Session 4

1. Derive the mass conservation in pressure coordinates:

$$\nabla_p \cdot \mathbf{u} + \frac{\partial \omega}{\partial p} = 0.$$

2. In the isentropic coordinate system, the potential temperature is used as the vertical coordinate. Show that the transformation of the horizontal pressure gradient force from z to θ coordinates is given by:

$$\frac{1}{\rho}\nabla_z p = \nabla_\theta M,$$

where $M = c_p T + \Phi$ is the Montgomery streamfunction, and Φ is the geopotential.

3. Calculate the geostrophic wind speed (m/s) for a pressure gradient of 10 hPa per 1000 km and compare with all possible gradient wind speeds for the same pressure gradient and a radius of curvature of $\pm$ 500 km. Let ρ = 1 kg/m^3 and f = 10^{-4} 1/s.

4. What is the maximum Rossby number at which the gradient wind differs by less than 10 % from the geostrophic wind for cyclonic flow? Calculate both velocities in that case for the cyclone of radius 500 km.