

Session 8

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

$$\begin{aligned}u &= u_g[1 - e^{-\gamma z} \cos \gamma z] - v_g e^{-\gamma z} \sin \gamma z \\v &= v_g[1 - e^{-\gamma z} \cos \gamma z] + u_g e^{-\gamma z} \sin \gamma z\end{aligned}$$

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.
(b) Calculate the profiles of x and y components of the friction force:

$$\begin{aligned}\tau_x &= \eta \frac{\partial u}{\partial z} \\ \tau_y &= \eta \frac{\partial v}{\partial z}\end{aligned}$$

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.