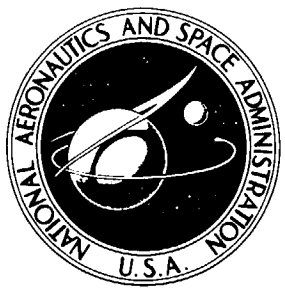
NASA SP-3054

WORLD MAPS OF CONSTANT B, L, AND FLUX CONTOURS



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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WORLD MAPS OF CONSTANT B, L, AND FLUX CONTOURS

by

E. G. STASSINOPOULOS

Goddard Space Flight Center
Greenbelt, Maryland

Prepared by
Goddard Space Flight Center

Scientific and Technical Information Division
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Washington, D.C.

ABSTRACT

A series of world maps showing B, L, and J (flux) contours at various heights between the earth's surface and 3000 km above sea level have been produced. Total field intensity, magnetic L-values, and electron and proton fluxes were computed, using the 99-term Hendricks and Cain field expansion for 1960.0, projected to 1965.0. Integral fluxes were calculated with Vette's AE2 electron and AP1-AP4 proton models which describe the trapped radiation environment prior to 1965. The minimum-B equator is included in all maps. It was obtained for each altitude level by tracing the appropriate geomagnetic field lines into space and by determining the position of their equatorial points.

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INTRODUCTION

The B and L contours presented with this paper are updated versions of similar ones published in 1965 by Roederer et al. (Reference 1). In many instances the B and L contours are used to study the trapped radiation environment. In order to facilitate this work, a set of comprehensive flux maps has been added to the series.* This arrangement is functional and facilitates the correlation of the material.

A total of 31 maps for each parameter, B and L, has been produced for successive altitudes 100 km apart, ranging from the earth's surface to 3000 km above sea level. The flux contours completed at the time of this writing are also presented in steps of 100 km and extend only from 100 to 1000 km above the oblate geoid; they are constructed separately for protons and electrons and are represented in sets of six integral energy thresholds per altitude. No differential energy fluxes were included in this effort because past requests and inquiries have been exclusively oriented towards integral flux values. If the scientific and engineering community indicates sufficient interest in differential maps, these may be added to the next updated version of this work, to be issued in about a year. Furthermore, because the environment models were produced from integral and broad band energy measurements, no great accuracy can be assigned to the spatial distribution of a differential band.

The minimum-B equator is calculated with a program developed for another study. In all maps, the continents are indicated by grey shading, and maps depicting surface projections of some typical circular orbits have been included.

METHOD

Map Generation

For a given altitude level, a grid is generated with constant intervals of two degrees in latitude and three degrees in longitude. At the grid points, the magnetic parameters B and L, and the instantaneous electron and proton fluxes for the given integral energies, are calculated and stored.

The location of the desired B or L contours is then determined latitudinally by an exponential, and azimuthally by a linear interpolation. The obtained positions are cross-correlated and the matrix elements are ordered into plotting vectors, or arrays, from which the curves are drawn by computer.

*These flux maps were proposed by Stassinopoulos in 1967 (Reference 2), and were initially intended as a supplement to Part 2 of Reference 2.

A similar procedure is employed for the construction of the J maps, but only after the environmental spectra have been applied to the positional fluxes at the grid points and the resulting J-values at the following cut-off energies have been stored:

Electrons	Protons
E > 0 MeV	E > 3 MeV
.5 MeV	5 MeV
1 MeV	15 MeV
3 MeV	30 MeV
5 MeV	50 MeV
7 MeV	100 MeV

B, L, and Flux Calculations

The magnetic field strength, B, is calculated with McIlwain's latest MAGNET subroutine employing the 99-term geomagnetic field model by Hendricks and Cain for the epoch 1960.0, projected to 1965.0 (Reference 3). The L-parameter is computed with Hassit and McIlwain's new INVAR subroutine (Reference 4).

Flux calculations are based on Vette's composite environment models: the AE2 for electrons (Reference 5), and the AP1-AP4 for protons (Reference 6). Starting with the geocentric coordinates of the grid points, the magnetic parameters are computed and the fluxes are then calculated as functions of these parameters.

Minimum-B Equator

The B_{min}-equator is obtained through field line tracing with the LINTRA program (Reference 7), especially modified for this purpose. An iterative scheme is employed whereby line-of-force arcs are traced about the magnetic dipole equator and the positions of their B_{min} values are located in geocentric coordinates; the process is continued for higher or lower lines until the specified altitude has been reached.

