high pressure extended over Shionomisaki from a large anticyclone over the North Pacific Ocean. Surface winds were light from east-north-east, while the middle-level air flow was light southerly.

R. F. Reinking, above the Rocky Mountains (Colorado, U.S.A.), at 6000 m, 17 December 1973, about 1500 hours (towards SE)

Orographic Altocumulus and Altostratus (standing lee waves)

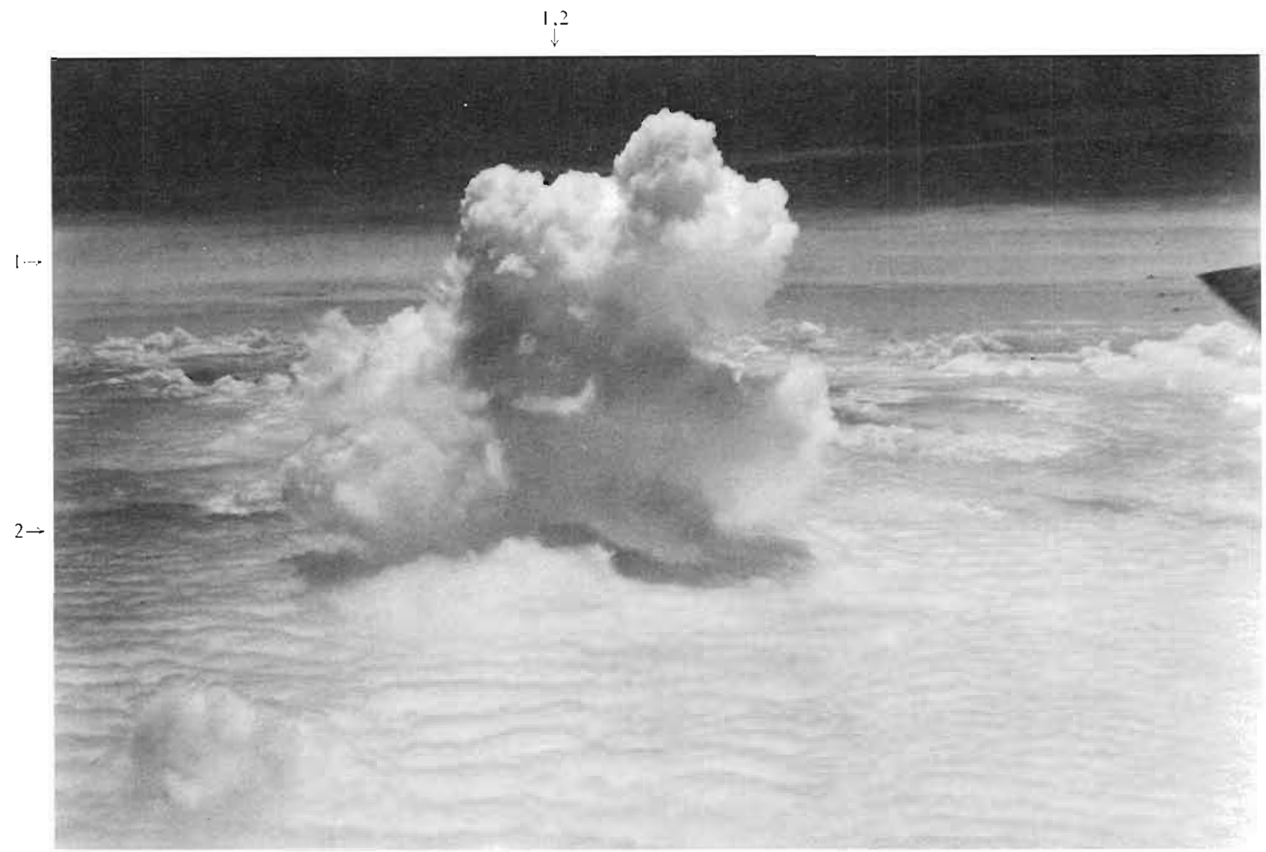
Wave clouds of two types are illustrated in this photograph. Thin altostratus at flight level can be seen at 1. These clouds were stationary and their shape is indicative of the orographic forcing from the mountains. The Altocumulus lenticularis clouds (2, 3) below the aircraft were produced by the mountains which lie behind the observer. Pikes Peak (4300 m) can be seen at 4. Low pressure was located to the east (leeward) and high pressure to the west (windward), and combined to produce a steep pressure gradient and strong winds across the mountains. The mountain barrier is oriented NNW-SSE.



R. Symons, Bishop (California, U.S.A.), altitude 9800 m, 5 March 1950 (towards S)

Orographic clouds

From the snow-capped Sierra Nevada mountains on the right the westerly winds (at 700 hPa SW, 15 $m\ s^{-1}$) swept into the valley, creating a dust-storm and a dust-wall (1-2), which reached up to the rotor cloud (3) on the left. From 4 to 5 there are lenticular Altocumulus, also formed by the wave ascent of the air in the lee of the mountains. Cirrostratus is also present in the distance (6).



Anonymous, India (24° N, 76° E), at 12000 m, 3 September 1951, 1235 hours (towards S)

Continuous stratiform cloud layer penetrated by isolated towering Cumulonimbus

A layer of Altocumulus stratiformis undulatus is penetrated by some tops of Cumulus congestus and by towering Cumulonimbus calvus (1). The peculiar mushroom-form of the top of the latter, which penetrated to an altitude well over 12000 m, is remarkable; it shows a constriction at 2, where the sun, almost in the zenith, casts a dark shadow on the Altocumulus.

The aircraft (BOAC "Comet") was flying over a rain area associated with a trough of low pressure over central India, from the Punjab to Ceylon. Thunderstorms with 180 mm of rain within 12 hours were observed over this region.

E. J. Zipser, above eastern Senegal (14° 45′ N, 13° 45′ W), at 3200 m, 5 September 1974, 1409 hours (towards W)

Stratiform cloud above flight level

This photograph illustrates a thick layer of Altostratus (1), from which snow turning to rain is falling, above the flight level of the aircraft. The Altostratus has originated from Cumulonimbus clouds 250 km to the south (left edge of picture) and terminates 110 km ahead. Distant Cumulus (2) can be seen even farther ahead. The precipitation is heaviest (3) in the direction of the generating Cumulonimbus, as indicated by the bright strip of sky (4) sloping downward in that direction. The base of the Altostratus is about 5000 m with the falling snow turning to rain 1000 – 1500 m above the aircraft. The satellite-inferred top of the mother-cloud is 12000 m.

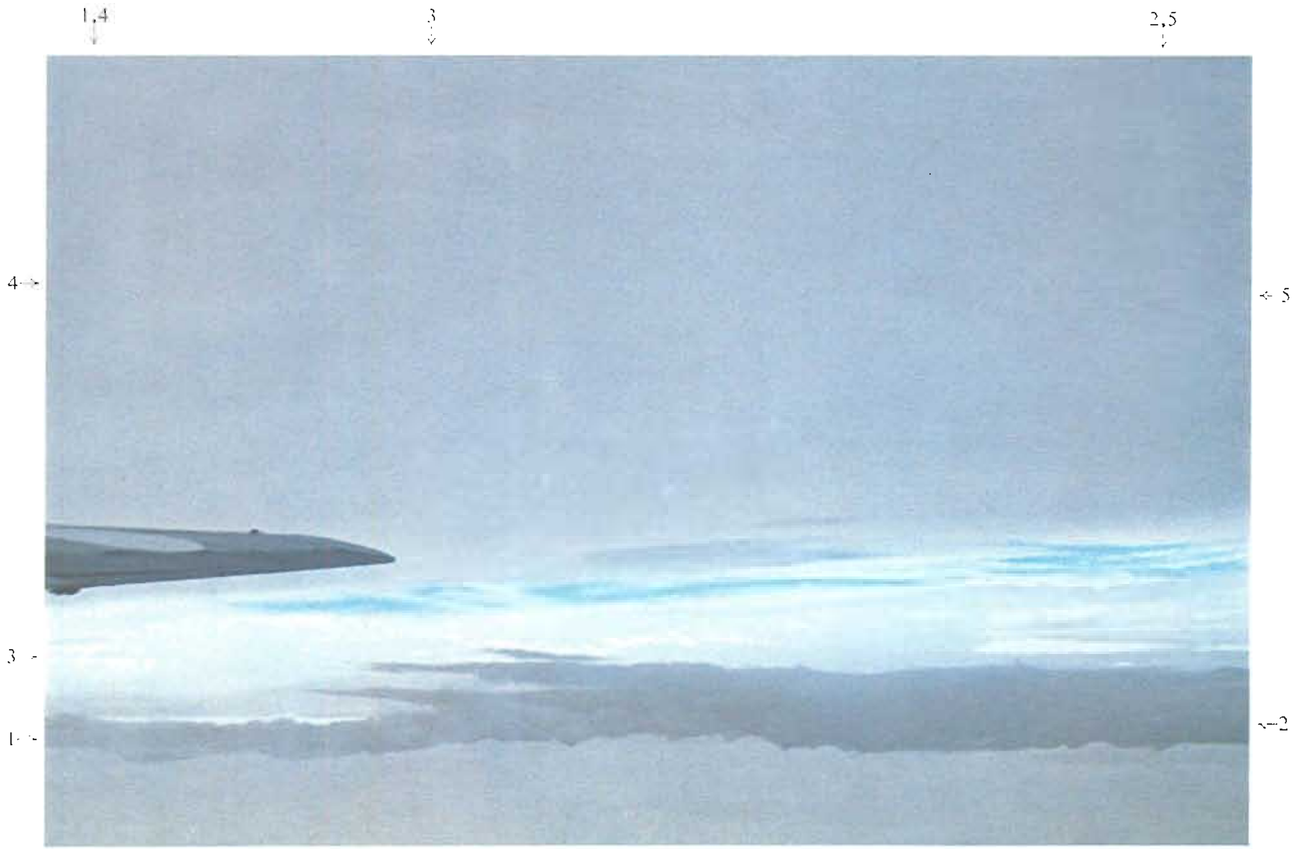
Dull, featureless skies do not lend themselves to good photographs, but Cumulonimbus, from which this Altostratus originated, is of great importance as a rainfall producer in moist tropical areas. A squall line with anvil Cumulonimbus was near the trough of a wave in the easterly air flow, oriented NE-SW. Similar cloud systems are often associated with other types of weather system.

A. J. Aalders, northern part of the Netherlands, at 1750 m, 12 December 1949, 1415 hours (towards NW)

A. J. Aalders, northern part of the Netherlands, at 1750 m, 12 December 1949, 1420 hours (towards NW)

Broken, mainly stratiform layer of clouds

This Stratocumulus had its base at 1000 m and its top at 1650 m. The layer is rather compact, though with large openings in the upper picture, where the Stratocumulus looks like a "sea of clouds". In the lower picture the layer appears to be disintegrating, as indicated by the frayed protuberances (1) and frayed fragments between the rounded elements.
The Altocumulus and Cirrus fibratus, clearly seen in the upper picture, indicate the approach of a marked warm front from the west-north-west (distance 600 km). The aircraft was flying in maritime polar air.



A. J. Aalders, above the province of South Holland (Netherlands), at 1950 m, 17 March 1950, 1449 hours (towards W)

Broken layers of mainly stratiform clouds

Below the aircraft, from 1 to 2, there is a layer of Stratocumulus stratiformis, dark in the background, somewhat lighter in the foreground; the layer is not completely continuous and shows some thin elongated patches (3). Above the flight level dense Altostratus opacus (4-5) is observed, with some elongated openings. The picture was taken immediately after the passage of a cold front oriented SW-NE which was moving in a south-easterly direction. There was rain at the surface, but no precipitation was observed at flight level.

A. J. Aalders, above IJsselmeer (Netherlands), at 2 000 m, 5 December 1951, 1029 hours (towards SE)

Stratiform clouds: below flight level isolated field in distance, above aircraft broken layer

The cloud sheet below the flight level (1, 2) (base 1 400 m, top 1 600 m), being non-fibrous and subdivided into fairly distinct parts, is Stratocumulus. The amount of cloud is sufficiently small to justify calling it scattered.
The narrow banded cloud layer above the aircraft, being lumpy and non-fibrous, yet dense enough in parts to show shading, is Altocumulus.
There was a strong WSW current over the area (surface winds 20 m s^{-1}), with an advancing cold front stretching SW-NE over the North Sea and England, at a distance of about 250 km.

Royal Australian Air Force, Port Stephens (New South Wales, Australia), 8 October 1943

Stratocumulus (roll cloud) under Altostratus

This is a special type of sky, usually accompanying a "burster" or squall from south to south-south-west with an invasion of polar air. In the upper part of the picture the frontal Altostratus is observed; across the middle is seen the typical isolated roll cloud, belonging to the genus Stratocumulus.
The base of the roll cloud, which lay N-S parallel to the coast, was at 450 m. Rain was observed beneath the cloud. Turbulence was light under and in the cloud.

