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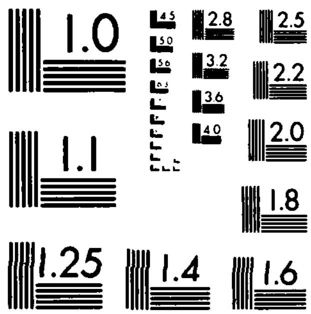

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Supplemental Summary of Cutoff Rigidities Calculated Using the International Geomagnetic Reference Field for Various Epochs

M.A. SHEA
D.F. SMART

1 NOVEMBER 1982

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Tables of cosmic-ray cutoff rigidities using the trajectory-tracing technique are given for three epochs of the geomagnetic field. These values have been determined utilizing the International Geomagnetic Reference Field with time derivatives applied so that the coefficients for the field model are appropriate for the following epochs: 1965.0, 1970.0, and 1975.0. Each table includes the geographic coordinates and L value of each location together with the main cutoff rigidity, the Stormer cutoff rigidity, and the effective

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20. Abstract (Continued)

cutoff rigidity. The altitude for which each set of values was calculated is also given. Tables for both vertical and non-vertical directions are included. These cutoff rigidity values are supplemental to those published in previous AFGL reports. In addition, minor corrections to previously published values are also included.

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Preface

The authors thank Louise C. Gentile, Stacey A. Horning, and Anne A. Bathurst for their assistance in ordering and checking the thousands of computer calculations from which the cutoff rigidities have been determined, and for computerizing the tables contained in this report.

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Supplemental Summary of Cutoff Rigidities Calculated Using the International Geomagnetic Reference Field for Various Epochs

1. INTRODUCTION

The cutoff rigidity (momentum per unit charge) is defined as the lowest rigidity a charged particle can possess and still arrive at a specific point on the earth's surface.[1,2] The cutoff rigidity of any geographic location is a function of both the zenith and azimuth angles of arrival. In the vertical direction the cutoff rigidity has a value of 13 to 18 GV at the magnetic equator and is theoretically zero at the magnetic poles.

The general equation of particle motion in the magnetic field does not have a solution in closed form even in a simple dipole field. To determine which rigidities are allowed at a specific geographical location, it is necessary to perform detailed and extensive numerical calculations of cosmic-ray trajectories in a mathematical model of the earth's magnetic field. To accurately determine the cutoff rigidity of a specific location on the earth in a specified direction, cosmic-ray trajectories are computed at successively lower rigidities until a rigidity is reached below which all particles are forbidden at that location.

(Received for publication 29 October 1982)

1. McCracken, K. G. (1962) The cosmic-ray flare effect. 1. Some new methods of analysis, J. Geophys. Res. 67:423.
2. Stromer, C. (1930) Periodische elektronenbahen im felde eines elementarmagneten und ihre anwendung auf bruches modellversuche und auf eschenhagans elementarwellen des erdmagnetismus, Z. Astrophys. 1:237-274.

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The method for making a rigorous determination of the cutoff rigidity by calculating the trajectories of particles as they traverse the earth's magnetic field has long been advocated,[3] but the tremendous amount of calculation involved has limited the application of this approach. With the advent of high-speed digital computers, the application of this numerical method was made tractable with Freon and McCracken[4] making the first use of this technique to determine the vertical cutoff rigidity of a specific location. Since that time a number of papers have been published in which cutoff rigidities calculated by the trajectory-tracing method have been presented.[5-9] Even with the highest speed computers available today, the calculation of cutoff rigidities for an unlimited number of geographical locations, and zenith and azimuth angles is not practical because of the extensive computer time involved. Consequently, most of the cutoff rigidities published to date have been for very specific directions (most often the vertical direction) and locations, or calculated for use in the analysis of very definitive problems.

We have been computing cutoff rigidities by the trajectory-tracing technique for several years. Many of these values have been published in various tables,[7-11] while the remaining and majority of values have been utilized primarily in various analyses.[12-20] Throughout this work we have maintained a composite listing of all locations for which we have made these calculations. The purpose of this set of publications is to present, in tabular form, listings of cutoff rigidities calculated using the trajectory-tracing method. The first four publications in this set[21-24] contained the results of the extensive cutoff rigidity calculations made using the Finch and Leaton[25] (Epoch 1955.0) internal geomagnetic field model, as well as a smaller set of results obtained using the Jensen and Cain[26] (Epoch 1960.0) field coefficients. The next four reports[27-30] contain similar results as calculated utilizing the International Geomagnetic Reference Field (IGRF)[31] with time derivatives applied so that the coefficients for the field model are appropriate for Epochs 1955.0, 1965.0, 1966.5, 1970.0, and 1975.0. This report contains tables of cutoff rigidities supplemental to those published in the previous eight reports. All of the cutoff rigidity values were calculated using the IGRF and its time derivatives. In addition, minor corrections to previously published values are also included.

2. METHOD

The orbit of a negatively-charged particle moving outward from the earth from a specific location and direction is identical to the orbit of a positive particle of

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Because of the large number of references cited above, they will not be listed here. See References, page 21.

equal rigidity approaching the earth ultimately arriving at the same location in the same direction. Programs and methods that use the differential equation of motion ($\ddot{\bar{r}} = \frac{q}{m} \dot{\bar{r}} \times \bar{B}$) to determine the path of a particle of charge q and mass m in the earth's magnetic field $\bar{B}$ by numerical integration have been published several times.[7,8,30,32-34]

Relatively few modifications to the original "McCracken" trajectory program[32] have been made throughout the period of this work, and in all cases these modifications have been to increase the efficiency of this program for operation on the various types of computers that have been utilized. One important modificatic was to replace the library of step sizes provided in the original McCracken program[32] with a computed step size that is between 1/25 and 1/50 of the dist traveled during one gyration. In an uniform magnetic field the time required one gyration is $\frac{33.33P}{B} \frac{2\pi}{\beta c}$ where P (rigidity) is in units of GV, c is in units km/sec, and β is the ratio between the particle velocity and the speed of light. the distance traveled during a gyration is divided into 50 steps, (when V is perpendicular to B) then the step size, in units of time, is approximatel $\frac{1.4 \times 10^{-5}}{B\,\beta}(1 + |\cos\alpha|)$ sec where α is the pitch angle between the velocity vector and the magnetic field vector. Since the earth's magnetic field is not uniform, we recomputed the step length for each Runge-Kutta iteration step. At each step the velocity of the particle was checked, and if the current value of β differed from the initial value by more than 1×10^{-5}, the integration was declared unacceptable and the trajectory recomputed with the previous step size divided in half. A listing of this revised FORTRAN computer program is given in Appendix F of Shea et al.[30]

The effect of the currents in the magnetosphere and the magnetospheric tail were not considered in these calculations. The work of Gall et al,[35] Smart et al,[36]

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32. McCracken, K.G., Rao, U.R., and Shea, M.A. (1962) The Trajectories of Cosmic Rays in a High Degree Simulation of the Geomagnetic Field, M.I.T. Tech Rpt. No. 77, NYO-2670.

33. Shea, M.A., Smart, D.F., and McCracken, K.G. (1965) A Study of Vertically Incident Cosmic-ray Trajectories Using Sixth-degree Simulations of the Geomagnetic Field, ERP No. 141, AFCRL-65-705, AD 623632.

34. Shea, M.A., Smart, D.F., McCracken, K.G., and Rao, U.R. (1968) Supplement to IQSY Instruction Manual No. 10, Cosmic Ray Tables - Asymptotic Directions, Variational Coefficients and Cutoff Rigidities, Special Report No. 71, AFCRL-68-0030, AD 667539.

35. Gall, R., Jimenez, J., and Camacho, L. (1968) Arrival of low energy cosmic rays via the magnetospheric tail, J. Geophys. Res. 73:1593.

36. Smart, D.F., Shea, M.A., and Gall, R. (1969) The daily variation of trajectory-derived high latitude cutoff rigidities in a model magnetosphere, J. Geophys. Res. 74:4731.

and Smart and Shea[37] have shown that the inclusion of these currents and the magnetospheric tail, results in a significant lowering of the cutoff values at locations for which the internal field vertical cutoff rigidity would be < 0.5 GV; therefore, care should be taken when using these tables for these locations. The effects of these external sources would result in slight decreases (~ 0.1 GV) for locations where the vertical cutoff rigidity calculated with the internal geomagnetic field model is between 0.5 and 2.0 GV. Little, if any, effect is found for locations where the vertical cutoff rigidity is higher than 2.0 GV.[38]

Each of the cutoff rigidity values given in the appendices of this report was calculated in the same manner by initiating the cosmic-ray trajectory at a specified altitude (usually 20 or 30 km) and direction above the surface of the earth. The calculations were continued until either access to the interplanetary medium was assured (the trajectory extended to a distance of more than 25 earth radii) or the orbit was found to be forbidden. Forbidden orbits were divided into two groups, those which intersected the solid earth (called a re-entrant orbit) and those for which no solution could be obtained within a reasonably number of iterations, which was arbitrarily selected at 40,000 iterations.

Details of each of the trajectories calculated for the determination of the cutoff rigidities, including the asymptotic direction of each allowed orbit and the number of iterative steps for each of the rigidities considered, are contained on magnetic tape and are available through World Data Center A for Solar-Terrestrial Physics, Boulder, Colorado 80303.

For each location calculations were initiated at a rigidity high above the highest possible cutoff, and cosmic-ray trajectories were calculated at discrete intervals decreasing in rigidity until we were satisfied that the cutoff had been reached. As the calculations progress down through the rigidity spectrum, the results change from the easily allowed orbits to a complex structure of allowed, forbidden, and quasi-trapped orbits (loosely called penumbra) and finally to a set of rigidities where the trajectories all intersect the solid earth. As a result of these types of trajectory calculations we defined three distinct cutoff rigidities: the main cutoff, P(M), above which all rigidities are allowed, the Stormer cutoff P(S), below which all rigidities are forbidden, and an effective cutoff rigidity, PC which we have defined as

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37. Smart, D.F., and Shea, M.A. (1972) Daily variation of electron and proton geomagnetic cutoffs calculated for Fort Churchill, Canada, J. Geophys. Res. 77:4595.

38. Shea, M.A., and Smart, D.F. (1971) Calculation of the magnitude of the daily variation of vertical cutoff rigidities and associated changes in the neutron monitor response for selected North American neutron monitors, 12th International Cosmic Ray Conf., Hobart, Conference Papers (University of Tasmania) 3:854.

$$PC = P(M) - \int_{P(S)}^{P(M)} dP \text{ allowed}$$

thus allowing for the opacity of the penumbra. A detailed definition of these effective cutoffs has been published,[8] and the effect of different spectral slopes and coupling functions has been investigated by Dorman et al.[39] All calculations extending from well above to well below the penumbra were made at discrete 0.01 GV intervals in an effort to define the structure within the penumbral region.

There is an inherent hazard in using the trajectory-tracing method to determine the structure within the penumbra in that some of the allowed rigidities may not be found due to a systematic limitation resulting from performing the trajectory calculations at discrete rigidity intervals. In our work we have made the specific assumption that if a trajectory is accessible (or forbidden) at a rigidity P_i, then this result is applicable over the interval between $P_i \pm \frac{\Delta P}{2}$ (where ΔP is the size of the rigidity interval). However, we recognize that the penumbra consists of a very complex structure of allowed and forbidden bands, and this structure is most certainly finer than the 0.01 GV intervals employed. Consequently, calculations down the rigidity spectrum at finite discrete intervals might miss some of the allowed rigidities for a specific location and direction. This problem has been discussed in detail by Shea et al[8] in which the effective cutoff rigidity was calculated using intervals of various sizes extending from rigidity intervals 0.1 to 0.01 GV. The results showed that while doubling the 0.01 GV intervals yields essentially the same effective cutoff rigidity (within 1 percent) a further expansion of the interval does not give the same consistency. Based on these results we have considered that the 0.01 GV intervals were adequate for the determination of the effective cutoff rigidity.

It is difficult to be assured that the lowest possible rigidity which may be allowed for a given location at a specific direction (that is, the Stormer cutoff value) has been precisely determined. We have found that for complex penumbra extending the calculations to lower rigidities at smaller rigidity intervals often results in "one or more allowed rigidity" below the previous last allowed rigidity. For a number of cosmic-ray applications, the determination of the last allowed rigidity would not present a serious problem; however, it is necessary for some experimenters in the analysis of their data. This problem and the degree of

39. Dorman, L.I., Gushchina, R.T., Shea, M.A., and Smart, D.F. (1972) Cosmic Rays Effective Cutoff Rigidities, Publishing House NAUKA, Moscow, USSR.

confidence to which we feel we have located the lowest possible allowed rigidity is discussed in detail by Shea and Smart.[40,41]

3. CUTOFF RIGIDITY TABLES

3.1 Format of the Tables

Tables summarizing the cutoff rigidities calculated using the trajectory-tracing method are given in Appendices A through D. These values have been calculated utilizing the IGRF[31] with its time derivatives applied such that the coefficients are appropriate for each specific epoch. Since the IGRF was derived utilizing magnetic observations that could be confidently applied to 1965, the cutoff rigidities calculated for this epoch are as accurate as the trajectory-tracing procedure permits. The time derivatives of the geomagnetic field associated with the IGRF coefficients were derived from the changes in the geomagnetic field over the approximate period 1955 through 1967 (Cain, private communication[42]); consequently, when these time derivatives are applied for epochs between these time periods, the resulting coefficients are relatively representative of the geomagnetic field for the selected epoch.

For epochs more recent than 1967 (such as 1970 and 1975) the geomagnetic field coefficients, as derived from the time derivatives, actually describe a "predicted" field and the cutoff rigidity calculations for these epochs are a predicted set of values. Magnetic field data obtained in the last decade have shown that the observed secular changes in the geomagnetic field were, in general, larger in the forward direction than those predicted using the IGRF time derivatives[43] derived in 1965. We feel, however, that the differences between these predicted cutoff rigidity values and the actual values that can be calculated using more recent magnetic field coefficients are relatively minor - certainly much smaller than the calculated changes in cutoff rigidities over a 10-year interval as noted in some regions of the world such as in the Caribbean and Atlantic Ocean areas.[44]

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40. Shea, M.A., and Smart, D.F. (1974) Tables of Asymptotic Directions, Cutoff Rigidities, and Reentrant Albedo Calculations for Palestine, Dallas, and Midland, Texas, Special Report No. 175, AFCRL-TR-74-0159, AD A005408.
41. Shea, M.A., and Smart, D.F. (1975) The evaluation of cutoff rigidities and reentrant albedo calculations for Palestine, Dallas, and Midland, Texas, J. Geophys. Res. 80:1202.
42. Cain, J.C. (1973) Private communication.
43. Regan, R.D., and Cain, J.C. (1975) The use of geomagnetic field models in magnetic surveys, Geophysics 40:621.
44. Shea, M.A., and Smart, D.F. (1975) A five by fifteen degree world grid of calculated and cosmic-ray vertical cutoff rigidities for 1965 and 1975, 14th International Cosmic Ray Conference, Conference Papers 4:1298.

The general format of the tables contained in Appendices A through D is identical for each of the tables of vertical cutoff rigidities and similar for cutoff rigidities calculated in non-vertical directions. Each location has been identified by a specific name or identifier that evolved in the course of this work and proved easy for us to utilize in our various analyses. This identification is followed by the geographic coordinates of each location together with the L value calculated using the same coefficients utilized in the trajectory-tracing program. All L values were calculated for an altitude consistent with the initializing of the trajectory-tracing technique.

For cutoff rigidities calculated in the non-vertical direction, the L value is followed by the zenith and azimuth angles for which the cutoff rigidity was calculated. The azimuth angles are measured in the clockwise direction with 0° toward geographic north, 90° toward geographic east, etc. Most of the azimuth angles are in the direction appropriate to geomagnetic north, east, south and west for each specific location, although occasionally additional azimuths are included. For completeness, the cutoff rigidity in the vertical direction, denoted by 0° zenith angle and 0° azimuth angle, is given for each location.

The remaining columns in each of the tables give the various cutoff rigidity values for each location in order of the main cutoff rigidity, P(M), the Stormer cutoff rigidity, P(S), the width of the penumbra, and the effective cutoff rigidity, PC*. All rigidities are in GV.

3.2 Arrangement of the Tables

The tables in Appendices A through C are listings of the rigidity values that are supplementary to those published in previous reports.[21-24,27-30] These appendices are ordered by the epoch for which the cosmic-ray cutoff rigidities are calculated. Table 1 summarizes the data sets in these appendices. Also given is the altitude for which the calculations were made, whether the values are for vertical or angular directions and the epoch of the magnetic field for which the cutoff rigidities were calculated.

Table A1 gives vertical and non-vertical cutoff rigidity values for Branson, Dallas, Midland, and Palestine, U.S.A. These locations are at or near locations from which cosmic-ray balloon experiments are frequently launched. These calculations were made using the 1965.0 Epoch of the geomagnetic field and for an altitude of 30 km. This increased altitude is more appropriate for balloon-borne

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*The abbreviations for the main cutoff rigidity, the Stormer cutoff rigidity, and the effective cutoff rigidity in this series of reports have been changed slightly to permit computerized headings in the tables. Earlier work used the abbreviations P_m, P_s, and P_c, for the main, Stormer, and effective cutoff rigidities, respectively.

detectors than the 20-km altitude customarily used for cosmic-ray neutron monitor locations.

Table 1. Summary of Data Sets Included in Appendices A Through C

Table No.	Locations	Directions*	Altitude (km)	Epoch
A1	Branson, USA Dallas, USA Midland, USA Palestine, USA	V, A V, A V, A V, A	30	1965.0
B1	Three Mexican Locations	V, A	30	1970.0
C1	Soviet Latitude Survey Locations	V	20	1975.0
C2	Miscellaneous Points	V	20	1975.0
C3	Cosmic-Ray Stations	V, A	20	1975.0
C4	Two World Grid Locations	V, A	20	1975.0
C5	South American Grid Locations	V	30	1975.0
C6	Locations Near Balloon Launching Sites	V	30	1975.0
C7	Cape Giradeau, USA Sioux Falls, USA Riyadh, Saudi Arabia	V, A	30	1975.0
C8	Cape Giradeau, USA	V, A	40	1975.0

*V = vertical, A = angular

Table B1 gives vertical and non-vertical cutoff rigidity values for three locations in Northern Mexico. These calculations were initially performed for use in the analysis of a balloon-borne cosmic-ray detector flown near the US-Mexican border. The geomagnetic field model used was formed by the IGRF coefficients with time derivatives appropriate for a 1970.0 Epoch. These values are for an altitude of 30 km.

The cutoff rigidity values in Appendix C were all calculated using the geomagnetic field model formed by the IGRF coefficients with time derivatives appropriate for a 1975.0 Epoch. Table C1 lists vertical cutoff rigidity values for locations along the route of a Soviet cosmic-ray survey to Antarctica.[45,46] Figure 1 presents a map upon which solid circles denote the locations included in this table. Table C2 lists vertical cutoff rigidities for several miscellaneous locations as denoted by circles shown on the map in Figure 2. Table C3 gives vertical and angular cutoff rigidity values for selected neutron monitor locations. Most of these values were calculated for studies of the 7 May 1978 ground-level solar cosmic-ray event.[47,48] Table C4 lists vertical and angular cutoff rigidity values for 20°S, 150°E and 25°S, 195°E—both locations on the world grid of vertical cutoff rigidities.[44] All cutoff rigidity values for Tables C1 through C4 were calculated for an initial altitude of 20 km.

Table C5 presents a list of vertical cutoff rigidities for a grid 5° in latitude and 5° in longitude over Central and South America. Table C6 lists vertical cutoff rigidities for various locations at or near cosmic-ray balloon launching sites. The locations included in this table are indicated by circles in Figure 3. Table C7 lists vertical and angular cutoff rigidity values for Cape Giradeau, USA, Sioux Falls, USA, and Riyadh, Saudi Arabia. All cutoff rigidity values for Tables C5 through C7 were calculated for an initial altitude of 30 km.

Table C8 lists vertical and angular cutoff rigidities calculated for an altitude of 40 km for Cape Giradeau, USA. Caution should be applied in comparing the different cutoff rigidity values for Cape Giradeau for 30- and 40-km altitude. Although these values would be expected to decrease slightly with increasing altitude, there are a few directions where small increases are noted. These increases are primarily from changes in the penumbra structure where a slight change in orbit can change a trajectory from "allowed" to "re-entrant" and vice-versa.

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45. Golenkov, A.E., Okhlopkov, V.P., Svirzhevsky, N.S., Svirzhevskaya, A.K., and Stozhkov, Yu.I. (1977) Latitude measurements of cosmic ray intensity in the stratosphere during the solar minimum in 1975-1976, 15th International Cosmic Ray Conference, Conference Papers 4:229.

46. Shea, M.A., Smart, D.F., Stozhkov, Yu.I., Svirzhevsky, N.S., Svirzhevskaya, A.K., Bazilevskaya, G.A., and Charackchyan, T.N. (1981) Analysis of cosmic ray intensity data and trajectory calculated vertical cutoff rigidities for the latitude survey made during the 22nd Soviet Antarctic expedition, 17th International Cosmic Ray Conference, Conference Papers 4:213.

47. Shea, M.A., Smart, D.F., Tanskanen, P.J., and Humble, J.E. (1979) Neutron monitor response to non-vertical arrival directions during GLE's, 16th International Cosmic Ray Conference, Conference Papers 12:249.

48. Shea, M.A., and Smart, D.F. (1982) Possible evidence for a rigidity-dependent release of relativistic protons from the solar corona, Space Sci. Rev. 32:251.

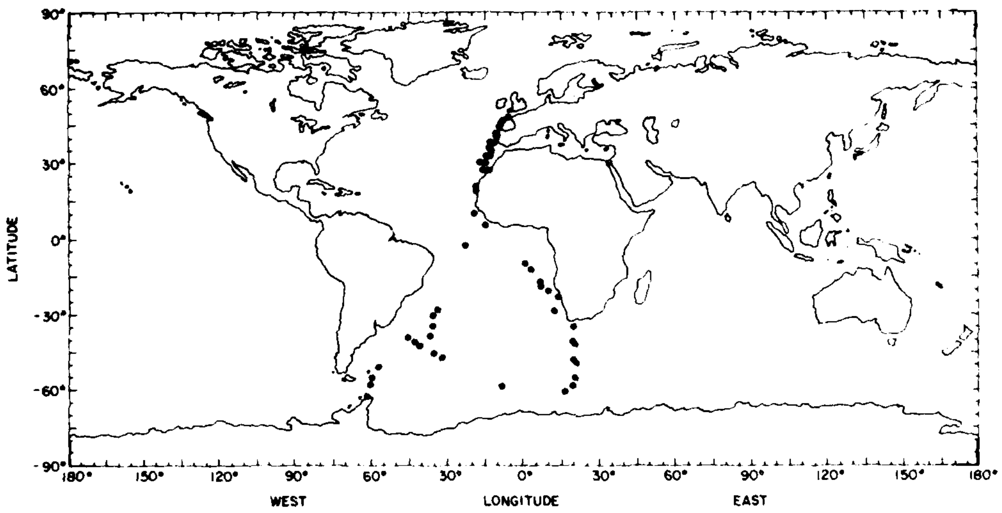

Figure 1. World Map Illustrating Specific Locations Along the Route of a Soviet Cosmic-Ray Survey to Antarctica for Which Vertical Cutoff Rigidities Have Been Calculated Utilizing the International Geomagnetic Reference Field Coefficients Appropriate for a 1975.0 Epoch

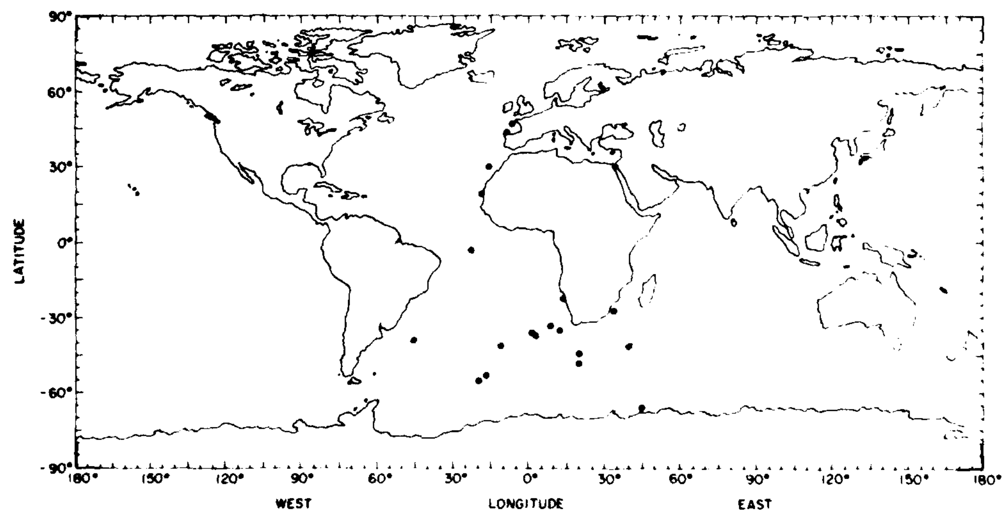

Figure 2. World Map Illustrating Miscellaneous Locations for Which Vertical Cutoff Rigidities Have Been Calculated Utilizing the International Geomagnetic Reference Field Coefficients Appropriate for a 1975.0 Epoch

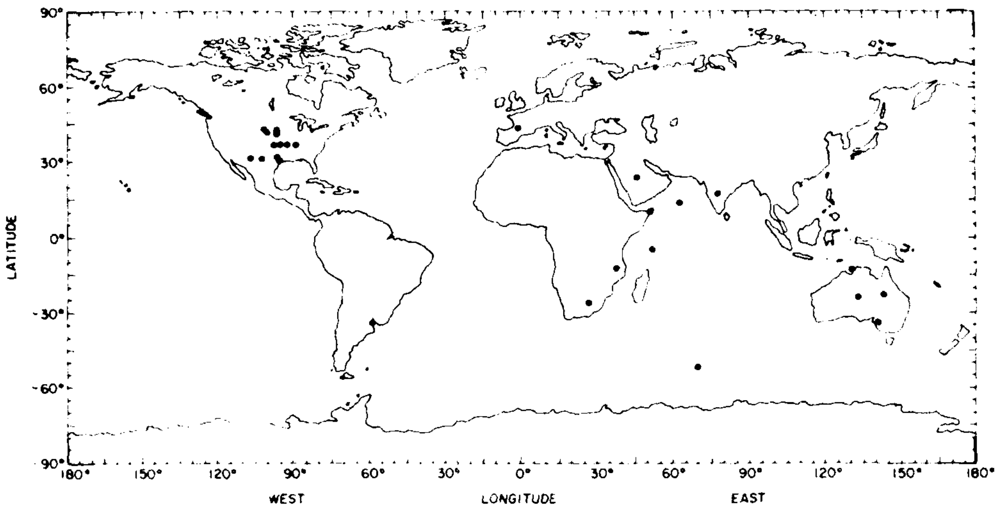

Figure 3. World Map Illustrating Locations at or Near Cosmic-Ray Balloon Launching Sites for Which Vertical Cutoff Rigidities Have Been Calculated Utilizing the International Geomagnetic Reference Field Coefficients Appropriate for a 1975.0 Epoch

Tables D1 and D2 list vertical cutoff rigidities for San Jose dos Campos, Brazil for Epoch 1965.0 and for five locations for Epoch 1975.0, respectively. These are additional locations for which these calculations were performed after publication of the previous tables.[30] These calculations were made for an altitude of 20 km using the IGRF for Epoch 1965 and this same field with time derivatives applied such that the coefficients were appropriate for Epoch 1975.

Finally, Table E1 lists corrections we have found to our previously published tables. The rigidity value to be corrected, the originally published value, the correct value, and the reference and page number within the reference where the value was originally published is listed for ease in identifying the changes.

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Appendix A

Table of Cutoff Rigidities Calculated Using the International Geomagnetic Reference Field Model for Epoch 1965.0

Table A1 summarizes the cutoff rigidity values for Branson, Dallas, Midland, and Palestine, USA with these values having been calculated by the trajectory-tracing method utilizing the International Geomagnetic Reference Field[A1] model for Epoch 1965.0. The calculations were made for an altitude of 30 km.

The format of this table is as follows:

Identification:	Each location has been identified with a specific name or identifier.
Geographic Location:	The geographic coordinates of each location are given with the latitude as positive for the northern hemisphere and the longitude in degrees E of Greenwich.
L Value:	The L value, in earth radii, calculated using the same geomagnetic field coefficients as utilized in the cutoff rigidity calculations.
Zenith Angle:	The angle (in degrees) from the zenith for which the cutoff calculation has been made.
Azimuth Angle:	The azimuth angle (in degrees) for which the cutoff calculation has been made. All azimuth angles are measured clockwise from the geographic north (that is, 0^o = geographic north, 90^o = geographic east, etc.)

A1. IAGA Commission 2, Working Group 4 (1969) International Geomagetic Field 1965.0, J. Geophys. Res. 74:4407.

P(M):	The main cutoff rigidity (in GV) for this location in the specified direction.
P(S):	The Stormer cutoff rigidity (in GV) for this location in the specified direction.
Penumbral Width:	The difference between the main cutoff rigidity and the Stormer cutoff rigidity (in GV).
PC:	The effective cutoff rigidity (in GV) for this location in the specified direction.

This table and the values contained therein are described in the text of this report.

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
			BRANSON, USA						
BRANSON, USA	36.63	266.67	2.2271	0	0	3.15	2.58	0.57	2.97
BRANSON, USA	36.63	266.67	2.2271	16	7	3.01	2.65	0.36	2.87
BRANSON, USA	36.63	266.67	2.2271	16	97	3.32	2.76	0.56	3.15
BRANSON, USA	36.63	266.67	2.2271	16	187	3.14	2.70	0.44	2.96
BRANSON, USA	36.63	266.67	2.2271	16	277	3.04	2.56	0.48	2.81
BRANSON, USA	36.63	266.67	2.2271	32	7	3.13	2.69	0.44	2.95
BRANSON, USA	36.63	266.67	2.2271	32	97	3.49	3.08	0.41	3.22
BRANSON, USA	36.63	266.67	2.2271	32	187	3.15	2.63	0.52	2.98
BRANSON, USA	36.63	266.67	2.2271	32	277	2.93	2.58	0.35	2.73
BRANSON, USA	36.63	266.67	2.2271	48	7	3.10	2.67	0.43	2.88
BRANSON, USA	36.63	266.67	2.2271	48	97	3.62	2.91	0.71	3.35
BRANSON, USA	36.63	266.67	2.2271	48	187	3.14	2.69	0.45	3.04
BRANSON, USA	36.63	266.67	2.2271	48	277	2.78	2.43	0.35	2.71
			DALLAS, USA						
DALLAS, USA	32.78	263.20	1.8790	0	0	4.49	3.62	0.87	4.22
DALLAS, USA	32.78	263.20	1.8790	5	7	4.49	3.62	0.87	4.24
DALLAS, USA	32.78	263.20	1.8790	5	97	4.57	3.72	0.85	4.27
DALLAS, USA	32.78	263.20	1.8790	5	187	4.48	4.02	0.46	4.28
DALLAS, USA	32.78	263.20	1.8790	5	277	4.41	3.98	0.43	4.20
DALLAS, USA	32.78	263.20	1.8790	10	7	4.49	3.39	1.10	4.27
DALLAS, USA	32.78	263.20	1.8790	10	97	4.66	4.19	0.47	4.45
DALLAS, USA	32.78	263.20	1.8790	10	187	4.47	3.63	0.84	4.27
DALLAS, USA	32.78	263.20	1.8790	10	277	4.34	3.86	0.48	4.12
DALLAS, USA	32.78	263.20	1.8790	15	7	4.46	3.62	0.84	4.30
DALLAS, USA	32.78	263.20	1.8790	15	97	4.75	4.21	0.54	4.48
DALLAS, USA	32.78	263.20	1.8790	15	187	4.49	4.05	0.44	4.23
DALLAS, USA	32.78	263.20	1.8790	15	277	4.28	3.85	0.43	4.13
DALLAS, USA	32.78	263.20	1.8790	20	7	4.39	3.61	0.78	4.31
DALLAS, USA	32.78	263.20	1.8790	20	97	4.85	3.82	1.03	4.65
DALLAS, USA	32.78	263.20	1.8790	20	187	4.44	3.74	0.70	4.29
DALLAS, USA	32.78	263.20	1.8790	20	277	4.21	3.67	0.54	3.93
DALLAS, USA	32.78	263.20	1.8790	25	7	4.38	3.66	0.72	4.13
DALLAS, USA	32.78	263.20	1.8790	25	97	4.95	4.34	0.61	4.66
DALLAS, USA	32.78	263.20	1.8790	25	187	4.43	3.70	0.73	4.26
DALLAS, USA	32.78	263.20	1.8790	25	277	4.15	3.72	0.43	3.99
DALLAS, USA	32.78	263.20	1.8790	30	7	4.34	3.72	0.62	4.11
DALLAS, USA	32.78	263.20	1.8790	30	97	5.06	4.04	1.02	4.79
DALLAS, USA	32.78	263.20	1.8790	30	187	4.42	3.90	0.52	4.30
DALLAS, USA	32.78	263.20	1.8790	30	277	4.09	3.35	0.74	3.92
DALLAS, USA	32.78	263.20	1.8790	35	7	4.27	3.59	0.68	4.05

[illegible] Summary of Vertical and Angular [illegible] Rigidities for [illegible] Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for [illegible] Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
DALLAS, USA	32.78	263.20	1.8790	35	97	5.16	4.02	1.14	4.91
DALLAS, USA	32.78	263.20	1.8790	35	187	4.40	3.91	0.49	4.32
DALLAS, USA	32.78	263.20	1.8790	35	277	4.00	3.38	0.62	3.95
DALLAS, USA	32.78	263.20	1.8790	40	7	4.28	3.70	0.58	3.99
DALLAS, USA	32.78	263.20	1.8790	40	97	5.27	4.33	0.94	5.14
DALLAS, USA	32.78	263.20	1.8790	40	187	4.52	3.79	0.73	4.29
DALLAS, USA	32.78	263.20	1.8790	40	277	3.88	3.24	0.64	3.83
DALLAS, USA	32.78	263.20	1.8790	45	7	4.28	3.82	0.46	4.01
DALLAS, USA	32.78	263.20	1.8790	45	97	5.45	4.17	1.28	5.30
DALLAS, USA	32.78	263.20	1.8790	45	187	4.50	3.89	0.61	4.29
DALLAS, USA	32.78	263.20	1.8790	45	277	3.96	3.44	0.52	3.75
DALLAS, USA	32.78	263.20	1.8790	50	7	4.38	3.54	0.84	3.96
DALLAS, USA	32.78	263.20	1.8790	50	97	5.41	4.23	1.18	5.32
DALLAS, USA	32.78	263.20	1.8790	50	187	4.43	3.49	0.94	4.25
DALLAS, USA	32.78	263.20	1.8790	50	277	3.82	3.34	0.48	3.65
DALLAS, USA	32.78	263.20	1.8790	55	7	4.34	3.70	0.64	4.20
DALLAS, USA	32.78	263.20	1.8790	55	97	5.81	4.32	1.49	5.26
DALLAS, USA	32.78	263.20	1.8790	55	187	4.47	3.85	0.62	4.21
DALLAS, USA	32.78	263.20	1.8790	55	277	3.76	3.20	0.56	3.57
DALLAS, USA	32.78	263.20	1.8790	60	7	4.29	3.64	0.65	4.09
DALLAS, USA	32.78	263.20	1.8790	60	97	5.77	4.26	1.51	5.09
DALLAS, USA	32.78	263.20	1.8790	60	187	4.37	3.88	0.49	4.24
DALLAS, USA	32.78	263.20	1.8790	60	277	3.69	3.39	0.30	3.54
DALLAS, USA	32.78	263.20	1.8790	65	7	4.12	3.76	0.36	4.01
DALLAS, USA	32.78	263.20	1.8790	65	97	5.30	4.54	0.76	5.03
DALLAS, USA	32.78	263.20	1.8790	65	187	4.47	3.89	0.58	4.25
DALLAS, USA	32.78	263.20	1.8790	65	277	3.72	3.35	0.37	3.47
DALLAS, USA	32.78	263.20	1.8790	70	7	5.88	5.88	0.00	5.88
DALLAS, USA	32.78	263.20	1.8790	70	97	5.27	4.28	0.99	4.94
DALLAS, USA	32.78	263.20	1.8790	70	187	4.49	3.93	0.56	4.25
DALLAS, USA	32.78	263.20	1.8790	70	277	3.77	3.32	0.45	3.54
DALLAS, USA	32.78	263.20	1.8790	75	7	8.70	8.70	0.00	8.70
DALLAS, USA	32.78	263.20	1.8790	75	97	6.06	6.06	0.00	6.06
DALLAS, USA	32.78	263.20	1.8790	75	187	4.45	4.01	0.44	4.24
DALLAS, USA	32.78	263.20	1.8790	75	277	3.76	3.63	0.13	3.66
DALLAS, USA	32.78	263.20	1.8790	80	7	11.72	11.72	0.00	11.72
DALLAS, USA	32.78	263.20	1.8790	80	97	14.89	14.89	0.00	14.89
DALLAS, USA	32.78	263.20	1.8790	80	187	4.50	4.02	0.48	4.24
DALLAS, USA	32.78	263.20	1.8790	80	277	3.80	3.16	0.64	3.64
DALLAS, USA	32.78	263.20	1.8790	85	7	15.20	15.20	0.00	15.20
DALLAS, USA	32.78	263.20	1.8790	85	97	24.61	24.61	0.00	24.61
DALLAS, USA	32.78	263.20	1.8790	85	187	4.61	3.83	0.78	4.26
DALLAS, USA	32.78	263.20	1.8790	85	277	3.81	3.22	0.59	3.70
DALLAS, USA	32.78	263.20	1.8790	90	7	19.55	19.55	0.00	19.55
DALLAS, USA	32.78	263.20	1.8790	90	97	39.41	39.41	0.00	39.41
DALLAS, USA	32.78	263.20	1.8790	90	187	4.64	3.70	0.94	4.34
DALLAS, USA	32.78	263.20	1.8790	90	277	3.65	3.28	0.37	3.52

Table A1. ... Vertical and Angular Cutoff Rigidities for Selected Locations Near ... Balloon Launching Sites as Calculated for 20-km Altitude ... the ... Geomagnetic Field Model (Contd)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.63	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.765[illegible]	[illegible]	188	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	278	[illegible]	[illegible]	[illegible]	4.75
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	5.12
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	188	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	15	98	[illegible]	[illegible]	0.58	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	188	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	20	8	[illegible]	[illegible]	[illegible]	5.29
[illegible]	[illegible]	25[illegible]	1.7651	20	188	[illegible]	[illegible]	0.67	[illegible]
[illegible]	[illegible]	25[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.72	[illegible]
[illegible]	[illegible]	[illegible]	1.7651	25	[illegible]	[illegible]	[illegible]	0.83	[illegible]
[illegible]	[illegible]	[illegible]	1.7651	25	98	[illegible]	4.36	0.82	5.46
[illegible]	[illegible]	257.[illegible]	[illegible]	25	188	5.04	[illegible]	0.41	4.96
MIDLAND, USA	[illegible]	[illegible]	1.7651	25	278	[illegible]	4.15	0.52	4.49
[illegible]	[illegible]	[illegible]	1.7651	30	8	[illegible]	4.34	0.79	4.89
[illegible]	[illegible]	257.[illegible]	1.7651	30	98	[illegible]	4.69	1.10	5.51
[illegible], USA	[illegible]	257.85	1.7651	30	188	5.07	4.61	0.46	5.04
[illegible]	[illegible]	[illegible]	1.7651	30	278	4.62	3.8?	0.75	4.31
[illegible]	32.00	[illegible]	1.7651	35	8	[illegible]	4.31	0.?2	5.10
[illegible]	32.00	257.85	1.7651	35	98	5.94	5.00	0.94	5.66
MIDLAND, USA	32.00	257.85	1.7651	35	188	5.07	4.22	0.85	5.00
MIDLAND, USA	32.00	257.85	1.7651	35	278	4.58	3.74	0.84	4.35
MIDLAND, USA	32.00	257.85	1.7651	40	8	5.17	4.16	1.01	4.79
MIDLAND, USA	32.00	257.85	1.7651	40	98	6.10	4.97	1.13	5.83
MIDLAND, USA	32.00	257.85	1.7651	40	188	5.08	4.59	0.49	5.04
MIDLAND, USA	32.00	257.85	1.7651	40	278	4.54	3.86	0.68	4.28
MIDLAND, USA	32.00	257.85	1.7651	45	8	4.81	4.25	0.56	4.61
MIDLAND, USA	32.00	257.85	1.7651	45	98	6.27	5.33	0.94	6.00
MIDLAND, USA	32.00	257.85	1.7651	45	188	5.09	4.35	0.74	5.04
MIDLAND, USA	32.00	257.85	1.7651	45	278	4.48	3.97	0.51	4.27
MIDLAND, USA	32.00	257.85	1.7651	50	8	4.79	4.32	0.47	4.58
MIDLAND, USA	32.00	257.85	1.7651	50	98	6.44	5.35	1.09	6.16
MIDLAND, USA	32.00	257.85	1.7651	50	188	5.28	4.55	0.73	5.06
MIDLAND, USA	32.00	257.85	1.7651	50	278	4.45	3.85	0.60	4.35
MIDLAND, USA	32.00	257.85	1.7651	55	8	4.88	4.33	0.55	4.54
MIDLAND, USA	32.00	257.85	1.7651	55	98	6.48	6.15	0.33	6.26
MIDLAND, USA	32.00	257.85	1.7651	55	188	5.28	4.55	0.73	5.07
MIDLAND, USA	32.00	257.85	1.7651	55	278	4.45	3.75	0.70	4.35
MIDLAND, USA	32.00	257.85	1.7651	60	8	4.96	4.38	0.58	4.56
MIDLAND, USA	32.00	257.85	1.7651	60	98	6.59	4.96	1.63	6.12

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
MIDLAND, USA	32.00	257.85	1.7651	60	188	5.26	4.53	0.73	5.03
MIDLAND, USA	32.00	257.85	1.7651	60	278	4.50	3.88	0.62	4.15
MIDLAND, USA	32.00	257.85	1.7651	65	8	5.02	4.28	0.74	4.76
MIDLAND, USA	32.00	257.85	1.7651	65	98	6.82	5.21	1.61	6.36
MIDLAND, USA	32.00	257.85	1.7651	65	188	5.21	4.51	0.70	4.98
MIDLAND, USA	32.00	257.85	1.7651	65	278	4.19	3.66	0.53	4.03
MIDLAND, USA	32.00	257.85	1.7651	70	8	6.93	6.93	0.00	6.93
MIDLAND, USA	32.00	257.85	1.7651	70	98	6.67	6.63	0.04	6.65
MIDLAND, USA	32.00	257.85	1.7651	70	188	5.14	4.30	0.84	4.91
MIDLAND, USA	32.00	257.85	1.7651	70	278	4.09	3.70	0.39	3.96
MIDLAND, USA	32.00	257.85	1.7651	75	8	9.62	9.62	0.00	9.62
MIDLAND, USA	32.00	257.85	1.7651	75	98	9.76	9.74	0.02	9.75
MIDLAND, USA	32.00	257.85	1.7651	75	188	5.05	4.14	0.91	4.89
MIDLAND, USA	32.00	257.85	1.7651	75	278	4.08	3.49	0.59	3.92
MIDLAND, USA	32.00	257.85	1.7651	80	8	12.52	12.52	0.00	12.52
MIDLAND, USA	32.00	257.85	1.7651	80	98	17.89	17.89	0.00	17.89
MIDLAND, USA	32.00	257.85	1.7651	80	188	5.02	4.21	0.81	4.84
MIDLAND, USA	32.00	257.85	1.7651	80	278	4.11	3.74	0.37	3.95
MIDLAND, USA	32.00	257.85	1.7651	85	8	15.86	15.86	0.00	15.86
MIDLAND, USA	32.00	257.85	1.7651	85	98	27.51	27.51	0.00	27.51
MIDLAND, USA	32.00	257.85	1.7651	85	188	5.00	4.28	0.72	4.86
MIDLAND, USA	32.00	257.85	1.7651	85	278	4.20	3.50	0.70	3.95
MIDLAND, USA	32.00	257.85	1.7651	90	8	19.96	19.96	0.00	19.96
MIDLAND, USA	32.00	257.85	1.7651	90	98	42.20	42.18	0.02	42.19
MIDLAND, USA	32.00	257.85	1.7651	90	188	5.04	4.31	0.73	4.86
MIDLAND, USA	32.00	257.85	1.7651	90	278	4.12	3.53	0.59	3.88
				PALESTINE, USA					
PALESTINE, USA	31.75	264.35	1.8272	0	0	4.72	4.38	0.34	4.48
PALESTINE, USA	31.75	264.35	1.8272	5	7	4.74	3.93	0.81	4.46
PALESTINE, USA	31.75	264.35	1.8272	5	37	4.78	3.99	0.79	4.49
PALESTINE, USA	31.75	264.35	1.8272	5	67	4.81	3.89	0.92	4.52
PALESTINE, USA	31.75	264.35	1.8272	5	97	4.51	4.43	0.38	4.57
PALESTINE, USA	31.75	264.35	1.8272	5	127	4.86	3.91	0.95	4.57
PALESTINE, USA	31.75	264.35	1.8272	5	157	4.75	4.06	0.69	4.48
PALESTINE, USA	31.75	264.35	1.8272	5	187	4.71	4.05	0.66	4.49
PALESTINE, USA	31.75	264.35	1.8272	5	217	4.67	3.80	0.87	4.46
PALESTINE, USA	31.75	264.35	1.8272	5	247	4.64	4.14	0.50	4.43
PALESTINE, USA	31.75	264.35	1.8272	5	277	4.64	3.79	0.85	4.40
PALESTINE, USA	31.75	264.35	1.8272	5	307	4.66	3.91	0.75	4.39
PALESTINE, USA	31.75	264.35	1.8272	5	337	4.69	3.73	0.96	4.40
PALESTINE, USA	31.75	264.35	1.8272	10	7	4.66	4.25	0.41	4.38
PALESTINE, USA	31.75	264.35	1.8272	10	37	4.74	3.79	0.95	4.46
PALESTINE, USA	31.75	264.35	1.8272	10	67	4.74	4.48	0.26	4.57
PALESTINE, USA	31.75	264.35	1.8272	10	97	4.91	3.97	0.94	4.67
PALESTINE, USA	31.75	264.35	1.8272	10	127	4.87	4.27	0.60	4.62
PALESTINE, USA	31.75	264.35	1.8272	10	157	4.79	4.00	0.79	4.53
PALESTINE, USA	31.75	264.35	1.8272	10	187	4.75	3.88	0.87	4.50
PALESTINE, USA	31.75	264.35	1.8272	10	217	4.61	4.01	0.60	4.44
PALESTINE, USA	31.75	264.35	1.8272	10	247	[illegible]	3.85	[illegible]	[illegible]

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	PENUMBRAL P(S)	WIDTH	P(C)
PALESTINE, USA	31.75	264.35	1.8272	10	277	[illegible]	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	10	307	4.59	3.65	0.94	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	10	337	4.61	4.24	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	7	4.64	4.08	0.56	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	37	4.73	[illegible]	0.76	4.50
PALESTINE, USA	31.75	264.35	1.8272	15	67	4.90	4.55	0.35	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	97	5.01	[illegible]	0.63	4.72
PALESTINE, USA	31.75	264.35	1.8272	15	127	4.96	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	157	[illegible]	4.03	0.94	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	187	[illegible]	4.05	0.63	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	217	4.56	[illegible]	0.71	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	247	[illegible]	[illegible]	0.67	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	277	[illegible]	[illegible]	0.65	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	307	[illegible]	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	15	337	[illegible]	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	7	[illegible]	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	37	[illegible]	[illegible]	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	67	[illegible]	4.50	0.51	4.66
PALESTINE, USA	31.75	264.35	1.8272	20	97	[illegible]	4.34	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	127	[illegible]	[illegible]	1.00	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	157	[illegible]	[illegible]	[illegible]	4.70
PALESTINE, USA	31.75	264.35	1.8272	20	187	4.67	4.16	0.51	4.50
PALESTINE, USA	31.75	264.35	1.8272	20	217	4.51	[illegible]	0.53	4.31
PALESTINE, USA	31.75	264.35	1.8272	20	247	4.44	3.73	0.71	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	20	277	4.44	3.76	0.69	4.16
PALESTINE, USA	31.75	264.35	1.8272	20	307	[illegible]	3.62	0.80	4.16
PALESTINE, USA	31.75	264.35	1.8272	20	337	[illegible]	3.71	0.71	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	7	[illegible]	4.05	0.66	4.61
PALESTINE, USA	31.75	264.35	1.8272	25	37	5.01	[illegible]	1.02	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	67	5.12	4.40	0.72	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	97	5.24	4.42	0.82	4.91
PALESTINE, USA	31.75	264.35	1.8272	25	127	5.15	4.20	0.96	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	157	4.94	4.06	0.89	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	187	4.67	3.95	0.72	4.53
PALESTINE, USA	31.75	264.35	1.8272	25	217	4.52	3.82	0.70	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	247	[illegible]	3.77	0.62	4.18
PALESTINE, USA	31.75	264.35	1.8272	25	277	4.29	3.76	0.53	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	307	4.36	[illegible]	0.58	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	25	337	4.51	3.47	1.04	4.41
PALESTINE, USA	31.75	264.35	1.8272	30	7	4.62	4.09	0.53	4.54
PALESTINE, USA	31.75	264.35	1.8272	30	37	5.04	4.19	0.85	4.91
PALESTINE, USA	31.75	264.35	1.8272	30	67	5.20	4.50	0.70	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	30	97	5.26	4.85	0.41	4.96
PALESTINE, USA	31.75	264.35	1.8272	30	127	5.26	4.24	1.02	4.97
PALESTINE, USA	31.75	264.35	1.8272	30	157	5.00	4.05	0.95	4.91
PALESTINE, USA	31.75	264.35	1.8272	30	187	4.70	3.92	0.78	4.52
PALESTINE, USA	31.75	264.35	1.8272	30	217	4.43	3.84	0.59	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	30	247	4.35	3.73	0.62	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	30	277	4.34	3.87	0.47	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	30	307	4.33	3.63	0.70	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	30	337	4.42	3.61	[illegible]	[illegible]