The repeated application of this procedure for starting points, incremented appropriately in latitude and longitude, yields the global equatorial intersect at a fixed constant height.

RESULTS

All contours are plotted on a Miller Cylindrical Projection. Improvements in the models, the codes, and the plotting techniques have greatly increased the accuracy of these maps over those previously published. The error in the location of the B and L curves does not exceed ±1 degree in longitude or ±.5 degree

in latitude. The same is true for the minimum-B equator. The error in the flux curves, however, is twice as large because of the uncertainty in the primary data used (which is about a factor of 2 for both types of particles).

For every altitude level a set of six proton and six electron maps has been produced, depicting constant intensity contours for energies $E > E_0$ MeV, where E_0 = 3, 5, 15, 30, 50, 100 and E_0 = 0, 1/2, 1, 3, 5, 7 respectively, and relating to instantaneous, omnidirectional fluxes in units of particles per square centimeter per second.

The electron intensities shown in the maps are those given by the undecayed environment model (effective date: August 1964). Although updated figures for 1966-1967 were available through the DECAY subroutine (Reference 8), they are not included in this paper because of difficulties in plotting the resulting irregular and complicated contours.

DISCUSSION

Flux Contours

An interesting feature in the electron maps is the appearance at high magnetic latitudes of the "horns" or protrusions of the outer belt (page 20, Figure 34 of Reference 5) which show up as the elongated contours traversing the entire map from east to west, almost parallel to the B_{min}-equator. In the northern magnetic hemisphere they merge in the low energy maps with the contours produced by the severe depression of the field (the Brazilian Anomaly), causing the tube of the radiation belt to bulge deeply into the atmosphere. For energies $E > 3$ MeV, the anomaly fluxes separate and become an isolated domain.

There are no such features in the proton maps, because the environmental models do not have similar prominences or horns (pages 46, 47, 48, 52, Figs. 55, 59, 62, 82, of Reference 6).

Some of the maps show small or large "islands," mostly along the prominences or around the anomaly. For the $E > 0$ MeV electron maps, these islands are probably due to the extrapolation of the environment from 0.5 MeV down to 0 MeV. For the $E > 5$ MeV and $E > 7$ MeV electrons, they are most likely part of the model data; this applies also to all proton "islands."

Radiation Environments

Models

All experimental data used in the construction of the models were pitch-angle integrated and were converted from unidirectional to omnidirectional, when not originally given in that form.

Protons

According to Vette*, the proton fluxes from 300 to 1000 km have been very stable over the past nine years. At lower altitudes, time variations do occur

*Vette, J. I., private communication.

but they are still somewhat difficult to ascertain. For example, the effects due to (a) the starfish detonation, (b) the changes in the atmosphere with the solar cycle, and (c) the secular changes of the earth's magnetic field, are not yet clarified enough to determine a time-varying model in this region. Consequently, the description of the proton environment, as used in this report, is a static model consisting of AP1, AP2, AP3, and AP4 with an exponential spectrum of the form:

$$N = e^{\frac{E_T - E}{E_0}},$$

where $E_0 = f(B, L)$ is the energy parameter, E_T is the assigned energy of the respective flux map, and E is the desired energy value. The integral intensity is then represented as:

$$T(>E, B, L) = F_T(B, L)*N,$$

with F_T being the omnidirectional, instantaneous flux at E_T (Reference 6).

Electrons

As Vette points out, the electron situation, however, is very different*. The inner zone conditions for the period from 1967 to 1971 are much more complicated. Recent evidence indicates that there are no natural sources of inner zone electrons for energies greater than approximately 700 kev. This means that the higher energy electrons are the residue of Starfish. It is reasonable to assume that they will continue to decay at the same rate as they have over the past 5 or 6 years. There seems to be no direct effect of solar activity on this decay. Therefore, by 1969, the inner zone electron contours for energies >1 MeV and above should be decreased by about a factor of 12. The lower electrons seem to have reached their natural background levels by late 1966. The $E > 0$ energy contours have remained about the same as in 1964, and the $E > 0.5$ MeV have dropped about a factor of 6. Until a new electron model is generated, these are the best estimates that can be given.

