Precipitation

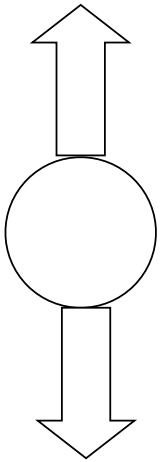
It’s raining, it’s pouring…

Ch. 7: Precipitation

- **Terminal Velocity**
- **Condensation Growth**
  - → **Cloud Droplets**
  - → **Ice Crystal Process (WBF)**
- **Collision Growth**
  - → **Collision/Coalescence, Accretion, Aggregation**
- **Precipitation Types**
- **Precipitation Modification**
- **Measurement**

Terminal Velocity

Air Drag



Gravity

Drag force $\propto$ Speed

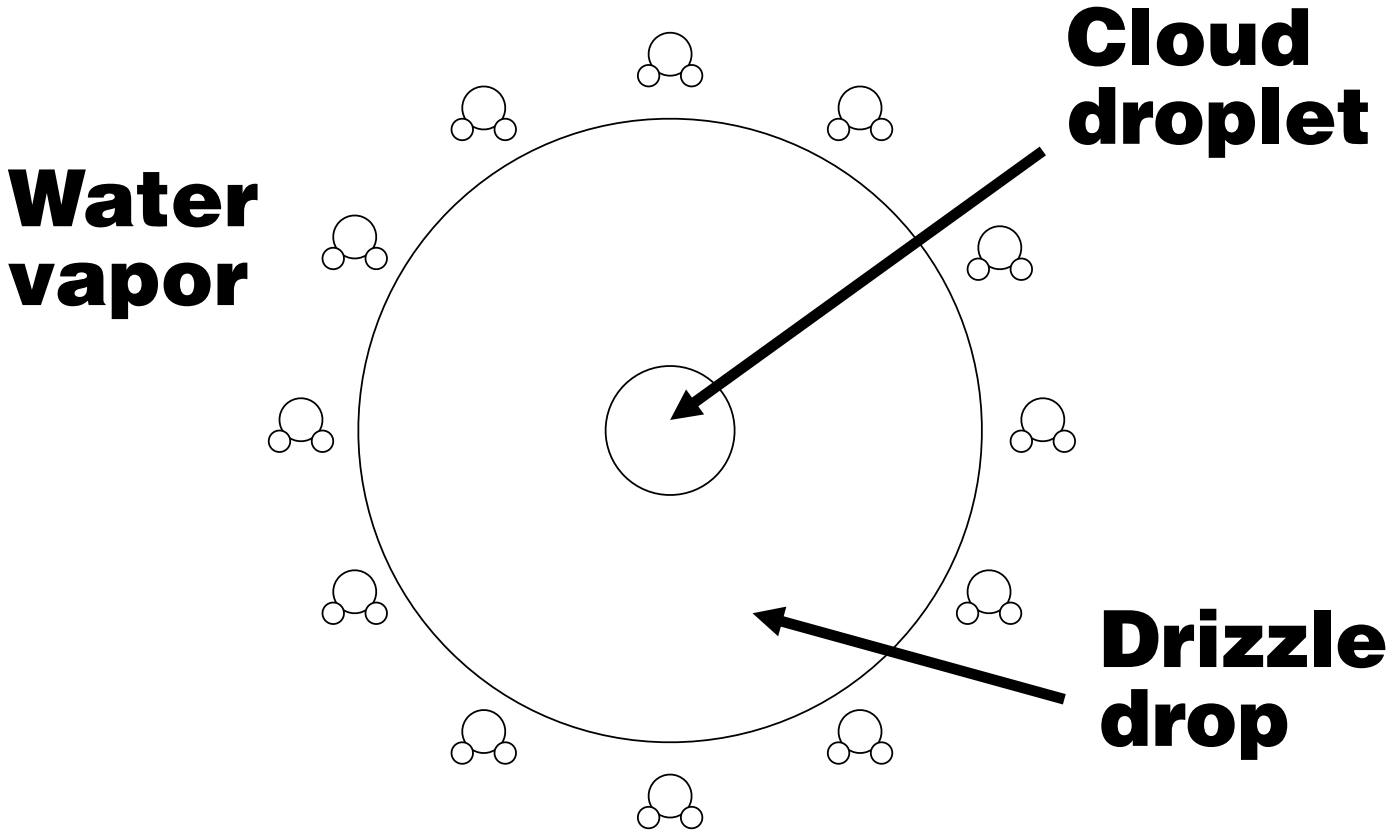
Falling object increases speed until:

