MTO 412E Physics of Cloud and Precipitation

Cloud Development and Cloud Types

Learning Objectives

1. The various atmospheric lifting mechanisms and how these influence cloud formation.
2. Static stability and how it influences cloud formation.
3. The major types of clouds that are produced by these processes.

What do clouds tell us?

- Clouds just don't happen - there's always a reason
- A particular cloud's shape and location depend on (and can therefore tell us about):
  - the movement of the air
  - amount of water vapor in air
  - stability (flat clouds = stable air while puffy clouds = unstable air)

Poem

I wandered lonely as a cloud
That floats on high o'er vales and hills,
When all at once I saw a crowd,
A host, of golden daffodils.

William Wordsworth

Clouds

Crucial Role in the Hydrologic Cycle

Most Prominent Feature of Daily Weather

Global Importance

Clouds

- Clouds result when air becomes saturated away from the ground
- They can
  - be thick or thin, large or small
  - contain water drops and/or ice crystals
  - form high or low in the troposphere
  - even form in the stratosphere (important for the ozone "hole"!)

- Clouds impact the environment in many ways
  - Radiative balance, water cycle, pollutant processing, earth-atmosphere charge balance, etc….

Producing Clouds

1. Adding Water Vapor into the Air

2. Mixing Warm Moist Air with Cold Air

3. Lowering the Air Temperature

Most Important for Clouds

Lifting the Air Will Cool It Adiabatically

Forming Clouds Requires Mechanisms to Lift Air

Mechanisms That Lift Air

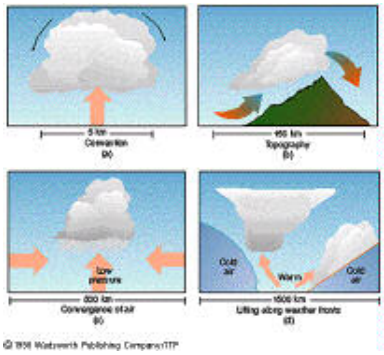
1. Orographic Lifting: Forcing of Air Above a Mountain (Land) Barrier.

2. Frontal Lifting: Displacement of One Air Mass (Warmer) Over Another Air Mass (Cooler).

3. Convergence: Horizontal Movement of Air Into an Area at Low Levels.

4. Localized Convective Lifting: Buoyancy (Heating).

Mechanisms that Lift Air



Orographic Lifting

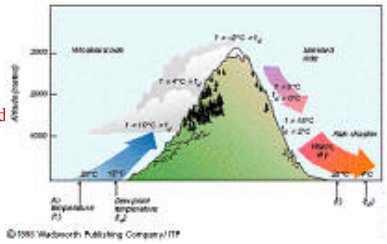
- Air flowing up a hill/mountain forces adiabatic cooling. This promotes precipitation.
- The opposite occurs downwind of a mountain (leeward side) as air descends and warms by compression. This inhibits precipitation.

Orographic Clouds

- Clouds can also be caused by mountains or hills
- Result to air flowing up and over mountains which causes condensation to occur and clouds to form
- Different types of clouds caused by orographic lift follow

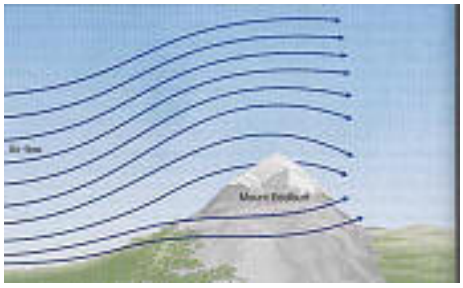
Orographic clouds

- Forced lifting along a topographic barrier causes air parcel expansion and cooling
- Clouds and precipitation often develop on upwind side of obstacle
- Air dries further during descent on downwind side



Orographic Lifting

Forcing of Air Above a Mountain (Land) Barrier.



Cloud Classification

- In 1803, Luke Howard devised the basic system of cloud classification
- Still used today
- Based on Latin names
- Two parts to a cloud's name:
  - Shape (ex: cirrus, stratus, cumulus)
  - Height (cloud base & vertical extent)

Classification of cloud

- First classification (Luke Howard) based on they appear to a ground observer:
  - Sheetlike cloud – stratus (in Latin means 'layer')
  - Puffy cloud – cumulus (means 'heap')
  - Cirrus (means curl of hair'
  - Nimbus (means 'violent rain')

  Other cloud description is based on the combination of these four basic cloud forms – e.g., nimbostratus

  Next classification based on the height of the cloud's base above the surface: high clouds, middle clouds, low clouds and clouds that show vertical rather than horizontal development

  Altitudes separating high and middle cloud groups overlaps and varies with latitude – cirrus clouds at 4,000 m above Alaska will not be seen above Miami at the same height

Cloud classification – contd.

- **High Clouds:** Clouds composed of ice crystals and are thin;
  - Cirrus clouds usually move across the sky from west to east
  - cirrocumulus less seen frequently than cirrus
  - cirrostratus form ahead of an advancing storm; appearance of cirrostratus used to predict rain or snow within 12-24 hrs
- **Middle Clouds:** Have bases 2-7 km;
  - Altocumulus: One part of the cloud is darker than the other
  - Altostratus: Gray or blue-gray cloud often covering entire sky or over an area that extends over many hundreds of square km; often forms ahead of storms having widespread and continuous precipitation; if precipitation takes place from this cloud, the base height lowers

Cloud classification – contd.

