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Volume 15-Ambient Geomagnetic Field

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Science Applications, Inc
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A preliminary model of the ambient geomagnetic field has been adopted for use in ROSCOE. The model fits a locally-best earth-centered dipole field in the battle space; this dipole field is then used for subsequent field evaluations and line tracings. Herein are presented derivations, flow diagrams, Fortran listings, and a test problem and evaluation. The model is found to be both fast and accurate.		

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18. SUPPLEMENTARY NOTES (Continued)

EDITORS' NOTE

Volumes 13 to 17 were originally published by SAI to describe the atmospheric, geomagnetic, and high-altitude energy deposition and neutral heave models for ROSCOE. This whole section of code, when associated with an appropriate DRIVER subroutine, operated as a package that ran independently of the rest of the ROSCOE structure. Provision was also made, within this high-altitude package, for two completely independent descriptions of atmospheric heave, each with its own description of atmospheric chemistry.

When GRC incorporated this section of code within the ROSCOE framework, some modifications were necessary, which means that some of the descriptions in Volumes 13 to 17 are inappropriate to ROSCOE as it now exists. In particular, the NRL heave routines (deck NRLHYD) and associated chemistry (deck NRLCHM) are not presently used in ROSCOE. Three other subroutines are different: subroutines ATMOSU, EIF, and XTCOEf correspond to the ROSCOE subroutines ATMOS, EXPINT, and WDXP respectively. With these exceptions, the subroutines described in Volumes 13 to 17 correspond exactly to those currently in ROSCOE.

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1. INTRODUCTION

The geomagnetic field plays an important role in a number of high-altitude nuclear explosion phenomena, including debris-air coupling, the guiding of beta rays and energetic ions down into the atmosphere, and the formation of striations, to mention a few. For first bursts, and sufficiently late after any burst, this field will be the ambient geomagnetic field. Accordingly, a model of the ambient geomagnetic field is needed for the new radar and optical systems code.

The requirements of such a model, apart from the general ones of modularity and minimal demands on computer storage and running time, are that it provide reasonably accurate values of the vector field components, and that it permit the efficient tracing of field lines.

The RANC codes used an earth-centered dipole approximation to the ambient geomagnetic field. Such a model is certainly fast, and permits the easy tracing of field lines, but its predictions are of low accuracy. On the other hand, there are available highly-accurate multipole field models [SM-72e] that are fast-running except for their field-line tracing routines, which necessarily integrate numerically.

Because of the fact that the systems code will be concerned with only a limited 'battle space' of the order of one thousand kilometers in linear dimension, a compromise solution incorporating the best features of both kinds of model becomes possible; it has been explored and is tentatively adopted. This model uses accurate field components obtained from the multipole model for some point in the middle of the battle space to fit a locally-best geocentric dipole field. This, of course, needs to be done only once, during problem setup. The dipole

model is then used for subsequent field evaluations, for line tracing, and so on. Thus both speed and good accuracy are obtained.

In the following sections there is a description of a set of computer subroutines that have been written to implement the model. Listings, cross-reference lists of variables, and input/output lists are included in an appendix, along with test problems that have been used in model evaluation.

2. SUBROUTINE ONEMG5 AND LINTRA

Personnel of the National Aeronautics and Space Administration have developed and thoroughly documented [SM-72e] a set of Fortran subroutines providing a multipole-expansion model of the geomagnetic field, including secular changes and provisions for tracing field lines to intersects at specified altitudes. One of these routines, called ONEMG5,* embodies the International Geomagnetic Reference Field (IGRF 1965.0), and it has been adopted here as the "good" magnetic field model. Another routine called LINTRA traces geomagnetic field lines to their intersections with prespecified altitudes; it has been used only for verification of the simplified dipole-field line-tracing routine.

A simplified flow diagram of ONEMG5 is shown in Fig. 1. Corresponding details for LINTRA have not been supplied here, for that routine does not form part of the present package, but was only used in evaluation. Moreover, these details are readily available in SM-72e.

One note of warning must be sounded concerning the description of secular changes that is provided in ONEMG5. This description is of first order only, and is based on a fairly small number of years of good data near the epoch 1965.0. Consequently, it is inadvisable to input a time more than a few years away from the data range of the model.

*Called ONEMAG in SM-72e.

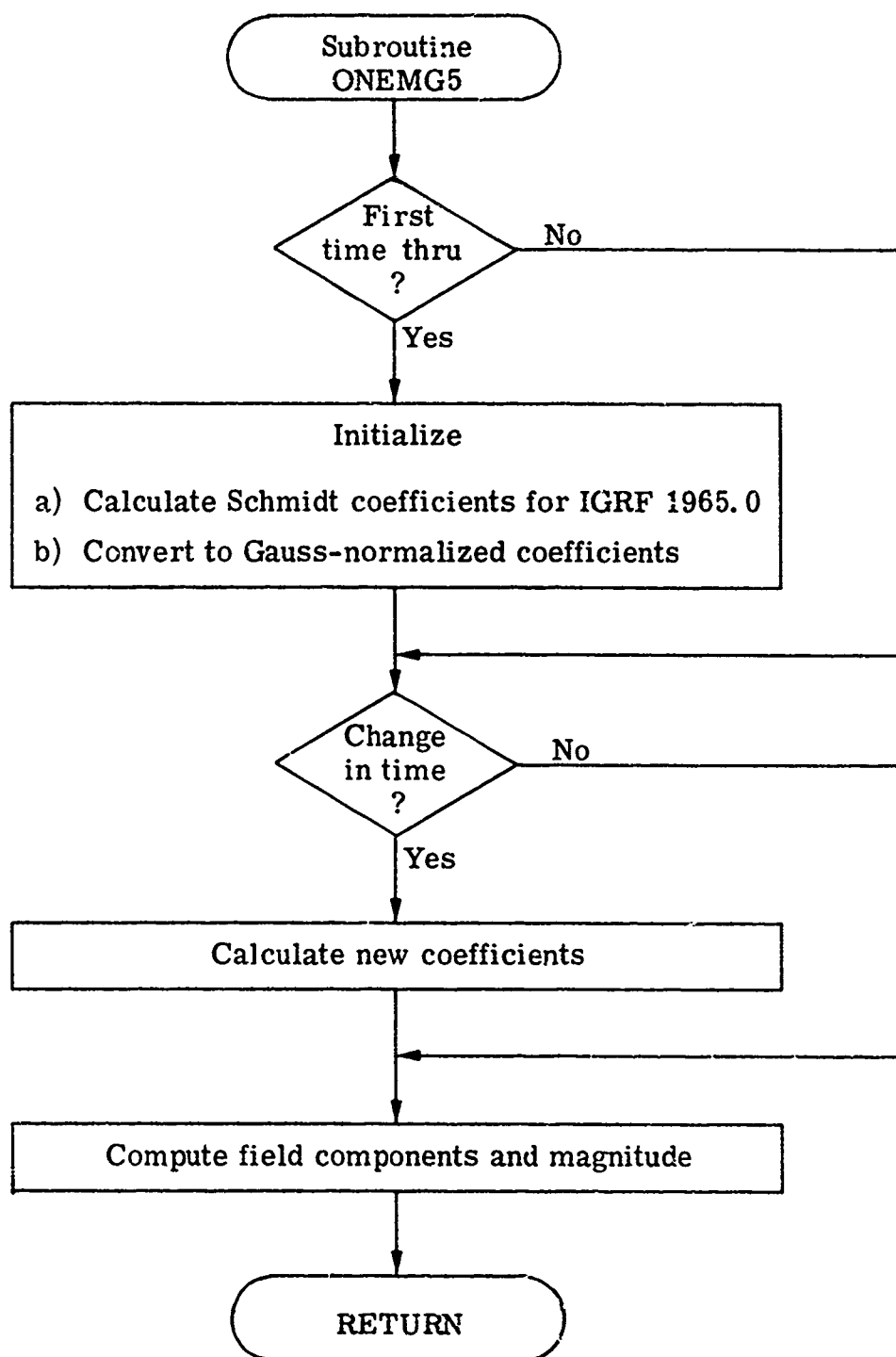


Fig. 1. Subroutine ONEMG5 Flow Diagram.

3. SUBROUTINE MAGFIT

Given a point in space (normally near the earth's surface and centrally located in the battle space) for which accurate values of the geomagnetic field components are known, subroutine MAGFIT calculates the strength and orientation of an earth-centered magnetic dipole to reproduce those components. The routine is used only once, during problem setup, and the dipole properties are then stored and used later to provide field component values at other points within the limited battle space.

In Fig. 2, the point P at geocentric radial distance r , north latitude λ (colatitude θ), and east longitude φ is the reference point at which the field components B_r , B_θ , and B_φ (in the same coordinate system (r, θ, φ)) are known. The point Q at north latitude λ_0 (colatitude θ_0) and east longitude φ_0 on the surface of an earth-centered sphere passing through P is the direction of the earth-centered dipole. The point N is the north geographic pole. The arc length (or central angle) between Q and P is denoted by χ .

From the equations for a magnetic dipole field we have the relations

$$B_r = \frac{2M \cos \chi}{r^3}, \quad (1)$$

$$B_\theta = \frac{M \sin \chi}{r^3}, \quad (2)$$

where M measures the dipole strength and B_θ is the angular component in the direction of increasing χ . Consequently, from simple geometry there follows the relations

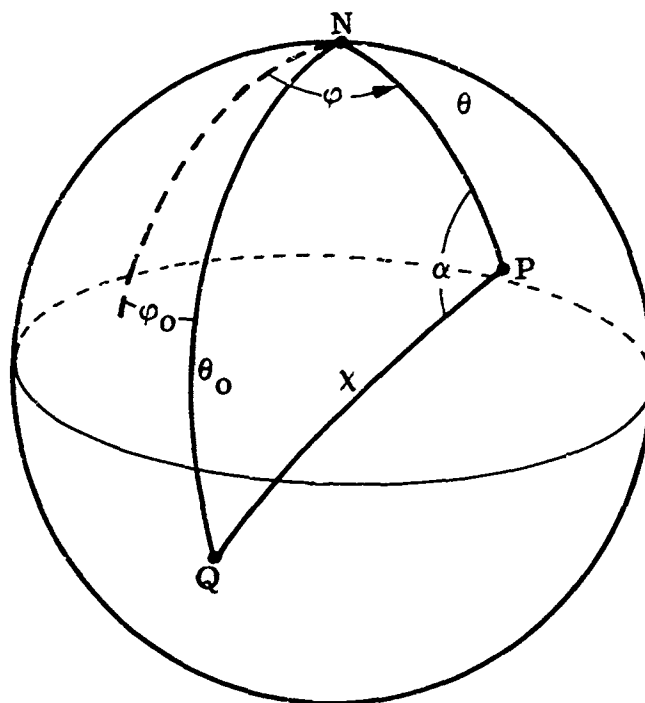


Fig. 2. Geometrical Relationships on an Earth-Centered Sphere through Point P.

$$B_{\theta} = B_2 \cos \alpha , \quad (3)$$

$$B_{\varphi} = B_2 \sin \alpha , \quad (4)$$

and

$$B_2^2 = B_{\theta}^2 + B_{\varphi}^2 , \quad (5)$$

where α is the angle QPN.

From Eqs. (1) and (2) one finds the formulas

$$M = \frac{r^3}{2} \left[B_r^2 + 4B_2^2 \right]^{\frac{1}{2}} , \quad (6)$$

$$\chi = \tan^{-1} (2B_2/B_r) . \quad (7)$$

From Eqs. (3) and (4) it follows that

$$\alpha = \tan^{-1} (B_{\varphi}/B_{\theta}) . \quad (8)$$

By applying the cosine law of spherical trigonometry to the spherical triangle QPN, one obtains the relation

$$\cos \theta_0 = \cos \chi \cos \theta + \sin \chi \sin \theta \cos \alpha . \quad (9)$$

Application of the sine law leads to the further relation

$$\sin (\varphi - \varphi_0) = \sin \chi \sin \alpha / \sin \theta_0 . \quad (10)$$

One more use of the cosine law yields the equation

$$\cos (\varphi - \varphi_0) = (\cos \chi - \cos \theta_0 \cos \theta) / (\sin \theta_0 \sin \theta) , \quad (11)$$

useful in establishing the correct quadrant.

Equations (5)-(11) constitute the working equations of subroutine MAGFIT. A Fortran listing of the routine appears in the appendix. A simplified flow diagram is given in Fig. 3.

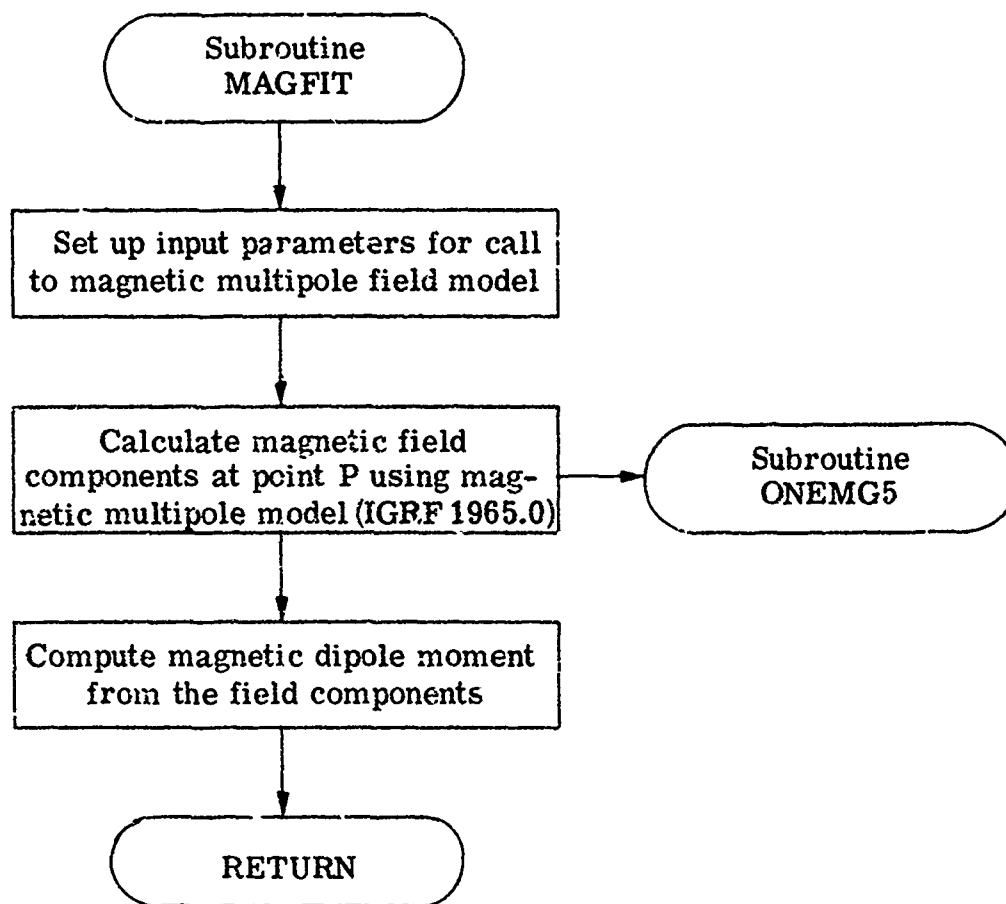


Fig. 3. Subroutine MAGFIT Flow Diagram.

4. SUBROUTINE BFIELD

For any point P at geocentric radial distance r , north latitude λ (colatitude θ), and east longitude φ , subroutine BFIELD calculates the geomagnetic field strength B , the dip angle I , and the declination angle D , based on a locally-fitted geocentric magnetic dipole of strength M oriented in the direction of north latitude λ_0 (colatitude θ_0) and east longitude φ_0 . These latter three quantities must have been found previously by the use of subroutines MAGFIT and ONEMG5 for a reference point within a thousand kilometers or so of point P, if good accuracy is to be assured. Figure 2 may be used to help visualize the geometrical relationships.

The equations of subroutine BFIELD are, for the most part, just those presented above in Section 3, but solved for different variables. Thus, the angle χ between the dipole moment and the field point is obtained from the equation

$$\cos \chi = \cos \theta \cos \theta_0 + \sin \theta \sin \theta_0 \cos (\varphi - \varphi_0) , \quad (12)$$

which follows from spherical trigonometry. The total field strength B is obtained by use of Eqs. (1) and (2) from the relation

$$B = \left[B_r^2 + B_\theta^2 \right]^{\frac{1}{2}} \quad (13)$$

$$= \frac{M}{r^3} \left[3 \cos^2 \chi + 1 \right]^{\frac{1}{2}} . \quad (14)$$

The dip angle I is obtained by use of Eqs. (1) and (2) and the definition

$$\sin I \equiv B_r / B \quad (15)$$

$$= 2 \cos \chi / \left[3 \cos^2 \chi + 1 \right]^{\frac{1}{2}} . \quad (16)$$

The declination angle D is obtained by use of the definition

$$D \equiv \pi - \alpha \quad (17)$$

and Eqs. (10) and (9) through the equations

$$\sin D = \sin \theta_0 \sin (\varphi - \varphi_0) / \sin \chi , \quad (18)$$

$$\cos D = (\cos \theta_0 - \cos \chi \cos \theta) / (\sin \chi \sin \theta) , \quad (19)$$

both equations being necessary to resolve quadrant ambiguities.