Capt. W. Kunikawa, All Nippon Airways, over the Akaishi Mountains (Japan), at 9000 m, 9 December 1978, 1330 hours

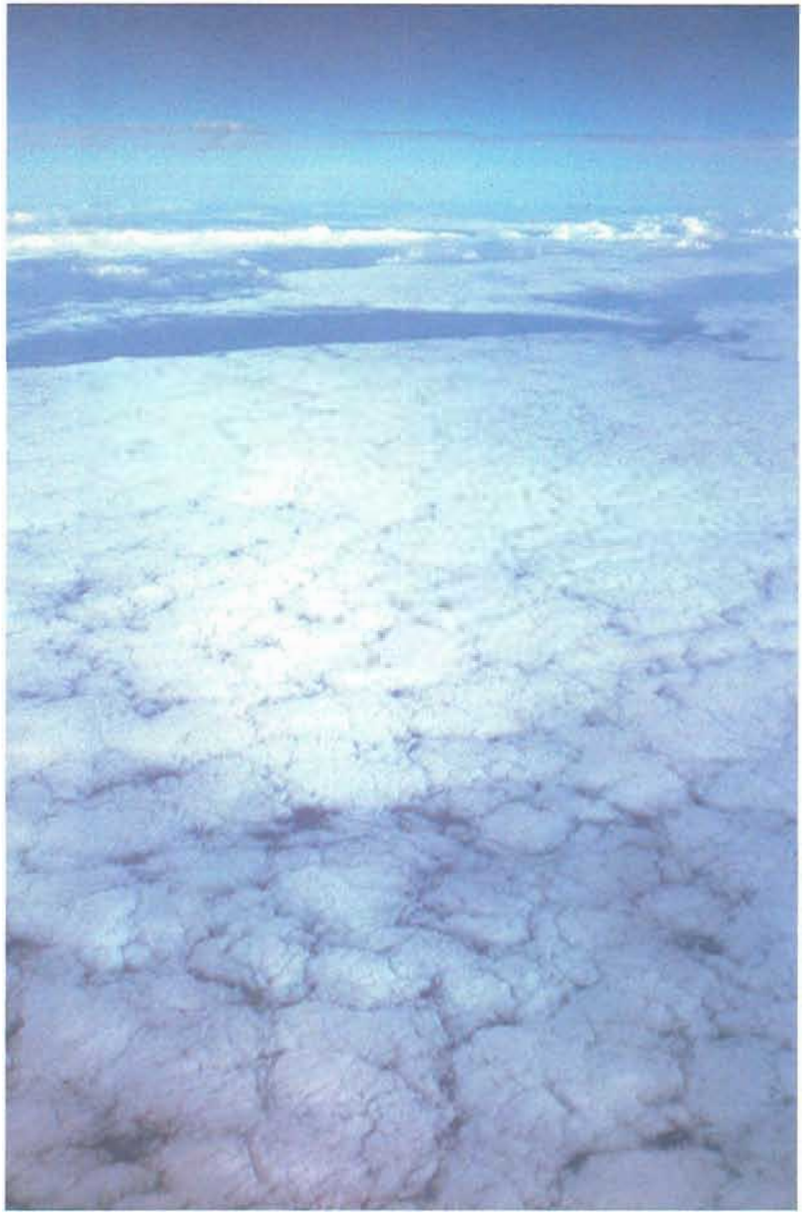
Orographic Stratocumulus

The picture shows Stratocumulus formed on the top of the Akaishi Mountains by the wind blowing up the mountain slope from the left of the picture. The clouds (1, 2) have an appearance similar to snow, but their smooth shape distinguishes them from the snow lying on the mountain ridge at 3. The tops of these orographic clouds at 3000 m are flattened by an inversion layer just above the top of the mountains.

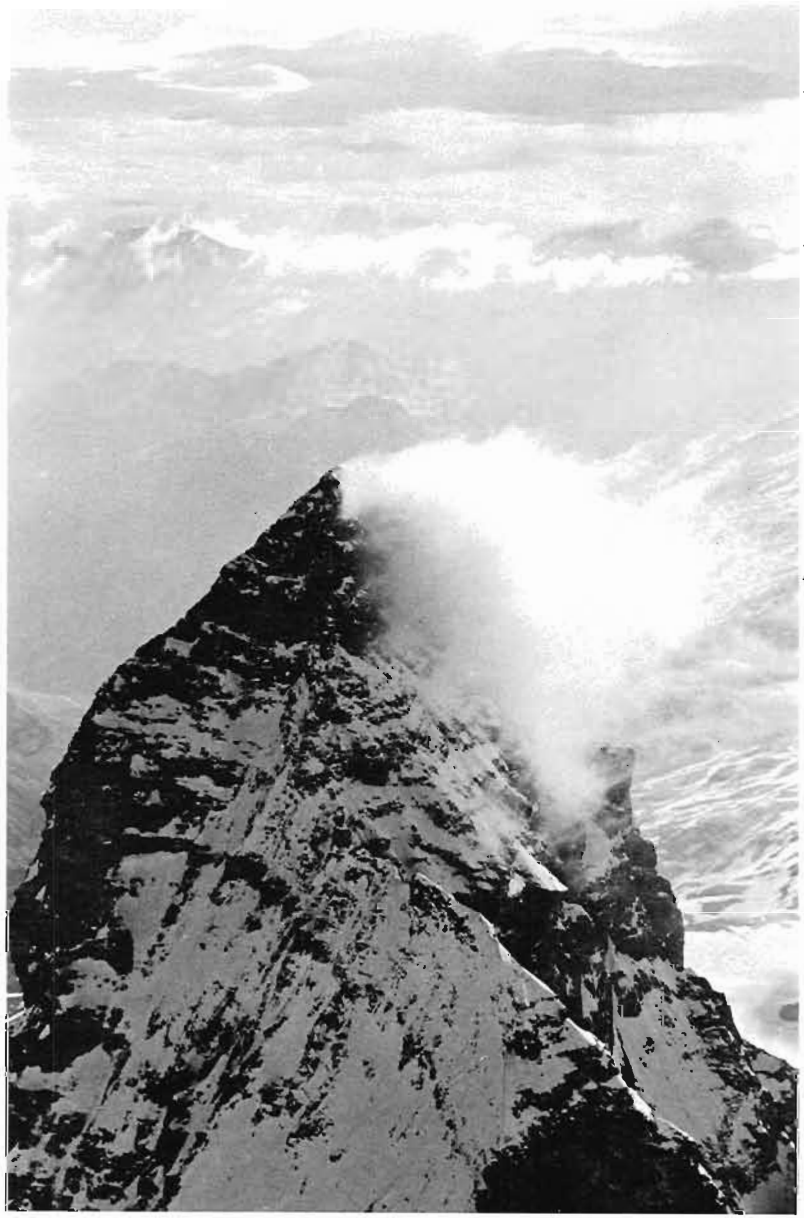
A surface cold front was orientated ENE-WSW about 400 km south-east of the area. At middle levels a strong westerly flow prevailed over Japan, with a jet core over 60 m s^{-1} at 12000 m about 80 km north of the area seen in the photograph.

Dissipating Stratocumulus

The Stratocumulus in the foreground (1) has begun to dissipate. It has started to thin, and a large rift (2) can be seen in the distance. The top of the Stratocumulus is at about 2300 m. Cumulus congestus clouds are seen at 3, and thin Altostratus is visible at 4 above the flight level of the aircraft. An observer at the Earth's surface would be guided by the large size of the regularly arranged elements in identifying the main layer as Stratocumulus stratiformis.
The area was located south of a ridge of high pressure oriented ENE-WSW over the Sea of Japan. Winds were rather light from the south-south-west in the lower levels, but became stronger with height as they veered to west-south-west at middle levels.



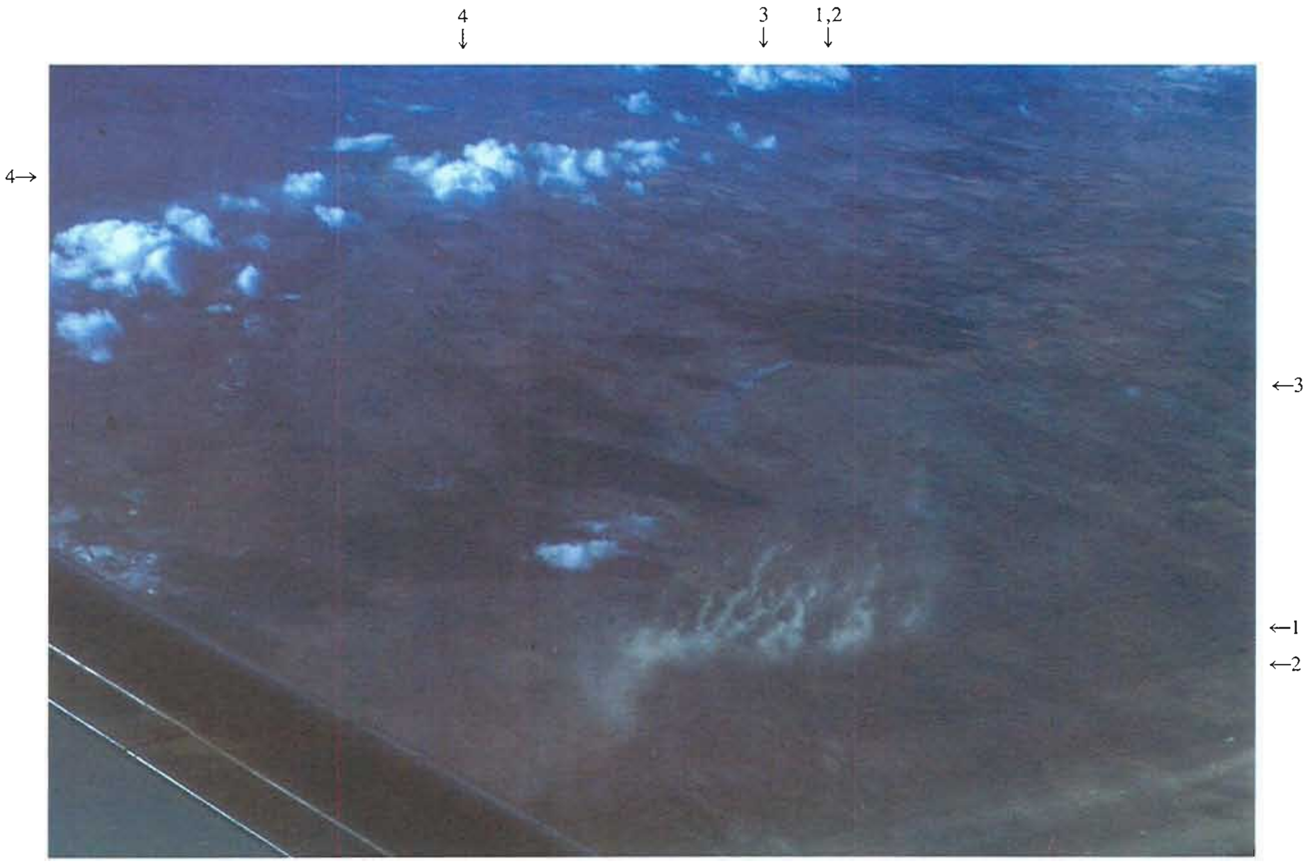
Capt. K. Shimizu, All Nippon Airways, above the Bay of Tosa (Japan), at 6300 m, 14 October 1977, 1030 hours



J. Galimberti, Zermatt Valley (Switzerland), July 1951, 0800 hours (towards SSE)

Orographic clouds (smoking mountain)

The picture shows a fairly ragged, stationary cloud (1) leeward of the Matterhorn peak (4482 m), apparently adhering to it. At about the same level clouds of a similar type cling to other high summits (2). Cumuliform clouds of a more usual type are on the other hand formed over lower mountains (3). Typical orographic Altocumulus is seen at 4-5. The wind was blowing from the north at an estimated speed of 15-20 m s^{-1}.



M. A. LeMone, above New Mexico, at about 9150 m, January 1971, 1448 hours (towards SW)

Blowing dust, smoke and Cumulus

Dust is being raised from ploughed fields by winds which are blowing towards the observer. The brown dust (1) has an abrupt leading edge on the near side (2) and reveals a linear/cellular structure of the boundary layer. At 3 smoke can be seen originating from a fire. Cumulus humilis cloud is present at 4. This cloud is easily distinguishable from the dust and smoke, even at the altitude of this aircraft, by the typical colour and shape of Cumulus humilis.

The region was dominated by a fair-weather regime, although winds were strong because of the effect of nearby mountains.

M. A. LeMone, over Louisiana (U.S.A.), at about 9150 m, June 1973

Cumulus rows (streets)

In this illustration the field of view is nearly filled with parallel rows of Cumulus (1, 2). This pattern is called *cloud streets* and the rows are aligned nearly parallel to the wind at that height. Their occurrence usually indicates winds over 7 m s^{-1}. Their spacing is generally two to three times the height of the cloud top. The cloud streets mark the rising portion of a double helical circulation. The limited vertical extent of the Cumulus in the illustration indicates that the ascending air currents have reached a stable layer, probably an inversion. A few Cumulus or Stratocumulus clouds in the distance (3) are not aligned in rows. Cloud streets which form over the tropical oceans are usually less continuous and have clouds of greater vertical extent than shown in this continental location.

