

Cloud: Type

Clouds: Aggregate of
ice or water droplets

Classification

1. Appearance

- a. Cirrus-wispy/curl of hair
- b. Stratus-sheet-like/layer
- c. Cumulus-puffy/heap
- d. Nimbo- or -nimbus:
“producing rain”

2. Height

- a. High clouds
- b. Middle clouds
- c. Low clouds
- d. Vertical development

Cloud Shapes



A Stratus: Flat, sheetlike



B Cumulus: Heaped up



C Cirrus: Wispy



D Nimbo-, or -Nimbus: Prefix or suffix meaning “Producing precipitation.”

Different Kinds of Cloud

Clouds has been defined as a visible aggregation of minute water droplets and / or ice particles in the air, usually above the general ground level.

A. High (mean heights 6 to 13 km) (Mean lower level 20000 ft)

- i) Cirrus (ci)
- ii) Cirrocumulus (cc)
- iii) Cirrostratus(cs)

B. Middle (Mean heights 2 to 7 km) (6500 to 20000')

- i) Altostratus (As)
- ii) Altocumulus (Ac)

C. Low (mean heights < 2 km) (Close to earth's surface to 6500')

- i) Nimbostratus (Ns)
- ii) Stratocumulus (Sc)
- iii) Stratus (St)
- iv) Cumulus (Cu) (Also Vertical Cloud)
- v) Cumulonimbus(Cn) (Also Vertical Cloud)

High Clouds

Above 6000 meters (20,000 feet) to 12,000 meters (top troposphere)

Height a little dependent on temperature

Lower for colder surface temperatures

Composed of ice crystals (ave. temp. -35°C)

Little water vapor at these temperatures

- 1. Cirrus (Ci)**
- 2. Cirrostratus (Cs)**
- 3. Cirrocumulus (Cc)**

High Clouds - Cirrus

Above 6000 meters (20,000 feet)

Cirrus (Ci)

Thin, wispy, detached filaments, or fibrous (Hair like) clouds of ice (curl or lock of hair)
"Mare's tail"

Simplest

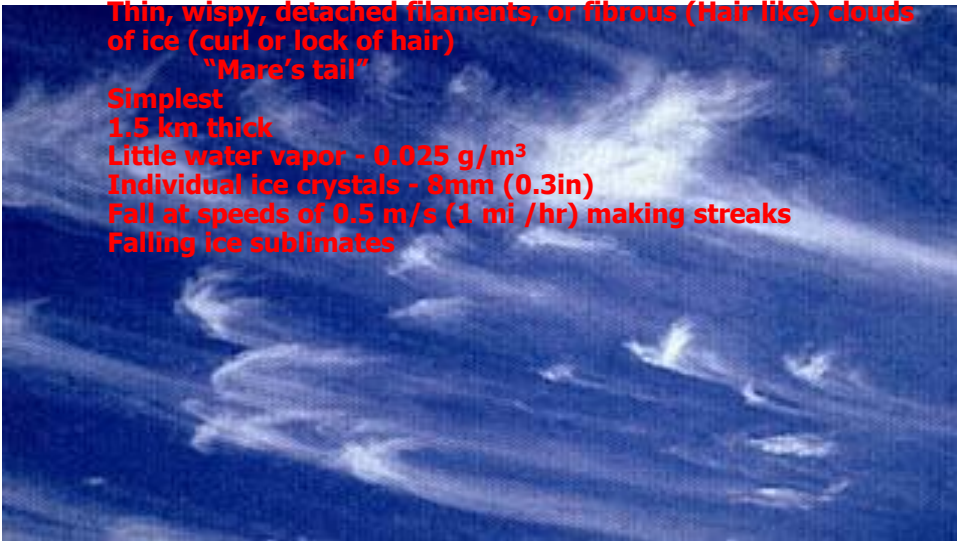
1.5 km thick

Little water vapor - 0.025 g/m^3

Individual ice crystals - 8mm (0.3in)

Fall at speeds of 0.5 m/s (1 mi /hr) making streaks

Falling ice sublimates



High Clouds - Cirrostratus

Above 6000 meters (20,000 feet)

