DATA SET CATALOG #166

64-069A-01D

COSMOS 49, MAGNETOMETER

Table of Contents

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP's).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here.
http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

SPMS 00363

COSMOS 49

MAGNETOMETER DATA, TAPE

64-069A-01D

THIS DATA SET HAS BEEN RESTORED. IT ORIGINALLY CONTAINED ONE 7-TRACK, 556 BPI TAPE WRITTEN IN BCD. THERE IS ONE RESTORED TAPE WRITTEN IN ASCII. THE DR TAPE IS A 3480 CARTRIDGE AND THE DS TAPE IS 9-TRACK, 6250 BPI. THE ORIGINAL TAPE WAS CREATED ON AN IBM 360 COMPUTER AND WAS RESTORED ON AN IBM 9021 COMPUTER. THE DR AND DS NUMBER ALONG WITH THE CORRESPONDING D NUMBER AND TIME SPAN IS AS FOLLOWS:

DR#	DS#	D#	FILES	TIME SPAN
DR005731	DS005731	D008038	1	10/24/64 - 11/03/64

64-069A-01D

COSMOS 49, MAGNETOMETER

556 BPI, 7 track, BCD, 1 file, IBM 360

D-08038 C-05818 10/24/64 - 11/03/64

The coefficient set used in the model may be found in the card cabinet in the GEOS room.

COSMOS 49 (64-069A-01D)

BCD TAPE FORMAT

CHARACTER	FORMAT	DESCRIPTION
1	I1	Detector 1 or 2
2-3	I2	Day of month
4-5	I2	Month
6-10	I5	Measurement #
11-12	I2	Hour
12-13	I2	Minute
14-18	F5.1	Altitude
19-24	F6.2	Latitude
25-30	F6.2	Longitude
31-35	I5	F1 - measured field strength
36-40	I5	F2 - Computed field strength
41-45	I5	F = F2-F2
46-80		Blanks

This is one logical record, there are 30 logical records per physical record.

Tape is 7 track, 556 BPI, BCD, 1 file, Tape was created on IBM 360

The coefficient set used in the model may be found in the GEOS room.

February 17, 1972

MEMORANDUM

TO: J. Johns

FROM: J. King

SUBJ: Disposition of data sets 64-069A-01B and -01C

Following the oral recommendation of Dr. J. Cain, eliminate from the NSSDC data holdings the two tapes which constitute data sets 64-069A-01B and 64-069A-01C. New data set 64-069A-01D will contain all the data found in data sets 01B and 01C, but in a better ordered, less error-plagued tape.

J. King

J. King

March 3, 1972

To: Data Repository

From: ADP Services

Subject: Releasing of D and C tapes.

Please release tapes D-04942 and D-00667 and their associated C tapes from the NSSDC tape library.

Space Physics Division
Goddard Space Flight Center
January 14, 1971

Derivation of COSMOS-49 (12/70) Model
Ron Sweeney

A new mathematical model has been derived for the quiet time Cosmos-49 magnetic field data of November and December, 1964. This model was created by fitting the Cosmos-49 data using the method of least squares, (Cain et.al., 1967) with a series of 120 internal spherical harmonic coefficients. The final RMS difference of this fit was 16γ.

The procedure used to create this coefficient set was basically threefold. First, we fit all of the Cosmos-49 data with 80 spherical harmonic coefficients (n = m = 8), using the GSFC (12/66) coefficient set as an initial estimate to the data. The resulting RMS difference after two iterations was 72γ.

Secondly, using the output coefficients of the first analysis as input, we fit the Cosmos-49 data with three different sets of spherical harmonics - n* = 9, 10, and 11. Only data within 100γ of the field values computed from the input coefficient set for each iteration were fit. The RMS differences after three iterations were 21γ, 19γ, and 18γ for n* = 9, 10, and 11 respectively. After examining the residual distributions of the fitted data versus the three resultant field models, we selected the 143 coefficients (n = m = 11) as the most realistic of the three models. We then created a Cosmos-49 data tape which contained only those data with residuals within 70γ of this model.

Finally, we fit all of this fixed Cosmos-49 data set (16,659 points) with spherical harmonic coefficients for $n^* = 9$, 10, and 11. After three iterations the RMS of these fits was 19γ, 16γ, and 15γ for $n^* = 9$, 10, and 11 respectively. The distribution of the absolute residuals of this fixed data set from each of the resulting three models is as follows:

n	100	90	80	70	60	50	40	30	20	10	0
9	3	11	33	91	175	378	1042	2541	5088	7297	
10	0	0	25	63	107	179	633	2058	5125	8467	
11	0	0	6	83	97	169	469	1779	4954	9102	

We chose the middle model ($n = m = 10$) as being sufficiently representative of this data set since the added 23 coefficients did not reduce the RMS residual appreciably.

*The symbol n^* is used here to denote the maximum degree n and order m of the spherical harmonic expansion used. Since g_0 is taken as zero, the number of coefficients is given by $(n^*)(n^* + 2)$. Thus $n^* = 10$ corresponds to 120 coefficients.

REFERENCES

Cain, Joseph C., Shirley J. Hendricks, Robert A. Langel, and William V. Hudson, A proposed model for the International Geomagnetic Reference Field - 1965, J. Geomag. Geoelec., 19, 335-355, 1967.

