Basic Radio Propagation Predictions

FOR JANUARY 1948

Three Months in Advance

Issued October 1947

CRPL Series D Number 38

The Central Radio Propagation Laboratory

The propagation of radio waves over long distances depends on their reflection from the ionosphere, the electrically conducting layers in the earth's upper atmosphere. The characteristics of these layers are continuously changing. For regular and reliable communication, it is therefore necessary to collect and analyze ionospheric data from stations all over the world in order that predictions of usable frequencies between any two places at any hour can be made. During the war, the United States Joint Communications Board set up the Interservice Radio Propagation Laboratory at the National Bureau of Standards to centralize ionospheric work and predictions for the Armed Forces of the United States.

On May 1, 1946, this activity returned to peacetime status as the Central Radio Propagation Laboratory of the National Bureau of Standards. Designed to act as a permanent centralizing agency for propagation predictions and studies, analogous in the field of radio to the reports of the Weather Bureau in the field of meteorology, the Central Radio Propagation Laboratory was established in cooperation with the many Government agencies vitally concerned with communication and radio propagation problems. These agencies are represented on the advisory Executive Council of the Laboratory, including representatives of the War Department, Navy Department, Civil Aeronautics Authority, Federal Communications Commission, State Department, Coast Guard, Coast and Geodetic Survey, and the Weather Bureau. In addition, industry is represented by the Radio Technical Planning Board, while the Carnegie Institution of Washington serves in an advisory capacity.

The Central Radio Propagation Laboratory receives and analyzes data from approximately 60 stations located throughout the world, including 13 domestic and 8 overseas stations which are operated either directly or under contract by the National Bureau of Standards. Ionospheric data and predictions are disseminated to the armed forces, commercial users, scientists, and laboratories. The basic ionospheric research of the Laboratory includes theoretical and experimental studies of maximum usable frequencies, ionospheric absorption, long-time variations of radio propagation characteristics, the effects of the sun on radio propagation, and the relation between radio disturbance and geomagnetic variation. In the microwave field, the Laboratory is investigating the relation between radio propagation and weather phenomena, as well as methods by which predictions can be made and radio communications improved in this portion of the radio-frequency spectrum. Another phase of the Laboratory's work is the development and maintenance of standards and methods of measurement of many basic electrical quantities throughout the entire frequency spectrum.

Basic Radio Propagation Predictions

The CRPL Series D, Basic Radio Propagation Predictions, is issued monthly as an aid in the determination of the best sky-wave frequencies over any path at any time of day for average conditions for the month of prediction, 3 months in advance. Charts of extraordinary-wave critical frequency for the $F2$ layer, of maximum usable frequency for a transmission distance of 4,000 km, and of percentage of time occurrence for transmission by sporadic E in excess of 15 Mc, for a distance of 2,000 km, are included.

Beginning with the July 1946 issue the CRPL–D series, "Basic Radio Propagation Predictions," is available on a purchase basis from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., on the following terms:

Single copy	10 cents
Annual subscription (12 issues)	$1.00

New subscribers and those desiring to continue to receive this publication should place their orders with the Superintendent of Documents.

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[Published with approval of the Director of the Budget]

U. S. DEPARTMENT OF COMMERCE
W. Averell Harriman, Secretary
NATIONAL BUREAU OF STANDARDS
E. U. Condon, Director

Oct. 1947
CRPL Series D
Number 38

BASIC RADIO PROPAGATION PREDICTIONS

For January 1948 — Three Months in Advance

Introduction

Beginning with the September 1947 issue, the CRPL–D series, "Basic Radio Propagation Predictions," issued by the National Bureau of Standards, contains contour charts of $F2$-zero-muf and $F2$-4000-muf for each of the three zones, W, I, and E, into which the world is divided for the purpose of taking into consideration the variation of the characteristics of the $F2$-layer with longitude (figs. 1 to 6); the world-wide contour chart of E-layer 2000-muf (fig. 7); the contour chart of median fEs (fig. 8); and the chart showing percentage of time occurrence for Es-2000-muf in excess of 15 Mc (fig. 9).

Methods for using these charts are given in Circular 465 of the National Bureau of Standards, entitled "Instructions for the Use of Basic Radio Propagation Predictions," and available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., price 25 cents. Requests for this manual from members of the Army or Navy should be sent to the proper service address as follows. *For the Army:* Office of the Chief Signal Officer, War Department, Washington 25, D. C., Attention: SIGOL–2. *For the Navy:* Chief of Naval Operations, Navy Department, Washington 25, D. C. (CNC–20–Q.)

The last two figures of this issue are copies of two of four figures in NBS Circular 465. These figures, numbered 1, 2, 11, and 12 in that publication, are given in rotation, two in each issue of the CRPL Series D, for convenience of the user. They are necessary for the preparation of tables and graphs of muf and owf, as explained in NBS Circular 465.

The charts in this issue were constructed from data through July 1947, together with a predicted smoothed 12-month running-average Zurich sunspot number of 130, centered on January 1948.

Attention is invited to the blank form at the end of this publication, for use in reporting the accuracy of the predictions of muf and owf as given in this report. Communications should be addressed to Central Radio Propagation Laboratory, National Bureau of Standards, Washington 25, D. C.