When this photograph was taken, strong winds at low levels were caused by a tight pressure gradient which was advancing into the region, although anticyclonic conditions prevailed aloft.

Capt. H. Ishizaki, All Nippon Airways, over the Okinawa Islands (Japan), at 7000 m, 22 June 1978, 0930 hours

Comparison of Cumulus development over land and over sea during summer

The picture illustrates the marked contrast between widespread Cumulus over land (1) and scattered Cumulus over the sea (2) on a summer's day. On the day the photograph was taken the surface air temperature at coastal land stations had reached 28°C by 0900 hours while the surrounding ocean remained much cooler. A sea breeze became established, which kept a narrow coastal strip free of Cumulus. The tops of some of the clouds over land were made ragged by the wind (3).
A weak stationary front was located about 400 km north of Okinawa. The area was on the east side of a middle-level trough. Winds were light southerly at lower levels and variable in direction at middle levels.

Guo Enming, above Hebei Province, China (39° 20′ N, 115° 41′ E), at 9000 m, 27 July 1981, 1110 hours (towards NW)

Widespread Cumulus, isolated Cumulonimbus and Altocumulus

The Cumulus clouds in the foreground (1) have rounded, protruding tops, while less developed Cumulus clouds are seen at 2. The characteristic anvil-shaped top of a well-developed Cumulonimbus capillatus (3) can be seen on the horizon. There are thin layers of Altocumulus at 4.
The clouds were located ahead of a trough which was situated in the northern part of Hebei Province. A surface front had passed through the area shortly before the photograph was taken.

R. A. Keen, 200 km SW of Hurricane "Ella" centred at 31° N, 72° W, at about 7600 m, 1 September 1979, 0900 hours (towards SE)

Bands of Cumulus spiralling in towards a hurricane

Rows of Cumulus congestus, mediocris and fractus are pictured here aligned to the low-level air flow near a hurricane. The Cumulus row at 1, 2 and 3 shows the curvature of the air flow as it spirals in towards the centre (eye) of the storm, which is 200 km to the left of the photograph. The upper portion of the picture (4, 5) shows dense Altostratus and Cirrostratus in the upper-level outflow from the convection in the storm centre.

Hurricane "Ella" was at peak strength with a well-developed eye and classic circular structure visible on satellite imagery at the time this photograph was taken.

U.S. Air Force, 54th Strategic Reconnaissance Squadron (17° N, 131° W), 1300 km ENE of Manila, Philippine Islands, at 3000 m, 20 July 1949, 0800 hours

Concentric cloud masses in a tropical cyclone

The picture was taken in a tropical cyclone which formed over the Pacific and was accompanied in its north-east quadrant by surface winds of 55 $m\ s^{-1}$. The aircraft was not far from the eye of the storm, which was circular, well defined and about 50 km in diameter.

Concentric masses of Cumulus clouds (1-2) are visible below the flight level; they constitute a continuous mass. These clouds are surrounded by a circular wall of Cumulonimbus clouds (3), extending to altitudes of well over 9 km. A ring of thick Cirrus or Cirrostratus, visible at 4, radiates from the Cumulonimbus tops and slopes inwards towards the centre, where blue sky was observed (left-hand upper corner). The observer reported that the eye looked like a gigantic gold-fish bowl.

C. Warner, from near the coast of Italy (42° 36′ N, 10° 30′ E), at 9500 m, 12 January 1979, 1430 hours (towards NE)

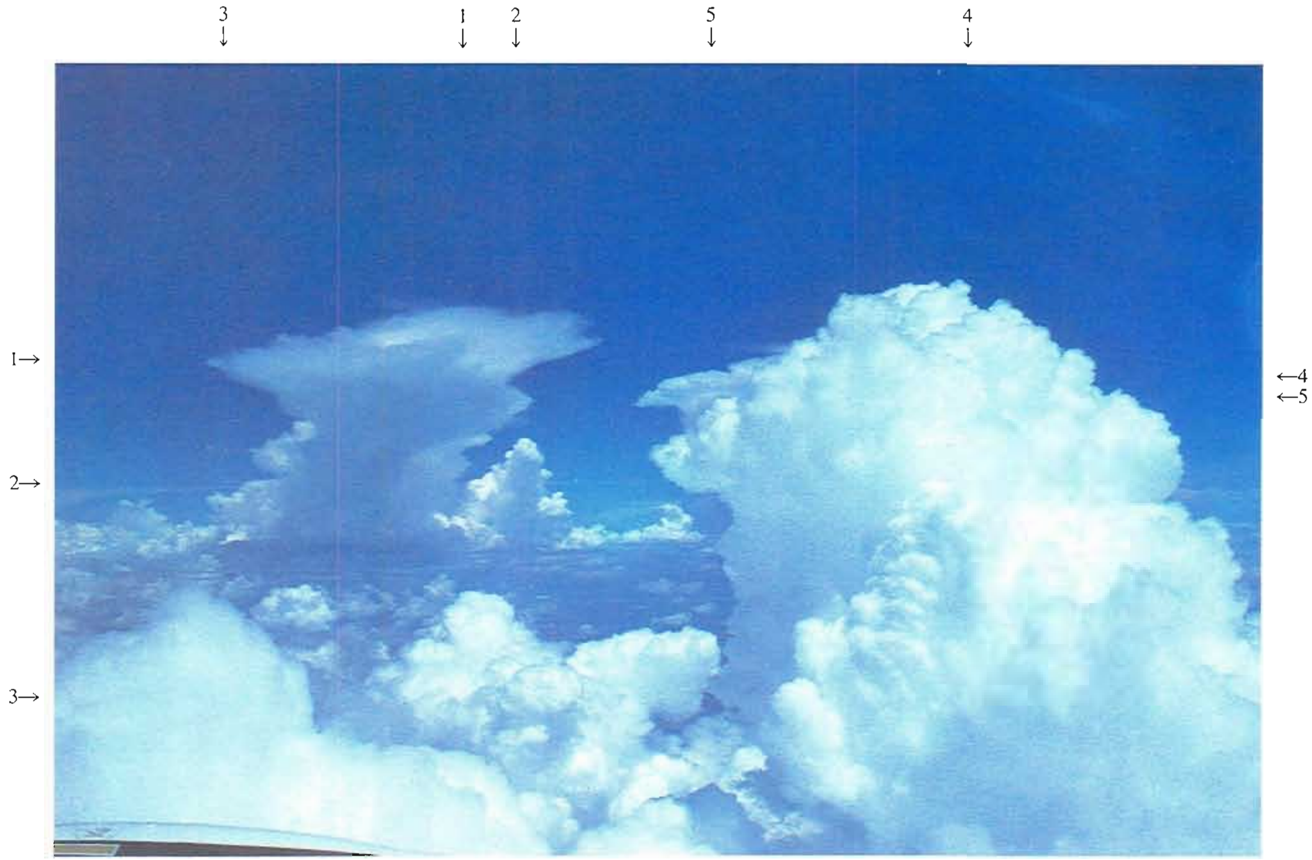
Isolated Cumulonimbus

This photograph shows an isolated Cumulonimbus (1) which has developed a long plume of Cirrus spissatus cumulonimbogenitus at 2. The Cirrus has been carried from the mother cloud by the strong winds at that level. The Cumulonimbus is flanked by Cumulus congestus at 3 and Cumulus mediocris at 4.
A cold front had moved south-eastwards over Italy 24 hours earlier in association with a deep depression over the North Sea and a weak depression in the Adriatic Sea.

Capt. K. Hirai, All Nippon Airways, over the sea south of Kagoshima City (Japan), at 10000 m, 2 July 1978, 1300 hours

Scattered Cumulus over the sea, isolated Cumulonimbus

Over the oceans convective air currents are not so large as those over land masses, and the diurnal variation of Cumulus is very small. The oceanic Cumulus clouds in the foreground (1) are numerous and their vertical development is much greater than their horizontal thickness. Above the Cumulus at 2 can be seen small patches of stratiform cloud. In the upper part of the picture, over land, are Cumulonimbus capillatus clouds (3), which are leaning to the right of the photograph due to wind shear. Cirrostratus nebulosus can be seen above 4. Beyond 5 the sea of Cumulus and Cumulonimbus can be seen.
The Kagoshima area was north of a surface ridge of high pressure, with a mid-level high over Okinawa. Low-level winds were moderate westerly, while the upper-level flow was very light from the south-south-east.



R. A. Keen, above southern Florida (U.S.A.), at about 6 100 m, 29 August 1978, 1300 hours (towards SE)

Isolated Cumulonimbus amidst Cumulus clouds of extensive vertical development

An isolated Cumulonimbus capillatus in the distance (1) has developed a well-defined anvil. An adjacent Cumulus congestus (2) has a bulging tower which does not show the fibrous or striated texture of Cumulonimbus. In the foreground the top of a Cumulus congestus (3) is near the flight level of the aircraft, and another top appears at 4. The latter tower has not yet begun to undergo icing at its top; the small section of anvil (5) apparently protruding from its side belongs to a more distant Cumulonimbus. Other Cumulus mediocris and congestus are scattered among the more prominent clouds. The sporadic occurrence of Cumulonimbus is typical of this area of southern Florida where high moisture contents are found, and deep clouds begin to form in the middle of the day in summer over the strongly heated land surface.
The area was beneath a subtropical ridge of high pressure in the middle and upper troposphere, with light south-easterly winds at the surface.

C. Warner, west of Sumatra (3° 54′ N, 93° E), at 7460 m, 9 December 1978, 1421 hours (towards NW)

Scattered Cumulus, isolated Cumulonimbus

Among a scattering of Cumulus clouds of varying species an isolated Cumulonimbus (1) has developed. Cumulus congestus (2) can be seen on the western flank of the Cumulonimbus. Cumulus mediocris (3, 4) interspersed with Cumulus humilis occur along an arc which is convex to the west. Elsewhere Cumulus mediocris, humilis and fractus occur in a variety of small-scale features separated by nearly clear air.

The monsoon flow was approximately from the east in the lower troposphere. Winds veered to south-west in the high troposphere.

A. Viaut, above the Mozambique Channel (about 15° S, 45° E), at 5500 m, 8 February 1953, 1118 hours (towards SW)

Isolated Cumulonimbus amidst scattered Cumulus clouds

In the middle of the picture (1) is an isolated Cumulonimbus of great vertical extent, a massive cloud with partly fibrous top. Nearby, at 2, are detached Cumulus clouds with rounded tops and horizontal bases. Above the Cumulus, and either veiling them (3) or obscuring them (4-5), there is a broken Stratocumulus sheet at 2500 m. Above the aircraft there is another layer, showing numerous small openings; in view of its altitude it is to be considered as Altocumulus.
There was a low-pressure trough extending NW-SE over the Mozambique Channel and Madagascar.

E. Szoke, near Miles City (Montana, U.S.A.), at 7050 m, 1 August 1981, 1557 hours (towards NE)

Cumulonimbus cloud complex

The Cumulonimbus cloud complex in this photograph is located from 20 km away on the left side of the picture to 80 km away in the distance at 1. It has developed a well-defined anvil (2) extending eastwards in the upper-level westerly air flow. Along the lower edges of the cloud (3) precipitation appears as whitish streaks, and probably consists of snow changing to rain. Almost all the precipitation is evaporated before it can reach the ground. A similar storm complex is located about 100 km to the north-east at 4.

A quasi-stationary weak cold front was positioned 400 km to the south-east while high pressure was centred about 300 km to the east.

R. F. Reinking, near Miles City (Montana, U.S.A.) at 5730 m, 13 July 1981, 2137 hours (towards E)

Cumulonimbus and Cumulus on a squall line

This photograph shows Cumulonimbus capillatus incus (1), large Cumulus congestus (2) and smaller Cumulus congestus (3). The anvil outflow of Cirrus from the Cumulonimbus can be seen at 4. These clouds marked a squall line which had begun strong development three and a half hours before the photograph was taken. Thunderstorms occurred and considerable lightning was seen in the area beneath the Cumulonimbus. Hail swathes were clearly seen from the aircraft. Vertical motions up to 35 m s^{-1} were measured by another aircraft which penetrated the cloud complex about this time.
The squall line developed in response to surface heating and to convergence associated with a surface low-pressure area centred a short distance to the south. The upper winds were south-westerly.

SPECIAL CLOUDS

C. Störmer, Oslo (Norway), 30 January 1944, 1605 hours (towards SW)

Nacreous cloud

The photograph, taken after sunset, shows a very brilliant nacreous cloud in the middle of the picture; its height is about 28.5 km. A transparent veil of Cirrostratus fibratus is also present. Near the horizon there are some Cumulus fractus.
The station was in the rear part of a very strong invasion of arctic air which crossed the Norwegian mountains in a deep north-westerly current.

J. Walden, Anchorage (Alaska), 24 January 1950, 1645 hours (towards WSW)

Nacreous clouds

The height of the nacreous clouds shown above was determined by triangulation (base line 250 km) and found to be 20 km at 1300 hours and 24 km at 1630 hours. They were moving slowly from north or north-north-west.

