

Quiz 6: Non-Dimensional Analysis

October 29, 2025

Q1.- For very low velocities it is known that the drag force F_D of a small sphere is a function solely of the velocity of the flow V past the sphere, the diameter d of the sphere, and the viscosity μ of the fluid. Determine:

1. How many non-dimensional Pi groups are there involving these variables?
2. Find an expression of it.

Q2.- In a convective boundary layer flow, where the surface is characterized by surface thermal variations (patches), the NS equation for the vertical velocity component reduces to,

$$w \frac{\partial w}{\partial z} \equiv -g \frac{\Delta T}{T_0}. \quad (1)$$

1. Assuming that the mean horizontal velocity is controlled by the geostrophic wind U_G , and that the characteristic length scales in the horizontal and vertical directions are l_p and l_d correspondingly, use mass conservation to estimate a scaling velocity that can be used for w , to non-dimensionalize the vertical momentum equation.
2. With the newly found scaling velocity for w , non-dimensionalize the simplified vertical momentum equation above, also considering that $\Delta T \equiv \Delta\theta$, and T_0 scales as T_0 . What new non-dimensional parameter appears?