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	P(C)
PALESTINE, USA	31.75	264.35	1.8272	35	7	4.65	3.77	0.88	4.41
PALESTINE, USA	31.75	264.35	1.8272	35	37	4.90	4.03	0.87	4.82
PALESTINE, USA	31.75	264.35	1.8272	35	67	[illegible]	4.08	1.19	4.43
PALESTINE, USA	31.75	264.35	1.8272	35	97	5.40	4.85	0.85	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	127	[illegible]	4.42	0.95	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	157	5.00	4.10	0.90	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	187	4.69	4.15	0.54	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	217	[illegible]	3.84	0.55	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	247	[illegible]	3.65	1.06	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	277	[illegible]	3.69	0.51	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	307	4.18	[illegible]	0.45	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	35	337	4.33	3.74	0.64	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	40	7	4.49	[illegible]	0.61	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	40	37	4.85	4.38	[illegible]	4.67
PALESTINE, USA	31.75	264.35	1.8272	40	67	5.36	4.16	1.20	5.06
PALESTINE, USA	31.75	264.35	1.8272	40	97	5.46	4.40	1.06	5.06
PALESTINE, USA	31.75	264.35	1.8272	40	127	5.49	4.35	1.14	5.14
PALESTINE, USA	31.75	264.35	1.8272	40	157	5.15	4.50	0.65	4.96
PALESTINE, USA	31.75	264.35	1.8272	40	187	4.64	4.06	0.58	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	40	217	4.46	3.82	0.64	4.16
PALESTINE, USA	31.75	264.35	1.8272	40	247	4.26	3.70	0.58	4.09
PALESTINE, USA	31.75	264.35	1.8272	40	277	4.20	3.82	0.56	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	40	307	4.22	3.58	0.64	3.96
PALESTINE, USA	31.75	264.35	1.8272	40	337	4.24	3.55	0.69	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	7	4.49	3.96	0.53	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	37	[illegible]	4.11	0.71	4.84
PALESTINE, USA	31.75	264.35	1.8272	45	67	5.47	4.31	1.16	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	97	5.72	4.65	1.07	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	127	5.60	4.94	0.66	5.18
PALESTINE, USA	31.75	264.35	1.8272	45	157	5.28	4.27	1.01	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	187	4.71	3.94	0.77	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	217	4.34	3.83	0.51	4.16
PALESTINE, USA	31.75	264.35	1.8272	45	247	4.25	3.67	0.58	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	277	4.13	3.34	0.79	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	45	307	4.06	3.48	0.55	3.84
PALESTINE, USA	31.75	264.35	1.8272	45	337	4.23	3.70	0.41	3.94
PALESTINE, USA	31.75	264.35	1.8272	50	7	4.51	4.04	1.47	4.24
PALESTINE, USA	31.75	264.35	1.8272	50	37	4.83	4.06	0.77	4.57
PALESTINE, USA	31.75	264.35	1.8272	50	67	5.62	4.67	1.00	5.29
PALESTINE, USA	31.75	264.35	1.8272	50	97	5.87	4.57	1.29	5.51
PALESTINE, USA	31.75	264.35	1.8272	50	127	5.57	4.35	1.32	5.20
PALESTINE, USA	31.75	264.35	1.8272	50	157	5.25	4.14	1.11	5.09
PALESTINE, USA	31.75	264.35	1.8272	50	187	4.77	3.75	1.02	4.53
PALESTINE, USA	31.75	264.35	1.8272	50	217	4.33	3.83	0.50	4.18
PALESTINE, USA	31.75	264.35	1.8272	50	247	4.12	3.45	0.67	3.94
PALESTINE, USA	31.75	264.35	1.8272	50	277	3.97	3.47	0.50	3.91
PALESTINE, USA	31.75	264.35	1.8272	50	307	4.02	3.41	0.61	3.81

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
PALESTINE, USA	31.75	264.35	1.8272	50	337	4.28	3.79	0.49	3.95
PALESTINE, USA	31.75	264.35	1.8272	55	7	4.63	4.07	0.56	4.23
PALESTINE, USA	31.75	264.35	1.8272	55	37	4.90	4.32	0.58	4.59
PALESTINE, USA	31.75	264.35	1.8272	55	67	5.56	4.43	1.13	5.08
PALESTINE, USA	31.75	264.35	1.8272	55	97	5.94	4.21	1.73	5.35
PALESTINE, USA	31.75	264.35	1.8272	55	127	5.65	4.75	0.90	5.34
PALESTINE, USA	31.75	264.35	1.8272	55	217	4.32	3.82	0.50	4.12
PALESTINE, USA	31.75	264.35	1.8272	55	247	4.18	3.80	0.38	3.94
PALESTINE, USA	31.75	264.35	1.8272	55	277	4.02	3.40	0.62	3.79
PALESTINE, USA	31.75	264.35	1.8272	55	307	3.98	3.45	0.53	3.76
PALESTINE, USA	31.75	264.35	1.8272	55	337	4.30	3.53	0.77	3.94
PALESTINE, USA	31.75	264.35	1.8272	60	7	4.59	4.00	0.59	4.45
PALESTINE, USA	31.75	264.35	1.8272	60	37	5.09	4.00	1.09	4.48
PALESTINE, USA	31.75	264.35	1.8272	60	67	5.27	4.56	0.71	4.98
PALESTINE, USA	31.75	264.35	1.8272	60	97	6.15	4.33	1.82	6.00
PALESTINE, USA	31.75	264.35	1.8272	60	127	5.76	4.73	1.03	5.51
PALESTINE, USA	31.75	264.35	1.8272	60	157	5.32	4.18	1.14	5.26
PALESTINE, USA	31.75	264.35	1.8272	60	187	4.71	4.28	0.43	4.54
PALESTINE, USA	31.75	264.35	1.8272	60	217	4.33	3.77	0.56	4.19
PALESTINE, USA	31.75	264.35	1.8272	60	247	4.14	3.62	0.52	3.9[illegible]
PALESTINE, USA	31.75	264.35	1.8272	60	277	3.91	3.49	0.42	[illegible]
PALESTINE, USA	31.75	264.35	1.8272	60	307	4.04	3.53	0.51	3.69
PALESTINE, USA	31.75	264.35	1.8272	60	337	4.30	3.48	0.82	4.[illegible]
PALESTINE, USA	31.75	264.35	1.8272	65	7	4.24	3.36	0.88	4.4[illegible]
PALESTINE, USA	31.75	264.35	1.8272	65	37	5.55	5.55	0.00	5.55
PALESTINE, USA	31.75	264.35	1.8272	65	67	5.36	4.51	0.85	5.01
PALESTINE, USA	31.75	264.35	1.8272	65	97	6.14	4.83	1.31	5.9[illegible]
PALESTINE, USA	31.75	264.35	1.8272	65	127	6.10	4.74	1.36	5.78
PALESTINE, USA	31.75	264.35	1.8272	65	157	5.29	4.26	1.03	5.22
PALESTINE, USA	31.75	264.35	1.8272	65	187	4.69	4.05	0.64	4.52
PALESTINE, USA	31.75	264.35	1.8272	65	217	4.35	3.80	0.55	4.11
PALESTINE, USA	31.75	264.35	1.8272	65	247	4.15	3.41	0.74	3.97
PALESTINE, USA	31.75	264.35	1.8272	65	277	3.83	3.42	0.41	3.66
PALESTINE, USA	31.75	264.35	1.8272	65	307	3.98	3.37	0.61	3.92
PALESTINE, USA	31.75	264.35	1.8272	65	337	4.25	3.59	0.66	4.0[illegible]
PALESTINE, USA	31.75	264.35	1.8272	70	7	6.42	6.42	0.00	6.42
PALESTINE, USA	31.75	264.35	1.8272	70	37	9.25	9.25	0.00	9.25
PALESTINE, USA	31.75	264.35	1.8272	70	67	8.59	8.59	0.00	8.59
PALESTINE, USA	31.75	264.35	1.8272	70	97	6.04	4.44	1.60	5.40
PALESTINE, USA	31.75	264.35	1.8272	70	127	6.16	4.61	1.55	6.05
PALESTINE, USA	31.75	264.35	1.8272	70	157	5.20	4.75	0.45	5.19
PALESTINE, USA	31.75	264.35	1.8272	70	187	4.68	3.93	0.75	4.39
PALESTINE, USA	31.75	264.35	1.8272	70	217	4.37	3.76	0.61	4.10
PALESTINE, USA	31.75	264.35	1.8272	70	247	4.07	3.45	0.62	4.0[illegible]
PALESTINE, USA	31.75	264.35	1.8272	70	277	3.87	3.56	0.31	3.66
PALESTINE, USA	31.75	264.35	1.8272	70	307	4.06	3.55	0.51	3.80
PALESTINE, USA	31.75	264.35	1.8272	70	337	4.14	3.69	0.45	3.90
PALESTINE, USA	31.75	264.35	1.8272	75	7	9.21	9.21	0.00	9.21
PALESTINE, USA	31.75	264.35	1.8272	75	37	13.10	13.10	0.00	13.10
PALESTINE, USA	31.75	264.35	1.8272	75	67	13.90	13.90	0.00	13.90

Table A1. Summary of Vertical and Angular Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1965.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
PALESTINE, USA	31.75	264.35	1.8272	75	97	7.13	7.13	0.00	7.13
PALESTINE, USA	31.75	264.35	1.8272	75	127	6.05	4.95	1.10	5.90
PALESTINE, USA	31.75	264.35	1.8272	75	157	5.41	4.22	1.19	5.05
PALESTINE, USA	31.75	264.35	1.8272	75	187	4.60	4.13	0.47	4.43
PALESTINE, USA	31.75	264.35	1.8272	75	217	4.40	3.71	0.69	4.17
PALESTINE, USA	31.75	264.35	1.8272	75	247	3.91	3.54	0.37	3.87
PALESTINE, USA	31.75	264.35	1.8272	75	277	3.93	3.39	0.54	3.62
PALESTINE, USA	31.75	264.35	1.8272	75	307	4.06	3.36	0.70	3.89
PALESTINE, USA	31.75	264.35	1.8272	75	337	4.28	4.28	0.00	4.28
PALESTINE, USA	31.75	264.35	1.8272	80	7	12.23	12.23	0.00	12.23
PALESTINE, USA	31.75	264.35	1.8272	80	37	17.52	17.52	0.00	17.52
PALESTINE, USA	31.75	264.35	1.8272	80	67	19.90	19.90	0.00	19.90
PALESTINE, USA	31.75	264.35	1.8272	80	97	15.64	15.64	0.00	15.64
PALESTINE, USA	31.75	264.35	1.8272	80	127	6.23	4.79	1.44	5.45
PALESTINE, USA	31.75	264.35	1.8272	80	157	5.25	4.45	0.80	5.00
PALESTINE, USA	31.75	264.35	1.8272	80	187	4.67	4.06	0.61	4.45
PALESTINE, USA	31.75	264.35	1.8272	80	217	4.41	4.14	0.27	4.21
PALESTINE, USA	31.75	264.35	1.8272	80	247	3.96	3.47	0.49	3.77
PALESTINE, USA	31.75	264.35	1.8272	80	277	3.85	3.69	0.16	3.81
PALESTINE, USA	31.75	264.35	1.8272	80	307	3.88	3.53	0.35	3.64
PALESTINE, USA	31.75	264.35	1.8272	80	337	6.48	6.48	0.00	6.48
PALESTINE, USA	31.75	264.35	1.8272	85	7	15.73	15.73	0.00	15.73
PALESTINE, USA	31.75	264.35	1.8272	85	37	23.00	23.00	0.00	23.00
PALESTINE, USA	31.75	264.35	1.8272	85	67	27.47	27.47	0.00	27.47
PALESTINE, USA	31.75	264.35	1.8272	85	97	25.28	25.28	0.00	25.28
PALESTINE, USA	31.75	264.35	1.8272	85	127	10.95	10.93	0.02	10.94
PALESTINE, USA	31.75	264.35	1.8272	85	157	5.16	4.54	0.62	4.96
PALESTINE, USA	31.75	264.35	1.8272	85	187	4.69	4.20	0.49	4.42
PALESTINE, USA	31.75	264.35	1.8272	85	217	4.40	3.60	0.80	4.10
PALESTINE, USA	31.75	264.35	1.8272	85	247	3.87	3.56	0.31	3.74
PALESTINE, USA	31.75	264.35	1.8272	85	277	3.80	3.47	0.33	3.73
PALESTINE, USA	31.75	264.35	1.8272	85	307	3.91	3.53	0.38	3.68
PALESTINE, USA	31.75	264.35	1.8272	85	337	8.73	8.73	0.00	8.73
PALESTINE, USA	31.75	264.35	1.8272	90	7	20.13	20.13	0.00	20.13
PALESTINE, USA	31.75	264.35	1.8272	90	37	30.71	30.71	0.00	30.71
PALESTINE, USA	31.75	264.35	1.8272	90	67	39.08	39.06	0.02	39.07
PALESTINE, USA	31.75	264.35	1.8272	90	97	40.12	40.12	0.00	40.12
PALESTINE, USA	31.75	264.35	1.8272	90	127	29.52	29.50	0.02	29.51
PALESTINE, USA	31.75	264.35	1.8272	90	157	5.18	4.62	0.56	4.87
PALESTINE, USA	31.75	264.35	1.8272	90	187	4.77	4.15	0.62	4.38
PALESTINE, USA	31.75	264.35	1.8272	90	217	4.42	3.96	0.46	4.21
PALESTINE, USA	31.75	264.35	1.8272	90	247	3.98	3.58	0.40	3.72
PALESTINE, USA	31.75	264.35	1.8272	90	277	3.95	3.41	0.54	3.87
PALESTINE, USA	31.75	264.35	1.8272	90	307	4.52	4.52	0.00	4.52
PALESTINE, USA	31.75	264.35	1.8272	90	337	11.22	11.22	0.00	11.22

Appendix B

Tables of Cutoff Rigidities Calculated Using the International Geomagnetic Reference Field Coefficients Appropriate for a 1970.0 Epoch

Table B1 summarizes the cutoff rigidity values for three locations in northern Mexico with these values having been calculated by the trajectory-tracing method utilizing the IGRF[B1] model with time derivatives applied such that the coefficients are appropriate for a 1970.0 Epoch. The calculations were made for an altitude of 30 km.

The format of this table is as follows:

Identification:	Each location has been identified with a specific name or identifier, in this case "Mexican Location".
Geographic Location:	The geographic coordinates of each location are given with the latitude as positive for the northern hemisphere and the longitude in degrees East of Greenwich.
L Value:	The L value, in earth radii, calculated using the same geomagnetic field coefficients as utilized in the cutoff rigidity calculations.
Zenith Angle:	The angle (in degrees) from the zenith for which the cutoff calculation has been made.

B1. IAGA Commission 2, Working Group 4 (1969) International Geomagnetic Field 1965.0, J. Geophys. Res. 74:4407.

MEXICAN LOCATION	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	1.71[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	1.7[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	1.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	[illegible]	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	1.661[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	31.00	252.00	1.6615	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	31.00	252.00	1.661[illegible]	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	252.00	1.6613	46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEXICAN LOCATION	[illegible]	[illegible]	1.661[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Appendix C

Tables of Cutoff Rigidities Calculated Using the International Geomagnetic Reference Field Coefficients Appropriate for a 1975.0 Epoch

The eight tables in this appendix summarize the cutoff rigidity values for a variety of locations on the earth, with these values having been calculated by the trajectory-tracing method utilizing the International Geomagnetic Reference Field[C1] model with time derivatives applied such that the coefficients are appropriate for a 1975.0 Epoch.

The tables are arranged in the following order:

Table C1: Vertical cutoff rigidities for locations along the route of a Soviet cosmic-ray survey to Antarctica.[C2,C3] The calculations were made for an altitude of 20 km.

C1. IAGA Commission 2, Working Group 4 (1969) International Geomagnetic Reference Field 1965.0, J. Geophys. Res. 74:4407.

C2. Golenkov, A.E., Okhlopkov, V.P., Svirzhevsky, N.S., Svirzhevskaya, A.K., and Stozhkov, Yu.I. (1977) Latitude measurements of cosmic ray intensity in the stratosphere during the solar minimum in 1975-1976, 15th International Cosmic Ray Conference, Conference Papers 4:229.

C3. Shea, M.A., Smart, D.F., Stozhkov, Yu.I., Svirzhevsky, N.S., Svirzhevskaya, A.K., Bazilevskaya, G.A., and Charackchyan, T.N. (1981) Analysis of cosmic ray intensity data and trajectory calculated vertical cutoff rigidities for the latitude survey made during the 22nd Soviet Antarctic expedition, 17th International Cosmic Ray Conference, Conference Papers 4:213.