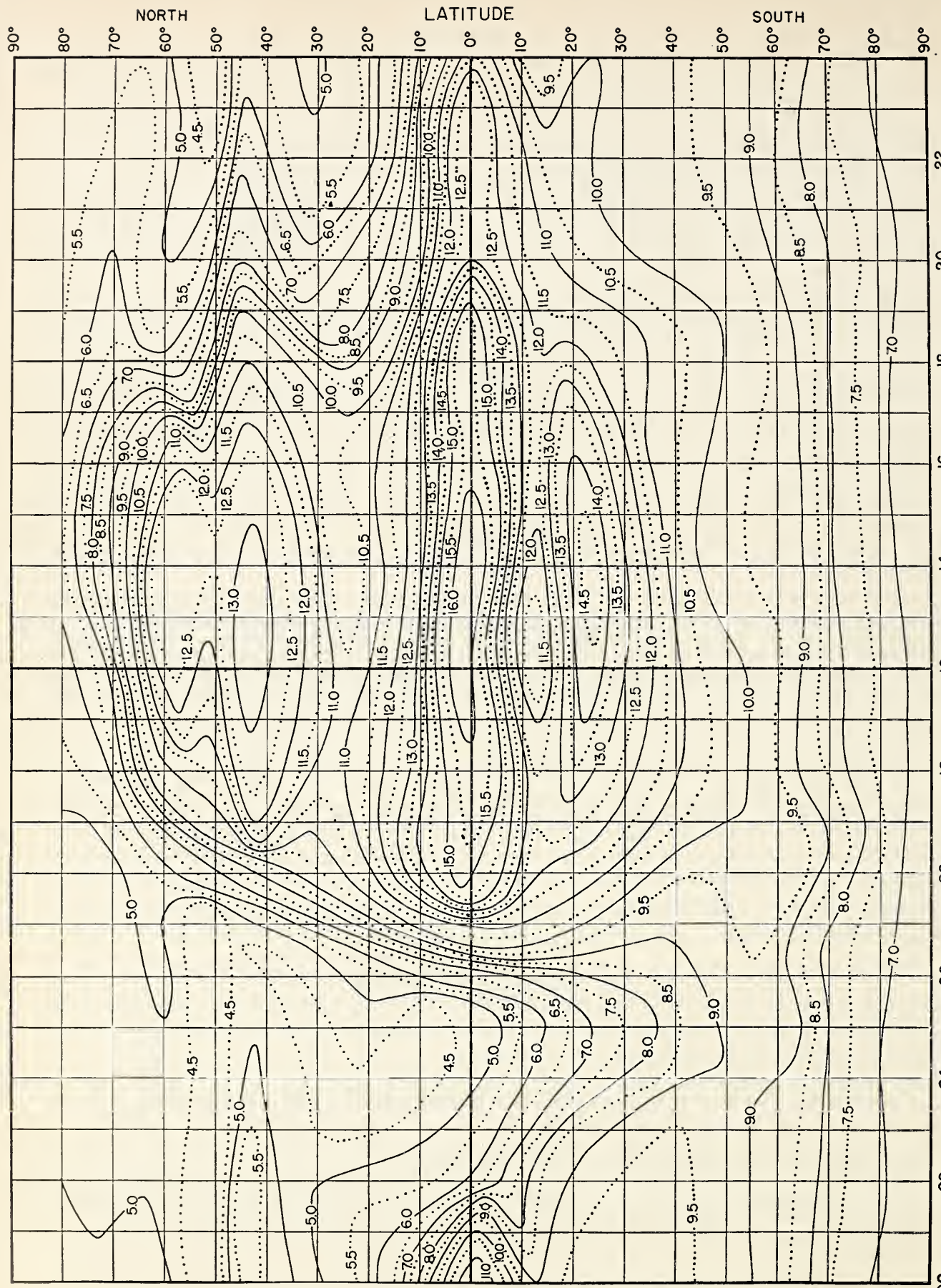


Fig. 1. F_2 ZERO—MUF, IN Mc, W ZONE, PREDICTED FOR JANUARY 1948

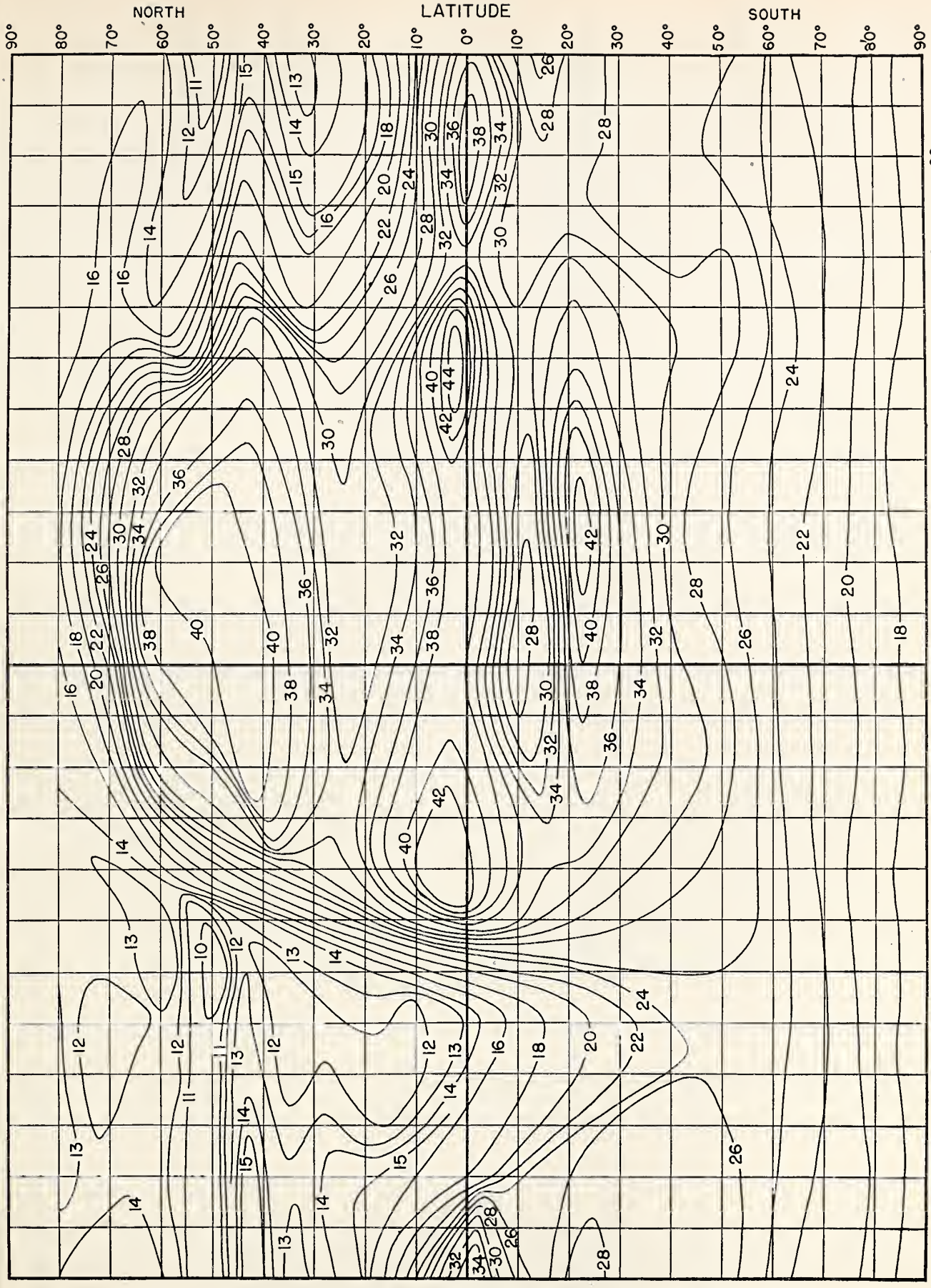


Fig. 2. F_2 4000—MUF, IN Mc, W ZONE, PREDICTED FOR JANUARY 1948.

