GEOS 602 – Geophysical Fields
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Problem Set #7 Due Tue March 30

1. Magnetic induction **B** is measured along a horizontal profile in the *x* direction directly above a single dipole located at depth *d* below the profile. Derive expressions for the following *horizontal* distances in terms of *d*:

   a. For a *vertical* dipole
      i. The distance between zero crossings of B_z.
      ii. The distance between maximum horizontal gradients of B_z (maxima in $\partial B_z/\partial x$).
      iii. The distance between the maximum and minimum values of B_x.

   b. For a *horizontal* dipole pointing in the *x*-direction
      i. The distance between zero crossings of B_x.
      ii. The distance between the maximum and minimum values of B_z.

2. Assume the Gaussian coefficients of the geomagnetic potential V (given below),

$$V = a\sum_{n=1}^{\infty}\sum_{m=0}^{n}\left(\frac{a}{r}\right)^{n+1} P_{nm}(\cos\theta)\left\{g_n^m \cos m\varphi + h_n^m \sin m\varphi\right\}$$

where the radius of the earth a = 6,378,137 meters, $P_{nm}(\cos\theta)$ are the normal Legendre polynomials, and the coefficients:

g_1^0 = -29,775	
g_1^1 = -1851	h_1^1 = 5411
g_2^0 = -2136	
g_2^1 = 3058	h_2^1 = -2278
g_2^2 = 1693	h_2^2 = -380

What will be the magnitude of the vertical (radial) component of the Earth's magnetic field at the surface at
   (a) The geographic north pole?
   (b) The geographic south pole?
   (c) The intersection of the Greenwich meridian and the equator (lat = long = 0)?

3. Using the same coefficients as above, calculate the east, north, and up components of **B** at
   a. The geographic North pole
   b. The equator at the Greenwich meridian

   Note, from **B** = - ∇*V*,

$$B_{east} = -\frac{1}{r\sin\theta}\frac{\partial V}{\partial\varphi}$$

$$B_{north} = \frac{1}{r}\frac{\partial V}{\partial\theta}$$

$$B_{up} = -\frac{\partial V}{\partial r}$$