- Low Clouds: Bases lie below 2000 m; composed of water droplets (in cold weather may contain ice crystals and snow)
  - Nimbostratus: Dark gray, 'wet'-looking cloud layer; associated with continuously falling rain or snow; intensity of rain is light or moderate; never heavy, showery variety
  - Stratocumulus: Rain or snow rarely fall from stratocumulus
  - Stratus: When a thick fog 'lifts,' the resulting cloud is low stratus; generally no precipitation falls from the stratus

  Clouds with Vertical Development: Takes a variety of shapes, most often looks like a piece of floating cotton with sharp outlines and flat base; precipitation from cumulus congestus is always showery

Shapes & Heights

- Shapes
  - Cirrus = curly and wispy
  - Stratus = layered or stratified
  - Cumulus = lumpy or piled up
- Heights
  - Cirro = high (bases above 20,000 ft)
  - Alto = mid level (bases 7,000-20,000 ft)
  - Nimbo = producing precipitation

Combining Shapes & Heights

- Many different names of clouds combine:
  - a height (cirro-, alto-, nimbo)
  - a shape (cirrus, stratus, cumulus)
- Let's look at examples of these word combinations to describe different cloud types.

Cloud classification

- Clouds are categorized by their height, appearance and vertical development
  - High Clouds - generally above 16,000 ft at middle latitudes
    - Main types - **Cirrus, Cirrostratus, Cirrocumulus**
  - Middle Clouds – 7,000-23,000 feet
    - Main types – **Altostratus, Altocumulus**
  - Low Clouds - below 7,000 ft
    - Main types – **Stratus, stratocumulus, nimbostratus**
  - Vertically developed clouds (via convection)
    - Main types – **Cumulus, Cumulonimbus**

Cloud Types By Height

1. High Clouds

Cirrus	**Thin, Wispy Clouds of Ice**
Cirrostratus	**Layered, Thin, Wispy Clouds of Ice**
Cirrocumulus	**Thin, Wispy Clouds of Ice with Vertical Development**

2. Middle Clouds

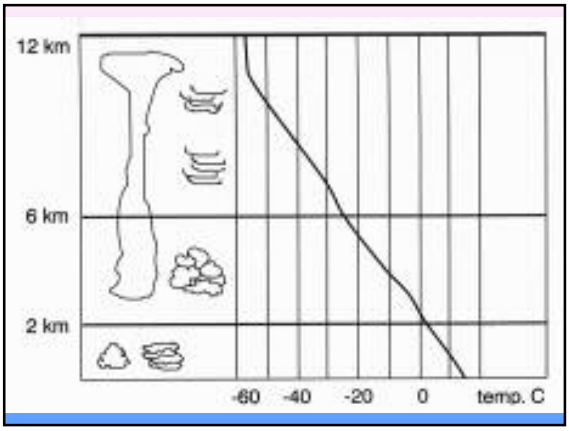
Altostratus	**Higher, Layered Clouds**
Altocumulus	**Higher Clouds with Vertical Development**

3. Low Clouds

Stratus	**Layered Clouds**
Stratocumulus	**Layered Clouds with Vertical Development**
Nimbostratus	**Rain-producing, Layered Clouds**

4. Extensive Vertical Development

Cumulus	**Clouds Having Vertical Development**
Cumulonimbus	**Rain-producing Clouds with Vertical Development**

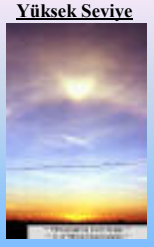


High Clouds (Cirrus, Ci, Cirrostratrus, Cs); Middle (Altostratus, As, Altocumulus, Ac); Low (Stratus, St, Stratocumulus, Sc, Nimbostratus, Ns); & Clouds w/vertical development (cumulus, Cu, & Cumulonimbus, Cb)

- Approxi. Height of cloud bases above surface

Cloud Group	Tropical Region	Mid-lati. region	Polar Region
High (Ci, Cs, Cc)	6000 – 18000 m	5000 – 13,000 m	3000 – 8000 m
Middle (As, Ac)	2000 – 8000 m	2000 – 7000 m	2000 – 4000 m
Low (St, Sc, Ns)	0 – 2000 m	0 – 2000 m	0 – 2000 m

Yüksek Seviye



•Cirrus
•Cirrostratus
•Cirroculumulus
5-13 km

Orta Seviye

•Altostratus
•Altocumulus
2-7 km

Alçak Seviye

•Stratus
•Stratocumulus
•Nimbostratus
0-2 km

High Clouds

Above 6000 meters (19,000 feet)
Height a Little Dependent on Temperature
Lower for Colder Surface Temperatures
Composed of Ice (Ave. Temp. -35°C)
Cooling to the Frost Point
Little Water Vapor at these Temperatures

1. Cirrus (Ci)

2. Cirrostratus (Cs)

3. Cirrocumulus (Cc)

High Clouds

- High clouds
  - White in day; red/orange/yellow at sunrise and sunset
  - Made of ice crystals
  - Cirrus
    - Thin and wispy
    - Move west to east
    - Indicate fair weather
  - Cirrocumulus
    - Less common than cirrus
    - Small, rounded white puffs individually or in long rows (fish scales; mackerel sky)

  - Cirrostratus
    - Thin and sheetlike
    - Sun and moon clearly visible through them
    - Halo common
    - Often precede precipitation

High Clouds - Cirrus

Above 6000 meters (19,000 feet)

Cirrus (Ci)
Thin, Wispy Clouds of Ice
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

Cirrus Clouds

- Cirrus = high altitude wispy clouds
- Quite thin and often have a hairlike or filament type of appearance.
- Made up of ice particles
- The curled up ends (called mares' tales) as depicted in the following picture are very common features.