Drag force = Gravitational force

$\Rightarrow$ Steady-state fall

$\Rightarrow$ Fallspeed = Terminal velocity

Condensation Growth of Droplets

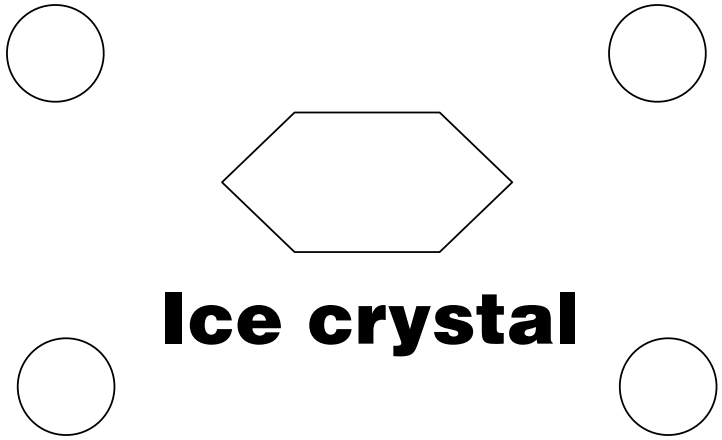


100x increase in diameter $\rightarrow$ 10^6x increase in volume to grow up to drizzle drop size

Condensation Growth of Ice Crystals

"Bergeron Process"

Supercooled droplets



Ice crystal

$e_{sat,i} < e_{sat,w}$

$T < 0°C$

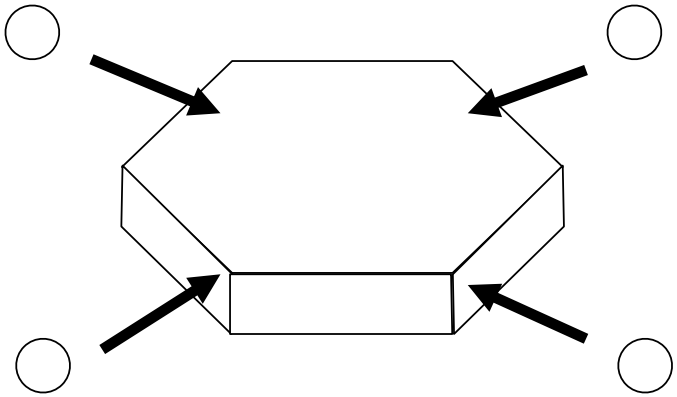
Supersaturated for crystals

Subsaturated for droplets

Condensation Growth of Ice Crystals

"Bergeron Process"

Water transfers from droplets to crystal



$e_{sat,i} < e_{sat,w}$

$T < 0°C$

Droplets evaporate

Crystals grow

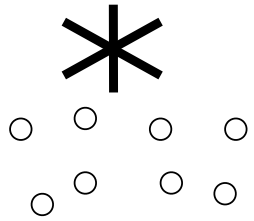
Collision/Coalescence Growth of Raindrops

Faster growth than condensation!

