Session 6

1. Derive the profile of the wind velocity in the atmospheric Ekman layer assuming the geostrophic wind is independent of height:

$$u = u_g[1 - e^{-\gamma z}\cos\gamma z] - v_g e^{-\gamma z}\sin\gamma z$$

$$v = v_g[1 - e^{-\gamma z}\cos\gamma z] + u_g e^{-\gamma z}\sin\gamma z$$

where $\gamma=\sqrt{\frac{f}{2K}}$ and K is eddy diffusivity. Assuming the geostrophic wind is purely zonal $(v_g=0)$:

- (a) Find the lowest height z_{Ek} at which the wind is parallel to the geostrophic wind. It conventionally designates the top of the Ekman layer. Calculate its value at 43° N using the eddy viscosity coefficient $K = 5 \text{ m}^2 \text{ s}^{-1}$.
- (b) Calculate the profiles of x and y components of the friction force:

$$\tau_x = \eta \frac{\partial u}{\partial z}$$

$$\tau_y = \eta \frac{\partial v}{\partial z}$$

where η is dynamic viscosity. Find the direction of the friction force at the z_{Ek} level with respect to the geostrophic wind.

- (c) Determine the limiting angle at the ground between the actual wind and the geostrophic wind.
- (d) Determine the direction of the net mass transport within the Ekman layer.