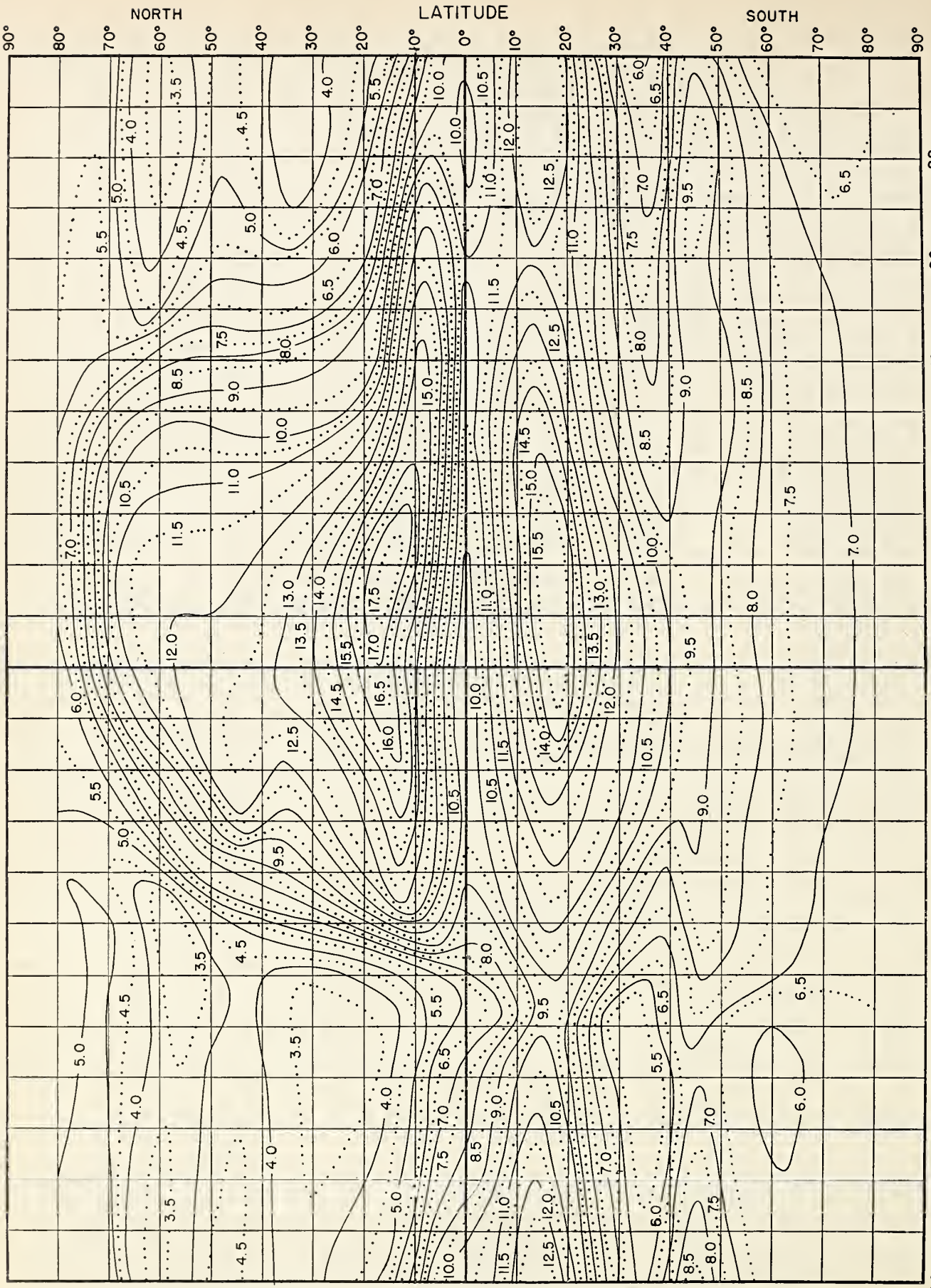


Fig. 3. F_2 ZERO—MUF, IN Mc, 1 ZONE, PREDICTED FOR JANUARY 1948

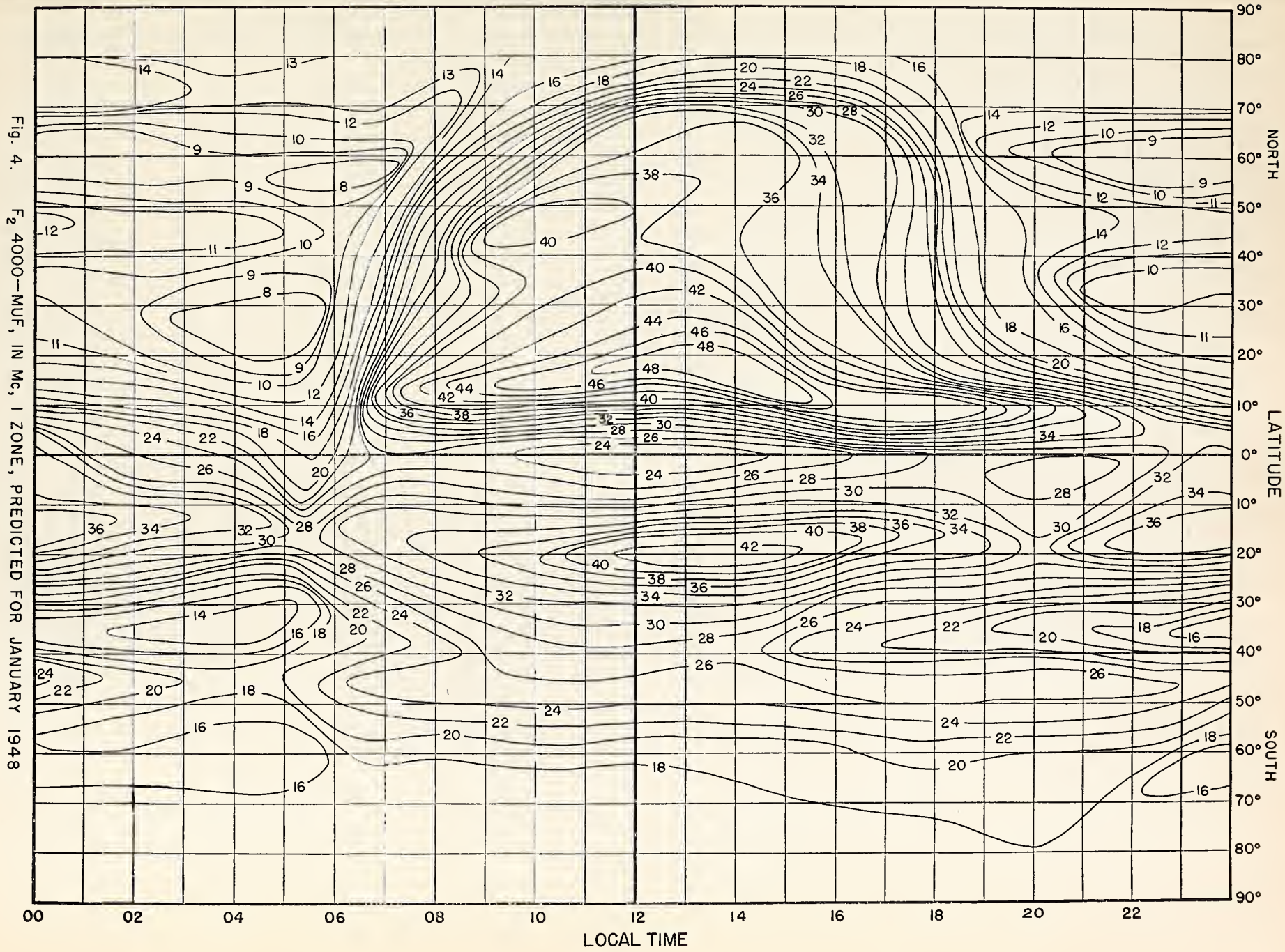


