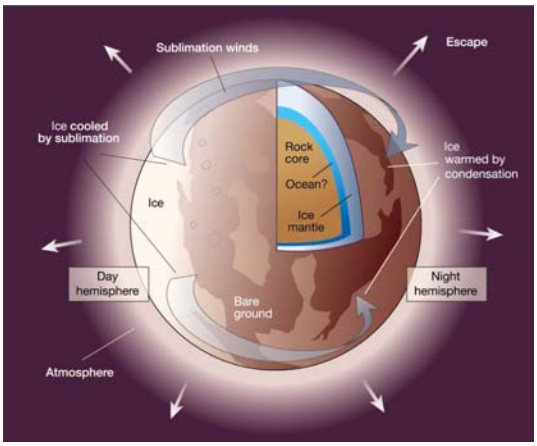
Exploring the Atmosphere of Pluto

Pluto radius… 1184 km
Pluto mass…. 1.3x10^{22} kg

Pluto temperature:
Closest to sun…. 55 kelvin (-218 C)
Farthest from sun… 33 kelvin (-240 C)



Pluto's atmospheric details. (Credit: NASA/JHUAPL)

Scale-height:

$$H = \frac{kT}{Mg}$$

k = 1.38x10^{-23} J/K
T = temperature in kelvin
g = acceleration of gravity at surface
M = mass of the molecule in kg

For Earth's atmosphere, T = 290 k, M=4.8x10^{-26} kg, g = 9.8 m/sec^2, then H = 8500 meters.

What this means is that each time you increase your altitude by 8500 meters, the density of the atmosphere decreases by a factor of 2.7 times.

Pluto's atmosphere consists of a thin envelope consisting of 90% nitrogen, and 10% methane, and traces of carbon monoxide gases. These are produced by the ices of these substances on its surface. As Pluto moves away from the Sun, its atmosphere gradually freezes out and falls to the ground. When Pluto is closer to the Sun, the temperature of Pluto's solid surface increases, causing the ices to sublimate into gas.

One way to compare the atmospheres of the planets is by calculating their scale heights. The scale height is the height above the surface such that 37% of the mass of the atmosphere is below this height. Mathematically, this is equal to

e^{-1}=1/2.7 of the material.

From the formula for H, you can see that as you make your planet more massive, the scale height 'thickness' of the atmosphere decreases. But if you have the same planet closer to the sun where it can be hotter, the thickness of the atmosphere can increase.

It is also the case that an atmosphere composed of low-mass molecules like hydrogen (smaller M) is much thicker than the atmospheres of heavier molecules (larger M) such as argon and carbon dioxide.

Things to think about: How does the scale height of Pluto's atmosphere change as it orbits the sun if the average atmosphere molecule mass (N_2) is 4.7x10^{-26} kg, and g for Pluto is 0.66 m/sec^2.