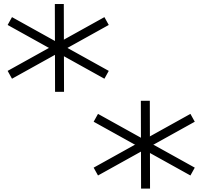
- **Conditions favoring growth of large raindrops:**
  - ➡ **Wide range of drop sizes**
  - ➡ **Strong updraft in cloud**
  - ➡ **Large cloud depth**
  - ➡ **Electrified cloud**

Other Collisional Growth Processes

Accretion: ice crystal vs. supercooled cloud droplet



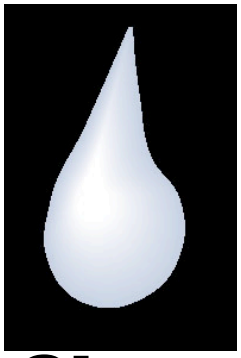
Aggregation: ice crystal vs. ice crystal

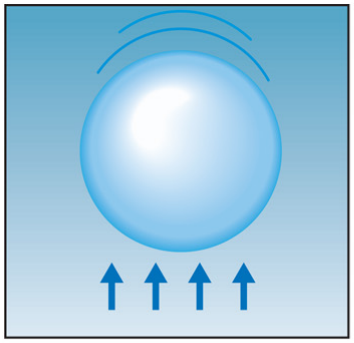


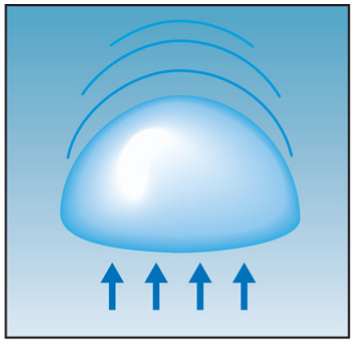
Types of Precipitation

- Rain
- Snow
- Sleet
- Freezing Rain
- Graupel Particles
- Hailstones

Drop shape: not teardrop







Showers: intermittent, spotty coverage

Rain: steady uniform coverage

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Virga: Rain or snow that evaporates before reaching the ground. Also called “fall streaks”

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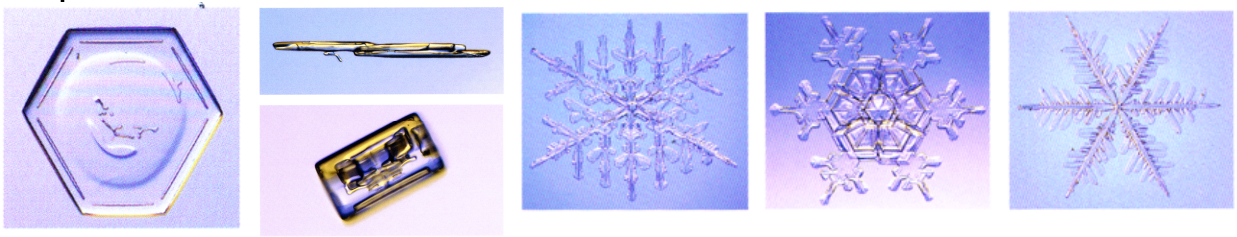
Snow crystals: single crystals (plate, column, dendrite)



Snowflakes: aggregates of snow crystals

Most middle-latitude precipitation starts out as snow, then melts to rain

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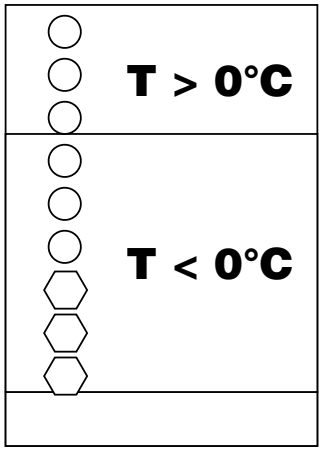
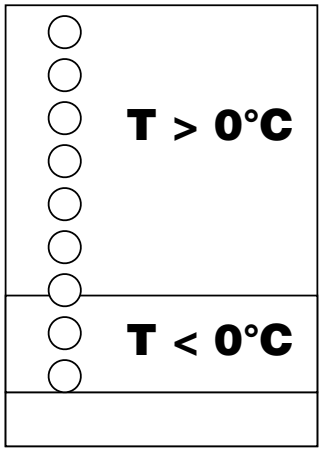
Sleet: "Ice Pellets"; frozen raindrops (deep freezing layer)



