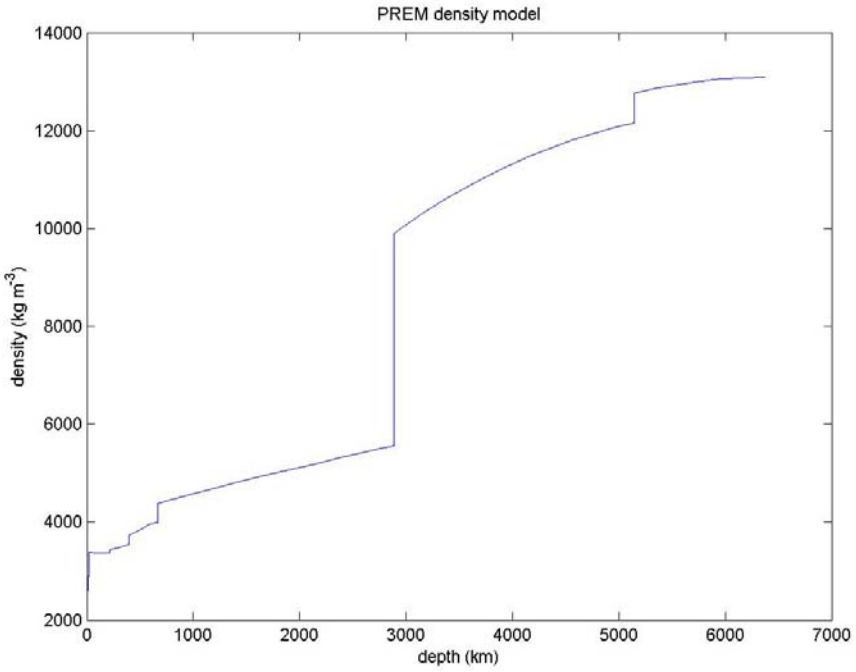
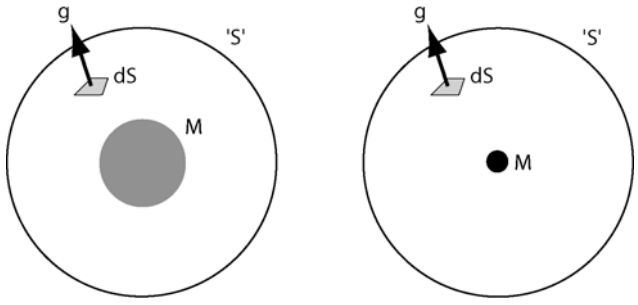
B8 : Radial density structure of Earth

- Density, ρ(r), varies with radial distance from the centre of the Earth
- Note that where composition changes, there is a jump in density (e.g mantle to outer core at depth of 300 km)
- In regions where composition stays constant, increasing pressure causes an increase in density through compaction.
- This model is the PREM (Preferred Reference Earth Model) that was first defined by Dziewonski and Anderson (1981).



However, this density model cannot be derived from gravity measurements on the Earth's surface because of Gauss's theorem. This states that

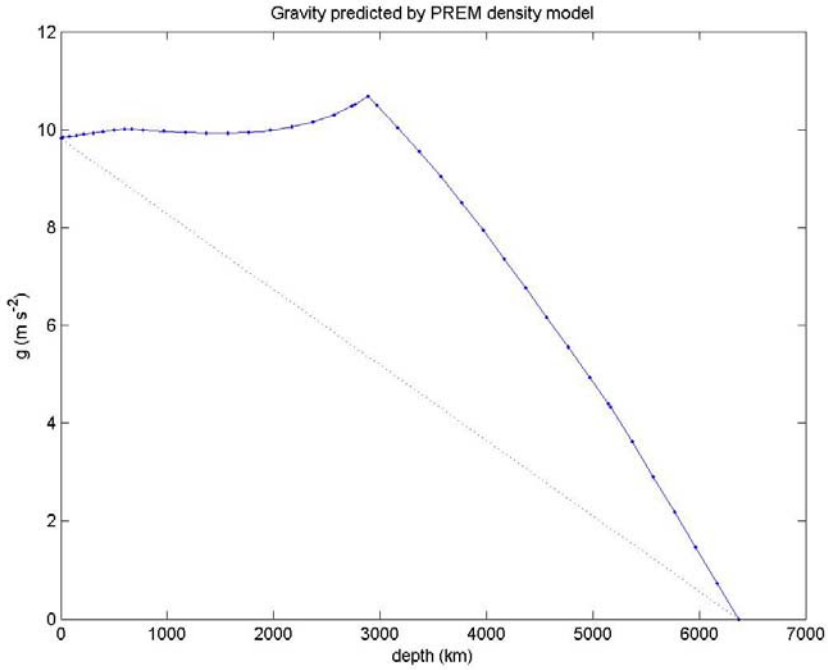
$\int_S g.dS = 4\pi GM$ where M = mass enclosed by the surface 'S'.



In the case of a radially symmetric Earth the surface 'S' is the surface of the Earth and g has a constant value. Thus

$4\pi R_E^2 g = 4\pi GM$

where R_E is the radius of the Earth. Note that M is mass enclosed by 'S' and the location is not important. Thus all mass distributions give same value of g at the surface.



- Could map the variation of density with depth if we could drill to the centre of the Earth and measure g. Figure above shows g (r) for the PREM density model and an Earth with uniform density (straight line).

- Lowest value of g is at the centre of the Earth. Why?

- The variation of density with depth, ρ(r) was determined from seismic studies, constrained by knowledge of the total mass of the Earth.

Dziewonski, A.M, D.L. Anderson, Preliminary reference Earth model, *PEPI*, 25, 297-356, 1981.