ACKNOWLEDGMENTS

The author gratefully acknowledges the valuable contribution of Dr. James I. Vette, Director of the National Space Sciences Data Center, Goddard Space Flight Center, to the part on the discussion of the radiation environments. Many thanks are also due to Mr. Christopher Bock on the Mathematics and Computing Branch, Laboratory for Theoretical Studies, for his very able and substantial assistance in the programming and plotting effort; also to Dr. H. L. Kyle of the

*Vette J. I., private communication.

Theoretical Studies Branch, Laboratory for Theoretical Studies, for many helpful discussions and for reviewing the manuscript.

Goddard Space Flight Center
National Aeronautics and Space Administration
Greenbelt, Maryland, August 18, 1969
188-48-01-99-51

REFERENCES

1. Roederer, J. G., Hess, W. H., and Stassinopoulos, E. G., "Conjugate Intersects to Selected Geophysical Stations," NASA Technical Note D-3091, July 1966.

2. Stassinopoulos, E. G., "Orbital Flux Integrations Within the Subsynchronous Regions of the Geomagnetic Cavity, Part One," NASA Technical Memorandum X-55875, March 1967.

3. Hendricks, S. J., and Cain, J. C., "Magnetic Field Data for Trapped Particle Evaluations," J. Geophys. Res. 71:346, 1966.

4. Hassit, A., and McIlwain, C. E., "Computer Programs for the Computation of B and L (May 1960)," NASA-NSSDC 67-27, May 1967.

5. Vette, J. I., Lucero, A. B., and Wright, J. A., "Models of the Trapped Radiation Environment, Volume II: Inner and Outer Zone Electrons," NASA SP-3024, 1966.

6. Vette, J. I., "Models of the Trapped Radiation Environment, Volume I: Inner Zone Protons and Electrons," NASA SP-3024, 1966.

7. Stassinopoulos, E. G., "Computer Codes for Geomagnetic Field Line Tracing and Conjugate Intersect Calculations," NASA Technical Memorandum X-63387, November 1968.

8. Stassinopoulos, E. G., "A Computer Program to Calculate Artificial Radiation Belt Decay Factors," NASA Technical Note D-2874, July 1965.

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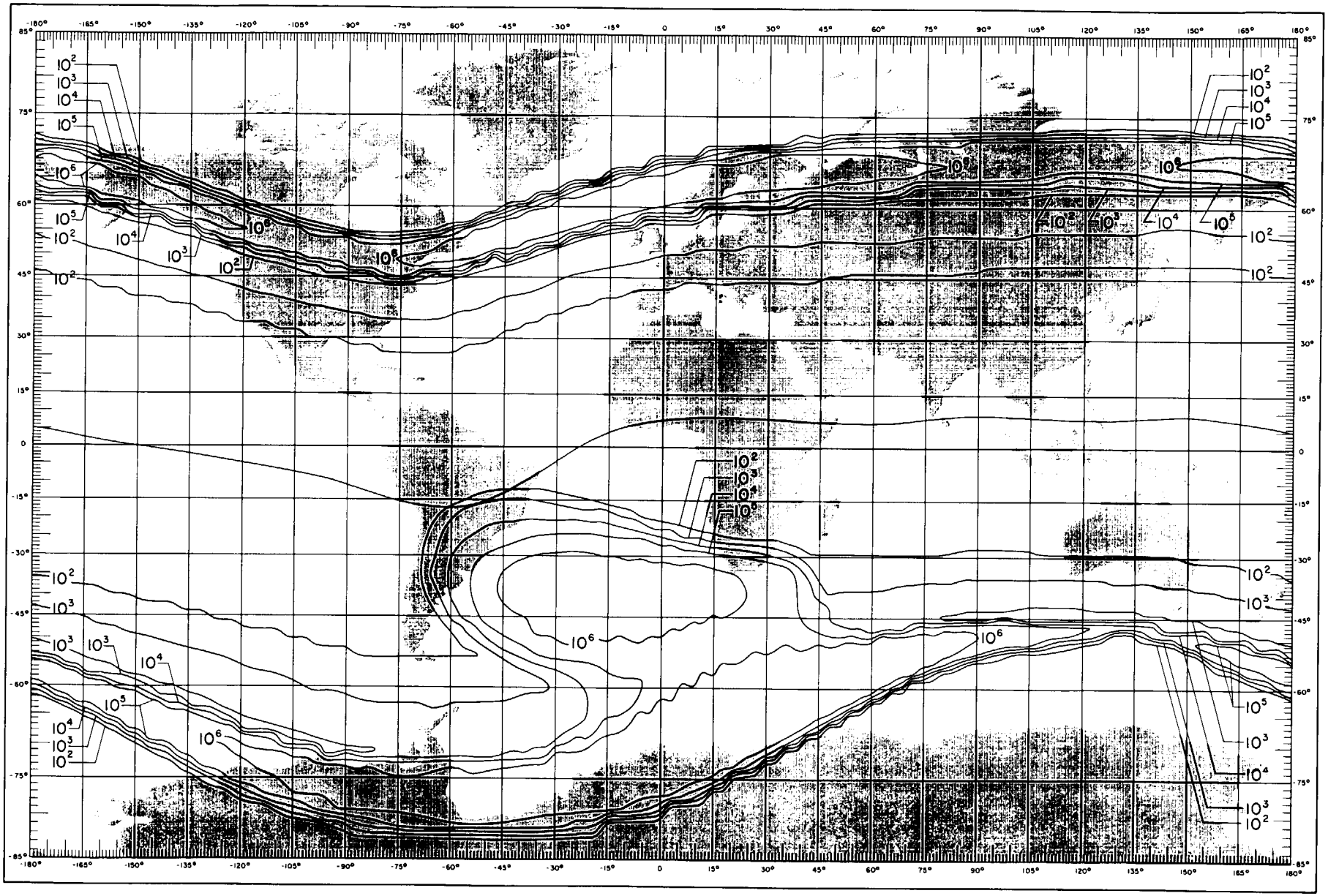

