Moisture modes and the MJO

1) Over the Indian Ocean, MJO's $c_p \approx 5\ ms^{-1}$

2) The MJO's vertical structure is approx. first baroclinic
∴ the gravity waves that adjust the MJO to WTG balance have $c = 50\ ms^{-1}$

3) The moisture mode criterion

$$N_{mode} = \frac{c_p^2}{c^2 \hat{\alpha}(1-\hat{\alpha})}$$

$\alpha \sim RH \sim 0.9$

$\alpha(1-\alpha) \sim 0.1$

$$\simeq 10\frac{(5)^2}{(50)^2} = 10\left(\frac{5}{50}\right)^2 = \frac{10^1}{10^2} \simeq 0.1$$

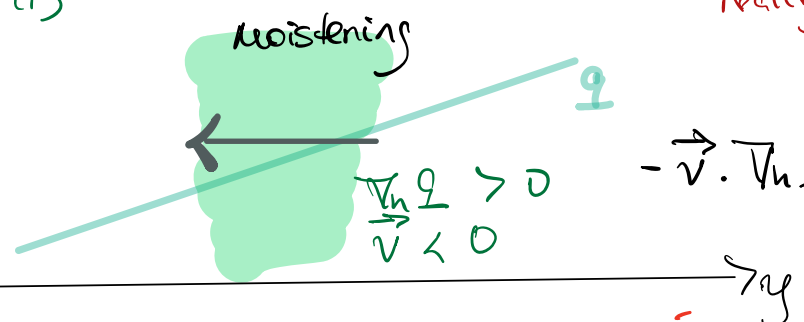
according to the scaling the MJO is a moisture mode over the Indian Ocean.

4) In moisture modes the WTG moisture budget is:

$$\frac{\partial q}{\partial t} = -\vec{v}\cdot\nabla_h q - \frac{w_c}{L_v}\frac{\partial MSE}{\partial p} - w_r\frac{\partial q}{\partial p} - \frac{\partial F_{MSE}}{\partial p}$$

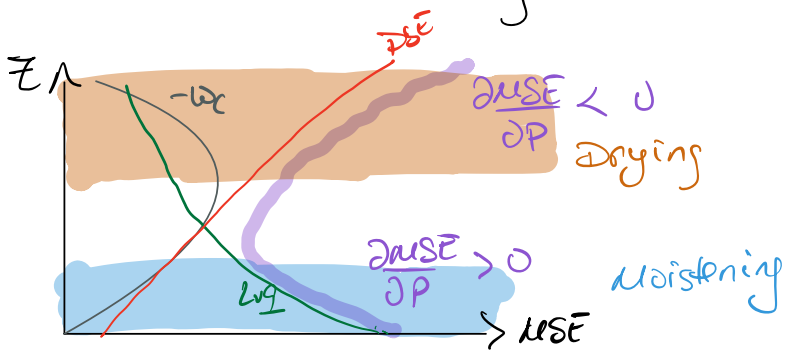
- $-\vec{v}\cdot\nabla_h q$: hor. moisture adv. (1)
- $-\frac{w_c}{L_v}\frac{\partial MSE}{\partial p}$: vertical MSE adv. by conv.
- $-w_r\frac{\partial q}{\partial p}$: vert. moisture adv. by rad. heating
- $-\frac{\partial F_{MSE}}{\partial p}$: vert. turb. flux conv.

(1) q ↑



$-\vec{v}\cdot\nabla_h q > 0$

(2) $-w_c\frac{\partial MSE}{\partial p}$



$$-\omega_c \frac{\partial MSE}{\partial p} = -\omega_c \frac{\partial DSE}{\partial p} - \omega_c \frac{\partial Lv\,q}{\partial p}$$

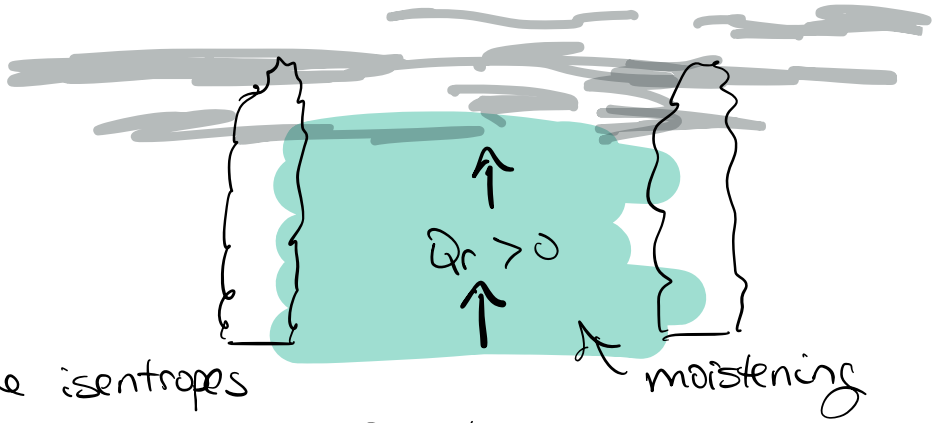
$$= \quad -Q_c \qquad (+)$$

$$\simeq -L_v (\underline{c} - e) + \cdots$$

Q_c latent heat release

sink of moisture b.c. of condensation

$$-\omega_r \frac{\partial q}{\partial p}$$



Under WTG the isentropes remain quasi-fixed

∴ Upward motion must ensue in order to satisfy WTG

You don't get warmi

$$\omega_r \frac{\partial DSE}{\partial p} = Q_r$$

$(-)\ (-) \quad (+)$

$(+)$

Radiative heating creates an overturning circulation that advects moisture upward. It moistens through the column.