Fig. 4. F_2 4000—MUF, IN Mc, I ZONE, PREDICTED FOR JANUARY 1948

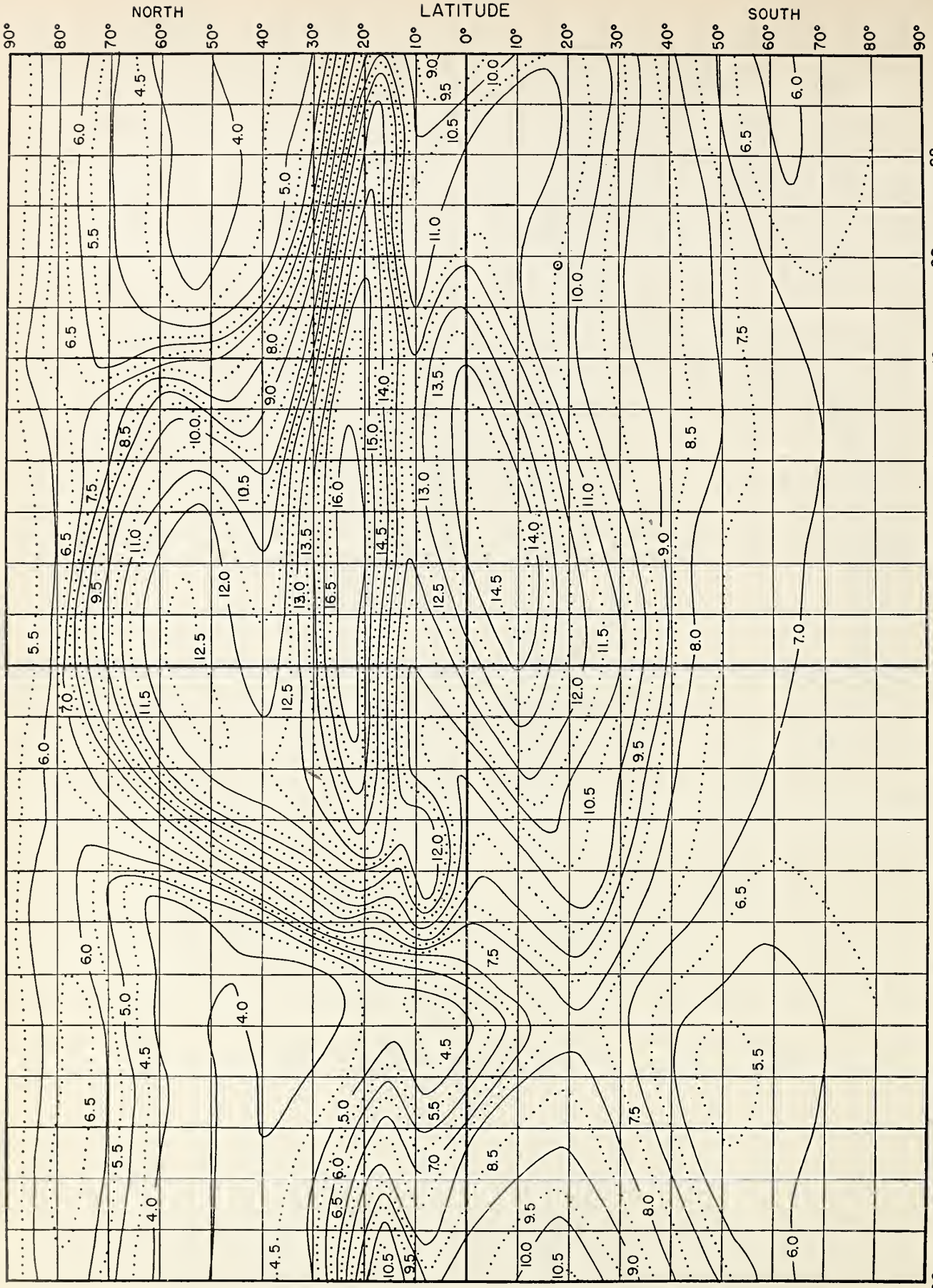


Fig. 5. F_2 ZERO—MUF, IN Mc, E ZONE, PREDICTED FOR JANUARY 1948