The clouds were observed all day. At 1515 hours, half an hour before sunset, they began assuming typical mother-of-pearl colours. Between 1600 and 1700 hours, "the display was very unusual and presented a constantly changing kaleidoscopic pattern". At the time the photograph was taken the colours were most brilliant, and diffuse shadows were cast on the snow. This brightness however did not last long.

An intense (warm) anticyclone over the Aleutian Islands extended to a considerable elevation. The temperaturė at the 100 hPa surface (16 km) was —63°C. At 1630 hours there was an indication of a tropopause at the extremely high level of 90 hPa with a temperature of —66°C.

E. Schroder, Holmestrand (near Oslo, Norway), night of 10-11 July 1949, near midnight (towards N)

Noctilucent clouds

Noctilucent clouds are present in long parallel brilliant bands of fibrous texture. The bands seem to be interconnected by a very fine set of waves, seen most clearly at 1. The height of the clouds was not determined, but judging from numerous other measurements it was estimated at 82 km. Dark patches of Altocumulus lenticularis (2, 3) contrast strongly against the lighter background.

There was a weak north-westerly current over southern Scandinavia, causing a trough leeward of the Norwegian mountains.

Royal Air Force, Farnborough (Hampshire, U.K.), 9 August 1944

Condensation trails (contrails)

Three condensation trails (1, 2, 3) can be seen. They expand with time. The two older trails (1, 2), probably made 15-30 minutes before the picture was taken, have assumed a fleecy aspect, while the most recent one (3), which is just being produced, merely looks like a white streak in the sky. Numerous Cirrus clouds can also be seen; they may have developed out of contrails formed earlier.

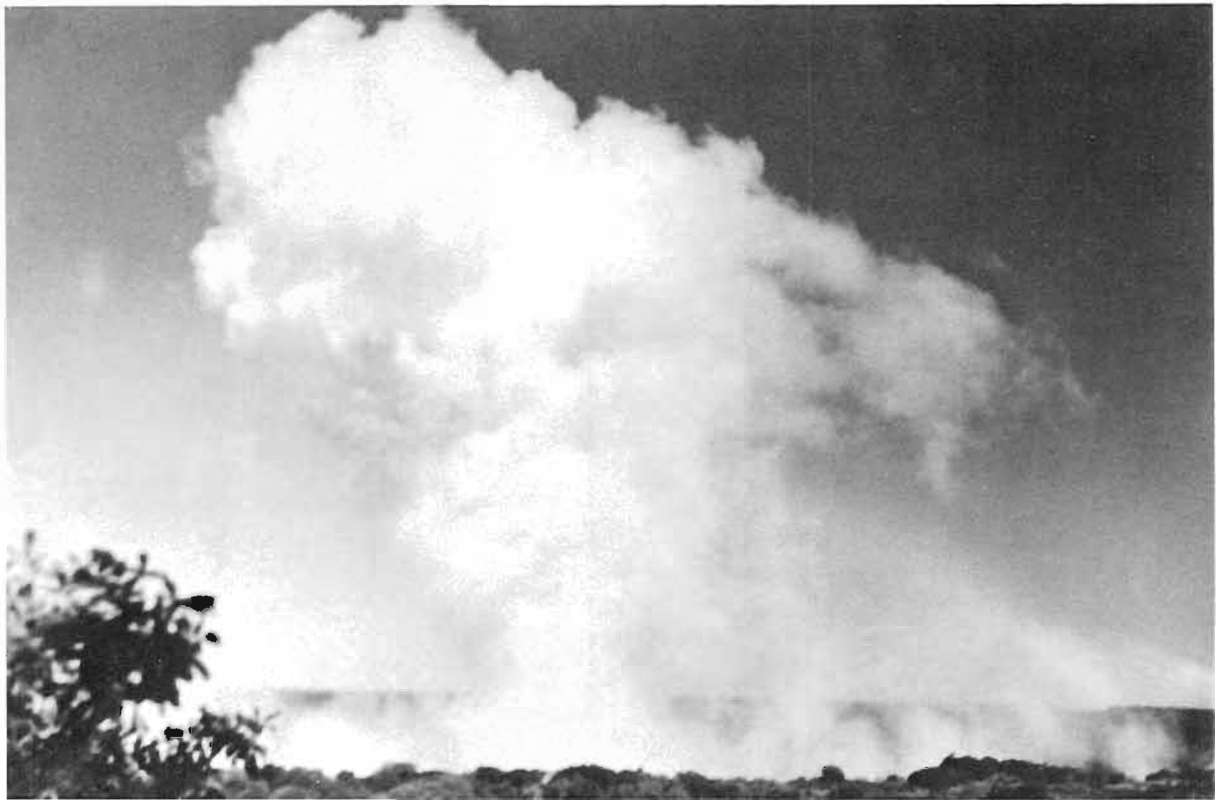
A weak trough associated with a low near Iceland was passing over southern England. Rather humid and warm air, associated with a weak warm front at about 700 km distance, was invading the higher layers of the troposphere from the north-west.

Royal Air Force, Farnborough (Hampshire, U.K.), 1 January 1945

Condensation trails (contrails)

The sky is crossed in every direction by contrails of different ages. As they expand progressively they form fluffy or fibrous clouds and it is impossible to say with certainty whether there are also clouds of natural origin in the sky. Note the pendant swellings, like inverted toadstools, at 1-2, typical of recently formed contrails.

From an anticyclone in the south-west a strong ridge of high pressure extended over the area. In the higher layers, advection of warm and rather humid air was in progress from the north-north-east. The associated warm front was at about 250 km west-north-west of Farnborough; it caused only light precipitation when it passed.



Lennon Ltd., Victoria Falls (Livingstone, Zambia)

Cloud produced by the Victoria Falls

Water, broken up into spray by the falls (1 600 m wide and 120 m high), adds considerably to the moisture content (vapour and droplets) of the surrounding air. The downdraught caused by the falling water is compensated locally by ascending motion of the air, which causes the formation of a cumuliform cloud.

Cloud formed by volcanic eruption

This huge convective cloud, caused by an eruption from a small volcanic island, is composed of a mixture of dust or grains of different sizes and of water drops thrown up by or condensing in the cooling column. The dark band at 1 is probably a "rain" of volcanic ash (dust or grains).

1
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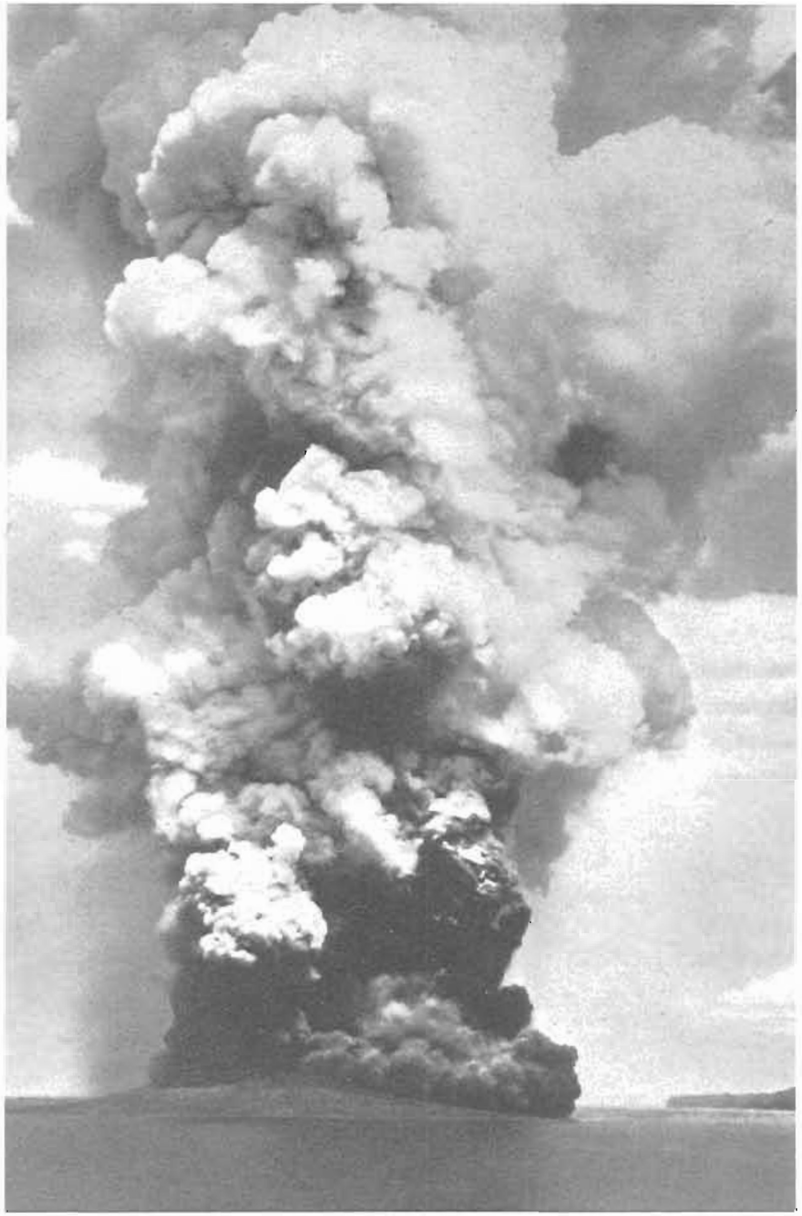
1→



C. E. Stehn, Anak Krahatau (Strait of Sunda, Indonesia), 1 May 1933

METEORS

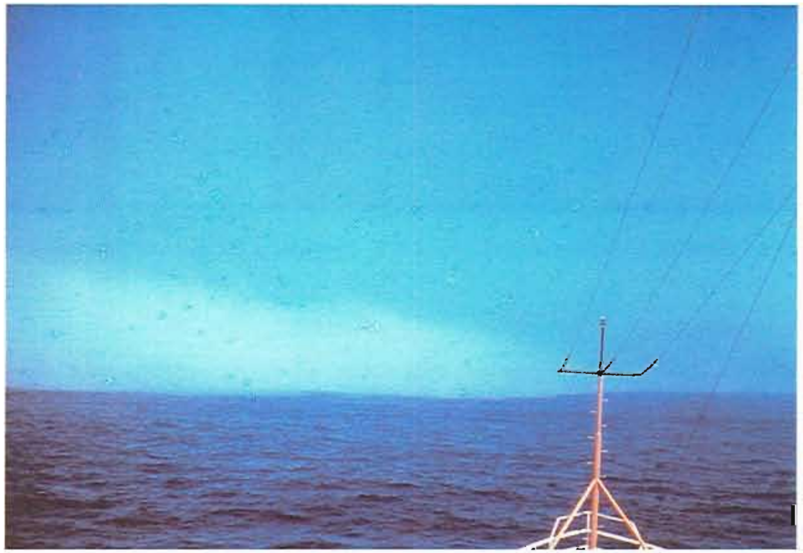
Fog

The amorphous grey veil of fog shows very little detail and hardly any variation of luminance.

A. J. Aalders, North Atlantic Ocean (47° N, 10° W), 23 March 1953, 1128 hours

Fog banks

The sea horizon is clearly visible at the extreme right of the picture, but elsewhere it is completely blotted out by dense fog banks, the nearest of which is on the left at a distance of 150 m.
The ship was traversing fog banks from 1030 until 1530 hours; winds were ENE, 5 m s^{-1}, and sea and air temperatures differed only slightly. The fog area was in a ridge of high pressure stretching west-south-westward from an anticyclone centred over the Netherlands.



