**Atm 622 Fall 2012**

 **Problem Set #2**

**Note: Equation numbers refer to Holton (2004, 4th Edition)**

1. Suppose that a baroclnic fluid is confined between two rigid horizontal lids in a rotating tank in which $β=0 $but frictional drag must be included. If the frictional force has the form $F=μ\vec{V} $(friction is everywhere linearly proportional to the velocity) show that the two-level model perturbation vorticity equations in Cartesian coordinates can be written as

$$\left(\frac{∂}{∂t}+U\_{1}\frac{∂}{∂x}+μ\right)\frac{∂^{2}ψ\_{1}^{'}}{∂x^{2}}-\frac{f}{δp}ω\_{2}=0$$

$$\left(\frac{∂}{∂t}+U\_{3}\frac{∂}{∂x}+μ\right)\frac{∂^{2}ψ\_{3}^{'}}{∂x^{2}}+\frac{f}{δp}ω\_{2}=0$$

where perturbations are assumed in the form given in (8.8). Assuming solutions of the form (8.17), show that the phase speed satisfies a relationship similar to (8.21) with $β$ replaced everywhere by $iμk$ and that as a result the condition for baroclinic instability becomes

$$U\_{T}>\frac{μ}{\left(2λ^{2}-k^{2}\right)^{^{1}/\_{2}}}$$

1. For the case $β=0 $determine the phase difference between the 250 hPa and 750 hPa geopotential height fields for the most unstable baroclinic wave. Show that the 500 hPa geopotential height and thickness fields are **90o** out of phase.
2. For the conditions of problem 2, given that the amplitude of $ψ\_{m} $is $A= 10^{7}m^{2}s^{-1}$, solve the system (8.18)-(8.19) to obtain **B**. Let $λ^{2}=2x10^{-12} m^{-2}$ and $U\_{T}=15 m s^{-1}$
3. For the situation of Problem 3 compute $ω\_{2}^{'}$ using the expression (8.28).