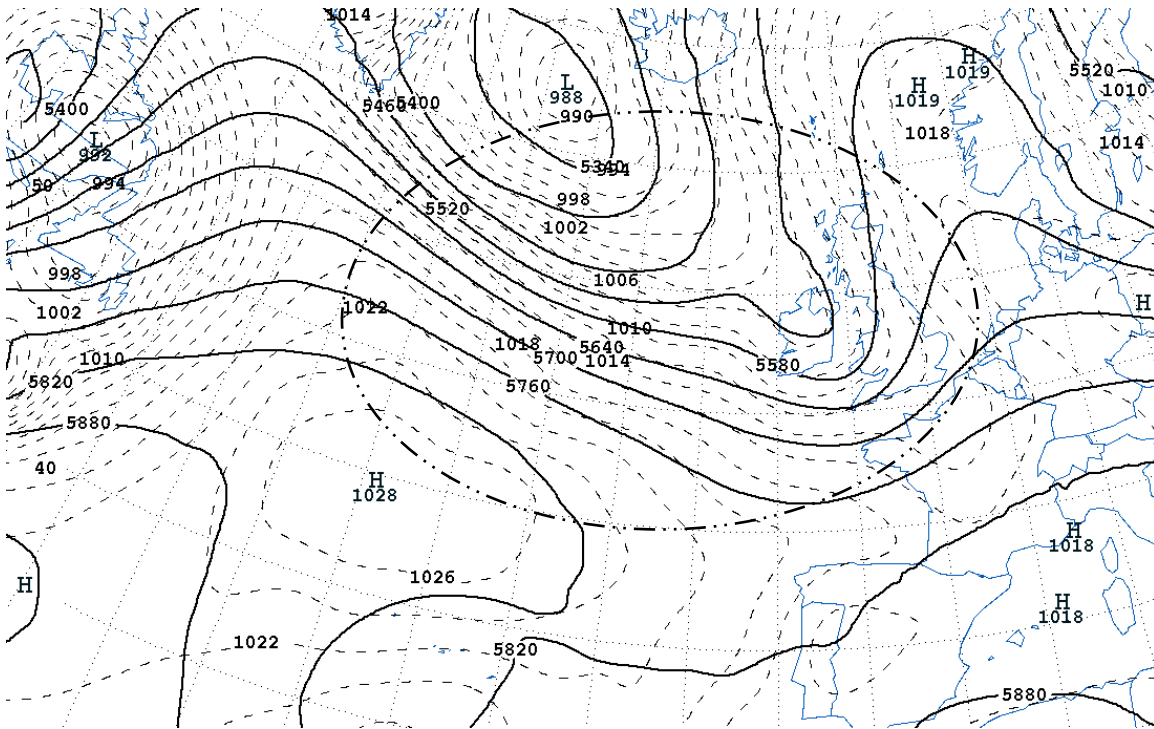


Name: \_\_\_\_\_

**MEA 443 WEATHER ANALYSIS AND FORECASTING, FALL 2011**  
**Quiz 4, Thursday 9/15/2011**

1.) Consider the GFS forecast map shown below, featuring 500-mb height (solid) and sea-level pressure (dashed lines). For the trough circled with the dash-dot line, use reasoning based on the QG height tendency equation (provided at end of quiz for reference if needed) to determine the expected evolution of this trough.

- \_\_\_ Which of the following best describes the situation and expected evolution?
- a.) A *digging* trough configuration with *cold advection* beneath the trough axis will lead to strengthening of this system and a southeastward movement.
  - b.) A *lifting* trough configuration with *a lack of cold advection* beneath the trough axis will lead to weakening of this system and a northeastward movement.
  - c.) A *digging* trough configuration, but *without appreciable temperature advection* will probably lead to strengthening of this system and a southeastward movement.
  - d.) A *lifting* trough configuration is evident, but *cold advection* beneath the trough axis will still likely allow the system to strengthen and drop southward.



