

CE 361A : Engineering Hydrology

Precipitation

Lecture -2

Revision

- Hydrology
 - Scope
 - Classification
 - Branches
- Hydrological Cycle
- Mass-conservation
 - Basin; watershed; catchment
 - Water year
- Residence time
- Virtual water

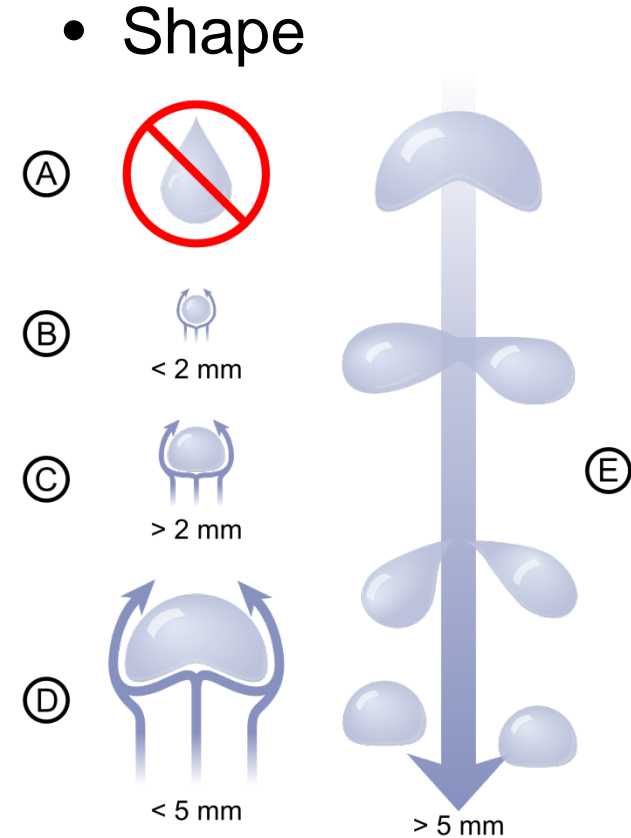
Objective

- Forms of precipitation
- Mechanism of precipitation
- Characteristic of precipitation over India
- Measurement of precipitation

Forms of precipitation

1. Rain: Precipitation in the form of water drops of size larger than 0.5 mm

- Size : typically less than 5-6 mm. The largest ever recorded size is 10 mm in Brazil in 2004
- Measured in depth units
- Classification based on intensity
 - Light : < 2.5 mm/h
 - Moderate: 2.5 to 7.5 mm/h
 - Heavy: 7.5 mm/h



Source: wikipedia

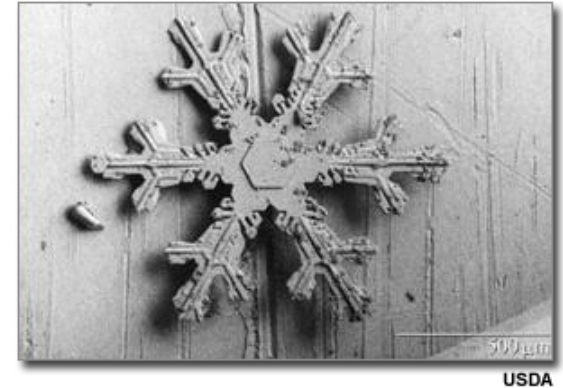
How can we measure raindrop size?