Cirrostratus (Cs)

Transparent Layered, thin veil or fibrous clouds of ice
gives milky appearance

More extensive horizontally than cirrus

Lower concentration of ice than cirrus

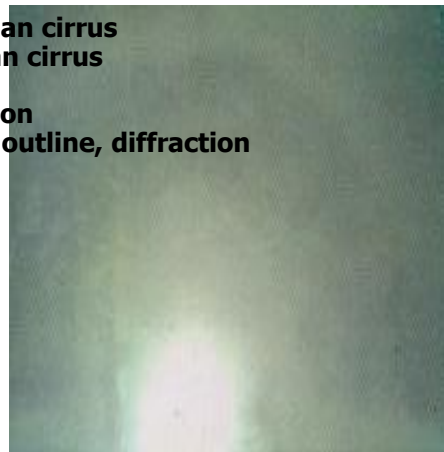
Surface objects cast shadows

Halo (22°) around sun and moon

whitish, milky disk with sharp outline, diffraction



Shadow



Halo

High Clouds - Cirrocumulus

Above 6000 meters (20,000 feet)

Cirrocumulus (Cc)

Composed of individual, puffy, very small elements in form of grains, ripples; rows of clouds of ice and supercooled liquid water

Refraction of light by ice produce colors,

Form when a wind shear exists

Wind speed or direction changes with height

Often precursor of precipitation - warm front

Resemble fish scales - "Mackerel Sky"



"Mackerel Sky"



Puffy Rows of Clouds

Middle Clouds

2000 to 7000 meters (6500 to 20,000 feet)

Composed of liquid droplets of water

Alto means middle in music

1. Altostratus (As)

2. Altocumulus (Ac)

Middle Clouds - Altostratus

2000 to 7000 meters (6500 to 20,000 feet)

Altostratus (As)

Middle-level counterparts to cirrostratus

Liquid water droplets; greyish or bluish uniform appearance

Scatter a lot of insolation back to space

Diffused light

Absence of shadows

Sun and Moon (if seen) are bright spots with no outline
supercooled liquid droplets, Fine drizzle or snow



No shadow



Diffused light

Middle Clouds Altocumulus

2000 to 7000 meters (6500 to 20,000 feet)

Altocumulus (Ac); Composed of Liquid supercooled water droplets

Layered but puffy clouds forming long bands, or

contains a series of puffy clouds in rows, rounded

masses, rolls etc referred as sheep clouds or woolpack

clouds sometime partly fibrous or diffused

White or Gray in color with possibly one part darker

width usually 1-5 degree(°)



Low Clouds

**Bases below 2000 meters (6500 feet)
Composed of liquid droplets**

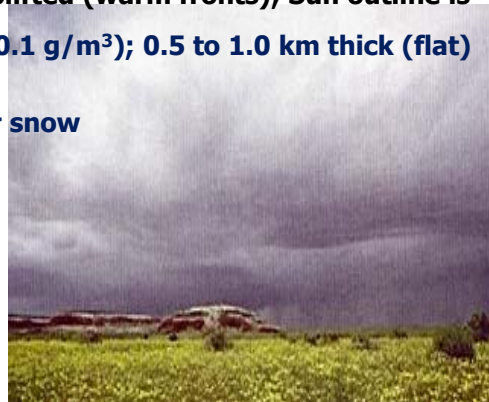
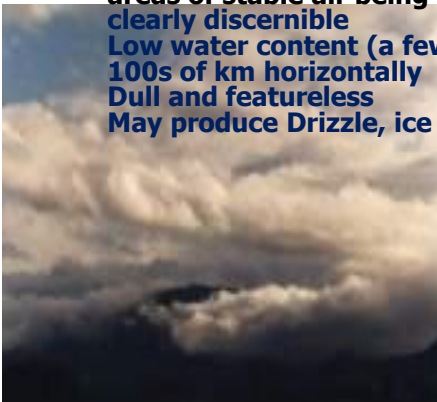
- 1. Stratus (St)**
- 2. Stratocumulus (Sc)**
- 3. Nimbostratus (Ns)**