2.) Consider the QG vorticity equation, as derived in HW #4 earlier this week (shown below). Perform a *scale analysis* of the 3 terms in this equation in the space provided below. Assume that the *advective* time scale applies.

$$\frac{\partial \zeta_g}{\partial t} = -\mathbf{V}_g \cdot \nabla(\zeta_g + f) - f_0 \nabla \cdot \bar{\mathbf{V}} \quad \text{where} \quad \zeta_g = \frac{\partial v_g}{\partial x} - \frac{\partial u_g}{\partial y}$$

3.) True/False. According to Durran and Snellman (1987):

- \_\_\_ a.) The q-vector form of the omega equation provides the best means of calculating the QG omega numerically.
- \_\_\_ b.) The vertical motion can be reasonably estimated by examining the vorticity advection by the thermal wind.
- \_\_\_ c.) The traditional QG omega equation *is not* well suited for practical application.
- \_\_\_ d.) The atmosphere is constantly advecting itself out of thermal wind balance, and the QG omega is the vertical component of a circulation that acts to restore balance.
- \_\_\_ e.) Vorticity, a measure of rotation in the atmosphere, causes air to rise. Where the vorticity is large, the air is forced to rise.

\_\_\_ 4.) In the QG height-tendency equation, the right side includes a term representing the *differential* geostrophic thickness (temperature) advection. Which of the following best explains why it is the *differential* advection rather than just the advection?

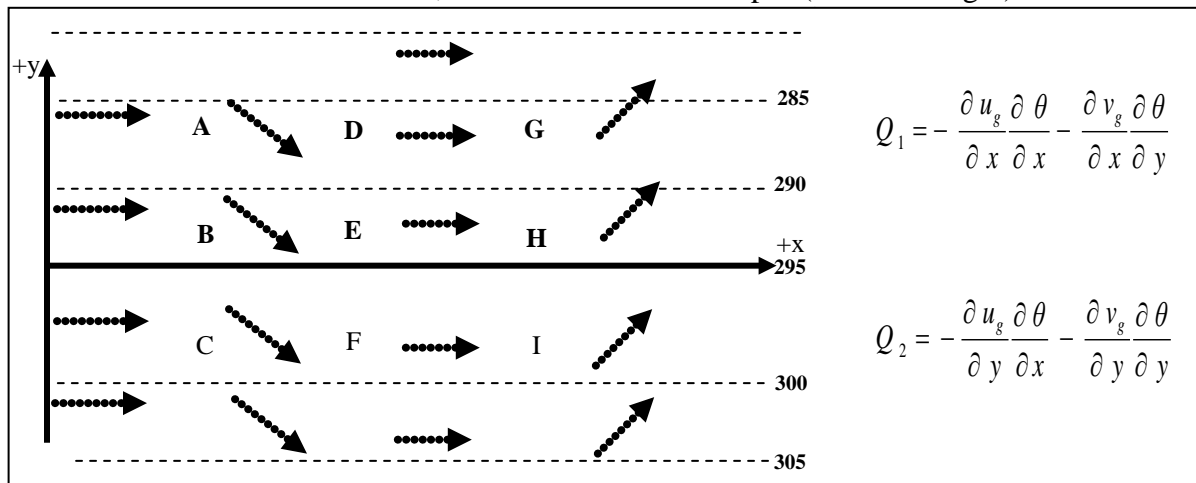
- a.) It actually *is* just the advection- warm advection is related to height falls and cold to height rises.
- b.) A local maximum of thermal advection leads to thickness changes that require height changes of opposite sign above and below the maximum.
- c.) Because the height-tendency equation is obtained from the vorticity and thermodynamic equations, and these equations contain vertical derivatives, the “differential” applies in this case to the temperature advection term.
- d.) Due to cancellation between the terms on the right-hand side of the height-tendency equation, height falls or rises due to thermal advection can be offset by those due to vorticity advection.

\_\_\_ 5.) Which of the following accurately describes the *QG potential vorticity*?

- a.) It is the product of the vorticity and static stability.
- b.) It is the sum of the vorticity and static stability.
- c.) It is equal to the vorticity divided by the static stability.
- d.) None of the above.

6.) Use the information provided below to *draw Q-vectors at the location of each letter*. Use this information to *shade and label regions of forcing for ascent and descent*.

Wind vectors are dotted arrows, dashed lines are isentropes (labeled at right).



