

Central Radio Propagation Laboratory

# IONOSPHERIC PREDICTIONS

*for  
April  
1964*

TB 11-499-13/TO 31-3-28



U. S. DEPARTMENT of COMMERCE  
National Bureau of Standards  
Number 13/Issued January 1964

U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, Secretary

NATIONAL BUREAU OF STANDARDS

A. V. Astin, Director

Central Radio Propagation Laboratory

# Ionospheric Predictions

for April 1964

Number 13

Issued

January 1964

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables

of numerical coefficients that define the functions describing the predicted worldwide distribution of foF2 and M(3000)F2 and maps for each even hour of universal time of MUF(Zero)F2 and MUF(4000)F2.

NOTE: Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents.

Annual subscription (12 issues) \$1.50 (50 cents additional for foreign mailing).

## National Bureau of Standards

The functions of the National Bureau of Standards are set forth in an Act of Congress, March 3, 1901, as amended. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and tech-

nical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The Bureau also serves as the Federal technical research center in a number of specialized fields.

## Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory at Boulder, Colorado, is the central agency of the Federal Government for the collection, analysis, and dissemination of information on propagation of radio waves at all frequencies along the surface of the earth, in the atmosphere, and in space, and performs scientific studies looking toward new techniques for the efficient use and conservation of the radio spectrum. To carry out this responsibility, the CRPL—

1. Acts as the central agency for the conduct of basic research on the nature of radio waves, the pertinent properties of the media through which radio waves are transmitted, the interaction of radio waves with those media, and on the nature of radio noise and interference effects. This includes compilation of reports by other foreign and domestic agencies conducting research in this field and furnishing advice to government and nongovernment groups conducting propagation research.

2. Performs studies of specific radio propagation mechanisms and performs scientific studies looking

toward the development of techniques for efficient use and conservation of the radiofrequency spectrum as part of its regular program or as requested by other government agencies. In an advisory capacity, coordinates studies in this area undertaken by other government agencies.

3. Furnishes advisory and consultative service on radio wave propagation, on radiofrequency utilization, and on radio systems problems to other organizations within the United States, public and private.

4. Prepares and issues predictions of radio wave propagation and noise conditions and warnings of disturbances in these conditions.

5. Acts as a central repository for data, reports, and information in the field of radio wave propagation.

6. Performs scientific liaison and exchanges data and information with other countries to advance knowledge of radio wave propagation and interference phenomena and spectrum conservation techniques, including that liaison required by international responsibilities and agreements.

## Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for the use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for  $f_oF_2$  and  $M(3000)F_2$  defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high frequency propagation problems. The basic equations, their interpretation, and methods of using the numerical maps are described in two papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variations of Ionospheric Data by Numerical Methods," Volume 66D, Number 4, July-August 1962, pages 419-438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Volume 66D, Number 6, November-December 1962, pages 649-662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, to arrange for the purchase of the set of punched cards and for further information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF (Zero)  $F_2$  and MUF (4000)  $F_2$  for each even hour of universal time. Figures 13 to 16 present the same predictions for hours 00 and 12 universal time for the North and South Polar areas. Predicted polar maps for each even hour of universal time may be obtained by special arrangements with the Central Radio Propagation Laboratory. Handbook 90 describes methods for including regular E- $F_1$  propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunspot number used for the current prediction.

Members of the U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for the Navy: The Director, Naval Communications, Department of the Navy, Washington, D.C., 20350; for the Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington, D.C., 20330. Attention: AFOCCAA. Army personnel should refer to the Handbook as TM-11-499 and to the monthly predictions as TB 11-499-( ), predictions for the month of April 1964 being distributed in January 1964 and designated TB 11-499-(13), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 65, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1957.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

Table A

Observed and Predicted Zurich Smoothed Relative  
Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	43 (53)	42 (51)	39 (52)	36 (52)	34 (52)	32 (52)	31 (51)	29 (49)	28 (46)	28 (43)	27 (38)	26 (33)
1953	24 (30)	22 (29)	20 (27)	19 (24)	17 (22)	15 (21)	13 (20)	12 (18)	11 (18)	10 (17)	9 (16)	7 (15)
1954	6 (14)	6 (12)	4 (11)	3 (10)	4 (10)	4 (9)	5 (8)	7 (8)	8 (8)	8 (10)	10 (10)	12 (11)
1955	14 (12)	16 (14)	20 (14)	23 (13)	29 (16)	35 (18)	40 (22)	46 (27)	55 (30)	64 (31)	73 (35)	81 (42)
1956	89 (48)	98 (53)	109 (60)	119 (68)	127 (77)	137 (89)	146 (95)	150 (105)	151 (119)	156 (135)	160 (147)	164 (150)
1957	170 (150)	172 (150)	174 (150)	181 (150)	186 (150)	188 (150)	191 (150)	194 (150)	197 (150)	200 (150)	201 (150)	200 (150)
1958	199 (150)	201 (150)	201 (150)	197 (150)	191 (150)	187 (150)	185 (150)	185 (150)	184 (150)	182 (150)	181 (150)	180 (150)
1959	179 (150)	177 (150)	174 (150)	169 (150)	165 (146)	161 (143)	156 (141)	151 (142)	146 (141)	141 (139)	137 (137)	132 (137)
1960	129 (136)	125 (135)	122 (133)	120 (130)	117 (125)	114 (120)	109 (118)	102 (115)	98 (110)	93 (108)	88 (105)	84 (100)
1961	80 (100)	75 (90)	69 (90)	64 (90)	60 (85)	56 (85)	53 (80)	52 (75)	52 (70)	51 (70)	50 (65)	49 (60)
1962	45 (60)	42 (50)	40 (48)	39 (45)	39 (42)	38 (37)	36 (34)	34 (31)	32 (29)	31 (28)	30 (27)	30 (34)
1963	29 (31)	30 (28)	30 (26)	29 (25)	(25)	(25)	(23)	(21)	(20)	(18)	(18)	(17)
1964	(17)	(17)	(17)	(17)*								

Note: Final numbers are listed through June 1962, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

\* Number used for predictions in this issue.



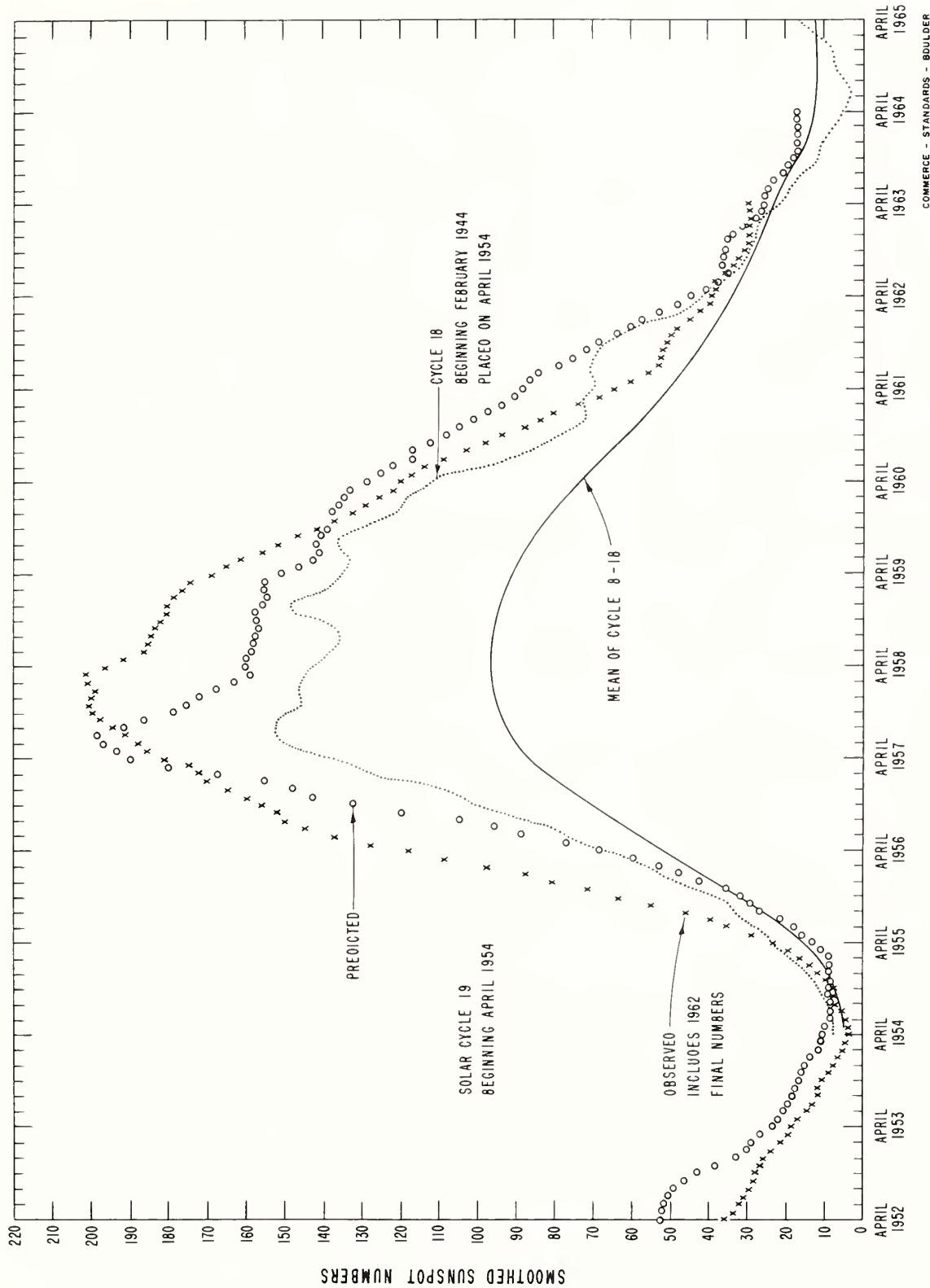


FIG. A. PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE I  
TIME VARIATION

Harmonic	0		1		2		3		4		5		6		7		8	
	K	S	K	S	K	S	K	S	K	S	K	S	K	S	K	S	K	S
I	0		0		0		0		0		0		0		0		0	
	1	7.4347459E 00	2.2963386E 00	1.8566117E 00	-5.6495561E -01	3.1444134E -01	-4.1578712E -01	-5.5270104E -01	2.6993137E -01	-2.6184307E -01	-1.2198459E -01							
	2	7.6851994E -02	-3.2259496E -01	-2.2550043E 01	3.6149538E -01	-9.2558877E -01	8.2327759E -01	-1.0440069E -01	-2.6184307E -01	-1.0600077E -02	9.1069077E -02							
	3	4.6987363E -01	1.9700319E 01	3.6149538E -01	-9.2558877E -01	8.2327759E -01	-1.0440069E -01	-2.6184307E -01	-1.0600077E -02	9.1069077E -02	-6.014433E -01							
	4	1.3387342E 01	4.7672029E 01	3.6149538E -01	-9.2558877E -01	8.2327759E -01	-1.0440069E -01	-2.6184307E -01	-1.0600077E -02	9.1069077E -02	6.6863392E 00							
	5	-3.7704791E -01	-3.6777862E 01	1.0749612E 02	-1.0749612E 02	3.5749266E 01	-5.6223590E 00	9.5649579E 00	-3.4663944E 01	-8.8553765E 01	9.5242484E 01							
	6	-1.1927917E 02	5.5559009E 02	6.8864183E 02	7.1070260E 02	3.9493175E 01	-3.4005689E 01	9.0775610E 01	1.1163872E -01	9.5242484E 01	9.5242484E 01							
	7	6.2073131E 04	5.3559009E 02	5.5627686E 02	-2.5395476E 02	7.9101347E 01	2.5817995E 01	2.5658895E 01	6.2803370E 01	1.4731692E 02	1.4731692E 02							
	8	-1.4261339E 02	-3.3674969E 02	-5.1580330E 02	-1.6028339E 02	9.0507941E 01	6.4337759E 01	3.1029561E 01	-2.4613821E 01	7.6780938E 02	7.6780938E 02							
	9	-2.6378400E 02	3.8837147E 02	-5.870730E 02	-4.2489950E 02	8.734927E 01	-3.4436775E 01	3.1029561E 01	-5.7766977E 01	3.1029561E 01	3.1029561E 01							
	10	1.4162552E 02	1.9439059E 02	4.577039E 02	-9.5612326E 00	-8.734927E 01	-5.1580330E 02	-1.6028339E 02	3.1029561E 01	3.1029561E 01	3.1029561E 01							
	11	7.4526151E 01	2.0039059E 02	2.0022659E 02	7.9882234E 01	-2.7140340E 01	1.4637193E 01	1.4637193E 01	1.4637193E 01	1.4637193E 01	1.4637193E 01							
12	-1.5727194E 01	-1.2944786E 02	-1.3733116E 02	-1.0090035E 01	3.0545991E 01	3.0545991E 01	3.0545991E 01	3.0545991E 01	3.0545991E 01	3.0545991E 01								
II	14	1.4830226E -01	1.0787779E -01	2.4441424E -01	9.2556711E -02	-4.2775015E -02	-9.0778999E -02	1.1927616E -01	5.7927344E -02	7.2312622E -02								
	15	1.9218040E -01	3.7607189E -01	3.7607189E -01	-2.5747501E -02	7.0750346E -01	-7.1795103E -02	8.7594385E -02	-2.6184307E -01	3.3553379E -02								
	16	2.5028748E 00	5.9797773E -01	1.0435309E 01	-2.3182409E -02	7.0750346E -01	-7.1795103E -02	8.7594385E -02	-2.6184307E -01	3.3553379E -02								
	17	-1.5891279E -01	-5.9812795E -01	8.6260941E 01	8.2747406E -01	-2.6263452E -01	-5.9903346E -01	9.7903346E -01	5.0274140E -01	1.3124105E 00								
	18	-1.5856538E -01	-5.9812795E -01	8.6260941E 01	8.2747406E -01	-2.6263452E -01	-5.9903346E -01	9.7903346E -01	5.0274140E -01	1.3124105E 00								
	19	-5.3518915E -01	-1.3213267E 02	1.3213267E 02	-2.4187473E 00	-8.9761666E 00	-2.49741529E 00	4.0778003E 00	-2.2810563E 00	-2.8495887E 00	-2.8495887E 00							
	20	9.282587663E 01	7.7468398E 01	2.3538428E 01	3.4878565E 01	9.26721089E 01	3.6757117E 01	5.6475476E 01	1.25429556E 01	5.5878159E 01	5.5878159E 01							
	21	1.6803161E 01	3.768606E 02	1.3343763E 02	3.8479615E 01	9.26721089E 01	-2.5262014E 02	2.78249760E 01	1.2337323E 01	2.8035378E 01	2.8035378E 01							
	22	7.65535398E 01	1.6094867E 01	3.3578417E 02	3.8479615E 01	9.26721089E 01	-2.5262014E 02	2.78249760E 01	1.2337323E 01	2.8035378E 01	2.8035378E 01							
	23	-8.0704401E 02	-4.5764130E 02	-5.9944670E 02	-2.8187317E 02	-4.9364084E 02	-1.4894724E 01	-1.8937850E 01	1.2007259E 01	4.9727926E 01	4.9727926E 01							
	24	-8.8892389E 02	-4.5764130E 02	-5.9944670E 02	-2.8187317E 02	-4.9364084E 02	-1.4894724E 01	-1.8937850E 01	1.2007259E 01	4.9727926E 01	4.9727926E 01							
	25	-2.9580039E 02	-5.2713746E 01	1.3351694E 01	-1.2647077E 02	7.8156048E -01	-4.9364084E 02	-1.4894724E 01	-1.8937850E 01	1.2007259E 01	4.9727926E 01							
26	1.2981131E 03	1.6659028E 03	1.7840596E 03	-1.7000734E 01	-8.9761666E 00	-2.49741529E 00	4.0778003E 00	-2.2810563E 00	-2.8495887E 00	-2.8495887E 00								
27	4.9725621E 02	8.7725621E 02	8.7725621E 02	-6.5585154E 02	-3.45033938E 02	3.20577738E 02	4.5380214E 00	4.5380214E 00	4.5380214E 00	4.5380214E 00								
28	1.33554427E 03	9.7876803E 02	4.19307856E 03	1.6513202E 01	1.3645334E 01	1.75134770E 01	1.8959621E 00	3.1462050E 01	3.1462050E 01	3.1462050E 01								
29	4.9725621E 02	8.7725621E 02	8.7725621E 02	-6.5585154E 02	-3.45033938E 02	3.20577738E 02	4.5380214E 00	4.5380214E 00	4.5380214E 00	4.5380214E 00								
30	1.33554427E 03	9.7876803E 02	4.19307856E 03	1.6513202E 01	1.3645334E 01	1.75134770E 01	1.8959621E 00	3.1462050E 01	3.1462050E 01	3.1462050E 01								
31	-2.5977587E 02	-4.1267879E 01	-4.1267879E 01	9.91188031E 01	3.2754777E 01	2.7681203E 02	-1.8966834E 02	4.0096683E 02	4.0096683E 02	4.0096683E 02								
32	-1.3472675E 03	-1.0571184E 03	-1.0571184E 03	4.8142859E 02	8.4170456E 02	3.0824939E 02	-1.0361594E 01	-1.5117201E 01	-1.5117201E 01	-1.5117201E 01								
33	-1.2162455E 03	-1.0571184E 03	-1.0571184E 03	4.8142859E 02	8.4170456E 02	3.0824939E 02	-1.0361594E 01	-1.5117201E 01	-1.5117201E 01	-1.5117201E 01								
34	-2.2117377E 02	-1.8067473E 03	-1.8067473E 03	6.5836569E 01	3.1204830E 01	-1.7260592E 01	1.5754587E 01	1.5754587E 01	1.5754587E 01	1.5754587E 01								
35	4.045352E 01	3.5483497E 03	3.5483497E 03	2.0550256E 02	1.0563401E 02	-1.7260592E 01	1.5754587E 01	1.5754587E 01	1.5754587E 01	1.5754587E 01								
36	3.046272E 02	1.4252644E 02	4.4292555E 01	-1.6467238E 02	3.3210835E 01	-1.12101863E 02	5.13748260E 00	5.13748260E 00	5.13748260E 00	5.13748260E 00								
37	2.8653095E 02	6.3615901E 02	6.3615901E 02	9.7274824E 00	1.88381221E 01	5.6825119E 00	5.13748260E 00	5.13748260E 00	5.13748260E 00	5.13748260E 00								
III	39	5.0705920E -02	-1.0695345E -01	1.3742173E -04	2.0101237E -01	-1.3825875E -02	-5.7946319E -02	-3.8350481E -02	1.5816068E -02	3.7678548E -02								
	40	1.1647117E -01	1.5986151E -01	3.7271950E -02	1.1555634E -01	5.2768976E -02	-7.0000000E -02	-5.6804053E -02	-5.6804053E -02	-5.6804053E -02								
	41	7.01402596E -01	1.8427151E -01	1.17454828E -02	1.73467110E -01	5.7698217E -02	-1.9436853E -02	-1.9436853E -02	-1.9436853E -02	-1.9436853E -02								
	42	1.04949696E -01	3.1787302E -01	-2.5349285E -02	3.9427710E -01	2.2618989E -02	-3.6038917E -02	-3.6038917E -02	-3.6038917E -02	-3.6038917E -02								
	43	3.5200451E -01	3.3008456E 00	3.3427091E -02	5.9813706E -01	-4.8037751E -02	3.6038917E -02	3.6038917E -02	3.6038917E -02	3.6038917E -02								
	44	-4.9537771E -01	-7.1343266E -01	3.8985542E -01	2.2323959E 00	-1.9941575E -02	3.6038917E -02	3.6038917E -02	3.6038917E -02	3.6038917E -02								
	45	-1.4370104E 00	3.0034902E 00	-1.0563114E 02	9.6435252E 00	4.8284747E -02	3.8985542E -01	3.8985542E -01	3.8985542E -01	3.8985542E -01								
	46	4.045352E 01	3.5483497E 03	3.5483497E 03	1.1636179E 01	3.3836759E -02	2.8888141E 00	9.9787497E -02	7.0186895E -01	7.0186895E -01								
	47	-1.1636179E 01	3.3836759E -02	2.8888141E 00	9.9787497E -02	7.0186895E -01	7.0186895E -01	7.0186895E -01	7.0186895E -01	7.0186895E -01								
	48	5.2953161E 01	-4.4476703E -01	-4.4476703E -01	1.0870703E 01	6.1674237E -02	2.8888141E 00	9.9787497E -02	7.0186895E -01	7.0186895E -01								
	49	2.953161E 01	-4.4476703E -01	-4.4476703E -01	1.0870703E 01	6.1674237E -02	2.8888141E 00	9.9787497E -02	7.0186895E -01	7.0186895E -01								
	50	-6.6822422E -01	-1.3430049E 00	-1.3430049E 00	1.8911007E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00								
51	1.0951985E 01			1.8911007E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00	-1.1221259E 00								
52				-6.2523292E 00														

