

1. (10 pts) (based on problem 6.4 in Holton): write a program, preferably in IDL, to plot the geopotential height field ϕ/g at two levels, 750 mb (assume a ϕ_o/g of 2,400 m) and 250 mb (take ϕ_o/g to be 10,000 m):

$$\phi = \phi_o(p) + cf_o \left[-y \left(1 + \cos\left(\frac{\pi p}{p_o}\right) \right) + \frac{\sin k(x - ct)}{k} \right] \quad (1)$$

Use an interval of 60 m, and label the contours. Use a domain of $y=[0,2000 \text{ km}]$ and $x=[0,3000 \text{ km}]$, and assume that $L=2\pi/k=1500 \text{ km}$. Assume $c=10 \text{ ms}^{-1}$, $p_o=10^5 \text{ Pa}$, and $f_o=10^{-4} \text{ s}^{-1}$, and evaluate the fields at $t=0$. (2 figures)

2. (20 pts) Compute the layer-mean temperature T_m (K) between 750-250 mb from (1). Then plot T_m in the same domain as a color field, and on top show the 750 mb geopotential height (GPH) field (contours). (1 figure)

3. (10 pts) Write an analytical expression for temperature T from (1), assuming hydrostatic balance. Then plot both T_m and T_{500} (temperature at 500 mb) as contour fields in the same domain as (1), and confirm that the patterns are similar. Use solid contours for T_{500} and dashed contours for T_m . (1 figure)

4. (10 pts) Write an analytical expression for the geostrophic wind for the GPH field shown in (1).

5. (20 pts) Write an analytical expression for temperature advection $-\vec{v}_g \cdot \nabla T$ for the GPH field shown in (1). Then plot this temperature advection (at 750 mb) in the same domain as a color field, and on top show both the 750 mb GPH field (solid contours) and the 750 mb T field (dashed contours). Interpret your results in terms of the solenoid (or 'box') method that quantifies advection, and in terms of the trof/ridge pattern revealed by the GPH field. (1 figure)

6. (10 pts) Write an analytical expression for the geostrophic absolute vorticity ζ_g for the GPH field shown in (1). Then plot ζ_g at 250 mb in the same domain as a color field, and on top show the 250 mb GPH field (contours). (1 figure)

7. (20 pts) Write an analytical expression for relative vorticity advection $-\vec{v}_g \cdot \nabla \zeta_g$ for the GPH field shown in (1). Then plot this vorticity advection (at 250 mb) in the same domain as a color field, and on top show the 250 mb GPH field (solid contours) and the 250 mb ζ_g (dashed contours). Interpret your results in terms of the vorticity field (solenoid method) and in terms of the trof/ridge pattern revealed by the GPH field. (1 figure)