Equations (14), (16), (18), and (19) are the working equations of subroutine BFIELD. A Fortran listing of the routine appears in the appendix. A simplified flow diagram is shown in Fig. 4.

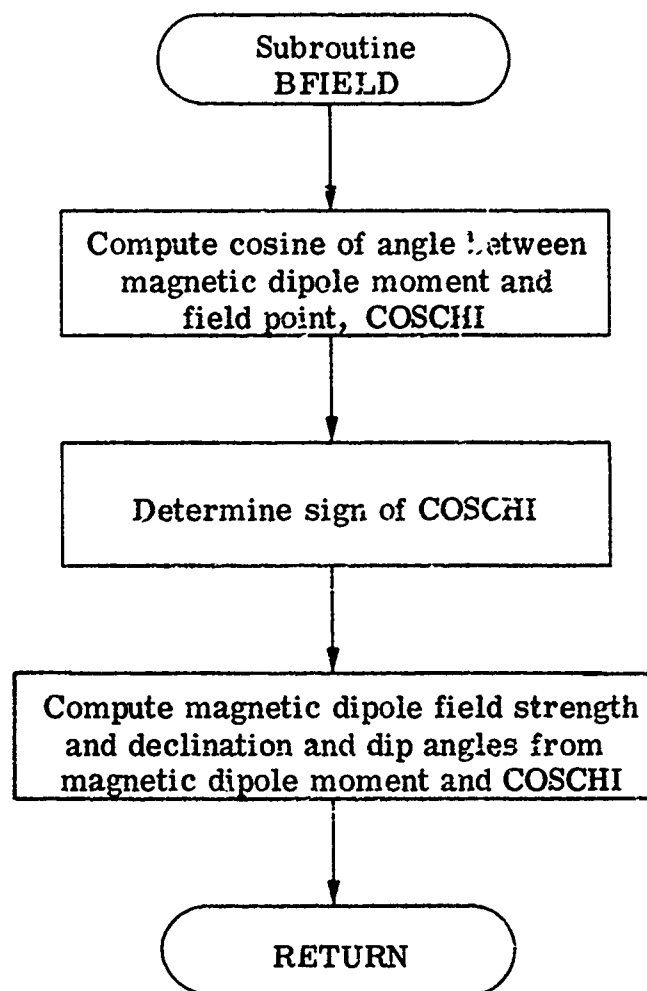


Fig. 4. Subroutine BFIELD Flow Diagram.

5. SUBROUTINE CONJUG

The main function of subroutine CONJUG is to locate the latitudes and longitudes of those points where a given geocentric magnetic dipole field line intersects a prespecified altitude. There are generally two such points; the routine will locate either, depending on the choice of an input quantity. CONJUG also computes (1) the dimensionless field-line distance (in units of the equatorial radius to the dipole field line) between two specified points P_1 and P_2 and (2) the ratio of the equatorial field to that at point P_1 , for the same field line.

Suppose the orientation of the geocentric dipole is specified by the north latitude λ_0 (colatitude θ_0) and east longitude φ_0 . Let the field line be specified by the fact that it passes through a point P_1 in space at altitude h_1 , north latitude λ_1 (colatitude θ_1), and east longitude φ_1 . Then we seek the north latitude λ_2 (colatitude θ_2) and east longitude φ_2 of a point P_2 on the same dipole field line as P_1 . The geometry of the situation is illustrated in Fig. 5.

From the cosine law of spherical trigonometry applied to the spherical triangle $P_0 P_1 N$, we obtain the result

$$\cos \chi_1 = \cos \theta_0 \cos \theta_1 + \sin \theta_0 \sin \theta_1 \cos (\varphi_1 - \varphi_0) . \quad (20)$$

The sine law for the same triangle gives the result

$$\sin \psi = \sin \theta_1 \sin (\varphi_1 - \varphi_0) / \sin \chi_1 , \quad (21)$$

and another application of the cosine law gives the formula

$$\cos \psi = (\cos \theta_1 - \cos \chi_1 \cos \theta_0) / \sin \chi_1 \sin \theta_0 , \quad (22)$$

so there is no ambiguity as to the quadrant of ψ .

The equation of a dipole field line has the form

$$r = r_0 \sin^2 \chi, \quad (23)$$

so the requirement that P_1 and P_2 lie on the same dipole field line leads to the result

$$\sin \chi_2 = \sin \chi_1 \left[(R_e + h_2) / (R_e + h_1) \right]^{\frac{1}{2}}, \quad (24)$$

where R_e is the radius of the earth and h_2 is the prespecified altitude of point P_2 . Note that there are, generally, two solutions for χ_2 , since if χ_2 is a solution, so is $\pi - \chi_2$.

Now, applying the sine and cosine laws to spherical triangle $P_0 P_2 N$ leads to the results

$$\cos \theta_2 = \cos \theta_0 \cos \chi_2 + \sin \theta_0 \sin \chi_2 \cos \psi \quad (25)$$

and

$$\sin (\varphi_2 - \varphi_0) = \sin \chi_2 \sin \psi / \sin \theta_2, \quad (26)$$

whence θ_2 (or λ_2) and φ_2 can be obtained.

The absolute value of the dimensionless field-line distance between points P_1 and P_2 is

$$s_{12} = \frac{1}{r_0} \left| \int_{s_1}^{s_2} ds \right|, \quad (27)$$

where the element of arc length is given by

$$\frac{ds}{d\chi} = r_0 \sin \chi (1 + 3 \cos^2 \chi)^{\frac{1}{2}}. \quad (28)$$

After substituting Eq. (28) into (27) and performing the integration, we obtain

$$S_{12} = \frac{\sqrt{3}}{6} \left| \eta_1 \sqrt{1 + \eta_1^2} - \eta_2 \sqrt{1 + \eta_2^2} + \ln \left(\frac{\eta_1 + \sqrt{1 + \eta_1^2}}{\eta_2 + \sqrt{1 + \eta_2^2}} \right) \right|, \quad (29)$$

where

$$\eta_1 = \sqrt{3} \cos \chi_1 \quad (30a)$$

$$\eta_2 = \sqrt{3} \cos \chi_2. \quad (30b)$$

Equation (29) is valid provided points P_1 and P_2 are in the same hemisphere. If points P_1 and P_2 are in opposite hemispheres, then we must perform the integration in two parts, with the equator being the intermediate point. The result may be expressed in the form

$$S_{12} = \frac{\sqrt{3}}{6} \left| S_{1E} - \text{AJUG} \times S_{2E} \right|, \quad (31a)$$

where

$$S_{1E} = \left| \eta_1 \sqrt{1 + \eta_1^2} + \ln \left(\eta_1 + \sqrt{1 + \eta_1^2} \right) \right| \quad (31b)$$

$$S_{2E} = \left| \eta_2 \sqrt{1 + \eta_2^2} + \ln \left(\eta_2 + \sqrt{1 + \eta_2^2} \right) \right|, \quad (31c)$$

and AJUG is a parameter equal to (+1) if Points P_1 and P_2 are in the same hemisphere and equal to (-1) if Points P_1 and P_2 are in opposite hemispheres.

The equatorial radius, r_o , is given by

$$r_o = (M/B_o)^{\frac{1}{3}}, \quad (32)$$

where the equatorial value of the field, B_0 , is related to the field $B(r, \chi)$ by the expression

$$B_0 \equiv B(r_0, \chi=\pi/2) = \frac{\sin^6 \chi}{(1 + 3 \cos^2 \chi)^{\frac{1}{2}}} B(r, \chi) . \quad (33)$$

Equations (20)-(22), (24)-(26), and (31)-(33) are the working equations of subroutine CONJUG. A simplified flow diagram of the routine is presented in Fig. 6. A Fortran listing is given in the appendix.

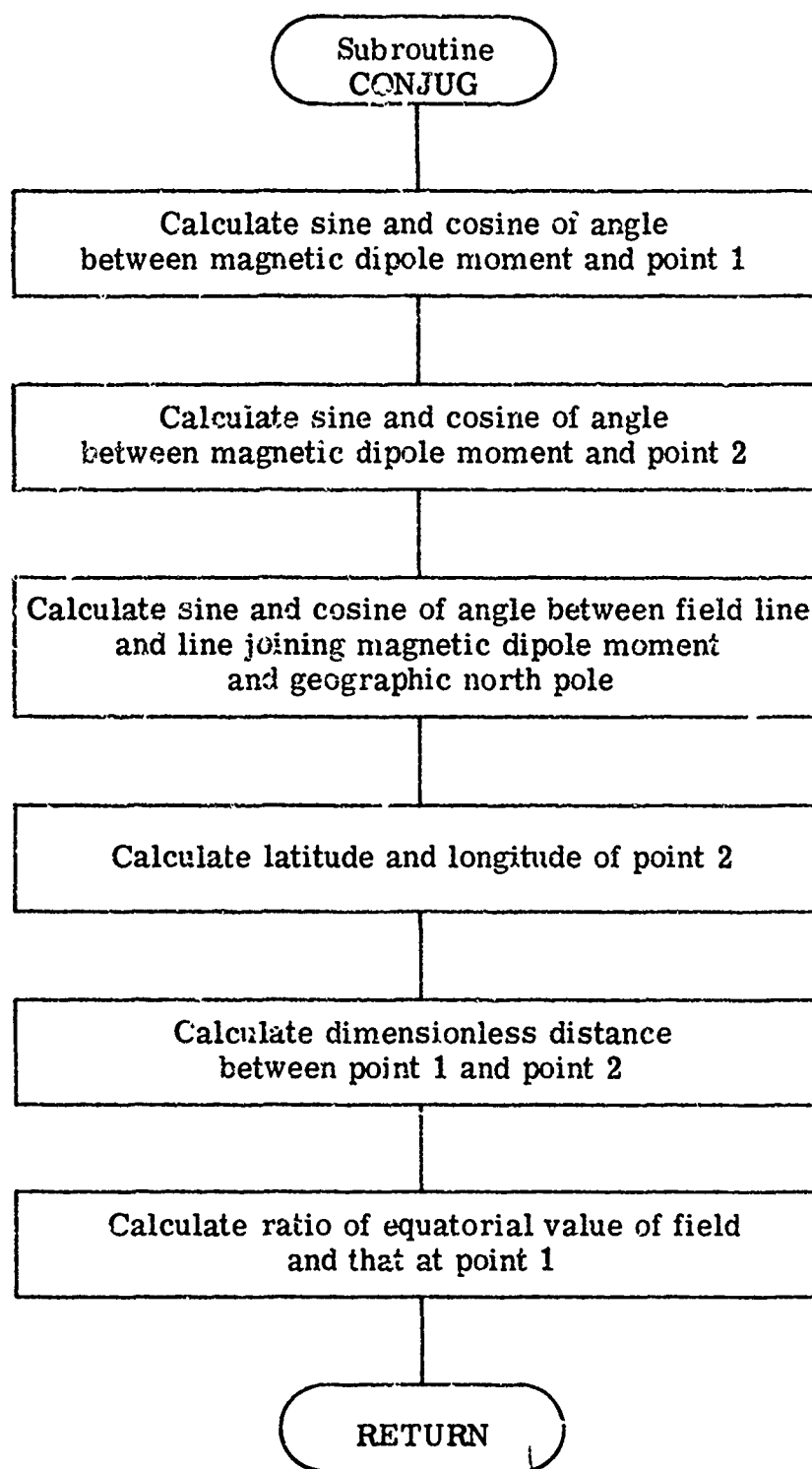


Fig. 3. Subroutine CONJUG Flow Diagram.

6. SUBROUTINE MAGDRV AND VERIFICATION TESTS OF THE AMBIENT GEOMAGNETIC FIELD MODEL

To permit the exercise of the ambient geomagnetic field model for purposes of testing and validation, a special driver routine called MAGDRV has been written. The required input consists of latitude, longitude, and altitude coordinates of a set of reference locations, at each of which the vector field of a geocentric magnetic dipole is fitted to an accurate multipole field, for a specified year. Further input consists in a set of locations, relative to each reference point, for which both the dipole field and the accurate multipole field are evaluated and compared for relative accuracy of the total field strength. Additional input consists in sets of altitudes for the calculation of field-line intersects for each of the test points, together with flags indicating whether the desired intersection is in the same or opposite magnetic hemisphere. Additional output consists in the inclination and declination angles for each test point, according to the fitted dipole model.

The principal testing carried out so far and described herein was for a set of reference points at 200-km altitude, distributed over $-60^{\circ}(30^{\circ})60^{\circ}$ in north latitude and $0^{\circ}(60^{\circ})300^{\circ}$ in east longitude. For each of these, a set of test points at 200-km altitude was specified with offsets in latitude of $+5^{\circ}$, 0° , -5° and in longitude of $+10^{\circ}$, 0° , -10° (a total of nine test points for each reference point). A field-line intersection altitude of 60-km altitude was called out, in separate runs for both the near and far magnetic hemisphere. (One additional reference point with a set of test points near the south magnetic pole was also run.) A check on the field-line intersection locations was provided by separate runs of the LINTRA routine.

The results of the field-strength comparisons are illustrated in Fig. 7 in the form of a histogram of the distribution of errors. It will be seen that the standard deviation is of the order of 1-2 percent. However, some test locations were found where the error was considerably larger than this. The geomagnetic field has considerable deviations from a dipole in some parts of the world. Nevertheless, it is felt that the fitted dipole model is of acceptable accuracy.

The results for the tests of field line intersection locations can be summarized by stating that, for intersection locations in the near magnetic hemisphere, the average latitude error was 0.038° and that in longitude, 0.019° . However, the median errors in both latitude and longitude were about 0.01° , showing again that occasional errors much larger than the average occur.

As for the location of intersection points in the opposite magnetic hemisphere, the less said the better, in general. The present ambient geomagnetic field model is a local best fit, and that is not a procedure that gives a good fit in the large.

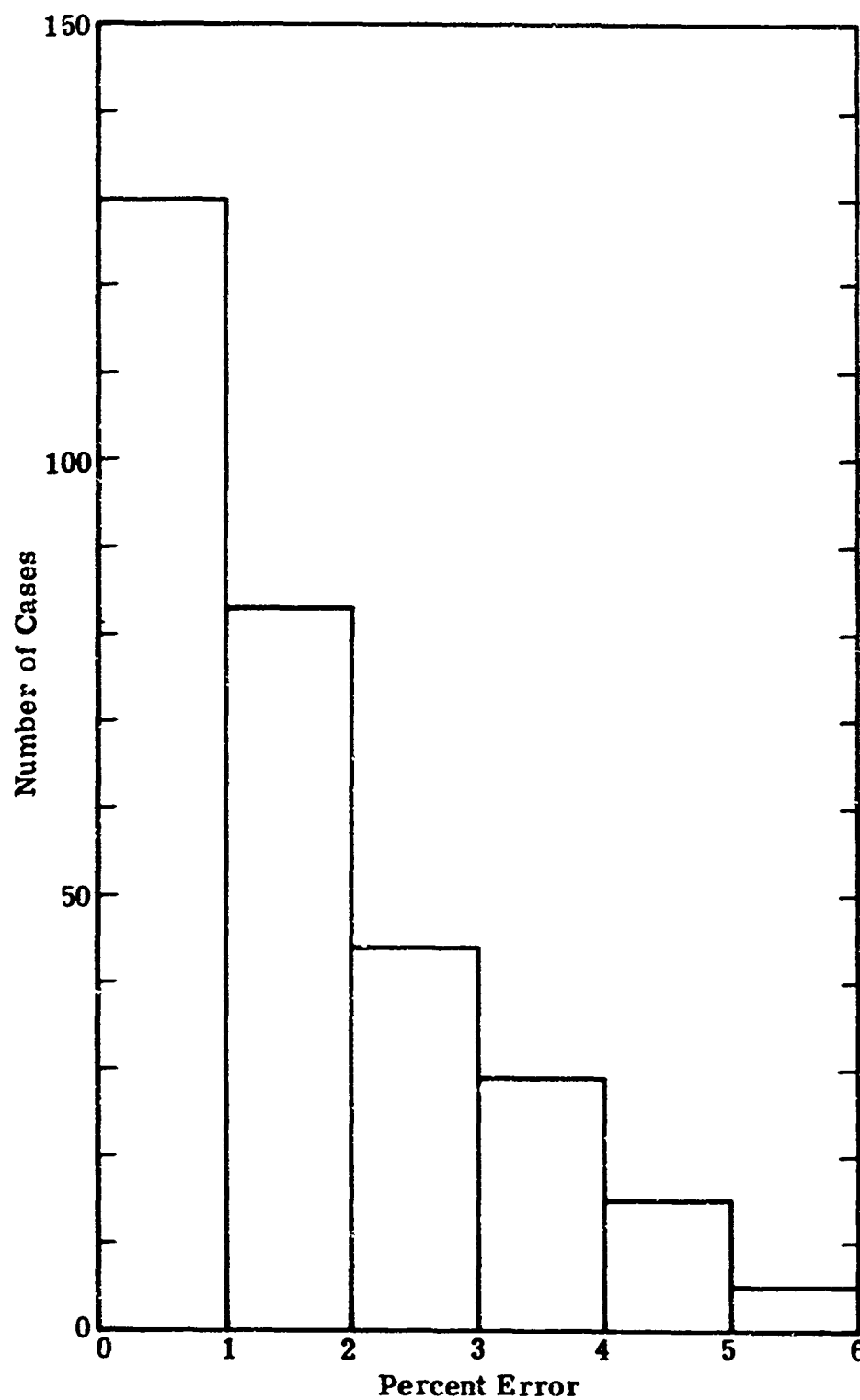


Fig. 7. Frequency Distribution of Errors in Total Field Strength.