Parts 1, 2, 3

CATALOG OF MEASURED AND CALCULATED VALUES OF THE STRESS MODULUS OF THE GEOMAGNETIC FIELD ALONG THE ORBIT OF THE COSMOS-49 SATELLITE

Part I

From No. 1 to No. 6205

24 October-4 November, 1964

Sh. Sh. Dolginov, V. N. Nalivayko, et al

Editor: V. P. Orlov

Institute of Terrestrial Magnetism, the Ionosphere and Propagation of Radio Waves, Academy of Sciences USSR, Moscow 1967

From NASA SP-3028 page 519

date Cosmos 49 = 10/24/64

Site – Kapustin Yar

orbit period 91.3 min

Perigee 162 miles

Apogee 324 miles

Inc. 49.0°

Catalog of Measured and Calculated Values
of the Stress Modulus of the Geomagnetic
Field Along the Orbit of the Cosmos-49
Satellite
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Annotation

The catalog of measured and calculated values of magnetic field intensity modulus (T) along the orbit of the satellite Cosmos-49 contains 17,489 measurements performed during November of 1964. The catalog consists of three parts. In the first part a brief text is presented, describing the measurements themselves, their processing, certain results and the content of the numerical tables. The first portion includes 6205 measurements. The second and third portions include only a description of the content of the tables and the tables themselves.

In the period from 24 October to 3 November 1964, measurements of the magnetic field of the earth were performed using absolute proton magnetometers in the Cosmos-49 satellite. These measurements were a part of the Soviet national program in the plan for world magnetic surveying.

1. Orbit and Magnetic Surveying

The satellite was placed in orbit at an angle of 49° to the plane of the equator. The distance from the surface of the earth at apogee was about 484 km, at perigee about 265 km. The rotation period around the earth was 91.83 min. The period of operation of the scientific apparatus on the flight was 11 days. Due to differences in the periods of rotation of the earth and the satellite and the asphericity of the earth, causing a shift of the orbit to the west at a rate of about 45° per day, during this eleven-day period the satellite performed even surveys over the surface bounded by latitudes ±49°, making up 75% of the surface of the earth.

An idea of the density of the survey net is given by Figure 1. This figure shows the flight trajectories at intervals of approximately 20 revolutions. The dots correspond to points where T was measured, the solid lines are flight sectors for which for various reasons no measurements were made. Figure 1 gives a good representation of the survey density along the orbits, but the number of orbits was actually approximately twenty times greater.

2. Nature of Primary Magnetometric Information

The Cosmos-49 satellite carried two proton magnetometers, which were operated alternately, with their transducer sections oriented at an angle of 90°. A skeletal diagram and description of the principle of operation of the proton magnetometers are presented in [1]. The accuracy of measurement using these proton magnetometers was 2 gammas. We present below a brief description of the cycle of operation of measurements of the magnetic field with the proton magnetometers, which is required in a discussion of the accuracy of the experimental material.

Upon receipt of an external command from the precision on-board time programming device, the polarization current was connected to magnetometer 1 for time $t_1 = 1.92$ sec, after which the winding of the transducer was connected to the amplifier input. After a certain delay (t = 0.18) the search for the optimal-signal range was begun. Depending on the field intensity and the preceding reading, search time t_3 varied between 0 and 650 msec. After the logic circuits of the magnetometer established the presence of an optimal signal, the signal search was halted and the actual measurement process was begun, which continued, depending on the field intensity present, from 0.2 to 0.6 sec (t_4). The indications of the frequency meter were retained for 8 sec, the time necessary to record the measured values in the on-board memory device.

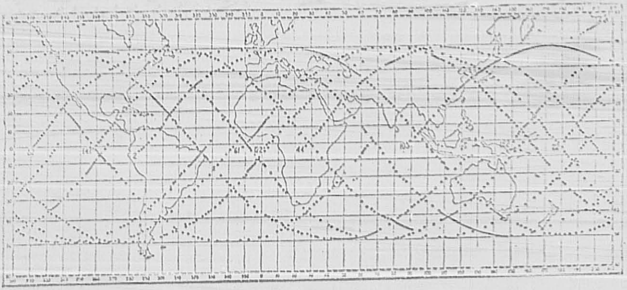

Figure 1

The scientific information was recorded as eight voltage levels varying between 0 and 6 volts. The information from one measurement (an octal number) consisted of six digits taken from the six photo units. The frequency meter measured the number of pulses N of the quartz magnetometer generator developed in time T, equal to 512 cycles of nuclear precession. In order to determine number N, the indications of the magnetometer were translated from octal code to decimal code.

The operation of calculation of T was performed using an M-20 computer:

$$T = \frac{12025.25\ (100000 + \Delta f)}{N}$$

where Δf is the temperature correction of the frequency of the crystal oscillator in the magnetometers;

N is the number of pulses, as mentioned above.

The memory device could store the information for up to 800 minutes. The information was recalled from storage on command from the earth as the satellite flew over the receiving stations.

The time programmer turned on the magnetometers in a 65.53-second cycle, alternately at intervals of 32.76 seconds. Also, the time programmer created on-board timing signals. Correlation of on-board time to absolute time was performed by comparing the on-board time signals in the reproduction mode with signals recorded during direct transmission. The above listed information processing steps produced a catalog of measured values of T of the geomagnetic field, correlated to Moscow time. The Moscow time of the moment of measurement was determined using the formula

$$t_{Mosc} = t + (n - 1)\Delta t + T_{inst}$$

where t_{Mosc} is the Moscow time of the first minute time signal;

Δt is the repetition period of the timer signals in seconds;

T_{inst} is the time correction required to consider the internal operating cycle of the magnetometer.

As was noted above, T_{inst} includes some uncertainty, since the value of search time t_3 is not precisely known. If in place of the precise value of T_{inst} we consider the mean value, the maximum error might be ±0.28 sec. Measurement time t_4 can be determined accurately, i.e. the field measured is known. However, the mean time was used in processing. These inaccuracies could lead to an error in time correlation of ±0.5 sec.