A. J. Aalders, North Atlantic Ocean (47° N, 10° W), 23 March 1953, 1425 hours

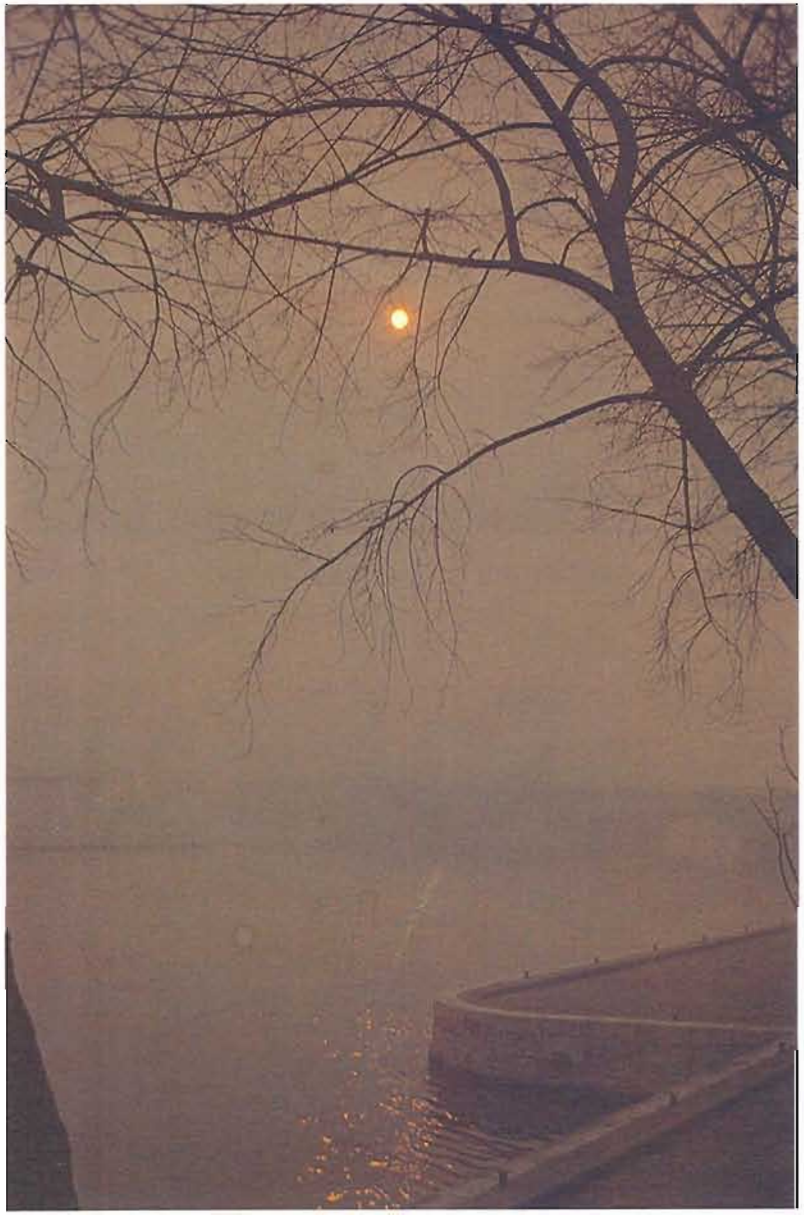
B. C. Haynes, Washington, D.C. (U.S.A.), 18 October 1950, from 0830 to 1030 hours (towards N)

Dissipating fog

Note the change in the appearance of the landscape during the progressive dissipation of the fog. One of the most striking features is that the chimney standing out at 1, in the lower left-hand photograph, is almost lost in the background of the lower right-hand photograph.
The station was a little to the west of the centre of an anticyclone; at 0100 hours the wind was calm or light and the sky very slightly cloudy or clear.

Fog and smoke (smog)

The fog and the smoke give the sky a purplish yellow tint. The outline of the sun is clearly visible.
A high extended from western France to Poland with weak winds and widespread fog over western Europe.



French Meteorological Service, Paris (France), 23 December 1949, 1232 hours (towards S)

1
↓

1→

R. K. Pilsbury, Freshwater (Isle of Wight, U.K.), February 1982, 1730 hours (towards SW)

Ground fog

As the sun sets, leaving the pink afterglow of a cold winter's evening, radiation fog soon begins to form in the low-lying part of a school's playing fields. The fog is only 60-90 cm deep, as indicated by the people at 1.

An anticyclone was situated over southern England, with clear skies and calm conditions prevailing.

1 3 4 2
↓ ↓ ↓ ↓

←3,4
←1,2

R. A. Keen, Evanston (Illinois, U.S.A.), 29 January 1966, 1615 hours (towards NE)

Steaming water

Steam is rising in streamers (1, 2) as much as 20 m above Lake Michigan. Occasionally, rotation was seen to last several seconds in some of the larger streamers. The flux of water vapour onto the cold, dry air allowed Stratocumulus clouds (3, 4) to form 20 km from the shore. The Stratocumulus continued to thicken farther downstream, and produced light snow 100 km away on the far shore of the lake.

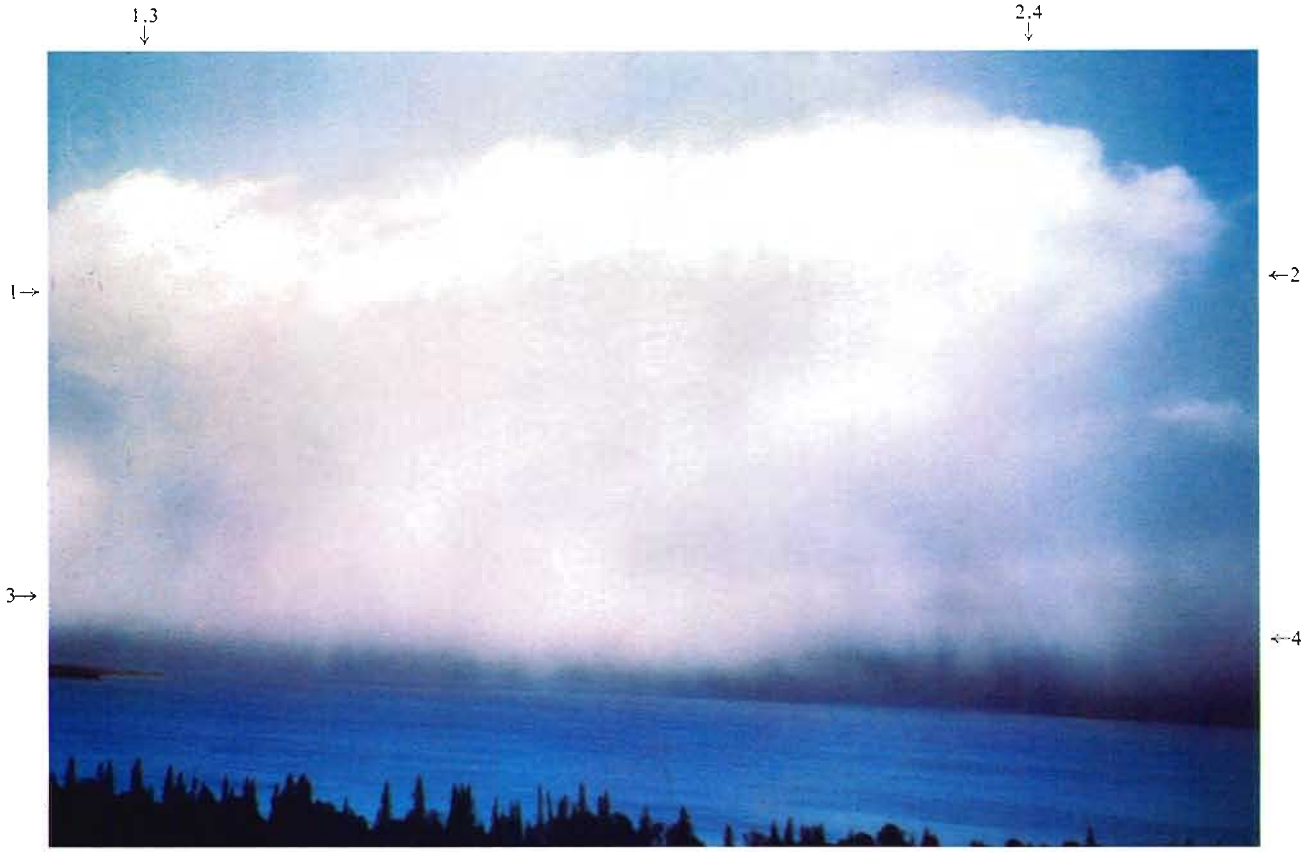
The area was under a strong flow of Arctic air at 5 to 10 m s^{-1} from the north-west; surface winds were blowing from land onto the lake. Air temperature was –23°C. However, the water temperature was measured as 0°C and the lake was ice-free because the winter had been relatively mild until shortly before the photograph was taken.

D. O. Blanchard, Boulder (Colorado, U.S.A.), 10 November 1982, 0800 hours (towards N)

Stratus and fog in valley

Stratus and fog are visible (1) from the top of Flagstaff Mountain (altitude 2 100 m). Temperatures in the Stratus and fog were near or below freezing-point, while they were well above it above the fog. The valley floor ranges from 1 600 to 1 650 m, and the top of the fog (2, 3) extended to 1 750 m. The fog lifted later in the day as the cold surface air was heated through the thin cloud layer, and the sky was clear but hazy by mid-afternoon.

Winds were light from the north-east in the fog layer, indicating a low-level upslope condition impinging on the mountains from right to left. Above the fog, winds were light from the south-west.



T. Bergeron, Ånn (Sweden), 5 July 1951, 1730 hours (towards SE)

Snow shower from a Cumulonimbus

The Cumulonimbus cloud (1-2) is only moderately developed, but the anvil form and the striated appearance are evident. A snow shower (3-4) is falling from the cloud; the snow changes into rain close below the level of the 0°C isotherm, a little above the surface of the lake (535 m above m.s.l.).
The station was in a flow of maritime polar air from between north and north-west, causing unusually cold summer weather and instability phenomena over Scandinavia.

Snow on the ground

This snow had fallen from showers in maritime polar air during the previous day and night. An elongated low extended from the Norwegian coast southward over the Netherlands. The temperature during the snowfall ranged from —3°C to 1°C; the wind was west, 4 m s^{-1}.

A. J. Aalders, Hilversum (Netherlands), 28 January 1952, 1021 hours

Snow cornice

Eddies, formed during a moderate snowfall by a south-easterly wind (10 m s^{-1}) blowing from right to left across the ditch, have caused the formation of an overhanging snow cornice in the form of rounded masses (1), some of which (2) have evidently broken off. Note the contrast between the white snow of the pillows and the melting snow on the ice of the ditch.
An occluded front had passed during the preceding night, marking the end of a cold period.

A. J. Aalders, Bussum (Netherlands), 9 February 1953, 1057 hours

R. K. Pilsbury, Totland (Isle of Wight, U.K.), 3 May 1979, 1215 hours

Snow pellets

Snow pellets that have fallen on to a lawn are seen in this illustration. Snow pellets are brittle and often break up on hitting hard ground, but in this instance the grass has cushioned their landing.
The British Isles were covered by a cold north-westerly airflow. A small depression was just south of the Isle of Wight.

R. K. Pilsbury, Totland (Isle of Wight, U.K.), 3 May 1973, 1440 hours

Hail

These hailstones collected on a lawn during a thunderstorm. A few are composed of transparent ice (1, 2) but most are opaque (3, 4). Some are partly clear and partly opaque (5, 6). Most of these hailstones are spherical although a few are conical (7, 8). Their diameters can be judged from the metric rule in the foreground of the picture. Hail falls only from Cumulonimbus. Thunderstorms over northern France, the English Channel and the Isle of Wight occurred in an unstable south-easterly airflow. Pressure was low to the south-west of Ireland.

R. K. Pilsbury, Totland (Isle of Wight, U.K.), 5 June 1983, 1215 hours

Small hail

This fall of small hail occurred during a thunderstorm. The small, spherical pellets are lying on a patch of short grass. The 12 in. (30.5 cm) ruler which has been placed on the grass affords an indication of the size of the pellets.
A depression over NW France gave rise to an easterly airflow over southern England. The air was unstable and there were many reports of thunderstorms.

A. J. Aalders, North Atlantic Ocean (south of Ireland), 6 April 1951, 1844 hours

Spray

The picture shows curtains of spray blown off the crests where the ship's wave meets the wind waves, the height of which is approximately 8 m.
There was a west-north-westerly wind of 18 m s^{-1} in the southern sector of a depression, the centre of which was west of Scotland.

R. K. Pilsbury, Totland (Isle of Wight, U.K.), May 1979

R. K. Pilsbury, Totland (Isle of Wight, U.K.), May 1973

Dew proper

In the upper picture deposits of dew are shown on blades of short grass. The globular water drops can be seen on horizontal surfaces (1) and at the tips of the blades of grass (2). In the lower picture dew has formed on a spider's web woven among spikes of short grass. There are also small drops of dew on the surrounding grass.

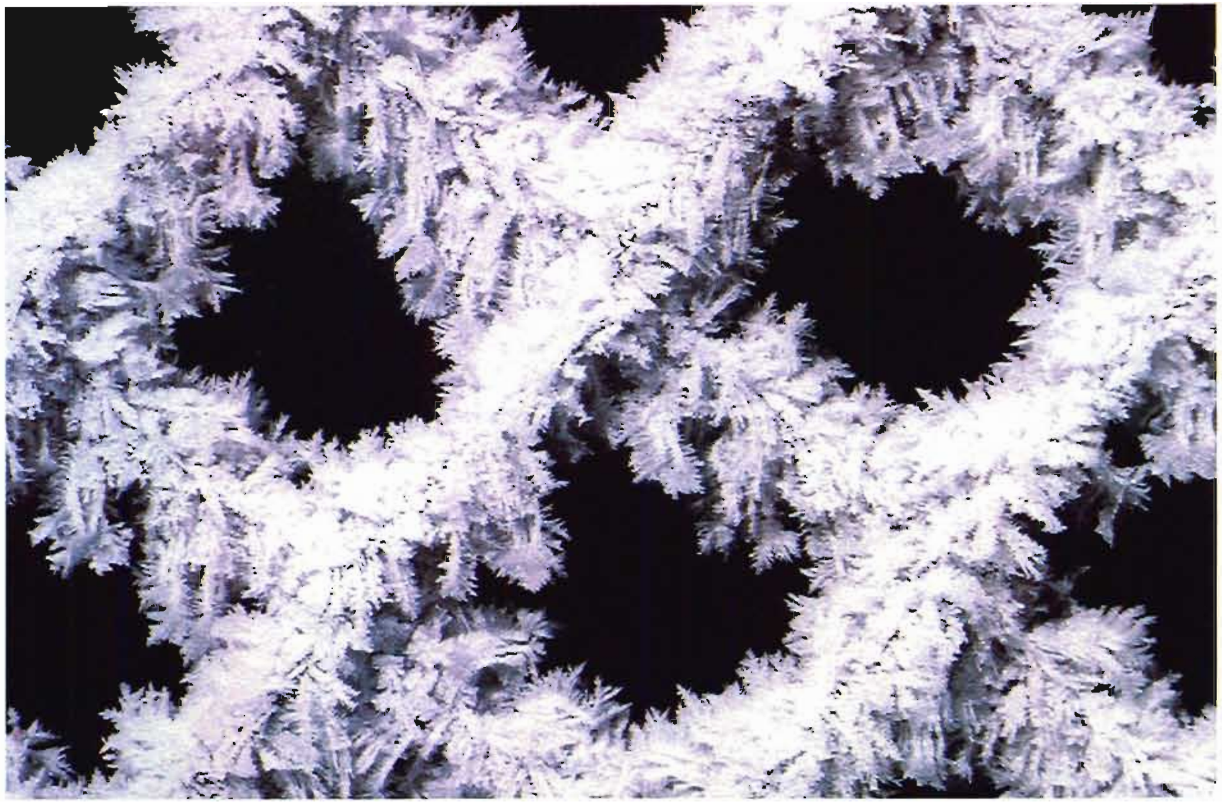
The dew formed overnight in conditions of calm air and clear skies.

