LETTER TO THE EDITOR

The International Geomagnetic Reference Field 1965.0

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An International Geomagnetic Reference Field (IGRF) for the field of internal origin and its secular variation was chosen by IAGA Commission 2 Working Group No. 4, Analysis of the Geomagnetic Field, at the Symposium on the Description of the Earth's Magnetic Field, held in Washington, D.C., October 22-25, 1968. A.J. Zmuda is the Reporter of the Working Group; B.R. Leaton, the Chairman of Commission 2, Representation of the Main Magnetic Field. The IGRF has been endorsed by the IAGA World Magnetic Survey Board and by the IAGA Executive Committee.

The reference field is a series of spherical harmonics in geocentric spherical coordinates with the geomagnetic potential V and intensity components given by

$$V = a \sum_{n=1}^{n=8} \sum_{m=0}^{m=n} \left(\frac{a}{r} \right)^{n+1} \cdot [g_n^m \cos m\lambda + h_n^m \sin m\lambda] P_n^m(\cos\theta),$$

$$X = \frac{1}{r} \frac{\partial V}{\partial \theta},$$

$$Y = \frac{-1}{r \sin \theta} \frac{\partial V}{\partial \lambda},$$

$$Z = \frac{\partial V}{\partial r},$$

where X , Y and Z represent respectively the northward, eastward and downward components of the intensity in geocentric coordinates; a , the radius (6371.2 km) of the reference sphere; r , the radial distance from the center of the reference sphere; θ , the geocentric colatitude measured from the North Pole; λ , the geocentric longitude measured east from Greenwich; $P_n^m(\cos\theta)$, an associated Legendre function of degree n and order m and of the Schmidt quasi-normalized type (*Chapman and Bartels*, 1940); g_n^m and h_n^m , spherical harmonic coefficients, of which there are eighty, up to $n=m=8$, for the main field as well as for the secular variation. The scalar intensity $F=[X^2+Y^2+Z^2]^{1/2}$; the horizontal intensity $H=[X^2+Y^2]^{1/2}$; the declination $D=\tan^{-1}[Y/X]$; the inclination $I=\tan^{-1}\left[\frac{Z}{H}\right]$.

The function $P_n^m(\cos\theta)$ may be written as

$$P_n^m(\mu) = \frac{1}{2^n n!} \left[\frac{\epsilon_m (n-m)! (1-\mu^2)^m}{(n+m)!} \right]^{1/2} \frac{d^{m+n}(\mu^2-1)^n}{d\mu^{m+n}},$$

where $\mu = \cos\theta$; $\epsilon_m=1$ for $m=0$; $\epsilon_m=2$ for $m \geq 1$.

The epoch is $t_0=1965.0$ and the value of a harmonic coefficient for another time t is obtained from

$C_n^m(t)=C_n^m(t_0)+\dot{C}_n^m(t-t_0),$

where $\dot{C}_n^m$ equals the secular change of the coefficient, in gammas/year (1 gamma=10⁻⁵ gauss).

For the earth's surface the International Ellipsoid is used : equatorial radius 6378.160 km

Table IGRF 1965.0 Coefficients

<i>n</i>	<i>m</i>	Main field, gammas		Secular change, gammas/year	
		<i>g</i> _{<i>n</i>} ^{<i>m</i>}	<i>h</i> _{<i>n</i>} ^{<i>m</i>}	$\dot{g}_n^m$	$\dot{h}_n^m$
1	0	−30339		15.3	
1	1	−2123	5758	8.7	−2.3
2	0	−1654		−24.4	
2	1	2994	−2006	0.3	−11.8
2	2	1567	130	−1.6	−16.7
3	0	1297		0.2	
3	1	−2036	−403	−10.8	4.2
3	2	1289	242	0.7	0.7
3	3	843	−176	−3.8	−7.7
4	0	958		−0.7	
4	1	805	149	0.2	−0.1
4	2	492	−280	−3.0	1.6
4	3	−392	8	−0.1	2.9
4	4	256	−265	−2.1	−4.2
5	0	−223		1.9	
5	1	357	16	1.1	2.3
5	2	246	125	2.9	1.7
5	3	−26	−123	0.6	−2.4
5	4	−161	−107	0.0	0.8
5	5	−51	77	1.3	−0.3
6	0	47		−0.1	
6	1	60	−14	−0.3	−0.9
6	2	4	106	1.1	−0.4
6	3	−229	68	1.9	2.0
6	4	3	−32	−0.4	−1.1
6	5	−4	−10	−0.4	0.1
6	6	−112	−13	−0.2	0.9
7	0	71		−0.5	
7	1	−54	−57	−0.3	−1.1
7	2	0	−27	−0.7	0.3
7	3	12	−8	−0.5	0.4
7	4	−25	9	0.3	0.2
7	5	−9	23	0.0	0.4
7	6	13	−19	−0.2	0.2
7	7	−2	−17	−0.6	0.3
8	0	10		0.1	
8	1	9	3	0.4	0.1
8	2	−3	−13	0.6	−0.2
8	3	−12	5	0.0	−0.3
8	4	−4	−17	0.0	−0.2
8	5	7	4	−0.1	−0.3
8	6	−5	22	0.3	−0.4
8	7	12	−3	−0.3	−0.3
8	8	6	−16	−0.5	−0.3

and flattening $1/298.25$ (*Transactions of the International Astronomical Union*, 1966).

Table shows the IGRF coefficients, which apply to the period 1955.0–1972.0. For dates after the epoch 1972.0, modifications, if needed, will be made at the XV General Assembly of IUGG, in 1971; future changes of the IGRF are likely only to the secular change coefficients. For the period near but preceding 1955.0, the 1945.0 field of Vestine *et al.* (1947) is suggested.

The reference field is not intended as a source of compass information for nautical and aeronautical charts. A detailed explanation of the IGRF is in preparation, including the background of its adoption, and will be published in the IUGG/IAGA volume, *The World Magnetic Survey 1957–1969*, to be dedicated to the memory of Dr. Ernest Harry Vestine.

A Fortran program to compute field values from the IGRF 1965.0 is obtainable from the U.S. National Space Science Data Center, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA, 20771; from the U.K. National Data Center, Institute of Geological Sciences, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England; and from the World Data Center A for Geomagnetism, U.S. Coast and Geodetic Survey-ESSA, Rockville, Maryland 20852, USA.

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