GEOGRAPHICAL  
VARIATION

Harmonic	5				6				7				8			
	9	10	11	12	13	14	15	16								
I	0	1.1165621E-01	2.0074036E-01	-1.1664978E-01	3.0709710E-02	-6.8429244E-02	-1.0151203E-01	7.1255313E-02	-1.656872E-02							
	1	-1.0920017E-01	-9.0393118E-03	-4.8163983E-02	-1.3567720E-01	1.1345740E-01	5.7580927E-02	2.4206275E-02	9.3384267E-02							
	2	3.684097E-02	1.3274759E-02	-3.6268497E-01	-3.6268497E-01	-1.1746906E-01	-6.6358476E-02	-1.4119648E-01	8.0738051E-03							
	3	1.8344388E-01	3.0904782E-01	1.8844475E-02	1.7844475E-02	-1.1510221E-01	-1.3006957E-01	6.7670531E-02	-1.0714463E-01							

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation; II - First order in longitude, III - Second order in longitude

PREDICTED COEFFICIENTS  $D_{sk}$  DEFINING THE FUNCTION  $\Gamma(\lambda, \theta, \uparrow)$  FOR MONTHLY MEDIAN  $f_o F2$  (Mc/s)

APRIL 1964

## GEOGRAPHICAL VARIATION

33	-1.2162455E 03	-6.5647953E 02	1.2018123E 02	4.6340820E 02	8.7170641E 02	-4.0108131E 02	-3.3467053E 01
34	-4.2212377E 02	-5.8080808E 02	-1.8067473E 03	-4.463691E 01	-3.2618751E 01	-1.4517532E 01	-9.7136093E 01
35	0.4393292E 01	-6.403932E 01	-1.8064937E 02	-4.463691E 01	-3.2618751E 01	-1.4517532E 01	-9.7136093E 01
36	1.0182234E 02	-1.9555555E 02	2.3555555E 02	2.0502925E 02	1.0553103E 02	-1.2433663E 01	7.0277308E 01
37	1.9252046E 02	-4.2925555E 02	-1.6667238E 02	3.3210835E 02	1.18201863E 02	3.3748246E 01	8.7728095E 01
38	2.4653095E 02	6.36159501E 02	9.7274824E 00	1.8838122E 01	5.6825117E 00	1.1530239E 00	2.4592253E 01
39	5.0705920E-02	-1.0695345E-01	1.3742172E-04	2.0101239E-03	1.3825885E-02	-5.7863138E-02	1.5816068E-02
40	1.4407117E-01	1.5886516E-01	-2.9719507E-02	1.4655431E-01	-5.4347576E-02	-4.9324661E-02	3.3897536E-02
41	7.6140275E-01	1.94827151E-01	1.17450482E-01	-1.7384645E-01	5.7649621E-02	-2.2808027E-02	-1.3166600E-01
42	1.0696976E-01	-2.1787302E-01	3.3492891E-02	3.9427710E-01	2.2489896E-01	1.79595921E-02	-0.1914318E-02
43	-3.2500451E-01	3.3084556E 00	2.5627077E-02	5.9813708E-01	-4.8034751E-01	-1.8480190E-01	-1.1939648E-01
44	3.054203E 00	3.054203E 00	1.0503116E-01	3.3329595E 00	-8.3015747E-01	1.2970556E 00	9.7642453E-01
45	-1.4370164E 00	9.6463952E 00	4.82644707E-02	-9.767908E-01	2.0721298E-03	7.0889543E-04	1.7030780E-01
46	-1.1636179E 01	-2.1730796E 01	3.3836703E-02	-2.9488141E 00	9.9767397E-02	-4.2343109E-01	1.43140456E-01
47	1.2130796E 01	-4.46476703E-01	1.3430848E 00	1.0497018E 00	6.1574237E-02	-4.28874205E-02	3.7375863E-02
48	-5.2953613E 00	-4.46476703E-01	1.3430848E 00	3.4093959E 00	2.0186842E-03	-2.3952350E-02	-1.2348872E 00
49	-4.9732452E-01	-1.0917865E 01	1.3430848E 00	-4.9732452E-01	7.1234429E-03	-3.3211643E 00	-1.2348872E 00
50	-1.0917865E 01	-4.9732452E-01	1.3430848E 00	-8.2523292E 00	-1.1212129E 00	3.5594153E-01	-1.2348872E 00
51	-4.9732452E-01	-1.0917865E 01	1.3430848E 00	-8.2523292E 00	-1.1212129E 00	3.5594153E-01	-1.2348872E 00
52	-1.0917865E 01	-4.9732452E-01	1.3430848E 00	-8.2523292E 00	-1.1212129E 00	3.5594153E-01	-1.2348872E 00

GEOGRAPHICAL  
VARIATION

Harmonic	5				6				7				8			
	9	10	11	12	13	14	15	16								
I	0	1.1165621E-01	2.0074036E-01	-1.1664978E-01	3.0709710E-02	-6.8429244E-02	-1.0151203E-01	7.1255313E-02	-1.656872E-02							
	1	-1.0920017E-01	-9.0393118E-03	-4.8169833E-02	-1.3567720E-01	1.1345740E-01	5.7580927E-02	2.4206275E-02	9.3384267E-02							
	2	3.684937E-02	1.3274759E-02	-3.6268497E-01	1.346497E-01	-6.6358476E-02	-1.411964E-01	8.7384507E-03	-1.241964E-01							
	3	8.6001901E-02	1.1116592E-01	3.5174759E-02	1.7844475E-02	-1.1510221E-01	-1.3006957E-01	1.0714463E-01	-6.7670531E-02							

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation; II - First order in longitude, III - Second order in longitude

PREDICTED COEFFICIENTS  $D_{SK}$  DEFINING THE FUNCTION  $\Gamma(\lambda, \theta, \uparrow)$  FOR MONTHLY MEDIAN  $f_o F2$  (Mc/s)

APRIL 1964

## TIME VARIATION

Harmonic	O		I		2		3		4		5		6	
	K	S	I		2		3		4		5		6	
I	0	2.9849960E 00	-1.4437802E-01	-2.2383676E-01	4.4332476E-02	-1.4509081E-01	4.0825358E-02	-9.4083001E-03	-2.3623885E-01	-2.476087E-02	4.0825358E-02	-9.4083001E-03	-2.3623885E-01	-2.476087E-02
	1	-2.9706136E-01	-1.6975449E-01	-2.2279410E-01	3.6274909E-01	-2.3623885E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	2	2.1688738E 00	1.1046029E 00	2.4606741E 00	-2.2933340E-02	2.4606741E 00	-2.2933340E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	3	1.1979625E 00	6.7675901E-01	9.9962348E-01	0.3010404E 00	1.4502062E 00	1.4502062E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	4	-6.8346441E 00	-2.7241098E-01	-5.7837794E 00	-1.1738000E 00	2.4699053E 00	2.4699053E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	5	2.1360720E 00	-7.6771049E-01	-1.8543144E 00	3.1191005E 00	-1.211129E 00	-1.211129E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	6	7.1767778E 00	3.1171654E 00	5.5346233E 00	-2.3795958E 00	-3.6501072E 00	-3.6501072E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	7	1.8853144E 00	2.8243191E-01	9.9201874E-01	-1.6456535E 00	5.4432277E 00	5.4432277E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
	8	-3.0036041E 00	-1.3333601E 00	-1.9609175E 00	-1.2316944E 00	-1.2316944E 00	-1.2316944E 00	4.7390788E-02	-9.3641381E-01	-9.3641381E-01	2.2476087E-02	4.7390788E-02	-9.3641381E-01	-9.3641381E-01
II	9	-6.9594153E-03	-5.2211776E-04	2.7093548E-02	3.8986295E-02	-5.1531379E-03	-2.8194239E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03
	10	3.1634972E-02	3.4758652E-02	2.7093548E-02	3.8986295E-02	-5.1531379E-03	-2.8194239E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03	-5.1531379E-03	-2.8194239E-03
	11	6.7296088E-02	9.6676737E-02	2.5938995E-01	1.0440404E-02	-6.0210111E-02	-1.5689758E-02	-1.5689758E-02	-6.0210111E-02	-1.5689758E-02	-6.0210111E-02	-1.5689758E-02	-6.0210111E-02	-1.5689758E-02
	12	-5.5658035E-01	-4.4137225E-01	-9.5904202E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01	1.6336244E-01
	13	8.0456971E-02	3.0616699E-01	5.1563795E-01	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03	5.7976185E-03
	14	-2.8362007E-01	-5.6952257E-01	3.4017514E-02	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00	1.1706595E 00
	15	-1.2767499E-01	7.8104359E-01	-9.8929787E-01	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02	3.5927209E-02
	16	3.7676402E 00	2.5361837E 00	5.4063344E 00	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01	-8.7111522E-01
III	17	-5.8038835E-02	2.1575591E 00	1.5812808E 00	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02	-9.5120733E-02
	18	7.8574020E-01	2.5085943E 00	-1.0392278E 00	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02	-5.0895675E-02
	19	-2.5145336E-01	-1.8961379E 00	9.926295E-01	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00	1.399100E 00
	20	-6.5545824E 00	-4.3861629E 00	-8.3686893E 00	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01	2.8065935E-01
	21	-8.772814E-01	-4.4686813E 00	1.4857396E 00	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01	7.7756124E-01
	22	7.2877388E-01	-4.1068363E 00	2.5851052E 00	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01	1.0700194E-01
	23	3.2284406E-01	1.1449983E 00	7.4637872E-02	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01	-6.8223388E-01
	24	3.5164496E 00	2.4664404E 00	4.2826554E 00	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01	-3.0271445E-01
IV	25	-2.5863987E 02	2.7889533E 00	6.2802306E-01	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00
	26	-2.5863987E 02	2.7889533E 00	6.2802306E-01	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00	-3.8220255E 00
	27	2.1930028E 02	-1.7238026E-02	1.9422917E-03	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02	-1.0016856E-02
	28	1.2981173E 03	-8.4827825E-03	2.1468335E-02	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03	-5.0407130E-03
	29	1.3354427E 03	-1.2988695E-01	-2.0332357E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02	4.5733716E-02
	30	4.6218144E 02	1.1734936E-02	-1.7341093E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02	7.1842762E-02
	31	-2.5975587E 02	1.8162049E-02	-1.2296588E-01	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02	8.2506096E-02
	32	-1.3472673E 03	9.7307937E-01	3.4940011E-03	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02
V	33	-1.2162455E 03	2.7659157E-01	3.4940011E-03	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02	-8.5827497E-02
	34	-4.2217377E 02	1.9953676E-02	4.6879343E-03	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02	-5.3118111E-02
	35	1.1315433E 02	3.7672046E 02	3.4451937E-02	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01
	36	5.077234E 02	3.7672046E 02	3.4451937E-02	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01	-1.2641121E-01