Hoar frost proper

In the upper photograph hoar frost has formed on fallen leaves and other debris lying on bare soil. The lower picture shows in close-up the crystalline appearance of the needle formation of the ice deposits.

R. K. Pilsbury, Bracknell (Berkshire, U.K.)

R. K. Pilsbury, Totland (Isle of Wight, U.K.), January 1976



R. K. Pilsbury, Bracknell (Berkshire, U.K.), 24 January 1963, 1800 hours

Advection hoar frost

This flashlight close-up of advection hoar frost was taken early on a winter's evening. It depicts hoar frost which has formed on all surfaces of cold, 2 in. (5 cm) mesh wire. The tiny crystalline ice deposits have built up into a fern-like covering of great beauty.
After a long spell of cold, mainly easterly winds, an anticyclone had become centred over the area.

F. Meyer, Mont Ventoux (France), altitude 1 900 m, February 1934, 0900 hours (towards N)

Rime

The preceding night was clear and moonlit, with very good visibility. The only cloud then present was a cap around the top of Mont Ventoux, presumably of orographic origin, with its base at 1 800 m; very dense fog was observed at the mountain top. The cloud cap disappeared at sunrise. The building is covered with white ice, some of which is developed outward to the right in spike-like form to a thickness of a metre or more in places, indicating that during the deposition of the rime the wind was blowing mainly from right to left. The ice was evidently formed by supercooled cloud droplets freezing on impact with the building, producing ice composed of grains, more or less separated by trapped air, rendering it white.

R. K. Pilsbury, Bracknell (Berkshire, U.K.), 4 January 1971, a.m.

R. K. Pilsbury, Bracknell (Berkshire, U.K.), 4 January 1971, a.m.

Soft rime

In the picture on the left soft rime has covered a leafless deciduous tree. The deposit occurred during a period of light winds and freezing fog. In the right-hand picture soft rime has encircled overhead telephone wires. The fragile ice can easily be dislodged as is evidenced by the bare stretches of telephone wire from which the rime has fallen.

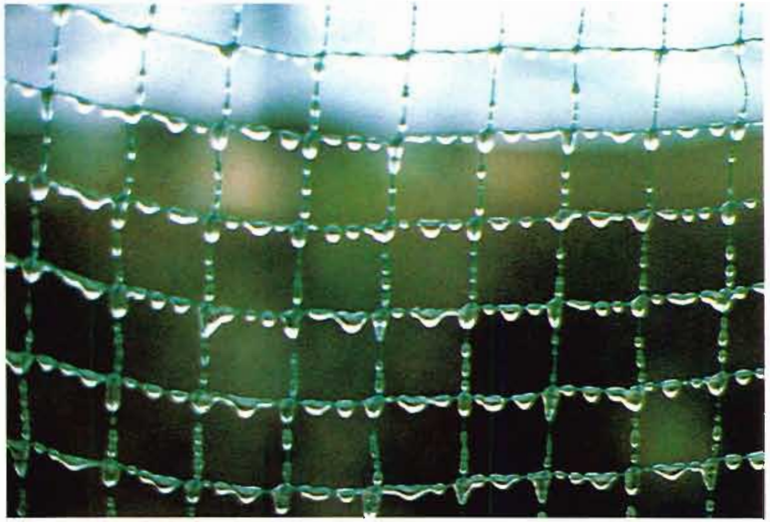
The area was covered by a weak ridge of high pressure from an anticyclone centred over France. SE England was affected by freezing fog.

Hard rime

This photograph shows deposits of hard rime on a 10 m anemometer tower at Great Dun Fell, 847 m above mean sea-level. The deposits on the south-western (windward) sides of the vertical structure have built up to an extrusion of about 30 cm. Most of the deposits, although rather adhesive, could be removed by chipping. The air temperature was —3°C.
A very weak cold front had cleared the station, leaving clear skies in a north-westerly airstream.

A. Robinson, Great Dun Fell (Cumbria, U.K.), 28 November 1982, 0930 hours (towards NW)

R. K. Pilsbury, Totland (Isle of Wight, U.K.), 25 January 1979



R. K. Pilsbury, Totland (Isle of Wight, U.K.), 25 January 1979

Glaze

In the picture on the left glaze has formed on the bare branches of a young tree. The smooth deposit of ice has covered all parts which have been exposed to precipitation. The ice has developed pendulous formations on the underside of many of the horizontal branches. The picture above shows beads of glaze which have formed on cold wire netting.

After a period of cold easterly and northerly winds a weak cold front crossed the area.

H. B. Bluestein, Key Biscayne (Florida, U.S.A.), 28 May 1975, about 1700 hours (towards SE)

Strong spout *(above)*

A wide "bush" of water droplets (1) raised from the sea surface is seen at the base of the inclined funnel cloud (2) in this photograph. The funnel cloud protrudes from the non-precipitating base (3) of a Cumulonimbus. During the mature stage, several funnels (not shown here) rotated about the main vortex of the spout. After the main spout dissipated, another "bush" formed near the same spot. The total life cycle of this display was approximately 30 minutes, during which time lightning was observed. Spouts which develop over a water surface are sometimes referred to as waterspouts.
The spouts formed in fairly unstable conditions. At low levels there was a weak disturbance about 200 kilometres east of Florida, with light southerly winds. Winds veered and increased with height.

Weak spout under a line of Cumulus congestus *(right)*

As is characteristic of Florida Keys spouts, the tuba as seen in this photograph (1) extends only about one-third of the way from the parent cloud base to the sea below, and exhibits a hollow core. The spout is most intense just above the warm sea surface (28-30°C), where a "bush" of sea-water droplets rises in helical fashion (2). A trailing wake (3) is left on the sea surface behind the "bush" as it moves to the right of the picture (westwards), largely in response to the outflow of cooler air from the shower in the background (4).
The parent Cumulus congestus cloud line was orientated E-W in a light, undisturbed easterly trade-wind flow.

J. H. Golden, above the Marquesas Keys (Florida, U.S.A.) at 450 m, 30 June 1969, 1725 hours (towards SE)

D. Hoadley, Plainville (Kansas. U.S.A.), 22 May 1972, 1800 hours (towards NW)

Funnel cloud not reaching the ground

A developing funnel cloud (tuba) is located at 1, about three kilometres from the photographer. It protrudes from a rain-free part (2) of the flanking line to a Cumulonimbus. Cloud fragments (3) near the vortex (4) did not appear to be rotating. Another flanking line at 5 was also associated with the same Cumulonimbus. Occasional large drops of rain reached the ground where the photographer was standing, and winds were blowing towards the vortex at about 15 m s^{-1}. A surface low was centred 250 kilometres to the south-south-west. It was part of an elongated NNE-SSW low-pressure area. The funnel cloud became one of ten tornadoes which occurred in a two-hour period in west-central Kansas. The cloud can also be seen on page 193 as it appeared two minutes later.

D. Houdley, Plainville (Kansas, U.S.A.), 22 May 1972, 1802 hours (towards WNW)

P. J. May and C. J. Crane, Northam (Western Australia), 21 September 1977, 1500 hours

Small tornado *(left)*

A small tornado (spout) is seen reaching the ground at 1 at a distance of about three kilometres. It is linked to a rain-free cloud base (2) of the flanking line of a Cumulonimbus. A secondary flanking line (3) belongs to the same cloud. Concentric banding can be seen around the vortex column near its base. Occasional large raindrops were falling at the photographer's position and winds were flowing towards the vortex at about 15 m s^{-1}.

A surface low was centred 250 kilometres to the south-south-west. It was part of an elongated NNE-SSW low-pressure area. The tornado was one of ten which occurred in a two-hour period in west-central Kansas. The tornado can also be seen in Plate 55 as it appeared two minutes earlier.

Large spout *(right)*

The spout (tornado) seen in this photograph has reached its mature stage. Dust from a newly ploughed field of reddish-brown soil has given the funnel this striking colour (1). The "bush" of dust raised from the ground by the vortex is clearly visible nearly to ground-level. The sharply defined funnel (2) is enveloped by another much less distinct shell of reddish dust (3) which extends upwards to the base of the cloud. This feature is due to dust particles of different densities arranging themselves at varying radii from the vortex. Clouds present were Cumulus congestus and fractus and Cumulonimbus calvus.

This spout developed in a thunderstorm along a trough line associated with a mesoscale low-pressure system just south of Northam, where the surface air temperature had reached 40°C.

Variation in visibility (haze)

These photographs show three successive aspects of the same landscape, with different turbidities of the air, corresponding respectively to total visibilities of 25, 100 and 400 km. When there is a veil of haze (0944 hours) the distant landscape has a greyish opalescent colour. When the visibility is good (1407 hours) the landscape takes on a much stronger blue hue and the real colours and details of the countryside appear.

The views were taken in an anticyclonic situation, outside the area of any disturbance.

T. Bergeron, Ånn (Sweden), 25 August 1944 (towards ESE)

R. F. Reinking, Ft. Lauderdale (Florida, U.S.A.), November 1974, 1800 hours (towards W)

Smoke layers

Smoke from sugar cane fires is spreading across the horizon (1) after sunset, so that the smoke, of relatively large particles, is distinguished by the colours of light scattered from the general small-particle haze aloft (2) in the humid air.

Drifting sand

A south-south-westerly wind of 11 m s^{-1} is blowing along the beach towards the direction in which the camera is pointing. The fine, dry sand of the beach is moved, but it is raised only a small distance above the surface. The visibility at normal observation level is not reduced, so the phenomenon is called drifting sand rather than blowing sand.

A. J. Aalders, Scheveningen (Netherlands), 8 December 1951, 1226 hours

Wall of sand

The distinct forward edge of the base of the wall of sand can be seen at 1-2; it is dark and slightly saw-toothed. The wall itself reaches up to 3000 m and all parts of it are formed of grey turbulent masses of sand raised into the air, probably without any condensation of water vapour.
The phenomenon was caused by a cold front, moving slowly towards the south-east. The invading polar air skirted the eastern edge of an anticyclone.

1 ↓ 2 ↓

1→

←2

Anonymous, 120 km SSE of Damascus (32° 24′ N, 36° 49′ E), at 3000 m, 17 April 1951, 1400 hours

Dust devil

This dust devil developed over barren fields during the dry season, and was moving towards the left of the picture. The rotating dust column is well-defined at the base (1) but gradually weakens upwards until it nearly disappears at 2. The dust devil had formed under cloudless conditions with strong instability from intense surface heating. The instability decreased with height. Outside the rotating column a mass of dust (3, 4) is raised nearly as high as the dust devil. The photograph was taken about 120 kilometres ahead of a cold front which was advancing southwards from the Gulf of Mexico.

