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Central Radio Propagation Laboratory

IONOSPHERIC PREDICTIONS

for May 1964

TB 11-499-14/TO 31-3-28



U. S. DEPARTMENT of COMMERCE National Bureau of Standards Number 14/Issued February 1964 U.S. DEPARTMENT OF COMMERCE Luther H. Hodges, Secretary



Central Radio Propagation Laboratory

Ionospheric Predictions

for May 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

NATIONAL BUREAU OF STANDARDS A. V. Astin, Director

Number 14

Issued

February 1964

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 technical 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 foF2 and M(3000)F2 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) F2 and MUF (4000) F2 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-F1 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 sunpot 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 May 1964 being distributed in February 1964 and designated TB 11-499-(14), 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.

<u>Table</u> <u>A</u>

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

Observed and Predicted Zurich Smoothed Relative Sunspot Numbers

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.



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VARIATION
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NOITAIRAV JADIH9AR0030

PREDICTED COEFFICIENTS D_{sk} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN f_o F2 (Mc/s) MAY 1964

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

OR MONTHLY MEDIAN to F2 (Mc/3) \sim MAY 1964 TABLE

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3 5 5 5 5 5 5 5 9 ,15957266-02 7 ,133569366-01 7 ,133569366-01 7 ,13356956-01 7 ,5956956-01 7 ,59569566-01 7 ,59569566-01 7 ,59569566-01 7 ,59569566-01 7 ,59569566-01 7 ,59569566-01 7 ,5956956-01 1 ,5567032866-01 1 ,5567032866-01 1 ,556703666-01 1 ,556703666-01 1 ,556703666-01 1 ,556703666-01 1 ,556703666-01 1 ,556703666-01 1 ,556703666-01 1 ,11053176-01 1 ,57670366-01 1 ,57670366-01 1 ,56653866-01 1 ,56673866-01 1 ,11053176-01 1 ,57670366-01 1 ,57670366-01 1 ,11053176-01 1 ,57670366-01 1 ,57670366-01 1 ,11053176-01 1 ,57670366-01 1 ,11053176-01 1 ,57670366-01 1 ,11053176-01 1 ,57670366-01 1 ,11053176-01 1 ,57670366-01 1 ,110531766-02 1 ,2384476-03 3 ,447256-02 1 ,10531766-01 1 ,106410156 1 ,0531386-01 1 ,11053176216-02 2 ,3364476-02 1 ,1053176676-02 2 ,3364476-02 1 ,10531791465-02 1 ,02692816 0 ,44125226-02 1 ,105405466-02 1 ,106410156 1 ,106410156 1 ,106410156 1 ,106410156 1 ,106410466 1 ,2384467-01 1 ,107531791465-02 1 ,02692816 1 ,110531791465 1 ,1795466-02 1 ,1237791465-02 1 ,1237791465-02 2 ,33644476-02 1 ,1237791465-02 2 ,39654467-02 2 ,396592646-02 2 ,396592646-02 2 ,3965925466-02 2 ,3965925466-02 2 ,3965982646-02 2 ,396594266-02 2 ,3965982646-02 2 ,3965982646-02 2 ,3965982646-02 2 ,39659456-02 2 ,39659456-02 2 ,39659456-02 2 ,39659456-02 2 ,39659456-02 2 ,39659456-02 2 ,39659456-02 1 ,237791465-02 1 ,237791465-02 1 ,237791465-02 1 ,1237791465-02 1 ,1237791765-02 1 ,12
6 1.2149962E-02 3.06326395-02 4.8955055E-01 4.8955055E-01 4.8955055E-01 4.8955055E-01 4.8955050501E-01 1.55326038E 00 1.55326038E 00 1.553260201E-01 6.1788030E-01 5.1788029E-02 1.940370E-02 1.940370E-02 1.940370E-02 1.940370E-01 4.11053178-01 4.11053178-01 4.11053178-01 4.11053178-01 4.1023178-01 4.1023178-01 4.11053178-01 4.11053178-01 4.11053178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.1023178-01 4.102317914E-01 4.102317914E-01 4.1023155E-01 4.90515546E-02 1.2377914E-01 1.2377914E-01 1.227784E-02 1.22878E-02

Notation: For each entry the number given by the first eight digits ond sign is multiplied by the power of ten defined by the lost two digits ond sign. 1 - Moin latitudinol variation. Mixed lotitudinal and longItudinol vorlotion: 🛙 - First order in longitude, 🎞 - Second order in longitude.

4.5770396E-03 -2.7577620E-02 -1.8540709E-03 2.8405804E-02

-8.5068868E-03 8.9215630E-04 1.2652942E-02 1.4466569E-03

2.1103643E-02 -8.5963055E-03 -2.7842312E-02 1.1646043E-03

8.6525357E-03 -3.1594375E-02 -4.9646334E-03 2.6137743E-02

-4.1573474E-03 5.7778618E-02 -4.9256201E-03 -5.8803042E-02

2.3321966E-C2 4.6761924E-(12 -3.8616646E-C2 -6.7056096E-C2

0-2-

ЧАЯ ЭОЗ Э

PREDICTED COEFFICIENTS D_{sk} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN M(3000)F2 MAY 1964















MAY 1964 UT 12



MAY 1964 UT = 14





MAY 1964 UT=16







MAY 1964 UT=20





FIG. I3B. PREDICTED MEDIAN MUF (4000)F2 (Mc/s)



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



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





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TB 11-499-14/TO 31-3-28, CRPL Ionospheric Predictions for May 1964, is published for the use of all concerned.

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NG: None.

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

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