Table C2: Vertical cutoff rigidities for miscellaneous points. The calculations were made for an altitude of 20 km.

Table C3: Vertical and non-vertical cutoff rigidities for selected neutron monitor locations. The calculations were made for an altitude of 20 km.

Table C4: Vertical and non-vertical cutoff rigidities for 20°S, 150°E and 25°S, 195°E. The calculations were made for an altitude of 20 km.

Table C5: Vertical cutoff rigidities for a grid 5° in latitude and 5° in longitude over Central and South America. The calculations were made for an altitude of 30 km.

Table C6: Vertical cutoff rigidities for locations at or near cosmic-ray balloon launching sites. The calculations were made for an altitude of 30 km.

Table C7: Vertical and non-vertical cutoff rigidities for Cape Giradeau, USA, Sioux Falls, USA and Riyadh, Saudi Arabia. The calculations were made for an altitude of 30 km.

Table C8: Vertical and non-vertical cutoff rigidities for Cape Giradeau, USA. The calculations were made for an altitude of 40 km.

The format of the vertical and non-vertical cutoff rigidity tables are similar; differences are noted in the following description:

Identification:	Each location has been identified with a specific name or identifier.
Geographic Location:	The geographic coordinates of each location are given with the latitude as positive for the northern hemisphere and negative for the southern hemisphere, and the longitude in degrees East of Greenwich.
L Value:	The L value, in earth radii, calculated using the same geomagnetic field coefficients as utilized in the cutoff rigidity calculations.
Zenith Angle:	(Tables C3, C4, C7, and C8.) The angle (in degrees) from the zenith for which the cutoff calculation has been made.
Azimuth Angle:	(Tables C3, C4, C7, and C8.) The azimuth angle (in degrees) for which the cutoff calculation has been made. All azimuth angles are measured clockwise from the geographic north (that is, 0° = geographic north; 90° = geographic east, etc.).
P(M):	The main cutoff rigidity (in GV) for this location in the specified direction.
P(S):	The Stormer cutoff rigidity (in GV) for this location in the specified direction.

Penumbral Width:	The difference between the main cutoff rigidity and the Stormer cutoff rigidity (in GV).
PC:	The effective cutoff rigidity (in GV) for this location in the specified direction.

Each of these tables and the values contained therein are described in the text of this report.

Table C1. Summary of Vertical Cutoff Rigidities for Locations Along the Route of a Soviet Latitude Survey as Calculated for 20-km Altitude Using the IGRF (Epoch [illegible]) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOVIET LAT. SURVEY	44.08	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	41.50	349.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	30.55	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	345.09	[illegible]	11.11	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	10.33	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	-12.81	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	-19.40	[illegible]	1.3469	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SOVIET LAT. SURVEY	-20.79	10.20	[illegible]	9.44	7.37	2.07	8.80
SOVIET LAT. SURVEY	[illegible]	13.75	1.4773	[illegible]	6.69	1.88	[illegible]
SOVIET LAT. SURVEY	[illegible]	12.57	1.6496	[illegible]	[illegible]	1.41	[illegible]
SOVIET LAT. SURVEY	[illegible]	[illegible]	[illegible]	[illegible]	4.01	0.78	4.61
SOVIET LAT. SURVEY	-40.95	[illegible]	2.1589	[illegible]	2.70	1.05	3.49
SOVIET LAT. SURVEY	-41.76	19.96	[illegible]	3.69	3.15	0.54	3.42
SOVIET LAT. SURVEY	-48.50	20.05	2.5699	2.58	2.26	0.32	2.41
SOVIET LAT. SURVEY	-55.08	20.06	3.0388	1.88	1.60	0.28	1.66
SOVIET LAT. SURVEY	-58.54	19.97	3.3486	1.53	1.26	0.27	1.37
SOVIET LAT. SURVEY	-61.00	16.78	3.5034	1.32	1.18	0.14	1.25
SOVIET LAT. SURVEY	-58.47	351.48	2.6130	2.38	2.08	0.30	2.14
SOVIET LAT. SURVEY	-47.10	328.39	1.6796	5.45	4.80	0.65	5.24
SOVIET LAT. SURVEY	-45.55	325.16	1.5952	6.31	5.07	1.24	5.98
SOVIET LAT. SURVEY	-41.98	319.07	1.4449	7.75	6.10	1.65	7.04
SOVIET LAT. SURVEY	-40.91	317.25	1.4064	8.14	6.74	1.40	7.12
SOVIET LAT. SURVEY	-50.72	303.82	1.6338	6.65	5.45	1.20	6.43
SOVIET LAT. SURVEY	-39.24	314.03	1.3500	8.64	7.35	1.29	7.87
SOVIET LAT. SURVEY	-50.76	303.82	1.5853	6.66	5.33	1.33	6.42
SOVIET LAT. SURVEY	-54.83	300.12	1.7270	5.21	4.50	0.71	5.11
SOVIET LAT. SURVEY	-58.27	298.98	1.8918	4.52	4.06	0.46	4.33
SOVIET LAT. SURVEY	-62.45	297.32	2.1550	3.66	3.11	0.55	3.43
SOVIET LAT. SURVEY	-38.55	323.26	1.4068	8.21	6.69	1.52	7.07
SOVIET LAT. SURVEY	-38.48	323.26	1.4054	7.87	6.82	1.05	7.02
SOVIET LAT. SURVEY	-34.42	324.22	1.3365	8.95	7.20	1.75	7.93
SOVIET LAT. SURVEY	-30.08	324.33	1.2675	9.70	8.24	1.46	9.01
SOVIET LAT. SURVEY	-27.65	326.35	1.2465	9.98	8.70	1.28	9.40
SOVIET LAT. SURVEY	-27.57	326.42	1.2459	10.00	8.66	1.34	9.43
SOVIET LAT. SURVEY	3.74	337.94	1.0253	13.90	13.90	0.00	13.90
SOVIET LAT. SURVEY	3.73	337.94	1.0253	13.90	13.90	0.00	13.90
SOVIET LAT. SURVEY	19.21	340.92	1.0714	13.47	13.47	0.00	13.47

Table C1. Summary of Vertical Cutoff Rigidities for Locations Along the Route of a Soviet Latitude Survey as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOVIET LAT. SURVEY	20.32	341.17	1.0827	13.32	13.32	0.00	13.32
SOVIET LAT. SURVEY	29.97	344.65	1.2441	11.22	9.69	1.53	10.65
SOVIET LAT. SURVEY	33.21	346.00	1.3338	10.04	8.74	1.30	9.66
SOVIET LAT. SURVEY	35.37	347.02	1.4063	9.00	7.48	1.52	8.70
SOVIET LAT. SURVEY	37.92	348.22	1.5083	7.47	6.26	1.21	7.31
SOVIET LAT. SURVEY	41.42	349.74	1.6851	5.75	5.09	0.66	5.59
SOVIET LAT. SURVEY	44.78	351.83	1.9300	4.89	4.04	0.85	4.58
SOVIET LAT. SURVEY	47.17	353.75	2.0881	4.21	3.57	0.64	3.93
SOVIET LAT. SURVEY	47.83	354.25	2.1341	3.97	3.27	0.70	3.64
SOVIET LAT. SURVEY	47.83	354.25	2.1341	3.97	3.27	0.70	3.64

Table C2. Summary of Vertical Cutoff Rigidities for Miscellaneous Points as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
MISCELLANEOUS POINT	47.67	353.71	2.1264	3.99	3.45	0.54	3.72
MISCELLANEOUS POINT	43.90	351.15	1.8548	5.07	4.37	0.70	4.80
MISCELLANEOUS POINT	29.58	344.65	1.2338	11.34	9.88	1.46	10.80
MISCELLANEOUS POINT	19.33	340.92	1.0726	13.45	13.45	0.00	13.45
MISCELLANEOUS POINT	3.74	337.42	1.0257	13.89	13.89	0.00	13.89
MISCELLANEOUS POINT	3.73	337.42	1.0258	13.89	13.89	0.00	13.89
MISCELLANEOUS POINT	-23.67	13.75	1.4743	8.59	6.91	1.68	7.84
MISCELLANEOUS POINT	-27.65	33.65	1.6264	7.19	5.81	1.38	6.82
MISCELLANEOUS POINT	-33.94	9.00	1.7822	5.44	4.00	1.44	5.03
MISCELLANEOUS POINT	-35.25	12.00	1.8527	4.95	3.76	1.19	4.67
MISCELLANEOUS POINT	-35.85	1.00	1.7722	5.33	4.29	1.04	5.02
MISCELLANEOUS POINT	-37.64	2.00	1.8425	4.83	3.83	1.00	4.51
MISCELLANEOUS POINT	-39.24	314.03	1.3500	8.64	7.35	1.29	7.86
MISCELLANEOUS POINT	-41.42	349.74	1.8050	4.82	4.16	0.66	4.62
MISCELLANEOUS POINT	-41.98	40.93	2.3660	3.12	2.51	0.61	2.85
MISCELLANEOUS POINT	-44.26	19.96	2.3255	3.21	2.63	0.58	2.94
MISCELLANEOUS POINT	-48.92	20.02	2.5955	2.57	2.03	0.54	2.31
MISCELLANEOUS POINT	-53.48	343.[illegible]	2.1719	3.30	2.95	0.35	3.09
MISCELLANEOUS POINT	-55.08	339.[illegible]	2.1786	3.48	2.83	0.65	3.12
MISCELLANEOUS POINT	-66.69	44.50	5.9703	0.42	0.42	0.00	0.42

Table C3. Summary of Vertical and Angular Cutoff Rigidities for Selected Cosmic Ray Station Locations as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.5[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.52[illegible]	16	[illegible]	[illegible]	5.41	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.52[illegible]	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	32	[illegible]	[illegible]	[illegible]	[illegible]	7.72
ALMA ATA, USSR	43.20	76.94	1.529[illegible]	32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	32	[illegible]	6.94	5.2[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.52[illegible]	32	[illegible]	6.64	5.6[illegible]	1.01	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	4[illegible]	[illegible]	[illegible]	7.04	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.529[illegible]	48	17[illegible]	7.83	[illegible]	1.4[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	4[illegible]	262	5.77	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	4[illegible]	352	7.24	5.7[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	64	[illegible]	9.2[illegible]	7.2[illegible]	1.9[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	[illegible]	64	1[illegible]	[illegible]	[illegible]	1.4[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.529[illegible]	64	[illegible]	5.75	[illegible]	[illegible]	[illegible]
ALMA ATA, USSR	43.20	76.94	1.529[illegible]	64	352	7.79	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	0	0	0.65	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	16	155	0.65	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	16	245	0.64	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	16	335	0.65	[illegible]	[illegible]	[illegible]
APATITY, USSR	67.55	33.33	5.0171	32	65	0.62	[illegible]	[illegible]	0.61
APATITY, USSR	67.55	33.33	5.0171	32	155	0.61	[illegible]	[illegible]	0.59
APATITY, USSR	67.55	33.33	5.0171	32	245	[illegible]	[illegible]	[illegible]	0.57
APATITY, USSR	67.55	33.33	5.0171	32	335	0.65	[illegible]	[illegible]	[illegible]
BUENOS AIRES, ARG	-34.58	301.50	1.2201	0	0	10.31	9.41	0.85	9.38
BUENOS AIRES, ARG	-34.58	301.50	1.2201	16	[illegible]	11.85	11.04	0.81	11.58
BUENOS AIRES, ARG	-34.58	301.50	1.2201	16	177	10.50	[illegible]	0.87	9.8[illegible]
BUENOS AIRES, ARG	-34.58	301.50	1.2201	16	267	9.24	8.35	0.89	8.7[illegible]
BUENOS AIRES, ARG	-34.58	301.50	1.2201	16	[illegible]	10.30	9.41	0.89	1[illegible].05
BUENOS AIRES, ARG	-34.58	301.5[illegible]	1.2201	32	[illegible]	14.10	13.43	0.67	14.04
BUENOS AIRES, ARG	-34.58	301.50	1.2201	32	17	10.56	9.67	0.89	9.[illegible]
BUENOS AIRES, ARG	-34.58	301.50	1.2201	32	267	8.56	7.72	0.84	8.07
BUENOS AIRES, ARG	-34.58	301.50	1.2201	32	357	11.58	10.41	[illegible]	10.[illegible]
DURHAM, USA	43.10	289.16	3.1239	0	0	1.67	1.45	0.22	1.53
DURHAM, USA	43.10	289.16	3.1239	16	0	1.77	1.40	0.37	1.51
DURHAM, USA	43.10	289.16	3.1239	16	90	1.71	1.44	0.27	1.57
DURHAM, USA	43.10	289.16	3.1239	16	180	1.71	1.44	0.27	1.50
DURHAM, USA	43.10	289.16	3.1239	16	270	1.61	1.34	0.27	1.48
DURHAM, USA	43.10	289.16	3.1239	32	0	1.70	1.42	0.28	1.54
DURHAM, USA	43.10	289.16	3.1239	32	180	1.66	1.38	0.28	1.52
DURHAM, USA	43.10	289.16	3.1239	32	270	1.59	1.37	0.22	1.43
DURHAM, USA	43.10	289.16	3.1239	32	90	1.72	1.49	0.2[illegible]	1.50

Table C3. Summary of Vertical and Angular Cutoff Rigidities for Selected Cosmic Ray Station Locations as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	PENUMBRAL P(S)	WIDTH	PC
HERMANUS, S AFRICA	-34.42	19.22	1.8667	0	0	4.92	4.30	0.62	4.68
HERMANUS, S AFRICA	-34.42	19.22	1.8667	16	76	5.23	4.60	0.63	5.02
HERMANUS, S AFRICA	-34.42	19.22	1.8667	16	166	4.83	4.40	0.43	4.60
HERMANUS, S AFRICA	-34.42	19.22	1.8667	16	256	4.60	3.85	0.75	4.40
HERMANUS, S AFRICA	-34.42	19.22	1.8667	16	346	5.02	4.03	0.99	4.66
HERMANUS, S AFRICA	-34.42	19.22	1.8667	32	76	5.49	4.68	0.81	5.25
HERMANUS, S AFRICA	-34.42	19.22	1.8667	32	166	4.92	4.08	0.84	4.69
HERMANUS, S AFRICA	-34.42	19.22	1.8667	32	256	4.28	3.80	0.48	4.08
HERMANUS, S AFRICA	-34.42	19.22	1.8667	32	346	5.08	4.23	0.85	4.72
KERGUELEN ISLAND	-49.35	70.22	3.6997	0	0	1.22	1.04	0.18	1.11
KERGUELEN ISLAND	-49.35	70.22	3.6997	16	76	1.25	1.08	0.17	1.14
KERGUELEN ISLAND	-49.35	70.22	3.6997	16	166	1.21	1.05	0.16	1.14
KERGUELEN ISLAND	-49.35	70.22	3.6997	16	256	1.20	1.08	0.12	1.11
KERGUELEN ISLAND	-49.35	70.22	3.6997	16	346	1.21	1.09	0.12	1.12
KERGUELEN ISLAND	-49.35	70.22	3.6997	32	76	1.32	1.12	0.20	1.15
KERGUELEN ISLAND	-49.35	70.22	3.6997	32	166	1.11	1.11	0.00	1.11
KERGUELEN ISLAND	-49.35	70.22	3.6997	32	256	1.18	1.01	0.17	1.08
KERGUELEN ISLAND	-49.35	70.22	3.6997	32	346	1.22	1.02	0.20	1.11
KIEL, FRG	54.33	10.13	2.6100	0	0	2.50	2.12	0.38	2.28
KIEL, FRG	54.33	10.13	2.6100	16	70	2.53	2.27	0.26	2.46
KIEL, FRG	54.33	10.13	2.6100	16	160	2.56	2.04	0.52	2.34
KIEL, FRG	54.33	10.13	2.6100	16	250	2.40	1.97	0.43	2.21
KIEL, FRG	54.33	10.13	2.6100	16	340	2.47	1.97	0.50	2.25
KIEL, FRG	54.33	10.13	2.6100	32	70	2.63	2.12	0.51	2.49
KIEL, FRG	54.33	10.13	2.6100	32	160	2.57	2.13	0.44	2.36
KIEL, FRG	54.33	10.13	2.6100	32	250	2.31	1.97	0.34	2.13
KIEL, FRG	54.33	10.13	2.6100	32	340	2.54	1.94	0.60	2.23
LEEDS, ENGLAND	53.82	358.45	2.6941	0	0	2.29	2.09	0.20	2.15
LEEDS, ENGLAND	53.82	358.45	2.6941	16	70	2.41	2.02	0.39	2.25
LEEDS, ENGLAND	53.82	358.45	2.6941	16	160	2.33	1.91	0.42	2.20
LEEDS, ENGLAND	53.82	358.45	2.6941	16	250	2.25	1.97	0.28	2.10
LEEDS, ENGLAND	53.82	358.45	2.6941	16	340	2.32	2.04	0.28	2.19
LEEDS, ENGLAND	53.82	358.45	2.6941	32	70	2.54	2.11	0.43	2.33
LEEDS, ENGLAND	53.82	358.45	2.6941	32	160	2.38	1.99	0.39	2.24
LEEDS, ENGLAND	53.82	358.45	2.6941	32	250	2.18	1.91	0.27	2.05
LEEDS, ENGLAND	53.82	358.45	2.6941	32	340	2.45	1.82	0.63	2.16
OULU, FINLAND	65.00	25.42	4.3711	0	0	0.85	0.73	0.12	0.82
OULU, FINLAND	65.00	25.42	4.3711	16	65	0.86	0.80	0.06	0.81
OULU, FINLAND	65.00	25.42	4.3711	16	155	0.86	0.78	0.08	0.79
OULU, FINLAND	65.00	25.42	4.3711	16	245	0.85	0.79	0.06	0.81
OULU, FINLAND	65.00	25.42	4.3711	16	335	0.80	0.78	0.02	0.79
OULU, FINLAND	65.00	25.42	4.3711	32	65	0.89	0.79	0.10	0.82
OULU, FINLAND	65.00	25.42	4.3711	32	155	0.86	0.74	0.12	0.78
OULU, FINLAND	65.00	25.42	4.3711	32	245	0.76	0.73	0.03	0.75
OULU, FINLAND	65.00	25.42	4.3711	32	335	0.78	0.78	0.00	0.78