Low Clouds - Stratus

**Bases below 2000 meters (6500 feet)
Composed of liquid droplets**

**Stratus (St); Hard to differentiate between high fog and stratus cloud
Generally grey uniform Layered clouds formed from large
areas of stable air being uplifted (warm fronts); Sun outline is
clearly discernible**

**Low water content (a few 0.1 g/m^3); 0.5 to 1.0 km thick (flat)
100s of km horizontally
Dull and featureless
May produce Drizzle, ice or snow**



Dark from blocking insolation

Low Clouds - Stratocumulus

Bases below 2000 meters (6500 feet)

Composed of liquid droplets

Stratocumulus (Sc)

Layered clouds with vertical development

Heaped up (rounded masse), non fibrous;

Large lumpy masses of dull gray colour with brighter interestices

Darkness varies because of vertical thickness

Darker is thicker

width >5 degree



Low Clouds - Nimbostratus

Bases below 2000 meters (6500 feet)

Composed of liquid droplets

Nimbostratus (Ns)

Much like stratus, except for presence of precipitation

Dull and featureless; thick enough to blot out the sun

Low moisture content produces light precipitation over many hours;



Clouds with Vertical Development

**Bases below 2000 meters but extend into middle-level
and even stratosphere for cumulonimbus**

Composed of liquid droplets

Cumuliform clouds

Those with substantial vertical development

**Updrafts have speeds greater than weak
hurricanes exceed 50 m/s (100 mi/hr)**

Water content $\sim 1 \text{ g/m}^3$

(much larger than stratiform clouds)

1. Cumulus (Cu)

a. Cumulus humilis

b. Cumulus congestus

2. Cumulonimbus (Cn)

Clouds with Vertical Development Cumulus humilis

Detached clouds, generally dense and with sharp outlines

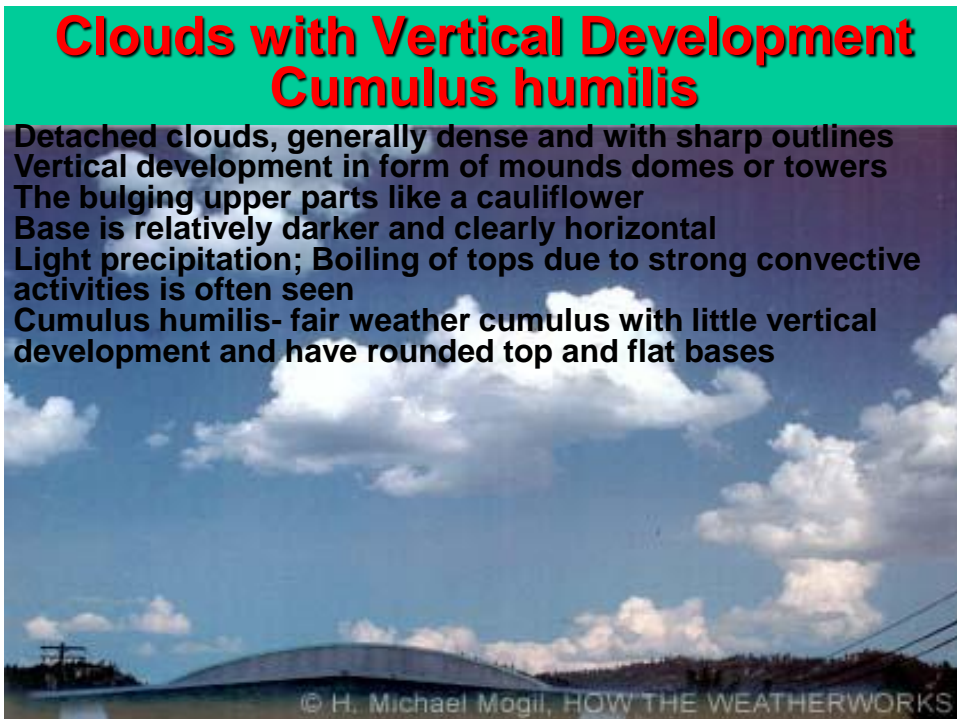
Vertical development in form of mounds domes or towers