7. REFERENCES

- SM-72e E. G. Stassinopoulos and G. D. Mead, ALLMAG, GDALMG, LINTRA: Computer Programs for Geomagnetic Field and Field-Line Calculations, NSSDC 72-12, NASA-Goddard Space Flight Center, Greenbelt, MD 20771, February 1972.

APPENDIX

In this appendix are included certain materials of interest only to those who wish to exercise this model on their own computer, and who presumably have a Fortran card deck or tape available.

Table A1 contains a definition of the variables used in the equations of the text, and a cross reference with the Fortran names of the variables used in the listing.

Tables A2 through A6 contain lists of the input/output quantities for subroutines ONEMG5, MAGFIT, BFIELD, CONJUG, and MAGDRV.

Table A7 contains a compile-and-run listing of the whole module, together with the input and output for the test problem described in the text of the report.

Finally, Table A8 contains a summary of our experience of the running times of the various routines on a CDC 7600 computer.

Table A1. Symbols and Their Fortran Names.

<u>Symbol</u>	<u>Fortran</u>	<u>Definition</u>
$\sin(\lambda_o)$	SINLT0	Sine and cosine of north latitude of magnetic dipole moment
$\cos(\lambda_o)$	COSLT0	
φ_o	PHI0	East longitude of magnetic dipole moment
M	MU0	Magnetic dipole moment
λ	ANGS	North latitude of field point
φ	ANGE	East longitude of field point
r	RCUBE	Geocentric radius of field point
B_r	BR	Geocentric spherical field vector components (B_r , positive outward; B_θ , positive southward; and B_φ , positive eastward) of IGRF 1965.0 field.
B_θ	BTHETA	
B_φ	BPHI	
χ	CHI	Angle between the magnetic dipole moment vector and field point
$\cos(\chi)$	COSCHI	Cosine of angle between the magnetic dipole moment vector and field point
α	ALPHA	Angle between the magnetic dipole moment and geographic north pole
B_2^2	B2SQ	Square of the angular component of the magnetic field
I	DIPANG	Magnetic dip angle at field point
D	DECANG	Magnetic declination angle at field point
B	BVAL	Magnetic field strength at field point
R_e	RE	Radius of earth
λ_1	ALAT1	North latitude of point 1

Table A1. (Continued)

<u>Symbol</u>	<u>Fortran</u>	<u>Definition</u>
ϕ_1	ALON1	East longitude of point 1
h_1	ALT1	Altitude of point 1
h_2	ALT2	Altitude of point 2
λ_2	ALAT2	North latitude of point 2
ϕ_2	ALON2	East longitude of point 2
	AJUG	Flag controlling which magnetic hemisphere the location of the intersection point is calculated
$\sin(\chi_1)$	SINZ1	Sine of angle between the magnetic dipole moment vector and point 1
$\cos(\chi_1)$	COSZ1	Cosine of χ_1
$\sin(\chi_2)$	SINZ2	Sine and cosine of angle between the magnetic dipole moment vector and point 2
$\cos(\chi_2)$	COSZ2	
$\sin(\psi_1)$	SINPSI	Sine and cosine of angle between the field line and line joining the magnetic dipole moment with the north geographic pole
$\cos(\psi_1)$	COSPSI	

Table A2. ONEMG5 Subroutine Input/Output.

INPUT VARIABLES

TM	Time in years for desired field
RKM	Geocentric distance of point (km)
ST	Sine of (geocentric) colatitude of point
CT	Cosine of (geocentric) colatitude of point
SPH	Sine of (geocentric) east longitude of point
CPH	Cosine of (geocentric) east longitude of point

OUTPUT VARIABLES

BR	Radial field component (gauss)
BTHETA	Positive-south field component (gauss)
BPHI	Positive-east field component (gauss)
B	Total field magnitude (gauss)

Table A3. MAGFIT Subroutine Input/Output

INPUT VARIABLES

Argument List

ALATF	North latitude of specified point P (radians)
ALONF	East longitude of specified point P (radians)
ALTF	Altitude of specified point P (km)
TM	Time for desired field (years)

OUTPUT VARIABLES

MAGLNK Common

MU0	Magnetic dipole moment (gauss km ³)
COSLT0	Cosine of north latitude of magnetic dipole moment
SINLT0	Sine of north latitude of magnetic dipole moment
PHI0	East longitude of magnetic dipole moment (radians)

Table A4. BFIELD Subroutine Input/Output

INPUT VARIABLES

Argument List

ANGS	North latitude of field point (radians)
ANGE	East longitude of field point (radians)
ALT	Altitude of field point (km)

MAGLNK Common

MU0	Magnetic dipole moment (gauss km ³)
COSLT0	Cosine of north latitude of magnetic dipole moment
SINLT0	Sine of north latitude of magnetic dipole moment
PHI0	East longitude of magnetic dipole moment (radians)

OUTPUT VARIABLES

Argument List

BVAL	Magnetic dipole field strength at point (gauss)
DIPANG	Dip angle of the magnetic dipole field at point (radians)
DECANG	Declination angle of the magnetic dipole field at point (radians)
COSCHI	Cosine of angle between the magnetic dipole moment vector and field point

Table A5. CONJUG Subroutine Input/Output

INPUT VARIABLES

Argument List

ALAT1	North latitude of point 1 (radians)
ALON1	East longitude of point 1 (radians)
ALT1	Altitude of point 1 (km)
ALT2	Altitude of point 2 (km)
AJUG	1. - Calculates latitude and longitude of point 2 in same magnetic hemisphere -1. - Calculates latitude and longitude of point 2 in opposite magnetic hemisphere

MAGLNK Common

MU0	Magnetic dipole moment (gauss km ³)
COSLT0	Cosine of north latitude of magnetic dipole moment
SINLT0	Sine of north latitude of magnetic dipole moment
PHI0	East longitude of magnetic dipole moment (radians)

OUTPUT VARIABLES

ALAT2	North latitude of point 2 (radians)
ALON2	East longitude of point 2 (radians)
S12	Path length along the field line from point 1 to point 2 (in units of the equatorial radius of the traced field line)
BEB1	Ratio of the equatorial value of the field to that at point 1 for the traced field line

Table A6. MAGDRV Input Quantities — START Namelist

ALATFI	Array of north latitudes of fit points (deg)
ALONFI	Array of east longitudes of fit points (deg)
ALTFI	Array of altitudes of fit points (km)
NFIT	Number of fit points
TM	Time at which to evaluate exact field (years)
RLATS*	Array of north-latitude deltas of test points (deg)
RLONS*	Array of east-longitude deltas of test points (deg)
RALTS*	Array of altitude deltas of test points (km)
NRS	Number of test points relative to a fit point
RCONS	Array of test altitudes for intersection calculations (km)
AJUGS	Array of calculation options for conjugate-region intersection calculations: 1. - Calculate intersection point in same magnetic hemisphere. -1. - Calculate intersection point in opposite magnetic hemisphere.
IOPT	MAGDRV calculation options: 1 - Calculate only magnetic dipole field at test points. 2 - Also calculate location of intersection points. 3 - Also calculate magnetic multipole field at test points.

*The (input) locations of the test points are relative to the fit point.

Table A7. Compile-and-Run Listing of the Ambient Magnetic-Field Module, with Input and Output of Test Problems.

MAGDRV

```

C      PROGRAM MAGDRV(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C      * * * *
C
C      THIS PROGRAM EXERCISES THE AMBIENT MAGNETIC FIELD MODEL. THE
C      MODEL CONSISTS OF FOUR ROUTINES. MAGFIT FITS A DIPOLE FIELD TO
C      THE MAGNETIC FIELD AT A GIVEN POINT, WHICH SHOULD BE NEAR
C      THE CENTER OF THE REGION OF INTEREST. THE EXACTO FIELD AT THE
C      POINT IS CALCULATED FROM OMFGS, A MODEL OF THE INTERNATIONAL
C      GEOMAGNETIC REFERENCE FIELD, EPOCH 1965.0.
C      (SEE (1) E.G. STASSINOPOLUS AND G.D. MEAD, NASA REPORT
C      NSSDC 72-12, ALLMAG,GDALMG,LINTRA COMPUTER PROGRAMS FOR
C      GEOMAGNETIC FIELD AND FIELD-LINE CALCULATIONS, FEBRUARY 1972
C      AND (2) J.C. CAIN AND S.J. CAIN, NASA TN D-6237, DERIVATION
C      OF THE INTERNATIONAL GEOMAGNETIC REFERENCE FIELD (IGRF(10/68)),
C      AUGUST 1971.)
C      A THIRD ROUTINE, BFIELD, CALCULATES THE MAGNETIC FIELD STRENGTH
C      FOR ANY GIVEN POINT FOR THE FITTED DIPOLE. THE FOURTH ROUTINE
C      CALCULATES THE LOCATION OF A POINT WITH A GIVEN ALTITUDE WHICH
C      IS ON THE SAME FIELD LINE AS SOME SPECIFIED POINT FOR THE FITTED
C      DIPOLE FIELD.
C
C      * * * *
C
C      INPUT PARAMETERS (NAMELIST START)
C      ALATFI = ARRAY OF NORTH LATITUDES OF FIT POINTS (DEG)
C      ALONFI = ARRAY OF EAST LONGITUDES OF FIT POINTS (DEG)
C      ALTFI  = ARRAY OF ALTITUDES OF FIT POINTS (KM)
C      NFIT   = NUMBER OF FIT POINTS
C      IM     = TIME AT WHICH TO EVALUATE EXACT FIELD (YEARS)
C      RLATS  = ARRAY OF NORTH LATITUDES OF TEST POINTS (DEG)
C      RLONS  = ARRAY OF EAST LONGITUDES OF TEST POINTS (DEG)
C      HALTS  = ARRAY OF ALTITUDES OF TEST POINTS (KM)
C      NRS    = NUMBER OF TEST POINTS
C      RCONS  = ARRAY OF TEST FIELD LINE ALTITUDES (KM)
C      AUGS   = ARRAY OF TEST FIELD LINE CALCULATION OPTIONS
C              1. CALCULATES INTERSECTION POINT IN SAME
C                  MAGNETIC HEMISPHERE
C              -1. CALCULATES INTERSECTION IN OPPOSITE
C                  MAGNETIC HEMISPHERE
C      *****
C      *      CAUTION = LOCATION OF OPPOSITE HEMISPHERE      *
C      *      INTERSECTIONS MAY NOT BE ACCURATE              *
C      *
C      *****
C      INPT   = CALCULATION OPTIONS
C              1 = CALCULATE ONLY DIPOLE B FIELD AT TEST POINTS
C              2 = ALSO CALCULATE LOCATION OF INTERSECTION POINTS
C              3 = ALSO CALCULATE MULTIPOLY B FIELD AT TEST POINTS
C
C      FIT DIPOLE TO POINT
C
C      REAL MU0
C
C      COMMON /MAGLNK/ MU0,COSLT0,SINLT0,PHI0

```

NEWMAG,2
 NEWMAG,3
 NEWMAG,4
 NEWMAG,5
 NEWMAG,6
 NEWMAG,7
 NEWMAG,8
 NEWMAG,9
 NEWMAG,10
 NEWMAG,11
 NEWMAG,12
 NEWMAG,13
 NEWMAG,14
 NEWMAG,15
 NEWMAG,16
 NEWMAG,17
 NEWMAG,18
 NEWMAG,19
 NEWMAG,20
 NEWMAG,21
 NEWMAG,22
 NEWMAG,23
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 NEWMAG,25
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 NEWMAG,27
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 NEWMAG,31
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 NEWMAG,36
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 NEWMAG,38
 NEWMAG,39
 NEWMAG,40
 NEWMAG,41
 NEWMAG,42
 NEWMAG,43
 NEWMAG,44
 NEWMAG,45
 NEWMAG,46
 NEWMAG,47
 NEWMAG,48
 NEWMAG,49
 NEWMAG,50
 NEWMAG,51
 NEWMAG,52
 NEWMAG,53
 NEWMAG,54
 NEWMAG,55
 NEWMAG,56
 NEWMAG,57

MAGDRV (Cont'd)

	C (COMMON/CNSINT/ RECM,PT,HALFPI,FOURPI,GRAVZ(7)	NEWMAG,58
	C	NEWMAG,59
	DIMENSION RLATS(50),RLONS(50),RCONS(50),AJUGS(50)	NEWMAG,60
	DIMENSION RALTS(50)	NEWMAG,61
	DIMENSION ALATFT(50),ALONFI(50),ALTFI(50)	NEWMAG,62
	C	NEWMAG,63
	NAMELIST /START/ALATFT,ALONFI,ALTFI,NFIT,TM,RLATS,RLONS,RALTS,NRS,	NEWMAG,64
	\$RCONS,AJUGS,IOP	NEWMAG,65
	C	NEWMAG,66
	RE = 1.0E-05*RECM	NEWMAG,67
4	RADS = HALFPI/90.	NEWMAG,68
	C	NEWMAG,69
	C READ IN DATA	NEWMAG,70
	C	NEWMAG,71
6	READ(5,START)	NEWMAG,72
11	WRITE(6,START)	NEWMAG,73
	C	NEWMAG,74
	C LOOP OVER FIT POINTS	NEWMAG,75
	C	NEWMAG,76
14	DO 900 JJ=1,NFIT	NEWMAG,77
17	ALATF = ALATFI(JJ)	NEWMAG,78
20	ALONF = ALONFI(JJ)	NEWMAG,79
21	ALTF = ALTFI(JJ)	NEWMAG,80
23	WRITE(6,1000)ALATF,ALONF,ALTF,TM	NEWMAG,81
37	ALATF = ALATF*RADS	NEWMAG,82
41	ALONF = ALONF*RADS	NEWMAG,83
	1000 FORMAT(1H1,33H LOCATION OF POINT THAT IS FITTED,/,12H LATITUDE	NEWMAG,84
	,F9,2,6H (DEG),/,13H LONGITUDE = ,F8,2,6H (DEG),/,13H ALTITUDE =	NEWMAG,85
	,F8,2,6H (DEG),/,13H TIME = ,F8,2,6H (YRS),///)	NEWMAG,86
	C	NEWMAG,87
	C FIT DIPOLE TO GIVEN FIELD POINT	NEWMAG,88
	C	NEWMAG,89
42	CALL MAGFIT(ALATF,ALONF,ALTF,TM)	NEWMAG,90
45	WRITE(6,1001)MUO,COSLT0,SINLT0,PHI0	NEWMAG,91
	1001 FORMAT(//,25H FITTED DIPOLE PARAMETERS,/,10H MUO = ,E13,6,	NEWMAG,92
	,13H GAUSS KM**3,/,10H COSLT0 = ,E13,6,/,10H SINLT0 = ,E13,6,/,	NEWMAG,93
	,10H PHI0 = ,F13,6,26H LONGITUDE EAST (RADIAN),///)	NEWMAG,94
61	10 WRITE(6,1002)	NEWMAG,95
	1002 FORMAT(1H+,1X,9H TEST LAT,2X,9H TEST LON,1X,9H TEST ALT,2X,	NEWMAG,96
	,9H DIPOLE B,1X,7H DIPANG,3X,7H DECANG)	NEWMAG,97
65	IF(IOP .LT. 2) GO TO 50	NEWMAG,98
70	20 WRITE(6,1003)	NEWMAG,99
	1003 FORMAT(1H+,62X,10HINTERS ALT,2X,6H AJUG ,4X,10HINTERS LAT,2X,	NEWMAG,100
	,10HINTERS LON)	NEWMAG,101
74	IF (IOP .LT. 3)GO TO 50	NEWMAG,102
77	30 WRITE(6,1004)	NEWMAG,103
	1004 FORMAT(109X,7H IGRF B,2X,8H PERCENT)	NEWMAG,104
103	50 CONTINUE	NEWMAG,105
	C	NEWMAG,106
	C LOOP OVER TEST POINTS	NEWMAG,107
	C	NEWMAG,108
103	DO 400 J=1,NRS	NEWMAG,109
	C	NEWMAG,110
	C CALCULATE DIPOLE FIELD VALUE AT TEST POINT	NEWMAG,111
	C	NEWMAG,112
106	ANGS = ALATF + RLATS(1)*RADS	NEWMAG,113