Forms of precipitation

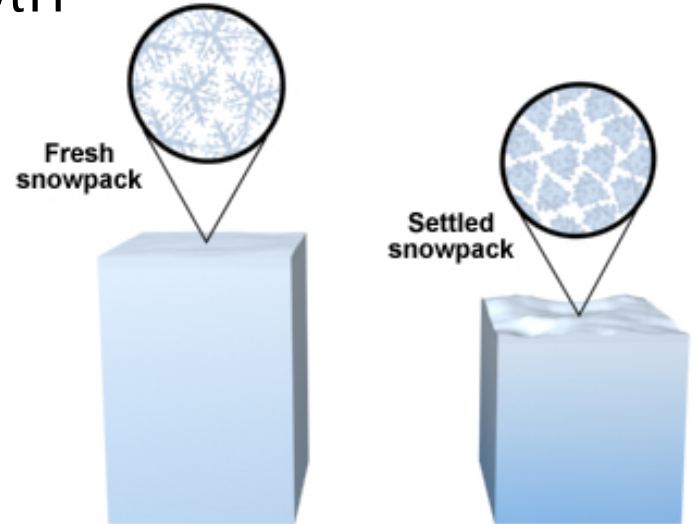
2. Snow: Precipitation in form of flakes of crystalline ice.

- Density: *Initial density* varies from 0.06 to 0.15 g/cm³. The density increases with age
- Measured in equivalent water depth

Pristine Snow Crystal

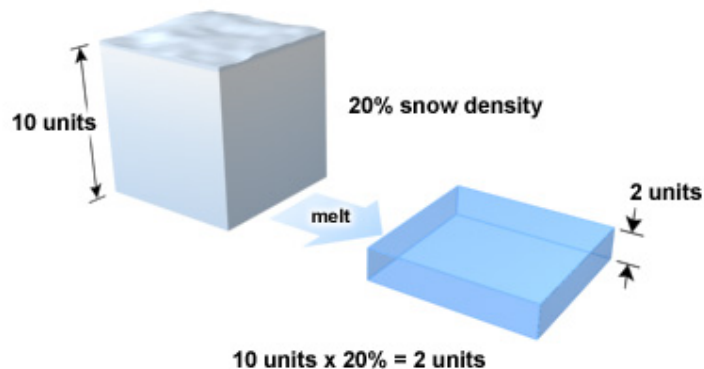


Snowpack Aging



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Example of Water Yield from a Volume of Snow



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Forms of precipitation

- 3. Drizzle: Precipitation in form of water droplets of size less than 0.5 mm and intensity 1 mm/h.
- 4. Hail : Precipitation in form of irregular pellets or lumps of ice more than 8 mm



Forms of precipitation

5. Glaze or freezing rain: The rain or drizzle when comes in contact with earth's surface at sub-freezing temperature it forms glaze.



Source: Wikipedia

Forms of precipitation

6. Sleet: Precipitation in form of frozen raindrops of transparent grains.



Source: Wikipedia

❑ What determines whether the precipitation will be in the form of rain, snow, glaze or sleet?

Forms of precipitation

Hail !!

Rain/Drizzle

$T < 0^{\circ}\text{C}$ 0°C $T > 0^{\circ}\text{C}$

Snow

$T < 0^{\circ}\text{C}$ 0°C $T > 0^{\circ}\text{C}$

**Glaze/
Freezing rain**

$T < 0^{\circ}\text{C}$ 0°C $T > 0^{\circ}\text{C}$

Sleet

$T < 0^{\circ}\text{C}$ 0°C $T > 0^{\circ}\text{C}$



Mechanism of precipitation

1. Presence of moisture in the air
2. Mechanism to cool air
3. Presence of cloud condensation nuclei (CCN)
4. Conditions for condensation product to reach earth

