MVI and the ITCZ

Recall that $\frac{D_h \langle q' \rangle}{Dt} = -v_i' \frac{\partial \langle \bar{q} \rangle}{\partial y}$ $\quad \frac{D_h}{Dt} = \frac{\partial}{\partial t} + \bar{u}_i \frac{\partial}{\partial x}$

Let's divide by $\partial \langle \bar{q} \rangle / \partial y$, and also mult. by $\langle q' \rangle$:

$$\frac{\langle q' \rangle}{\partial \langle \bar{q} \rangle / \partial y} \left(\frac{\partial \langle q' \rangle}{\partial t} + \bar{u}_i \frac{\partial \langle q' \rangle}{\partial x} \right) = -v_i' \langle q' \rangle$$

↑ assume it evolves slowly in time and space

Let's define $A = -\frac{1}{2} \frac{\langle q' \rangle^2}{\partial \langle \bar{q} \rangle / \partial y}$ moisture mode activity

We can now write

$$\frac{D_h A}{Dt} = \overline{v_i' \langle q' \rangle} \quad \text{Eddy moisture flux}$$

Now let's look at the mean state:

Let's assume zonal symmetry, so that ($\bar{q}$ means zonal mean)

$$\frac{\partial \langle \bar{q} \rangle}{\partial t} = -\frac{\partial}{\partial y} \langle \overline{vq} \rangle - \bar{P} + \bar{E}$$

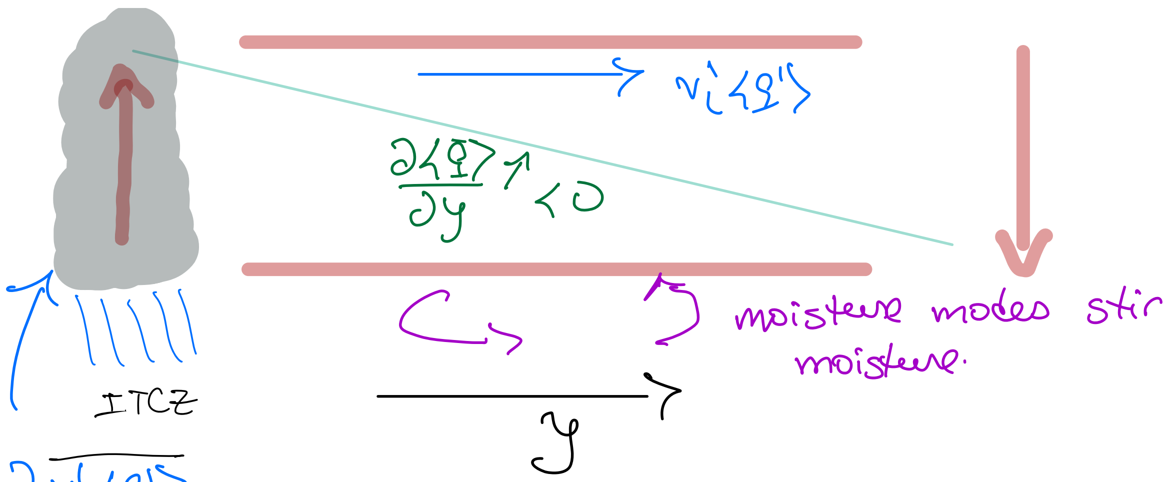
Recall: $v = \bar{v} + v'$ $\quad q = \bar{q} + q'$

$$\overline{vq} = \overline{(\bar{v} + v')(\bar{q} + q')}$$
$$= \overline{\bar{v}\bar{q}} + \overline{v'q'} = \bar{v}\bar{q} + \overline{v'q'}$$

($\bar{v}\bar{q}$: ITCZ moisture flux; $\overline{v'q'}$: eddy moisture flux)

$$\frac{\partial \langle \bar{q} \rangle}{\partial t} = -\frac{\partial}{\partial y} \left(\bar{v}_i \langle \bar{q} \rangle + \overline{v_i' \langle q' \rangle} \right) - \bar{P} + \bar{E}$$

$$\frac{\partial \langle \bar{q} \rangle}{\partial t} = -\frac{\partial \overline{v_i' \langle q' \rangle}}{\partial y} + \bar{C} \qquad \bar{C} = -\frac{\partial \bar{v}_i \langle \bar{q} \rangle}{\partial y} + \bar{E} - \bar{P}$$



$$\frac{\partial \overline{v_i' \langle q' \rangle}}{\partial y} > 0$$

Which means that

$$\frac{\partial \langle q \rangle}{\partial t} = \underbrace{- \frac{\partial \overline{v_i' \langle q' \rangle}}{\partial y}}_{< 0} + \underbrace{C_z}_{\simeq 0} =$$

The eddies are removing moisture from the ITCZ, therefore weakening it.

The moisture modes tap into the energy of the ITCZ for their growth.

* The moisture modes grow at the expense of the ITCZ!