Table C3. Summary of Vertical and Angular Cutoff Rigidities for Selected Cosmic Ray Station Locations as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
ROME, ITALY	41.90	12.52	1.5911	0	0	6.37	5.54	0.83	6.20
ROME, ITALY	41.90	12.52	1.5911	16	74	6.84	5.87	0.97	6.69
ROME, ITALY	41.90	12.52	1.5911	16	164	6.63	5.43	1.20	6.43
ROME, ITALY	41.90	12.52	1.5911	16	254	5.88	5.08	0.80	5.73
ROME, ITALY	41.90	12.52	1.5911	16	344	6.10	5.29	0.81	6.00
ROME, ITALY	41.90	12.52	1.5911	32	74	7.34	6.39	0.95	7.21
ROME, ITALY	41.90	12.52	1.5911	32	164	6.82	5.72	1.10	6.58
ROME, ITALY	41.90	12.52	1.5911	32	254	5.48	4.85	0.63	5.35
ROME, ITALY	41.90	12.52	1.5911	32	344	6.21	5.21	1.00	5.89
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	0	0	9.88	8.27	1.61	9.45
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	16	78	11.43	9.44	1.99	10.89
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	16	168	10.58	8.82	1.76	9.80
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	16	258	8.89	7.27	1.62	8.37
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	16	348	9.38	7.90	1.48	9.20
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	32	78	13.77	10.59	3.18	12.99
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	32	168	11.49	9.01	2.48	10.23
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	32	258	8.29	6.98	1.31	7.72
TSUMEB, NAMIBIA	-19.20	17.58	1.3545	32	348	8.98	7.35	1.63	8.81
UTRECHT, HOLLAND	52.06	5.07	2.4104	0	0	3.03	2.57	0.46	2.77
UTRECHT, HOLLAND	52.06	5.07	2.4104	16	71	3.11	2.59	0.52	2.89
UTRECHT, HOLLAND	52.06	5.07	2.4104	16	161	3.03	2.52	0.51	2.83
UTRECHT, HOLLAND	52.06	5.07	2.4104	16	251	2.81	2.50	0.31	2.66
UTRECHT, HOLLAND	52.06	5.07	2.4104	16	341	3.06	2.49	0.57	2.78
UTRECHT, HOLLAND	52.06	5.07	2.4104	32	71	3.38	2.52	0.86	3.07
UTRECHT, HOLLAND	52.06	5.07	2.4104	32	161	3.07	2.45	0.62	2.84
UTRECHT, HOLLAND	52.06	5.07	2.4104	32	251	2.78	2.41	0.37	2.60
UTRECHT, HOLLAND	52.06	5.07	2.4104	32	341	2.79	2.49	0.30	2.65

Table C4. Summary of Vertical and Angular Cutoff Rigidities for Two Locations on the World Grid as Calculated for 20-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	PENUMBRAL P(S)	WIDTH	PC
WORLD GRID	-20.00	150.00	1.2654	0	0	11.69	9.35	2.34	10.74
WORLD GRID	-20.00	150.00	1.2654	20	0	10.92	9.22	1.70	10.44
WORLD GRID	-20.00	150.00	1.2654	20	90	13.74	11.22	2.52	13.26
WORLD GRID	-20.00	150.00	1.2654	20	180	12.66	10.30	2.36	12.07
WORLD GRID	-20.00	150.00	1.2654	20	270	10.49	7.96	2.53	9.41
WORLD GRID	-25.00	195.00	1.2284	0	0	11.65	10.29	1.36	11.22
WORLD GRID	-25.00	195.00	1.2284	20	0	10.96	9.39	1.57	10.49
WORLD GRID	-25.00	195.00	1.2284	20	90	13.61	13.61	0.00	13.61
WORLD GRID	-25.00	195.00	1.2284	20	180	12.72	9.48	3.24	11.88
WORLD GRID	-25.00	195.00	1.2284	20	270	10.65	8.87	1.78	9.68

Table C5. Summary of Vertical Cutoff Rigidities for a 5 Degree by 5 Degree Grid of Locations Over South America as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOUTH AMERICA GRID	15.00	275.00	1.2688	8.85	8.85	0.00	8.85
SOUTH AMERICA GRID	15.00	280.00	1.2970	10.36	8.26	2.10	8.31
SOUTH AMERICA GRID	15.00	285.00	1.3222	10.38	7.81	2.57	8.40
SOUTH AMERICA GRID	15.00	290.00	1.3402	10.56	7.93	2.63	8.77
SOUTH AMERICA GRID	15.00	295.00	1.3465	10.88	8.71	2.17	9.63
SOUTH AMERICA GRID	15.00	300.00	1.3372	11.27	9.60	1.67	10.70
SOUTH AMERICA GRID	15.00	305.00	1.3093	11.69	10.43	1.26	11.53
SOUTH AMERICA GRID	15.00	310.00	1.2644	12.10	11.30	0.80	12.08
SOUTH AMERICA GRID	15.00	315.00	1.2118	12.48	12.48	0.00	12.48
SOUTH AMERICA GRID	15.00	320.00	1.1613	12.82	12.82	0.00	12.82
SOUTH AMERICA GRID	15.00	325.00	1.1190	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	10.00	275.00	1.1745	11.77	10.64	1.13	11.18
SOUTH AMERICA GRID	10.00	280.00	1.1996	11.67	10.38	1.29	11.01
SOUTH AMERICA GRID	10.00	285.00	1.2236	11.65	10.27	1.38	11.07
SOUTH AMERICA GRID	10.00	290.00	1.2430	11.74	10.38	1.36	11.34
SOUTH AMERICA GRID	10.00	295.00	1.2533	11.93	10.72	1.21	11.77
SOUTH AMERICA GRID	10.00	300.00	1.2493	12.18	11.25	0.93	12.14
SOUTH AMERICA GRID	10.00	305.00	1.2269	12.47	12.47	0.00	12.47
SOUTH AMERICA GRID	10.00	310.00	1.1889	12.76	12.76	0.00	12.76
SOUTH AMERICA GRID	10.00	315.00	1.1466	13.04	13.04	0.00	13.04
SOUTH AMERICA GRID	10.00	320.00	1.1079	13.29	13.29	0.00	13.29
SOUTH AMERICA GRID	10.00	325.00	1.0762	13.52	13.52	0.00	13.52
SOUTH AMERICA GRID	5.00	275.00	1.1084	12.62	11.67	0.95	12.44
SOUTH AMERICA GRID	5.00	280.00	1.1300	12.50	11.48	1.02	12.34
SOUTH AMERICA GRID	5.00	285.00	1.1518	12.45	11.49	0.96	12.36
SOUTH AMERICA GRID	5.00	290.00	1.1712	12.48	11.59	0.89	12.44
SOUTH AMERICA GRID	5.00	295.00	1.1835	12.58	12.58	0.00	12.58
SOUTH AMERICA GRID	5.00	300.00	1.1832	12.73	12.73	0.00	12.73
SOUTH AMERICA GRID	5.00	305.00	1.1659	12.92	12.92	0.00	12.92
SOUTH AMERICA GRID	5.00	310.00	1.1362	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	5.00	315.00	1.1041	13.32	13.32	0.00	13.32
SOUTH AMERICA GRID	5.00	320.00	1.0761	13.49	13.49	0.00	13.49
SOUTH AMERICA GRID	5.00	325.00	1.0542	13.63	13.63	0.00	13.63
SOUTH AMERICA GRID	0.00	275.00	1.0652	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	0.00	280.00	1.0832	12.99	12.99	0.00	12.99
SOUTH AMERICA GRID	0.00	285.00	1.1019	12.91	12.91	0.00	12.91
SOUTH AMERICA GRID	0.00	290.00	1.1199	12.89	12.89	0.00	12.89
SOUTH AMERICA GRID	0.00	295.00	1.1325	12.93	12.93	0.00	12.93
SOUTH AMERICA GRID	0.00	300.00	1.1345	13.01	13.01	0.00	13.01
SOUTH AMERICA GRID	0.00	305.00	1.1224	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	0.00	310.00	1.1018	13.23	13.23	0.00	13.23
SOUTH AMERICA GRID	0.00	315.00	1.0798	13.34	13.34	0.00	13.34
SOUTH AMERICA GRID	0.00	320.00	1.0614	13.43	13.43	0.00	13.43
SOUTH AMERICA GRID	0.00	325.00	1.0485	13.49	13.49	0.00	13.49

Table C5. Summary of Vertical Cutoff Rigidities for a 5 Degree by 5 Degree Grid of Locations Over South America as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOUTH AMERICA GRID	-5.00	275.00	1.0413	13.33	13.33	0.00	13.33
SOUTH AMERICA GRID	-5.00	280.00	1.0553	13.20	13.20	0.00	13.20
SOUTH AMERICA GRID	-5.00	285.00	1.0709	13.10	13.10	0.00	13.10
SOUTH AMERICA GRID	-5.00	290.00	1.0861	13.04	13.04	0.00	13.04
SOUTH AMERICA GRID	-5.00	295.00	1.0976	13.03	13.03	0.00	13.03
SOUTH AMERICA GRID	-5.00	300.00	1.1012	13.04	13.04	0.00	13.04
SOUTH AMERICA GRID	-5.00	305.00	1.0949	13.08	13.08	0.00	13.08
SOUTH AMERICA GRID	-5.00	310.00	1.0829	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	-5.00	315.00	1.0703	13.15	13.15	0.00	13.15
SOUTH AMERICA GRID	-5.00	320.00	1.0609	13.16	13.16	0.00	13.16
SOUTH AMERICA GRID	-5.00	325.00	1.0565	13.14	13.14	0.00	13.14
SOUTH AMERICA GRID	-10.00	275.00	1.0339	13.32	13.32	0.00	13.32
SOUTH AMERICA GRID	-10.00	280.00	1.0443	13.18	13.18	0.00	13.18
SOUTH AMERICA GRID	-10.00	285.00	1.0564	13.07	13.07	0.00	13.07
SOUTH AMERICA GRID	-10.00	290.00	1.0686	12.98	12.98	0.00	12.98
SOUTH AMERICA GRID	-10.00	295.00	1.0786	12.92	12.92	0.00	12.92
SOUTH AMERICA GRID	-10.00	300.00	1.0836	12.88	12.88	0.00	12.88
SOUTH AMERICA GRID	-10.00	305.00	1.0825	12.86	12.86	0.00	12.86
SOUTH AMERICA GRID	-10.00	310.00	1.0780	12.83	12.83	0.00	12.83
SOUTH AMERICA GRID	-10.00	315.00	1.0738	12.78	12.78	0.00	12.78
SOUTH AMERICA GRID	-10.00	320.00	1.0728	12.72	12.72	0.00	12.72
SOUTH AMERICA GRID	-10.00	325.00	1.0764	12.63	12.63	0.00	12.63
SOUTH AMERICA GRID	-15.00	275.00	1.0413	13.12	13.12	0.00	13.12
SOUTH AMERICA GRID	-15.00	280.00	1.0483	12.98	12.98	0.00	12.98
SOUTH AMERICA GRID	-15.00	285.00	1.0570	12.85	12.85	0.00	12.85
SOUTH AMERICA GRID	-15.00	290.00	1.0664	12.74	12.74	0.00	12.74
SOUTH AMERICA GRID	-15.00	295.00	1.0750	12.64	12.64	0.00	12.64
SOUTH AMERICA GRID	-15.00	300.00	1.0811	12.55	12.55	0.00	12.55
SOUTH AMERICA GRID	-15.00	305.00	1.0844	12.47	12.47	0.00	12.47
SOUTH AMERICA GRID	-15.00	310.00	1.0864	12.39	12.39	0.00	12.39
SOUTH AMERICA GRID	-15.00	315.00	1.0897	12.28	12.28	0.00	12.28
SOUTH AMERICA GRID	-15.00	320.00	1.0966	12.14	12.06	0.08	12.13
SOUTH AMERICA GRID	-15.00	325.00	1.1079	11.99	11.37	0.62	11.94
SOUTH AMERICA GRID	-20.00	275.00	1.0627	12.77	12.77	0.00	12.77
SOUTH AMERICA GRID	-20.00	280.00	1.0667	12.63	12.63	0.00	12.63
SOUTH AMERICA GRID	-20.00	285.00	1.0721	12.49	12.49	0.00	12.49
SOUTH AMERICA GRID	-20.00	290.00	1.0793	12.36	12.36	0.00	12.36
SOUTH AMERICA GRID	-20.00	295.00	1.0867	12.23	12.23	0.00	12.23
SOUTH AMERICA GRID	-20.00	300.00	1.0938	12.10	12.05	0.05	12.09
SOUTH AMERICA GRID	-20.00	305.00	1.1004	11.98	11.55	0.43	11.94
SOUTH AMERICA GRID	-20.00	310.00	1.1081	11.83	11.40	0.43	11.79
SOUTH AMERICA GRID	-20.00	315.00	1.1180	11.67	11.18	0.49	11.62
SOUTH AMERICA GRID	-20.00	320.00	1.1318	11.48	10.63	0.85	11.39
SOUTH AMERICA GRID	-20.00	325.00	1.1506	11.26	10.27	0.99	11.01
SOUTH AMERICA GRID	-25.00	275.00	1.0979	12.31	12.27	0.04	12.30
SOUTH AMERICA GRID	-25.00	280.00	1.0987	12.17	12.13	0.04	12.16
SOUTH AMERICA GRID	-25.00	285.00	1.1017	12.03	11.75	0.28	12.01
SOUTH AMERICA GRID	-25.00	290.00	1.1068	11.88	11.54	0.34	11.84

