ESCI 343 – Atmospheric Dynamics II
Answers to Selected Exercises for Lesson 13

2. The ocean is often represented as a two-layer fluid. Assume the upper layer has a depth of 700 m and a density of 1021 kg/m^3, while the lower layer has a depth of 3300 m and a density of 1023 kg/m^3.

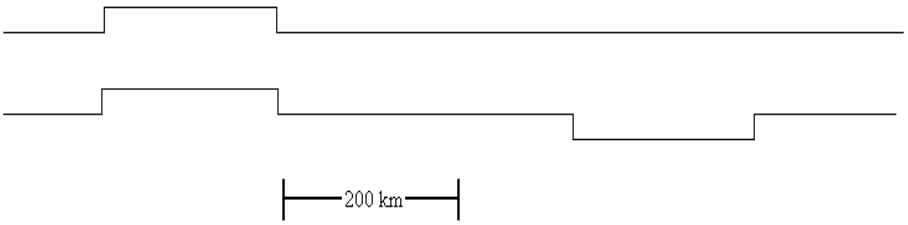
   a. Find the barotropic (external) radius of deformation at latitude 45°N.

      Answer: For barotropic mode, $c = \sqrt{gH}$ which is 198 m/s, so λ_R is 1921 km.

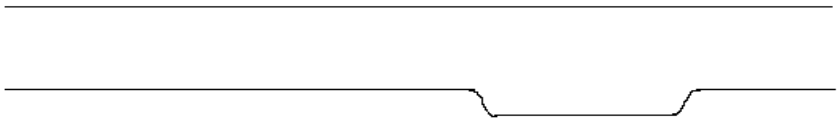
   b. Find the baroclinic (internal) radius of deformation at the same latitude.

      Answer: For baroclinic mode, $c \cong \sqrt{g' \frac{H_1 H_2}{H}}$ which is 3.32 m/s, so λ_R is 32 km.

   c. For the disturbances in this ocean shown below, sketch the final position of the upper and lower surfaces. Assume the disturbance on the left only generates waves in the barotropic mode, while the disturbance on the right only generates waves in the baroclinic mode. The top line represents the external surface, while the bottom line represents the internal interface.



      Answer:



3. Calculate the radius of deformation for a typical bathtub. How large would a disturbance in the tub have to be in order for rotational effects to be important?

   Answer: H ~ 0.5 m, so $2\pi\lambda_R$ ~ 138 km, so disturbance would have to be ~ 14 km for rotational effects to be important.