The bulging upper parts like a cauliflower

Base is relatively darker and clearly horizontal

**Light precipitation; Boiling of tops due to strong convective
activities is often seen**

**Cumulus humilis- fair weather cumulus with little vertical
development and have rounded top and flat bases**



© H. Michael Mogil, HOW THE WEATHERWORKS

Clouds with Vertical Development Cumulus congestus

Cumulus congestus have marked vertical development, but not reaching the cumulonimbus stage



Clouds with Vertical Development Cumulonimbus

Cumulonimbus (Cn)

Most violent, heavy and dense cloud with a considerable vertical extent, base often very dark

Warm, humid, and unstable air

Produce thunderstorms, lightning, short duration

heavy rain, strong gusty winds

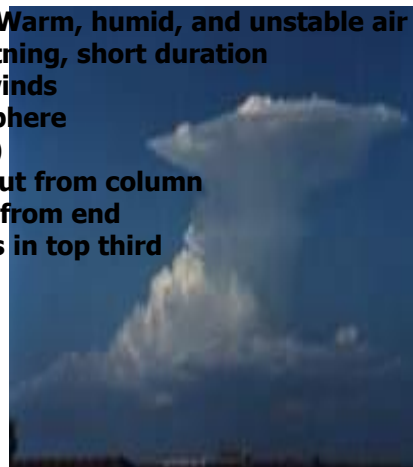
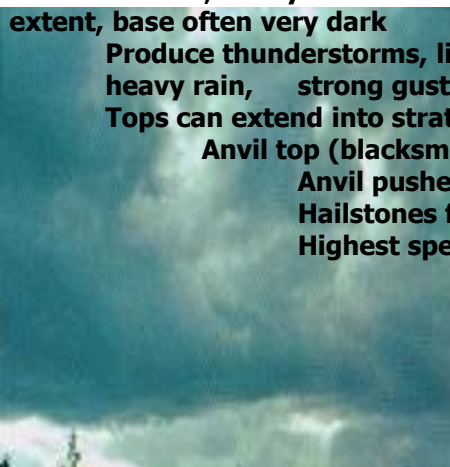
Tops can extend into stratosphere

Anvil top (blacksmith)

Anvil pushed out from column

Hailstones fall from end

Highest speeds in top third



Anvil over Column
Forward Edge - Hailstones

Unusual Clouds - Lenticular

Lenticular: Lens-like

Form downwind of mountain barriers

Usually only two or three form, but six have been observed



Unusual Clouds - Banner

Banner

Similar, but are located above isolated peaks



Unusual Clouds - Mammatus

Mammatus

Cumulus clouds that seem to have sack-like hangings, places that are heavy with water



Unusual Clouds Above the Troposphere - Nacreous

1. Nacreous

**Seen in the winter at twilight in the polar regions
Supercooled water or ice crystals
Height: 30 km (20 miles) in stratosphere**