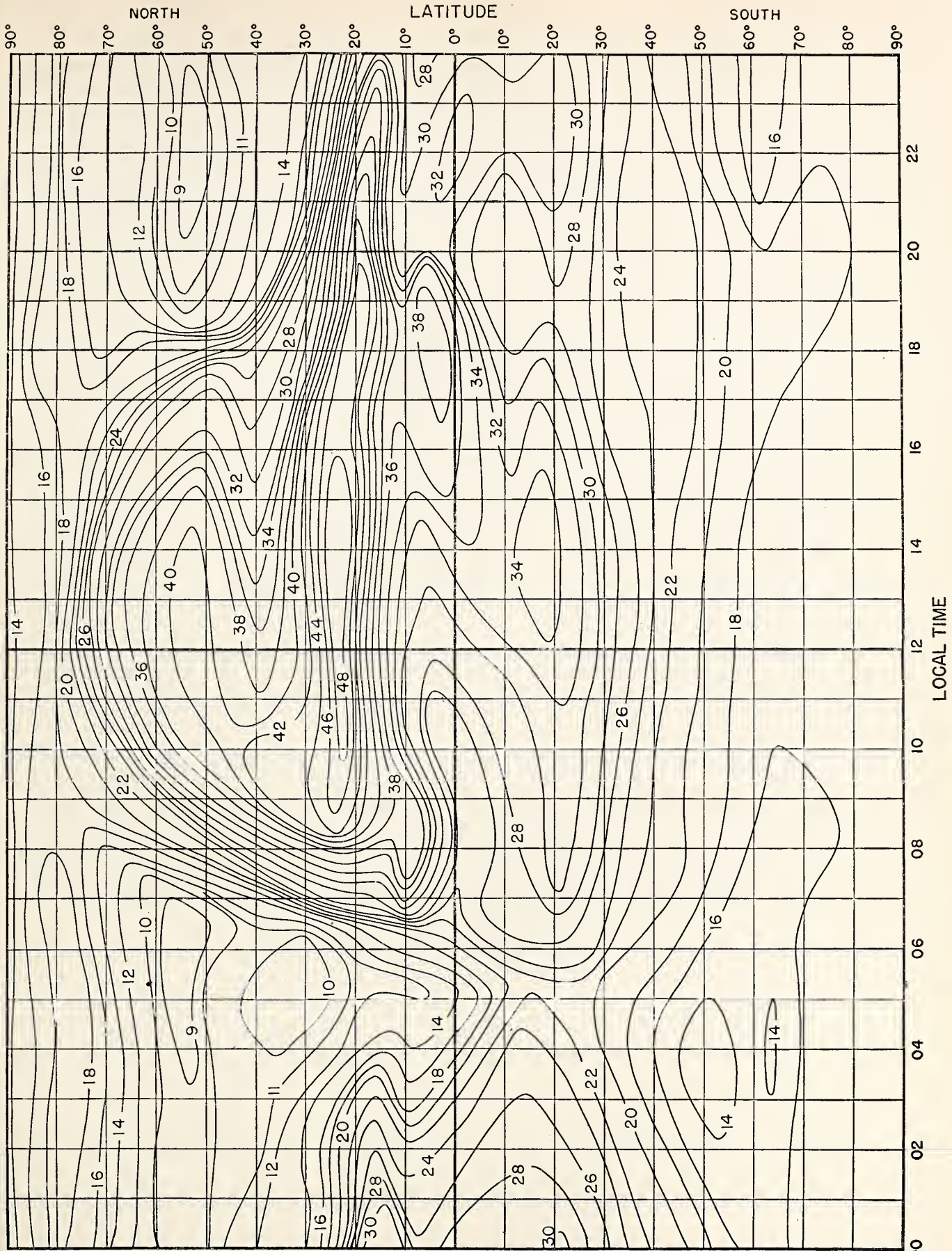


Fig. 6. F_2 4000—MUF, IN Mc, E ZONE, PREDICTED FOR JANUARY 1948

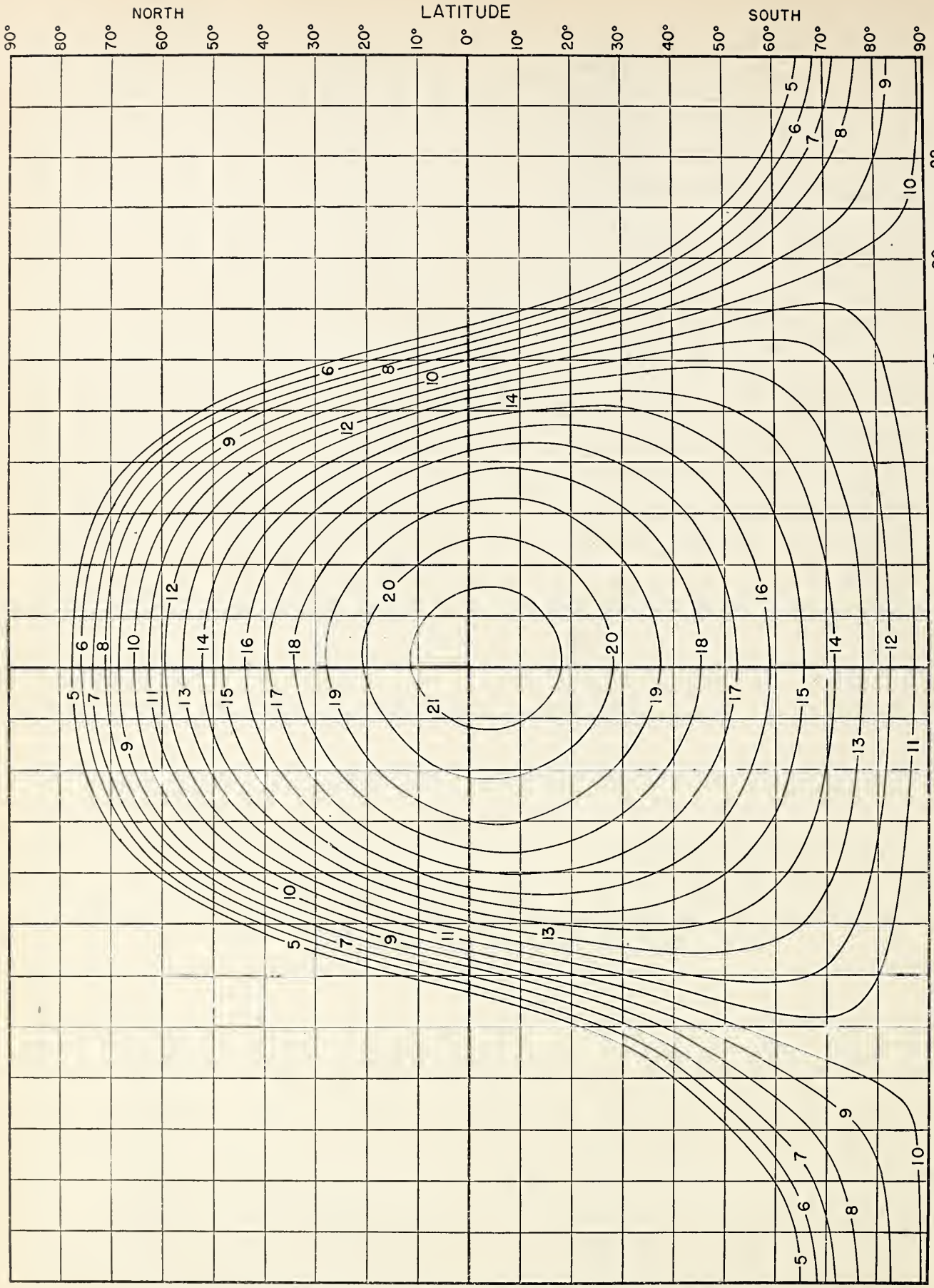