Cirrus clouds-6-18 km in tropics; 5-13 km in midlatitude; 3-8 km in polar region

Cirrus

Cirrus Display at Dawn

Cirrus Photo

Cirrus

Cirrus

Cirrus

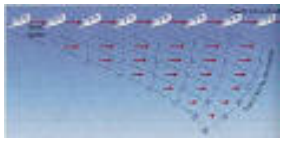
Cirrus

very high altitude

all ice crystals

Cirrus

Fall Streaks



Ice Sublimates

Table top radiation cloud (plus cirrus)

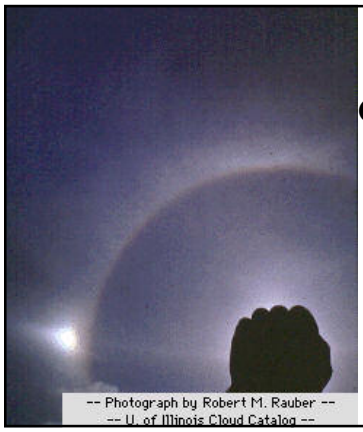
High Clouds - Cirrostratus

Above 6000 meters (19,000 feet)

Cirrostratus (Cs)

- **Layered, Thin Clouds of Ice**
- **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**

Cirrus and stratocumulus clouds at sunset by a lake in northern Sweden



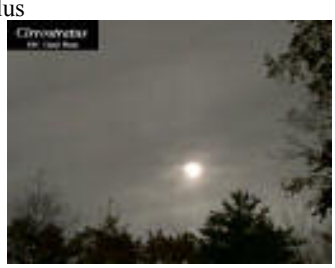
Cirrostratus ve Hale

Cirrostratus

Cirrostratus

Cirrostratus

- High-level stratus clouds
- Not as thin as cirrus and less defined than cumulus



Cirrostratus

Cirrostratus with Halo

Cirrostratus clouds with a halo: form ahead (12-24 hrs) of an advancing storm

High Clouds - Cirrocumulus

Above 6000 meters (19,000 feet)

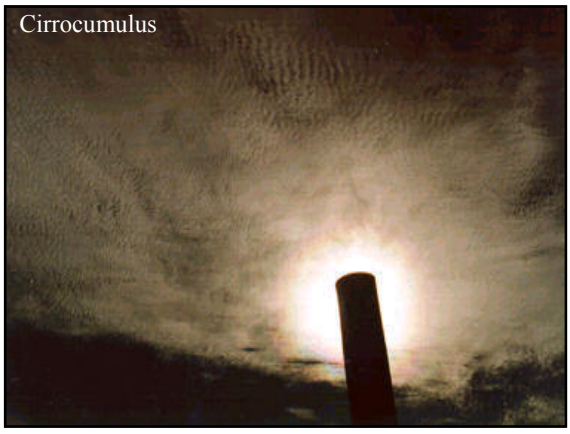
Cirrocumulus (Cc)

- **Individual, Puffy Rows of Clouds of Ice**
- **Form When a Wind Shear Exists**
  - **Wind Speed or Direction Changes with Height**
- **Often Precursor of Precipitation - Warm Front**
- **Resemble Fish Scales - "Mackerel Sky"**

High Clouds (cirro)

- Located above 6,000 m (19,000 ft).
- Composed of ice crystals
- Low water content because of low temperatures (-35°C)

Cirrocumulus



Cirrocumulus

Cirrocumulus

Cirrocumulus

Cirrocumulus

Cirrocumulus at Sunset

Cirrocumulus

- high cumulus clouds
- Can see individual “puffy” features

Cirrocumulus clouds: Less frequently seen, appear as small, rounded, white puffs

Contrails

Fall Streaks

Middle Clouds

2000 to 6000 meters (6000 to 19,000 feet)
Composed of Liquid Droplets of Water
Alto means Middle

1. Altostratus (As)

2. Altocumulus (Ac)

Middle Clouds (alto)

- Located between 2000 - 6,000 m (6,000 - 19,000 ft).
- Composed mainly of liquid droplets

Middle Clouds

- Altocumulus
  - <1 km thick
  - mostly water drops
  - Gray, puffy
  - Differences from cirrocumulus
    - Larger puffs
    - More dark/light contrast
- Altostratus
  - Gray, blue-gray
  - Often covers entire sky
  - Sun or moon may show through dimly
    - Usually no shadows

Middle Clouds - Altostratus

2000 to 6000 meters (6000 to 19,000 feet)

Altostratus (As)

Middle-level Counterparts to Cirrostratus
Liquid Water Droplets
Scatter a Lot of Insolation Back to Space
Diffused Light
Absence of Shadows
Sun and Moon (If Seen) Are Bright Spots With No Outline

Altostratus cloud: Often form ahead of storms having widespread and relatively continuous precipitation

Altostratus

Alto Stratus Castellanus

Altostratus

Altostratus

Altostratus

- Mid level stratus clouds

Middle Clouds - Altocumulus

2000 to 6000 meters (6000 to 19,000 feet)

Altocumulus (Ac)

- **Liquid Water Droplets**
- **Layered but Puffy Clouds Forming Long Bands, or Contains a Series of Puffy Clouds in Rows**
- **Gray in Color With Possibly One Part Darker**

Altocumulus cloud: Presence in warm, humid summer morning – thunderstorms by late afternoon