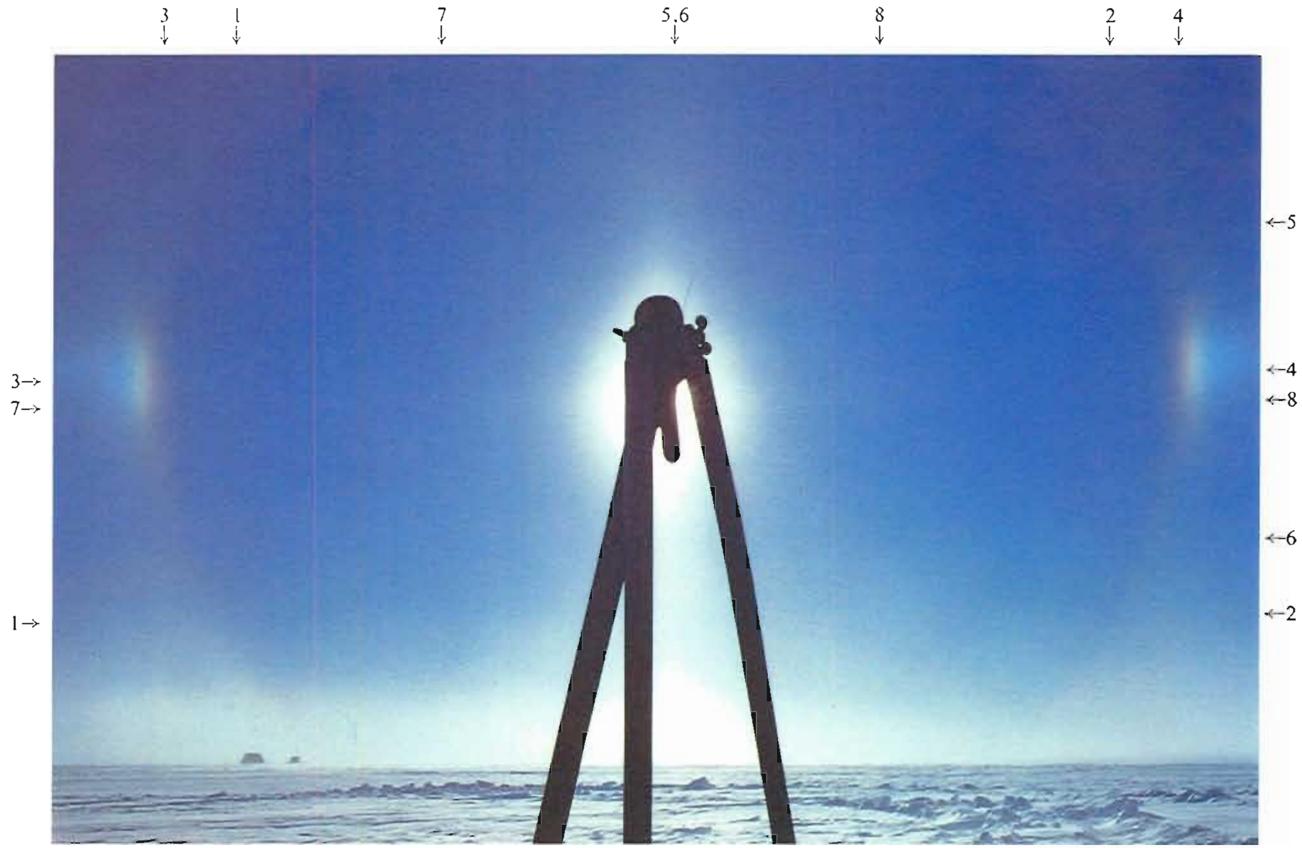
J. de Keijzer, El Limon (Veracruz, Mexico), 25 March 1977, 1525 hours (towards NW)

H. H. Larkin, Elma (New York, U.S.A.), 30 March 1950, at sunset (towards W)

Halo phenomena

In this veil of Cirrostratus nebulosus, with faintly striated structure, visible at 1, various halo phenomena can be seen. The halo of 22° is clearly defined, the sky inside the halo being a little darker than that outside the halo. The upper tangent arc can be seen at 2 and a luminous column at 3.

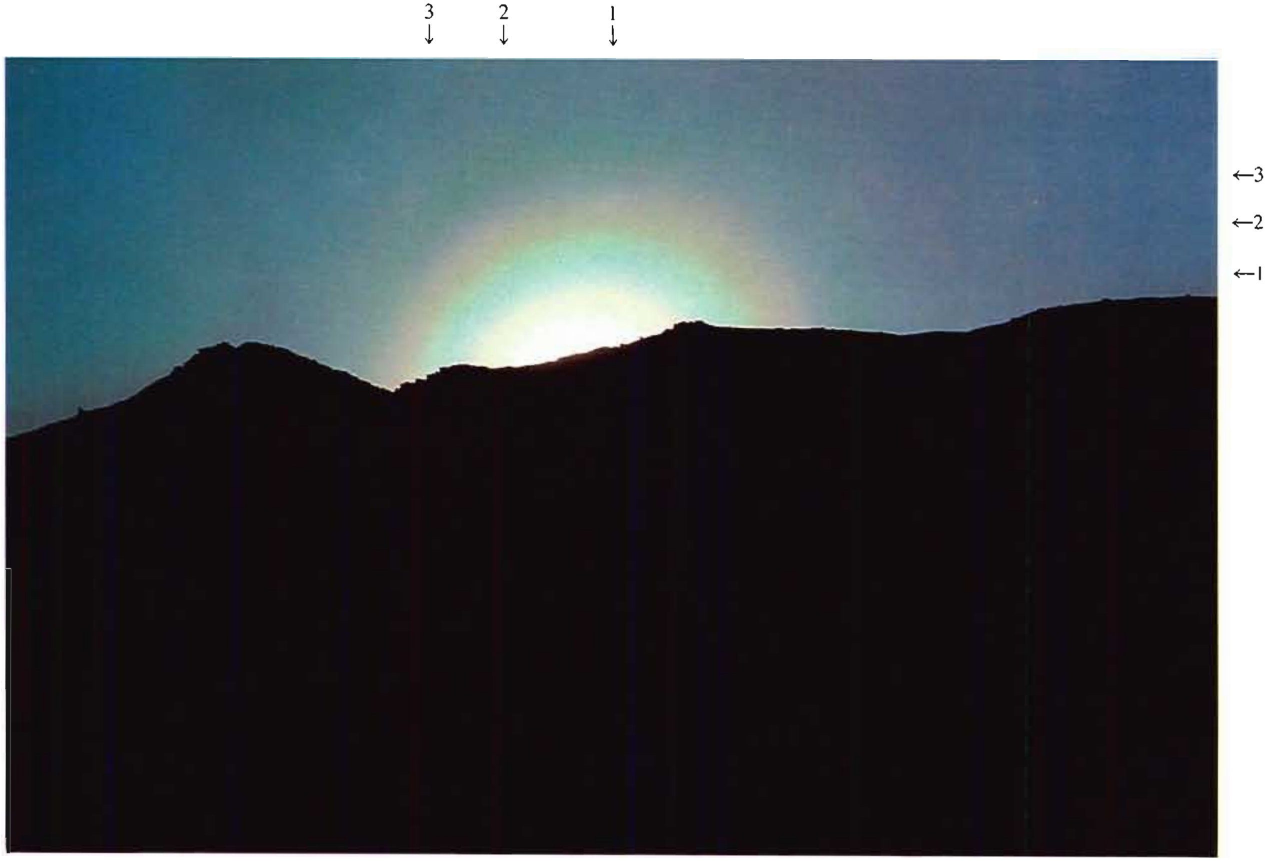
The picture was taken in the cold continental air in the rear of a withdrawing low at a considerable distance (1 500 km) to the north-west. The weather-map shows extensive Cirrostratus but no disturbance can be located in the vicinity of the station.



P. Stahl, Greenland (70° 54′ N, 40° 42′ W), altitude 2995 m, 23 July 1951, 0820 hours (towards E)

Halo phenomena

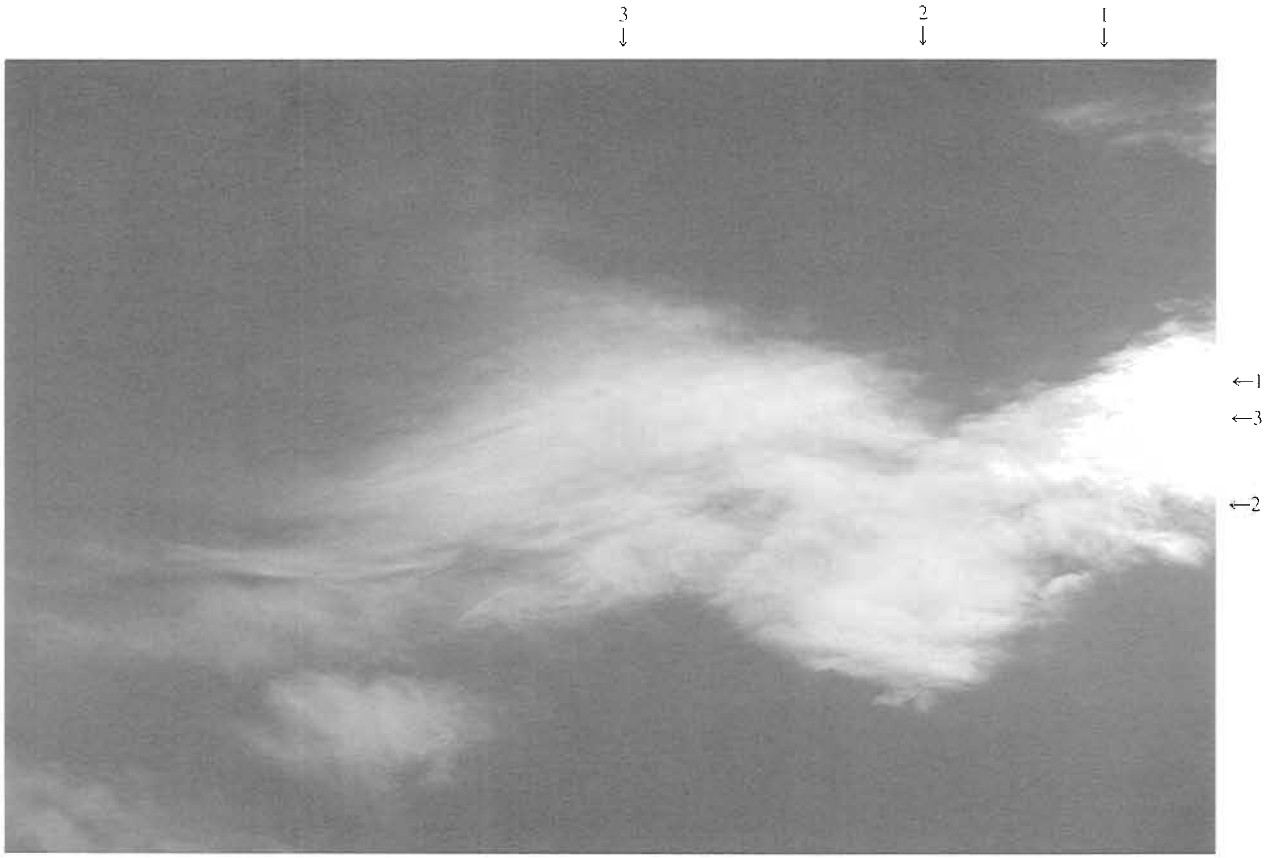
The veil of Cirrostratus nebulosus is almost invisible and probably only a small height above the ice cap. The halo phenomena comprise two portions of a 22° halo (1 and 2) and left and right parhelia (3 and 4), presumably with arcs of Lowitz. There is also a vague indication of a cross (5-6, 7-8).
The place of observation was in a flow of maritime polar air from the south.



D. O. Blanchard, Medicine Bow Mountains (Colorado, U.S.A.), 27 September 1981, 0720 hours (towards E)

Corona

The corona is observed around the sun as it is about to rise over the mountain ridge approximately 1½ hours after sunrise. An extremely thin overcast of Altostratus or Cirrus cloud is present, but it is not thick enough to whiten the sky. The inside ring (1) is green to violet, while the outer ring (2) is red. A faint secondary blue ring (3) is visible outside the red ring.



M. A. LeMone, Boulder (Colorado, U.S.A.), 10 January 1971

Irisation

This Altocumulus cloud is the result of deflection of airflow by the nearby Rocky Mountains, although it has some appearance of a breaking shear-gravity wave. Such clouds, which are frequently lens-shaped (lenticular), are excellent producers of irisation, such as the yellow (1) giving way to pink (2) and light blue (3), because of their relatively uniform drop size. The photo was taken at a small angular distance from the sun (under 30°), therefore the photograph was underexposed, resulting in the unnaturally dark sky.