Fig. 7. E—LAYER 2000—MUF, IN Mc, PREDICTED FOR JANUARY 1948

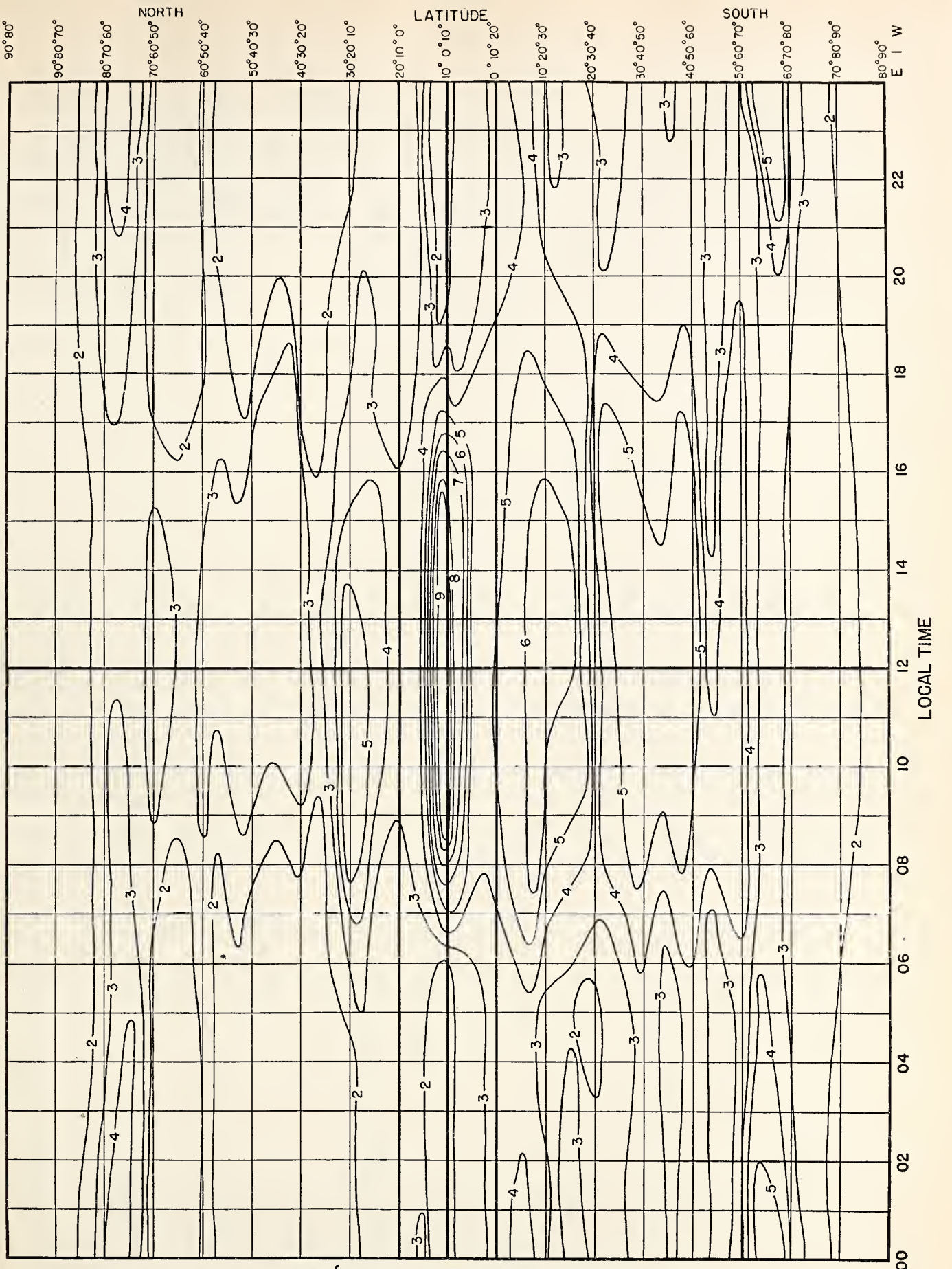


Fig. 8. MEDIAN fE_s, IN