GEOGRAPHICAL VARIATION

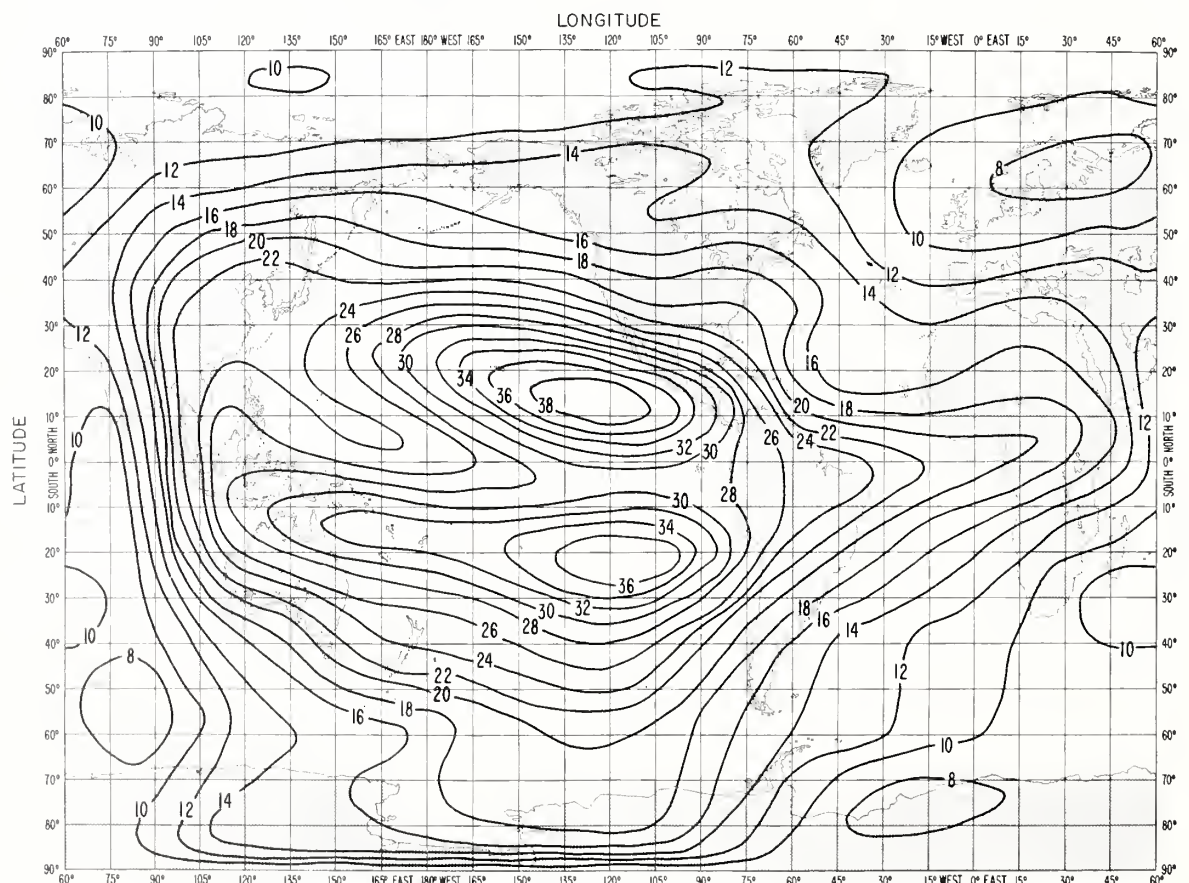
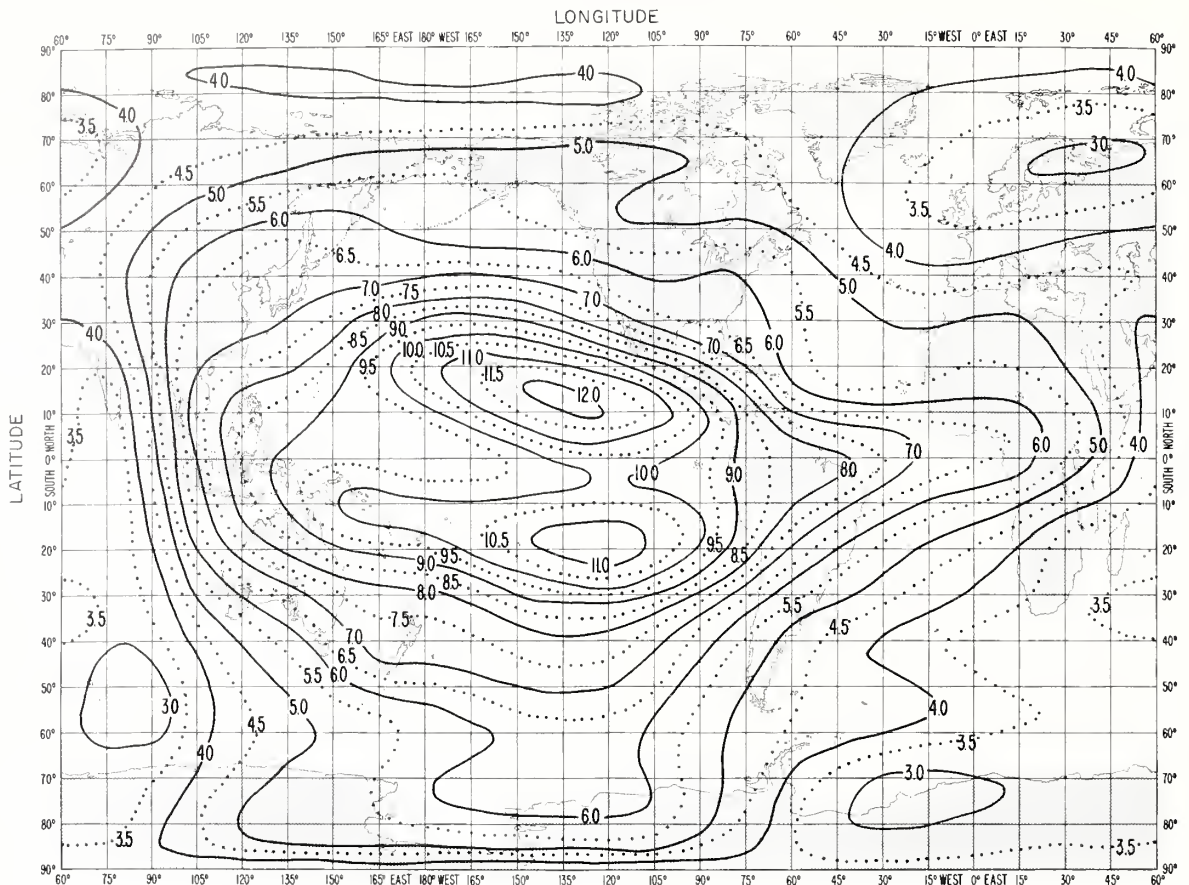
I - Main latitudinal variation. Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude. Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS  $D_{SK}$  DEFINING THE FUNCTION  $I(\lambda, \theta, t)$  FOR MONTHLY MEDIAN  $M(3000)F2$

APRIL 1964

Erratum: See page following order form.







APRIL 1964 UT=02

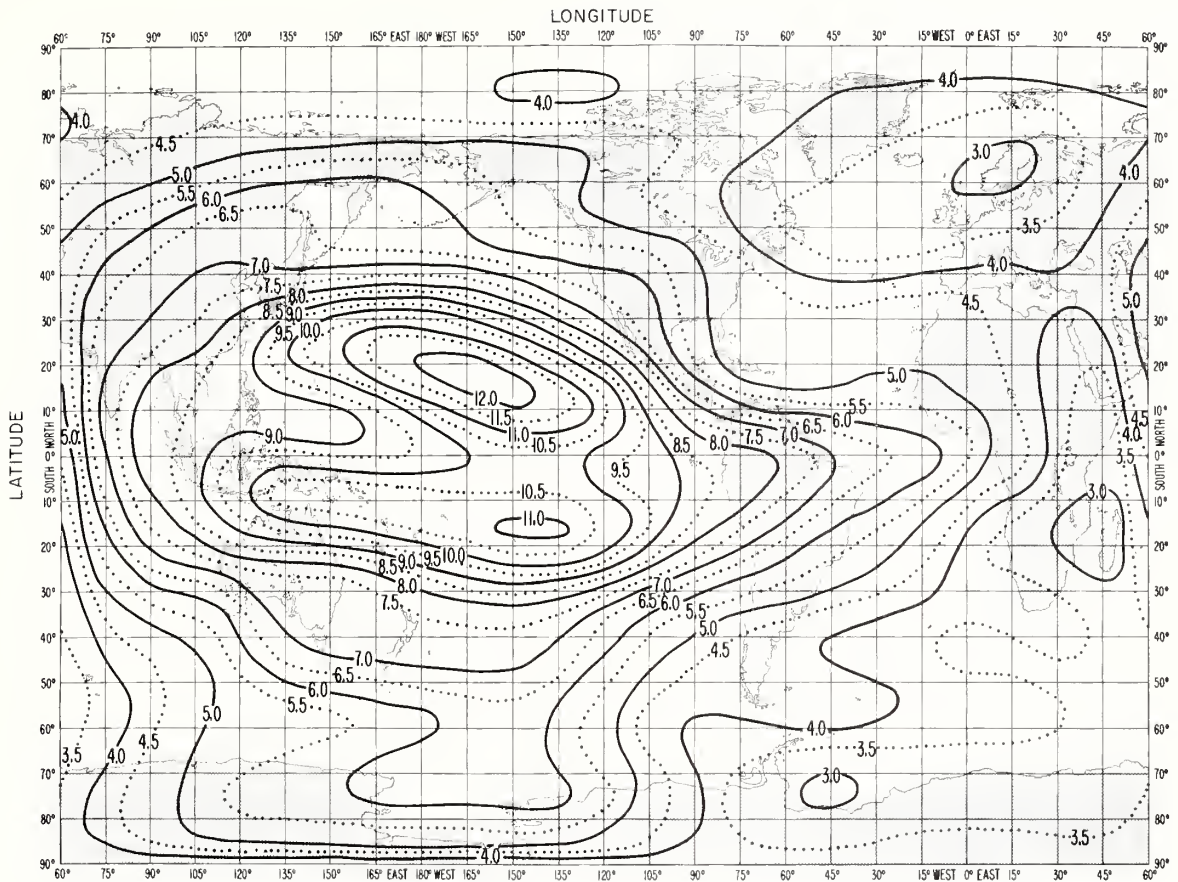


FIG. 2A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

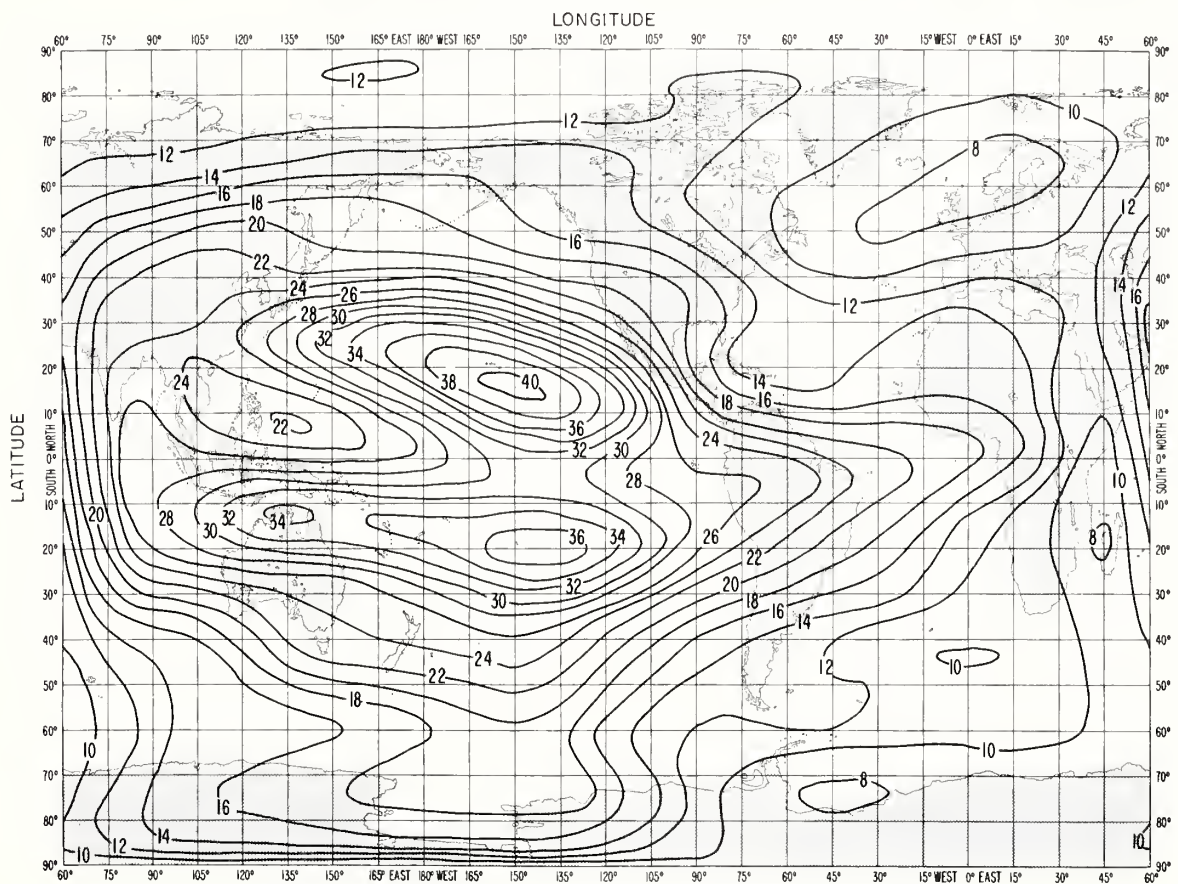
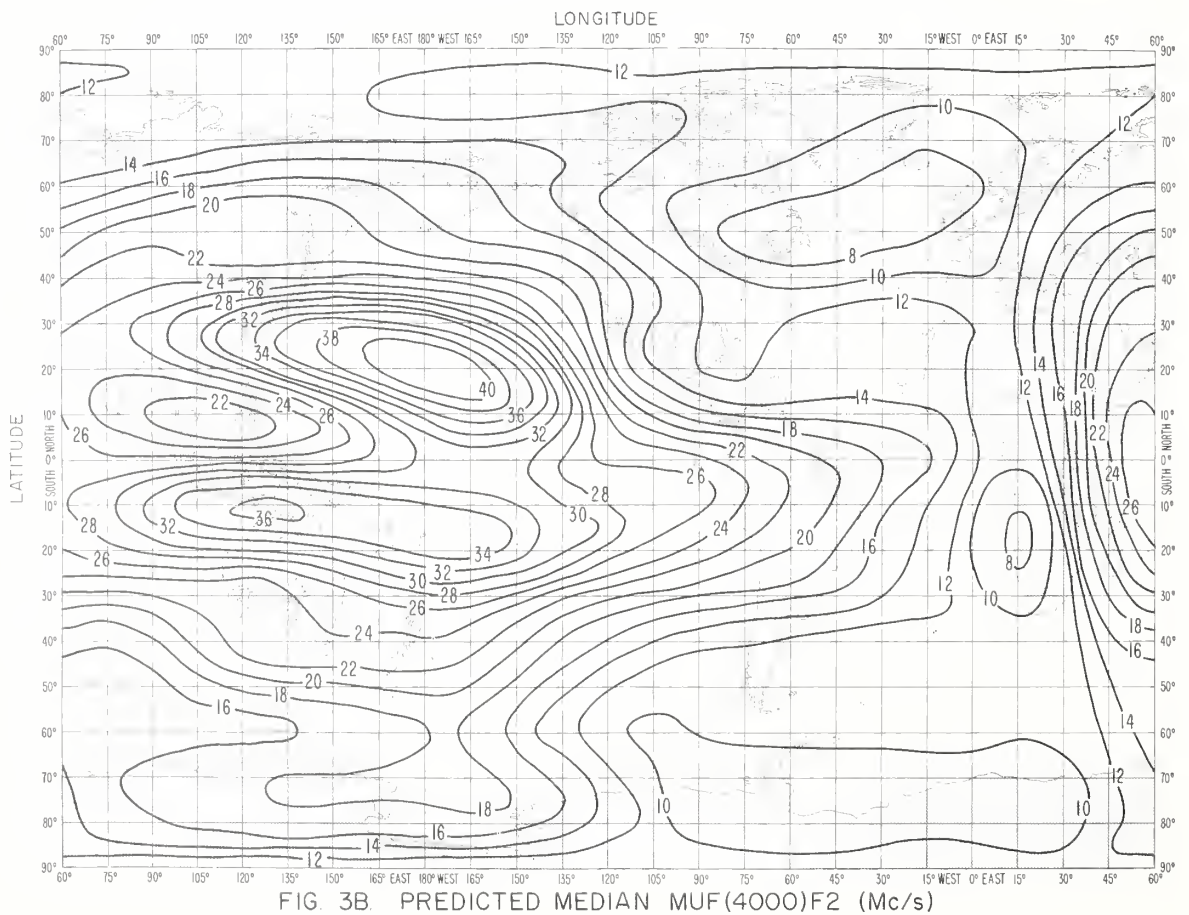
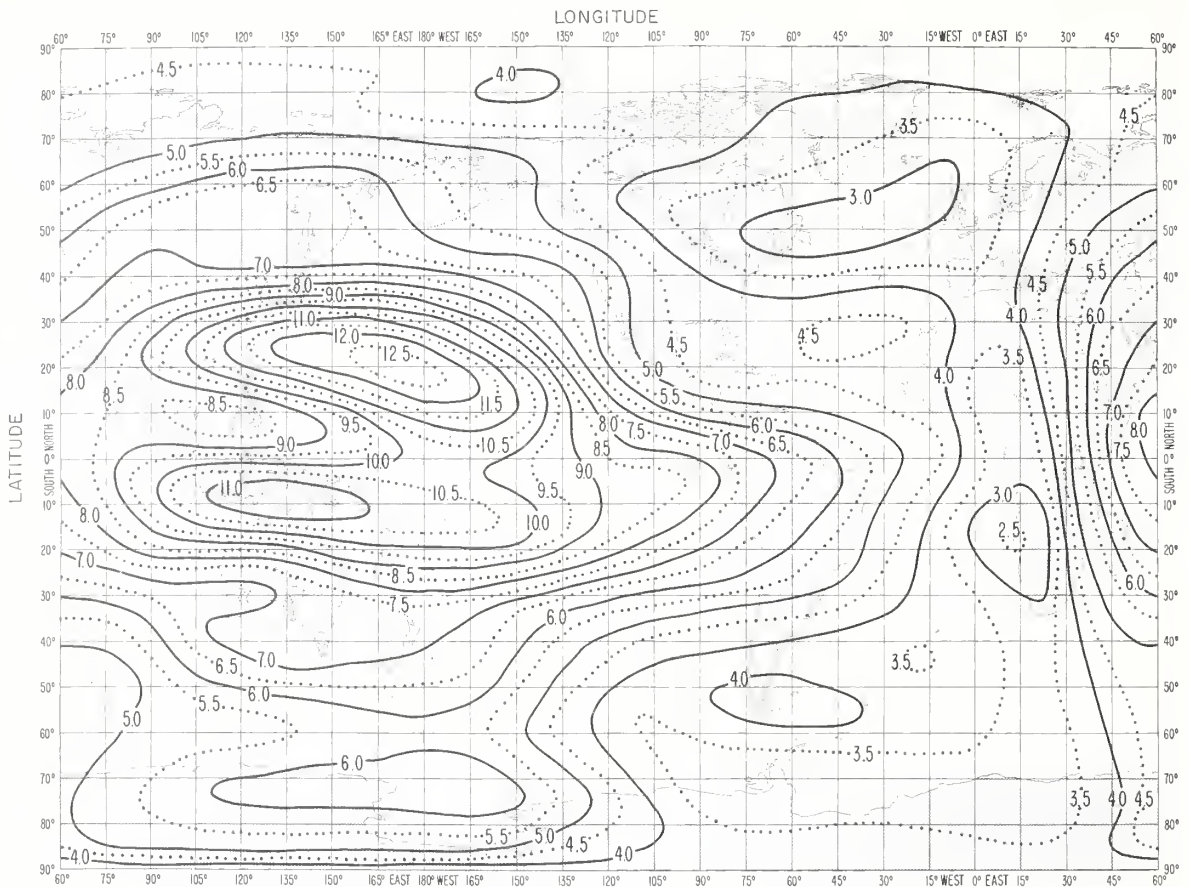