In the final analysis, it was necessary to know the coordinates ϕ, λ, and h of the satellite at the moment of measurement of the field. In order to produce these values, the catalog of orbits of the Cosmos-49 satellite can be used. The catalog contained values of h in meters, ϕ and λ in degrees and fractions of a degree for whole minutes (at intervals of one minute) of Moscow time. The geodesic coordinates and altitude of the satellite were calculated relative to a biaxial ellipsoid with the following characteristics: large half axis $\overline{a}$ = 6378.178 km, compression α = 0.00335238918. The maximum error in determination of the coordinates of the Cosmos-49 satellite was one kilometer of altitude h, three kilometers along the trajectory and one kilometer in the direction of a plane perpendicular to the orbit. Determination of the coordinates at the moment of measurement was performed by the method of interpolation using the quadratic formula. This operation was performed using the Ural-2 computer; the error of the process of interpolation was an order of magnitude less than the error involved in the process of output the coordinates.

3. Analytic Geomagnetic Field

Since for most investigations which include a program of scientific processing of the results of magnetic measurements performed by satellite it is necessary to use some variant of analytic representation of the geomagnetic field, this catalog includes calculated values of the scalar quantity T_{theor} along the orbit at the points of measurement of the field by the instruments of the satellite. The theoretical field was calculated using the coefficients of spherical harmonic analysis of world magnetic maps of the 1960 epoch, composed at the Leningrad department of IZMIRAN [Institute of Geomagnetism, the Ionosphere and Propagation of Radio Waves, Academy of Sciences USSR]. The analysis [2] was performed for a spherical earth using n = 6, m = 6, i.e. considering 48 coefficients. In order to produce T_{theor}, the values of the northern and eastern components were calculated for the coefficients g_n^m, h_n^m, values of the vertical coefficients using the coefficients j_n^m, k_n^m (Table 1). All coefficients up to n = 3 and m = 3 were corrected for the secular variation using the data of analyses of the secular variation for 1955-1960 [3].

Table 1. Coefficients of Spherical Harmonic Analysis Used in Calculation of T_{theor}

n	0	1	2	3	4	5	6	1	2	3	4	5	6
				g_n^m							h_n^m		
1	-3047	-210						581					
2	-161	292	166					-198	27				
3	119	-194	129	84				-43	20	-16			
4	96	82	47	-36	31			-14	-31	-1	-24		
5	-19	35	25	-3	-17	-5		2	-12	-7	-11	7	
6	6	0	-1	-28	1	-1	-10	-3	12	3	-1	-1	-1
				j_n^m							k_n^m		
1	6076	436						-1151					
2	468	-906	-490					+592	-59				
3	-443	+795	-514	-335				166	-74	71			
4	-507	-398	-260	183	-131			-61	+142	11	104		
5	+143	-207	-137	23	101	45		-8	-71	50	69	-64	
6	-70	-50	-18	164	-13	-2	48	23	-72	-39	24	-5	-13

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5	- 19	35	25	- 3	- 17	-5		2	-12	- 7	-11	7	
6	6	0	- 1	-28	1	-1	-10	- 3	12	3	- 1	-1	- 1
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5	+ 143	-207	- 137	23	101	45		- 8	- 71	50	69	-64	
6	- 70	- 50	- 18	164	- 13	- 2	48	23	- 72	- 39	24	- 5	-13

4. Testing of Initial and Calculated Values

Both the measured and the calculated values of T could contain errors. Improper measurement of T could occur in case of unfavorable positions of the axis of either transducer relative to the geomagnetic field. Although the magnetometer circuit forbids the performance of measurements with these positions, still, under boundary conditions, i.e. when the signal is not so slight as to be forbidden, false readings could be made. As a rule, false readings were easy to detect, since they differed sharply from neighboring values of field gradients. For testing purposes, graphs were constructed and the readings indicating sharp field gradients were easily recognized.

After the theoretical fields along the trajectory and the differences ΔT between measured and calculated field values were calculated, the graphs of ΔT allowed testing to be performed more easily, using the same criteria -- absence of sharp field gradients at the altitude of the satellite flight path. Subsequently, some of the readings which had been discarded can be subjected to additional filtration upon comparison with the effects in a variable field.

More detailed analysis of the value and geographic distribution of ΔT [4] allowed us to make the following conclusions:

1) over most of the area of the earth's surface which was investigated, the values of ΔT are less than 200 gamma; the areas of larger values (500-600 gamma) represent large scale anomalies. Our attention was drawn to the tendency of areas of ΔT to correspond with the world ocean, for which the world maps are less accurate.

2) there is no relationship between distribution of values of T and ΔT.

3) the dimensions and distribution of regions with large ΔT are such that the field of T should be described by low order harmonics.

Figure 2 shows a histogram of the distribution of ΔT from [4]. In correspondence with this histogram, made up on the basis of 4,000 values of ΔT, the algebraic mean value of ΔT (excess of negative ΔT over positive) is -60 gamma, the arithmetic mean is ±184 gamma. These values of ΔT are rather characteristic for the entire set of measurements on board Cosmos-49.

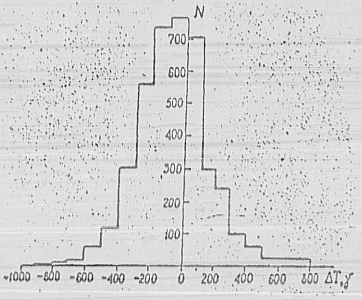

Figure 2

The results of the primary processing are presented in the form of a numerical catalog and set of graphics.

5. Description of Catalog

Due to the large volume of information produced from Cosmos-49 (17300 measurements), the catalog is divided into three parts. The first part contains this text plus the first 6,000 measurements.

The second part is a description of the catalog, plus measurements from 6,000 to 12,000; the third part consists of another description and measurements from 12,000 to 17,300.

The catalog consists of eight columns:

1. The ordinal number of the measurement.

2. Moscow time in hours and minutes. The moments of time are rounded off to the even minutes in correspondence with the time base of standard magnetograms (20 mm-60 min).

3. Height h, at which the measurement was performed, in kilometers.

4-5. The geographical coordinates down to 0.01°. Northern and southern latitudes are distinguished by their sign, longitudes are measured from Greenwich, always east.