Table C5. Summary of Vertical Cutoff Rigidities for a 5 Degree by 5 Degree Grid of Locations Over South America as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOUTH AMERICA GRID	-25.00	295.00	1.1135	11.72	11.39	0.33	11.69
SOUTH AMERICA GRID	-25.00	300.00	1.1215	11.56	11.03	0.53	11.50
SOUTH AMERICA GRID	-25.00	305.00	1.1311	11.39	10.77	0.62	11.28
SOUTH AMERICA GRID	-25.00	310.00	1.1431	11.21	10.46	0.75	11.02
SOUTH AMERICA GRID	-25.00	315.00	1.1588	10.99	10.15	0.84	10.69
SOUTH AMERICA GRID	-25.00	320.00	1.1793	10.74	9.77	0.97	10.40
SOUTH AMERICA GRID	-25.00	325.00	1.2051	10.48	9.38	1.10	10.03
SOUTH AMERICA GRID	-30.00	275.00	1.1476	11.75	11.70	0.05	11.72
SOUTH AMERICA GRID	-30.00	280.00	1.1453	11.62	11.57	0.05	11.60
SOUTH AMERICA GRID	-30.00	285.00	1.1459	11.47	11.02	0.45	11.42
SOUTH AMERICA GRID	-30.00	290.00	1.1491	11.32	10.80	0.52	11.20
SOUTH AMERICA GRID	-30.00	295.00	1.1553	11.14	10.55	0.59	10.98
SOUTH AMERICA GRID	-30.00	300.00	1.1642	10.96	10.28	0.68	10.72
SOUTH AMERICA GRID	-30.00	305.00	1.1764	10.74	9.98	0.76	10.44
SOUTH AMERICA GRID	-30.00	310.00	1.1926	10.52	9.64	0.88	10.13
SOUTH AMERICA GRID	-30.00	315.00	1.2135	10.27	9.30	0.97	9.85
SOUTH AMERICA GRID	-30.00	320.00	1.2401	9.97	8.77	1.20	9.41
SOUTH AMERICA GRID	-30.00	325.00	1.2728	9.65	8.17	1.48	8.89
SOUTH AMERICA GRID	-35.00	275.00	1.2141	11.09	10.57	0.52	11.05
SOUTH AMERICA GRID	-35.00	280.00	1.2084	10.99	10.43	0.56	10.89
SOUTH AMERICA GRID	-35.00	285.00	1.2066	10.84	10.24	0.60	10.63
SOUTH AMERICA GRID	-35.00	290.00	1.2083	10.68	10.01	0.6	10.42
SOUTH AMERICA GRID	-35.00	295.00	1.2139	10.50	9.78	0.72	10.18
SOUTH AMERICA GRID	-35.00	300.00	1.2239	10.29	9.45	0.84	9.93
SOUTH AMERICA GRID	-35.00	305.00	1.2385	10.04	9.08	0.96	9.53
SOUTH AMERICA GRID	-35.00	310.00	1.2582	9.79	8.71	1.08	9.24
SOUTH AMERICA GRID	-35.00	315.00	1.2840	9.48	8.10	1.38	8.69
SOUTH AMERICA GRID	-35.00	320.00	1.3160	9.16	7.82	1.34	8.25
SOUTH AMERICA GRID	-35.00	325.00	1.3550	8.79	7.29	1.50	7.75
SOUTH AMERICA GRID	-40.00	275.00	1.3006	10.29	9.47	0.82	10.06
SOUTH AMERICA GRID	-40.00	280.00	1.2917	10.22	9.43	0.79	9.92
SOUTH AMERICA GRID	-40.00	285.00	1.2872	10.10	9.26	0.84	9.73
SOUTH AMERICA GRID	-40.00	290.00	1.2874	9.94	9.06	0.88	9.50
SOUTH AMERICA GRID	-40.00	295.00	1.2926	9.75	8.70	1.05	9.25
SOUTH AMERICA GRID	-40.00	300.00	1.3035	9.52	8.52	1.00	8.99
SOUTH AMERICA GRID	-40.00	305.00	1.3202	9.25	8.03	1.22	8.55
SOUTH AMERICA GRID	-40.00	310.00	1.3431	8.84	7.75	1.09	8.10
SOUTH AMERICA GRID	-40.00	315.00	1.3733	8.38	7.24	1.14	7.57
SOUTH AMERICA GRID	-40.00	320.00	1.4110	8.06	6.71	1.35	7.03
SOUTH AMERICA GRID	-40.00	325.00	1.4557	7.60	5.95	1.65	6.89
SOUTH AMERICA GRID	-45.00	275.00	1.4146	9.25	7.78	1.47	9.05
SOUTH AMERICA GRID	-45.00	280.00	1.4016	9.24	7.91	1.33	8.90
SOUTH AMERICA GRID	-45.00	285.00	1.3941	9.16	7.89	1.27	8.67
SOUTH AMERICA GRID	-45.00	290.00	1.3925	9.02	7.66	1.36	8.42
SOUTH AMERICA GRID	-45.00	295.00	1.3972	8.67	7.65	1.02	8.15
SOUTH AMERICA GRID	-45.00	300.00	1.4087	8.46	7.17	1.29	7.81

Table C5. Summary of Vertical Cutoff Rigidities for a 5 Degree by 5 Degree Grid of Locations Over South America as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	PC
SOUTH AMERICA GRID	-45.00	305.00	1.4271	8.15	6.61	1.54	7.64
SOUTH AMERICA GRID	-45.00	310.00	1.4532	7.91	6.22	1.69	7.31
SOUTH AMERICA GRID	-45.00	315.00	1.4877	7.24	6.49	0.75	6.93
SOUTH AMERICA GRID	-45.00	320.00	1.5298	7.05	5.26	1.79	6.64
SOUTH AMERICA GRID	-45.00	325.00	1.5803	6.52	5.22	1.30	6.18
SOUTH AMERICA GRID	-50.00	275.00	1.5657	7.57	5.97	1.60	7.35
SOUTH AMERICA GRID	-50.00	280.00	1.5475	7.70	6.19	1.51	7.52
SOUTH AMERICA GRID	-50.00	285.00	1.5362	7.74	6.06	1.68	7.52
SOUTH AMERICA GRID	-50.00	290.00	1.5323	7.63	6.00	1.63	7.42
SOUTH AMERICA GRID	-50.00	295.00	1.5361	7.47	5.83	1.64	7.22
SOUTH AMERICA GRID	-50.00	300.00	1.5480	7.17	6.14	1.03	6.95
SOUTH AMERICA GRID	-50.00	305.00	1.5682	6.85	5.56	1.29	6.62
SOUTH AMERICA GRID	-50.00	310.00	1.5973	6.42	5.30	1.12	6.18
SOUTH AMERICA GRID	-50.00	315.00	1.6349	5.90	4.97	0.93	5.67
SOUTH AMERICA GRID	-50.00	320.00	1.6818	5.41	4.44	0.97	5.22
SOUTH AMERICA GRID	-50.00	325.00	1.7375	5.00	4.42	0.58	4.84
SOUTH AMERICA GRID	-55.00	275.00	1.7707	5.17	4.29	0.38	5.06
SOUTH AMERICA GRID	-55.00	280.00	1.7463	5.26	4.65	0.61	5.17
SOUTH AMERICA GRID	-55.00	285.00	1.7306	5.35	4.97	0.33	5.26
SOUTH AMERICA GRID	-55.00	290.00	1.7236	5.34	5.04	0.30	5.22
SOUTH AMERICA GRID	-55.00	295.00	1.7258	5.29	4.59	0.70	5.12
SOUTH AMERICA GRID	-55.00	300.00	1.7373	5.15	4.70	0.45	5.02
SOUTH AMERICA GRID	-55.00	305.00	1.7585	4.98	4.42	0.56	4.80
SOUTH AMERICA GRID	-55.00	310.00	1.7894	4.80	4.30	0.50	4.68
SOUTH AMERICA GRID	-55.00	315.00	1.8302	4.60	3.88	0.72	4.41
SOUTH AMERICA GRID	-55.00	320.00	1.8811	4.40	3.87	0.53	4.12
SOUTH AMERICA GRID	-55.00	325.00	1.9419	4.12	3.49	0.63	3.78
SOUTH AMERICA GRID	-60.00	275.00	2.0559	4.14	3.36	0.78	3.88
SOUTH AMERICA GRID	-60.00	280.00	2.0234	4.23	3.43	0.80	3.90
SOUTH AMERICA GRID	-60.00	285.00	2.0014	4.23	3.52	0.71	3.98
SOUTH AMERICA GRID	-60.00	290.00	1.9900	4.28	3.74	0.54	4.03
SOUTH AMERICA GRID	-60.00	295.00	1.9893	4.25	3.51	0.74	3.99
SOUTH AMERICA GRID	-60.00	300.00	1.9995	4.11	3.34	0.77	3.88
SOUTH AMERICA GRID	-60.00	305.00	2.0207	4.11	3.33	0.78	3.87
SOUTH AMERICA GRID	-60.00	310.00	2.0529	3.88	3.42	0.46	3.65
SOUTH AMERICA GRID	-60.00	315.00	2.0959	3.71	2.73	0.98	3.46
SOUTH AMERICA GRID	-60.00	320.00	2.1504	3.64	2.98	0.66	3.33
SOUTH AMERICA GRID	-60.00	325.00	2.2152	3.36	2.85	0.51	3.10

Table C6. Summary of Vertical Cutoff Rigidities for Selected Locations Near Cosmic-Ray Balloon Launching Sites as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	P(M)	P(S)	PENUMBRAL WIDTH	[illegible]
AIRE-SUR-ADOUR, FRANCE	43.70	359.75	1.7582	5.38	4.39	0.99	[illegible]
ALICE SPRINGS, AUSTRALIA	-23.75	133.85	1.4044	8.89	7.34	1.55	[illegible]
BUENOS AIRES, ARGENTINA	-34.58	301.50	1.2219	10.27	9.44	0.83	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3379	2.88	2.40	0.48	[illegible]
CARTHAGE, USA	37.17	265.67	2.2548	3.08	2.62	0.46	[illegible]
DAKAR, SENEGAL	14.63	342.55	1.0331	13.95	13.95	0.00	[illegible]
DALLAS, USA	32.78	263.20	1.8795	4.46	3.57	0.89	[illegible]
DARWIN, AUSTRALIA	-12.38	130.73	1.0973	14.16	14.16	0.00	[illegible]
HOLLOMAN, USA	32.87	253.92	1.7753	5.00	4.36	0.64	[illegible]
HYDERBAD, INDIA	17.37	78.43	.9477	17.03	17.03	0.00	[illegible]
KERGUELEN ISLANDS	-49.35	70.22	3.7053	1.21	1.08	0.13	[illegible]
LINDAU/HARZ, FRG	51.60	10.10	2.3229	3.11	2.76	0.35	[illegible]
LONGREACH, AUSTRALIA	-23.43	144.27	1.3813	[illegible]	6.82	[illegible]	[illegible]
MILDURA, AUSTRALIA	-34.23	142.22	1.9674	4.45	3.59	0.86	[illegible]
MIDLAND, USA	32.00	257.85	1.7689	4.99	4.21	[illegible]	[illegible]
PALESTINE, USA	31.75	264.35	1.8277	4.70	4.19	0.51	[illegible]
POTCHEFSTROOM, S.AFRICA	-26.70	27.10	1.5935	7.55	5.36	2.19	[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.0643	14.04	[illegible]	[illegible]	[illegible]
SIOUX FALLS, USA	43.57	263.30	2.9653	1.79	1.54	0.25	[illegible]
SIOUX CITY APT, USA	42.24	263.80	2.7881	1.99	1.81	0.18	[illegible]
SIOUX CITY WEST PT, USA	42.20	259.00	2.6733	2.21	1.87	0.34	[illegible]
SIOUX FALLS WEST PT, USA	43.50	258.00	2.8208	1.95	1.68	0.27	[illegible]
SPRINGFIELD, USA	37.18	266.68	2.2712	3.04	2.53	0.51	[illegible]
TRAPANI, ITALY	38.03	12.53	1.4126	8.66	7.16	1.50	[illegible]
UTRECHT, NETHERLANDS	52.06	5.07	2.4140	3.02	2.47	0.55	[illegible]
WICHITA, USA	37.72	262.67	2.2582	3.08	2.49	0.59	[illegible]

Table C7. Summary of Vertical and Angular Cutoff Rigidities for Cape Giradeau, Sioux Falls and Riyadh as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
				CAPE GIRADEAU, USA					
CAPE GIRADEAU, USA	37.31	270.47	2.3379	0	0	2.88	2.40	0.48	2.63
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	6	2.87	2.44	0.43	2.65
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	51	3.02	2.47	0.55	2.75
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	96	2.91	2.40	0.51	2.70
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	141	2.90	2.58	0.32	2.70
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	186	2.91	2.44	0.47	2.64
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	231	2.85	2.29	0.56	2.58
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	276	2.84	2.51	0.33	2.62
CAPE GIRADEAU, USA	37.31	270.47	2.3379	5	321	2.85	2.30	0.55	2.63
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	6	2.86	2.42	0.44	2.70
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	51	2.92	2.30	0.62	2.68
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	96	3.09	2.67	0.42	2.76
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	141	2.92	2.62	0.30	2.71
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	186	2.87	2.34	0.53	2.59
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	231	2.83	2.52	0.31	2.63
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	276	2.81	2.42	0.39	2.56
CAPE GIRADEAU, USA	37.31	270.47	2.3379	10	321	2.82	2.27	0.55	2.62
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	6	2.83	2.34	0.49	2.64
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	51	2.94	2.43	0.51	2.75
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	96	2.98	2.44	0.54	2.76
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	141	2.94	2.41	0.53	2.70
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	186	2.86	2.39	0.47	2.69
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	231	2.82	2.31	0.51	2.59
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	276	2.80	2.40	0.40	2.52
CAPE GIRADEAU, USA	37.31	270.47	2.3379	15	321	2.77	2.28	0.49	2.59
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	6	2.78	2.44	0.34	2.65
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	51	2.94	2.47	0.47	2.79
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	96	3.02	2.47	0.55	2.79
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	141	2.97	2.37	0.60	2.74
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	186	2.87	2.42	0.45	2.65
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	231	2.79	2.40	0.39	2.59
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	276	2.74	2.29	0.45	2.55
CAPE GIRADEAU, USA	37.31	270.47	2.3379	20	321	2.71	2.35	0.36	2.57
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	6	2.89	2.39	0.50	2.59
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	51	2.91	2.22	0.69	2.73
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	96	3.05	2.40	0.65	2.83
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	141	2.99	2.51	0.48	2.80
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	186	2.85	2.26	0.59	2.62
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	231	2.77	2.33	0.44	2.61
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	276	2.70	2.23	0.47	2.56
CAPE GIRADEAU, USA	37.31	270.47	2.3379	25	321	2.70	2.35	0.35	2.57
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	6	2.85	2.11	0.74	2.56
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	51	3.00	2.58	0.42	2.79

Table C7. Summary of Vertical and Angular Cutoff Rigidities for Cape Giradeau, Sioux Falls and Riyadh as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	PENUMBRA FIRST	PENUMBRA WIDTH	PC
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	96	[illegible]	2.55	[illegible]	2.88
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	141	3.01	2.39	0.62	2.95
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	186	2.84	2.37	0.47	2.69
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	231	2.75	2.50	0.25	2.55
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	276	2.64	2.43	0.21	2.56
CAPE GIRADEAU, USA	37.31	270.47	2.3379	30	321	2.73	2.29	0.44	2.47
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	6	2.80	2.48	0.32	2.60
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	51	3.04	2.49	0.55	2.72
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	96	3.10	2.51	0.59	2.91
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	141	3.09	2.33	0.76	2.86
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	186	2.83	2.61	0.22	2.69
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	231	2.74	2.24	0.50	2.54
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	276	2.58	2.31	0.27	.47
CAPE GIRADEAU, USA	37.31	270.47	2.3379	35	321	2.72	2.29	0.43	2.47
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	6	2.85	2.55	0.30	2.66
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	51	3.04	2.59	0.45	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	96	3.09	2.62	0.47	2.96
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	141	3.04	2.48	0.56	2.88
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	186	2.83	2.44	0.39	2.66
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	231	2.61	2.26	0.35	2.45
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	276	2.65	2.31	0.34	2.48
CAPE GIRADEAU, USA	37.31	270.47	2.3379	40	321	2.74	2.19	0.55	2.49
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	6	2.75	2.36	0.39	2.57
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	51	3.04	2.38	0.66	2.74
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	96	3.07	2.59	0.48	2.93
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	141	3.04	2.60	0.44	2.91
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	186	2.83	2.47	0.36	2.66
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	231	2.56	2.42	0.14	2.51
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	276	2.63	2.27	0.36	2.41
CAPE GIRADEAU, USA	37.31	270.47	2.3379	45	321	2.66	2.22	0.44	2.48

SIOUX FALLS, USA

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	PENUMBRA FIRST	PENUMBRA WIDTH	PC
SIOUX FALLS, USA	43.57	263.30	2.9653	0	0	1.79	1.54	0.25	1.67
SIOUX FALLS, USA	43.57	263.30	2.9653	5	9	1.80	1.62	0.18	1.68
SIOUX FALLS, USA	43.57	263.3-	2.9653	5	54	1.81	1.65	0.16	[illegible]
SIOUX FALLS, USA	43.57	263.30	2.9653	5	99	1.81	1.66	0.15	1.71
SIOUX FALLS, USA	43.57	263.30	2.9653	5	144	1.80	1.49	0.31	1.66
SIOUX FALLS, USA	43.57	263.30	2.9653	5	189	1.79	1.64	0.15	1.67
SIOUX FALLS, USA	43.57	263.30	2.9653	5	234	1.78	1.52	0.26	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	5	279	1.78	1.47	0.31	1.60
SIOUX FALLS, USA	43.57	263.30	2.9653	5	324	1.85	1.50	0.35	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	10	9	1.80	1.51	0.29	1.67
SIOUX FALLS, USA	43.57	263.30	2.9653	10	54	1.82	1.56	0.26	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	10	99	1.83	1.60	0.23	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	10	144	1.81	1.54	0.27	1.67
SIOUX FALLS, USA	43.57	263.30	2.9653	10	189	1.79	1.57	0.22	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	10	234	1.77	1.48	0.29	1.64
SIOUX FALLS, USA	43.57	263.30	2.9653	10	279	1.77	1.59	0.18	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	10	324	1.78	1.58	0.20	1.67