Freezing Rain: raindrops freeze *after* reaching ground (shallow freezing layer)



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Graupel ≡ "Kernel"

Formed from ice particle accreting supercooled droplets in cloud

Soft and porous texture

Also known as "snow pellet"

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Larger than graupel — falls faster, collects supercooled drops faster

"Wet growth" forms solid ice; causes rock-like damage

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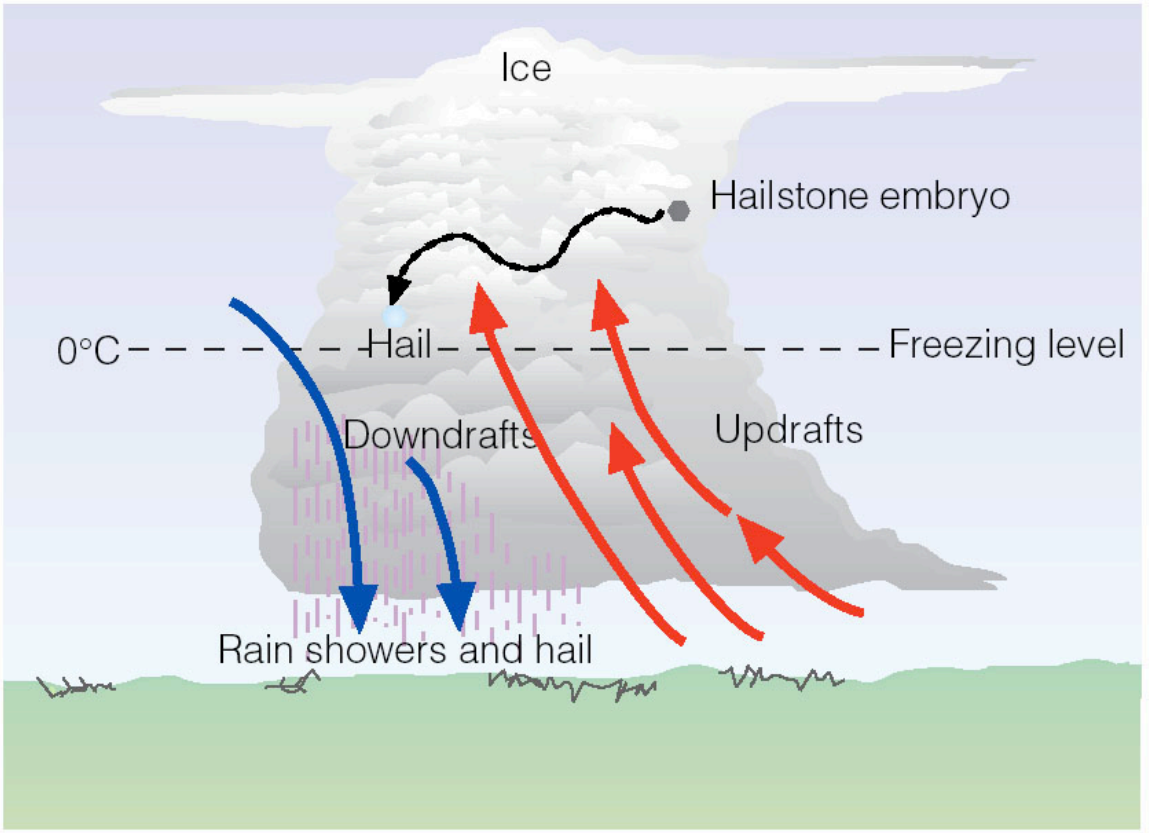

Precipitation Enhancement

- **Increase number of precipitation particles to get more rainfall**
  - → **Cloud seeding with an ice-forming nucleant, usually silver iodide (AgI)**
  - → **Overseeding may inhibit precipitation formation —too many particles competing for limited water supply**

Precipitation Measurement

- **Rain Gauge**
  - → **Gets accumulated rain or snowfall**
- **Recording Gauges**
  - → **Tipping Bucket**
  - → **Weighing-type**