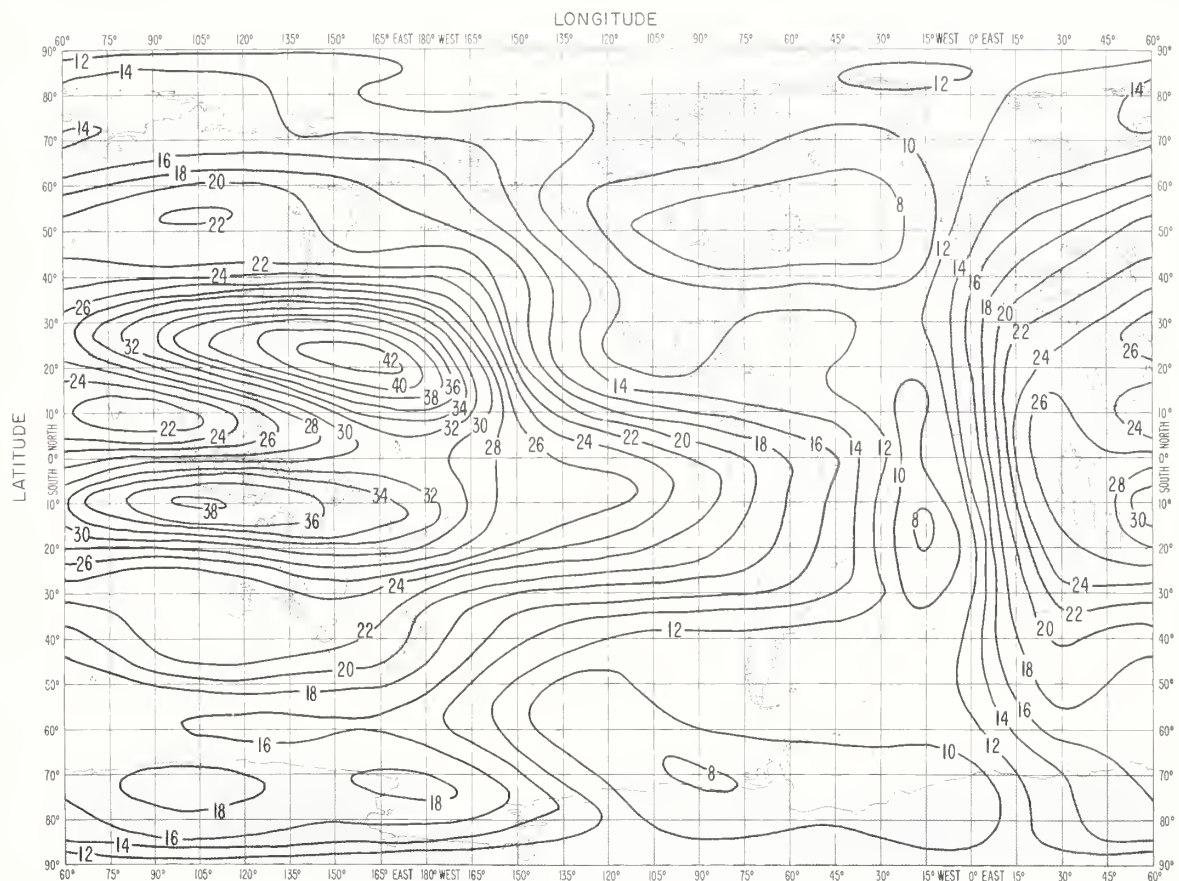
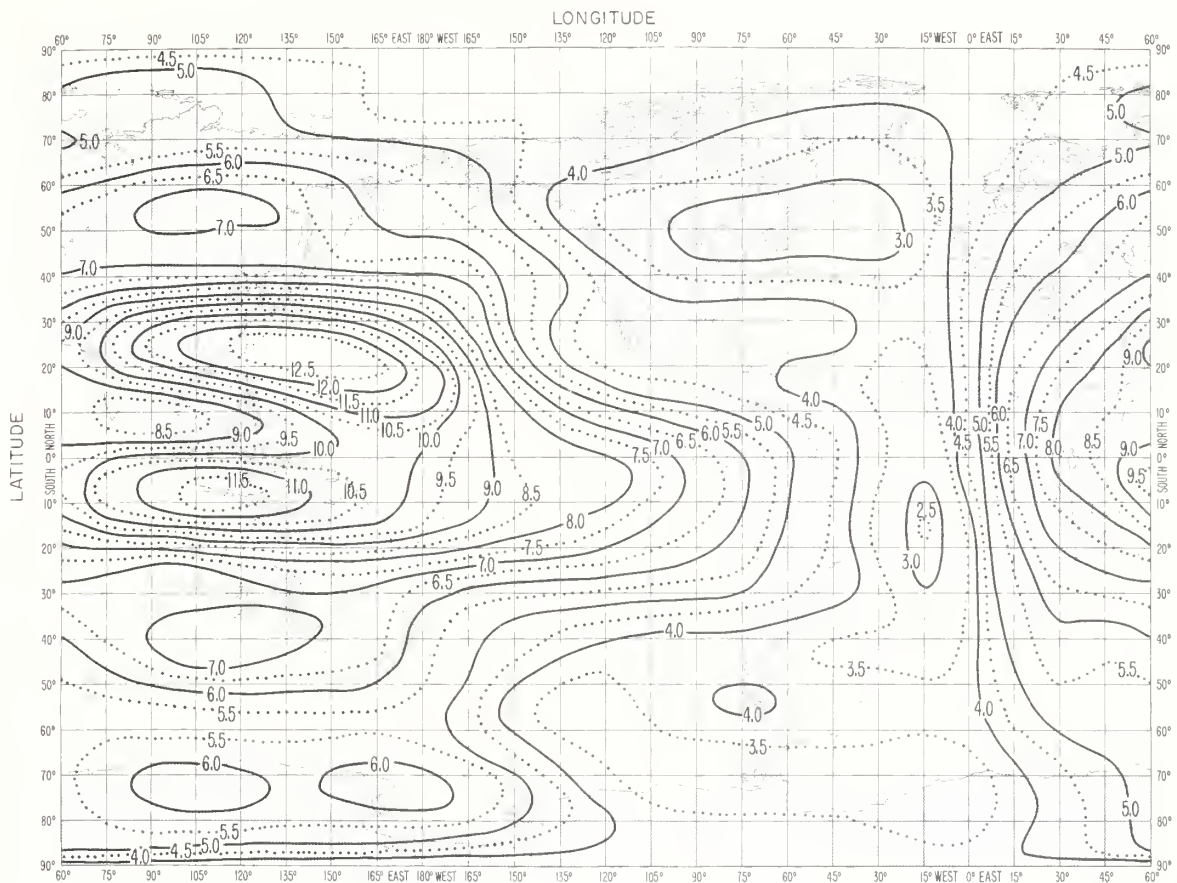
FIG. 2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

