Name____________________

Homework 2, Dynamics, MET 341

Match with next two pages. All equations are only used once. However, since there are 21 equations and 15 blanks, multiple answers exist for some. 2 pts each

____________ The 3-D vector equations of motion

____________ The 2-D vector equations of motion

____________ The zonal equation of motion, scaled for synoptic systems, (x, y, z)

____________ The meridional equation of motion, scaled for synoptic systems, (x, y, z)

____________ The Rossby number

____________ The mass divergence form of the continuity equation

____________ The velocity divergence form of the continuity equation

____________ 3-D divergence in (z,y,z)

____________ Continuity equation in (x,y,p)

____________ 2-D divergence (all forms)

____________ Vector equation for $\vec{V}_g$ in (x,y,z)

____________ Vector equation for $\vec{V}_g$ in (x,y,p)

____________ The component equations of motion in natural coordinates

____________ Temperature advection

EQUATIONS

$$\frac{1}{\text{Area}}\frac{D(\text{Area})}{Dt} \qquad A$$

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z} \qquad B$$

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial \omega}{\partial p} \qquad C$$

$$\frac{|\vec{V}|^2}{R}+f|\vec{V}|=-\frac{\partial \Phi}{\partial n} \qquad D$$

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y} \qquad E$$

$$\frac{1}{\text{Volume}}\frac{D(\text{Volume})}{Dt} \qquad F$$

$$\frac{D|\vec{V}|}{Dt}=-\frac{\partial \Phi}{\partial s} \qquad G$$

$$\hat{k}\times\frac{1}{f}\nabla_h\Phi \qquad H$$

$$\frac{D\ln\rho}{Dt}+\nabla\cdot\vec{V}=0 \qquad I$$

$$\frac{\partial \rho}{\partial t}+\nabla\cdot(\rho\vec{V})=0 \qquad J$$

$$\frac{Dw}{Dt}<<g \qquad K$$

$$\frac{\mathrm{U}^2/\mathrm{L}}{\mathrm{f_o U}} \qquad L$$

$$|\frac{D\vec{V}}{Dt}|/|f\hat{k}\times\vec{V}| \qquad M$$

$$\frac{\partial p}{\partial z}=-\rho g \qquad N$$

$$\frac{D\vec{V}}{Dt}=-\frac{1}{\rho}\nabla p+\vec{g}-2\vec{\Omega}\times\vec{V} \qquad O$$

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

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

$$-\vec{V} \cdot \nabla T \qquad R$$

$$\frac{D\vec{V}}{Dt} = -\frac{1}{\rho}\nabla_h p - f\hat{k} \times \vec{V} \qquad S$$

$$\hat{k} \times \frac{1}{\rho f}\nabla_h p \qquad T$$

$$\frac{\partial|\vec{V}|}{\partial s} + \frac{|\vec{V}|}{R_N} \qquad U$$

2a) From the chain rule, derive an expression for $\frac{Dq}{Dt}$ in (x,y,p) coordinates where q is mixing ratio. Show all steps. 10 pts

2b) Is $\frac{Dq}{Dt}$ an Eulerian or Lagrangian point of view? (2 pts)

2c) Is $\frac{\partial q}{\partial t}$ an Eulerian or Lagrangian point of view? (2 pts)

2d) Suppose q=10 g kg^{-1} at a location to the west, and q=15 g kg^{-1} at a location to the east. Suppose there is a west wind at u=8 ms^{-1}. Is this moist air advection or dry air advection? (2 pts)

3) Given the general relationship:

$$\frac{D_G\vec{A}}{Dt} = \frac{D\vec{A}}{Dt} + \vec{\Omega}\times\vec{A}$$

Derive the 3-D vector equation of motion in final form. Show all steps and substitutions. (10 pts)

4a) Write the equations of motion for a typical tornado using scales as $U \sim 100$ ms^{-1}, $W \sim 10$ ms^{-1}, $L \sim 100$ m, $H \sim 10{,}000$ m, and $\delta p \sim 4000$ Pa (40 mb). (10 pts)

4b) Is the hydrostatic equation valid in this case? (2 pts)

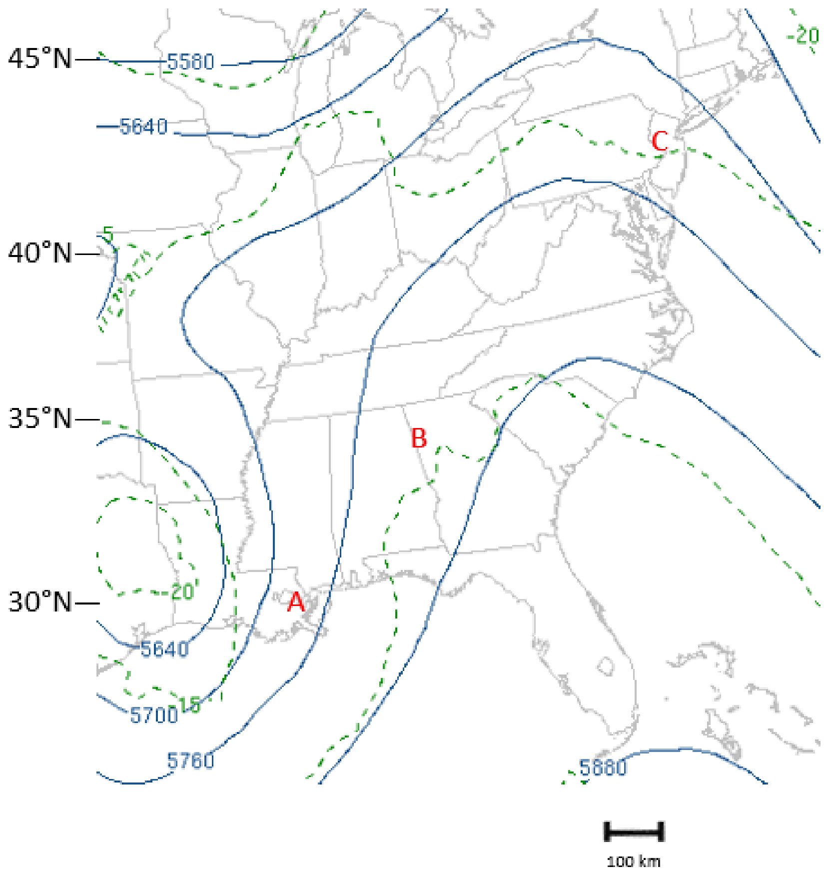
4c) Is the geostrophic approximation valid in this case? (2 pts)

4d) What is the Rossby number in this case? (2 pts)

5) At the three points shown in the picture below:

a) Drawn an arrow indicating wind direction (6 pts)

b) Compute the geostrophic wind magnitude. While a 100-km scale is provided, can also get distance using the website http://www.daftlogic.com/projects-google-maps-distance-calculator.htm



Calculation for geostrophic wind at Point A:

Calculation for geostrophic wind at Point B:

Calculation for geostrophic wind at Point C: