Take $P = P_0$ at $r = 0$ (e.g. Sun)

$$P(r) = P_0 \, e^{-r/H_p}$$

or we can write $r = R + h$ (e.g. Earth)

radius of surface ($R$)

height above surface ($h$)

$$P(h) = P_s \, e^{-h/H_p}$$

Pressure at surface ($P_s$)

$H_p$ = length scale over which pressure drops by a factor of $e$

From previous slides, $H_p = \frac{P}{\rho g} = \frac{\rho k T}{\bar{m} \rho g}$

$$\Rightarrow \quad P = P_s \exp\left[-\frac{\bar{m} g h}{kT}\right]$$

As $T \uparrow$, $H_p \uparrow$ $\Rightarrow$ atmosphere extends further

As $\bar{m}, g \uparrow$, $H_p \downarrow$ $\Rightarrow$ atmosphere extends less far