APRIL 1964 UT=04





APRIL 1964 UT = 06



APRIL 1964 UT=08

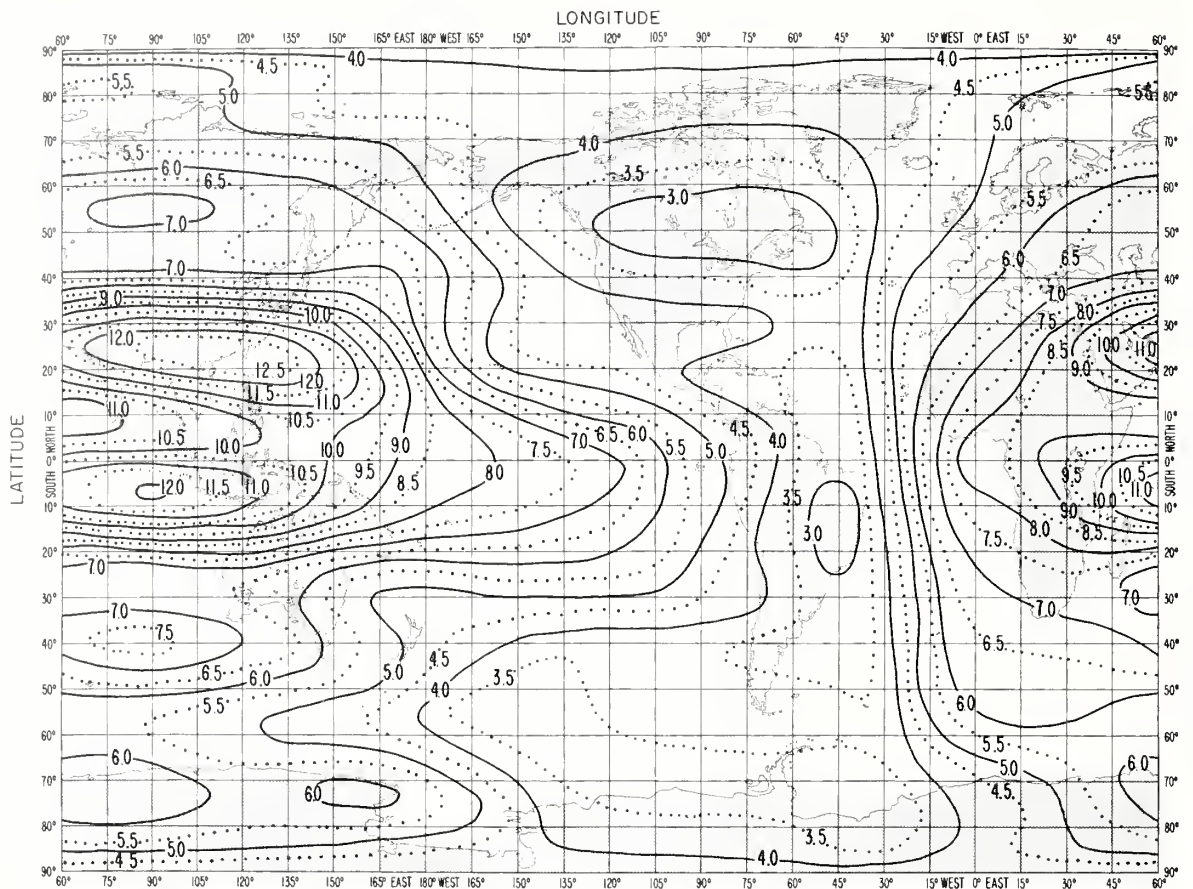


FIG 5A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

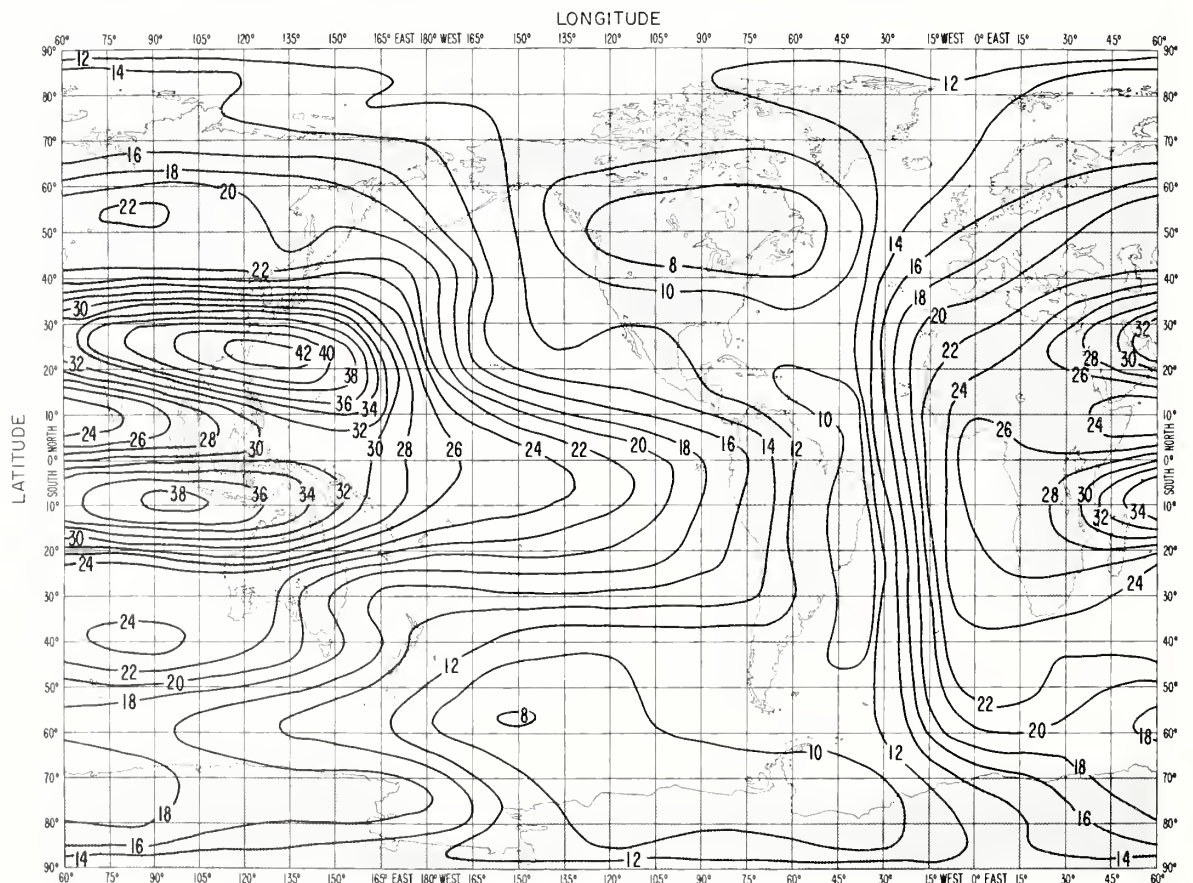


FIG 5B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



APRIL 1964 UT = 10

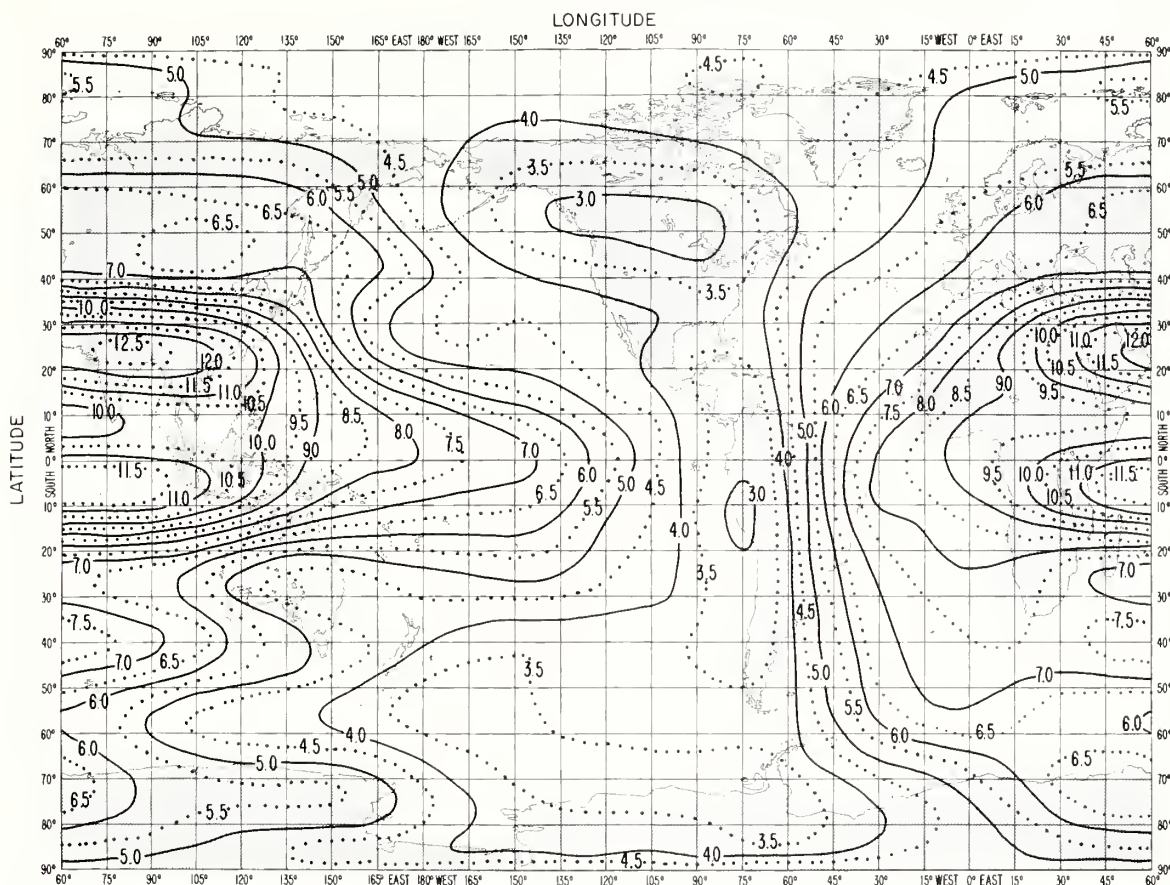


FIG. 6A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

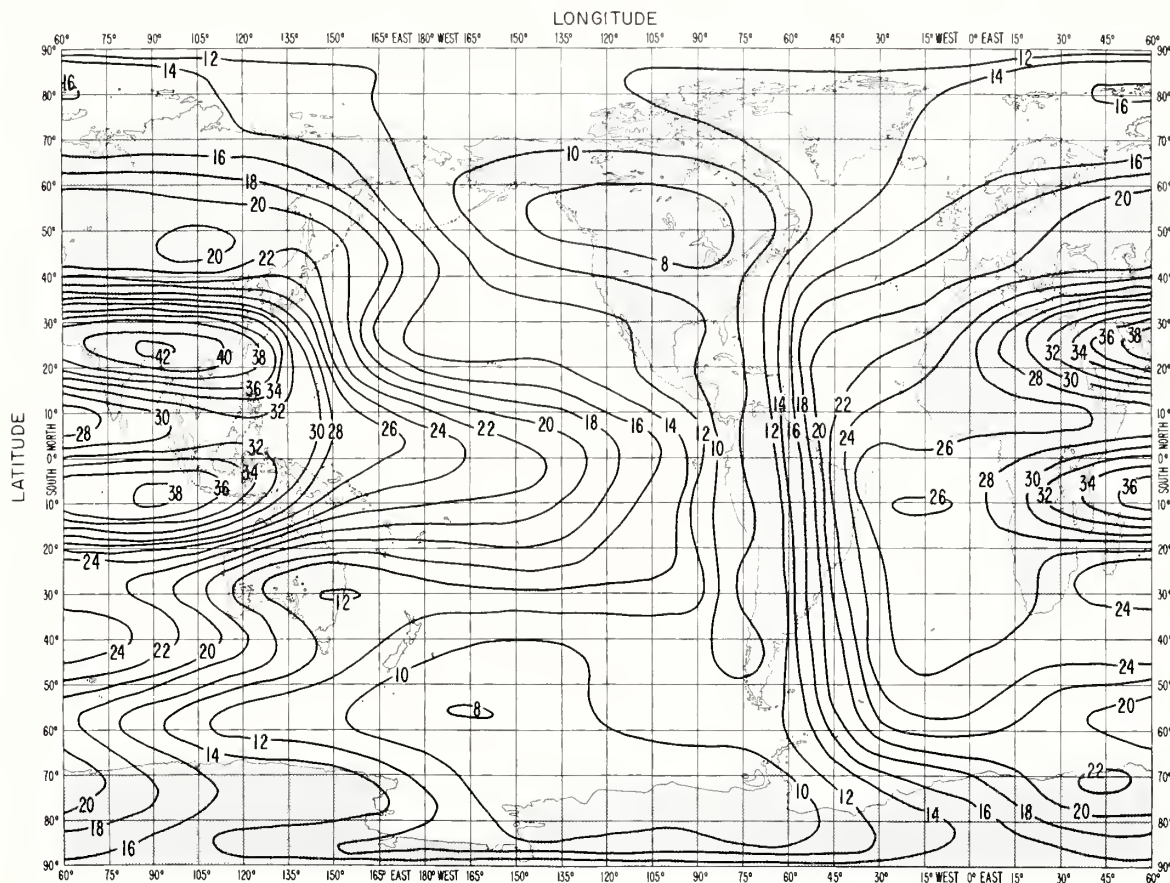
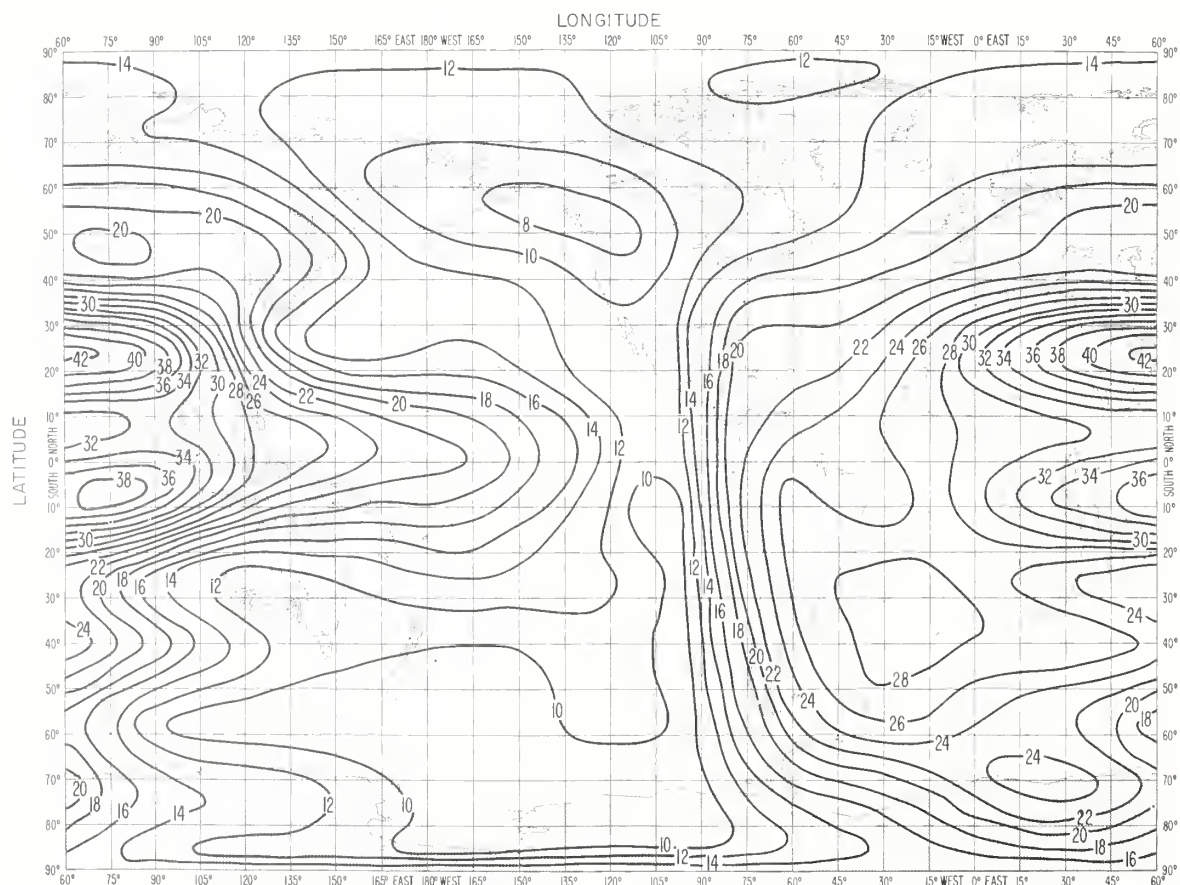
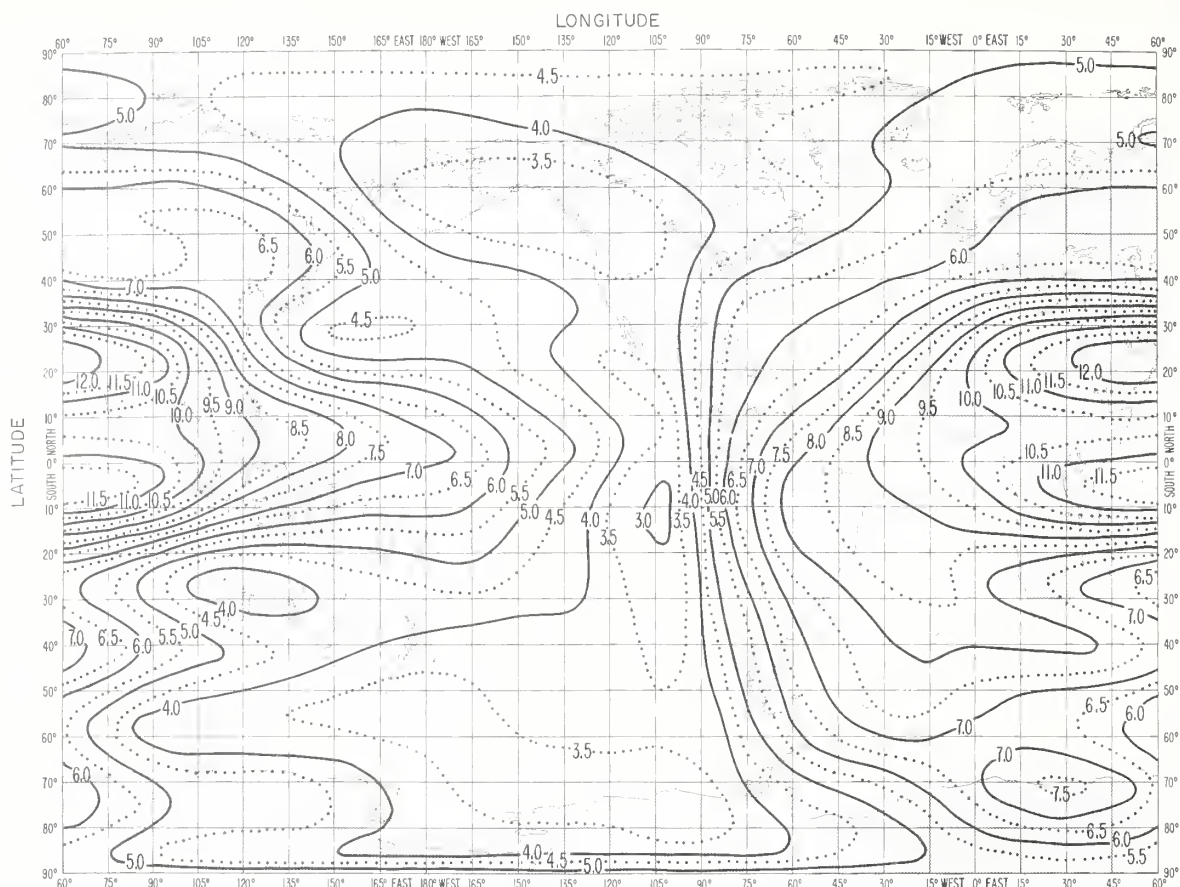
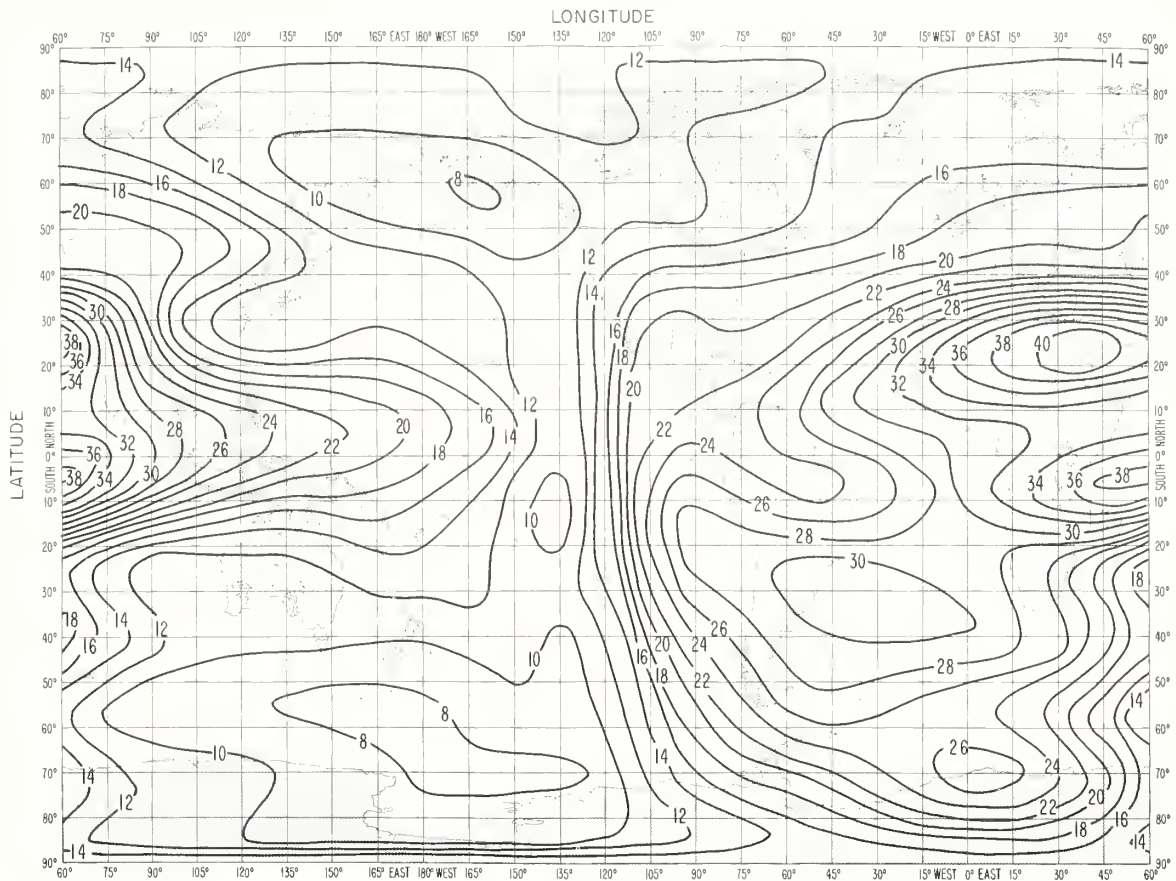
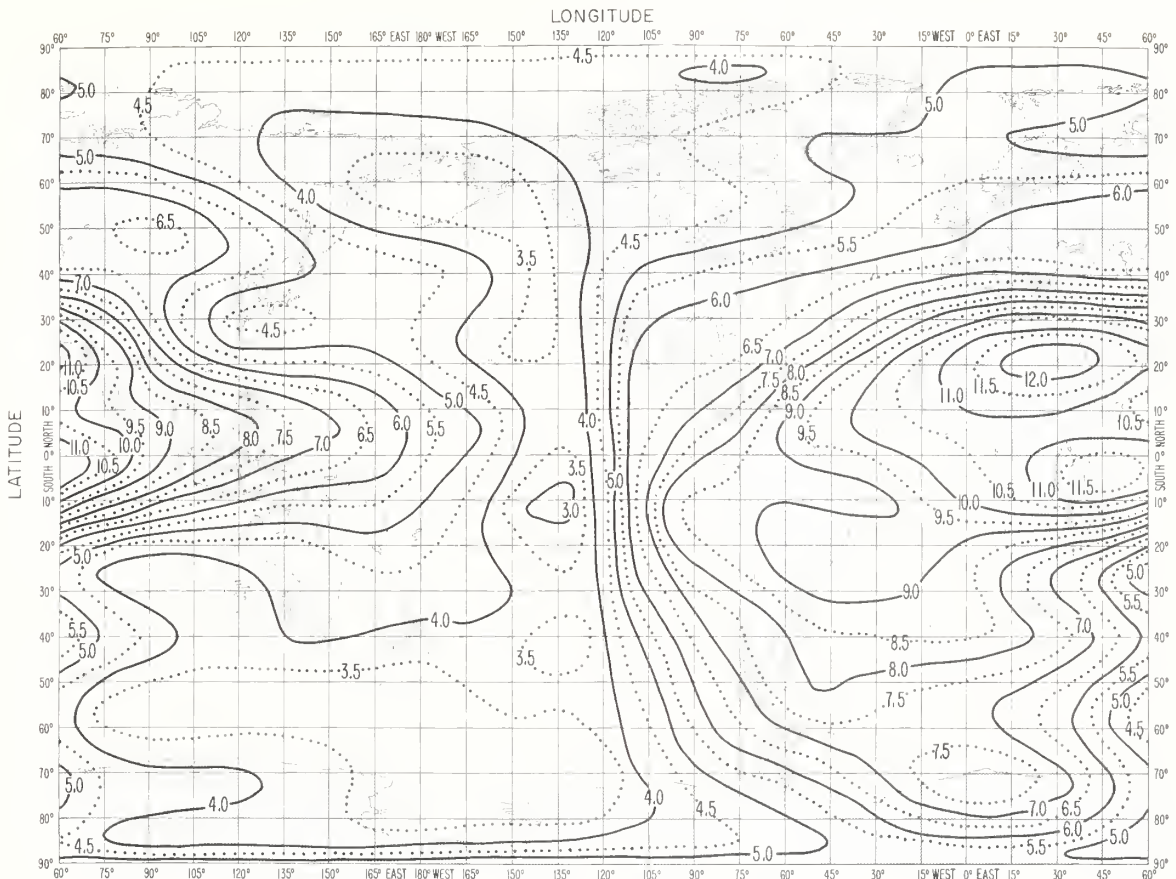


FIG. 6B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)