Altocumulus

- Mid level cumulus clouds

Altocumulus

Altocumulus

Alto Cumulus Radiatus

Alto Cumulus

Alto Cumulus Undulatus

Altocumulus

Altocumulus

Low Clouds

Bases below 2000 meters (6000 feet)
Composed of Liquid Droplets

1. Stratus (St)

2. Stratocumulus (Sc)

3. Nimbostratus (Ns)

Low Clouds

- Stratus
  - Uniform, gray
  - Resembles fog that does not reach the ground
  - Usually no precipitation, but light mist/drizzle possible
- Stratocumulus
  - Low lumpy clouds
  - Breaks (usually) between cloud elements
  - Lower base and larger elements than altostratus
- Nimbostratus
  - Dark gray
  - Continuous light to moderate rain or snow
  - Evaporating rain below can form *stratus fractus*

Stratus fractus

Stratiform cloud layers

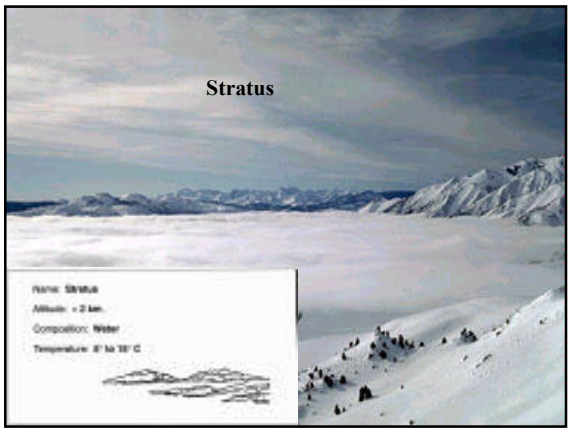
Low Clouds - Stratus

Bases below 2000 meters (6000 feet)
Composed of Liquid Droplets

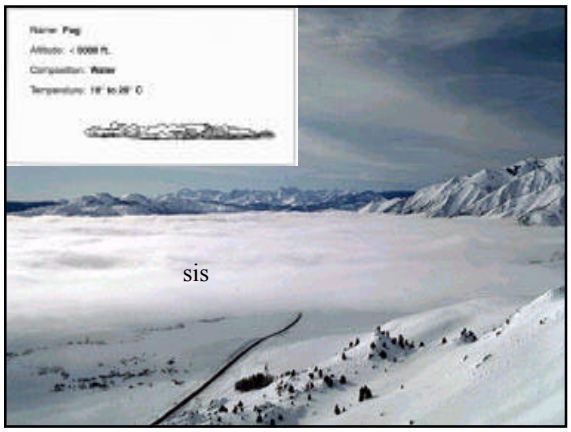
Stratus (St)
Layered Clouds Formed From Large Areas of Stable Air being Uplifted (Warm Fronts)
Slow Uplift (Few 10s cm/s), or
Turbulence From Strong Winds Forced Convection
Low Water Content (a few 0.1s g/m^3)
0.5 to 1.0 Km Thick
100s of km Horizontally

Stratus Clouds

- Stratus clouds are usually the lowest of the low clouds.
- Often appear as an overcast deck (as shown in next slide), but can be scattered.
- The individual cloud elements have very ill-defined edges compared to cumulus
- Fog is just stratus clouds on the surface



A layer of low-lying stratus clouds: no precipitation falls from the stratus clouds



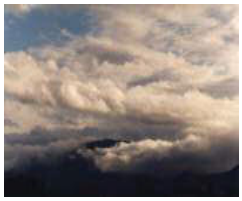
Stratus Photo

Fog (Stratus on Ground) Photo

Stratus

A Layer of Stratocumulus Cloud viewed from above

Stratus



Dark from Blocking Insolation

Stratus

Low Clouds - Stratocumulus

Bases below 2000 meters (6000 feet)
Composed of Liquid Droplets

Stratocumulus (Sc)
Layered Clouds With Vertical Development
Darkness Varies Because of Vertical Thickness
Darker Is Thicker

Alçak Seviye Bulutu Stratocumulus

Stratocumulus

Stratocumulus cloud streets

Stratus undulatus

Stratocumulus

- Cross between stratus and cumulus

Stratocumulus

Stratocumulus - low level layer cloud - mainly water
gentle updraft - slow droplet growth - drizzle

Stratocumulus clouds: Rarely rain or snow fall from this cloud

Low Clouds - Nimbostratus

Bases below 2000 meters (6000 feet)
Composed of Liquid Droplets

Nimbostratus (Ns)
Much Like Stratus, Except for Presence of Precipitation
Low Moisture Content Produces Light Precipitation

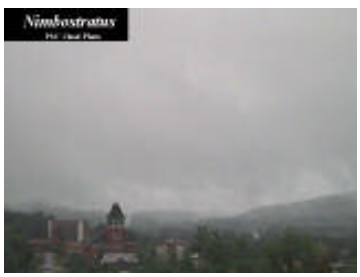
Nimbostratus

Nimbostratus

Nimbostratus cloud: associated with continuously falling rain or snow; Intensity: light to moderate

Nimbostratus

- Stratus clouds that are precipitating



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
Vertical Velocities Exceed 50 m/s (100 mi/hr)
Updrafts Have Speeds Greater Than Weak Hurricanes
Water Content ~1 g/m^3 (Much Larger Than Stratiform Clouds)

1. Cumulus (Cu)
a. Cumulus humilis
b. Cumulus congestus

2. Cumulonimbus (Cn)

Clouds with Vertical Development

- Cumuliform Clouds
  - Can have violent updrafts
  - Can have heavy precipitation
  - Can have vast temperature differences

Clouds with vertical development

- Cumulonimbus is a thunderstorm cloud; condensation of water vapor --- release of energy – violent up- and down-drafts – lightning, thunder, violent tornadoes associated with the cumulonimbus

Other Clouds:

Lenticular clouds: formed in the wave crest ; wave is formed by the moist air crossing a mountain barrier 0rkednmoist air crossing

