PHYC/OCEA 4412/5412

Assignment #2

Due: Friday, 12 February 2010, by 5 PM in my office.

Links to Met charts and other data are available from the class Web page.

1) Identify a region of stretching deformation on a Met chart and track it with time. Do events unfold as you would expect from the theory in class?

2) Identify a jet streak on a met chart (pay attention to both winds and temperatures). Compare the vertical motion field you expect from theory with either the moisture or cloud charts. Do theory and practice agree?

3) a) Show that

$$-\frac{R}{\sigma p}[\nabla_H^2(-\vec{u}_g\cdot\vec{\nabla}_H T)] = \frac{f_0}{\sigma}\left[\frac{\partial \vec{u}_g}{\partial p}\cdot\vec{\nabla}_H\zeta_g - \vec{u}_g\cdot\vec{\nabla}_H\frac{\partial \zeta_g}{\partial p} + \left(D_y\frac{\partial D_x}{\partial p} - D_x\frac{\partial D_y}{\partial p}\right)\right]$$

where $D_x = \frac{\partial u_g}{\partial x} - \frac{\partial v_g}{\partial y}$ and $D_y = \frac{\partial v_g}{\partial x} + \frac{\partial u_g}{\partial y}$ are “geostrophic deformation terms” (not to be confused with total derivatives).

b) Starting from the traditional omega equation, derive the “Trenberth” form of the omega equation

$$\left(\nabla_H^2 + \frac{f_0^2}{\sigma}\frac{\partial^2}{\partial p^2}\right)\omega = \frac{f_0}{\sigma}\left[2\left(\frac{\partial \vec{u}_g}{\partial p}\cdot\vec{\nabla}_H\zeta_g\right) + \frac{\partial \vec{u}_g}{\partial p}\cdot\vec{\nabla}_H f - 2D_g^2\frac{\partial \theta_D}{\partial p}\right]$$

where

$$\vec{D}_g = D_x\hat{i} + D_y\hat{j}$$

(not to be confused with the total derivative) and θ_D is the angle between the “axis of dilatation” and the x-axis. Hint: express the dilatation term given in round brackets in part a) using a vector product.

c) The second and third terms on the right-hand-side of the equation are usually small. Provide an interpretation of the first term on the right and side as a forcing for upward/downward motions (as we did for the other omega equations).

d) Use the Trenberth form of the omega equation explain vertical motions for i) the stretching deformation; and ii) the jet streak. Use similar diagrams of temperature contours and streamlines as provided in class.