APRIL 1964 UT = 14



APRIL 1964 UT = 16

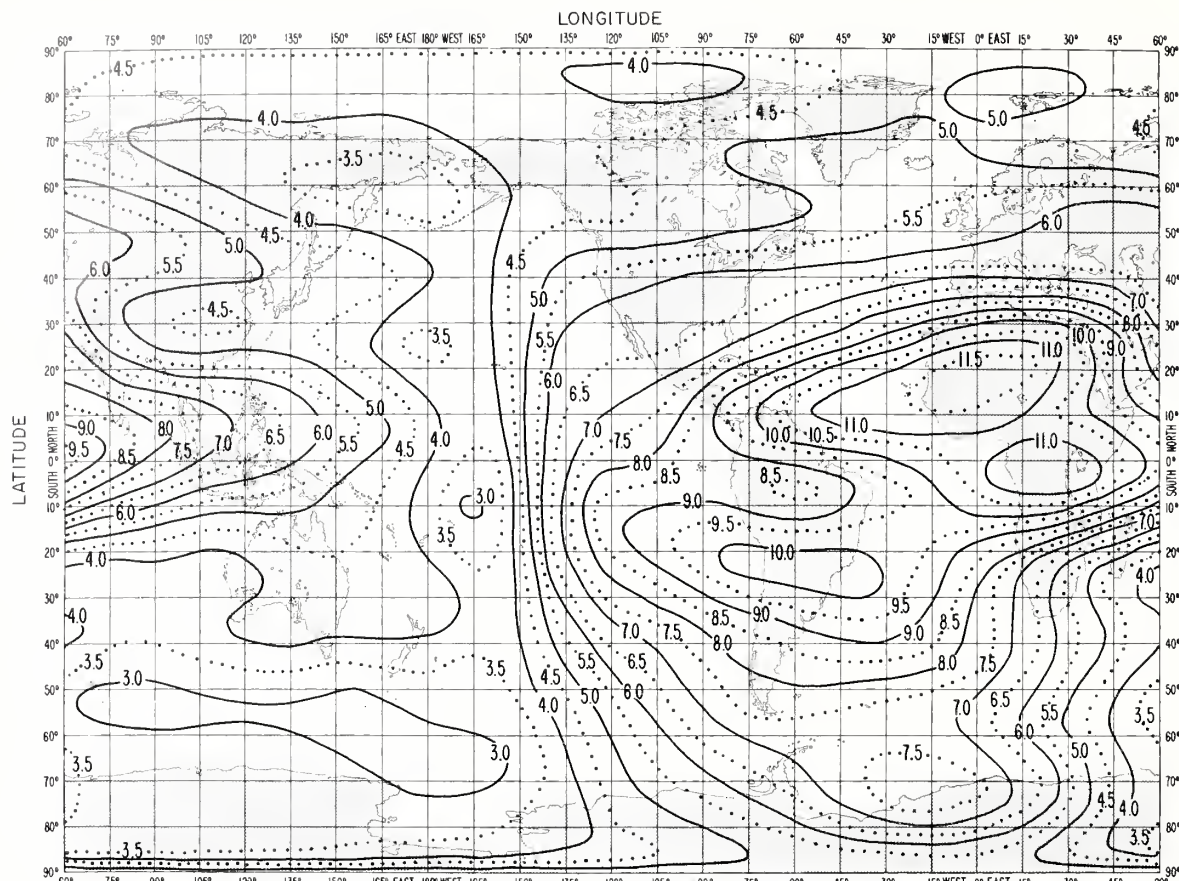


FIG 9 A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

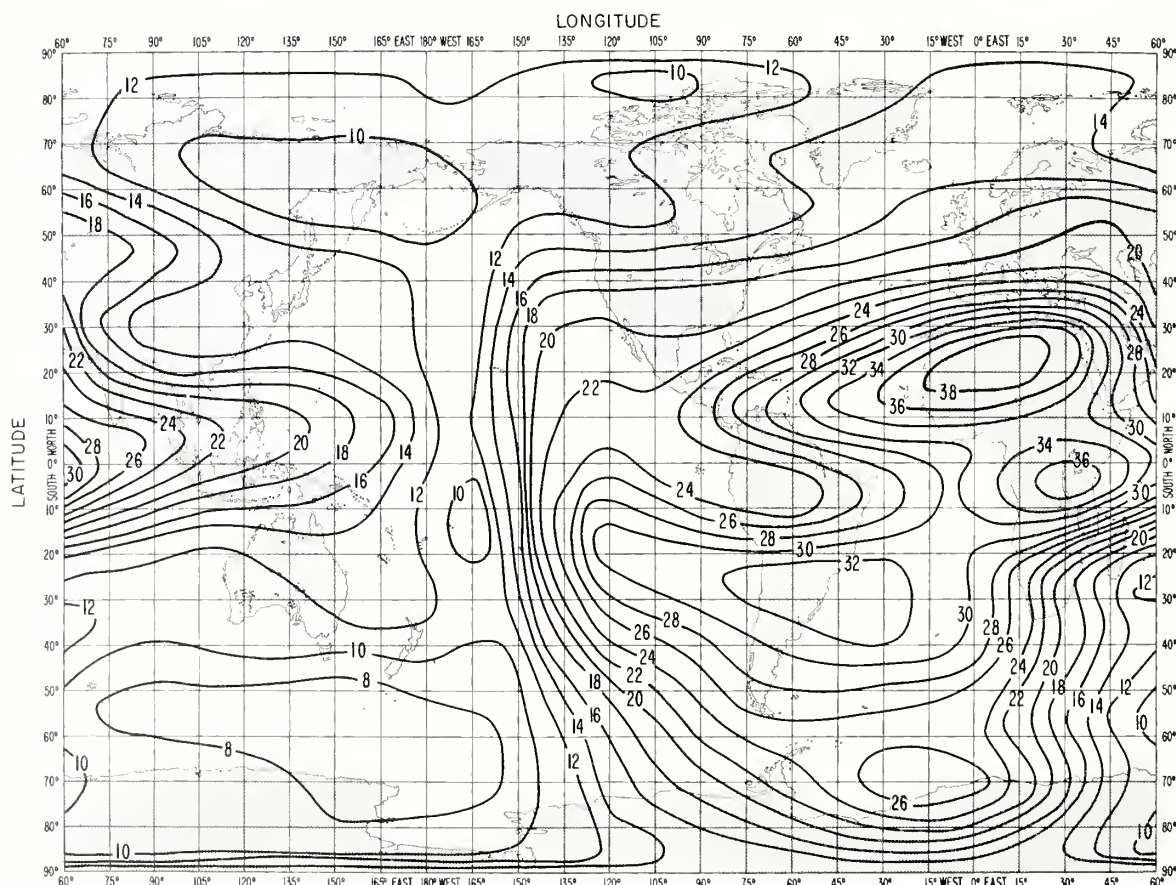


FIG. 9B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



APRIL 1964 UT = 18

LONGITUDE

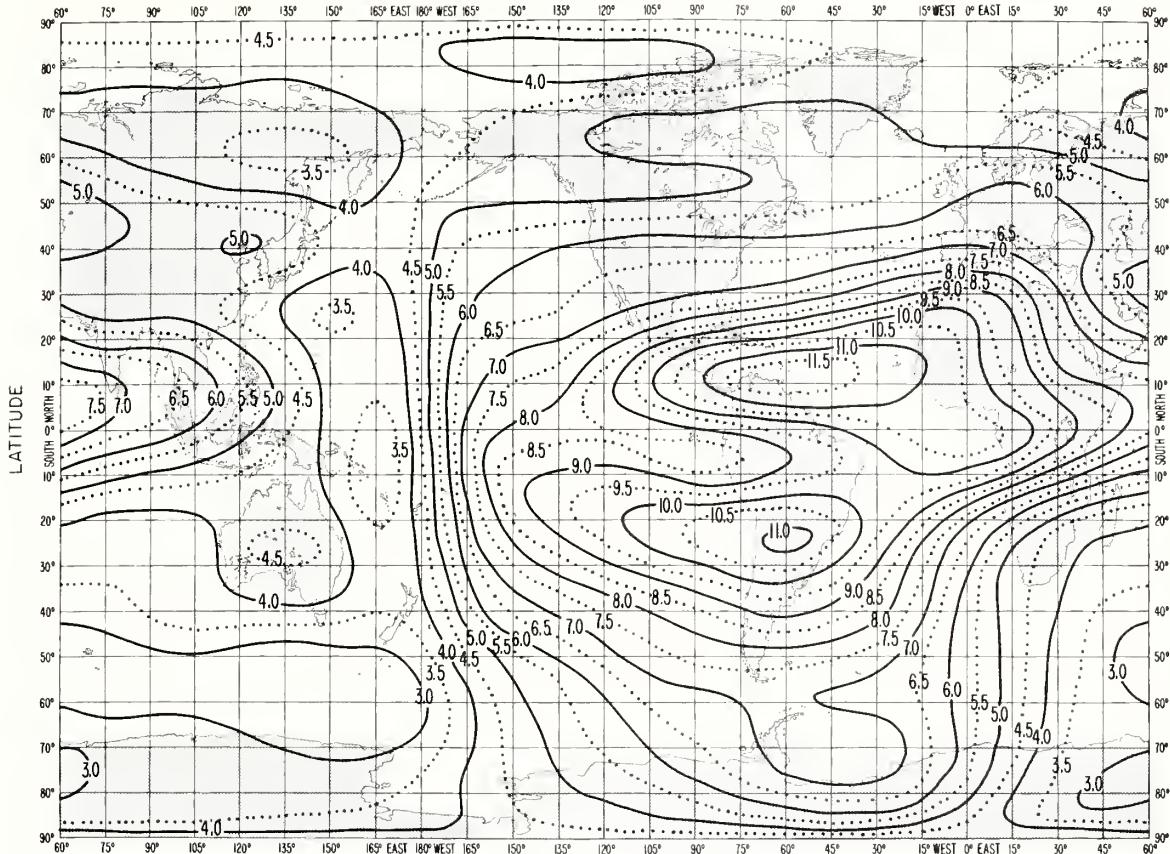


FIG. 10A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

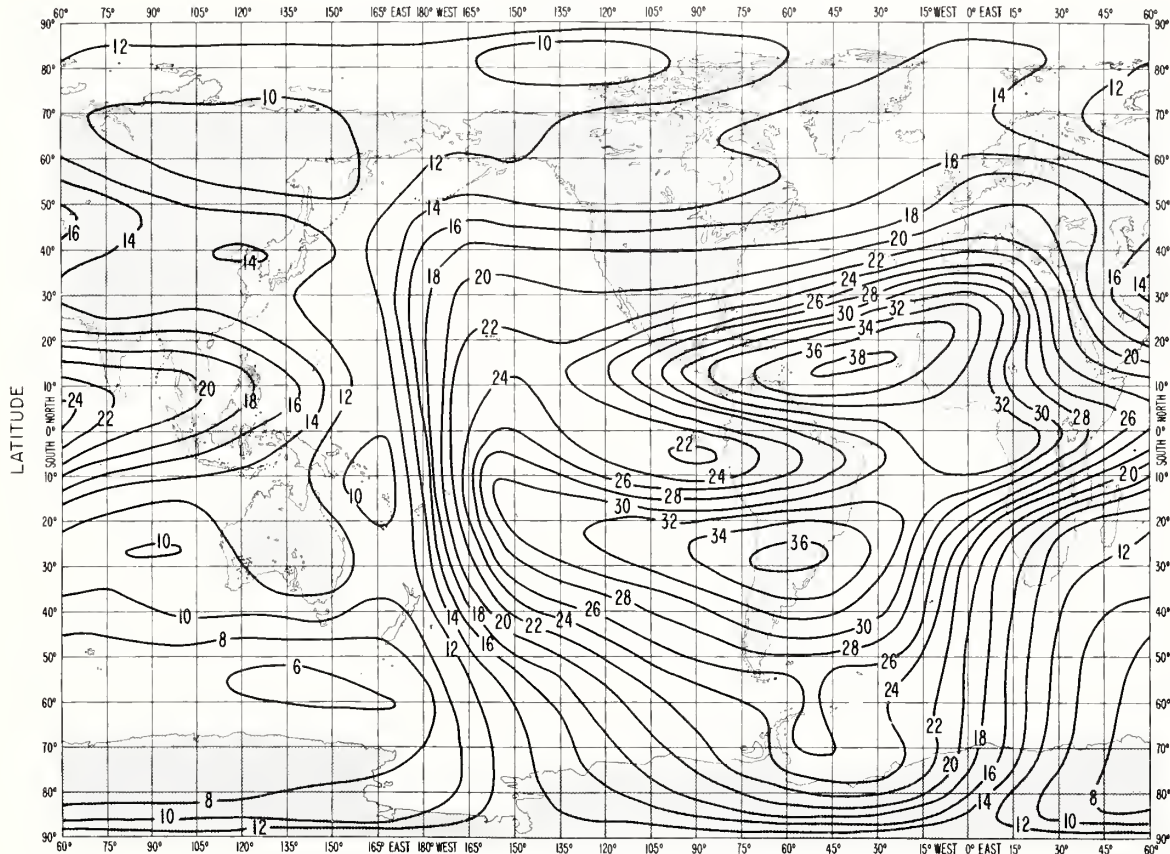


FIG. 10B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

APRIL 1964 UT = 20

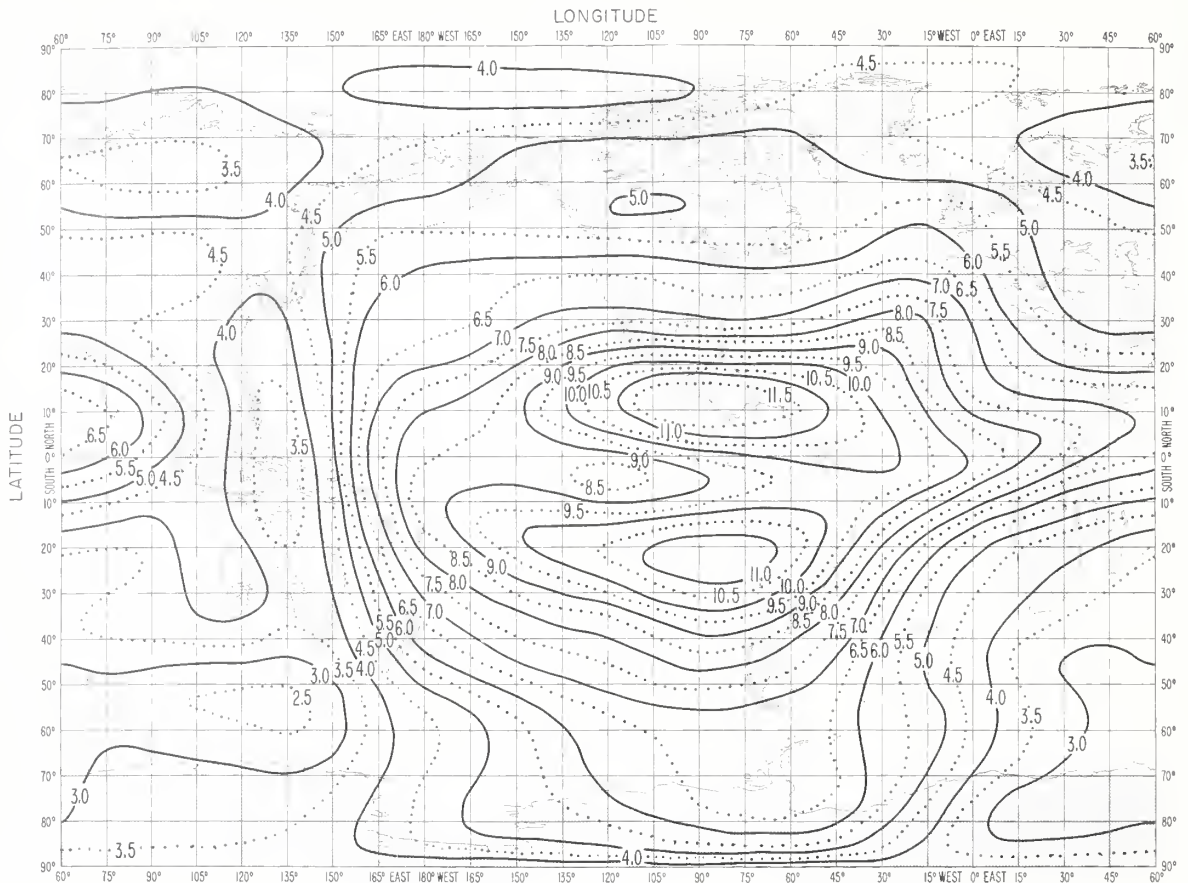


FIG IIA. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

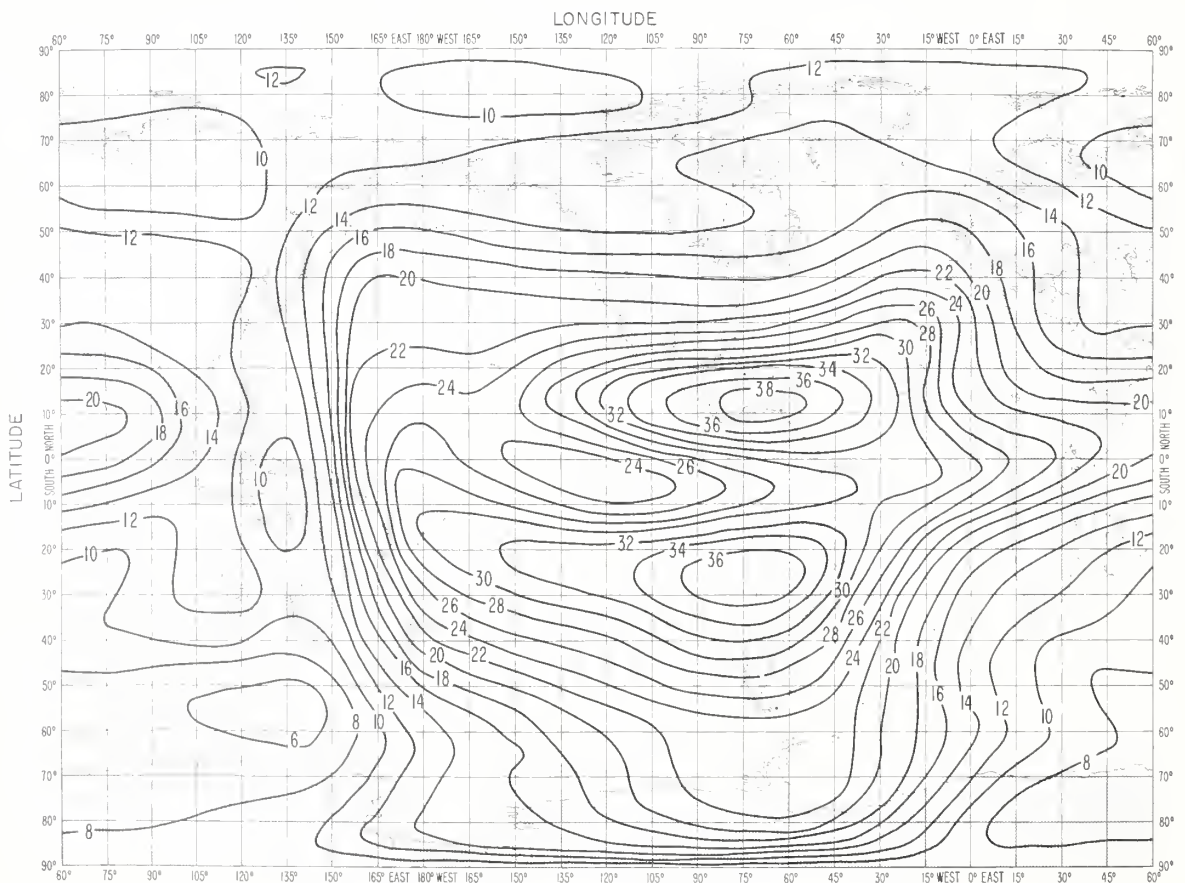
