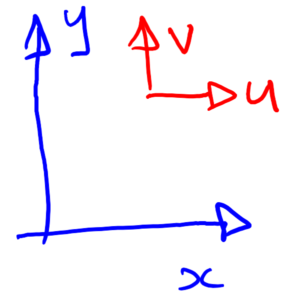
HORIZONTAL MTM EQNS + GEOSTROPHIC WIND

$$\frac{D}{Dt}(u,v) = -\frac{1}{\rho}\nabla_H p - \left(\hat{k}\times\vec{u}_H\right)f$$

Accel^n Press grad. Coriolis



$$\hat{k}\times\vec{u}_H = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ u & v & 0 \end{vmatrix} = \hat{i}\begin{vmatrix} 0 & 1 \\ v & 0 \end{vmatrix} - \hat{j}\begin{vmatrix} 0 & 1 \\ u & 0 \end{vmatrix} + \hat{k}\begin{vmatrix} 0 & 0 \\ u & v \end{vmatrix}$$

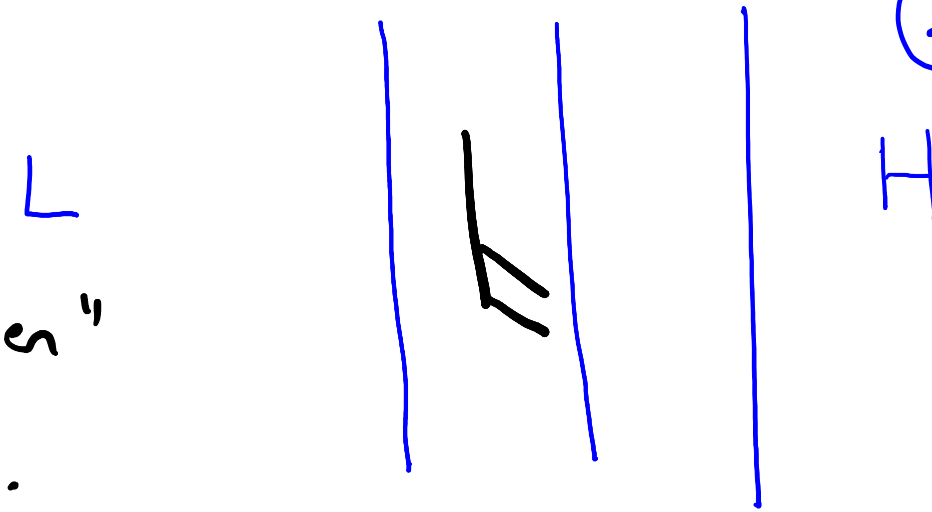
$$= -\hat{i}\,v + \hat{j}\,u + \vec{0}$$

$$\frac{Du}{Dt} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + fv \qquad u_g = \frac{-1}{\rho f}\frac{\partial p}{\partial y}$$

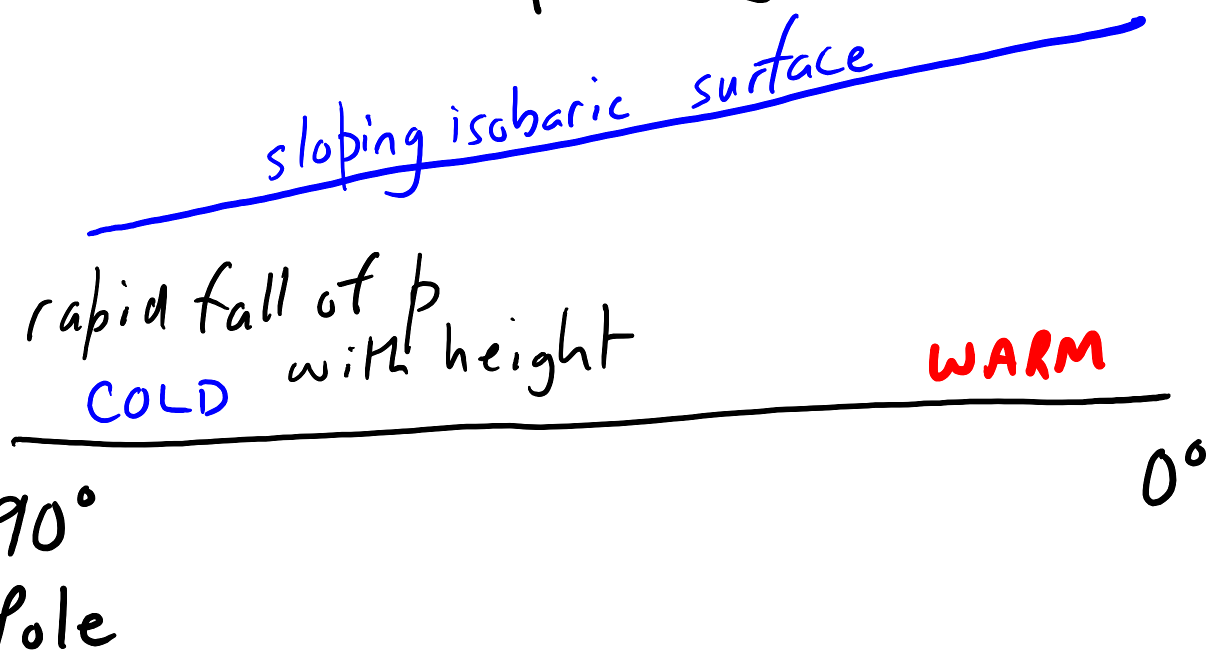
$$\frac{Dv}{Dt} = \frac{-1}{\rho}\frac{\partial p}{\partial y} - fu \qquad v_g = \frac{1}{\rho f}\frac{\partial p}{\partial x}$$

In "balanced" flow, accel^n is zero (and the velocity components are "conserved variables")

$$\frac{\partial p}{\partial x} > 0 \quad \text{and} \quad V > 0$$



Zonal component is "driven" by latitudinal press. grad.



$$u_g = \frac{-g}{f} \frac{\partial Z}{\partial y}$$

$$V_g = \frac{g}{f} \frac{\partial Z}{\partial x}$$

Alternate expressions for the geostrophic wind

③

$$\vec{V}_g = \frac{g}{f}\,\hat{k} \times \nabla_H Z = \frac{g}{f}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 0 & 1 \\ \frac{\partial Z}{\partial x} & \frac{\partial Z}{\partial y} & 0 \end{vmatrix}$$

or in the natural coordinate system

$$|\vec{V}_g| = \frac{g}{f}\frac{\partial Z}{\partial n}$$