$$M\ddot{z} = (P_b - P_a)A - Mg \tag{1}$$

$$\dot{P}_b = \frac{\gamma RT}{Az}(\dot{m}_{in} - \dot{m}_{escape} - \frac{P_b A \dot{z}}{RT}) \tag{2}$$

$$\rho\frac{\partial P}{\partial x} = \frac{\beta}{L^2}(\frac{\dot{m}_{escape}}{z})^2 + \frac{\mu}{\kappa L}(\frac{\dot{m}_{escape}}{z}) \tag{3}$$

$$\frac{\partial P}{\partial x} = \frac{P_b - P_a}{\ell} \tag{4}$$