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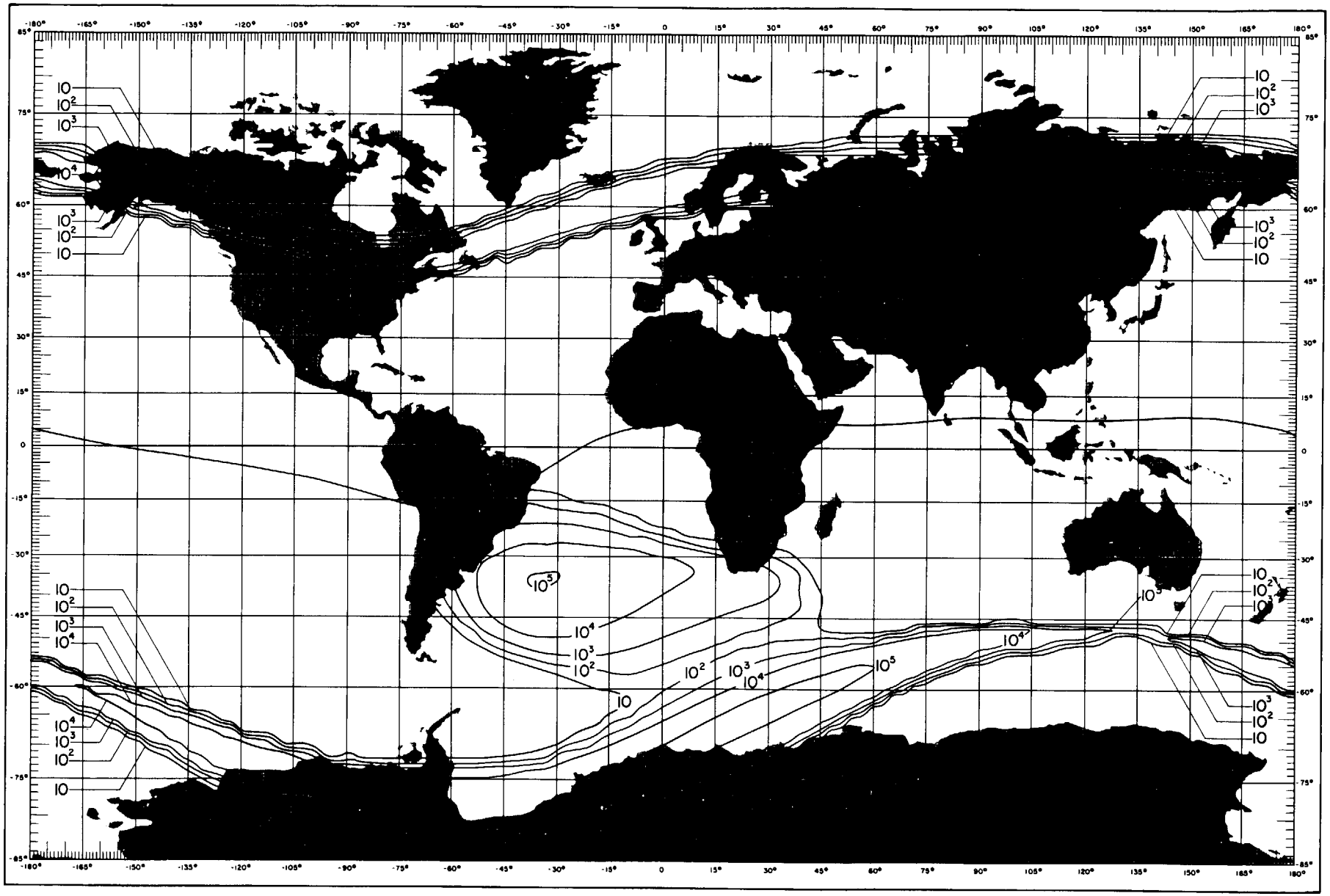