Mechanism of precipitation

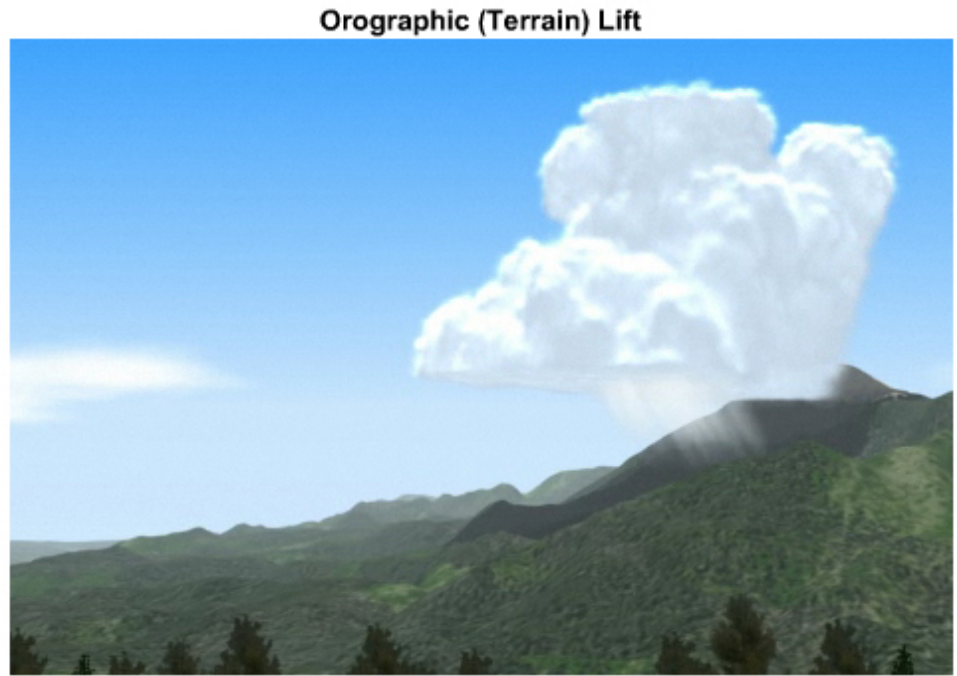
1. Moisture in the air

- Local evaporation & transpiration (summer)
- Large scale wind circulation (monsoon)

Mechanism of precipitation

2. Mechanism for cooling

a. Orographic lift



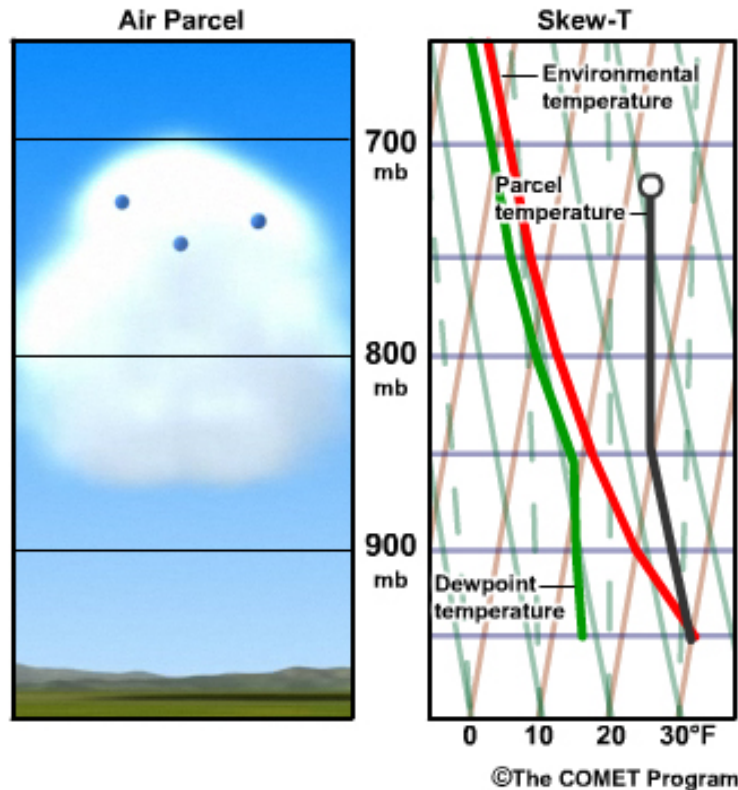
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Orographic or Relief precipitation

