Availability
On one magnetic tape as provided by the author (NSSDC ID #**MG-22A**).

Reference
Olson, W. P. (1969) The shape of the tilted magnetosphere. *J. geophys. Res.* **74**, 5642.

Olson–Pfitzer Field Model (1974)

K. A. Pfitzer, W. P. Olson
(for address see "MDTILT Magnetic Field Model" above)

Parameter
Earth's magnetic field vector and strength including external sources.

Brief description
This is an analytical model of the Earth's magnetic field valid from the dayside subsolar magnetosphere to beyond lunar orbit in the nightside magnetotail. Only the quiet-time magnetosphere is represented including the contributions from magnetopause, tail, and ring currents. The internal (core) field is represented by a fixed dipole. The field representation is given in Cartesian GMS coordinates using sixth-order expansions of power series and exponential terms. The 180 coefficients were determined by fitting to over 600 magnetometer measurements from *OGO 3* and *5*. Shortcomings of this model are the restriction to quiet conditions and the fact that the direction of the main dipole and the ring current is fixed (i.e. perpendicular to the Earth–Sun direction).

Availability
On one magnetic tape (NSSDC ID #**MG-23A**). A more recent, unpublished version is available from the authors in computer form.

References
Olson, W. P. (Ed.) (1979) *Quantitative Modeling of Magnetospheric Processes.* American Geophysical Union, Washington, D.C.
Olson, W. P. and Pfitzer, K. A. (1974) A quantitative model of the magnetospheric magnetic field. *J. geophys. Res.* **79**, 3739.

Mead–Fairfield Field Model (1975)

D. H. Fairfield
NASA/GSFC, Code 695, Greenbelt, MD 20771, U.S.A.
NSI-DECnet: LEPVAX::U2DHF

Parameter
Earth's magnetic field direction and intensity out to 17 Earth radii.

Brief description
For this tilt-dependent model, four sets of model coefficients are available for four levels of magnetic activity as parameterized by *Kp*. It is valid out to 17 Earth radii. The model is expressed as second-order power series expansions in solar magnetic coordinates, quadratic in position and linear in tilt. Model coefficients (17) were obtained by a least-square-fit to 12,616 vector field measurements from 451 orbits of four *IMP* satellites between 1966 and 1972. The effect of localized current systems like the ring current and sheet currents in the tail are not particularly well modeled by these quadratic expansions. The program includes the GSFC (12/66) main field model for the representation of the internal (core) part of Earth's total magnetic field. A simple offset dipole field can be chosen instead of the spherical harmonics GSFC model, to reduce the computation time.

Availability
On tape and networks (NSSDC ID #**MG-21A**). Also available is the data base used in constructing the model (NSSDC ID #**MG-21B**).

Reference
Fairfield, D. H. and Mead, G. D. (1975) Magnetospheric mapping with a quantitative geomagnetic field model. *J. geophys. Res.* **80**, 535.

Geotail Field Model (1979)

D. B. Beard
Department of Physics and Astronomy, University of Kansas, Lawrence, KA 66045, U.S.A.

Parameter
Earth's magnetic field vector and strength including external sources.

Brief description
This data set consists of a set of subroutines designed to calculate the magnetic field of the Earth from −40 Earth radii to +10 Earth radii. The coefficients are calculated assuming the axis of the Earth's dipole is perpendicular to the Earth–Sun line. The magnetic potential was obtained by integrating over a model magnetotail current system and fitting the surface field to a set of Bessel functions.

Availability
On one tape as provided by author (NSSDC ID #**MG-24A**).

Reference
Beard, D. B. (1979) The magnetotail magnetic field. *J. geophys. Res.* **84**, 2118.

Tsyganenko Magnetic Field Model (Related Software) (1987)

N. A. Tsyganenko
Institute of Physics, Leningrad State University, Leningrad 198904, U.S.S.R.

Parameter
Earth's magnetic field (strength and vector) out to 70 Earth radii.

Brief description
This software package contains (1) the semi-empirical model of the magnetospheric magnetic field developed by Tsyganenko (1987), (2) the third generation of the International Geomagnetic Reference Field (IGRF) model 1965–1990 for the inner dipole-like part of the geomagnetic field, and (3) programs for field-line tracing and coordinate transformations.

The 1987 Tsyganenko model is based on *IMP-A*, *-B*, *-C*, *-D*, *-E*, *-F*, *-G*, *-H*, *-I*, *-J*, and *HEOS 1*, *2* measurements over the time period 1966–1980, using a total of 36,682 data points. It describes the magnetic field from about four to 70 Earth radii for several levels of magnetic disturbance. It includes a tilted geodipole and the contributions from external magnetospheric sources: (1) the field of the ring current, (2) the magnetotail current system, (3) the remaining part of the total external field including the field of magnetopause currents and an averaged contribution from the large-scale system of field-aligned currents. Two versions were established, a "long" version with 26 parameters and six disturbance levels, valid up to 70 Earth radii, and a "short" version with 20 parameters and eight disturbance levels, valid up to 30 Earth radii. Improvements of the 1987 Tsyganenko model have been proposed by Stern (1988) and Tsyganenko (1989).