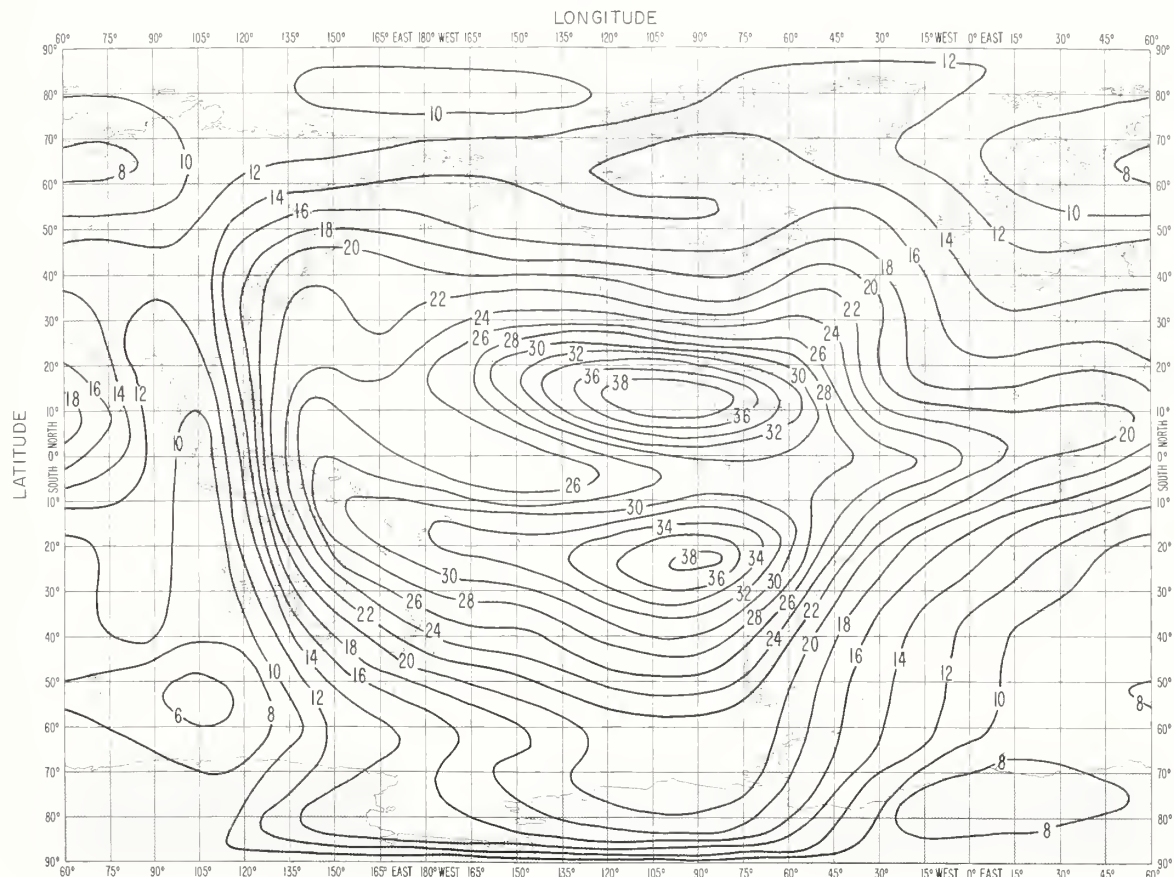
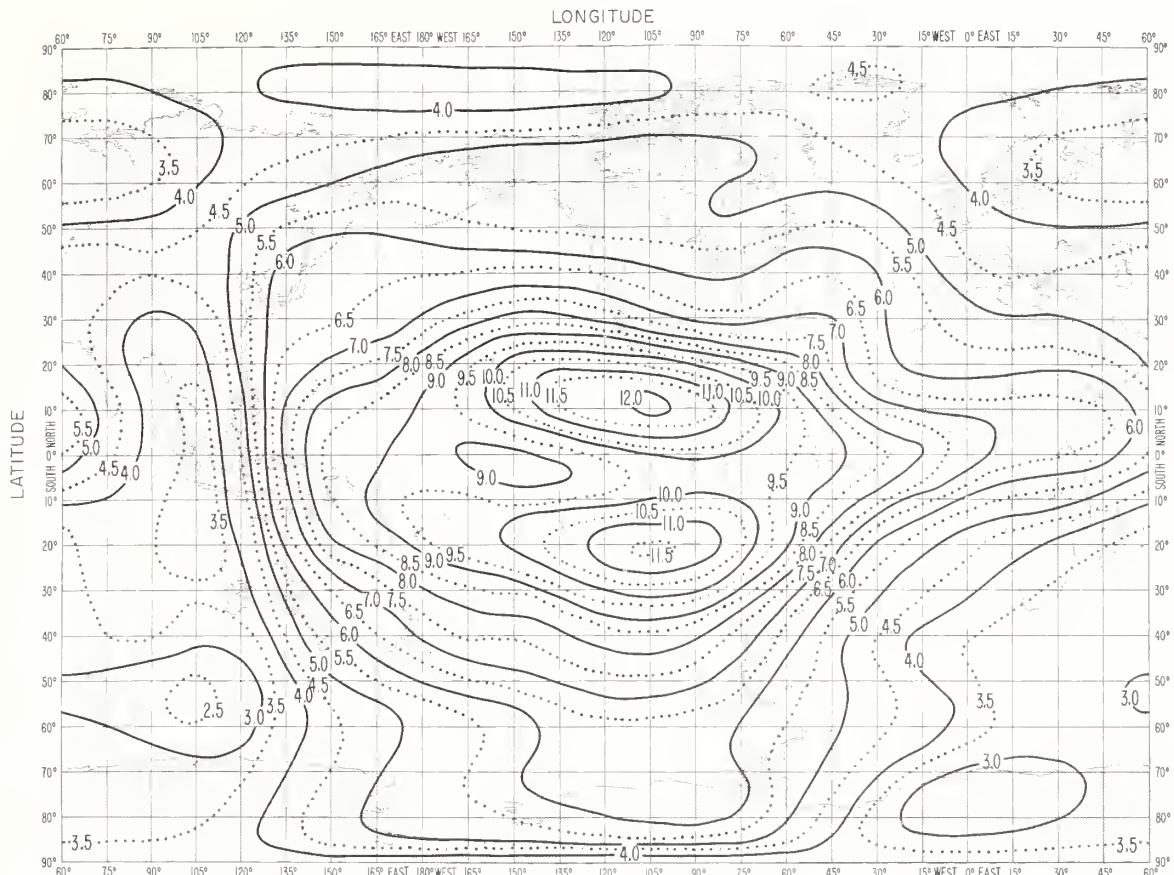


FIG IIB. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



APRIL 1964 UT = 22



NORTH POLAR AREA  
APRIL 1964 UT = 00

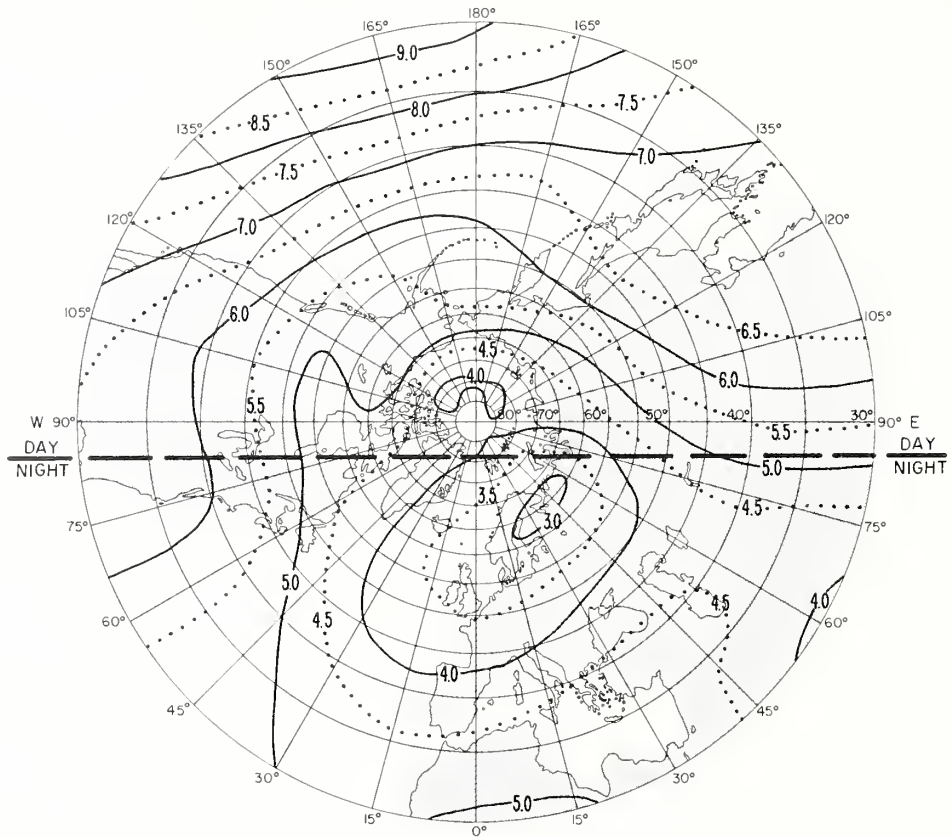


FIG. 13A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

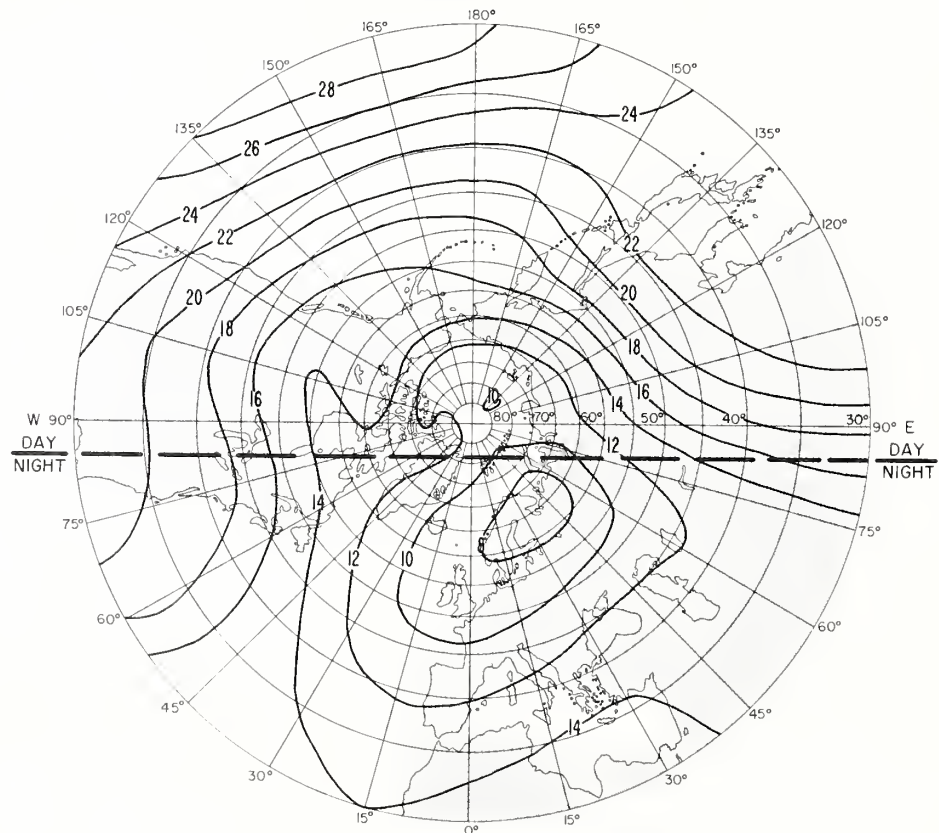


FIG. 13B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)



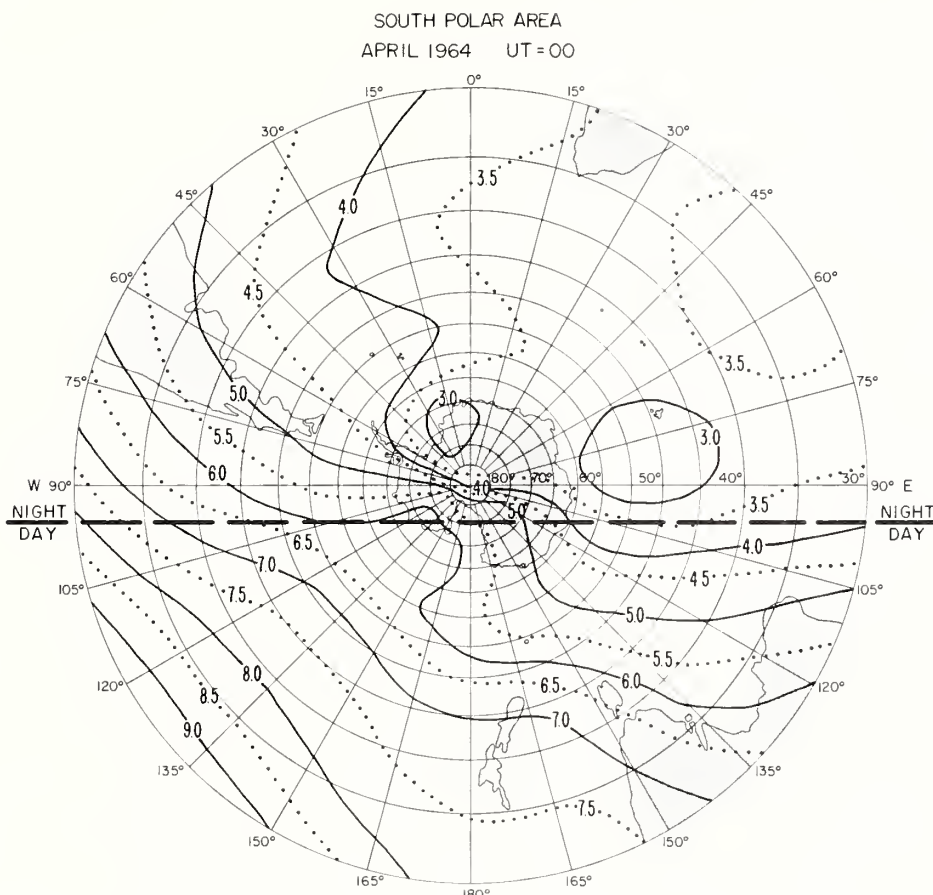


FIG. 14A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

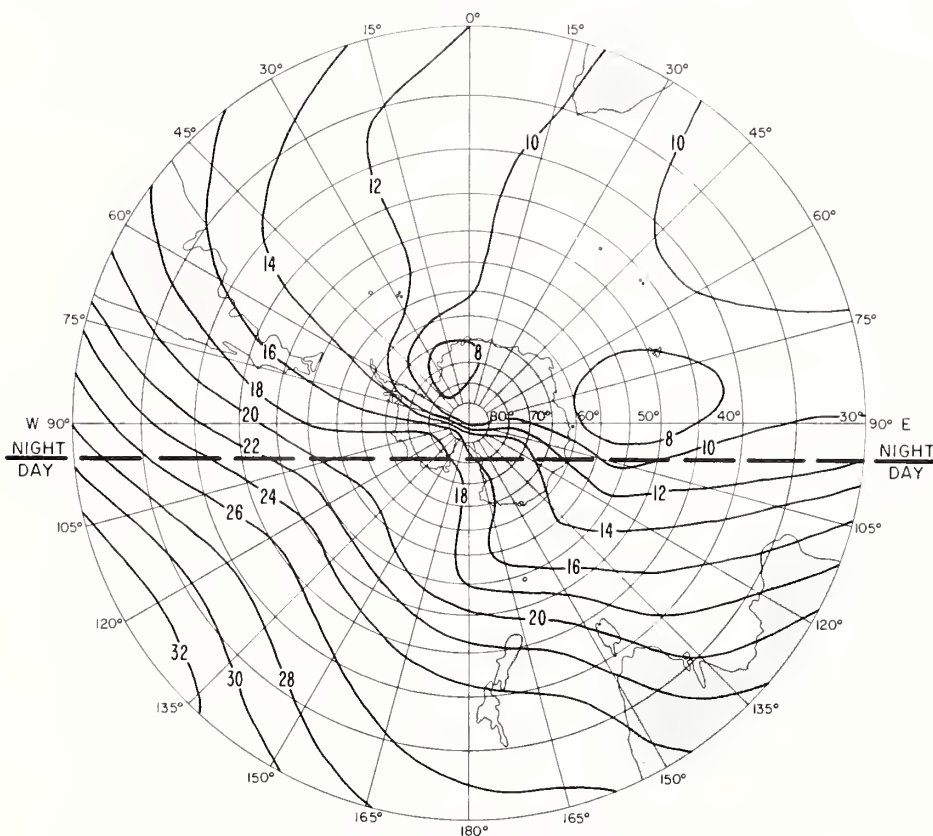


FIG. 14B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA  
APRIL 1964 UT = 12