Mammatus clouds: Formed in sinking air

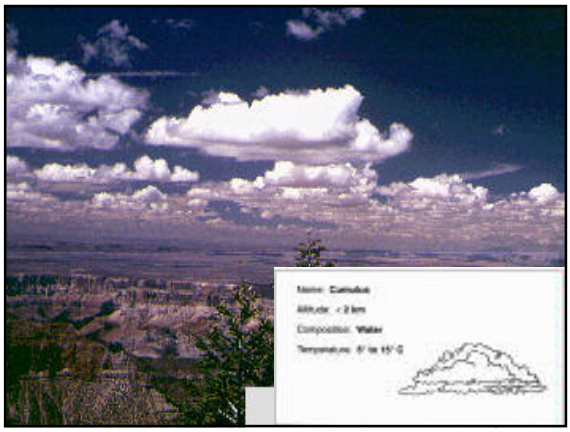
Condensation trail air (or contrail): Trail of Condensed vapor produced by a jet aircraft

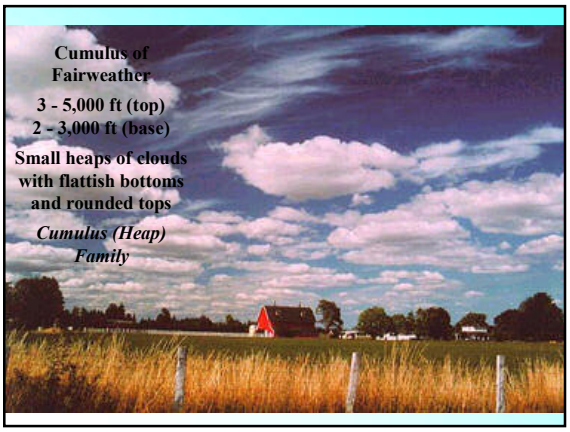
Vertically developed clouds

- Cumulus
  - Puffy "cotton"
  - Flat base, rounded top
  - More space between cloud elements than stratocumulus
- Cumulonimbus
  - Thunderstorm cloud
  - Very tall, often reaching tropopause
  - Individual or grouped
  - Large energy release from water vapor condensation

Cumulus Clouds

- Cumulus clouds are puffy (like popcorn)
- Often have noticeable vertical development
- Cells can be rather isolated or they can be grouped together in clusters as shown
- The base of a cumulus cloud can look like a stratus cloud if it is overhead.
- Thick cumulus can make skies dark (filters out sun's rays)





Clouds with Vertical Development
Cumulus

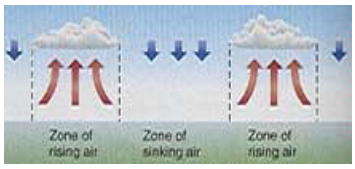
Cumulus (Cu)

2. Cumulus congestus
- **Multi-Towers with Several Cells of Uplift**
- **Strong Vertical Development from Unstable Air**
- **Individual Towers Last Only Tens of Minutes**
  - **Constantly Replaced by New Ones**
- **Large Temperatures from Bottom to Top**
  - **Supercooled Droplets then Ice**
- **Glaciated - Ice Visible Where No Distinct Edges of Clouds**
  - **Washed Out Appearance**

Clouds with Vertical Development
Cumulus

Cumulus (Cu)

1. Cumulus humilis
- **Fair Weather Cumulus**
- **Does Not Yield Precipitation**
- **Evaporate rather Quickly After Formation**
- **Single Raising Plume - Zone of Raising Air**
- **Clear Sky - Zone of Sinking Air**



Clouds with Vertical Development
Cumulus congestus

Fair-weather cumulus

Cumulus clouds

Clouds with Vertical Development
Cumulus humilis

Cumulus Humilis

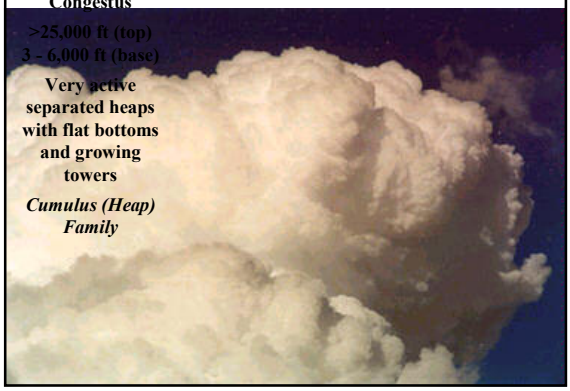
Güneş doğarken Cumulu congestus

Cumulus Congestus

>25,000 ft (top)
3 - 6,000 ft (base)

Very active separated heaps with flat bottoms and growing towers

Cumulus (Heap) Family



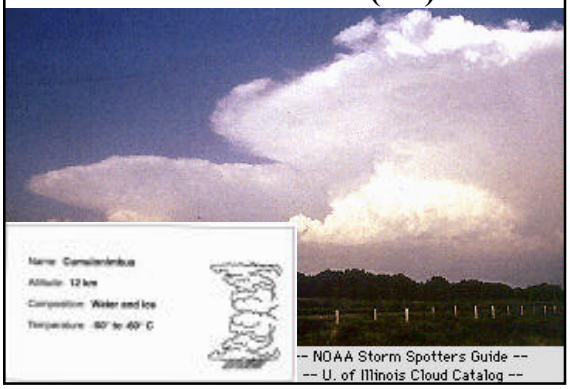
Cumulus Congestus

Cumulus congestus: Precipitation is always showery

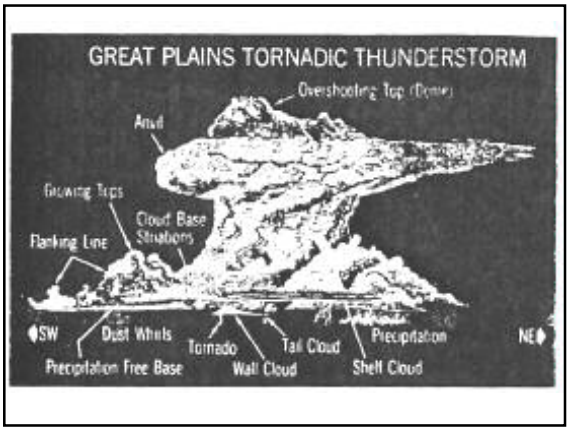
Clouds with Vertical Development
Cumulonimbus