MAGDRV (Cont'd)

110	ANGF = ALONF + RLONS(J)*RADS	NEWMAG,114
113	ALT = ALTF + RALTS(J)	NEWMAG,115
115	CALL RFIELD(ANGS,ANGE,ALT,R,DIPANG,DECANG,COSCH?)	NEWMAG,116
124	ANGSD = ANGS / RADS	NEWMAG,117
126	ANGED = ANGE / RADS	NEWMAG,118
127	DIPANG = DIPANG / RADS	NEWMAG,119
131	DECANG = DECANG / RADS	NEWMAG,120
132	WRITE(6,1005) ANGSD,ANGED,ALT,H,DIPANG,DECANG	NEWMAG,121
1005	FORMAT(1H+,3(2X,F8,2),2X,F8,3,3X,F7,2,2X,F8,2)	NEWMAG,122
152	IF(IOPT .LE. 1)GO TO 400	NEWMAG,123
C		NEWMAG,124
C	CALCULATE LOCATION OF POINTS AT ALTITUDE ROUNS WHICH ARE ON THE SAME	NEWMAG,125
C	FIELD LINE AS THE TEST POINT	NEWMAG,126
C		NEWMAG,127
156	AJUG = AJUGS(J)	NEWMAG,128
157	ALT2=RCONS(J)	NEWMAG,129
161	CALL CONJUG(ANGS,ANGE,ALT,ALT2,AJUG,ALA2,ALO2,S12,BEB1)	NEWMAG,130
171	ALA2=ALA2/RADS	NEWMAG,131
173	ALO2=ALO2/RADS	NEWMAG,132
174	WRITE(6,1006)ALT2,AJUG,ALA2,ALO2	NEWMAG,133
1006	FORMAT(1H+,60X,F10,2,F9,2,4X,2(F10,3,2X))	NEWMAG,134
207	IF(IOPT .LE. 2) GO TO 400	NEWMAG,135
C		NEWMAG,136
C	CALCULATE EXACTO FIELD FROM IGRF(1965.) AT TEST POINT	NEWMAG,137
C		NEWMAG,138
212	RKM = RF + ALT	NEWMAG,139
213	COLAT = HALFPI-ANGS	NEWMAG,140
216	ST = SIN(COLAT)	NEWMAG,141
217	CT = COS(COLAT)	NEWMAG,142
221	SPH = SIN(ANGF)	NEWMAG,143
223	CPH = COS(ANGE)	NEWMAG,144
226	CALL ONEHG5(TM,RKM,ST,CT,SPH,CPH,BH,BT,P,BEXACT)	NEWMAG,145
237	DELT = (R - BEXACT)/BEXACT*100,	NEWMAG,146
243	WRITE(6,1007)BEXACT,DELT	NEWMAG,147
1007	FORMAT(103X,2X,F10,3,1X,F10,3)	NEWMAG,148
252	400 CONTINUE	NEWMAG,149
255	900 CONTINUE	NEWMAG,150
257	WRITE(6,1008)	NEWMAG,151
1008	FORMAT(///,20H END OF TEST PROBLEM)	NEWMAG,152
263	STOP	NEWMAG,153
265	END	NEWMAG,154

BFIELD

	SUBROUTINE BFIELD(ANGS,ANGE,ALT,BVAL,DIPANG,DECANG,COSCHI)	NEWMAG,155
C		NEWMAG,156
C	* * *	NEWMAG,157
C		NEWMAG,158
C	THIS ROUTINE CALCULATES THE AMBIENT MAGNETIC FIELD AT A POINT	NEWMAG,159
C	FROM THE MAGNITUDE AND DIRECTION OF THE MAGNETIC DIPOLE MOMENT,	NEWMAG,160
C	AND THE LOCATION OF THE POINT	NEWMAG,161
C		NEWMAG,162
C	* * *	NEWMAG,163
C		NEWMAG,164
C	INPUT PARAMETERS	NEWMAG,165
C	ARGUMENT LIST =	NEWMAG,166
C	ANG = NORTH LATITUDE OF FIELD POINT (RADIAN)	NEWMAG,167
C	ANGF = EAST LONGITUDE OF FIELD POINT (RADIAN)	NEWMAG,168
C	ALT = ALTITUDE OF FIELD POINT (KM)	NEWMAG,169
C		NEWMAG,170
C	MAGLNK COMMON	NEWMAG,171
C	MUO = MAGNETIC DIPOLE MOMENT (GAUSS-KM ³)	NEWMAG,172
C	COSLT0 = COSINE OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT	NEWMAG,173
C	SINLT0 = SINE OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT	NEWMAG,174
C	PHI0 = EAST LONGITUDE OF MAGNETIC DIPOLE MOMENT (RADIAN)	NEWMAG,175
C	CNSTNT COMMON	NEWMAG,176
C	PI = 3.1415926535894	NEWMAG,177
C	RECM = EARTH RADIUS (CM)	NEWMAG,178
C		NEWMAG,179
C	OUTPUT PARAMETERS	NEWMAG,180
C	ARGUMENT LIST =	NEWMAG,181
C	BVAL = MAGNETIC FIELD STRENGTH AT FIELD POINT (GAUSS)	NEWMAG,182
C	DIPANG = DIP ANGLE OF MAGNETIC FIELD AT FIELD POINT (RAD).	NEWMAG,183
C	DIP (OR INCLINATION) IS THE VERTICAL ANGLE MEASURED	NEWMAG,184
C	FROM THE HORIZONTAL AT ANY POINT TO THE (VECTOR)	NEWMAG,185
C	LINE OF FORCE THROUGH THAT POINT. IT IS POSITIVE IN	NEWMAG,186
C	THE NORTHERN MAGNETIC HEMISPHERE AND NEGATIVE IN	NEWMAG,187
C	THE SOUTHERN MAGNETIC HEMISPHERE.	NEWMAG,188
C	DECANG = DECLINATION OF MAGNETIC FIELD AT FIELD POINT (RAD).	NEWMAG,189
C	DECLINATION (OR VARIATION), THE ANGLE BETWEEN THE	NEWMAG,190
C	GEOGRAPHIC AND MAGNETIC MERIDIANS AT A POINT, IS	NEWMAG,191
C	POSITIVE IF THE COMPASS NEEDLE POINTS EAST OF	NEWMAG,192
C	GEOGRAPHIC NORTH.	NEWMAG,193
C	COSCHI = COSINE OF MAGNETIC DIPOLE COLATITUDE.	NEWMAG,194
C	COSCHI IS NEGATIVE IN THE NORTHERN MAGNETIC	NEWMAG,195
C	HEMISPHERE AND POSITIVE IN THE SOUTHERN MAGNETIC	NEWMAG,196
C	HEMISPHERE.	NEWMAG,197
C		NEWMAG,198
C	REAL MUO	NEWMAG,199
C		NEWMAG,200
C	COMMON /MAGLNK/ MUO,COSLT0,SINLT0,PHI0	NEWMAG,201
C	COMMON/CNSTNT/RECM,PI,HALFT,FIDURPI,GRAVZ,GZHEZ,BOLTZX,GAM1,GH1I	NEWMAG,202
C	1 ,PMNIT,PMOXY	NEWMAG,203
C		NEWMAG,204
C	RF=RECM*1.E-5	NEWMAG,205
C		NEWMAG,206
C	CALCULATE SINE AND COSINE OF NORTH LATITUDE OF FIELD POINT	NEWMAG,207
C		NEWMAG,208
12	COSLAP = COS(ANGS)	NEWMAG,209
14	SINLAP = SIN(ANGS)	NEWMAG,210

BFIELD (Cont'd)

21	DELLON = ANGE - PHIO	NEWMAG,211
C		NEWMAG,212
C	CALCULATE SINE AND COSINE OF ANGLE BETWEEN MAGNETIC	NEWMAG,213
C	DIPOLE MOMENT AND FIELD POINT	NEWMAG,214
C		NEWMAG,215
27	COSCHI = COSLAP * COSLT0 + COS(ANGE - PHIO) * SINLAP * SINLT0	NEWMAG,216
41	SINCHI = SQRT(1. - COSCHI * COSCHI)	NEWMAG,217
C		NEWMAG,218
C	CALCULATE CUBE OF GEOCENTRIC RADIUS OF POINT	NEWMAG,219
C		NEWMAG,220
51	RCUBE = RE + ALT	NEWMAG,221
53	RCUBE = RCUBE * RCUBE * RCUBE	NEWMAG,222
C		NEWMAG,223
C	TOTAL FIELD STRENGTH	NEWMAG,224
C		NEWMAG,225
54	BTERM = SQRT(3. * COSCHI * COSCHI + 1.)	NEWMAG,226
65	BVAL = MU0 / RCUBE * BTERM	NEWMAG,227
C		NEWMAG,228
C	MAGNETIC DIP ANGLE AT POINT	NEWMAG,229
C		NEWMAG,230
67	SINDIP = 2. * COSCHI / BTERM	NEWMAG,231
72	DIPANG = -ASIN(SINDIP)	NEWMAG,232
C		NEWMAG,233
C	MAGNETIC DECLINATION ANGLE AT POINT	NEWMAG,234
C		NEWMAG,235
77	SINPSI = COSLT0 * SIN(DELLON) / SINCHI	NEWMAG,236
103	DECANG = ASIN(SINPSI)	NEWMAG,237
115	COSPSI = -SINLT0 * COSCHI * SINLAP	NEWMAG,238
120	IF(COSPSI.LT.0.) DECANG = SIGN(PI,SINPSI) - DECANG	NEWMAG,239
C		NEWMAG,240
125	RETURN	NEWMAG,241
126	END	NEWMAG,242

BLOCKH

	BLOCK DATA BLOCKH	NEWMAG,263
C	INITIALIZE NAMED COMMON CONSTANTS AND DEFAULT VALUES	NEWMAG,268
C	SET OF CHEM QUANTITIES APPEARING UNDER VARIOUS CHEM OPTIONS	NEWMAG,265
C	DEPOSITION COEFFICIENTS FOR PRUMPG	NEWMAG,266
C	COMMON/DEPDAT/SIGU(5,4),PREFF(5,4),ERGU(5),THRESH(4),SPINTH,	NEWMAG,267
	SPINT,XMU1	NEWMAG,248
1	MATHEMATICAL AND GEOPHYSICAL CONSTANTS	NEWMAG,249
C	COMMON/CNSTNT/RE,PI,HALFPI,FOURPI,GRAVZ,GZREZ,BOLTZK,GAM1,GM11	NEWMAG,250
	,PMNIT,PMOXY	NEWMAG,251
1		NEWMAG,252
C		NEWMAG,253
C	CNSTNT	NEWMAG,254
	DATA RE /6.367650E+08/,	NEWMAG,255
1	PI /3.1415926535895/,	NEWMAG,256
3	HALFPI/1.5707963267949/,	NEWMAG,257
5	FOURPI/12.5663706143592/,	NEWMAG,258
7	GRAVZ/980.665/,	NEWMAG,259
5	BOLTZK/1.38054E-16/,	NEWMAG,260
2	PMNIT /2.324743E-23/,	NEWMAG,261
3	PMOXY /2.656850E-23/,	NEWMAG,262
6	GAM1/0.5/	NEWMAG,263
C	DEPDAT	NEWMAG,264
	DATA SIGU /0.0 ,8.0E-18,2.0E-17,2.5E-17,2.0E-17,	NEWMAG,265
1	2.0E-18,1.6E-17,2.0E-17,2.5E-17,2.0E-17,	NEWMAG,266
2	0.0 ,1.0E-17,1.0E-17,1.0E-17,1.0E-17,	NEWMAG,267
3	0.0 ,3.2E-18,3.2E-18,9.0E-18,9.0E-18/,	NEWMAG,268
4	ERGU /1.762E-11,2.371E-11,2.595E-11,3.525E-11,5.767E-11/,	NEWMAG,269
5	THRESH/1.564E-11,8.202E-12,2.331E-11,2.182E-11/,	NEWMAG,270
6	SPINTH/1.00E11/,SPINT/2.07E11/	NEWMAG,271
	END	NEWMAG,272
		NEWMAG,273

CONJUG

```

C      SUBROUTINE CONJUG(ALAT1,ALON1,ALT1,ALT2,AJUG,ALAT2,ALON2,S12,REB1)NEWMAG,274
C      * * * * *
C      THE ROUTINE CONJUG CALCULATES, FOR A GIVEN ALTITUDE, THE LOCATION
C      (LAT,LON) OF THE POINT(2), WHICH IS ON THE SAME MAGNETIC DIPOLE
C      FIELD LINE AS SOME OTHER GIVEN POINT(1). IT ALSO CALCULATES THE
C      FIELD LINE DISTANCE BETWEEN POINT(1) AND POINT(2), IN UNITS OF
C      THE EQUATORIAL RADIUS OF THE TRACED LINE, AND THE RATIO OF THE
C      EQUATORIAL VALUE OF THE FIELD TO THAT AT POINT(1) FOR THE TRACED
C      LINE.
C      * * * * *
C      INPUT PARAMETERS
C      ARGUMENT LIST -
C      ALAT1 = NORTH LATITUDE OF POINT 1 (RADIAN)
C      ALON1 = EAST LONGITUDE OF POINT 1 (RADIAN)
C      ALT1 = ALTITUDE OF POINT 1 (KM)
C      ALT2 = ALTITUDE OF POINT 2 (KM)
C      AJUG =
C      1. CALCULATES LOCATION (LAT,LON) OF POINT 2
C      IN SAME MAGNETIC HEMISPHERE
C      -1. CALCULATES LOCATION (LAT,LON) OF POINT 2
C      IN OPPOSITE MAGNETIC HEMISPHERE
C      *****
C      * CAUTION - LOCATION OF OPPOSITE HEMISPHERE
C      * INTERSECTIONS MAY NOT BE ACCURATE *
C      *
C      *****
C      MAGLNK COMMON
C      MU0 = MAGNETIC DIPOLE MOMENT (GAUSS*CM3)
C      COSLT0 = COSINE OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT
C      SINLT0 = SINE OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT
C      PH10 = EAST LONGITUDE OF MAGNETIC DIPOLE MOMENT (RADIAN)
C      CNSTNT COMMON
C      RECM = EARTH RADIUS (CM)
C      PI = 3.1415926535898
C      OUTPUT PARAMETERS
C      ALAT2 = NORTH LATITUDE OF POINT 2 (RADIAN)
C      ALON2 = EAST LONGITUDE OF POINT 2 (RADIAN)
C      S12 = DISTANCE ALONG FIELD BETWEEN POINT 1 AND POINT 2 (IN
C      UNITS OF THE EQUATORIAL VALUE OF THE TRACED LINE)
C      REB1 = RATIO OF THE EQUATORIAL VALUE OF THE FIELD TO THAT AT
C      POINT 1 FOR THE TRACED LINE
C      COMMON /MAGLNK/ MU0,COSLT0,SINLT0,PH10
C      COMMON/CNSTNT/ RECM,PI,HALFPI,F0URPI,GRAVZ(7)
C      REAL MU0
C      RE = 1.0E-05*RECM
C      TWOPI = 2.*PI
C      CALCULATE SINE AND COSINE OF ANGLE BETWEEN MAGNETIC DIPOLE MOMENT
C      AND POINT 1

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CONJUG (Cont'd)

17	COSLT1 = COS(ALAT1)	NEWMAG,335
20	SINLT1 = SIN(ALAT1)	NEWMAG,336
25	DIFF = ALON1 - PHIO	NEWMAG,337
33	COSZ1 = SINLT0*SINLT1 + COSLT0*COSLT1*COS(DIFF)	NEWMAG,338
41	SINZ12 = 1. - COSZ1*COSZ1	NEWMAG,339
43	SINZ1 = SQRT(SINZ12)	NEWMAG,340
	C	NEWMAG,341
	C	NEWMAG,342
	C	NEWMAG,343
	C	NEWMAG,344
45	SINZ22 = SINZ12*(RE + ALT2)/(RE + ALT1)	NEWMAG,345
55	SINZ2 = SQRT(SINZ22)	NEWMAG,346
57	COSZ2 = SQRT(1. - SINZ22)	NEWMAG,347
	C	NEWMAG,348
	C	NEWMAG,349
	C	NEWMAG,350
	C	NEWMAG,351
	C	NEWMAG,352
	C	NEWMAG,353
	C	NEWMAG,354
	C	NEWMAG,355
63	COSZ2 = SIGN(COSZ2,AJUG*COSZ1)	NEWMAG,356
	C	NEWMAG,357
	C	NEWMAG,358
	C	NEWMAG,359
	C	NEWMAG,360
72	SINPS1 = COSLT1 * SIN(DIFF) / SINZ1	NEWMAG,361
102	COSPS1 = (SINLT1 + COSZ1*SINLT0)/(SINZ1+COSLT0)	NEWMAG,362
	C	NEWMAG,363
	C	NEWMAG,364
	C	NEWMAG,365
106	SINLT2 = COSZ2 * SINLT0 + SINZ2 * COSLT0 * COSPS1	NEWMAG,366
112	ALAT2 = ASIN(SINLT2)	NEWMAG,367
	C	NEWMAG,368
	C	NEWMAG,369
	C	NEWMAG,370
117	SINDIF = SINZ2 * SINPS1 / COS(ALAT2)	NEWMAG,371
122	DIFF = ASIN(SINDIF)	NEWMAG,372
124	COSSGN = COSZ2 * SINLT0*SINLT2	NEWMAG,373
127	IF(COSSGN,LT, 0.)DIFF = SIGN(PI,SINDIF) * DIFF	NEWMAG,374
141	ALON2 = PHIO + DIFF	NEWMAG,375
143	IF(ALON2,LT, 0.) ALON2 = ALON2 + TWOPI	NEWMAG,376
147	ALON2 = AMOD(ALON2,TWOPI)	NEWMAG,377
	C	NEWMAG,378
	C	NEWMAG,379
	C	NEWMAG,380
153	R3 = SQRT(3.)	NEWMAG,381
155	R3MU1 = R3 * COSZ1	NEWMAG,382
156	R3MU2 = R3 * COSZ2	NEWMAG,383
160	R1PR12 = SQRT(1. + R3MU1 * R3MU1)	NEWMAG,384
164	R1PR22 = SQRT(1. + R3MU2 * R3MU2)	NEWMAG,385
171	S1E = ABS(R3MU1 * R1PR12 + ALOG(R3MU1 + R1PR12))	NEWMAG,386
200	S2E = ABS(R3MU2 * R1PR22 + ALOG(R3MU2 + R1PR22))	NEWMAG,387
215	S12 = ABS(S1E - AJUG * S2E) * R3/6.	NEWMAG,388
	C	NEWMAG,389
	C	NEWMAG,390
	C	NEWMAG,391
	C	NEWMAG,392
	C	NEWMAG,393
217	BEB1 = SINZ12**3/R1PR12	NEWMAG,394
	C	NEWMAG,395
223	RETURN	NEWMAG,396
223	END	

MAGFIT