Unusual Clouds Above the Troposphere - Noctilucent

2. Noctilucent

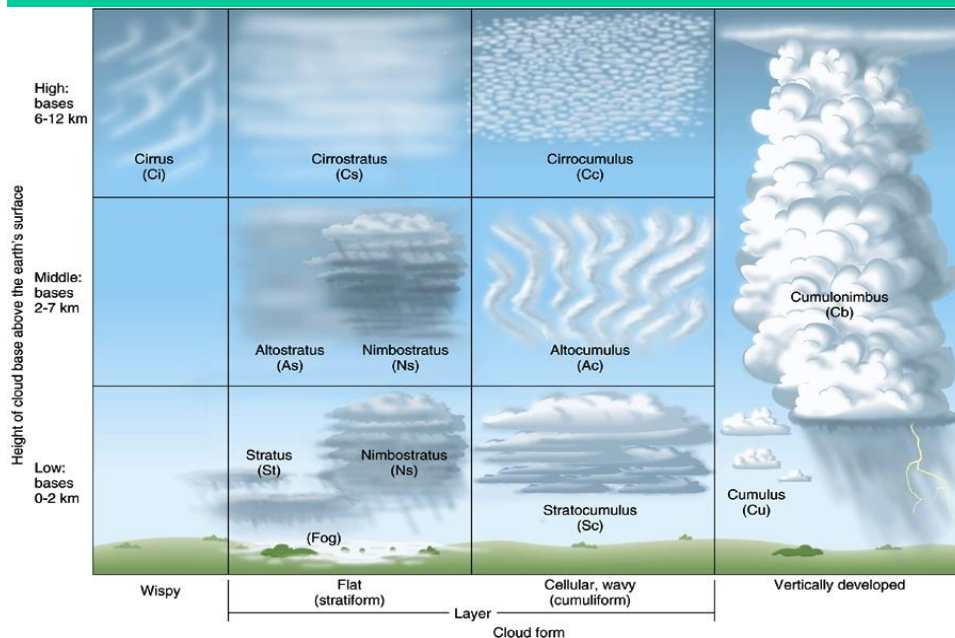
In mesosphere

Illuminated after sunset or before sunrise

Ice crystals



The 10 Cloud Genera



Artificial Rain Making

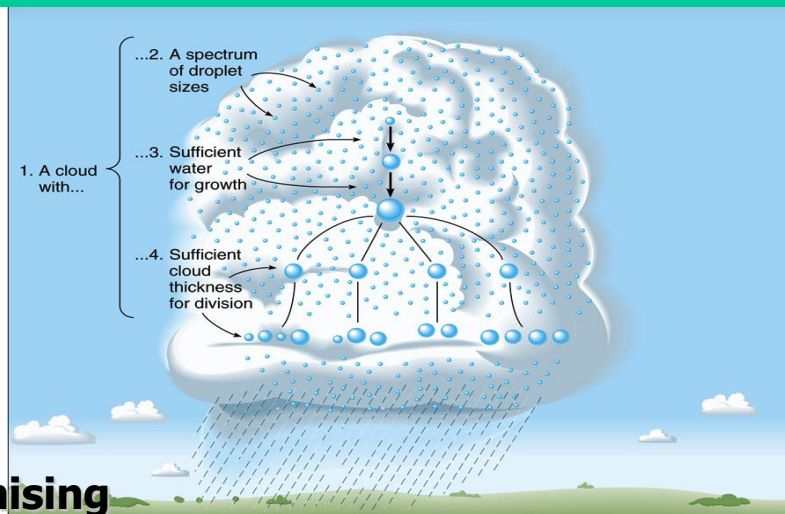
What is needed for process to proceed?

1. Must be a cloud
2. Must contain sufficient water in form of droplets
3. Some droplets must be considerably larger than others (collision-coalescence)

Also need

1. Collision-coalescence efficiencies need to be high
2. Cloud thick enough for large droplets to grow and divide repeatedly

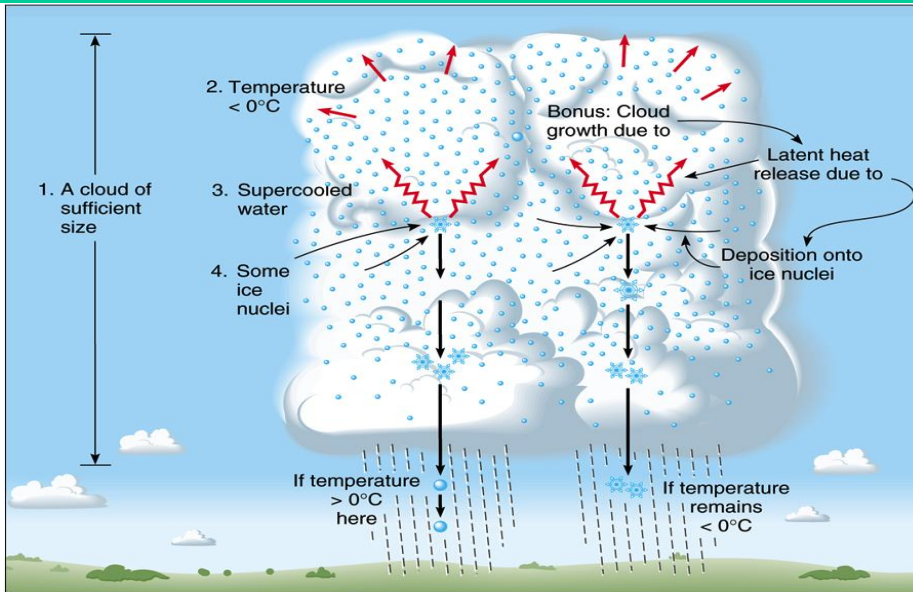
Precipitation via Collision-Coalescence



Promising

For a cloud with sufficient moisture and thickness
 Introduce large droplets into cloud
 Some success: More precipitation produced