3. Cumulonimbus (Cn)
- **Most Violent**
  - **Warm, Humid, and Unstable Air**
  - **Produce Thunderstorms**
  - **Tops Can Extend Into Stratosphere**
  - **Anvil Top (Blacksmith)**
    - **Composed of Ice in High Winds of Stratosphere)**
    - **Anvil Pushed out from Column**
      - **Hailstones Fall from End**
  - **Strong Updrafts are Not Uniform**
    - **Highest Speeds in Top Third**

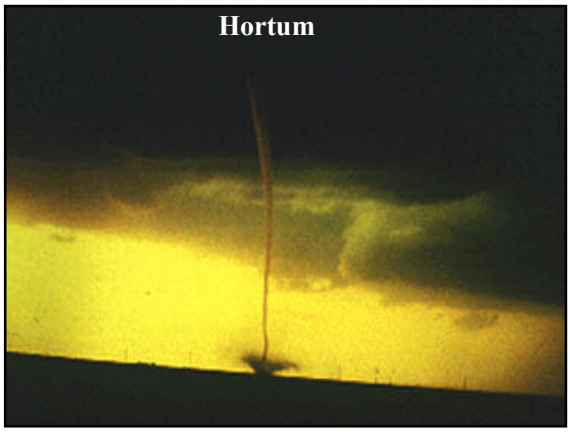
Cumulonimbus (Cb)



Cumulonimbus



Hortum



Cumulonimbus

Anvil over Column
Forward Edge - Hailstones

Cumulonimbus

- Cumulus cloud with precipitation

Cumulonimbus

Strong vertical motion

rapid droplet and crystal growth by condensation then collision

heavy precipitation

Cumulonimbus with Pileaus caps

Cumulonimbus Clouds Spawn Tornadoes

Cumulonimbus: Thunderstorm cloud

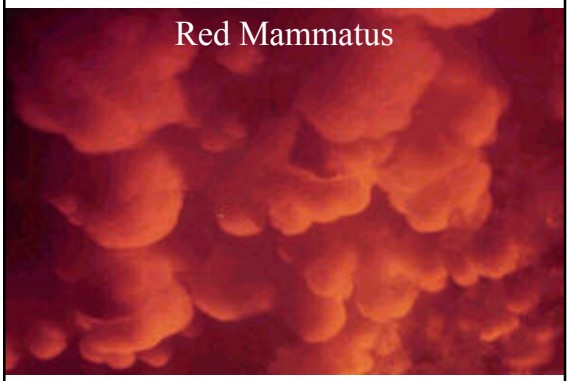
Cumulonimbus

Unusual Clouds

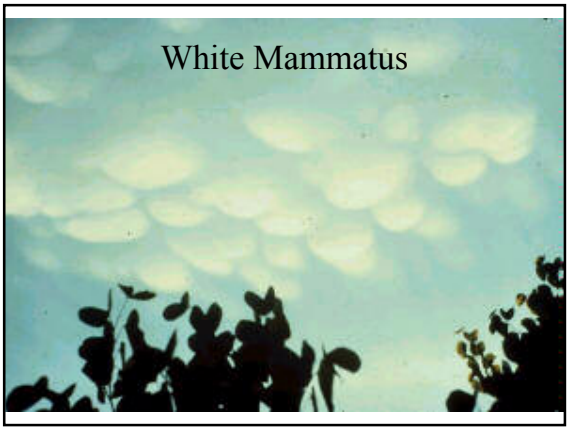
1. Lenticular: Lens-like
   - From Downwind of Mountain Barriers
   - From Disruption of Air Flow
     - Series of Waves
   - Adiabatically
     - Droplets evaporate on Downwind Side, Form on Upwind
   - Usually Only Two or Three Form, but Six Have Been Observed
2. Banner
   - Similar, but Are Located Above Isolated Peaks
3. Mammatus
   - Cumulus Clouds That Seem to Have Sack-like Hangings
   - Places that are Heavy with Water

Mammatus clouds: forms in sinking air

Red Mammatus



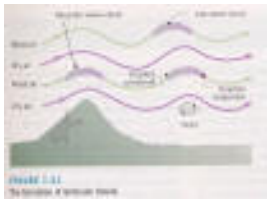
White Mammatus



Bir fırtına sonrası gökyüzü

Lenticular clouds

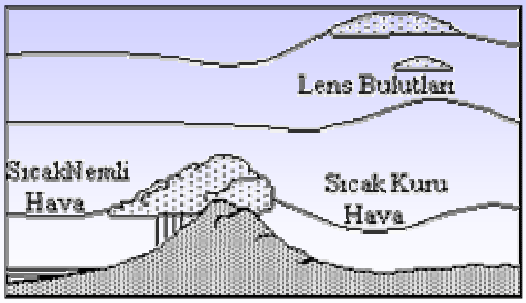
- Stable air flowing over a mountain range often forms a series of waves
  - Think of water waves formed downstream of a submerged boulder
- Air cools during rising portion of wave and warms during descent
- Clouds form near peaks of waves
- A large swirling eddy forms beneath the lee wave cloud
  - Observed in formation of rotor cloud
  - Very dangerous for aircraft



Lenticular Clouds

- Lenticular means “like a lens”
- Looks like flying saucers
- Forms from air rising up a mountain

“Mercek ve Kep” Bulutları



Tuhaf Bulutlar!