Low intensity long duration

Mechanism of cooling

b. Thermal lift



Thermal (Convective) Lift



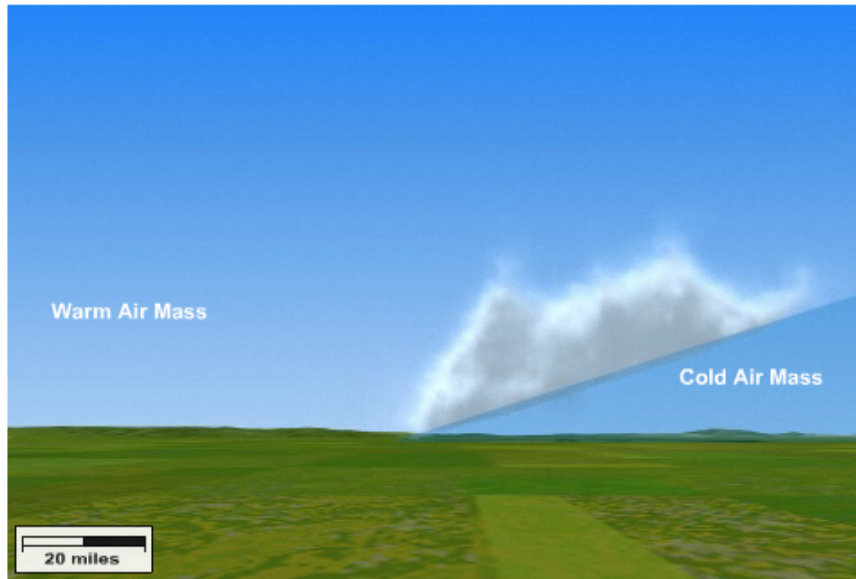
Convective precipitation

High intensity, accompanied by lightning and thunder

Mechanism of cooling

c. Frontal lift

Frontal Lift – Warm Front



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Frontal Lift – Cold Front



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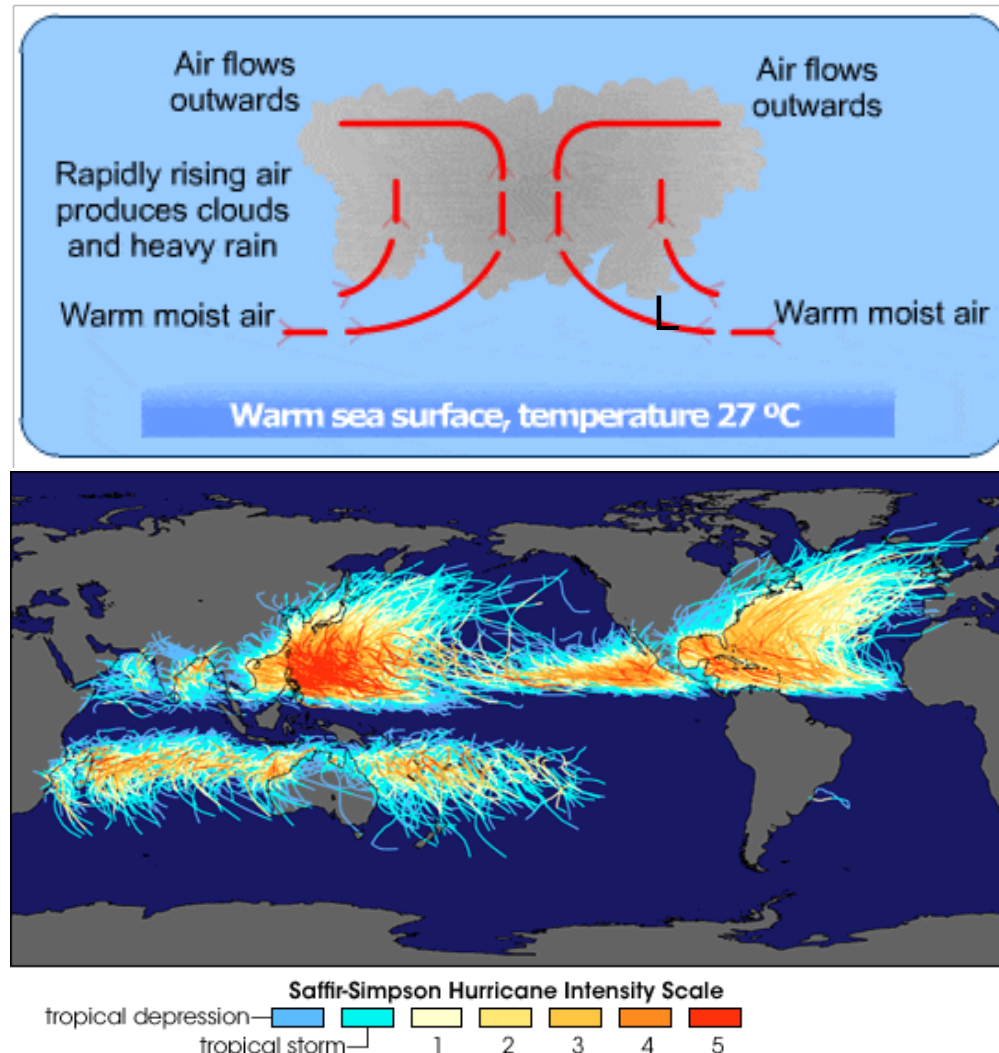
Frontal precipitation

