Climate of the Ocean – Exercise 3 **23.11.2016**

Task 1:

What is the pressure gradient required at the earth's surface at 45° latitude to maintain a geostrophic wind velocity of 30 m/s?

Task 2:

Compute and compare the Rossby numbers for the planets Earth, Mars and Venus at 45°N. Is the geostrophic approximation valid on all three planets? (Assume U ~ 10 m/s, L ~ 10^6 m on all three planets.)

Task 3:

In the lecture you have seen the Lagrangian derivation of the continuity equation. Another approach is to consider a volume element δx δy δz that is fixed in a Cartesian coordinate frame as shown in Fig. 1. Use this approach to derive the relationship

$$\frac{\delta\rho}{\delta t} + \nabla \cdot (\rho U) = 0 \,,$$

which is the mass divergence form of the continuity equation.

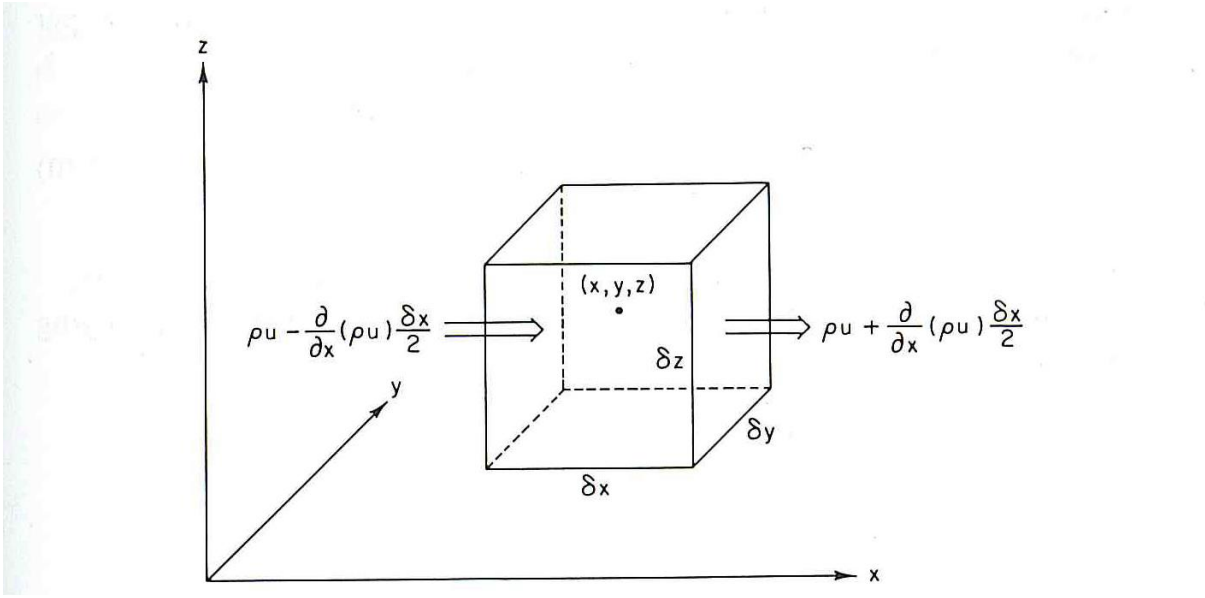

Figure 1: Mass inflow into a fixed (Eulerian) control volume, owing to motion parallel to the x axis (from Holton, p. 43, Fig. 2.5).

Task 4:

Suppose a 1-kg parcel of dry air is rising at a constant vertical velocity. If the parcel is being heated by radiation at the rate of 10^{-1} W kg^{-1}, what must be the speed of rise to maintain the parcel at constant temperature?