Name: _____

MEA 443 WEATHER ANALYSIS AND FORECASTING, FALL 2011
Quiz 3, Thursday 9/8/2011

1.) This week, we derived the QG omega equation:

$$\underbrace{\left(\nabla^2 + \frac{f_0^2}{\sigma}\frac{\partial^2}{\partial p^2}\right)}_{A}\omega = \underbrace{\frac{1}{\sigma}\nabla^2\left[\vec{V}_g \cdot \nabla\left(-\frac{\partial \Phi}{\partial p}\right)\right]}_{B} + \underbrace{\frac{f_0^2}{\sigma}\frac{\partial}{\partial p}\left[\vec{V}_g \cdot \nabla\left(\frac{1}{f_0}\nabla^2\Phi + f\right)\right]}_{C} \quad (1)$$

Briefly explain or describe what each term in this equation represents, physically:

A:
B:
C:

2.) The vertical motion in isobaric coordinates, omega, can be related to the vertical motion in geometric coordinates using the chain rule of calculus and the hydrostatic equation:

$$\omega = \frac{dp}{dt} = \frac{dp}{dz}\frac{dz}{dt} = -\rho g w \quad (2)$$

In (2), ρ is the air density and g is the gravitational acceleration. For synoptic scale motions in midlatitudes, a typical value of w is on the order of 1 $cm\ s^{-1}$. Given this information, what is the corresponding scale of omega? Be sure to include units in meters, kilograms, and seconds.

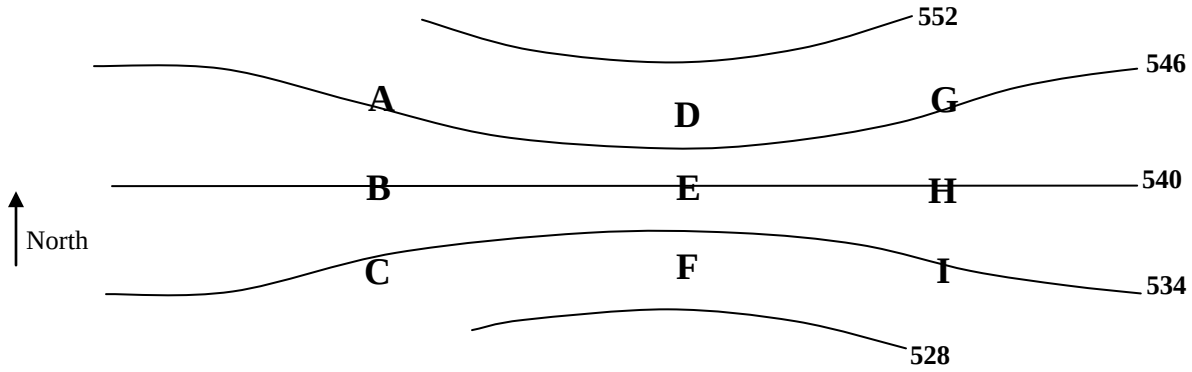
___ 3.) Which of the following statements best describes the physical and conceptual interpretation of the QG vertical motion?

a.) When air is forced to ascend or descend on the synoptic scale, for whatever reason, it is QG omega.

b.) The QG omega is the vertical component of an ageostrophic circulation that acts in the sense needed to restore thermal wind balance.

c.) Cyclonic vorticity advection and warm advection cause air to rise, and anticyclonic vorticity advection and cold advection cause air to sink.

4.) The map below shows 500-mb heights for a Northern Hemisphere easterly jet streak.



On the diagram above:

a.) Sketch and label several contours of cyclonic and anticyclonic relative vorticity.

b.) Sketch vectors representing the geostrophic wind at each of the points indicated.

c.) Circle and shade regions of cyclonic and anticyclonic vorticity advection.

d.) At which point or points would you most expect to find ascent? _____

e.) At which point or points would you most expect to find descent? _____

___ f.) At point "H", thermal wind balance is being disrupted. What is the sense of the imbalance?

(i) Vertical wind shear is becoming too strong for the horizontal temperature gradient
(ii) Vertical wind shear is becoming too weak for the horizontal temperature gradient
(iii) Actually, thermal wind balance ***is not*** being disrupted at point "H"