Sierra Dağlarının doğusunda bir mercek bulutu...

Mt. Hood Lenticular Cloud

Lenticular

Lenticular clouds (forms in crest) formed on the eastern side of the Sierra Nevada

Cap Clouds

- Air containing water vapor lifted until it is saturated, producing liquid water cloud droplets which can "cap" the summit. (cap cloud over Mt. Ranier)

Wave cloud

Kelvin-Helmholtz Billows

- Occurs in regions of strong density and velocity changes. (dynamics class)

Kelvin-Helmholtz Instability

Contrails

- Contrail is short for "condensation trails"
- Formed from vapor contained in the exhaust of a jet engine when it condenses in cold air aloft

Contrail forming behind a jet aircraft – 10 km from ground

Uçak Egzoz İzi

Banner

Mammatus

Unusual Clouds Above the Troposphere

1. Nacreous
- **Seen in the Winter at Twilight in the Polar Regions**
- **Supercooled Water or Ice Crystals**
- **Height: 30 Km (20 miles) in Stratosphere**

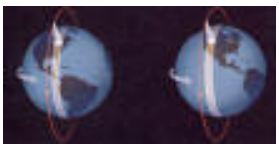
2. Noctilucent
- **In Mesosphere**
- **Illuminated After Sunset or Before Sunrise**
- **Ice Crystals**

Nacreous

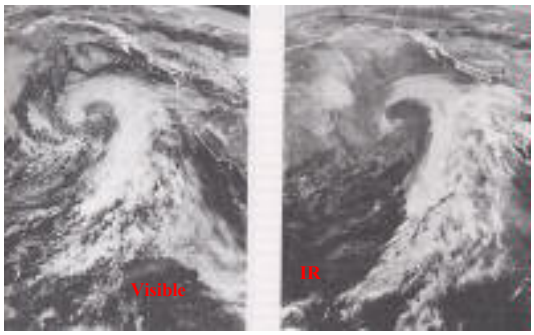
Noctilucent

Satellite observations

- Satellites can be
  - Geostationary
    - Monitors fixed spot on Earth's surface
  - Polar orbiting
    - Orbit poles with Earth revolving below
- Satellites observe
  - Clouds
  - Water vapor
  - Precipitation
  - Surface properties (temperature, snow cover, vegetation, etc…)



Visible and Infrared Satellite Photos



Changing cloud forms

- Differential heating/cooling of top and bottom of a continuous cloud layer can cause it to break up into smaller cloud elements
  - Cloud top absorbs solar radiation but cools more quickly by radiative cooling
  - Bottom of cloud warms by net absorption of IR radiation from below
  - The result is that the layer within the cloud becomes less stable and convection may ensue

Cloud Coverage

Other Characteristic of Clouds Is Coverage
1/10 parts to 10/10 in tenths

Overcast	**More Than Nine-tenths (9/10)**
Broken	**Six-tenths to Nine-tenths (6/10 to 9/10)**
Scattered	**One-tenth to Five-tenths (1/10 to 5/10)**
Clear-sky	**Less Than one-tenth (1/10)**

Detailed Reports
Breakdown is in Tenths of Sky Coverage
Height That Conditions Exist

Cloud Coverage

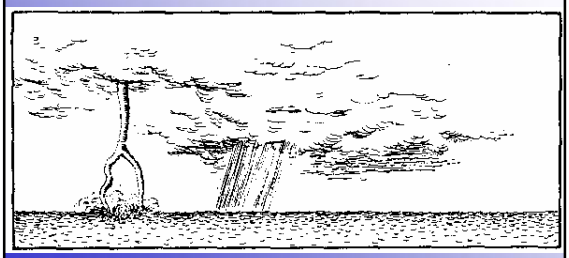
- Overcast – Above 90% of the sky is covered with clouds.
- Broken - Between 60 and 90% of the sky is covered.
- Scattered – Between 10 and 60% of the sky is covered.
- Clear – less than 10% of the sky is covered.

Strange Clouds

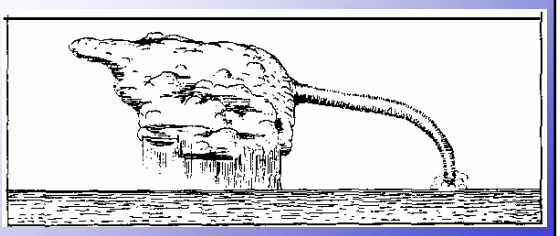
Are you hungry for some "big" popcorn?

