Lecture 21 Formation of Rain and Snow

- How do cloud droplets grow to raindrops 100 times as large?

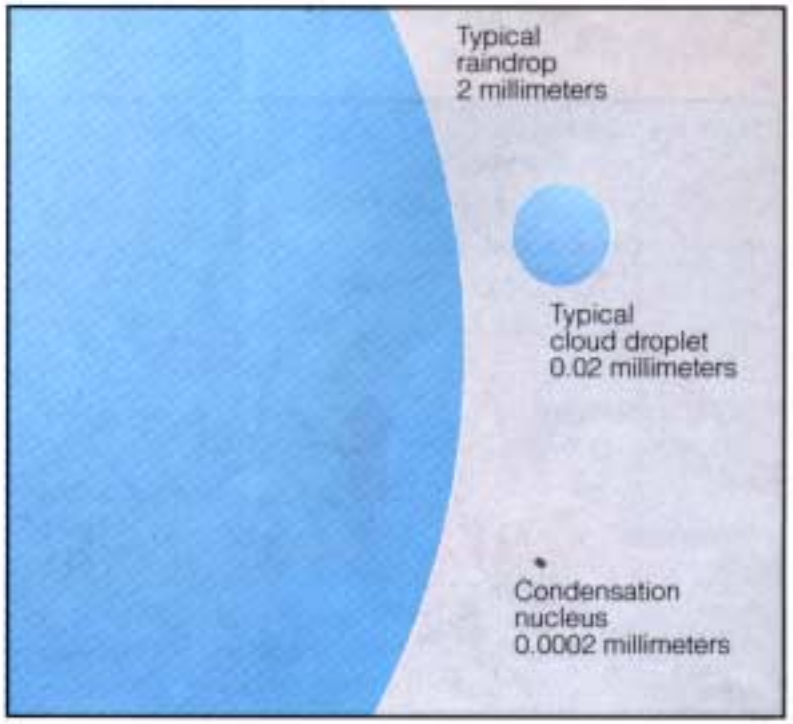


Figure 5.14
Relative sizes of raindrops, cloud droplets, and condensation nuclei.

EOM 5.15

- How are precipitation processes different when water droplets freeze?

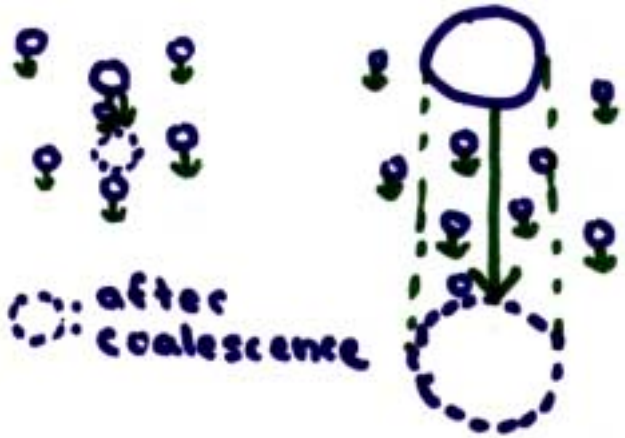
Warm cloud precipitation (no frozen water):

Even cloud droplets fall

Drop diameter	Fall speed	
20 microns	0.01 m s^{-1}	(cloud droplet)
100	0.27	(drizzle droplet)
1000 (1 mm)	4	(small raindrop)
5000 (5 mm)	9	(large raindrop)

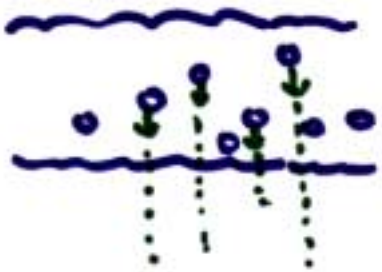
Collision and coalescence - merging of colliding small drops.

- Collisions occur mainly because cloud drops have varying sizes, so fall at different speeds.
- Large drops get even larger as they collect the small drops in their path



Thin clouds at most drizzle because

- Collisions occur infrequently
- Drops fall out of cloud before reaching raindrop size, then evaporate below cloud base.