```

SUBROUTINE MAGFIT(ALATF,ALONF,ALTF,TH)
C
C * * * *
C
C THIS ROUTINE FITS A DIPOLE FIELD TO THE LOCAL MAGNETIC
C FIELD AT A SPECIFIED POINT P. P IS GIVEN BY ALATF,ALONF,ALTF.
C THE MAGNETIC FIELD AT P IS FOUND FROM MODEL 5 OF STASSINOPOULOS
C MODELS. MODEL 5 IS IGRF 10/68. REFERENCE = STASSINOPOULOS, E.G.
C AND G.D. MEAD, ALLMAG, FIELD-LINE CALCULATION, NASA-GODDARD SPACE
C FLIGHT CENTER, NSSDC 72-12, FEBRUARY 1972.
C
C * * * *
C
C INPUT PARAMETERS
C   ALATF = GEOCENTRIC NORTH LATITUDE
C           OF SPECIFIED POINT P (RADIAN)
C   ALONF = GEOCENTRIC EAST LONGITUDE
C           OF SPECIFIED POINT P (RADIAN)
C   ALTF  = ALTITUDE OF SPECIFIED POINT P (KM)
C   TH    = TIME FOR DESIRED FIELD (YEARS)
C
C CNSTNT COMMON
C
C   HALFPI = PI/2
C   PI      = 3.1415926535898
C   RECM    = EARTH RADIUS (CM)
C
C OUTPUT PARAMETERS (TO MAGLNK COMMON)
C   MU0     = MAGNETIC DIPOLE MOMENT (GAUSS-KM3)
C   COSLTO  = COSINE OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT
C   SINLTO  = SINE   OF NORTH LATITUDE OF MAGNETIC DIPOLE MOMENT
C   PHIO    = EAST LONGITUDE OF MAGNETIC DIPOLE MOMENT (RADIAN)
C
C REAL LAMDA,LAMARG
C REAL MU0
C
C COMMON /MAGLNK/ MU0,COSLTO,SINLTO,PHIO
C COMMON/CNSTNT/RECM,PI,HALFPI,FOURPI,GRAVZ,GZNEZ,BOLTZK,GAM1,GM1
C 1      ,PHNIT,PHOXY
C
C RE=RECM*1.E-5
C TWOPI=2.*PI
C PTOV2=HALFPI
C
C SET UP INPUT FOR CALL TO EXACT AMBIENT MAGNETIC FIELD MODEL
C
C   RKM = RE + ALTF
C   COLAT = PTOV2 - ALATF
C   ST = SIN(COLAT)
C   CT = COS(COLAT)
C   SPH = SIN(ALONF)
C   CPH = COS(ALONF)
C
C CALCULATE MAGNETIC FIELD COMPONENTS AT POINT P
C FROM STASSINOPOULOS MODEL, MODEL 5 (IGRF 10/68).
C

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NEWMAG,397
 NEWMAG,398
 NEWMAG,399
 NEWMAG,400
 NEWMAG,401
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 NEWMAG,451
 NEWMAG,452

MAGFIT (Cont'd)

35	CALL DNEMGS(TM,RKM,ST,CT,SPH,CPH,BR,BTHETA,BPHI,B)	NEWMAG,453
C		NEWMAG,454
C	CALCULATE MAGNETIC DIPOLE MOMENT(GAUSS-KM3) FROM THE FIELD COMPONENTS	NEWMAG,455
C	BR (RADIAL), BTHETA (POSITIVE SOUTH), AND BPHI (POSITIVE EAST).	NEWMAG,456
C		NEWMAG,457
51	B2SQ = BTHETA*BTHETA + BPHI*BPHI	NEWMAG,458
53	MUO = RKM**3*0.5*SQRT(BR*BR + 4.*B2SQ)	NEWMAG,459
C		NEWMAG,460
C	CALCULATE THE SINE AND COSINE OF THE ANGLE ALPHA AT P WHICH IS THE	NEWMAG,461
C	ANGLE BETWEEN THE MAGNETIC DIPOLE MOMENT AND GEOGRAPHIC NORTH POLE	NEWMAG,462
C	AND DETERMINE THE PROPER SIGNS	NEWMAG,463
C		NEWMAG,464
63	ALPARG = BPHI/BTHETA	NEWMAG,465
65	ALPHA = ATAN(ALPARG)	NEWMAG,466
67	COSALP = ABS(COS(ALPHA))	NEWMAG,467
73	SINALP = ABS(SIN(ALPHA))	NEWMAG,468
77	IF(BTHETA .LT. 0.)COSALP = -COSALP	NEWMAG,469
104	IF(BPHI .LT. 0.)SINALP = -SINALP	NEWMAG,470
C		NEWMAG,471
C	CALCULATE THE ANGLE CHI MEASURED AT EARTH CENTER WHICH	NEWMAG,472
C	IS THE ANGLE BETWEEN THE MAGNETIC DIPOLE MOMENT AND THE SPECIFIED	NEWMAG,473
C	POINT P	NEWMAG,474
C		NEWMAG,475
107	CHIARG = 2.*SQRT(B2SQ)/BR	NEWMAG,476
113	CHI = ATAN(CHIARG)	NEWMAG,477
115	IF(CHI .LT. 0.)CHI = PI + CHI	NEWMAG,478
123	COSCHI = COS(CHI)	NEWMAG,479
125	SINCHI = SIN(CHI)	NEWMAG,480
C		NEWMAG,481
C	CALCULATE SINE AND COSINE OF THE	NEWMAG,482
C	NORTH LATITUDE OF THE MAGNETIC DIPOLE MOMENT	NEWMAG,483
C		NEWMAG,484
127	SINLTO = COSCHI*CT + SINCHI*ST*COSALP	NEWMAG,485
133	COSLTO = SQRT(1. - SINLTO*SINLTO)	NEWMAG,486
C		NEWMAG,487
C	CALCULATE THE EAST LONGITUDE OF THE MAGNETIC DIPOLE MOMENT	NEWMAG,488
C		NEWMAG,489
137	SINDEL = SINCHI*SINALP/COSLTO	NEWMAG,490
142	DEL = ASIN(SINDEL)	NEWMAG,491
144	COSDEL = COSCHI - SINLTO*CT	NEWMAG,492
147	IF(COSDEL .LT. 0.)DEL = SIGN(PI,SINDEL) - DEL	NEWMAG,493
160	PHIO = ALONG = DEL	NEWMAG,494
162	IF(PHIO .LT. 0.) PHIO = PHIO + TWOPI	NEWMAG,495
C		NEWMAG,496
165	RETURN	NEWMAG,497
166	END	NEWMAG,498

ONEMG5

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SUBROUTINE ONEMG5(TM,RKM,ST,CT,SPH,CPH,BR,BTHETA,BPHI,B)
C
C * * * *
C
C THIS ROUTINE CALCULATES THE MAGNETIC FIELD VECTOR AT A SPECIFIED
C POINT USING MODEL 5 OF STASSINOPOULOS AND MEAD (NSSDC 72-12). THE
C ROUTINE IS A MODIFIED VERSION OF ONEMAG FOR THE INTERNATIONAL
C GEOMAGNETIC REFERENCE FIELD (IGRF 1965,0).
C
C INPUT PARAMETERS
C TM = TIME IN YEARS FOR DESIRED FIELD
C RKM = GEOCENTRIC DISTANCE OF POINT (KM)
C ST = SINE OF GEOCENTRIC COLATITUDE OF POINT
C CT = COSINE OF GEOCENTRIC COLATITUDE OF POINT
C SPH = SINE OF GEOCENTRIC LONGITUDE OF POINT (POSITIVE EAST)
C CPH = COSINE OF GEOCENTRIC LONGITUDE OF POINT (POSITIVE EAST)
C
C OUTPUT PARAMETERS
C BR = RADIAL FIELD COMPONENT (GAUSS)
C BTHETA = POSITIVE SOUTH FIELD COMPONENT (GAUSS)
C BPHI = POSITIVE EAST FIELD COMPONENT (GAUSS)
C B = TOTAL FIELD MAGNITUDE (GAUSS)
C
C DIMENSION LG(9,9),LGT(9,9),G(9,9),GG(9,9),GGT(9,9),
C SHMIT(9,9)
C DIMENSION CONST(9,9),FN(9),FM(9)
C DIMENSION P(9,9),DP(9,9),SP(9),CP(9)
C
C EQUIVALENCE (LG(1,1),GG(1,1)),(LGT(1,1),GGT(1,1))
C
C DATA LG/1,-30339,-1654,1297,958,-223,47,71,10,5758,-2123,2994,
A -2036,805,357,60,-54,9,-2006,130,1567,1289,492,246,4,0,-5,-403,
B 242,-176,843,-392,-26,-229,12,-12,149,-280,8,-265,256,-161,3,-25,
C -4,16,125,-123,-107,77,-51,-4,-9,7,-14,106,68,-32,-10,-13,-112,
D 13,-5,-57,-27,-8,9,23,-19,-17,-2,12,3,-13,5,-17,4,22,-3,-16,6/
DATA LGT/10,153,-244,2,-7,19,-1,-5,1,-23,87,3,-108,2,11,-3,-3,4,
E -118,-167,-16,7,-30,29,11,-7,6,42,7,-77,-38,-1,6,19,-5,0,-1,16,
F 29,-42,-21,0,-4,3,0,23,17,-24,8,-3,13,-4,0,-1,-9,-4,20,-11,1,9,
G -2,-2,3,-11,3,4,2,4,2,3,-6,-3,1,-2,-3,-2,-3,-4,-3,-3,-5/
DATA SHMIT(1,1)/0,/,TMOLD/0,/,TZERU/1965,/,NMHAX/4/
DATA P(1,1),CP(1),DP(1,1),SP(1) / 2*1.,2*0. /
C
C IF(SHMIT(1,1),EQ,-1.) GO TO 8
C
C ***** INITIALIZE * ONCE ONLY, FIRST TIME SUBROUTINE IS CALLED
C
16 SHMIT(1,1)=1.
16 DO 18 N=1,9
20 FN(N)=N
22 DO 18 M=1,9
37 FM(M)=M-1
41 18 CONST(N,M) = FLOAT((N-2)**2*(M-1)**2) / ((2*N-3)*(2*N-5))
54 DO 2 N=2,9
57 SHMIT(N,1) = (2*N-3) * SHMIT(N-1,1) / (N-1)
66 JJ=2
70 DO 2 M=2,N

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ONEMG5 (Cont'd)

71	SHMIT(N,M) = SHMIT(N,M-1) * SQRT(FLDNT((N+M+1)*JJ)/(N+M-2))	NEW MAG, 555
107	SHMIT(M-1,N)=SHMIT(N,M)	NEW MAG, 556
117	2 JJ = 1	NEW MAG, 557
124	F1 = LG(1,1)	NEW MAG, 558
125	F2 = LGT(1,1)	NEW MAG, 559
127	DO 7 N=1,NMAX	NEW MAG, 560
130	DO 7 M=1,NMAX	NEW MAG, 561
140	GG(N,M) = LG(N,M)*SHMIT(N,M)/F1	NEW MAG, 562
143	7 GGT(N,M) = LGT(N,M)*SHMIT(N,M)/F2	NEW MAG, 563
155	8 IF(TM.EQ.TMOLD) GO TO 11	NEW MAG, 564
157	TMOLD=TM	NEW MAG, 565
160	T = TM - TZERO	NEW MAG, 566
161	DO 10 N=1,NMAX	NEW MAG, 567
163	DO 10 M=1,NMAX	NEW MAG, 568
173	10 G(N,M) = GG(N,M) + T*GGT(N,M)	NEW MAG, 569
C		NEW MAG, 570
C	***** CALCULATION USUALLY BEGINS HERE	NEW MAG, 571
C		NEW MAG, 572
204	11 SP(2)=SPH	NEW MAG, 573
205	CP(2)=CPH	NEW MAG, 574
206	DO 12 M=3,NMAX	NEW MAG, 575
215	SP(M)=SP(2)*CP(M-1)+CP(2)*SP(M-1)	NEW MAG, 576
220	12 CP(M)=CP(2)*CP(M-1)-SP(2)*SP(M-1)	NEW MAG, 577
227	AOR=6371.2/RKM	NEW MAG, 578
230	AR=AOR**2	NEW MAG, 579
231	BR=0.0	NEW MAG, 580
232	BT=0.0	NEW MAG, 581
233	BP=0.0	NEW MAG, 582
234	DO 21 N=2,NMAX	NEW MAG, 583
242	P(N=1,N)=0.	NEW MAG, 584
243	21 DP(N=1,N)=0.	NEW MAG, 585
245	DO 17 M=2,NMAX	NEW MAG, 586
252	AR=AUR*AR	NEW MAG, 587
253	DO 17 M=1,N	NEW MAG, 588
255	IF(M.EQ.N) GO TO 13	NEW MAG, 589
256	IF(N.EQ.2) GO TO 19	NEW MAG, 590
262	P(N,M)=C(P(N=1,M)-CONST(N,M)*P(N=2,M)	NEW MAG, 591
265	DP(N,M)=CT*DP(N=1,M)-ST*P(N=1,M)-CONST(N,M)*DP(N=2,M)	NEW MAG, 592
272	GO TO 14	NEW MAG, 593
301	19 P(N,M)=CT	NEW MAG, 594
302	DP(N,M)=-ST	NEW MAG, 595
304	GO TO 14	NEW MAG, 596
307	13 P(N,N)=ST*P(N=1,N=1)	NEW MAG, 597
311	DP(N,N)=ST*DP(N=1,N=1)+CT*P(N=1,N=1)	NEW MAG, 598
317	14 PAR = P(N,M)*AR	NEW MAG, 599
323	IF(M.EQ.1) GO TO 15	NEW MAG, 600
332	TEMP=G(N,M)*CP(M)+G(M=1,N)*SP(M)	NEW MAG, 601
335	BP=HP-(G(N,M)*SP(M)+G(M=1,N)*CP(M))*FM(M)*PAR	NEW MAG, 602
342	GO TO 16	NEW MAG, 603
346	15 TEMP = G(N,M)	NEW MAG, 604
352	16 BR=RR-TEMP*FN(N)*PAR	NEW MAG, 605
357	17 BT=BT+TEMP*DP(N,M)*AR	NEW MAG, 606
371	BPHI = BP/ST/100000.	NEW MAG, 607
373	BR = BR/100000.	NEW MAG, 608
374	BTHETA = BT/100000.	NEW MAG, 609
376	B = SQRT(BR*BR + BTHETA*BTHETA + BPHI*BPHI)	NEW MAG, 610
404	RETURN	NEW MAG, 611
405	END	NEW MAG, 612