Precipitation via Three-phase Process (Bergeron Process)



Dry Ice Seeding

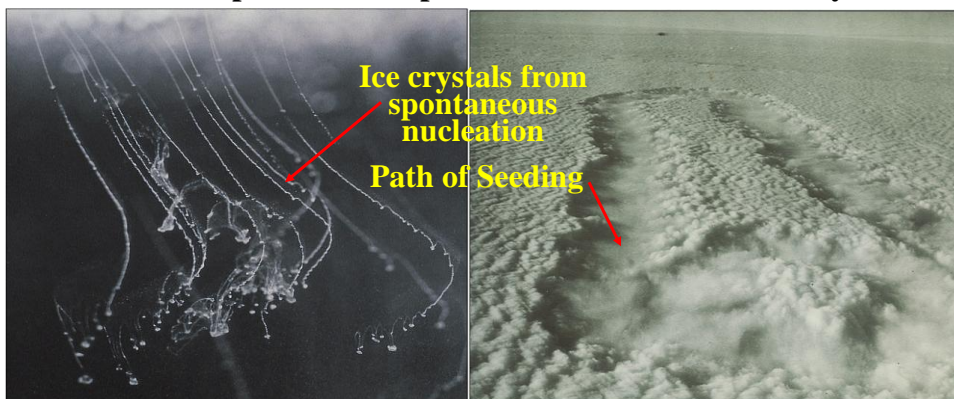
Dry Ice (CO_2) has a temperature of -78.5°C

Well below -39°C needed for spontaneous nucleation of supercooled water

Dropped in a cloud

Would lower temperature to -39°C

Cause supercooled droplets to freeze on contact to dry ice



Other Seeding

Other particles active in seeding
By providing a nucleus

Ice (H_2O): Obviously, since that is the original

Silver Iodide (AgI): Has similar structure and dimensions to ice: 6-sided

Soil: Hygroscopic in nature

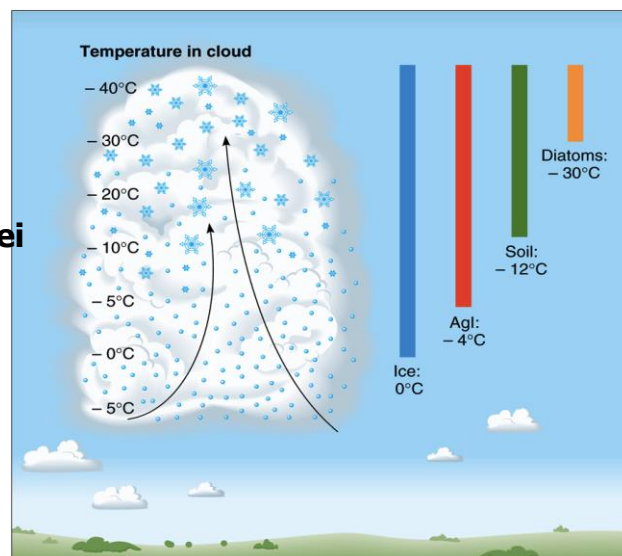
Salt (NaCl): Hygroscopic in nature

Diatoms (microscopic , one-cell organisms)

Each of these has an activation temperature only below which it will work

Active Seeding Temperature

Silver Iodide
has a reasonable
temperature
Such seeding can
produce 10^{17} nuclei



Dynamic Effects

Seeding causes motion in the cloud

Water deposition on to Silver Iodide releases latent heat

Warms the cloud

**Cloud is further unstable and produces strong
updrafts**

This promotes more water droplets