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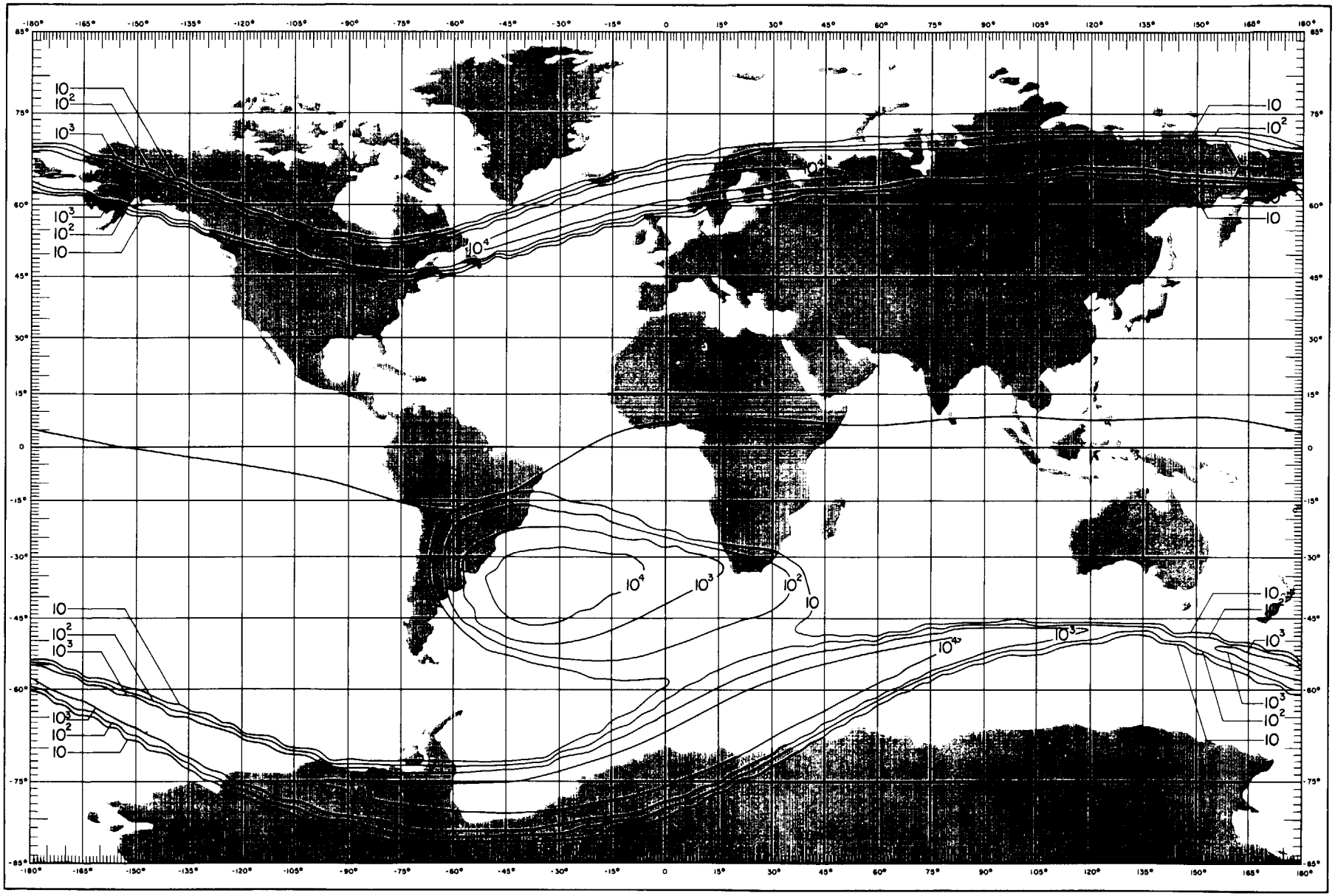