6. The measured value of intensity modulus T in gammas.

7. The theoretical (calculated) value of intensity modulus in gammas.

8. The difference $\Delta T = t_{meas} - t_{theor}$ in gammas.

Columns 1 and 8 require additional explanation.

For technical reasons, the processing of experimental material was performed first for the measurements made by the first instrument, then by the second. The machine carried 360 measurements at one time. In order to simplify composition of the overall numeration of the catalog, the numbers were given out in the following order: ~360 measurements of the first instrument, then ~360 measurements over the same trajectory interval and the same time interval by the second instrument. The next numbers cover the following trajectory-time segment for the first instrument, etc. Changes of instruments and dates are indicated. The distribution of ordinal numbers by instruments is given preceding the numerical tables in each portion of the catalog.

Column 8 gives the difference between T_{meas} and T_{theor}. This difference was produced using values of T_{meas} and T_{theor} which had not been rounded off, and may differ by one gamma from the values produced directly from catalog data.

6. Set of Graphs of ΔT

Based on the catalog, a set of graphs of ΔT, ϕ and h as a function of λ has been produced for all revolutions from 1 to 163. The beginning of a revolution was considered to be the moment when the satellite intersected the plane of the equator moving from south to north. The relationship between the beginning of a revolution and the catalog number is given in Table II. In those cases when no measurements were made near the equator, a dash is placed in the column "according to catalog." The instrument used to make the measurement taken as the first for the revolution is shown after the hyphen. A reduced sample of one such graph is shown on Figure 3.

Photo copies of the set of illustrations in natural size can be ordered from IZMIRAN. The basis of the composition of the graphs was the fact that each 77 revolutions, the trajectories of the satellite had corresponding values of ϕ and λ; revolution 79 had similar ϕ and λ to revolution 2, revolution 80 to revolution 3, etc., although there was considerable change in the altitude due to orbital deformation. Since altitude changes have little influence on ΔT_i and ΔT_{i+77}, these "paired" revolutions could be considered repetitions. The "paired" orbits, their ϕ, λ and h are shown on one sheet of the graph set and are accompanied by curves for $dT = \Delta T_i - \Delta T_{i+77}$ and $\Delta H = H_i - H_{i+77}$.

The values of dT depend on:

1. The error in determination of coordinates.

2. The difference in the magnetic activity and local time, i.e. the varying influence of external field sources. Therefore, it can be considered that the value of dT characterizes the summary uncertainty of the measured values of T resulting from field sources within the earth.

Table II. Ordinal Number of Revolutions of Flight of Cosmos-49 and Corresponding Catalog Numbers

Revolution	Catalog numbers	Revolution	Catalog numbers	Revolution	Catalog numbers
2-II	227	30-II	3322	58-II	5642
3-II	238	3I-II	3385	59-I	570I
4	–	32	–	60-I	5766
5-II	3I6	33	–	6I-I	5832
6-I	380	34-I	3573	62	–
7-I	450	35	–	63-I	6258
8-I	520	36	–	64	–
9-I	589	37-I	3832	65-I	6500
I0-II	II75	38-I	3895	66-I	6564
II-I	936	39-I	3956	67-II	688I
I2-I	I029	40-I	40I3	68-II	6943
I3-I	I065	4I	–	69	–
I4-II	I425	42	–	70	–
I5-I	I477	43	–	7I-I	7I36
I6-I	I536	44-I	4248	72-II	7462
I7-I	I60I	45-II	4507	73	–
I8-I	I668	46	–	74	–
I9-I	I968	47-I	4420	75-II	7869
20-I	2034	48	–	76-II	7950
2I-I	2095	49	–	77-I	80I2
22-II	2426	50-I	4670	78-I	8074
23-I	2485	5I-I	4729	79-I	8I34
24	–	52-I	4785	80-I	8202
25	–	53-II	5085	8I-I	8240
26-I	2642	54-I	5I74	82-I	8534
27-I	2692	55-I	52I2	83-I	8602
28-II	3I97	56-II	5534	84-I	8659
29-II	3265	57	–		

Note: I, II mean first and second instruments.

Table II continued. Ordinal Number of Revolutions of Flight of Cosmos-49

and Corresponding Catalog Numbers

Revolution	Catalog numbers	Revolution	Catalog numbers	Revolution	Catalog numbers
85-I	87I5	II2	-	I39	-
86	-	II3	-	I40-I	I4833
87-I	9068	II4-I	II693	I4I	-
88	-	II5-I	II86I	I42-I	I5073
89-П	9627	II6-П	I2I70	I43-I	I5360
90-П	9684	II7	-	I44-I	I54I4
9I-П	9740	II8	-	I45-I	I546I
92-П	9783	II9	-	I46	-
93-П	9846	I20	-	I47	-
94-П	I0I66	I2I-П	I2746	I48-П	I5629
95-П	I0224	I22-П	I28I5	I49-П	I569I
96-П	I0268	I23	-	I50	-
97-П	I03II	I24-I	I2936	I5I	-
98-I	I0372	I25	-	I52-I	I6276
99-I	I0430	I26	-	I53-П	I6072
I00-I	I0496	I27-I	I3II7	I54-I	I6384
I0I-I	I0525	I28-I	I3436	I55-П	I6445
I02	-	I29-I	I3505	I56-П	I6503
I03-I	I0878	I30-П	I3938	I57-I	I6720
I04-П	III83	I3I-П	I4002	I58-П	I6576
I05-I	I0999	I32-П	I4070	I59-I	I6636
I06-I	II06I	I33-П	I4I33	I60-П	I6878
I07-П	II497	I34	-	I6I-I	I7I73
I08-I	II428	I35-П	I45I7	I62-П	I7238
I09	-	I36-П	I4579	I63-I	I7306
II0	-	I37-П	I4639		
III-I	II60I	I38-I	I4698		