Warm front: Less intense rainfall but widespread

Cold front : Intense but localized

Mechanism of cooling

Cyclonic precipitation: Often considered a type of frontal system

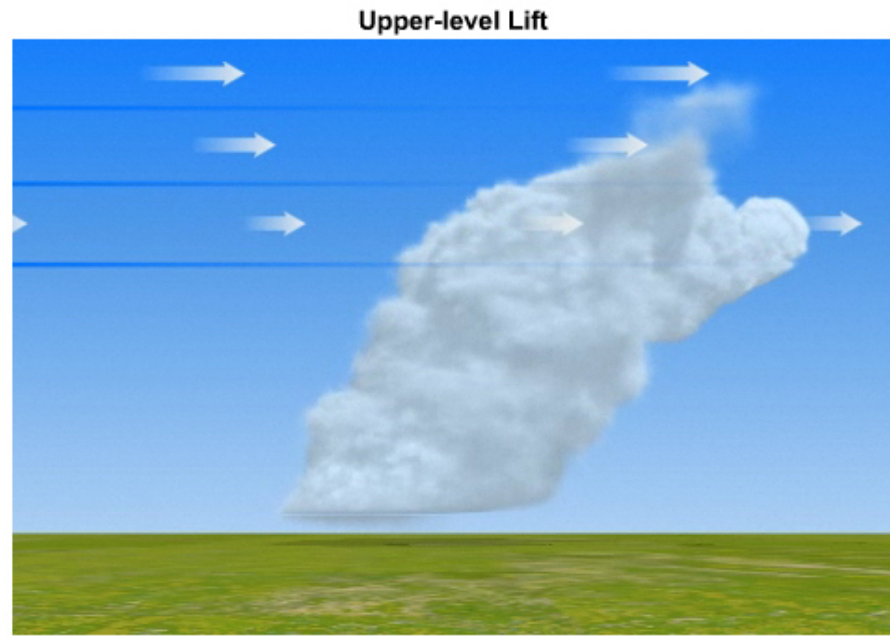


Widespread precipitation

Mechanism of cooling

d. Jet stream or Upper-level lift:

The jet stream is a channel of swiftly moving air often found at high altitudes of the troposphere.