Mc, PREDICTED FOR JANUARY 1948

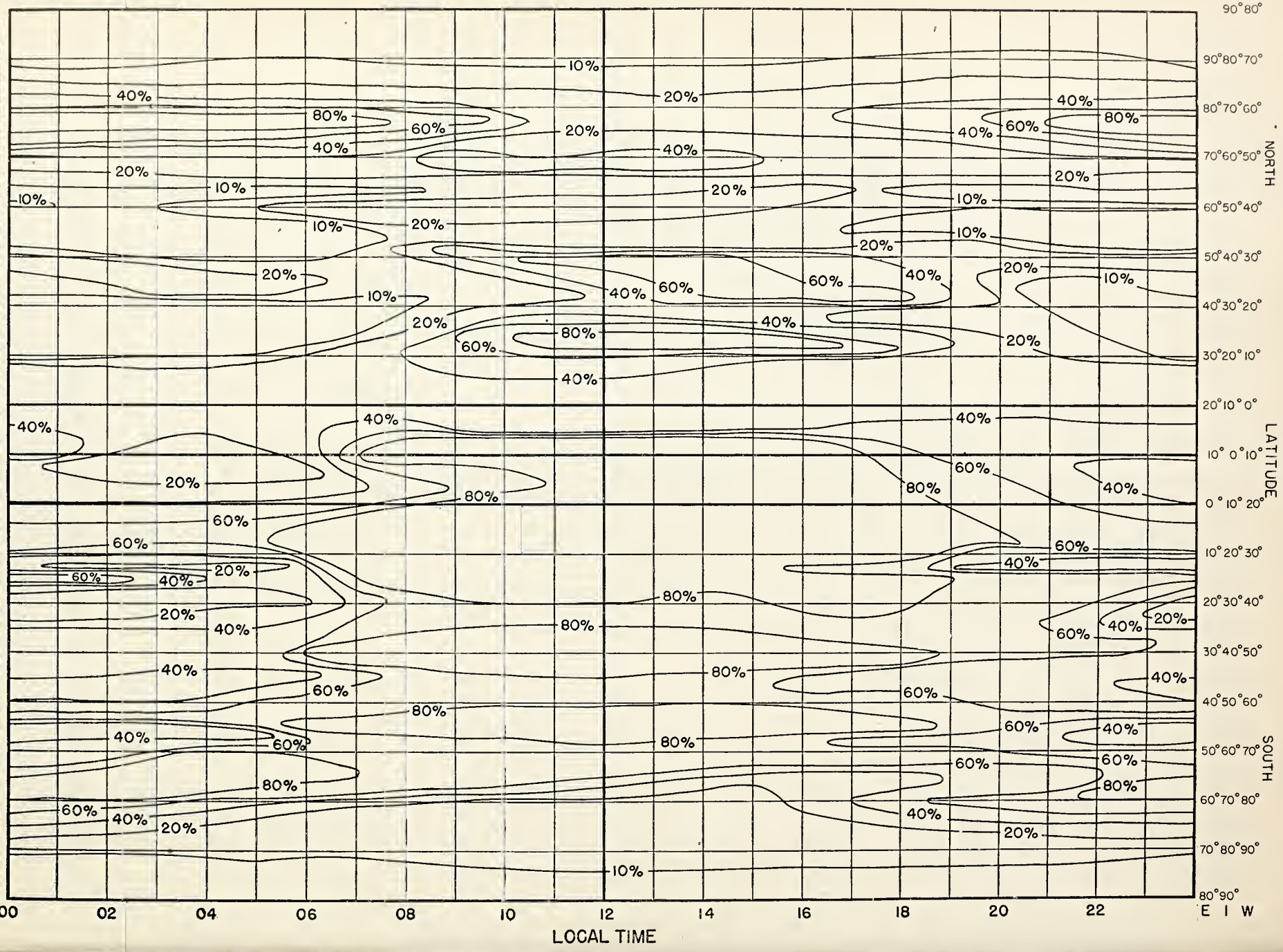
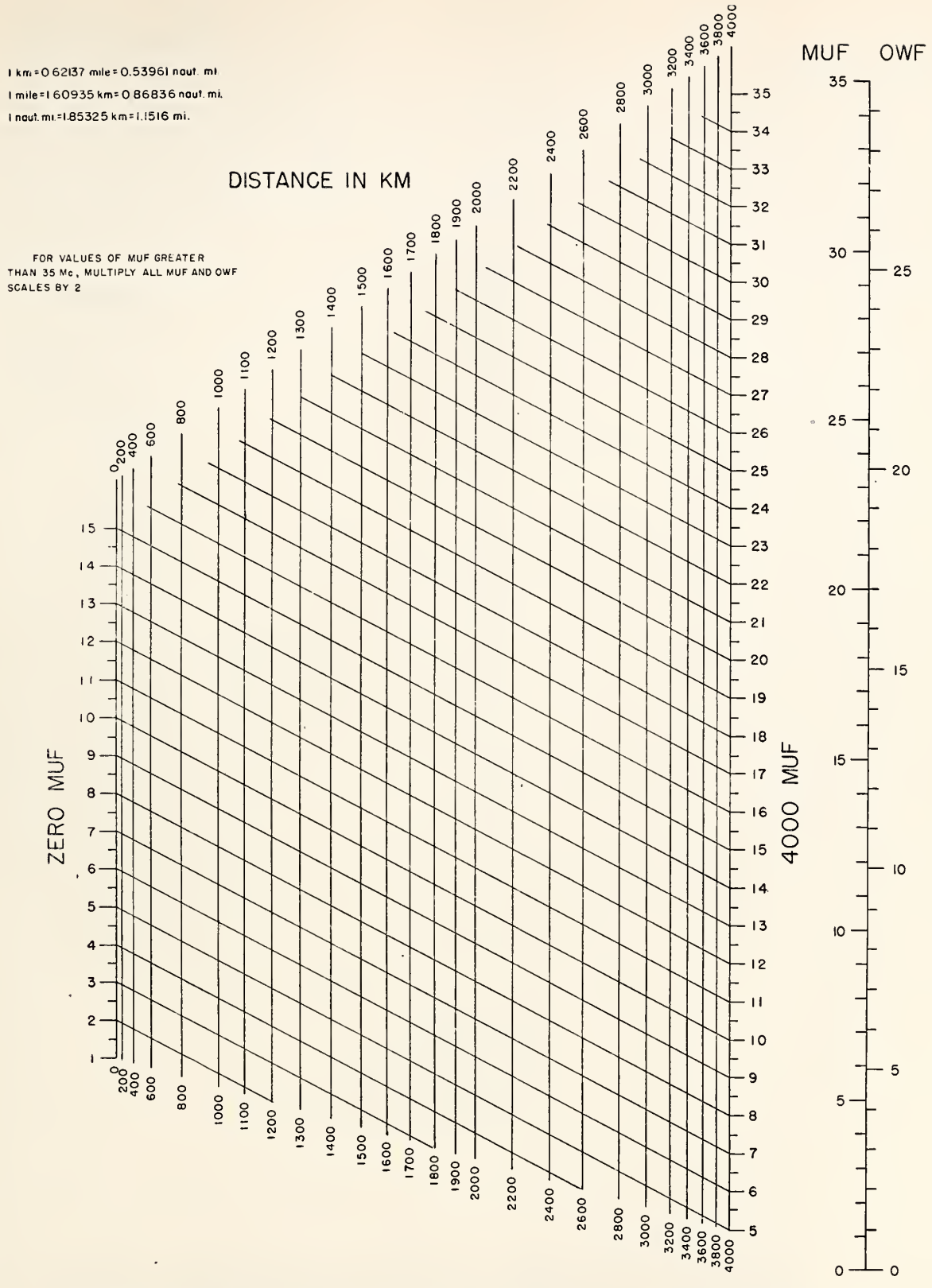
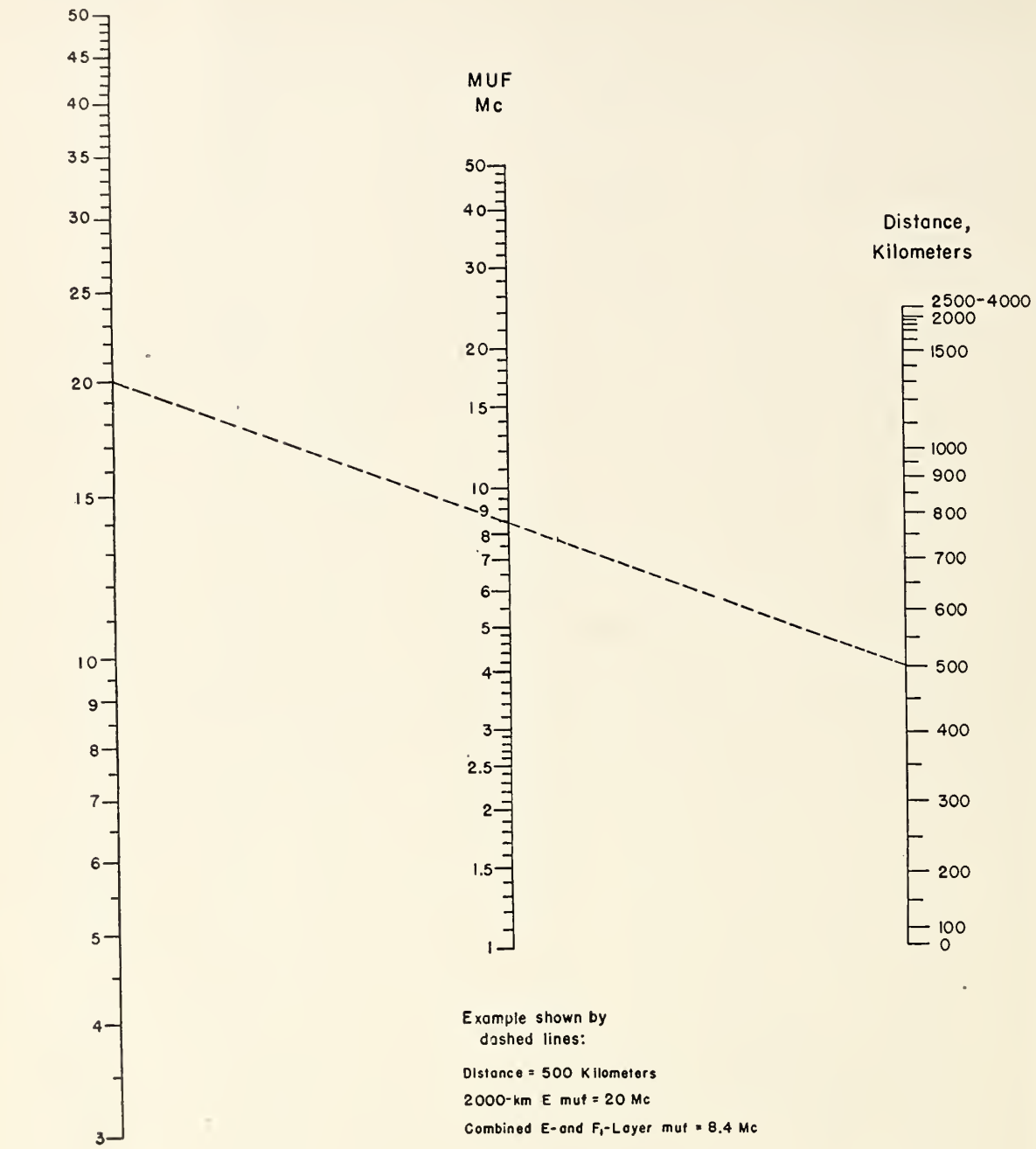


