ATM 500: Atmospheric Dynamics
Homework 6
Due Friday October 14 2016 by 10:15 am

Note special due date because of class cancellation

1. *Question 2.19 from Vallis* Consider a dry, hydrostatic, ideal-gas atmosphere whose lapse rate is one of constant potential temperature. What is its vertical extent? That is, at what height does the density vanish? Is this a problem for the anelastic approximation discussed in the text?

2. Consider a layer of fluid between two solid boundary at $z = 0$ and $z = H$. Suppose that the flow is horizontally convergent (i.e. $\nabla_z \cdot \vec{u} < 0$) in some thin layer near the lower boundary, and horizontally divergent in a thin layer near the upper boundary. Assume that the horizontal flow is non-divergent elsewhere. What can you infer from the continuity equation about the vertical structure of vertical motion $w(z)$?

    a. Assume a Boussinesq fluid. Be as quantitative as you can, and draw a sketch of $w(z)$.

    b. Now calculate and sketch $w(z)$ for an anelastic fluid. For the reference profile $\tilde{\rho}(z)$ assume an *isothermal ideal gas*.

    c. Give a physical explanation (in words) for the differences between your two sketches.

    d. How would your sketch in part (b) differ if you used an isentropic (constant potential temperature) reference profile as in Question 1 instead of an isothermal profile? Here a qualitative answer is sufficient.