47

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = -60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 7.496569E+10 GAUSS KM+3
 COSLTO = 2.540002E-01
 SINLTO = -9.671084E-01
 PHI0 = 1.4403367E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
5.00	-70.00	200.00	.300	33.00	-7.08	60.00	1.00	6.790	289.776	.315	-4.818
5.00	-60.00	200.00	.295	30.75	-9.28	60.00	1.00	6.927	299.683	.304	-2.959
5.00	-50.00	200.00	.289	27.05	-11.17	60.00	1.00	7.128	309.577	.289	-.040
0.00	-70.00	200.00	.284	24.43	-6.91	60.00	1.00	2.814	289.707	.290	-2.075
0.00	-60.00	200.00	.280	22.18	-9.08	60.00	1.00	2.646	299.577	.280	-.000
0.00	-50.00	200.00	.276	19.22	-10.96	60.00	1.00	3.000	309.419	.268	2.830
-5.00	-70.00	200.00	.272	15.82	-6.80	60.00	1.00	-1.468	289.579	.269	1.327
-5.00	-60.00	200.00	.270	13.21	-8.95	60.00	1.00	-1.021	299.373	.260	3.899
-5.00	-50.00	200.00	.268	9.88	-10.63	60.00	1.00	-.312	309.104	.251	6.710

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = 0.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 7.473368E+10 GAUSS KM+3
 COSLTO = 2.467086E-01
 SINLTO = -9.632215E-01
 PHI0 = 7.187107E-01 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
5.00	-10.00	200.00	.267	-9.55	-12.13	60.00	1.00	.251	331.019	.275	-2.960
5.00	0.00	200.00	.270	-13.32	-10.26	60.00	1.00	1.056	.714	.285	-5.126
5.00	10.00	200.00	.273	-16.34	-8.08	60.00	1.00	1.562	10.488	.294	-7.379
0.00	-10.00	200.00	.276	-18.87	-12.26	60.00	1.00	-3.032	350.600	.270	2.240
0.00	0.00	200.00	.280	-22.44	-10.41	60.00	1.00	-2.628	.483	.280	.000
0.00	10.00	200.00	.285	-25.29	-8.22	60.00	1.00	-2.364	10.342	.291	-2.203
-5.00	-10.00	200.00	.289	-27.69	-12.49	60.00	1.00	-7.196	350.879	.266	8.511
-5.00	0.00	200.00	.295	-30.78	-10.64	60.00	1.00	-6.917	.363	.278	6.070
-5.00	10.00	200.00	.301	-33.39	-8.42	60.00	1.00	-6.760	10.262	.290	3.816

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 9.060742E+10 GAUSS KM**3
 COSLT0 = 1.988444E-01
 SINLT0 = -9.800307E-01
 PHI0 = 1.261959E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
5.00	50.00	200.00	.323	-9.04	-6.37	60.00	1.00	.037	50.553	.327	-1.166
5.00	60.00	200.00	.325	-10.00	-4.62	60.00	1.00	.490	60.364	.338	-4.071
5.00	70.00	200.00	.326	-12.15	-2.73	60.00	1.00	.757	70.202	.352	-7.471
0.00	50.00	200.00	.333	-18.53	-6.43	60.00	1.00	-3.129	50.353	.322	3.305
0.00	60.00	200.00	.336	-20.31	-4.67	60.00	1.00	-2.908	60.238	.336	-0.000
0.00	70.00	200.00	.338	-21.49	-2.76	60.00	1.00	-2.775	70.134	.353	-4.341
-5.00	50.00	200.00	.349	-27.32	-6.55	60.00	1.00	-7.198	50.254	.321	8.748
-5.00	60.00	200.00	.353	-28.96	-4.77	60.00	1.00	-7.075	60.174	.337	4.654
-5.00	70.00	200.00	.355	-30.05	-2.62	60.00	1.00	-7.000	70.099	.359	-0.937

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 1.018630E+11 GAUSS KM**3
 COSLT0 = 1.863079E-01
 SINLT0 = -9.860739E-01
 PHI0 = 1.879308E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
5.00	110.00	200.00	.363	-9.07	.39	60.00	1.00	.017	109.966	.370	-1.832
5.00	120.00	200.00	.363	-8.46	2.04	60.00	1.00	.093	119.819	.363	-0.047
5.00	130.00	200.00	.362	-7.68	3.63	60.00	1.00	-3.363	129.660	.354	2.364
0.00	110.00	200.00	.374	-18.65	.39	60.00	1.00	-3.136	109.979	.380	-1.410
0.00	120.00	200.00	.374	-18.25	2.06	60.00	1.00	-3.189	119.685	.374	-0.000
0.00	130.00	200.00	.372	-17.30	3.67	60.00	1.00	-3.319	129.787	.366	1.765
-5.00	110.00	200.00	.392	-27.26	.40	60.00	1.00	-7.201	109.965	.397	-1.134
-5.00	120.00	200.00	.391	-27.09	2.10	60.00	1.00	-7.230	119.918	.392	-0.144
-5.00	130.00	200.00	.389	-26.23	3.73	60.00	1.00	-7.100	129.840	.385	1.059

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = 180.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 0.977634E+10 GAUSS KM**3
 COSLTO = 1.485915E-01
 SINLTO = -0.820522E-01
 PHIO = 1.811749E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE R	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF R	PERCENT
5.00	170.00	200.00	.317	1.12	9.94	60.00	1.00	12.735	171.385	.314	.847
5.00	180.00	200.00	.318	4.66	10.56	60.00	1.00	11.267	181.184	.309	2.921
5.00	190.00	200.00	.319	8.34	10.68	60.00	1.00	10.090	190.992	.305	4.682
0.00	170.00	200.00	.320	-8.68	9.97	60.00	1.00	-5.012	169.117	.328	-2.049
0.00	180.00	200.00	.318	-5.15	10.56	60.00	1.00	-6.095	178.659	.318	-0.000
0.00	190.00	200.00	.317	-1.84	10.85	60.00	1.00	-7.570	188.541	.311	1.933
-5.00	170.00	200.00	.329	-18.12	10.07	60.00	1.00	-8.157	169.434	.344	-0.473
-5.00	180.00	200.00	.325	-14.74	10.64	60.00	1.00	-8.677	179.301	.333	-0.467
-5.00	190.00	200.00	.321	-11.15	10.90	60.00	1.00	-9.307	189.145	.323	-0.434

LOCATION OF POINT THAT IS FITTED

LATITUDE = 0.00 (DEG)
 LONGITUDE = 240.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 0.277103E+10 GAUSS KM**3
 COSLTO = 1.777912E-01
 SINLTO = -0.840679E-01
 PHIO = 2.116454E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE R	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF R	PERCENT
5.00	230.00	200.00	.301	16.12	9.79	60.00	1.00	8.457	230.603	.305	-1.158
5.00	240.00	200.00	.305	19.17	9.09	60.00	1.00	8.024	240.489	.308	-0.846
5.00	250.00	200.00	.309	21.80	8.12	60.00	1.00	7.706	250.389	.312	-0.903
0.00	230.00	200.00	.294	4.56	9.70	60.00	1.00	5.639	230.967	.296	-0.840
0.00	240.00	200.00	.295	9.77	8.99	60.00	1.00	4.742	240.752	.295	.000
0.00	250.00	200.00	.298	12.65	8.01	60.00	1.00	4.101	250.578	.296	.628
-5.00	230.00	200.00	.293	-3.27	9.69	60.00	1.00	-11.616	228.813	.294	-0.512
-5.00	240.00	200.00	.292	-0.03	8.96	60.00	1.00	-13.274	238.664	.290	-0.669
-5.00	250.00	200.00	.292	2.90	7.96	60.00	1.00	1.999	250.977	.286	2.164

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = -60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOL PARAMETERS

MUN = 8.274113E+10 GAUSS KM**3
 COSLTO = 2.036150E-01
 SINLTO = -9.56931E-01
 PHIO = 1.286178E+00 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	ICRF R	PERCENT
35.00	-70.00	200.00	.474	65.36	-14.93	60.00	1.00	35.243	289.828	.483	-1.954
35.00	-60.00	200.00	.463	63.63	-16.97	60.00	1.00	35.579	299.783	.463	.032
35.00	-50.00	200.00	.451	61.57	-18.76	60.00	1.00	35.625	309.739	.439	2.742
30.00	-70.00	200.00	.450	61.48	-13.23	60.00	1.00	30.845	289.824	.459	-1.880
30.00	-60.00	200.00	.440	59.61	-15.86	60.00	1.00	30.868	299.776	.440	.000
30.00	-50.00	200.00	.427	57.36	-17.44	60.00	1.00	30.744	309.728	.416	2.763
25.00	-70.00	200.00	.426	57.14	-12.29	60.00	1.00	25.768	289.814	.432	-1.366
25.00	-60.00	200.00	.415	55.09	-14.64	60.00	1.00	25.820	299.762	.414	.362
25.00	-50.00	200.00	.403	52.61	-16.40	60.00	1.00	25.889	309.709	.390	3.137

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = 0.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOL PARAMETERS

MUN = 8.374920E+10 GAUSS KM**3
 COSLTO = 1.234338E-01
 SINLTO = -9.923528E-01
 PHIO = 6.754146E-01 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	ICRF B	PERCENT
35.00	-10.00	200.00	.392	49.29	-4.16	60.00	1.00	36.034	349.862	.383	2.416
35.00	0.00	200.00	.368	48.37	-5.08	60.00	1.00	36.069	359.882	.384	.964
35.00	10.00	200.00	.365	47.62	-3.88	60.00	1.00	36.099	9.908	.389	-1.133
30.00	-10.00	200.00	.367	43.25	-5.86	60.00	1.00	31.268	349.847	.361	1.810
30.00	0.00	200.00	.363	42.19	-4.84	60.00	1.00	31.317	359.869	.363	.000
30.00	10.00	200.00	.360	41.32	-3.71	60.00	1.00	31.357	9.897	.369	-2.451
25.00	-10.00	200.00	.345	36.37	-5.67	60.00	1.00	26.598	349.822	.339	1.782
25.00	0.00	200.00	.341	35.15	-4.69	60.00	1.00	26.669	359.847	.342	-0.361
25.00	10.00	200.00	.338	34.16	-3.59	60.00	1.00	26.729	9.879	.340	-3.126

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 9.408114E+10 GAUSS KM**3
 C08LTO = 6.029442E-02
 S1MLTO = -9.981806E-01
 PH10 = 7.120605E-01 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
35.00	50.00	200.00	.440	50.87	.57	60.00	1.00	35.985	50.012	.428	4.681
35.00	60.00	200.00	.449	51.02	1.26	60.00	1.00	35.980	60.027	.481	1.739
35.00	70.00	200.00	.450	51.26	1.91	60.00	1.00	35.971	70.040	.454	-.005
30.00	50.00	200.00	.420	45.01	.54	60.00	1.00	31.202	50.013	.409	2.720
30.00	60.00	200.00	.421	45.18	1.20	60.00	1.00	31.195	60.029	.421	-.000
30.00	70.00	200.00	.422	45.46	1.82	60.00	1.00	31.164	70.044	.432	-2.204
25.00	50.00	200.00	.394	38.34	.52	60.00	1.00	26.533	50.015	.369	1.328
25.00	60.00	200.00	.394	38.53	1.15	60.00	1.00	26.493	60.034	.399	-1.242
25.00	70.00	200.00	.396	38.85	1.75	60.00	1.00	26.475	70.050	.409	-3.222

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 9.441025E+10 GAUSS KM**3
 C08LTO = 9.015556E-02
 S1MLTO = -9.950719E-01
 PH10 = 2.861015E+00 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
35.00	110.00	200.00	.464	48.92	.47	60.00	1.00	36.015	109.902	.472	-1.669
35.00	120.00	200.00	.460	49.27	-3.53	60.00	1.00	36.039	119.921	.459	.365
35.00	130.00	200.00	.458	48.78	-2.50	60.00	1.00	36.058	129.943	.438	4.419
30.00	110.00	200.00	.435	43.95	.42	60.00	1.00	31.242	109.892	.444	-2.077
30.00	120.00	200.00	.431	43.21	-3.37	60.00	1.00	31.275	119.912	.431	-.000
30.00	130.00	200.00	.429	42.64	-2.34	60.00	1.00	31.300	129.936	.412	-.053
25.00	110.00	200.00	.408	37.15	.41	60.00	1.00	26.551	109.875	.417	-2.289
25.00	120.00	200.00	.405	36.30	-3.25	60.00	1.00	26.608	119.898	.406	-.450
25.00	130.00	200.00	.402	35.64	-2.31	60.00	1.00	26.645	129.926	.388	3.630

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = 180.00 (DEG)
 ALTITUDE = 200.00 (FEET)
 TIME = 1975.00 (YR)

FITTED DIPOLAR PARAMETERS

MUO = 7.722420E+10 GAUSS METERS

COIL TO = 1.503202E-01

SIN TO = 2.022275E-01

PHI TO = 2.000000E+00 LONGITUDE THAT (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR H	DIPANG	MEANG	INTERP ALT	AJUG	INTERP LAT	INTERP LON	IGMF H	PERCENT
35.00	170.00	200.00	.350	48.10	8.32	60.00	1.00	34.072	170.100	.363	-1.040
35.00	180.00	200.00	.350	48.55	9.33	60.00	1.00	36.017	180.200	.362	.932
35.00	190.00	200.00	.352	51.11	10.30	60.00	1.00	35.911	190.214	.368	.979
35.00	200.00	200.00	.357	41.02	7.26	60.00	1.00	31.320	170.214	.363	-1.815
30.00	170.00	200.00	.352	41.59	9.00	60.00	1.00	31.225	180.231	.362	-1.000
30.00	180.00	200.00	.350	45.10	9.81	60.00	1.00	31.170	190.236	.369	.071
30.00	190.00	200.00	.354	35.84	7.69	60.00	1.00	24.424	170.253	.327	-3.301
25.00	180.00	200.00	.321	35.81	8.68	60.00	1.00	24.560	180.267	.327	-1.465
25.00	190.00	200.00	.327	30.86	9.43	60.00	1.00	24.457	190.270	.332	-1.400

LOCATION OF POINT THAT IS FITTED

LATITUDE = 30.00 (DEG)
 LONGITUDE = 200.00 (DEG)
 ALTITUDE = 200.00 (FEET)
 TIME = 1975.00 (YR)

FITTED DIPOLAR PARAMETERS

MUO = 8.455126E+10 GAUSS METERS

COIL TO = 2.174540E-01

SIN TO = -3.780700E-01

PHI TO = 2.000000E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR H	DIPANG	MEANG	INTERP ALT	AJUG	INTERP LAT	INTERP LON	IGMF H	PERCENT
35.00	230.00	200.00	.404	57.45	15.07	60.00	1.00	35.730	230.245	.437	1.595
35.00	240.00	200.00	.455	50.13	14.26	60.00	1.00	35.469	240.214	.457	-.511
35.00	250.00	200.00	.465	61.00	13.94	60.00	1.00	35.448	250.183	.475	-2.221
30.00	230.00	200.00	.419	51.11	16.15	60.00	1.00	30.883	230.260	.411	1.920
30.00	240.00	200.00	.430	59.20	13.34	60.00	1.00	30.822	240.227	.430	1.000
30.00	250.00	200.00	.440	57.04	12.03	60.00	1.00	30.772	250.141	.447	-1.671
25.00	230.00	200.00	.391	47.73	13.43	60.00	1.00	26.067	230.260	.385	2.278
25.00	240.00	200.00	.404	50.04	12.49	60.00	1.00	25.988	240.244	.401	.713
25.00	250.00	200.00	.414	52.13	11.32	60.00	1.00	25.920	250.204	.417	-0.775