Table C7. Summary of Vertical and Angular Cutoff Rigidities for Cape Giradeau, Sioux Falls and Riyadh as Calculated for 30-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	GEOGRAPHIC LONG.	L VALUE	ANGLES ZEN.	ANGLES AZI.	P(M)	P(S)	PENUMBRAL WIDTH	PC
SIOUX FALLS, USA	43.57	263.30	2.9653	15	9	1.79	1.49	0.30	1.66
SIOUX FALLS, USA	43.57	263.30	2.9653	15	54	1.83	1.57	0.26	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	15	99	1.85	1.57	0.28	1.74
SIOUX FALLS, USA	43.57	263.30	2.9653	15	144	1.83	1.61	0.22	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	15	189	1.78	1.51	0.27	1.66
SIOUX FALLS, USA	43.57	263.30	2.9653	15	234	1.76	1.51	0.25	1.62
SIOUX FALLS, USA	43.57	263.30	2.9653	15	279	1.78	1.53	0.25	1.61
SIOUX FALLS, USA	43.57	263.30	2.9653	15	324	1.76	1.45	0.31	1.60
SIOUX FALLS, USA	43.57	263.30	2.9653	20	9	1.76	1.52	0.24	1.66
SIOUX FALLS, USA	43.57	263.30	2.9653	20	54	1.84	1.55	0.29	1.71
SIOUX FALLS, USA	43.57	263.30	2.9653	20	99	1.88	1.58	0.30	1.76
SIOUX FALLS, USA	43.57	263.30	2.9653	20	144	1.84	1.57	0.27	1.70
SIOUX FALLS, USA	43.57	263.30	2.9653	20	189	1.78	1.54	0.24	1.68
SIOUX FALLS, USA	43.57	263.30	2.9653	20	234	1.75	1.46	0.29	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	20	279	1.74	1.62	0.12	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	20	324	1.74	1.54	0.20	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	25	9	1.77	1.58	0.19	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	25	54	1.87	1.63	0.24	1.74
SIOUX FALLS, USA	43.57	263.30	2.9653	25	99	1.88	1.59	0.29	1.74
SIOUX FALLS, USA	43.57	263.30	2.9653	25	144	1.85	1.61	0.24	1.68
SIOUX FALLS, USA	43.57	263.30	2.9653	25	189	1.78	1.63	0.15	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	25	234	1.74	1.48	0.26	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	25	279	1.72	1.51	0.21	1.62
SIOUX FALLS, USA	43.57	263.30	2.9653	25	324	1.72	1.45	0.27	1.59
SIOUX FALLS, USA	43.57	263.30	2.9653	30	9	1.75	1.59	0.16	1.67
SIOUX FALLS, USA	43.57	263.30	2.9653	30	54	1.80	1.63	0.17	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	30	99	1.90	1.57	0.33	1.75
SIOUX FALLS, USA	43.57	263.30	2.9653	30	144	1.87	1.61	0.26	1.73
SIOUX FALLS, USA	43.57	263.30	2.9653	30	189	1.81	1.60	0.21	1.68
SIOUX FALLS, USA	43.57	263.30	2.9653	30	234	1.75	1.47	0.28	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	30	279	1.69	1.52	0.17	1.60
SIOUX FALLS, USA	43.57	263.30	2.9653	30	324	1.70	1.33	0.37	1.61
SIOUX FALLS, USA	43.57	263.30	2.9653	35	9	1.78	1.49	0.29	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	35	54	1.90	1.53	0.37	1.70
SIOUX FALLS, USA	43.57	263.30	2.9653	35	99	1.91	1.63	0.28	1.84
SIOUX FALLS, USA	43.57	263.30	2.9653	35	144	1.88	1.56	0.32	1.73
SIOUX FALLS, USA	43.57	263.30	2.9653	35	189	1.77	1.51	0.26	1.65
SIOUX FALLS, USA	43.57	263.30	2.9653	35	234	1.73	1.47	0.26	1.58
SIOUX FALLS, USA	43.57	263.30	2.9653	35	279	1.66	1.47	0.19	1.56
SIOUX FALLS, USA	43.57	263.30	2.9653	35	324	1.75	1.45	0.30	1.57
SIOUX FALLS, USA	43.57	263.30	2.9653	40	9	1.72	1.51	0.21	1.66
SIOUX FALLS, USA	43.57	263.30	2.9653	40	54	1.84	1.67	0.17	1.74
SIOUX FALLS, USA	43.57	263.30	2.9653	40	99	1.89	1.59	0.30	1.78
SIOUX FALLS, USA	43.57	263.30	2.9653	40	144	1.90	1.61	0.29	1.75
SIOUX FALLS, USA	43.57	263.30	2.9653	40	189	1.77	1.65	0.12	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	40	234	1.73	1.55	0.18	1.61
SIOUX FALLS, USA	43.57	263.30	2.9653	40	279	1.66	1.43	0.23	1.60
SIOUX FALLS, USA	43.57	263.30	2.9653	40	324	1.73	1.54	0.19	1.62
SIOUX FALLS, USA	43.57	263.30	2.9653	45	9	1.78	1.56	0.22	1.71
SIOUX FALLS, USA	43.57	263.30	2.9653	45	54	1.88	1.59	0.29	1.71
SIOUX FALLS, USA	43.57	263.30	2.9653	45	99	1.90	1.74	0.16	1.79

Table C7. Summary of Vertical and Angular Cutoff Rigidities for Cape Girardeau, Sioux Falls and Riyadh as Calculated for 3?-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model (Contd)

IDENTIFICATION	GEOGRAPHIC LAT.	LONG.	L VALUE	ANGLES ZEN.	AZI.	P(M)	PENUMBRAL P(S)	WIDTH	P(C)
SIOUX FALLS, USA	43.57	263.30	2.9653	45	144	1.37	1.66	0.2[illegible]	1.[illegible]
SIOUX FALLS, USA	43.57	263.30	2.9653	45	189	1.77	1.66	0.11	1.69
SIOUX FALLS, USA	43.57	263.30	2.9653	45	234	1.72	1.54	0.18	1.63
SIOUX FALLS, USA	43.57	263.30	2.9653	45	279	1.6[illegible]	1.51	0.16	1.56
SIOUX FALLS, USA	43.57	263.30	2.9653	45	324	1.69	1.47	0.2[illegible]	1.5[illegible]

RIYADH, SAUDI ARABIA

IDENTIFICATION	LAT.	LONG.	L VALUE	ZEN.	AZI.	P(M)	P(S)	WIDTH	P(C)
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	0	0	14.65	[illegible]	[illegible]	[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	19	15.[illegible]	[illegible]	0.00	15.[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	79	16.15	16.15	[illegible]	16.15
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	139	[illegible]	[illegible]	[illegible]	[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	199	13.96	13.96	[illegible]	13.96
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	259	13.4[illegible]	13.47	0.06	13.4[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	10	319	14.[illegible]	14.2[illegible]	[illegible]	14.[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	19	16.69	16.69	0.00	16.69
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	79	18.05	18.05	0.00	18.05
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	139	16.19	16.19	0.00	16.19
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	199	13.40	13.40	0.00	13.40
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	259	12.54	12.49	0.05	12.55
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	20	319	[illegible]	13.08	0.84	13.92
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	19	17.91	17.91	0.00	17.91
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	79	20.44	20.44	0.00	20.44
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	139	17.3[illegible]	17.3[illegible]	0.00	17.3[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	199	12.97	12.97	0.00	12.97
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	259	11.[illegible]	10.86	0.86	11.7[illegible]
RIYADH, SAUDI ARABIA	24.50	46.50	1.2284	30	319	13.[illegible]	[illegible]	0.90	13.6[illegible]

Table C8. Summary of Vertical and Angular Cutoff Rigidities for Cape Giradeau as Calculated for 40-km Altitude Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

IDENTIFICATION	[illegible] LAT.	LONG.	[illegible]	ANGLES ZEN.	AZI.	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	37.31	[illegible]	[illegible]	5	96	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	[illegible]	[illegible]	[illegible]	5	186	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	37.31	[illegible]	[illegible]	5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	[illegible]	[illegible]	[illegible]	10	6	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	[illegible]	[illegible]	[illegible]	[illegible]	96	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	37.31	[illegible]	[illegible]	10	186	[illegible]	[illegible]	[illegible]	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3416	10	276	[illegible]	2.40	0.40	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3416	15	6	[illegible]	2.42	0.42	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3416	15	96	2.97	2.60	[illegible]	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3416	15	186	2.91	2.38	0.53	2.66
CAPE GIRADEAU, USA	37.31	270.47	2.3416	15	276	2.77	2.42	0.30	2.56
CAPE GIRADEAU, USA	37.31	270.47	2.3416	20	6	2.77	2.41	0.36	2.66
CAPE GIRADEAU, USA	37.31	270.47	2.3416	20	96	3.01	2.47	0.54	2.80
CAPE GIRADEAU, USA	37.31	270.47	2.3416	20	186	2.84	2.52	0.32	2.70
CAPE GIRADEAU, USA	37.31	270.47	2.3416	20	276	2.73	2.39	0.34	2.58
CAPE GIRADEAU, USA	37.31	270.47	2.3416	25	6	2.88	2.38	0.50	2.63
CAPE GIRADEAU, USA	37.31	270.47	2.3416	25	96	3.05	2.49	0.56	2.92
CAPE GIRADEAU, USA	37.31	270.47	2.3416	25	186	2.84	2.40	0.44	2.62
CAPE GIRADEAU, USA	37.31	270.47	2.3416	25	276	2.69	2.17	0.52	2.50
CAPE GIRADEAU, USA	37.31	270.47	2.3416	30	6	2.84	2.29	0.55	2.57
CAPE GIRADEAU, USA	37.31	270.47	2.3416	30	96	3.11	2.37	0.74	[illegible]
CAPE GIRADEAU, USA	37.31	270.47	2.3416	30	186	2.83	2.40	0.43	2.62
CAPE GIRADEAU, USA	37.31	270.47	2.3416	30	276	2.63	2.28	0.35	[illegible]

Appendix D

Tables of Cutoff Rigidities Calculated for Locations Not Included in the Previously Published Tables

The two tables in this appendix summarize the vertical cutoff rigidity values for specific locations for which these calculations were performed after publication of the original tables by Shea et al.[D1] Table D1 lists the vertical cutoff rigidity for San Jose dos Campos, Brazil utilizing the International Geomagnetic Reference Field[D2] model for Epoch 1965.0. The values for this location are additional to the values in Table B1 of Shea et al.[D1] Table D2 lists the vertical cutoff rigidity for five locations utilizing the IGRF model with time derivatives applied such that the coefficients are appropriate for a 1975.0 Epoch. The values for these locations are additional to the values in Table E1 of Shea et al.[D1] The calculations for Tables D1 and D2 were made for an altitude of 20 km.

The format of the tables is as follows:

Identification: Each location has been identified with a specific name or identifier.

D1. Shea, M.A., Smart, D.F., and Carmichael, H. (1976) Summary of Cutoff Rigidities Calculated With the International Geomagnetic Reference Field for Various Epochs, ERP No. 561, AFGL-TR-76-0115, AD A028978.

D2. IAGA Commission 2, Working Group 4 (1969) International Geomagnetic Reference Field 1965.0, J. Geophys. Res. 74:4407.

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Geographic Location:	The geographic coordinates of each location are given with the latitude as positive for the northern hemisphere and negative for the southern hemisphere, and the longitude in degrees East of Greenwich.
L Value:	The L value, in earth radii, calculated using the same geomagnetic field coefficients as utilized in the cutoff rigidity calculations.
P(M):	The main cutoff rigidity (in GV) for this location in the specified direction.
P(S):	The Stormer cutoff rigidity (in GV) for this location in the specified direction.
Penumbral Width:	The difference between the main cutoff rigidity and the Stormer cutoff rigidity (in GV).
PC:	The effective cutoff rigidity (in GV) for this location in the specified direction.

Each of these tables and the values contained therein are described in the text of this report.

Table D1. Summary of Vertical Cutoff Rigidities for Specific Locations as Calculated Using the IGRF (Epoch 1965.0) Geomagnetic Field Model

Identification	Geographic Lat.	Long.	L Value	P(M)	P(S)	Penumbral Width	PC
San Jose dos Campos, Brazil	-23.23	314.15	1.1250	11.57	10.86	0.71	11.45

Table D2. Summary of Vertical Cutoff Rigidities for Specific Locations as Calculated Using the IGRF (Epoch 1975.0) Geomagnetic Field Model

Identification	Geographic Lat.	Long.	L Value	P(M)	P(S)	Penumbral Width	PC
Newark, USA	39.68	284.25	2.6980	2.22	1.87	0.35	1.97
San Jose dos Campos, Brazil	-23.23	314.15	1.1386	11.30	10.51	0.79	11.12
Tashkent, USSR	41.33	69.62	1.4655	7.87	6.58	1.29	7.65
Uccle, Belgium	50.80	4.36	2.2946	3.19	2.79	0.40	3.00
Ushuaia, Argentina	-54.80	291.70	1.7113	5.42	4.73	0.69	5.29

Appendix E

Corrections to Previously Published Values

In archiving the results of the trajectory calculations from which the cutoff rigidity values have been determined, a check was made on values previously published in this series of reports.[E1-E8] Of the approximate 6000 locations for which we have published cutoff rigidity values in these reports, errors were found for four locations. These mistakes can be corrected by using the information contained in Table E1. The specific data set, geomagnetic field model, and geographic coordinates for the locations for which a correction has been found is identified. Then the value to be corrected is listed together with the original (incorrect) value and the new (correct) value. Finally, the reference number (see the list of references in this report) and the page number in the specific reference is given for the correction to be made. Note that summary values of the World Grid calculated using the Finch and Leaton geomagnetic field model for Epoch 1955.0 were published in two reports for the completeness of each report.

Because of the large number of references cited above, they will not be listed here. See References, page 61.

Table E1. Corrections to Previously Published Values

Data Set	Geomagnetic Field Model	Geographic Lat.	Geographic Long.	Value to be Corrected	Original Value	Correct Value	Reference Number	Page Number
World Grid Vertical	FL 1955	-45.0	285.0	PC	9.33	9.34	21 23	54 164
World Grid Vertical	FL 1955	-50.0	105.0	PM	0.61	0.59	21 23	54 164
World Grid Vertical	FL 1955	-50.0	105.0	Penumbral Width	0.02	0.00	21 23	54 164
World Grid Vertical	FL 1955	-50.0	105.0	PC	0.60	0.59	21 23	54 164
Equator Studies	FL 1955	-6.0	335.0	PS	13.00	13.30	21	80
Stations Vertical	IGRF 1970	20.71	151.01	PS	1.97	1.86	30	61
Stations Vertical	IGRF 1970	20.71	151.01	Penumbral Width	0.35	0.46	30	61
Stations Vertical	IGRF 1970	20.71	151.01	PC	2.09	2.03	30	61

References

E1. Shea, M.A., Smart, D.F., McCall, J.R., and Gumm, B.S. (1974) Tables of Vertical Cutoff Rigidities for Epochs 1955 and 1960, ERP No. 493, AFCRL-TR-74-0550, AD A006677.

E2. Shea, M.A., Smart, D.F., McCall, J.R., and Gumm, B.S. (1974) Tables of Non-vertical Cutoff Rigidities for 76 Various Locations, ERP No. 497, AFCRL-TR-75-0008, AD A006397.

E3. Shea, M.A., Smart, D.F., McCall, J.R., and Gumm, B.S. (1975) Tables of Asymptotic Directions and Vertical Cutoff Rigidities for a Five Degree by Fifteen Degree World Grid Using the Finch and Leaton Geomagnetic Field Model, ERP No. 498, AFCRL-TR-75-0032, AD A010426.

E4. Shea, M.A., and Smart, D.F. (1975) Asymptotic Directions and Vertical Cutoff Rigidities for Selected Cosmic-ray Stations as Calculated Using the Finch and Leaton Geomagnetic Field Model, ERP No. 502, AFCRL-TR-75-0177, AD A012249.

E5. Shea, M.A., and Smart, D.F. (1975) Tables of Asymptotic Directions and Vertical Cutoff Rigidities for a Five Degree by Fifteen Degree World Grid as Calculated Using the International Geomagnetic Reference Field for Epoch 1975.0, ERP No. 503, AFCRL-TR-75-0185, AD A012509.

E6. Shea, M.A., and Smart, D.F. (1975) Asymptotic Directions and Vertical Cutoff Rigidities for Selected Cosmic-ray Stations as Calculated Using the International Geomagnetic Reference Field Model Appropriate for Epoch 1975.0, ERP No. 510, AFCRL-TR-75-0247, AD A015736.

E7. Shea, M.A., and Smart, D.F. (1975) Tables of Asymptotic Directions and Vertical Cutoff Rigidities for a Five Degree by Fifteen Degree World Grid as Calculated Using the International Geomagnetic Reference Field for Epoch 1965.0, ERP No. 524, AFCRL-TR-75-0381, AD A015739.

E8. Shea, M.A., Smart, D.F., and Carmichael, H. (1976) Summary of Cutoff Rigidities Calculated With the International Geomagnetic Reference Field for Various Epochs, ERP No. 561, AFGL-TR-76-0115, AD A028978.

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