Fig. 9 PERCENTAGE OF TIME OCCURRENCE FOR E_s 2000-MUF IN EXCESS OF 15 Mc, PREDICTED FOR JANUARY 1948



NOMOGRAM FOR TRANSFORMING F_2—ZERO—MUF AND F_2—4000—MUF TO EQUIVALENT MAXIMUM USABLE FREQUENCIES AT INTERMEDIATE TRANSMISSION DISTANCES; CONVERSION SCALE FOR OBTAINING OPTIMUM WORKING FREQUENCIES.

1 km = 0.62137 mile = 0.53961 naut. mi.
1 mile = 1.60935 km = 0.86836 naut. mi.
1 naut. mi. = 1.85325 km = 1.1516 mi.



NOMOGRAM FOR TRANSFORMING E—LAYER 2000—MUF TO EQUIVALENT MAXIMUM USABLE FREQUENCIES AND OPTIMUM WORKING FREQUENCIES DUE TO COMBINED EFFECT OF E LAYER AND F_1 LAYER AT OTHER TRANSMISSION DISTANCES.

(Cut along this line)

Form for Report to CRPL on Accuracy of Predictions

Name _____ Date _____

Address _____ _____ _____ _____ _____ _____
No. Street City P.O. Zone State Country

From (between) _____ to (and) _____ Date _____

Time (specify zone) _____																
Frequency Used																
D-Series Predicted OWF (Regular Layers)																
D-series Predicted OWF (Including Es)																

Further comment (including notes on quality of communication):

CRPL and IRPL Reports

Daily:
Radio disturbance warnings, every half hour from broadcast station WWV of the National Bureau of Standards.
Telephoned and telegraphed reports of ionospheric, solar, geomagnetic, and radio propagation data.

Weekly:
CRPL–J. Radio Propagation Forecast (of days most likely to be disturbed during following month).

Semimonthly:
CRPL–Ja. Semimonthly Frequency Revision Factors for CRPL Basic Radio Propagation Prediction Reports.

Monthly:
CRPL–D. Basic Radio Propagation Predictions—Three months in advance. (War Dept. TB 11–499–, monthly supplements to TM 11–499; Navy Dept. DNC–13–1 ( ), monthly supplements to DNC–13–1.)
CRPL–F. Ionospheric Data.

Quarterly:
*IRPL–A. Recommended Frequency Bands for Ships and Aircraft in the Atlantic and Pacific.
*IRPL–H. Frequency Guide for Operating Personnel.
Reports on high-frequency standards.
Reports on microwave standards.

Nonscheduled reports:
CRPL–1–1. Prediction of Annual Sunspot Numbers.
CRPL–7–1. Preliminary Instructions for Obtaining and Reducing Manual Ionospheric Records.
NBS Circular 465. Instructions for the Use of Basic Radio Propagation Predictions.

Reports issued in past:
IRPL Radio Propagation Handbook, Part 1. (War Dept. TM 11–499; Navy Dept. DNC–13–1.)
IRPL–C61. Report of the International Radio Propagation Conference, 17 April to 5 May 1944.
IRPL–G1 through G12. Correlation of D. F. Errors With Ionospheric Conditions.
IRPL–R. Nonscheduled reports:
- R4. Methods Used by IRPL for the Prediction of Ionosphere Characteristics and Maximum Usable Frequencies.
- R5. Criteria for Ionospheric Storminess.
- R6. Experimental Studies of Ionospheric Propagation as Applied to the Loran System.
- R7. Second Report on Experimental Studies of Ionospheric Propagation as Applied to the Loran System.
- R9. An Automatic Instantaneous Indicator of Skip Distance and MUF.
- R10. A Proposal for the Use of Rockets for the Study of the Ionosphere.
- R11. A Nomographic Method for Both Prediction and Observation Correlation of Ionosphere Characteristics.
- R12. Short Time Variations in Ionospheric Characteristics.
- R14. A Graphical Method for Calculating Ground Reflection Coefficients.
- R15. Predicted Limits for *F*2-layer Radio Transmission Throughout the Solar Cycle.
- R16. Predicted *F*2-layer Frequencies Throughout the Solar Cycle, for Summer, Winter, and Equinox Season.
- R17. Japanese Ionospheric Data—1943.
- R18. Comparison of Geomagnetic Records and North Atlantic Radio Propagation Quality Figures—October 1943 Through May 1945.
- R19. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for June.
- R20. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for September.
- R21. Notes on the Preparation of Skip-Distance and MUF Charts for Use by Direction-Finder Stations. (For distances out to 4000 km.)
- R22. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for December.
- R23. Solar-Cycle Data for Correlation with Radio Propagation Phenomena.
- R24. Relations Between Band Width, Pulse Shape and Usefulness of Pulses in the Loran System.
- R25. The Prediction of Solar Activity as a Basis for Predictions of Radio Propagation Phenomena.
- R26. The Ionosphere as a Measure of Solar Activity.
- R27. Relationships Between Radio Propagation Disturbance and Central Meridian Passage of Sunspots Grouped by Distance From Center of Disc.
- R28. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for January.
- R29 and 29–A. Revised Classification of Radio Subjects Used in National Bureau of Standards and First Supplement (NBS Letter Circular LC–814 and Supplement, superseding Circular C385).
- R30. Disturbance Rating in Values of IRPL Quality-Figure Scale From A. T. & T. Co. Transmission Disturbance Reports to Replace T. D. Figures as Reported.
- R31. North Atlantic Radio Propagation Disturbances, October 1943 Through October 1945.
- R32. Nomographic Predictions of *F*2-layer Frequencies Throughout the Solar Cycle, for February.
- R33. Ionospheric Data on File at IRPL.
- R34. The Interpretation of Recorded Values of *fEs*.
- R35. Comparison of Percentage of Total Time of Second-Multiple *Es* Reflections and That of *fEs* in Excess of 3 Mc.

IRPL–T. Reports on Tropospheric Propagation:
- T1. Radar operation and weather. (Superseded by JANP 101.)
- T2. Radar coverage and weather. (Superseded by JANP 102.)

CRPL–T3. Tropospheric Propagation and Radio-Meteorology. (Reissue of Columbia Wave Propagation Group WPG–5.)

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