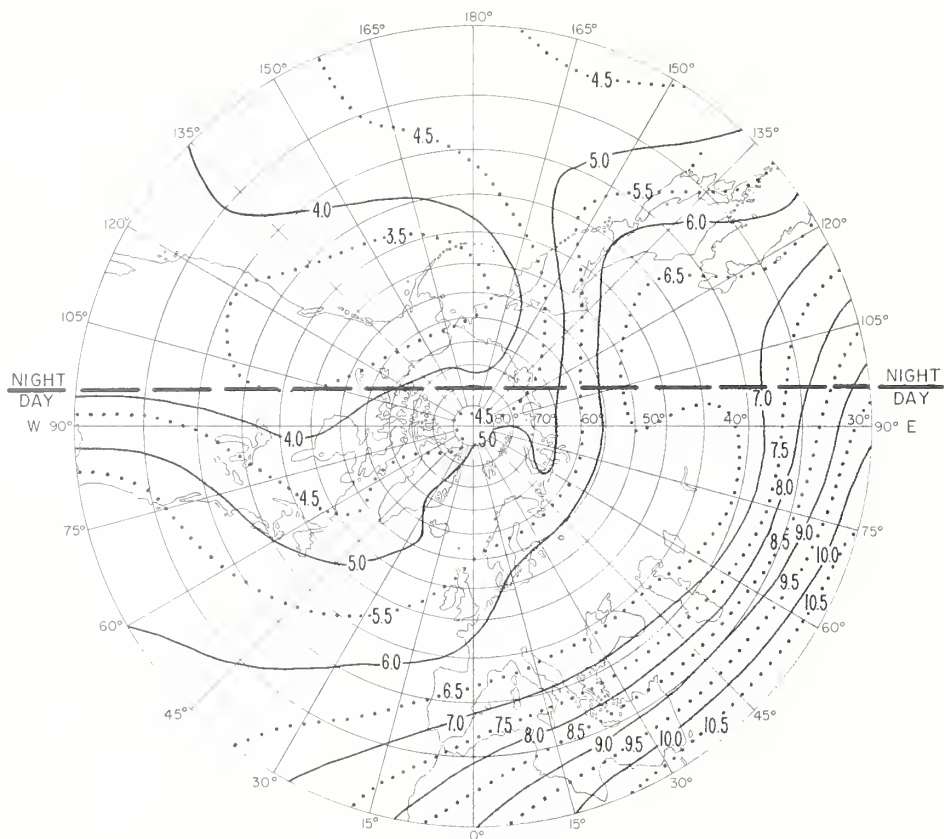


FIG. 15A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

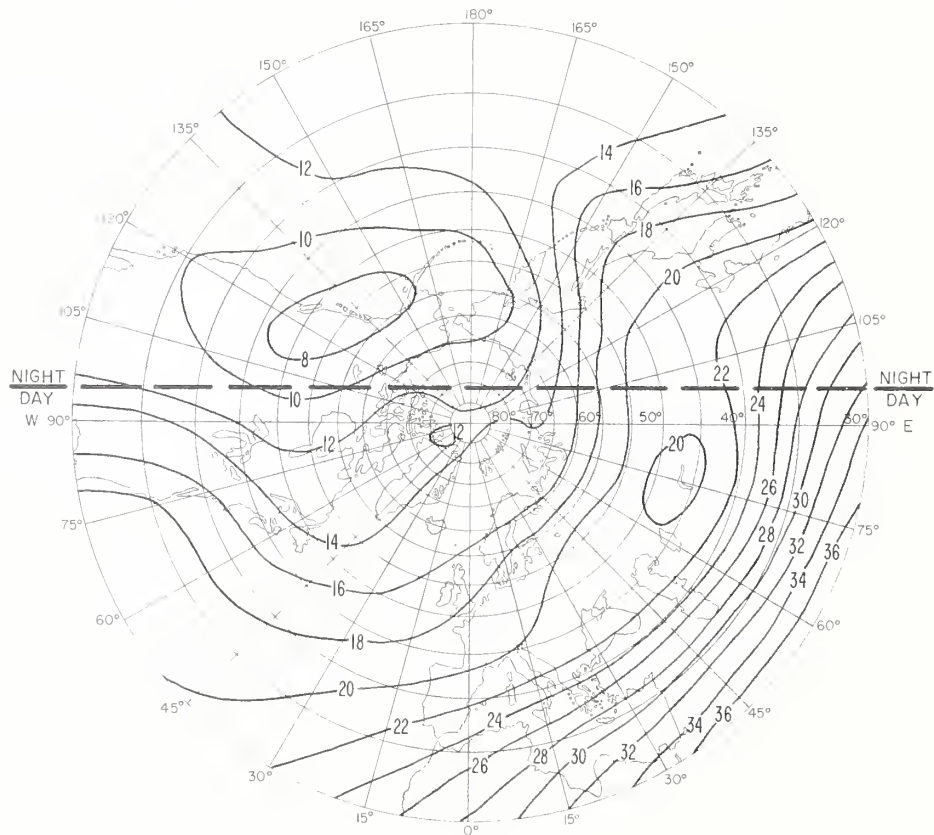


FIG. 15B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

SOUTH POLAR AREA  
APRIL 1964 UT =12

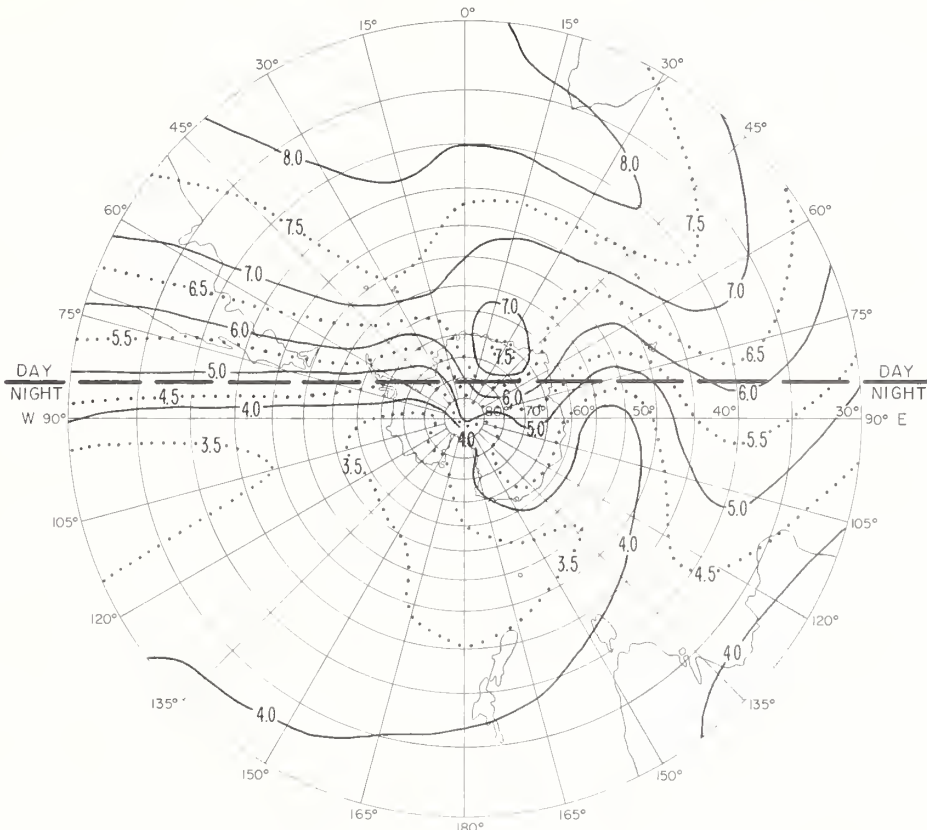


FIG. 16A. PREDICTED MEDIAN MUF(0)F2 (Mc/s)

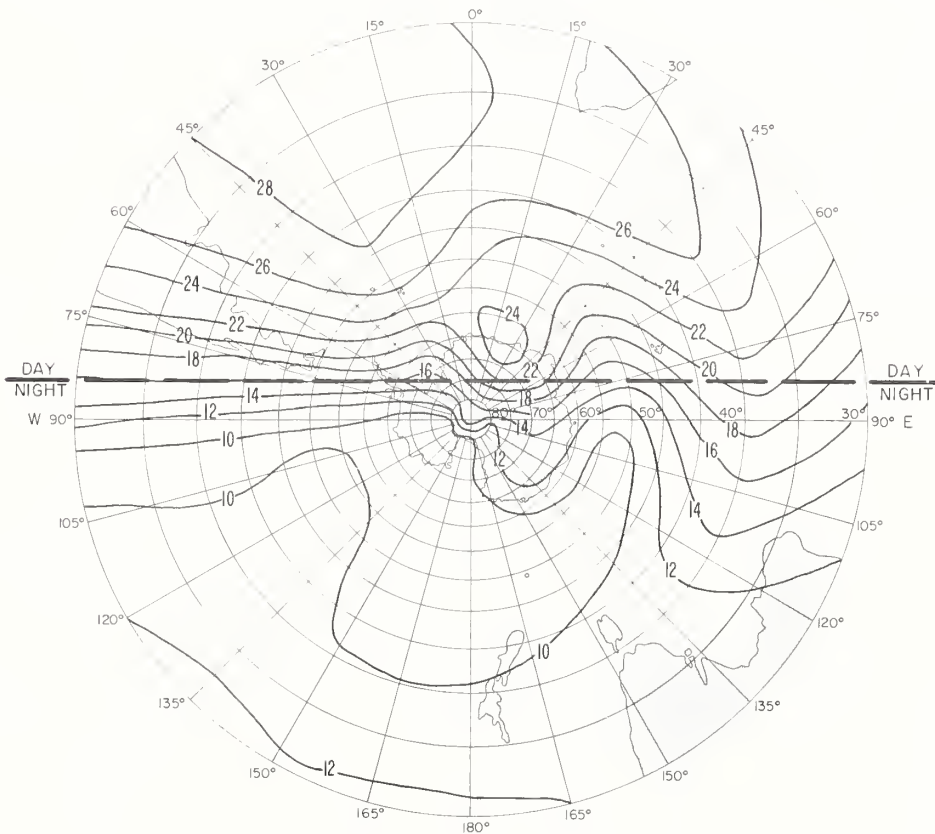


FIG. 16B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)





**H A N D B O O K**  
**for**  
**CRPL IONOSPHERIC PREDICTIONS**

Based on Numerical Methods of Mapping

NBS Handbook 90 — by S. M. Ostrow — 58 pages — December 1962 — \$0.40

All persons engaged in the solution of high frequency radio propagation problems will need this new *Handbook*, which replaces *Instructions for the Use of Basic Radio Propagation Predictions*, Circular 465 of the National Bureau of Standards.

Beginning with the January 1963 issue, the monthly radio propagation predictions from the Central Radio Propagation Laboratory of the National Bureau of Standards at Boulder, Colorado, will be entitled *CRPL Ionospheric Predictions*, instead of *Basic Radio Propagation Predictions (CRPL-D Series)*, as now called.

*CRPL Ionospheric Predictions* will fulfill the same functions as its predecessor. However, this new version will be prepared by numerical mapping methods, using an electronic computer. The predictions will be presented in two forms, giving the user the choice of either computer or graphical methods. Those using a computer will derive maximum benefits from the system. However, even when a computer cannot be used, the new prediction maps will provide more information than the earlier zone prediction charts, which were prepared by manual methods and designed primarily for graphical solution of high frequency propagation problems.

Thus the new *Handbook* is a necessity. All users of the *CRPL Ionospheric Predictions* should discard the now-obsolete *Instructions* and obtain a copy of the *Handbook*.

Use the order form below. Please order promptly so that you will have your *Handbook* by the time the January issue of *Predictions* arrives.

-----

Superintendent of Documents  
U.S. Government Printing Office  
Washington, D.C., 20402

Enclosed find \$\_\_\_\_\_ in check ☐ money order ☐ for which please send \_\_\_\_\_ copies of NBS Handbook 90, *Handbook for CRPL Ionospheric Predictions* to:

Name\_\_\_\_\_

Organization\_\_\_\_\_

Address\_\_\_\_\_

City\_\_\_\_\_ Zone\_\_\_\_\_ State (or Country)\_\_\_\_\_

(Please Note: Remittances from foreign countries should be by international money order or by draft on a U.S. bank.)

## ERRATUM

Corrections to table 2 in this issue—

s=0, k=26 through k=36 should be blank.

s=1, k=36 should be blank.

s=5, k=28 through k=36 should be blank.

## THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

### WASHINGTON, D. C.

**Electricity.** Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

**Metrology.** Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

**Heat.** Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

**Radiation Physics.** X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

**Analytical and Inorganic Chemistry.** Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

**Mechanics.** Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

**Polymers.** Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

**Metallurgy.** Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

**Inorganic Solids.** Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

**Building Research.** Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

**Applied Mathematics.** Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

**Data Processing Systems.** Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

**Atomic Physics.** Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

**Instrumentation.** Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

**Physical Chemistry.** Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

**Office of Weights and Measures.**

### BOULDER, COLO.

**Cryogenic Engineering Laboratory.** Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

### CENTRAL RADIO PROPAGATION LABORATORY

**Ionosphere Research and Propagation.** Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

**Troposphere and Space Telecommunications.** Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

**Radio Systems.** Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

**Upper Atmosphere and Space Physics.** Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

### RADIO STANDARDS LABORATORY

**Radio Standards Physics.** Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

**Radio Standards Engineering.** High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

### NBS LABORATORY ASTROPHYSICS GROUP

(Joint Institute for Laboratory Astrophysics at Univ. of Colo.)



UNITED STATES  
GOVERNMENT PRINTING OFFICE  
DIVISION OF PUBLIC DOCUMENTS  
WASHINGTON, D. C., 20402

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID  
PAYMENT OF POSTAGE, \$300  
(GPO)

DEPARTMENTS OF THE ARMY  
AND THE AIR FORCE  
WASHINGTON, D. C., 20301, 1 January 1964

TB 11-499-13/TO 31-3-28, CRPL Ionospheric Predictions for April 1964, published for the use of all concerned.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

EARLE G. WHEELER,  
*General, United States Army,*  
*Chief of Staff.*

OFFICIAL:

J. C. LAMBERT,  
*Major General, United States Army,*  
*The Adjutant General.*

CURTIS E. LEMAY,  
*Chief of Staff, United States Air Force.*

OFFICIAL:

R. J. PUGH,  
*Colonel, United States Air Force,*  
*Director of Administrative Services.*

DISTRIBUTION:

*Active Army:*

USASA (4); USA Elct Comd (1); CSigO (1); USA MI Comd (1); USA Test & Eval Comd (1); USACD Agcy (1); USA Msl Spt Comd (1); USCONARC (3); ARADCOM (2); OS Maj Comd (5); OS Base Comd (2); Log Comd (2); MDW (1); Armies (5); Corps (2); Div (2); USA Elct RD Agcy (4); Svc Colleges (4); Br Svc Sch (4) except USASCS (20); USAADCEN (4); ARADCOM Rgn (2); WSMR (2); USA Elct RD Actv (4); JBUSMC (12); USA Corps (1); USA Mbl Spt Cen (1); USAEPG (2); USAMC (1); Units org under fol TOE: 11-18 (1); 11-95 (1); 11-500 (AC) (1).

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.