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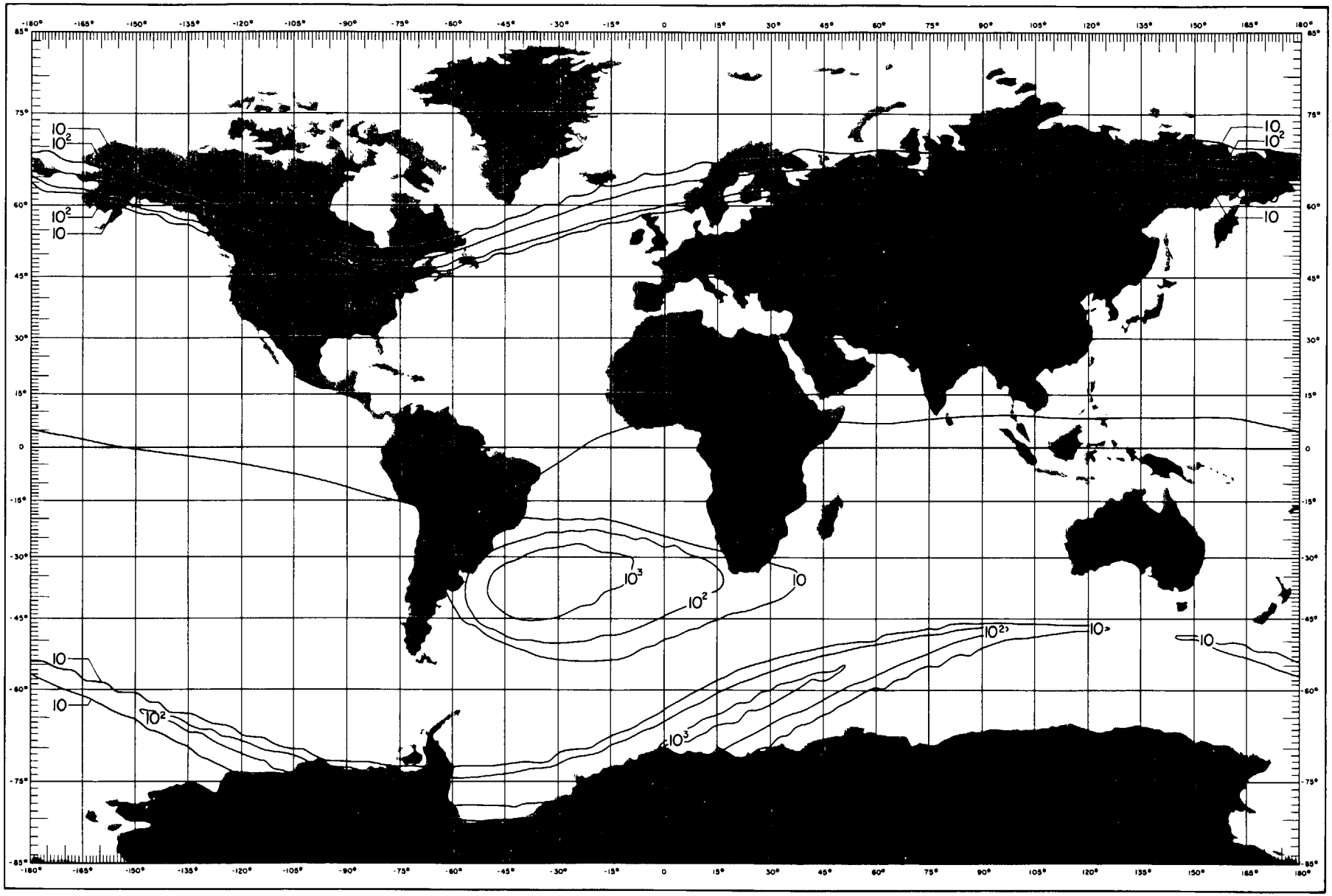