The software package available from the National Space Science Data Center (NSSDC) was provided by V. A. Pilipenko, Institute of the Physics of the Earth, B. Gruzinskayz, 10, Moscow, 123810, U.S.S.R. It includes (1) an interactive driver program developed at NSSDC to compute the main and the magnetospheric parts of the geomagnetic field at arbitrary points (GSM or GEO coordinates) in the near-Earth space (up to 70 Earth radii) for given year, day of year, universal time, and magnetic disturbance level (*Kp*); (2) the subroutines and functions; (3) a program to compute dipole and corrected geomagnetic coordinates from various coordinate systems; (4) a program to compute the distance between two points on the geosphere; (5) a program to calculate the field-aligned projection of a given point in space onto the Earth's surface; (6) a test program; and (7) the output from this program.

Availability

On one tape, one diskette (for use on PCs), networks (NSSDC ID #**PG-18D**). The predecessor model by Tsyganenko and Usamanov (1982) is also available from NSSDC (NSSDC ID #**MG-25A**), one tape. The Tsyganenko 1989 model is now also available on one tape, one diskette, and on networks (NSSDC ID #**PG-18E**).

References

Peddie, N. W. (1982) A third generation of International Geomagnetic Reference Field Models. *J. Geomagn. Geoelectr.* **34**, 310.

Russell, C. T. (1971) Geophysical coordinate transformations. *Cosmic Electrodynamics*, Vol. 2, pp. 184–196.

Stern, D. (Personal Communication, 1988) (For more information, contact D. Stern, NASA/GSFC, Code 695; telephone: (301) 286-8292; NSI-DECnet: LEPVAX::U5DPS.)

Tsyganenko, N. A. (1987) Global quantitative models of the geomagnetic field in the cislunar magnetosphere for different disturbance levels. *Planet Space Sci.* **35**, 1347.

Tsyganenko, N. A. (1989) A magnetospheric magnetic field model with a wrapped tail current sheet. *Planet. Space Sci.* **37**, 5.

Tsyganenko, N. A. and Usmanov, A. V. (1982) Determination of the magnetospheric current system parameters and development of experimental geomagnetic field models based on data from *IMP* and *HEOS*-satellites. *Planet. Space Sci.* **30**, 985.

Tsyganenko, N. A., Usmanov, A. V., Papirashvili, V. O., Papitashvili, N. E. and Popov, V. A. (1987) Software for computations of geomagnetic field and related coordinate systems. Soviet Geophysical Committee. Special Report, 58 pp., Moscow.

FIELD/FIELDG (1968)

J. C. Cain

Department of Geology, Florida State University, Tallahassee, FL 32306-3026, U.S.A.

(904) 644-4014

Parameter

Computation of magnetic field parameters from spherical harmonics coefficients.

Brief description

The program calculates the Earth's magnetic field components at a given point in space and time from a spherical harmonic expansion of the main (core) field. The program accepts geodetic or geocentric coordinates and accommodates Gauss-normalized as well as Schmidt-normalized coefficients. In a first step the coefficients are determined for the time in decimal years required by the user. In its present form the package includes the coefficients of the IGRF (10/68) model, which is of degree and order 8 in its constant and first derivative term (epoch 1965, oblateness considered). But other sets of spherical harmonics coefficients can be easily adopted for use with FIELDG.

Availability

On one tape (NSSDC ID #**PG-11A**).

Reference

Cain, J. C., Hendricks, S., Daniels, W. E. and Jensen, D. C. (1968) Computation of the main geomagnetic field from spherical harmonic expansions. National Space Science Data Center. Report 68-11, Greenbelt, Maryland. (Revised version of NASA-TM-X-611-64-316, 1964.) (B01411)

INVAR/NEWMAG (1967)

C. E. McIlwain, A. Hassitt

University of California, San Diego, CASS C-011, La Jolla, CA 92093, U.S.A.

NSI-DECnet: CASS::CARL

Parameter

Computation of magnetic field parameters and *L*-value from spherical harmonics coefficients.

Brief description

This package includes the subroutine INVAR to calculate *L*-values at any specified point in space (geocentric coordinates) and NEWMAG to calculate the vector components of the Earth's main (core) magnetic field as given by the GSFC (9/65) model. Subroutine INTEG determines the value of the integral invariant *I* by numerically integrating along the field-line from the specified point of interest to its conjugate point. An input accuracy parameter controls the number of points (maximum: 200) used in the integration. CARMEL computes the shell parameter *L* from *I* and *B* by using McIlwain's (1961) formulas. These programs should be used only for the time range 1960–1965 for which the GSFC (9/65) is considered valid. The package was designed for card deck operation on an IBM 7094 and 360 mainframe. Hilberg (1971) compared *L*-values calculated with INVAR, SHELLG, and INTELG (see "FELDG, SHELLG, INTELG", p. 565).