Strong cumulus updrafts can suspend rain-size droplets and allow them to grow even larger by coalescence with rising cloud droplets.

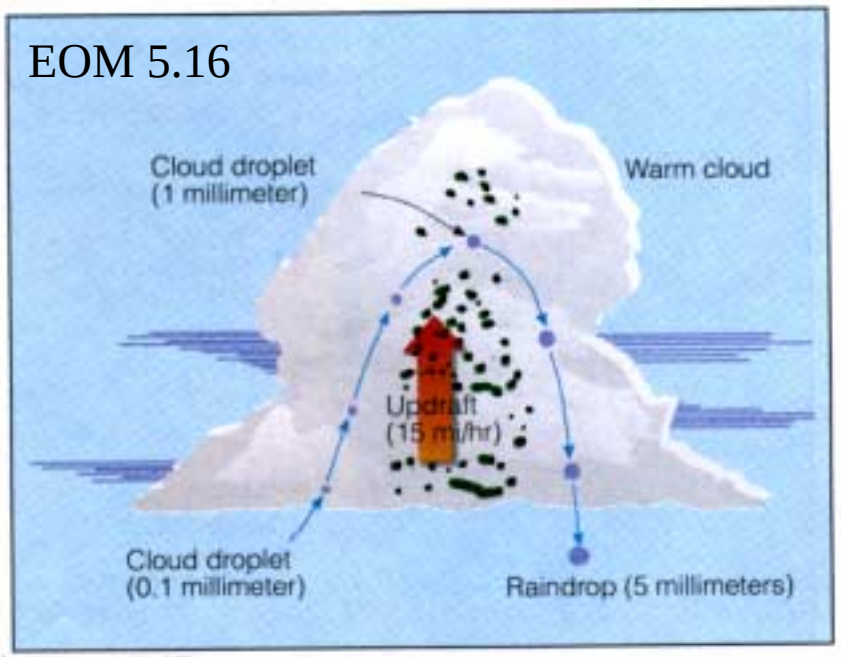


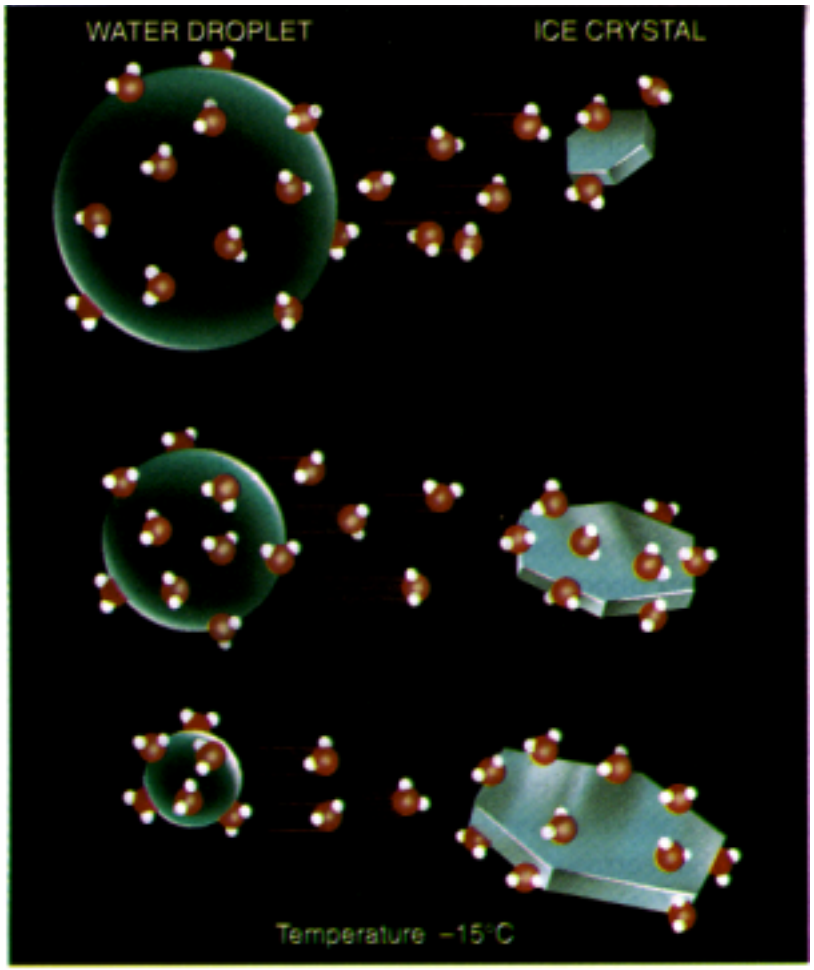
Figure 5.15
A cloud droplet rising then falling through a warm cumulus cloud can grow by collision and coalescence and emerge from the cloud as a large raindrop.