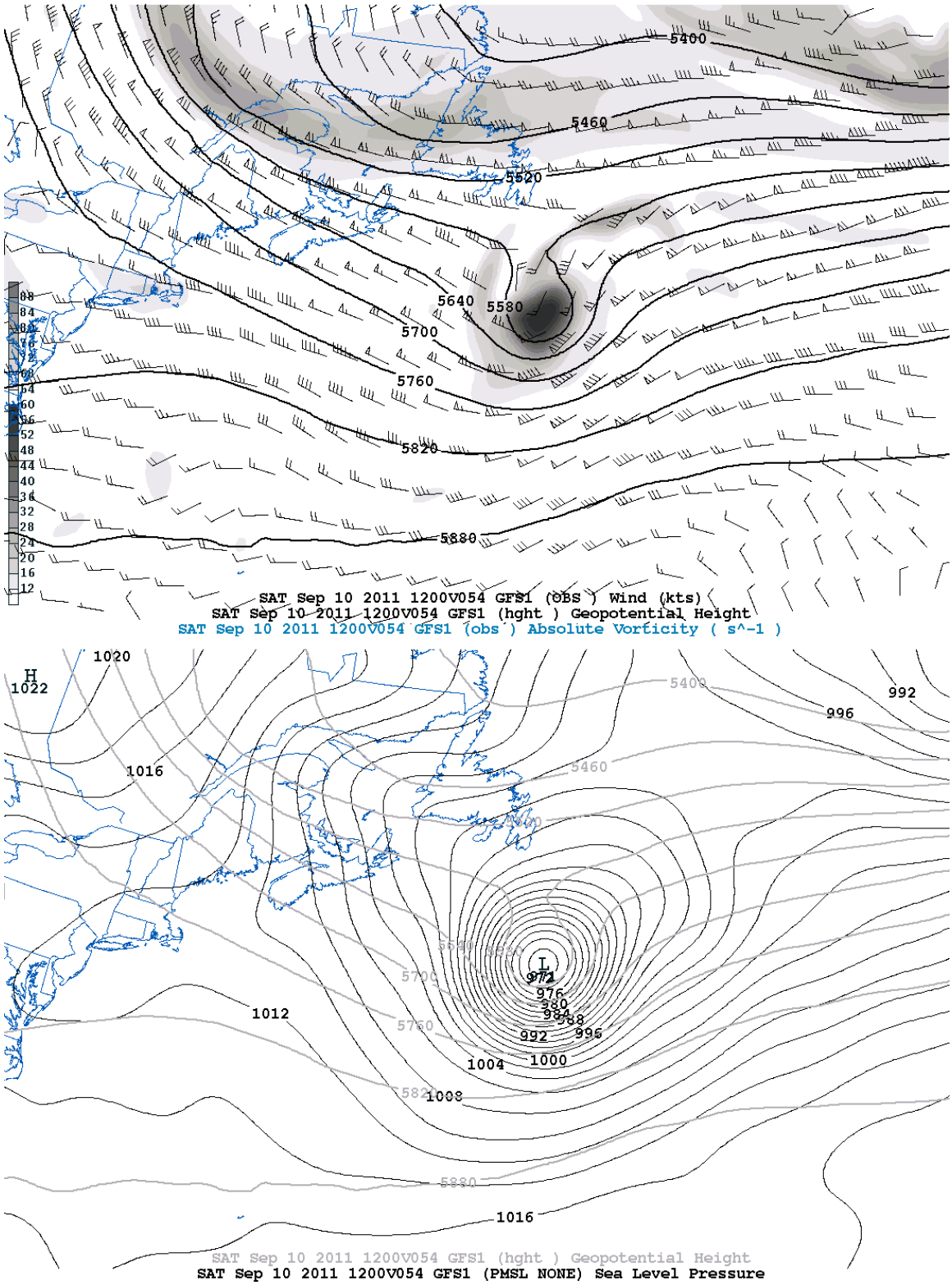
5.) The remnants of Hurricane Katia will move into the westerly jet stream over the next few days. The dynamical processes at work in the storm will change during this transformation. On the following page are two GFS forecasts valid 12 UTC Saturday, 10 September. The first panel shows wind barbs, geopotential height, and absolute vorticity at the 500-mb level, and indicates that Katia is embedded in the jet. The second image shows sea level pressure and 500-mb height.

a.) On the first diagram, indicate with a dot and label "CVA" one location that is experiencing strong cyclonic vorticity advection.

b.) On the second diagram, indicate with a dot and label one location that is experiencing strong warm advection (WA).

___ c.) Hurricanes don't generally do well with strong vertical wind shear. However, the GFS forecast lowers the sea level pressure from 971 to 962 mb in the following 18 hours. Which of the following most likely explains this fact?

(i) If the winds are equally strong at other levels, then there isn't necessarily strong vertical wind shear in this situation.
(ii) Perhaps QG processes, such as strong forcing for ascent, are leading to vortex stretching and maintaining the intensity of the system via midlatitude processes.
(iii) This model forecasts is unlikely to verify. The GFS model doesn't do well in forecasting hurricane intensity, and is not to be trusted.
(iv) The system is still located over the warm Gulf Stream, and so the intensification is related to tropical processes, which are still at work so long as the storm remains over warm water.


5400
5460
5520
5580
5640
5700
5760
5820
5880
SAT Sep 10 2011 1200V054 GFS1 (OBS) Wind (kts)
SAT Sep 10 2011 1200V054 GFS1 (hght) Geopotential Height
SAT Sep 10 2011 1200V054 GFS1 (obs) Absolute Vorticity (s^-1)
H
1022
1020
1016
1012
1008
1004
1000
996
992
988
984
980
976
972
L
SAT Sep 10 2011 1200V054 GFS1 (hght) Geopotential Height
SAT Sep 10 2011 1200V054 GFS1 (PMSL NONE) Sea Level Pressure