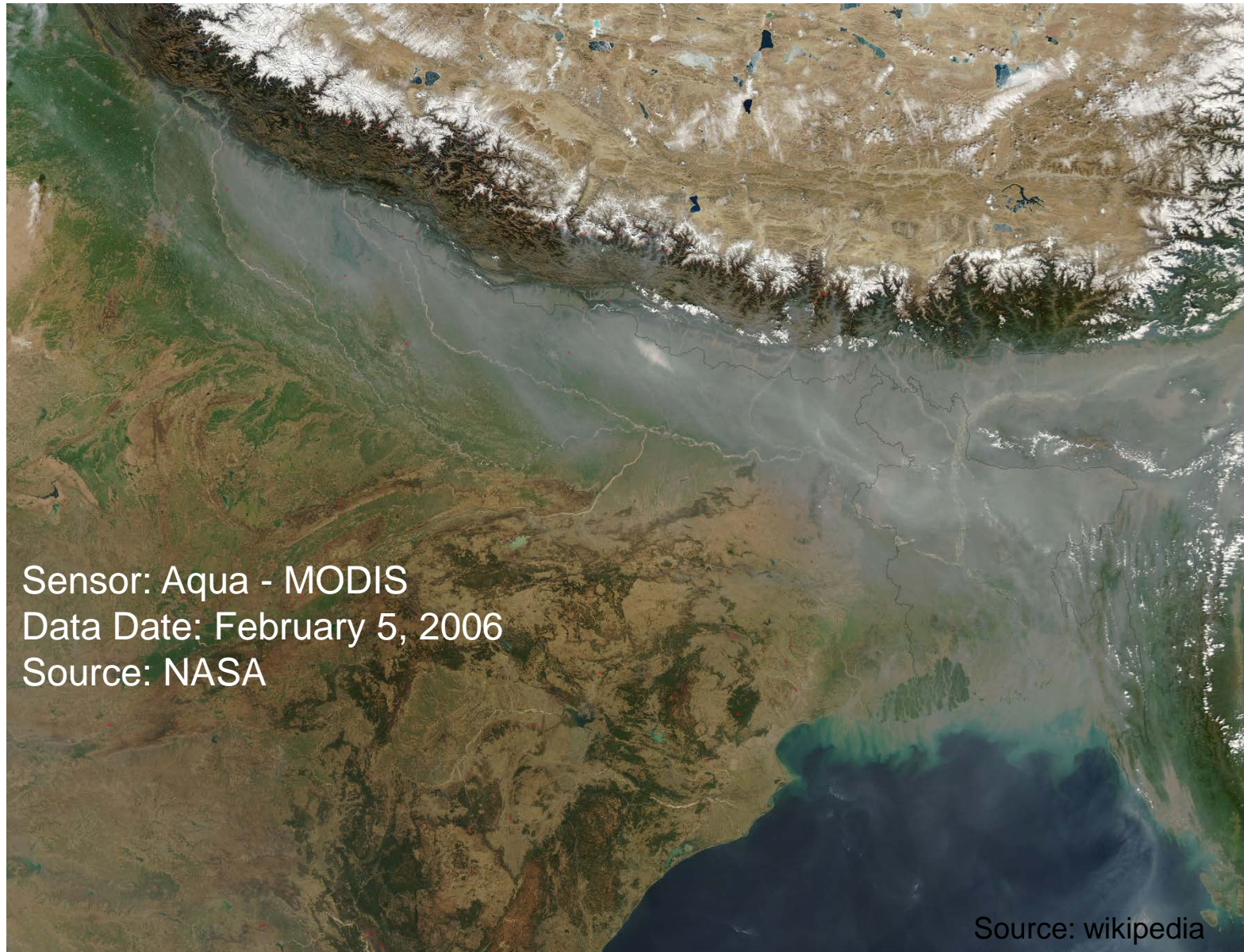
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Mechanism of precipitation

3. Cloud condensation nuclei (CCN)

- Natural – Volcanoes, airborne sea salt, forest fire, desert
- Anthropogenic – Industry, transportation, waste disposal
- Cloud seeding - Silver iodide
- Typical size: 0.2 micron
- International political issue

