Geomagnetism 2015
Exercise 3/6
Return to reko.hynonen@fmi.fi by: Sun 11.10.2015 10:00
Exercise session: Mon 12.10.2015 14-16, Physicum room D115

1. Download IGRF-12 coefficients from

http://www.ngdc.noaa.gov/IAGA/vmod/igrf12coeffs.txt.

Write a Matlab-function (or equivalent)

[year,n,m,g,h,g_sv,h_sv] = read_igrf12coeffs()

that reads and returns the coefficients in the file.

2. Write a function

[north_lat,north_lon,south_lat,south_lon,dipole_moment] = igrf_dipole(year)

that returns the geographic locations of the north (north_lat,north_lon) and south (south_lat,south_lon) geomagnetic pole as well as the dipole moment for the given year. Plot the dipole moment as a function of year (1900-2020). If the approximately linear downward trend continues, when will the dipole moment be reduced to zero?

3. Write a function

d = sph_distance(lat1,lon1,lat2,lon2,R)

that computes the distance between point (lat1,lon1) and point (lat2,lon2) along the surface of a sphere with a radius R. Use your function to plot the distance of the north geomagnetic pole from Helsinki as a function of year.

4. Write a function

dSP = dlegendre(n,x)

that computes the first derivative of the Schmidt semi-normalized associated Legendre functions of degree n and order $m = 0, 1, ..., n$ with respect to x (dSP_n^m/dx), evaluated for each element of x ($-1 \leq x \leq 1$). If x is a vector, dSP is an $(n+1)$-by-l matrix, where l = length(x). The $dSP(m+1,i)$ entry corresponds to dSP_n^m/dx evaluated at $x(i)$.

The Matlab function “legendre” me be helpful.

5. Write a function

[X,Y,Z,B,H,D,I] = igrf(h,lat,lon,year)

that evaluates the three geographic components of the magnetic field (*X,Y,Z*), the strength of the magnetic field (*B*), the horizontal component of the magnetic field (*H*), the declination (*D*), and the inclination (*I*) at a location determined by the geographic latitude (*lat*), longitude (*lon*), and altitude from the Earth's surface (*h*) using the IGRF model for a given year.

6. Use your igrf-function to plot the value and secular variation of *X, Y, Z, B, H, D,* and *I* as a function of year (1900-2020) for the location of Helsinki. How do the results change if only the dipole component of the model is used? How about if the dipole component is not included?