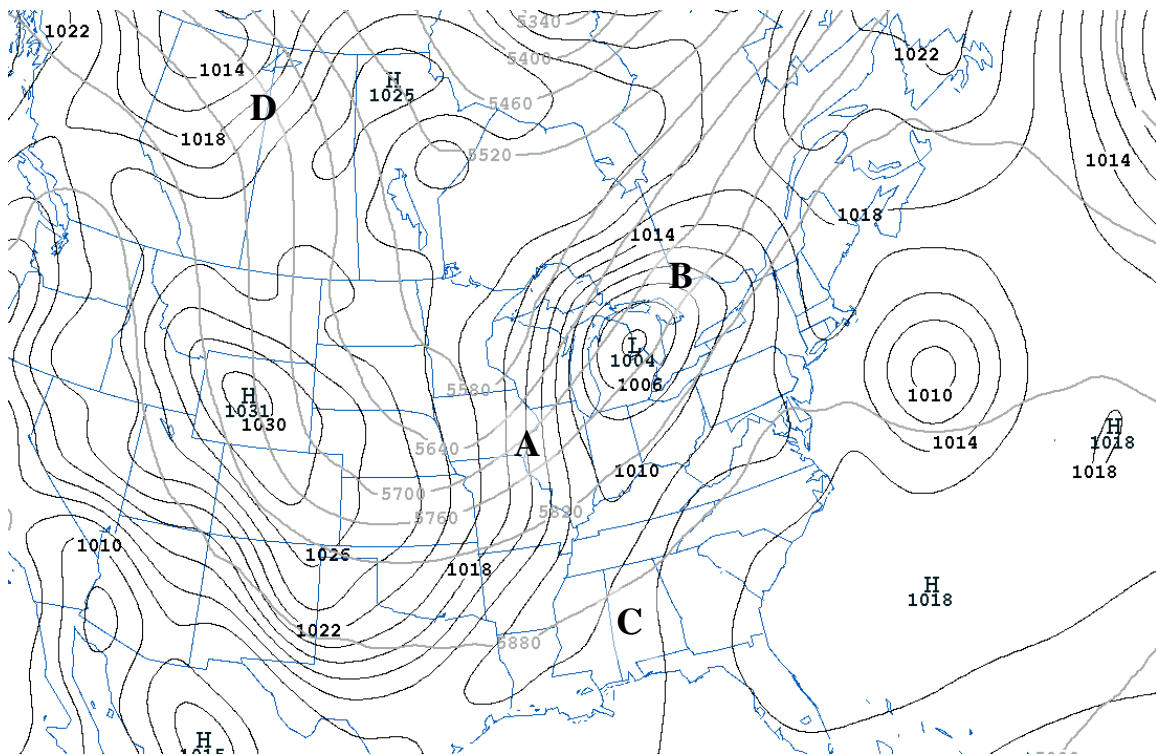
Questions 7-9 all relate to the map shown below. This map depicts 500-mb geopotential height (grey solid lines), and sea level pressure (darker lines).

7.) Consider the upper trough in the center of this image, located over the northern Plains. Based on the 500-mb height alone, is this trough “digging” or “lifting”? \_\_\_\_\_

8.) Assuming that thermal advection is maximized near the 850-mb level, what would you expect the 500-mb height tendency to be in the vicinity of point “B”, based on the thermal advection term? \_\_\_\_\_ (rising, falling, or weak).

9.) The traditional form of the QG omega equation is prone to cancellation between the terms on the right-hand side. On the map below, for the points A-D, which would be most likely to experience *cancellation between the terms on the right side of the traditional QG omega equation* for lower tropospheric omega values?

- Point A: circle: (no cancellation, weak cancellation, or strong cancellation)
- B: circle: (no cancellation, weak cancellation, or strong cancellation)
- C: circle: (no cancellation, weak cancellation, or strong cancellation)
- D: circle: (no cancellation, weak cancellation, or strong cancellation)



\_\_\_ 10.) Would you prefer to have quizzes in MEA 443 given on Tuesdays, or stick with Thursdays?

- a.) Prefer Tuesday
- b.) Prefer Thursday
- c.) Don't care
- d.) Other

Some equations for reference are included below.

QG omega equation:

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

QG height-tendency equation:

$$\left[ \nabla^2 + \frac{\partial}{\partial p} \left( \frac{f_0^2}{\sigma} \frac{\partial}{\partial p} \right) \right] \chi = -f_0 \vec{V}_g \cdot \nabla \left( \frac{1}{f_0} \nabla^2 \Phi + f \right) - \frac{\partial}{\partial p} \left[ -\frac{f_0^2}{\sigma} \vec{V}_g \cdot \nabla \left( -\frac{\partial \Phi}{\partial p} \right) \right]$$