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (DEG)
 LONGITUDE = -60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1075.00 (VRS)

FITTED DIPOLY PARAMETERS

MUA = 7.13282E+10 GAUSS KMOE+3
 COSLTO = 3.09877E-01
 SINALTO = -9.90841E-01
 PHIO = 1.15921E+00 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LUN	TEST ALT	DIPOLY M	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LUN	IGHF M	PERCENT
65.00	-70.00	200.00	.535	83.18	-45.09	60.00	1.00	65.103	289.753	.533	.820
65.00	-60.00	200.00	.529	81.18	-47.00	60.00	1.00	65.124	299.684	.521	1.059
65.00	-50.00	200.00	.523	79.91	-48.00	60.00	1.00	65.149	309.621	.508	2.026
60.00	-70.00	200.00	.527	81.13	-51.55	60.00	1.00	60.159	289.787	.536	-1.510
60.00	-60.00	200.00	.521	79.56	-53.91	60.00	1.00	60.181	299.727	.521	-1.000
60.00	-50.00	200.00	.513	77.85	-56.19	60.00	1.00	60.207	309.671	.505	1.607
55.00	-70.00	200.00	.517	78.76	-58.44	60.00	1.00	55.218	289.809	.515	-3.308
55.00	-60.00	200.00	.510	77.22	-60.18	60.00	1.00	55.240	299.755	.518	-1.590
55.00	-50.00	200.00	.501	75.68	-62.10	60.00	1.00	55.269	309.704	.499	.308

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (DEG)
 LONGITUDE = 0.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1075.00 (VRS)

FITTED DIPOLY PARAMETERS

MUA = 7.11937E+10 GAUSS KMOE+3
 COSLTO = 0.19507E-02
 SINALTO = -0.98989E-01
 PHIO = 1.21303E+00 LONGITUDE EAST (RADIANS)

TEST LAT	TEST LUN	TEST ALT	DIPOLY M	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LUN	IGHF M	PERCENT
65.00	-10.00	200.00	.477	74.13	-10.74	60.00	1.00	65.297	349.865	.472	1.208
65.00	0.00	200.00	.475	75.08	-9.96	60.00	1.00	65.308	359.870	.470	1.117
65.00	10.00	200.00	.473	75.27	-8.94	60.00	1.00	65.318	369.880	.471	.403
60.00	-10.00	200.00	.462	73.15	-9.17	60.00	1.00	60.346	349.840	.461	.114
60.00	0.00	200.00	.459	72.66	-8.54	60.00	1.00	60.378	359.805	.459	-1.000
60.00	10.00	200.00	.457	72.21	-7.70	60.00	1.00	60.389	369.893	.460	-1.605
55.00	-10.00	200.00	.444	69.93	-8.04	60.00	1.00	55.423	309.800	.450	-1.259
55.00	0.00	200.00	.441	69.00	-7.52	60.00	1.00	55.454	319.844	.448	-1.486
55.00	10.00	200.00	.439	68.91	-6.80	60.00	1.00	55.489	329.901	.449	-2.397

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YHR)

FITTED DIPOLE PARAMETERS

MUO = 7.043127E+10 GAUSS KM+03
 COSLTO = 1.021802E+01
 SINSLO = -9.025037E+01
 PHIO = 5.433608E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF H	PERCENT
65.00	50.00	200.00	.522	76.93	16.69	60.00	1.00	65.273	50.195	.503	3.799
65.00	60.00	200.00	.526	77.63	16.74	60.00	1.00	65.257	60.185	.516	1.823
65.00	70.00	200.00	.524	78.31	16.79	60.00	1.00	65.243	70.170	.520	7.080
60.00	50.00	200.00	.506	76.07	16.08	60.00	1.00	60.336	50.172	.496	2.150
60.00	60.00	200.00	.511	76.81	14.03	60.00	1.00	60.323	60.163	.511	.000
60.00	70.00	200.00	.515	75.52	13.52	60.00	1.00	60.308	70.149	.526	-2.169
55.00	50.00	200.00	.488	70.68	12.26	60.00	1.00	55.413	50.158	.480	.438
55.00	60.00	200.00	.493	71.77	12.14	60.00	1.00	55.394	60.149	.502	-1.794
55.00	70.00	200.00	.498	72.53	11.61	60.00	1.00	55.378	70.137	.519	-4.072

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YHR)

FITTED DIPOLE PARAMETERS

MUO = 8.078007E+10 GAUSS KM+03
 COSLTO = 1.006431E+01
 SINSLO = -9.005106E+01
 PHIO = 4.413345E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF H	PERCENT
65.00	110.00	200.00	.569	79.15	-11.87	60.00	1.00	65.230	109.888	.557	2.085
65.00	120.00	200.00	.567	78.65	-12.98	60.00	1.00	65.240	119.838	.553	2.378
65.00	130.00	200.00	.564	78.10	-13.87	60.00	1.00	65.251	129.852	.545	3.378
60.00	110.00	200.00	.554	76.36	-9.18	60.00	1.00	60.294	109.902	.557	-0.508
60.00	120.00	200.00	.551	75.85	-10.27	60.00	1.00	60.304	119.884	.551	.000
60.00	130.00	200.00	.548	75.27	-11.54	60.00	1.00	60.316	129.870	.540	1.521
55.00	110.00	200.00	.516	73.38	-7.98	60.00	1.00	55.382	119.911	.552	-2.746
55.00	120.00	200.00	.513	72.84	-9.14	60.00	1.00	55.373	119.894	.543	-1.847
55.00	130.00	200.00	.529	72.24	-9.99	60.00	1.00	55.387	129.881	.520	.191

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (NEG)
 LONGITUDE = 180.00 (NEG)
 ALTITUDE = 200.00 (NEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

WUO = 7.05R226E+10 GAUSS MM+3
 COSLTO = 1.225075E-01
 SINLTO = -9.624076E-01
 PHIO = 2.633006E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF R	PERCENT
65.00	170.00	200.00	.501	72.95	5.05	60.00	1.00	65.170	170.080	.500	-1.000
65.00	180.00	200.00	.503	73.27	7.80	60.00	1.00	65.365	180.120	.503	-.024
65.00	190.00	200.00	.505	73.67	9.83	60.00	1.00	65.350	190.147	.504	.236
60.00	170.00	200.00	.482	69.70	4.96	60.00	1.00	60.491	170.079	.487	-1.147
60.00	180.00	200.00	.480	70.05	6.84	60.00	1.00	60.441	180.107	.484	-.990
60.00	190.00	200.00	.486	70.50	8.59	60.00	1.00	60.420	190.131	.486	.109
55.00	170.00	200.00	.460	66.15	6.45	60.00	1.00	55.534	170.074	.464	-.864
55.00	180.00	200.00	.463	66.55	6.13	60.00	1.00	55.528	180.100	.461	.823
55.00	190.00	200.00	.466	67.05	7.60	60.00	1.00	55.515	190.122	.464	.333

LOCATION OF POINT THAT IS FITTED

LATITUDE = 60.00 (NEG)
 LONGITUDE = 240.00 (NEG)
 ALTITUDE = 200.00 (NEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

WUO = 8.050072E+10 GAUSS MM+3
 COSLTO = 2.675581E-01
 SINLTO = -9.635017E-01
 PHIO = 1.756012E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF R	PERCENT
65.00	230.00	200.00	.505	80.18	39.72	60.00	1.00	65.160	230.320	.535	1.078
65.00	240.00	200.00	.551	81.60	37.98	60.00	1.00	65.143	240.265	.542	1.574
65.00	250.00	200.00	.556	82.93	34.87	60.00	1.00	65.125	250.205	.540	1.441
60.00	230.00	200.00	.534	77.92	31.71	60.00	1.00	60.223	230.278	.530	.178
60.00	240.00	200.00	.581	79.35	29.06	60.00	1.00	60.200	240.239	.531	-.000
60.00	250.00	200.00	.547	80.62	25.77	60.00	1.00	60.182	250.177	.550	-.525
55.00	230.00	200.00	.521	75.18	26.57	60.00	1.00	55.286	230.231	.520	.178
55.00	240.00	200.00	.529	76.43	24.28	60.00	1.00	55.261	240.207	.535	-1.159
55.00	250.00	200.00	.535	77.09	20.53	60.00	1.00	55.242	250.159	.567	-.37

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = -60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 5.834788F+10 GAUSS KM=3
 CURLTO = 2.641004F-01
 SIMLTO = -9.644852F-01
 PHIO = 1.053820E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE M	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGMF M	PERCENT
-25.00	-70.00	200.00	.215	-16.85	.28	60.00	1.00	-26.105	289.983	.234	-8.185
-25.00	-60.00	200.00	.215	-16.16	-2.39	60.00	1.00	-26.061	300.145	.223	-1.555
-25.00	-50.00	200.00	.216	-20.23	-5.00	60.00	1.00	-27.916	312.209	.219	-1.384
-30.00	-70.00	200.00	.225	-27.47	.29	60.00	1.00	-32.184	209.987	.238	-5.398
-30.00	-60.00	200.00	.227	-28.89	-2.44	60.00	1.00	-32.160	300.108	.225	-7.000
-35.00	-70.00	200.00	.239	-35.59	.30	60.00	1.00	-32.080	314.219	.221	-2.042
-35.00	-60.00	200.00	.239	-35.43	-2.50	60.00	1.00	-36.450	289.989	.237	-1.418
-35.00	-50.00	200.00	.241	-36.44	-5.25	60.00	1.00	-36.635	300.089	.233	-2.020
								-36.585	310.181	.227	5.950

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = 0.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 9.403396F+10 GAUSS KM=3
 CURLTO = 3.039478F-01
 SIMLTO = -9.101158F-01
 PHIO = 9.501033F-01 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE M	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGMF M	PERCENT
-25.00	-10.00	200.00	.235	-52.04	-25.08	60.00	1.00	-25.856	350.846	.254	-7.008
-25.00	0.00	200.00	.247	-55.86	-23.63	60.00	1.00	-25.755	367	.265	-6.732
-25.00	10.00	200.00	.256	-59.10	-21.27	60.00	1.00	-25.679	10.244	.275	-6.202
-30.00	-10.00	200.00	.269	-56.59	-26.61	60.00	1.00	-30.717	357.418	.251	-7.736
-30.00	0.00	200.00	.261	-60.04	-25.28	60.00	1.00	-30.835	344	.261	.000
-30.00	10.00	200.00	.271	-63.04	-22.94	60.00	1.00	-30.572	10.262	.269	.898
-35.00	-10.00	200.00	.283	-60.61	-24.51	60.00	1.00	-35.603	350.403	.251	4.587
-35.00	0.00	200.00	.274	-63.74	-27.37	60.00	1.00	-35.514	340	.259	5.861
-35.00	10.00	200.00	.244	-66.56	-25.15	60.00	1.00	-35.480	10.277	.265	7.112

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1075.00 (YRS)

FITTED DIPOLAR PARAMETERS

MUO = 6.639740E+10 GAUSS KM=3
 COSLTO = 4.447848E-01
 SINLTO = 8.956370E-01
 PHIO = 2.007116E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR H	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	ICMP #	PERCENT
-25.00	50.00	200.00	.323	-52.71	-25.83	60.00	1.00	-25.808	50.495	.319	1.359
-25.00	60.00	200.00	.341	-56.98	-27.37	60.00	1.00	-25.702	60.404	.353	-3.430
-25.00	70.00	200.00	.357	-60.59	-28.86	60.00	1.00	-25.624	70.321	.395	-9.599
-30.00	50.00	200.00	.341	-57.04	-30.60	60.00	1.00	-30.679	50.497	.320	6.443
-30.00	60.00	200.00	.359	-60.93	-29.34	60.00	1.00	-30.591	60.384	.359	.000
-30.00	70.00	200.00	.375	-64.28	-26.96	60.00	1.00	-30.524	70.310	.404	-7.347
-35.00	50.00	200.00	.350	-60.46	-32.79	60.00	1.00	-35.571	50.453	.325	10.253
-35.00	60.00	200.00	.376	-64.44	-31.81	60.00	1.00	-35.496	60.376	.366	2.514
-35.00	70.00	200.00	.391	-67.58	-29.62	60.00	1.00	-35.438	70.306	.414	-5.627

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1075.00 (YRS)

FITTED DIPOLAR PARAMETERS

MUO = 9.357861E+10 GAUSS KM=3
 COSLTO = 2.746644E-01
 SINLTO = -9.818619E-01
 PHIO = 2.091790E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR H	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	ICMP #	PERCENT
-25.00	110.00	200.00	.498	-59.81	-3.55	60.00	1.00	-25.708	110.049	.498	.099
-25.00	120.00	200.00	.500	-60.05	.05	60.00	1.00	-25.702	119.999	.501	-1.194
-25.00	130.00	200.00	.498	-59.79	3.66	60.00	1.00	-25.708	129.950	.499	-1.107
-30.00	110.00	200.00	.526	-63.96	-3.86	60.00	1.00	-30.595	110.047	.522	.722
-30.00	120.00	200.00	.527	-64.19	.06	60.00	1.00	-30.591	119.999	.527	-1.134
-30.00	130.00	200.00	.526	-63.95	3.97	60.00	1.00	-30.596	129.952	.524	-1.535
-35.00	110.00	200.00	.552	-67.71	-4.25	60.00	1.00	-35.500	110.046	.544	1.535
-35.00	120.00	200.00	.554	-67.92	.07	60.00	1.00	-35.496	119.999	.551	.433
-35.00	130.00	200.00	.552	-67.70	4.38	60.00	1.00	-35.500	129.953	.552	.098

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = 100.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 9.145700E+10 GAUSS KM=3
 COSLYO = 2.514174E-01
 SINLYO = -9.678777E-01
 PHIO = 2.730489E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LONG	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LONG	ICRF B	PERCENT
-25.00	170.00	200.00	.445	-52.36	11.97	60.00	1.00	-25.907	169.749	.451	-1.354
-25.00	180.00	200.00	.432	-49.37	15.19	60.00	1.00	-25.984	170.703	.432	-1.090
-25.00	190.00	200.00	.418	-47.05	15.89	60.00	1.00	-26.079	180.658	.413	-1.230
-30.00	170.00	200.00	.472	-57.28	14.85	60.00	1.00	-30.758	169.764	.476	-1.239
-30.00	180.00	200.00	.459	-54.96	16.06	60.00	1.00	-30.819	179.725	.459	-1.000
-30.00	190.00	200.00	.445	-52.45	16.73	60.00	1.00	-30.893	189.687	.439	-1.279
-35.00	170.00	200.00	.499	-61.89	15.98	60.00	1.00	-35.637	169.775	.503	-1.680
-35.00	180.00	200.00	.486	-59.46	17.18	60.00	1.00	-35.687	179.738	.484	-1.317
-35.00	190.00	200.00	.472	-57.21	17.78	60.00	1.00	-35.746	189.705	.465	-1.526

LOCATION OF POINT THAT IS FITTED

LATITUDE = -30.00 (DEG)
 LONGITUDE = 200.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 7.457319E+10 GAUSS KM=3
 COSLYO = 2.431241E-01
 SINLYO = -9.607608E-01
 PHIO = 2.337033E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LONG	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LONG	ICRF B	PERCENT
-25.00	230.00	200.00	.337	-39.41	16.45	60.00	1.00	-26.380	239.505	.344	-1.972
-25.00	240.00	200.00	.326	-36.01	15.40	60.00	1.00	-26.565	239.511	.327	-1.211
-25.00	250.00	200.00	.317	-32.43	14.36	60.00	1.00	-26.781	249.489	.310	-1.435
-30.00	230.00	200.00	.354	-45.67	14.12	60.00	1.00	-31.116	239.596	.366	-1.980
-30.00	240.00	200.00	.347	-42.72	16.17	60.00	1.00	-31.246	239.577	.347	-1.000
-30.00	250.00	200.00	.337	-39.59	14.82	60.00	1.00	-31.392	249.568	.327	-1.044
-35.00	230.00	200.00	.381	-51.37	17.98	60.00	1.00	-35.920	239.631	.390	-2.129
-35.00	240.00	200.00	.370	-48.62	16.90	60.00	1.00	-36.018	239.617	.369	-1.045
-35.00	250.00	200.00	.350	-45.90	15.42	60.00	1.00	-36.124	249.616	.347	-1.465