R. F. Reinking, Northern Texas (U.S.A.), December 1977, 1300 hours (towards ENE)

Glory

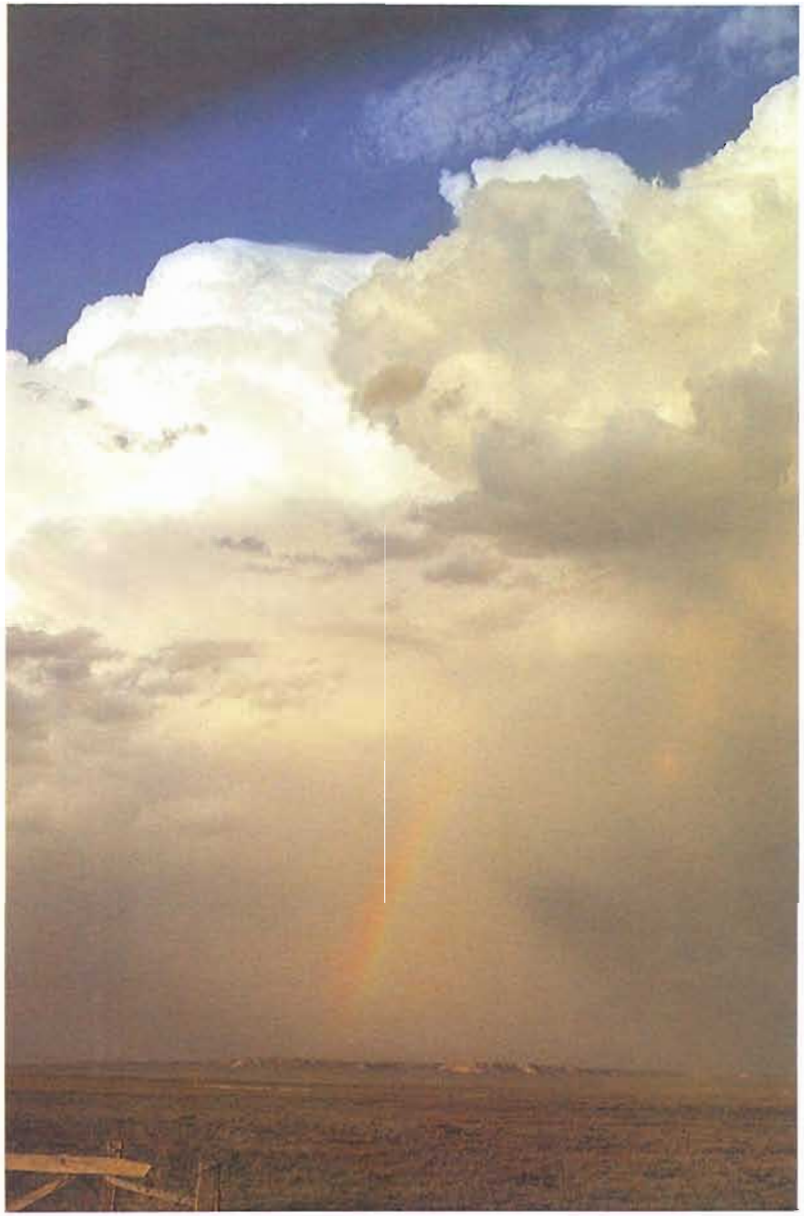
This quadruple set of anticoronal rings (i.e. glory) is found at 1, 2, 3 and 4 around the shadow of a commercial aircraft (5). Sunlight is being diffracted through water droplets at the top of a winter Altocumulus layer at 6. The glory occurs at a point directly opposite the sun, where the (airborne) observer's shadow falls.

M. A. LeMone, western United States, at about 10 000 m, October 1972

The glory is centred at the antisolar point from the observer (1), who is located just forward of the right wing of the jet aircraft. The coloured ring, particularly visible at 2, is thought to be caused by the backscatter of light by the cloud's water droplets.

Rainbow

Precipitation is visible (1) beneath deep convection (2) and a small glaciated tower (3) in this Cumulonimbus cloud. The brightness of the precipitation in the background suggests the presence of ice, probably in the form of ice pellets or small hail. The rainbow reveals the presence of water drops, either associated with the spreading frozen precipitation or slightly closer to the photographer. The indistinct top of the rainbow and the increased brightness of the cloudy background above the rainbow may indicate the freezing level, which at this time and location is only slightly above the cloud base. The rainbow subtends a significant fraction of the cloud depth because of the low sun angle, the proximity of the photographer to the cloud and the height of the visible precipitation column.



M. A. LeMone, NE Colorado (U.S.A.), July 1972, 1800 hours (towards NE)

K. B. Shone (U.K.)

1 ↓ 2 ↓ 3 ↓

←3 ←2 1→

A. J. Aalders, Bussum (Netherlands), 17 December 1949, 1402 hours (towards SW)

Crepuscular rays

The term "crepuscular rays" is sometimes used, although not universally, to describe the pale blue or whitish beams which diverge from the sun when it is hidden behind Cumulus or Cumulonimbus, or shafts of sunlight which penetrate gaps in a cloud layer. Such rays are not restricted to twilight. In this photograph a number of wide bands of blue can be seen with several narrower bands between them.

The most striking feature in this photograph is the appearance of the bluish shadows cast across the sunlit sky by the dense, heavily shaded Cumulus congestus (1-2). The lines accentuating these shadows, though actually parallel, appear to radiate from the position of the sun (crepuscular rays). Apart from the Cumulus, there are some dark patches of Stratocumulus (3).

A series of disturbances was passing over western Europe, moving from south-west towards north-east; an occlusion had passed the station shortly before the photograph was taken.

H. B. Bluestein, Norman (Oklahoma, U.S.A.), 4 September 1980, approximately 2100 hours (towards S)

Lightning from Cumulonimbus praecipitatio

The lightning flash in this photograph extends from the top of the Cumulonimbus (1) to the ground below (2). Branches from the main discharge dissipate into clear air (3, 4). Smaller branching is evident in the lower part of the main channel (5). The flash is particularly strong in appearance because the luminous channel is outside the cloud. Other lightning activity is occurring within the cloud, as shown at 6. It is not known whether the flash outside the cloud was connected with the one inside. Sometimes thunder, lightning or hail provides the only indication of the presence of Cumulonimbus and it is not possible to see whether the species is calvus or capillatus. Then, by convention, the coding is C_L = 9.
A stationary cold front at the surface was located several hundred kilometres to the north, and upper winds were rather light.

S. I. Akasofu, near Fairbanks (Alaska, U.S.A.), 28 January 1977

Polar aurora

The aurora is a visible manifestation of electrically charged solar particles channelled by the Earth's magnetic field acting on the rarefied gases of the higher atmosphere. The altitude of the lower limit is approximately 100 kilometres (occasionally as low as 60 kilometres), while the upper limit ranges between 100 and 400 kilometres (occasionally as high as 1000 kilometres). By comparison, noctilucent clouds occur between 75 and 90 kilometres. Auroral curtains surround both the northern and southern magnetic poles and appear as a luminous ring when viewed from well above the polar region. Such curtains, seen in the photograph at 1, 2, 3 and 4, 5, become intermittently active, and fold, curl and break up in a phenomenon known as an "auroral substorm".

APPENDIX

LIST OF PLATES

CLOUDS AS SEEN FROM THE EARTH'S SURFACE

C_L — Clouds of genera Stratocumulus, Stratus, Cumulus and Cumulonimbus *(continued)*

Page	Cloud name	Code figure		
		C_L	C_M	C_H
42	Cumulonimbus, Altocumulus and Altostratus of weakly disturbed tropical conditions	**9**	7	3
43	Cumulonimbus capillatus praecipitatio arcus	**9**	/	/
44	Formation of a Cumulonimbus capillatus incus	**3**	6	0
		9	6	0

Page	Cloud name	Code figure		
		C_L	C_M	C_H
45	Further development of a Cumulonimbus capillatus incus	**9**	6	0
46	Cumulonimbus capillatus incus	**9**	4	3
47	Cumulonimbus mamma	**9**	/	/
48	Cumulonimbus capillatus with mamma in anvil	**9**	0	3

C_M — Clouds of genera Altocumulus, Altostratus and Nimbostratus

Page	Cloud name	Code figure		
		C_L	C_M	C_H
49	Altostratus translucidus	0	**1**	/
50	Altostratus translucidus	0	**1**	/
51	Altostratus translucidus and Cumulus fractus	7	**1**	/
52	Nimbostratus	0	**2**	/
53	Nimbostratus with Stratus fractus	7	**2**	/
54	Nimbostratus with Altocumulus stratiformis	0	**2**	/
55	Nimbostratus	0	**2**	/
56	Altocumulus translucidus	0	**3**	0
57	Altocumulus stratiformis translucidus perlucidus	0	**3**	0
58	Altocumulus stratiformis translucidus perlucidus	0	**3**	0
59	Altocumulus lenticularis	2	**4**	1
60	Altocumulus lenticularis duplicatus with Cirrostratus fibratus	5	**4**	7
61	Altocumulus lenticularis radiatus	0	**4**	0
62	Altocumulus lenticularis undulatus radiatus and Cirrostratus	5	**4**	5
63	Altocumulus lenticularis	5	**4**	1
64	Altocumulus lenticularis undulatus radiatus	0	**4**	0
65	Altocumulus lenticularis	0	**4**	6
66	Altocumulus lenticularis and Stratocumulus	5	**4**	0
67	Altocumulus stratiformis lacunosus	0	**4**	0
68	Altocumulus stratiformis perlucidus undulatus	0	**5**	0
69	Altocumulus stratiformis translucidus undulatus	0	**5**	8
70	Altocumulus stratiformis undulatus translucidus perlucidus radiatus	0	**5**	0

Page	Cloud name	Code figure		
		C_L	C_M	C_H
71	Altocumulus stratiformis undulatus radiatus translucidus perlucidus	2	**5**	0
72	Altocumulus cumulogenitus with Cumulus congestus	2	**6**	0
73	Altocumulus cumulogenitus formed by Cumulus congestus	2	**6**	0
74	Altocumulus cumulogenitus	9	**6**	0
75	Altocumulus stratiformis opacus	4	**7**	0
76	Altostratus translucidus above Altocumulus stratiformis perlucidus	0	**7**	0
77	Altostratus undulatus radiatus translucidus	0	**7**	/
78	Altocumulus with virga	0	**7**	0
79	Altocumulus castellanus with Cumulus congestus	2	**8**	1
80	Altocumulus castellanus with virga	0	**8**	1
81	Altocumulus castellanus	0	**8**	0
82	Altocumulus stratiformis and Altocumulus floccus with virga	0	**8**	0
83	Altocumulus floccus	0	**8**	0
84	Altocumulus floccus	0	**8**	0
85	Altocumulus floccus, castellanus and lenticularis	0	**8**	0
86	Chaotic sky	1	**9**	8
87	Chaotic sky	0	**9**	0
88	Chaotic sky	3	**9**	2

C_H — Clouds of genera Cirrus, Cirrocumulus and Cirrostratus

Page	Cloud name	Code figure C_L	Code figure C_M	Code figure C_H
89	Cirrus fibratus and Cirrus uncinus	0	0	**1**
90	Cirrus uncinus and Cirrus fibratus	5	0	**1**
91	Cirrus uncinus and Cirrus fibratus	0	0	**1**
92	Cirrus fibratus vertebratus	0	0	**1**
93	Cirrus spissatus with virga	2	0	**2**
94	Cirrus floccus	0	0	**2**
95	Cirrus floccus	0	1	**2**
96	Cirrus floccus with virga and Cirrocumulus floccus	0	0	**2**
97	Cirrus spissatus cumulonimbogenitus with Cumulus congestus	2	0	**3**
98	Formation and dissipation of Cirrus spissatus cumulonimbogenitus	9	0	**3**
99	Further formation and dissipation of Cirrus spissatus cumulonimbogenitus	9	0	**3**
100	Cirrus spissatus cumulonimbogenitus with virga	2	0	**3**
101	Cirrus spissatus from Cumulonimbus	9	0	**3**
102	Cirrus spissatus cumulogenitus with virga	9	0	**3**
103	Cirrus uncinus with Cirrostratus	0	2	**4**

Page	Cloud name	Code figure C_L	Code figure C_M	Code figure C_H
104	Cirrus uncinus radiatus	0	0	**4**
105	Cirrus uncinus	0	0	**4**
106	Cirrus uncinus radiatus	0	0	**4**
107	Cirrus fibratus duplicatus	7	0	**4**
108	Cirrus uncinus and Cirrostratus	0	0	**5**
109	Cirrus and Cirrostratus thickening into Altostratus (with Altocumulus)	0	7	**5**
110	Cirrostratus	0	0	**6**
111	Cirrus fibratus and Cirrostratus	0	3	**6**
112	Cirrostratus nebulosus	0	0	**7**
113	Cirrostratus translucidus fibratus	1	0	**7**
114	Cirrostratus fibratus	0	0	**7**
115	Cirrostratus fibratus with Altocumulus castellanus undulatus	0	8	**8**
116	Cirrostratus nebulosus	2	0	**8**
117	Cirrocumulus stratiformis undulatus	0	0	**9**
118	Cirrocumulus stratiformis lacunosus	0	0	**9**
119	Cirrocumulus stratiformis undulatus lacunosus	0	0	**9**
120	Cirrocumulus lenticularis	0	0	**9**

OROGRAPHIC CLOUDS

Page	Description	Code figure C_L	Code figure C_M	Code figure C_H
123	Conjoined orographic clouds	**5**	**4**	0
124	Orographic cloud (cap)	5	**4**	1
125	Cumulus fractus	**1**	0	0
126	Föhn wall, rotor clouds and orographic Altocumulus lenticularis	**2**	**4**	0
127	Orographic Stratocumulus and Altocumulus (wave clouds)	**8**	**4**	0

Page	Description	Code figure C_L	Code figure C_M	Code figure C_H
128	Cumulus fractus and Altocumulus lenticularis	**1**	**2**	0
129	Orographic Stratocumulus	**8**	0	7
130	Cumulus fractus, Cumulus humilis and Altocumulus	**1**	**4**	0

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135	Lenticular Altocumulus with Cumulus and Cirrostratus
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141	Broken layers of mainly stratiform clouds
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Page	Special cloud
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