Raindrop shape

- Drizzle and cloud droplets are nearly spherical due to surface tension.
- Larger raindrops are flattened by the push of the air on them as they fall.
- Raindrops larger than 5 mm in diameter flatten so much they are split apart.

Ice in Clouds

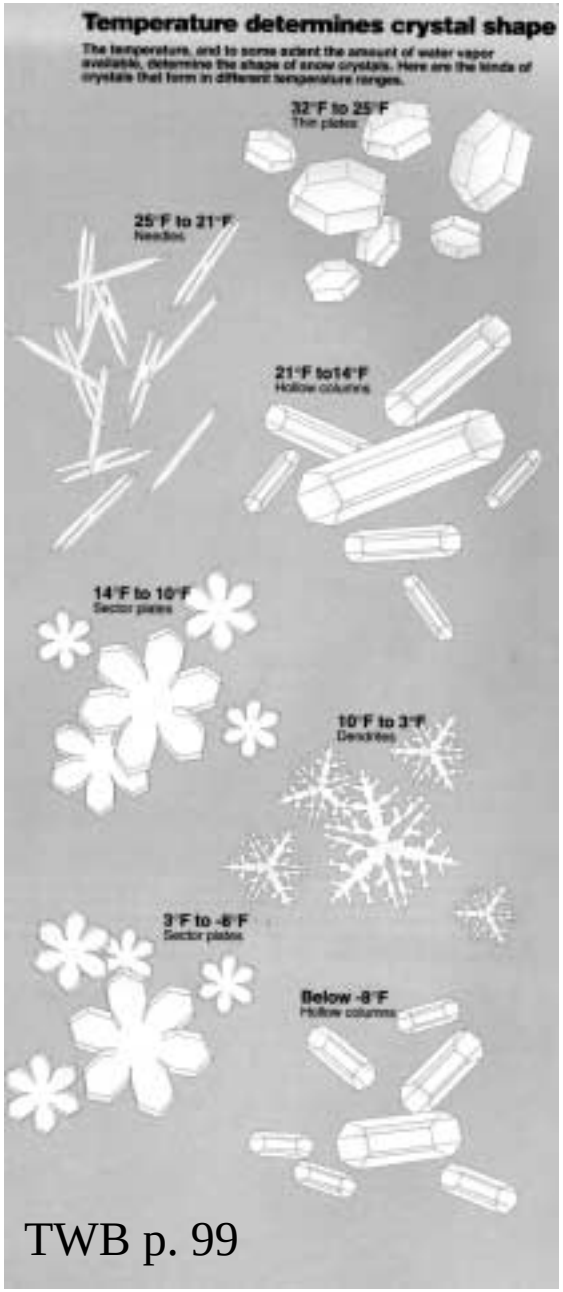
- 0 to -40 C: Surface tension of small cloud droplets can keep them from freezing - ‘supercooled’.
- In such a cloud, vapor pressure saturated wrt water, supersaturated wrt ice.
- Ice crystals can form on sparse *ice nucleii*, which are much less common than condensation nucleii.
- Vapor is deposited onto ice crystals, low-ering vapor pressure, so vapor evaporates from droplets (Bergeron process).



EOM fig. 5.20

Snow

- Ice crystals can splinter into many small crystals that collide with and freeze most of the liquid droplets in the cloud.
- These ice crystals can stick to each other to create *snowflakes*, which grow by vapor deposition or aggregation.
- The shape of snowflakes reflects their formation temperature.
- Snow falls 300 m or more below freezing level before fully melting.



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