Introduction

Topics in this lecture

- We begin to look at the influence of the atmosphere and atmospheric dust on observations of Mars
- The vertical structure of the atmosphere
- Pressure and temperature structure
- Dust as an atmospheric heat source
- Clouds (if we have time....).

Mars Atmospheric Composition

Species	Abundance [%]
CO_2	95.3
N_2	2.7
Ar	1.6
O_2	0.13
CO	0.07
H_2O	0.03
Ne	2.5 ppm
Kr	0.3 ppm
Xe	0.08 ppm
O_3	0.10 ppm

Pressure Scale Height

- If H = constant with z (crude approx.) and z=0 is set as a reference level then

$$p(z)=p(0)\exp(-z/H)$$

- Scale height is the altitude over which the atmospheric pressure decreases by a factor, *e*

T ≈ 250 K, m = 44 x 1.67e-27 kg, k = 1.38e-23, g = 3.71 m s^{-2}
H(z=0) ≈ 12.6 km

- Curiosity - most planetary atmospheres have H between 10 and 20 km (except exospheres).
  - This probably has to do with lighter elements/compounds being more abundant but balanced against escape.
- H is a linear function of T

Density Scale Height

$$\frac{dn}{n}=-\frac{dT}{T(z)}-\frac{m(z)g(z)}{kT(z)}dz$$

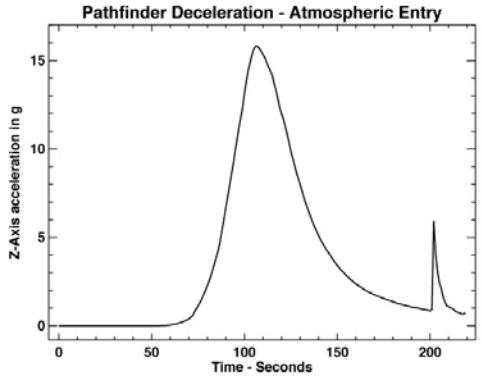
$$\frac{dn}{n}\approx-\frac{dT}{T(z)}-\frac{dz}{H(z)}$$

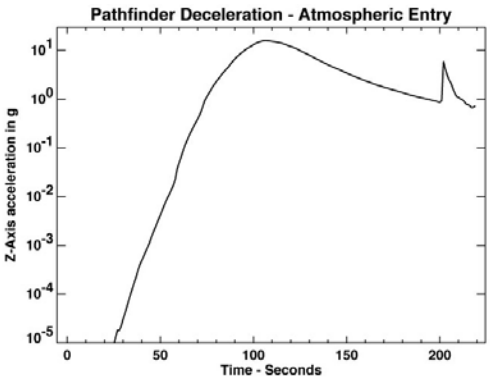
$$\frac{dn}{n}=-\left(\frac{1}{T(z)}\frac{dT}{dz}+\frac{1}{H}\right)dz=-\frac{dz}{H^*}$$

Defines the density scale height.

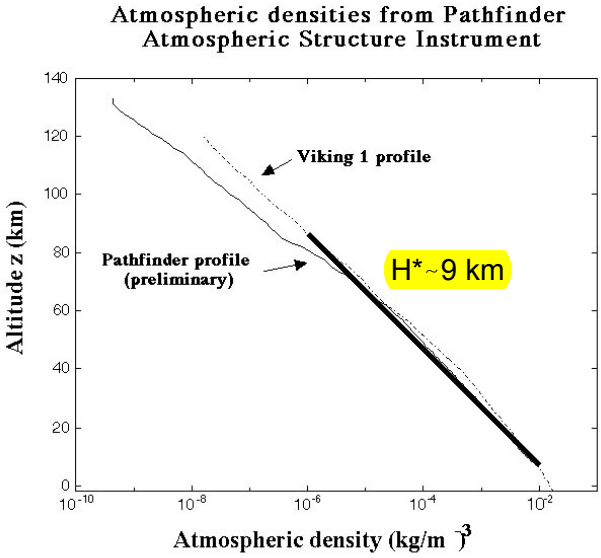
- The density scale height only equals the pressure scale height for an isothermal atmosphere. Otherwise.....

$$n(z'') = n(z')\frac{T(z')}{T(z'')}\exp\left(-\int_{z=z'}^{z=z''}\frac{dz}{H(z)}\right)$$

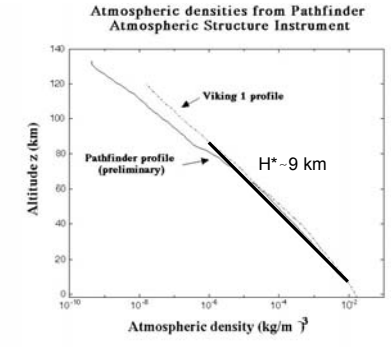




Descent Profile of MPF



How Do You Get This?



$$\rho = \frac{-2ma_s}{C_D \sigma V_r^2}$$

The deceleration depends upon the atmospheric density (ρ), the cross-sectional area of the s/c (σ), velocity (V_r), mass of the s/c (m), and the drag coefficient (C_D). *For specialists, C_D varies with Reynolds number, angle of attack etc.*

Measure either the velocity (via Doppler of a radio signal) or the deceleration (via onboard accelerometers), get knowledge of the drag coefficient from pre-launch testing, then derive the local density.

To explain the difference in dT/dz between the observation and theory we need .....

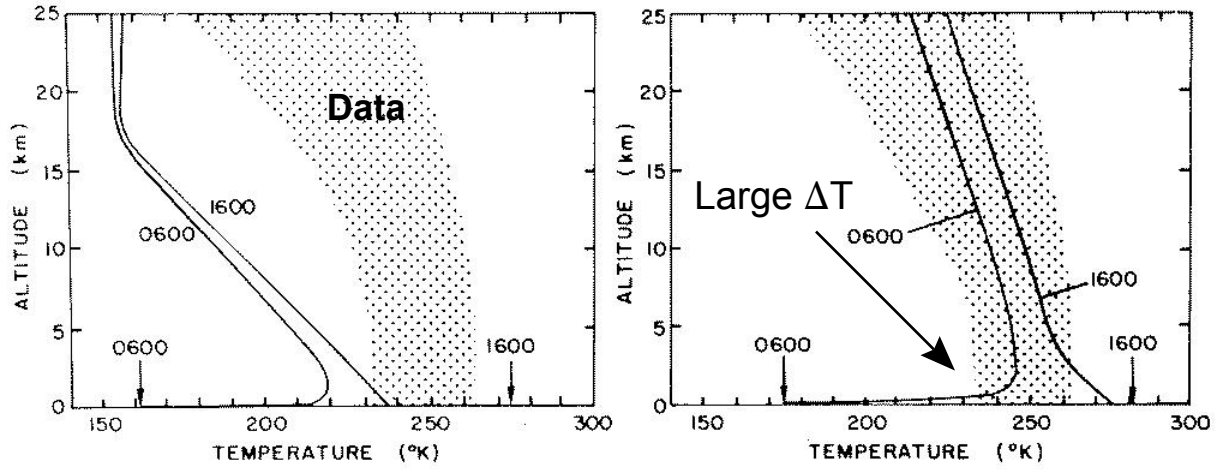
DUST

- There are huge amounts of dust in the atmosphere at all times.
- The dust particles are large enough to be efficient absorbers and scatterers of sunlight.
- They re-emit energy thermally to the surroundings and heat the CO_2 atmosphere.

Effect of Dust on the Martian Temperature Profiles

Without Dust

With Dust



Data - Mariner 6 and 7 , Models Gierasch and Goody (1972)