Pegasus Horse of the Gods

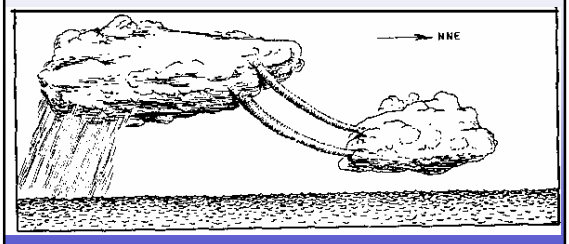
Çatallı Su Hortumu



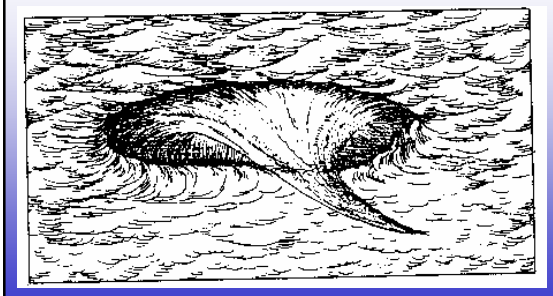
Su Hortumu



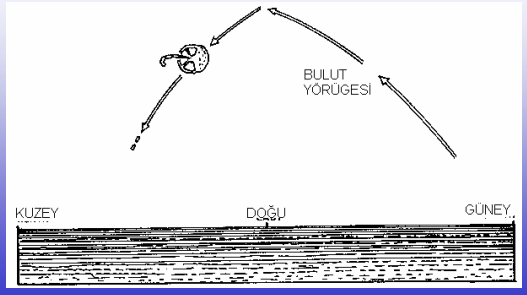
“Tanker” Bulutu



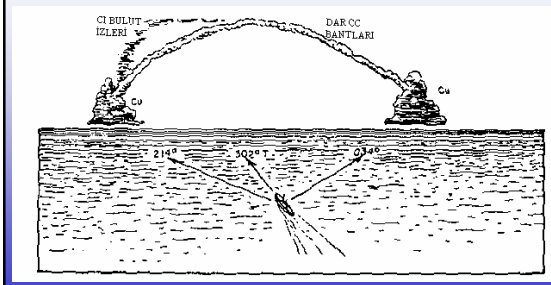
“Yüzük” Bulutu



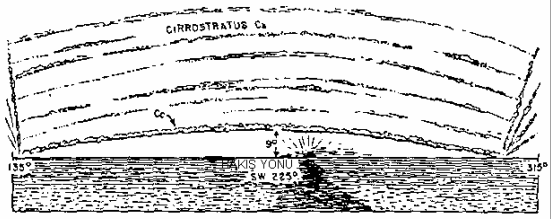
"Şemsiye" Bulutu



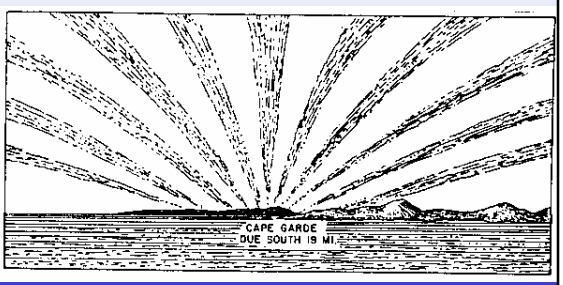
"Kemer" Bulutu



"Kemer" Bulutları



"Kemer" Bulutları



Summary

1. **Lifting Mechanisms: frontal uplift, convergence, orographic uplift, and convection.**

2. **Frontal uplift, convergence, orographic uplift are enhanced or hindered by the static stability of the atmosphere, whereas free convection necessarily occurs only when the air is unstable.**

3. **Instability implies that if a parcel is given an initial boost upward, it will become buoyant and continue to rise. On the other hand, if the air is stable, a parcel displaced vertically will tend to return to its original position.**

Summary

4. Static stability or instability is determined by the air column's rate of temperature decrease with altitude. When the temperature lapse rate is less than the saturated adiabatic rate, the air is statically stable; when it exceeds the dry adiabatic lapse rate, it is unstable. Conditional instability arises when the lapse rate is between the two adiabatic rates. When the air is conditionally unstable, a lifted parcel will rise on its own accord only if it is lifted above a certain critical point called the level of free convection.

5. Three processes modify the lapse rate: the inflow of warm and cold air at different altitudes, the advection of a different air mass, and heating or cooling of the surface.

Summary

6. Environmental lapse rates vary not only through time, but also with elevation. Thus, a column of atmosphere might be unstable at one level but stable aloft.

7. No matter what the condition of the troposphere, the stratosphere is always statically stable and thereby limits the maximum height of updrafts.

8. Inversions are a special case in which the temperature increases with altitude. Because of their strong static stability, inversions suppress the vertical motions necessary for cloud formation and for the dispersion of air pollution. Inversions are formed by subsidence (sinking air), the emission of longwave radiation from the surface, and the presence of fronts.

Summary

9. Clouds have been categorized into ten distinct types grouped according to their height and form.

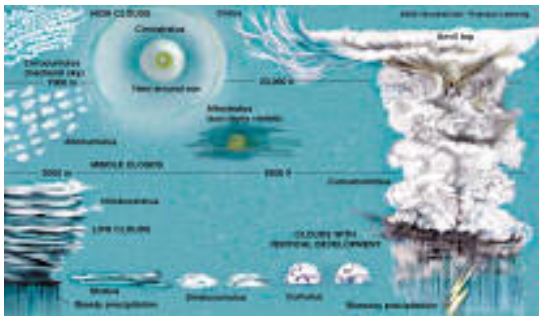
Form

1. Cirrus
2. Stratus
3. Cumulus
4. Nimbus

Height

1. High Clouds
Cirrus, Cirrostratus, Cirrocumulus
2. Middle Clouds
Altostratus, Altocumulus
3. Low Clouds
Stratus, Stratocumulus, Nimbostratus
4. Extensive Vertical Development
Cumulus, Cumulonimbus

Generalized Classification of cloud type based on height



Reference and A good web page to visit

- A great website for clouds (where I got most of the lecture material) is:
- http://vortex.plymouth.edu/cloud.html