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = -60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 6.886550E+10 GAUSS KM**3
 COSLTO = 4.368574E-01
 SINLTO = -8.995308E-01
 PHI0 = 2.466508E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGNF B	PERCENT
-55.00	-70.00	200.00	.328	-50.81	15.45	60.00	1.00	-55.051	289.530	.331	-.951
-55.00	-60.00	200.00	.323	-49.37	10.40	60.00	1.00	-56.019	299.659	.313	3.084
-55.00	-50.00	200.00	.319	-48.04	5.45	60.00	1.00	-56.066	309.811	.301	6.128
-60.00	-70.00	200.00	.348	-55.79	16.37	60.00	1.00	-60.762	289.522	.341	-3.536
-60.00	-60.00	200.00	.343	-54.51	11.30	60.00	1.00	-60.846	298.656	.343	-.000
-60.00	-50.00	200.00	.340	-53.85	5.97	60.00	1.00	-60.882	309.811	.330	2.937
-65.00	-70.00	200.00	.368	-60.19	17.54	60.00	1.00	-65.065	289.489	.392	-6.079
-65.00	-60.00	200.00	.364	-59.24	11.98	60.00	1.00	-65.709	298.638	.376	-3.117
-65.00	-50.00	200.00	.361	-58.64	6.37	60.00	1.00	-65.738	308.799	.363	-.488

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = 0.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 5.909245E+10 GAUSS KM**3
 COSLTO = 3.738803E-01
 SINLTO = -9.274931E-01
 PHI0 = 2.331204E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGNF B	PERCENT
-55.00	-10.00	200.00	.298	-55.83	-15.92	60.00	1.00	-55.805	350.409	.294	1.329
-55.00	0.00	200.00	.304	-57.13	-20.03	60.00	1.00	-55.738	10.778	.297	2.362
-55.00	10.00	200.00	.312	-59.10	-23.95	60.00	1.00	-55.665	10.525	.303	3.080
-60.00	-10.00	200.00	.315	-59.88	-17.04	60.00	1.00	-60.674	350.423	.318	-.845
-60.00	0.00	200.00	.321	-61.30	-21.52	60.00	1.00	-60.620	10.000	.321	-.000
-60.00	10.00	200.00	.328	-62.97	-25.89	60.00	1.00	-60.560	10.553	.327	-.294
-65.00	-10.00	200.00	.332	-63.85	-18.47	60.00	1.00	-65.568	350.460	.347	-4.319
-65.00	0.00	200.00	.337	-65.02	-23.41	60.00	1.00	-65.521	10.546	.350	-3.694
-65.00	10.00	200.00	.343	-66.81	-28.27	60.00	1.00	-65.469	10.609	.356	-3.671

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUN = 7.437010E+10 GAUSS KM+3
 COSLTO = 5.308905E-01
 SINLTO = -8.476909E-01
 PHIO = 2.487779E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-55.00	50.00	200.00	.406	-61.73	-46.34	60.00	1.00	-55.450	50.637	.302	6.279
-55.00	60.00	200.00	.425	-65.17	-50.75	60.00	1.00	-55.356	60.771	.220	1.119
-55.00	70.00	200.00	.423	-68.51	-54.89	60.00	1.00	-55.275	70.492	.461	3.885
-60.00	50.00	200.00	.420	-64.42	-50.03	60.00	1.00	-60.373	50.907	.403	4.235
-60.00	60.00	200.00	.437	-67.40	-55.30	60.00	1.00	-60.287	60.645	.437	.000
-60.00	70.00	200.00	.434	-70.34	-60.53	60.00	1.00	-60.213	70.767	.473	-4.175
-65.00	50.00	200.00	.433	-66.74	-54.34	60.00	1.00	-65.303	51.023	.426	1.729
-65.00	60.00	200.00	.448	-69.27	-60.65	60.00	1.00	-65.224	60.964	.455	-1.541
-65.00	70.00	200.00	.462	-71.60	-67.08	60.00	1.00	-65.154	70.883	.465	-4.630

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUN = 8.686070E+10 GAUSS KM+3
 COSLTO = 4.302325E-01
 SINLTO = -9.027181E-01
 PHIO = 2.408340E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-55.00	110.00	200.00	.591	-81.42	-44.35	60.00	1.00	-55.132	110.226	.590	.203
-55.00	120.00	200.00	.599	-83.39	-36.04	60.00	1.00	-55.115	120.146	.603	-1.764
-55.00	130.00	200.00	.603	-84.80	-19.51	60.00	1.00	-55.105	130.065	.609	-1.006
-60.00	110.00	200.00	.598	-83.07	-50.79	60.00	1.00	-60.077	110.256	.590	1.218
-60.00	120.00	200.00	.604	-85.23	-53.87	60.00	1.00	-60.060	120.164	.604	.000
-60.00	130.00	200.00	.608	-87.07	-55.97	60.00	1.00	-60.051	130.074	.612	-5.555
-65.00	110.00	200.00	.601	-84.01	-79.56	60.00	1.00	-65.023	110.300	.587	2.342
-65.00	120.00	200.00	.606	-86.15	-85.42	60.00	1.00	-65.006	120.195	.601	.968
-65.00	130.00	200.00	.610	-88.28	-94.43	60.00	1.00	-64.997	130.007	.609	.153

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = 100.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 8.716033E+10 GAUSS KM**3
 COSLTO = 3.345241E-01
 SINLTO = -9.409563E-01
 PHI0 = 2.281095F+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGMF B	PERCENT
-55.00	170.00	200.00	.579	-78.07	33.39	60.00	1.00	-55.216	169.750	.581	-.315
-55.00	180.00	200.00	.569	-76.20	35.54	60.00	1.00	-55.245	179.693	.568	.217
-55.00	190.00	200.00	.556	-74.16	36.17	60.00	1.00	-55.280	189.640	.553	.026
-60.00	170.00	200.00	.581	-78.02	41.34	60.00	1.00	-60.158	169.721	.593	-.356
-60.00	180.00	200.00	.570	-76.50	42.58	60.00	1.00	-60.185	179.658	.581	-.000
-60.00	190.00	200.00	.569	-74.50	42.24	60.00	1.00	-60.218	189.602	.569	.321
-65.00	170.00	200.00	.599	-82.10	53.23	60.00	1.00	-65.102	169.676	.599	-.083
-65.00	180.00	200.00	.591	-80.29	52.41	60.00	1.00	-65.126	179.605	.590	.115
-65.00	190.00	200.00	.582	-78.47	50.38	60.00	1.00	-65.159	189.541	.579	.368

LOCATION OF POINT THAT IS FITTED

LATITUDE = -60.00 (DEG)
 LONGITUDE = 200.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MU0 = 8.280516E+10 GAUSS KM**3
 COSLTO = 8.014215E-01
 SINLTO = -9.150143E-01
 PHI0 = 2.469823E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGMF B	PERCENT
-55.00	230.00	200.00	.481	-66.37	38.00	60.00	1.00	-55.416	229.625	.486	-.886
-55.00	240.00	200.00	.465	-63.97	34.02	60.00	1.00	-55.488	239.399	.464	.399
-55.00	250.00	200.00	.450	-61.82	31.29	60.00	1.00	-55.567	249.389	.438	2.699
-60.00	230.00	200.00	.489	-69.50	41.97	60.00	1.00	-60.343	229.375	.505	-1.366
-60.00	240.00	200.00	.484	-67.02	38.09	60.00	1.00	-60.407	239.352	.484	-.000
-60.00	250.00	200.00	.471	-64.42	33.95	60.00	1.00	-60.475	249.349	.460	2.194
-65.00	230.00	200.00	.513	-71.48	46.92	60.00	1.00	-65.275	229.292	.522	-1.549
-65.00	240.00	200.00	.501	-69.31	43.16	60.00	1.00	-65.334	239.272	.502	-.180
-65.00	250.00	200.00	.489	-67.03	37.28	60.00	1.00	-65.395	249.275	.481	1.824

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (DEG)
 LONGITUDE = -80.00 (NEG)
 ALTITUDE = 200.00 (NEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 6.110570E+10 GAUSS KM=3
 COSLTO = 4.956139E-01
 SINLTO = -8.685430E-01
 PHI0 = 2.613075E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-80.00	-70.00	200.00	.484	-68.74	31.04	60.00	1.00	-80.405	288.526	.480	.911
-80.00	-60.00	200.00	.481	-68.18	23.15	60.00	1.00	-80.449	298.639	.472	1.942
-80.00	-50.00	200.00	.478	-67.78	15.32	60.00	1.00	-80.481	309.201	.465	2.914
-85.00	-70.00	200.00	.502	-71.36	34.81	60.00	1.00	-85.330	287.135	.504	-485
-85.00	-60.00	200.00	.500	-71.28	25.97	60.00	1.00	-85.370	297.747	.500	-600
-85.00	-50.00	200.00	.499	-71.07	17.19	60.00	1.00	-85.400	308.451	.496	.451
-90.00	-70.00	200.00	.517	-74.08	39.72	60.00	1.00	-89.650	149.718	.525	-1.607
-90.00	-60.00	200.00	.517	-74.08	29.72	60.00	1.00	-89.650	149.718	.525	-1.607
-90.00	-50.00	200.00	.517	-74.08	19.72	60.00	1.00	-89.650	149.718	.525	-1.607

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (NEG)
 LONGITUDE = 0.00 (NEG)
 ALTITUDE = 200.00 (NEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 4.102490E+10 GAUSS KM=3
 COSLTO = 5.327540E-01
 SINLTO = -8.685430E-01
 PHI0 = 2.623186E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-80.00	-10.00	200.00	.471	-67.84	-15.38	60.00	1.00	-80.489	350.816	.454	3.669
-80.00	0.00	200.00	.473	-67.85	-23.24	60.00	1.00	-80.456	1.185	.454	3.790
-80.00	10.00	200.00	.476	-68.41	-31.16	60.00	1.00	-80.411	11.505	.460	3.676
-85.00	-10.00	200.00	.491	-70.75	-17.22	60.00	1.00	-85.407	351.561	.491	-606
-85.00	0.00	200.00	.492	-70.97	-24.02	60.00	1.00	-85.376	2.300	.492	-600
-85.00	10.00	200.00	.494	-71.26	-34.86	60.00	1.00	-85.335	12.924	.494	-657
-90.00	-10.00	200.00	.509	-73.79	-19.70	60.00	1.00	-89.644	150.297	.525	-3.118
-90.00	0.00	200.00	.509	-73.79	-29.70	60.00	1.00	-89.644	150.297	.525	-3.118
-90.00	10.00	200.00	.509	-73.79	-39.70	60.00	1.00	-89.644	150.297	.525	-3.118

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (DEG)
 LONGITUDE = 60.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 8.1490662E+10 GAUSS KM=3
 COSLTO = 5.058555E-01
 SINLTO = -8.420182E-01
 PHIO = 2.420106E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-80.00	50.00	200.00	.505	-71.70	-84.52	60.00	1.00	-80.168	52.142	.492	2.726
-80.00	60.00	200.00	.512	-72.74	-73.40	60.00	1.00	-80.102	62.123	.503	1.694
-80.00	70.00	200.00	.518	-73.60	-62.65	60.00	1.00	-80.039	72.043	.515	.557
-85.00	50.00	200.00	.513	-72.49	-71.80	60.00	1.00	-85.105	58.203	.510	.462
-85.00	60.00	200.00	.516	-73.42	-81.43	60.00	1.00	-85.041	64.177	.516	.000
-85.00	70.00	200.00	.519	-73.96	-91.30	60.00	1.00	-85.980	70.030	.522	.494
-90.00	50.00	200.00	.517	-73.66	-79.88	60.00	1.00	-89.641	150.121	.525	-1.479
-90.00	60.00	200.00	.517	-73.66	-89.88	60.00	1.00	-89.641	150.121	.525	-1.479
-90.00	70.00	200.00	.517	-73.66	-80.12	60.00	1.00	-89.641	150.121	.525	-1.479

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (DEG)
 LONGITUDE = 120.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1973.00 (YRS)

FITTED DIPOLE PARAMETERS

MUO = 8.135095E+10 GAUSS KM=3
 COSLTO = 4.922884E-01
 SINLTO = -8.708435E-01
 PHIO = 2.401215E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLE B	DIPANG	DECANG	INTERS ALT	AJUG	INTERS LAT	INTERS LON	IGRF B	PERCENT
-80.00	110.00	200.00	.555	-74.28	-126.02	60.00	1.00	-79.648	111.168	.558	.521
-80.00	120.00	200.00	.559	-74.99	-138.77	60.00	1.00	-79.919	120.690	.566	-1.223
-80.00	130.00	200.00	.561	-75.53	-152.40	60.00	1.00	-79.799	130.593	.572	-1.776
-85.00	110.00	200.00	.545	-76.42	-134.53	60.00	1.00	-84.788	112.325	.543	.413
-85.00	120.00	200.00	.547	-76.75	-145.90	60.00	1.00	-84.758	121.773	.547	.000
-85.00	130.00	200.00	.548	-76.98	-157.50	60.00	1.00	-84.737	131.183	.550	.353
-90.00	110.00	200.00	.532	-74.21	-140.96	60.00	1.00	-89.653	149.039	.525	1.402
-90.00	120.00	200.00	.532	-74.21	-150.96	60.00	1.00	-89.653	149.039	.525	1.402
-90.00	130.00	200.00	.532	-74.21	-160.96	60.00	1.00	-89.653	149.039	.525	1.402

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (DEG)
 LONGITUDE = 180.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLAR PARAMETERS

MUO = 8.186501E+10 GAUSS KM**3
 COSLTO = 4.775505E-01
 SINLTO = -8.765904E-01
 PHI0 = 2.568745E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR B	DIPANG	DECANG	INTERS ALT	INTERS LAT	INTERS LON	ICRF A	PERCENT
-80.00	170.00	200.00	.567	-79.04	188.10	60.00	-79.818	169.348	.577	-1.767
-80.00	180.00	200.00	.534	-79.33	130.55	60.00	-79.837	179.066	.574	-1.770
-80.00	190.00	200.00	.560	-78.57	121.95	60.00	-79.667	188.804	.570	-1.885
-85.00	170.00	200.00	.554	-77.48	154.15	60.00	-80.754	188.701	.554	.021
-85.00	180.00	200.00	.553	-77.22	142.54	60.00	-84.776	178.141	.553	-0.000
-85.00	190.00	200.00	.551	-76.88	131.20	60.00	-84.607	187.622	.551	.050
-90.00	170.00	200.00	.539	-74.40	158.25	60.00	-89.667	148.250	.525	2.685
-90.00	180.00	200.00	.539	-74.40	148.25	60.00	-89.667	148.250	.525	2.685
-90.00	190.00	200.00	.539	-74.40	136.25	60.00	-89.667	148.250	.525	2.685

LOCATION OF POINT THAT IS FITTED

LATITUDE = -85.00 (DEG)
 LONGITUDE = 240.00 (DEG)
 ALTITUDE = 200.00 (DEG)
 TIME = 1975.00 (YRS)

FITTED DIPOLAR PARAMETERS

MUO = 8.295032E+10 GAUSS KM**3
 COSLTO = 4.835432E-01
 SINLTO = -8.753205E-01
 PHI0 = 2.568884E+00 LONGITUDE EAST (RADIAN)

TEST LAT	TEST LON	TEST ALT	DIPOLAR B	DIPANG	DECANG	INTERS ALT	INTERS LAT	INTERS LON	ICRF B	PERCENT
-80.00	230.00	200.00	.532	-74.53	60.59	60.00	-80.050	228.062	.540	-1.567
-80.00	240.00	200.00	.525	-73.49	71.47	60.00	-80.110	237.895	.530	.925
-82.00	250.00	200.00	.519	-72.49	62.72	60.00	-80.171	247.087	.520	.147
-85.00	230.00	200.00	.533	-74.78	89.68	60.00	-84.991	226.178	.535	.377
-85.00	240.00	200.00	.530	-74.26	79.86	60.00	-85.049	236.055	.530	.000
-85.00	250.00	200.00	.527	-73.74	70.29	60.00	-85.109	246.050	.525	.433
-90.00	230.00	200.00	.532	-74.56	81.21	60.00	-89.661	148.791	.525	1.301
-90.00	240.00	200.00	.532	-74.56	68.79	60.00	-89.661	148.791	.525	1.301
-90.00	250.00	200.00	.532	-74.56	78.79	60.00	-89.661	148.791	.525	1.301

END OF TEST PROGRAM

Table A8. Summary of Running Time Experience for
Ambient Magnetic Field Module
on a CDC 7600 Computer.

Timing runs have been made for the various subroutines in the ambient magnetic field model, with the following results obtained on the Berkeley CDC 7600 computer:

MAGFIT (includes call to ONEMG5)	0.30 msec ^a or 0.64 msec ^b
BFIELD	0.055 msec
CONJUG	0.067 msec ^c
ONEMG5	0.21 msec ^a or 0.56 msec ^b

^aFor a 6-page Fortran version containing no DO-loops.

^bFor a 2-page Fortran version containing DO-loops.

^cThis number should be contrasted with a value of 26.7 msec required if ONEMG5 (i. e. , the multipole field) were used instead of BFIELD (i. e. , the dipole field) in tracing the field line to the conjugate region.

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