Haze over India

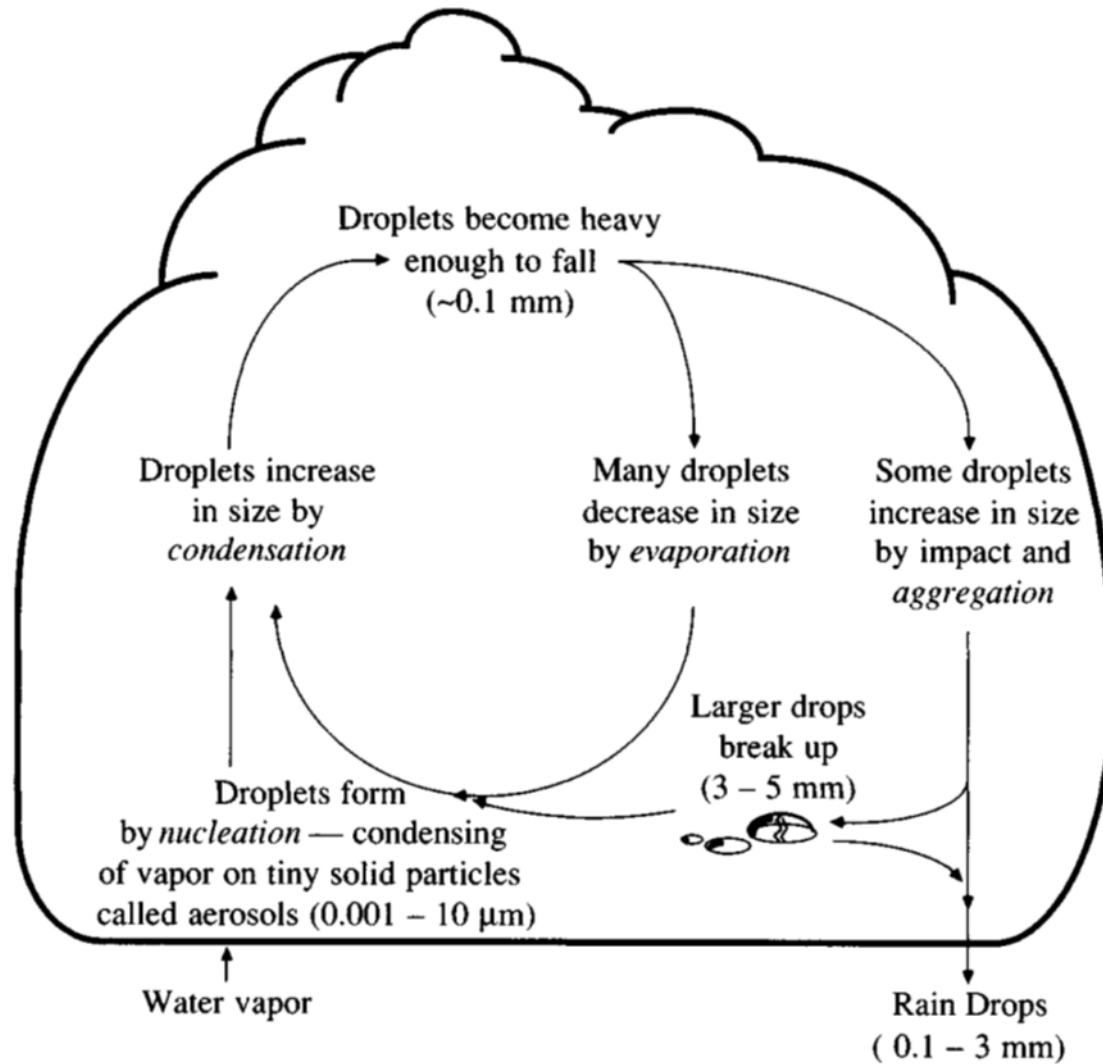


Sensor: Aqua - MODIS
Data Date: February 5, 2006
Source: NASA

Source: wikipedia

Mechanism of precipitation

4. Conditions for condensation product to reach earth



Source: Chow et al.,