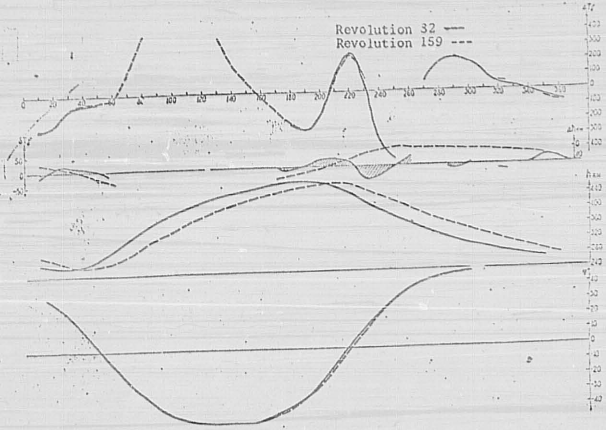

Figure 3

7. Map of Residual Field T at Altitude h = 400 km

The results of measurements made on the Cosmos-49 satellite were also summarized in the form of a map of the residual field of modulus T. This map was made on the basis of 4,000 measurements of T performed at various altitudes and corrected to an altitude of 400 km according to the gradients $\partial T/\partial h$, calculated from the spherical harmonic coefficients (see Table I). The values of the field of homogeneous magnetization for the same altitude were subtracted from the values of T_{400}, i.e. the field of the first harmonic term was subtracted. T_{res} is shown on Figure 4. The distribution of T_{res} (figure 4) at the altitude of the Cosmos-49 retains all the primary features of the residual field at the surface of the earth: the centers of the world anomalies, the areas of large gradients both retain the same geographic distribution.

A comparison of T_{res} at 400 km and on the surface of the earth is presented below:

	Northern hemisphere						Southern hemisphere	
Longitude of epicenter of anomaly	λ = 102°		λ = 190°		λ = 270°		λ = 135°	
h in km	0	400	0	400	0	400	0	400
T_{res}	I5300	II300	-2300	-I400	6I00	3900	II200	8800

The lack of change in the position of the world anomalies when the distance from the surface of the earth is increased indicates the correctness of approximating their fields by radial dipoles located at great depths (MacNish, Rancorn, Aldridge, Pudovkin, et al.). The decrease in intensity of T_{res} at 400 km altitude corresponds to a location of the dipoles approximating the world anomalies at the boundary of the core or near it (at depths of 2000-4000 km), which confirms the evaluations of Aldridge, made using surface data alone.

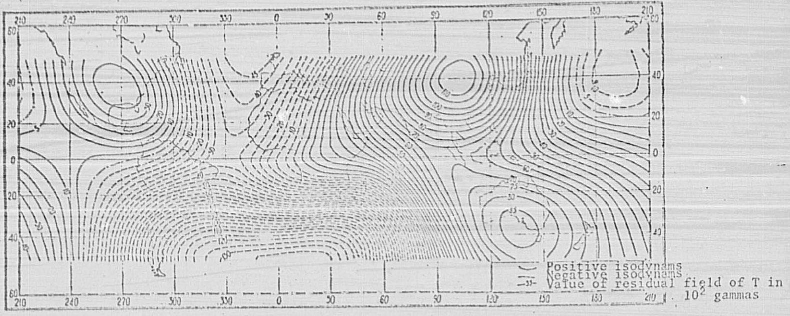
Positive isodynams
Negative isodynams
Value of residual field of T in 10^2 gammas

Figure 4

8. Spherical Analysis of Modulus T

The observations of modulus T made on the Cosmos-49 satel te were used to calculate the coefficients of spherical harmonic analysis by the method described in [5] and [6]. The analysis was performed for two samples of 4,000 measurement points each with a spherical harmonic series length n = 9 and m = 9 [7]. The mean square error in the reproduction of measured values of T was ±15 gamma, although in the polar areas the error would be greater.

The coefficients produced (see Table III) can be used for calculation of the field in near earth space or can be used as an analytical representation of the world magnetic maps and maps of the "normal" field, but cannot be used to give information on regional anomalies.

9. Personnel

The program, technical assignment for the experiment and technical assignment for development of the measuring apparatus were made up by Candidate of Physical and Mathematical Sciences Sh. Sh. Dolginov and Senior Engineer of the Magnetic Laboratory of IZMIRAN V. I. Nalivayko.

The magnetometric apparatus of Cosmos-49 was developed and prepared by the team of P.O. Box 244, Kiev, Sovnarkhoz, consisting of M. M. Chinchevoy, Zh. Dazhuk, E. A. Bulychev, G. V. Drov, B. G. Tavrovskiy, O. G. Nagasnik and T. Ya. Bezmen, under the leadership of M. M. Chinchevoy. Independent tests of the magnetometric apparatus, adjustment of the apparatus and geophysical correlation, as well as tests of all on-board equipment as assembled were performed by: M. M. Chinchevoy, V. I. Nalivayko, Sh. Sh. Dolginov and A. V. Tyurmin.

Decoding of satellite data and composition of the initial catalog of measured values of T correlated to absolute time were performed by a team at the Computations

Bureau of Box No. 2286 and by IZMIRAN, consisting of scientific workers R. Z. Brodskaya, G. N. Zlotyn, I. N. Kiknadze, A. R. Freydin and laboratory assistants: R. D. Kuznetsova, I. P. Ivchenko, N. Yu. Protenko, V. N. Fursenko, T. D. Grishina and A. K. Pozorova. Primary processing of the experimental data, the composition of this catalog and graph set were performed by teams from the Constant Field Laboratory, the Computations Department and Magnetic Laboratory of IZMIRAN consisting of scientific colleagues: N. V. Adam, L. O. Tyurmina, T. N. Cherevko, N. A. Zhuravleva, L. V. Konovalova, and laboratory assistants: Z. F. Agafonnikova, T. N. Baranova, V. V. Blinova, T. D. Grishina, L. V. Kurakova, I. P. Ivchenko, Ye. Ye. Kanonidi, A. I. Tereshchenko, L. I. Ulanova and O. A. Krutikhovskaya, under the leadership of Doctor of Physical and Mathematical Sciences N. P. Ben'kova.

