Sept 27, Monday.

ended on Wednesday 101 - concept of adiabatic parcel.  
- obs that in cn clouds often sub. adiabatic

⇒ mixing:

shades clouds: cloud top mixing driven by radiative cooling.

entrainment: interface that mediates  
- dries out BL  
- subsidence + surface fluxes.

huge modeling challenge.

droplet growth post-nucleation:

\[ \frac{d n}{d t} = \alpha n^2 \quad \text{where } n = \text{vapor molecule count, } \quad f\alpha = \text{mass of 1 water molecule.} \]

if steady state: \[ \frac{d n}{d t} = 0 \]

in spherical coordinates becomes

\[ \frac{d M}{d t} = 4\pi x^2 D \frac{d P}{dx} \quad \text{there is both a heat and mass diffusion eqn with just treat mass.} \]
\begin{align*}
\frac{\partial \rho}{\partial t} &= \frac{D}{r^2} \left[ \rho(u) - \rho(v) \right] \\
\text{most commonly written as: } \quad \frac{\partial \rho}{\partial t} &= \frac{D \rho(u)}{r} \\
\frac{\partial \rho}{\partial r} &= \frac{1}{r} \frac{D \rho(u)}{r} \\
\text{with } r(t) = r_0 + \frac{D}{r^2} \int_0^t \rho(u) \, dt \\
\text{if } r_0 = 0.75 \mu m \text{, takes ~10 min to grow to } 9 \mu m \text{, but 12 hours to grow to } 50 \mu m. \\
\text{This also means an initially broad spectrum will narrow with time.}
\end{align*}

6.17: note: \( r \propto 6 \mu m \).

Also ground evaporation: ex. 6.24

- bigger drops evaporate more slowly; \( RH=80\% \)
- \( r_{99} = 100 \mu m \) \( 20 \% \) \( R = 0.05 \mu m \) = \( 150 \mu m \) \( 1.05 \text{ km} \)

\( r > 100 \mu m \) more likely to reach the ground \( \rightarrow \) rainfall.

As drops increase in size, they begin to fall relative to air:

\[ \text{drag } \quad F_r = \frac{1}{2} \pi r^2 \left( \rho - \rho \right) \text{gravity-drag} \]

Set the 2 eq:

\[ \frac{v}{g} = \frac{2}{9} \frac{\rho}{\mu} \left( \frac{r}{\eta} \right)^2 \]

- \( 10 \mu m \): 0.3 cm/s
- \( 20 \mu m \): 1.2 cm/s
- \( 40 \mu m \): 5 cm/s

Break down for \( r > 50 \mu m \).
Marshak Palmer

\[ N(D) = N_0 \exp(-\mu D) \]

(1)

\[ \frac{dD}{dt} = \gamma_0 \frac{D}{1 + \lambda C \cdot E} \]

(2)

\[ \frac{d\gamma_0}{dt} = \gamma_0 (\frac{\gamma_1}{1 + \lambda C \cdot E} - \gamma_2) \]

(3)

\[ \gamma_1 = \gamma_2 \]

(4)

\[ \gamma_0 = \frac{1}{1 + \lambda C \cdot E} \]

(5)

\[ \lambda C \cdot E \]

(6)

\[ \text{as the bigger drops fall, they collide and collect the smaller drops.} \]

\[ \text{Problem of fine-scale...} \]

\[ \text{drops break up beyond} \]

\[ r > 6 \text{ mm} \]

\[ \text{raindrops:} \]

\[ \text{exp. dist.}\]