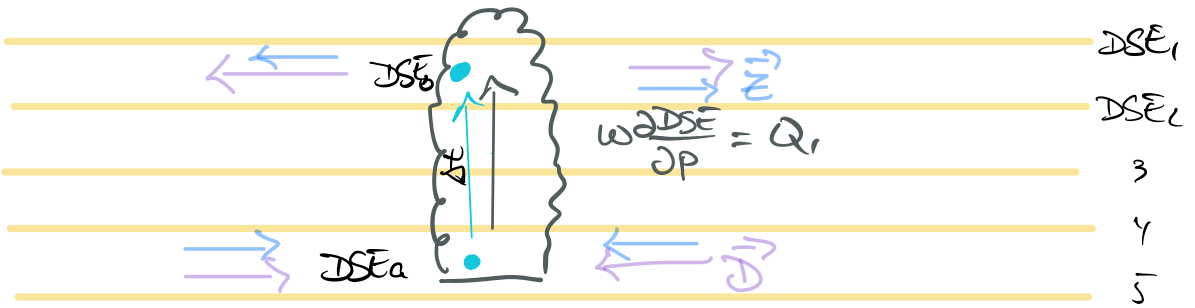
How WTG constrains the large-scale circulation



$\frac{DPV}{Dt} = -\nabla\cdot(\vec{n}_e Q_1)$ $\qquad \frac{DDSE}{Dt} \simeq Q_1$ $\qquad \frac{D\delta w}{Dt} = \Sigma - \nabla\cdot\frac{\partial\vec{u}}{\partial p}\frac{Q_1}{S_p}$

Essentially, the parcel moves from DSEa + DSEb satisfying WTG at the large-scale (DSE is horizontally flat)

$$\frac{D(DSE)}{Dt} = Q_1 \longrightarrow \frac{\Delta DSE}{\Delta t} = \frac{DSE_b - DSE_A}{\Delta t} = Q_1$$

$$DSE_b = DSE_A + Q_1\Delta t$$

Recalling that $\frac{\partial\Sigma}{\partial t} = -\nabla_h\cdot\vec{E}$

$\frac{\partial\delta w}{\partial t} = -\nabla_h\cdot\vec{D}$

The forcing vectors $\vec{E}$ and $\vec{D}$ move Σ_e and the δw, respectively, so that when a parcel moves from DSEa to DSEb (different pressure levels) you also satisfy the Lagrangian δw and Σ equations

Recall that $\nabla\cdot\vec{n}_a Q_1 = Q_1\nabla\cdot\vec{n}_a + \vec{n}_e\cdot\nabla Q_1$

$\nabla\cdot\vec{u}Q_1 = Q\nabla\cdot\vec{u} + \vec{u}\cdot\nabla Q_1$

$\vec{u} = u\hat{i} + v\hat{j} + w\hat{k}$