Editor -- Dr. of Physical and Mathematical Sciences V. P. Orlov

Table III. Coefficients Calculated from Measurements on Cosmos-49

n-m	g_n^m	h_n^m	n-m	g_n^m	h_n^m
I-0	-30362	-	7-0	+64	-
I-I	-2I49	+5707	7-I	-55	-73
2-0	-I625	-	7-2	+ 4	-27
2-I	+3000	-20I3	7-3	+ 3	-I4
2-2	+I552	+ 204	7-4	-I9	+I2
3-0	+I297	-	7-5	- 8	+3I
3-I	-2033	- 392	7-6	+I3	-I6
3-2	+I289	+ 264	7-7	-I0	-I3
3-3	+ 758	- 228	8-0	+I6	-
4-0	+ 976	-	8-I	+I0	+ 4
4-I	+ 8I4	+ I38	8-2	- 9	-22
4-2	+ 486	- 308	8-3	-I0	+ 2
4-3	- 388	- 2	8-4	- 6	-II
4-4	+ 266	- I74	8-5	+I8	- 2
5-0	- 242	-	8-6	+ 8	+26
5-I	+ 344	- 6	8-7	+I6	-I0
5-2	+ 262	+ I02	8-8	+ 8	- 8
5-3	- 5	- 99	9-0	0	-
5-4	- I74	- I06	9-I	+ 5	-3I
5-5	- 42	+ 52	9-2	+I2	+ 4
6-0	+ 62	-	9-3	-I4	+I3
6-I	+ 68	- 78	9-4	+I0	- 2
6-2	+ 6	+ II2	9-5	+ 2	- 6
6-3	- 226	+ 76	9-6	0	+ 6
6-4	+ 2	- 58	9-7	+ 4	+ 9
6-5	- 20	+ 5	9-8	+ 4	- 2
6-6	- I60	- 30	9-9	- 2	+ I

Note: Coefficients calculated for spheroidal earth.

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Part I

From No. 1 to No. 6205

Table

Distribution of Catalog Numbers by Dates and Instruments

Instrument I:	Date	Numbers of points	Time	Instrument II	Date	Point numbers	Time
	24/X	I-I90	07 I6-I3 42		24/X	I9I-352	07 I8- I3 44
	-	353-653	I3 44-20 I8		-	654-9I2	I3 44-20 I6
	24-25/X	9I3-II67	20 I8-02 52		24-25/X	II68-I437	20 I8- 02 50
	25/X	I438-I690	03 02-09 38		25/X	I69I-I945	02 54-09 38
		I946-22I6	09 38-I6 I2			22I7-2480	09 38-I6 I0
	-	248I-2703	I6 I6-22 46			2704-2898	I6 I2-22 42
	25-26/X	2900-3I48	23 02-05 I8		25-26/X	3I49-34I7	22 46-05 I8
	26/X	34I8-3599	05 20-09 52		26/X	3600-376I	05 20-09 52
	-	3762-40I3	II 56-I8 20		-	40I4-4247	II 56-I8 20
	26-27/X	4248-4443	00 30-05 40		27/X	4444-4637	00 30-05 38
	27/X	4638-4884	03 52-I5 20			4885-5I34	08 54-I5 26
		5I35-5396	I5 26-2I 50			5397-5645	I5 26-22 00
	27-28/X	5646-5927	2I 54-04 24		27-28/X	5928-6205	22 00-04 26

Point numbers	Time hr	min	Height in km			T^{γ}_{meas}	T^{γ}_{theor}	
			Instrument I		24 October			
c Б I								
I	07	06	282,5	+2I,24	I02,95	38402	38392	+ I0
2	07	06	287,I	+I8,07	I05,93	36962	36930	+ 32
3	07	20	292,2	+I4,86	I08,78	35794	35692	+I02
4	07	22	297,9	+II,6I	III,53	34922	3476I	+I60
5	07	22	304,I	+ 8,33	II4,2I	34476	34200	+276
6	07	24	310,8	+ 5,04	II6,84	34322	34037	+284
7	07	24	317,9	+ I,74	II9,43	34582	34275	+307
8	07	26	325,4	- I,55	I22,00	35I92	34880	+3II
9	07	26	333,3	- 4,83	I24,58	36II3	35802	+3II
I0	07	28	34I,5	- 8,I0	I27,I8	37255	36968	+286
II	07	30	358,5	-I4,53	I32,5I	39985	39730	+254
I2	07	30	367,3	-I7,68	I35,28	4I399	4II74	+225
I3	07	32	376,I	-20,77	I38,I5	4277I	4257I	+200
I4	07	34	385,0	-23,80	I4I,I5	44024	43868	+I55
I5	07	36	402,6	-29,59	I47,59	46I3I	4602I	+II0
I6	07	38	4I9,5	-34,94	I54,80	475II	47466	+ 44
I7	07	38	427,6	-37,4I	I58,76	47922	479I5	+ 7
I8	07	40	435,4	-39,7I	I62,98	48I48	48I89	- 4I
I9	07	40	442,7	-4I,82	I67,50	482I2	48296	- 85
20	07	42	449,7	-43,7I	I72,30	48I08	48246	-I39

CATALOG OF MEASURED AND CALCULATED VALUES OF GEOMAGNETIC FIELD INTENSITY MODULUS ALONG ORBIT OF SATELLITE COSMOS-49

Part II

From No. 6206 to No. 12336

24 October-4 November 1964

Sh. Sh. Dolginov, V. N. Nalivayko, et al

Editor: V. P. Orlov

Institute of Terrestrial Magnetism, the Ionosphere and
Propagation of Radio Waves,
Academy of Sciences USSR, Moscow, 1967

Explanation of Numerical Tables of Catalog

1. Ordinal number of measurement

2. Moscow time in hours and minutes. Moments of time rounded off to even minutes in correspondence with time scale of standard magnetograms (20 mm-60 min).

