the Earth into account, but is useful for visualizing some of the physical processes involved in formulating the equations due to its relative simplicity.

Note that the capital D time derivatives are material derivatives. Five equations in five unknowns comprise the system.

- the inviscid (frictionless) momentum equations:

$$\cancel{\frac{Du}{Dt}}\ \boxed{-fv_g = -\frac{\partial \Phi}{\partial x}}$$

$$\cancel{\frac{Dv}{Dt}}\ \boxed{+fu_g = -\frac{\partial \Phi}{\partial y}}$$

Path to geostrophic “balance” wind approximation:

assume forces are balanced.

or $\boxed{\text{neglect } \frac{D}{Dt}(\vec{v})}$

Lost
$\left\{ \begin{array}{l} \bullet \text{ divergence } \frac{\partial u_g}{\partial x} + \frac{\partial v_g}{\partial y} = 0 \\ \bullet \text{ time changes!} \end{array} \right\}$

- the hydrostatic equation, a special case of the vertical momentum equation in which vertical acceleration is considered negligible:

$$0 = -\frac{\partial \phi}{\partial p} - \frac{RT}{p}$$

Costly assumption!

But “primary flow” is mostly geostrophic

- the continuity equation, connecting horizontal divergence/convergence to vertical motion under the hydrostatic approximation ($dp = -\rho\, d\phi$):

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial \omega}{\partial p} = 0$$

So we “captured most of the wind”

en.wikipedia.org/wiki/Primitive_equations#Pressure_coordinate_in_vertical%2C_Cartesian_tangential_plane

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- the inviscid (frictionless) momentum equations:

$$\frac{Du}{Dt} - fv = -\frac{\partial \Phi}{\partial x}$$

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this was V_g's definition

$$\frac{f V_g = -\frac{\partial \Phi}{\partial x}}{\text{Cor} = \text{PGF}}$$

Assumed $u \equiv u_g + u_a$, $v \equiv V_g + V_a$

$V_a \equiv V - V_g$

$$\frac{Du}{Dt} = f(V_g + V_a) - \frac{\partial \Phi}{\partial x}$$

zero!

$= f V_a$

4 terms!

"a-geostrophic" defined by this e

Evolution of $\vec{V}_{total}$ equals Coriolis force acting on V_a

it is "secondary" but plays key role

divergent $\Rightarrow \omega$

controls evolution!