3. Height h, at which measurement was performed, in kilometers.

4-5. Geographical coordinates to 0.01°. North and south latitudes distinguished by sign, longitude, from Greenwich, always east.

6. Measured value of intensity modulus T in gammas.

7. Theoretical (calculated) values of intensity modulus in gammas.

8. Difference $\Delta T = T_{meas} - T_{theor}$ in gammas.

For technical reasons, processing of the experimental material was done first for measurements made by the first instrument, then by the second. 360 measurements were put in the machine simultaneously. In order to simplify composition of the overall numeration of the catalog, the numbers were given in the following order: ~360 measurements by the first instrument, then ~360 measurements, covering the same interval of trajectory and time, by the second instrument. Subsequently, the next numbers were assigned for the next segment of the trajectory by the first instrument, etc. Changes of instruments and dates are indicated. The distribution of ordinal numbers by instruments is given before the numerical tables in each portion of the catalog.

Column 8 shows the difference between T_{meas} and T_{theor}. It was produced using values of T_{meas} and T_{theor} which had not been rounded off, and may differ by one gamma from the data produced directly from the catalog.

Table

Distribution of Catalog Numbers by Dates and Instruments

Instrument I. Date	Numbers of points	Time	Instrument II Date	Numbers of points	Time
28/X	6209 - 6345	04 24 - 07 28	28/X	6346- 6467	04 28-07 28
	6468 - 674I	07 52 - I4 I0.		6742 - 6982	07 52-I4 I0
	6984 - 7247	I4 I0 - 20 40		7248 - 7498	I4 I0-20 44
28-29/X	7499 - 7763	20 44 - 03 I8	28-29/X	7764 - 8026	20 46-03 I8
29/X	8027 - 8274	03 I8 - 09 52	29/X	8275 - 852[illegible]	03 I8-09 52
	8524 - 8753	I0 20 - I6 22		8755 - 8990	09 54-I6 20
	899I - 9068	I6 28 - I8 I6		9069 - 9137	I6 28-I8 I6
	9138 - 9245	I8 22 - 2I I8		9246 - 9356	I8 22-2I I4
29-30/X	9357 - 9626	2I 20 - 03 54	29-30/X	9627 - 9863	2I 20-03 54
30/X	9864 - I0I22	03 56 - I0 28	30/X	I0I23 - I0347	03 56-I0 28
	I0348 - I057I	I0 28 - I7 02		I0572 -I0808	I0 28-I7 02
	I0809 - II072	I7 02 - 23 36		II073 -II325	I7 02-23 36
30-3I/X	II326 - II438	23 36 - 02 34	30-3I/X	II439 -II563	23 36-06 I0
3I/X	II564 - II7I6	06 I2 - I2 44	3I/X	II7I7 -II848	06 I0-I2 44
	II849 - I2III	I2 44- I9 I8		I2II2 -I2336	I2 44-I9 I8

Point numbers	Time hr min	Height in km	$\varphi°$	$\lambda°$	T^Y_{meas}	T^Y_{theor}	ΔT^Y
I	2	3	4	5	6	7	8

Instrument I 28 October

c № 6206							
206[xx]	04 22	3II,6	+47,78	34,62	4253I	42615	-85
207[xx]	04 22	305,6	+48,60	40,77	43418	43633	-215
208[xx]	04 24	299,8	+49,04	47,08	44399	44668	-269
209[xx]	04 24	294,4	+49,II	53,48	45432	45700	-268
2I0	04 28	280,4	+47,04	72,I3	47950	48255	-305
2II	04 28	276,5	+45,65	77,89	48439	48702	-263
2I2	04 30	273,2	+43,95	83,34	48633	48837	-204
2I3	04 32	270,3	+4I,99	88,46	48480	486I3	-I34
2I4	04 36	264,6	+32,03	I05,7I	44082	44I20	-38
2I5	04 36	264,7	+29,I6	I09,35	4232I	4233I	-I0
2I6	04 38	265,4	+26,I8	II2,76	40467	40449	+I8
2I7	04 40	268,8	+I9,96	II9,06	36976	36850	+I26
2I8	04 40	27I,5	+I6,76	I2I,99	35554	3535I	+202
2I9	04 42	274,8	+I3,5I	I24,82	34474	34I78	+295
220	04 44	278,8	+I0,23	I27,56	33773	33399	+374
22I	04 44	283,3	+ 6,92	I30,24	33495	3305I	+443
222	04 46	288,5	+ 3,60	I32,86	3364I	33I40	+500
223	04 46	294,2	+ 0,28	I35,47	34I59	33638	+52I
224	04 48	300,5	- 3,03	I38,06	35000	34489	+5II
225	04 48	307,3	- 6,34	I40,67	36II5	356I8	+496
226	04 50	3I4,5	- 9,62	I43,3I	37407	3694I	+466
227	04 50	322,I	-I2,87	I46,00	38777	38368	+408

Note: [xx] points with numbers 6206-6209 [Part II] correspond to numbers 5924-5927 [Part I].

CATALOG OF MEASURED AND CALCULATED VALUES OF GEOMAGNETIC FIELD INTENSITY MODULUS ALONG ORBIT OF SATELLITE COSMOS-49

Part III

From No. 12337 to No. 17489

24 October-4 November 1964

Sh. Sh. Dolginov, V. N. Nalivayko, et al

Editor: V. P. Orlov

Institute of Terrestrial Magnetism, the Ionsophere and
Propagation of Radio Waves,
Academy of Sciences USSR, Moscow 1967

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Table

Distribution of Catalog Numbers by Dates and Instruments

Instrument I: Date	Numbers of points	Time	Instrument II Date	Point numbers	Time
3I.X-I.XI	I2337-I2624	I9^h I2^m-0I^h 46^m	3I.X-I.XI	I2625-I2882	I9^h I2^m-0I^h 46^m
I-XI	I2883-I3I47	0I 38-08 I2	I-XI	I3I48-I3393	0I 38-08 I2
	I3394-I3567	08 06-I2 02		I3568-I3720	08 06-I2 02
	I372I-I3937	I2 I2-I8 22		I3938-I4I92	I2 06-I8 20
I.XI-2.XI	I4I93-I4473	I8 40-0I I4	I-2-XI	I4475-I4744	I8 40-0I I4
2-XI	I4745-I4947	0I I4-07 48	2-XI	I4948-I5II4	0I I4-07 48
	I5II5-I5353	07 48-I4 20		I5354-I5592	07 50-I4 22
	I5593-I5795	I4 26-20 58		I5796-I599I	I4 22-20 58
2-3-XI	I5992-I6240	20 58-03 30	2-3-XI	I624I-I649I	20 58-03 30
3-XI	I6492-I6684	03 30-I0 04	3-XI	I6685-I6883	03 03-I0 02
	I6884-I7I26	I0 04-I6 38		I7I27-I7394	I0 08-I6 38
	I7395-I7439	I6 38-I7 48		I7440-I7489	I6 38-I7 48

Point numbers	Time hr min	Height in km	φ°	λ°	T^{γ}_{meas}	T^{γ}_{theor}	ΔT^{γ}
I	2	3	4	5	6	7	8

Instrument I · 31 October

c k I2337

337-343	No points in catalog						
344	I9 20	430,2	+I6,7I	89,47	34069	34I26	− 57
345	I9 20	424,2	+I9,77	92,25	35220	35266	− 46
346	I9 22	4I7,9	+22,78	95,16	36523	36574	− 52
347	I9 22	4II,4	+25,73	98,22	37993	37995	− 3
348	I9 24	404,6	+28,60	I0I,44	39433	39460	− 28
349	I9 26	397,8	+3I,38	I04,87	40895	4089I	+ 3
350	I9 30	369,0	+4I,20	I2I,I5	447I6	44857	−I4I
35I	I9 30	36I,7	+43,2I	I25,99	44967	45I6I	−I95
352	I9 32	354,3	+44,97	I3I,I6	44930	45I6I	−23I
353	I9 32	347,0	+46,46	I36,67	44635	44879	−I45
354	I9 34	339,8	+47,65	I42,47	44I47	44363	−2I7

```
12410    2 4 6287.1   REC   1, LENGTH 2400
12410    1 4 6282.5 21.24102.9538402 38399    3
22410  192 420289.6 16.47107.37363663635
18.07105.933696236980  -18
12410    3 420292.2 14.86108.783579435802  -8
6    9
12410    4 422297.5 11.61111.533492234935  -13
12410    5 422304.1
22410  193 422301.0  9.97112.863460434634  -30
22410  194 422307.4  6.68115.53343103432
8.33114.213447634431   45
12410    6 424310.8  5.04116.843432234313   9
4  -14
22410  195 424314.3  3.39118.143441434399   15
22410  196 424321.6
12410    7 424317.9  1.74119.433458234578   4
12410    8 426325.4 -1.55122.00351923519
-0.09120.723485834895  -37
12410    9 426333.3 -4.83124.583611336107   6
3   -1
22410  197 428337.4 -6.47125.883667036660   10
22410  198 428346.7
12410   10 428341.5 -8.10127.163725537262   -7
22410  199 430354.3-12.94131.16392823927
-9.72128.493791137904    7
12410   11 430358.5-14.53132.513998539982    3
5    7
12410   12 430367.3-17.68135.284139941400   -1
12410   13 432376.1-
22410  200 432371.7-19.24136.714211342099   14
22410  201 432380.6-22.30139.64434164342
20.77138.154277142771    0
12410   14 434385.0-23.80141.154402444044  -20
5   -9
22410  202 434389.4-25.28142.704462444628   -4
22410  203 436406.9-
12410   15 436402.8-29.59147.594613146138   -7
22410  204 436415.4-33.65152.92472584723
30.97149.314657546550   25
12410   16 438419.5-34.94154.804751147512   -1
7   21
22410  205 438423.6-36.20156.754773647741   -5

22410  206 440431.5-   REC   2, LENGTH 2400
12410   17 438427.6-37.41158.764792247920    2
12410   18 440435.4-39.71162.98481484814
38.58160.844807248054   18
22410  207 440439.1-40.79165.214819348195   -2
6    2
12410   19 440442.7-41.82167.504821248204    8
12410   20 442449.7-
22410  208 442446.3-42.79169.874818948169   20
12410   21 442456.2-45.36177.41478554785
43.71172.304810848102    6
22410  209 444459.2-46.09180.074768147680    1
3    2
12410   22 444462.1-46.74182.804745647469   -3
22410  210 446470.0-
12410   23 446467.5-47.83188.444695746954    3
12410   24 446472.4-48.60194.29463144630
48.25191.354667646643   33
22410  211 446474.6-48.86197.274594945933   16
6    8
12410   25 448476.6-49.03200.274553845525   13
22410  212 448481.7-
12410   26 448480.1-49.12206.324461844607   11
22410  213 450484.5-48.61215.31429894295
49.04209.344409944094    5
12410   27 450485.3-48.28218.254233642333    3
0   39
12410   28 452486.9-47.36223.974096640971   -5
12410   29 452487.7-
22410  214 452487.4-46.79226.754024640239    7
12410   30 454487.9-44.66234.67377693786
46.15229.463948939478   11
22410  215 454487.8-43.82237.173702837022    6
5  -96
22410  216 456487.0-41.96241.943530835288   20
22410  217 456485.5-
12410   31 456486.3-40.96244.213441334413    0
12410   32 458484.6-38.80248.53326723265
39.90246.413352633530   -5
22410  218 458483.4-37.68250.593180531799    5
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360 Dump.

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