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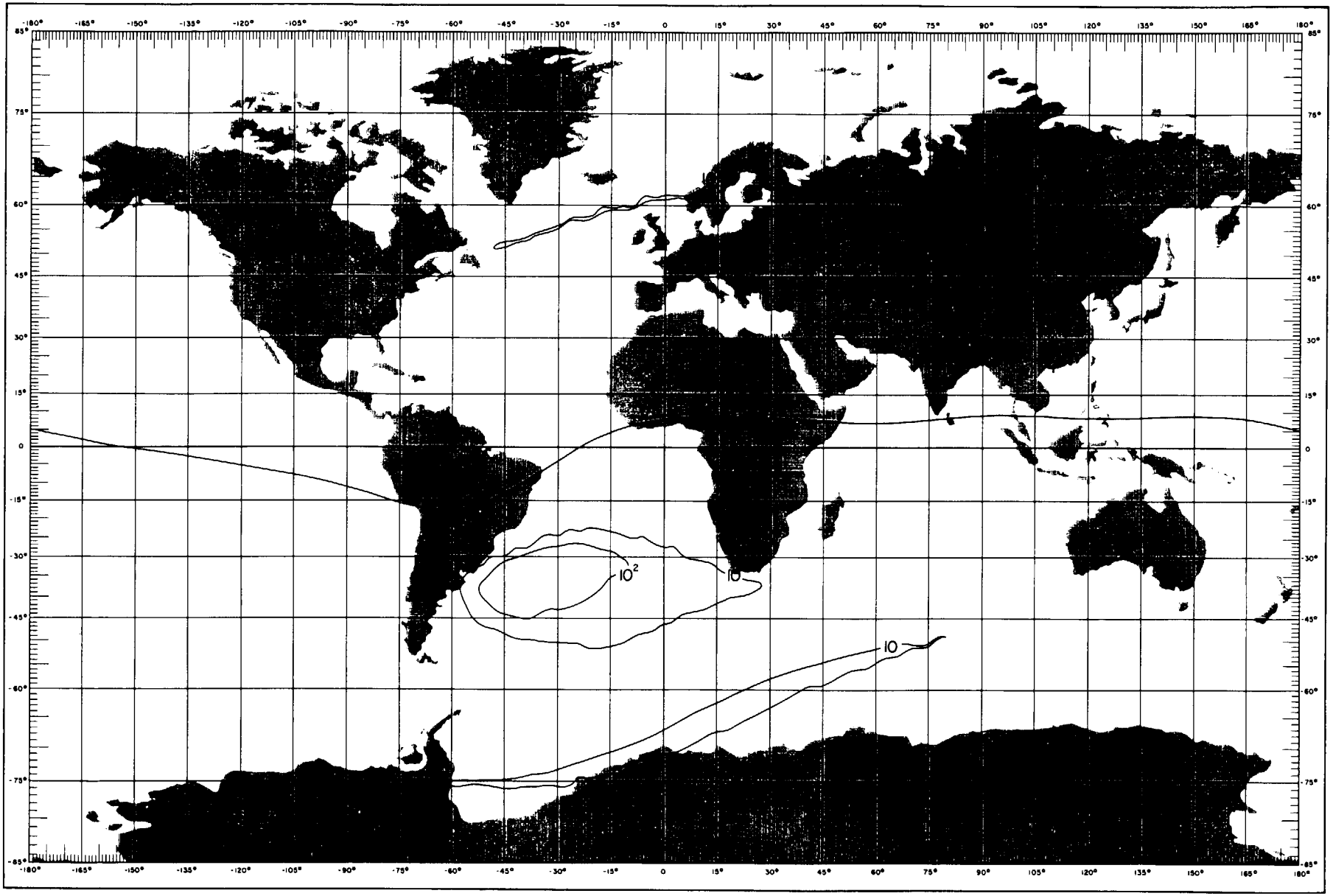

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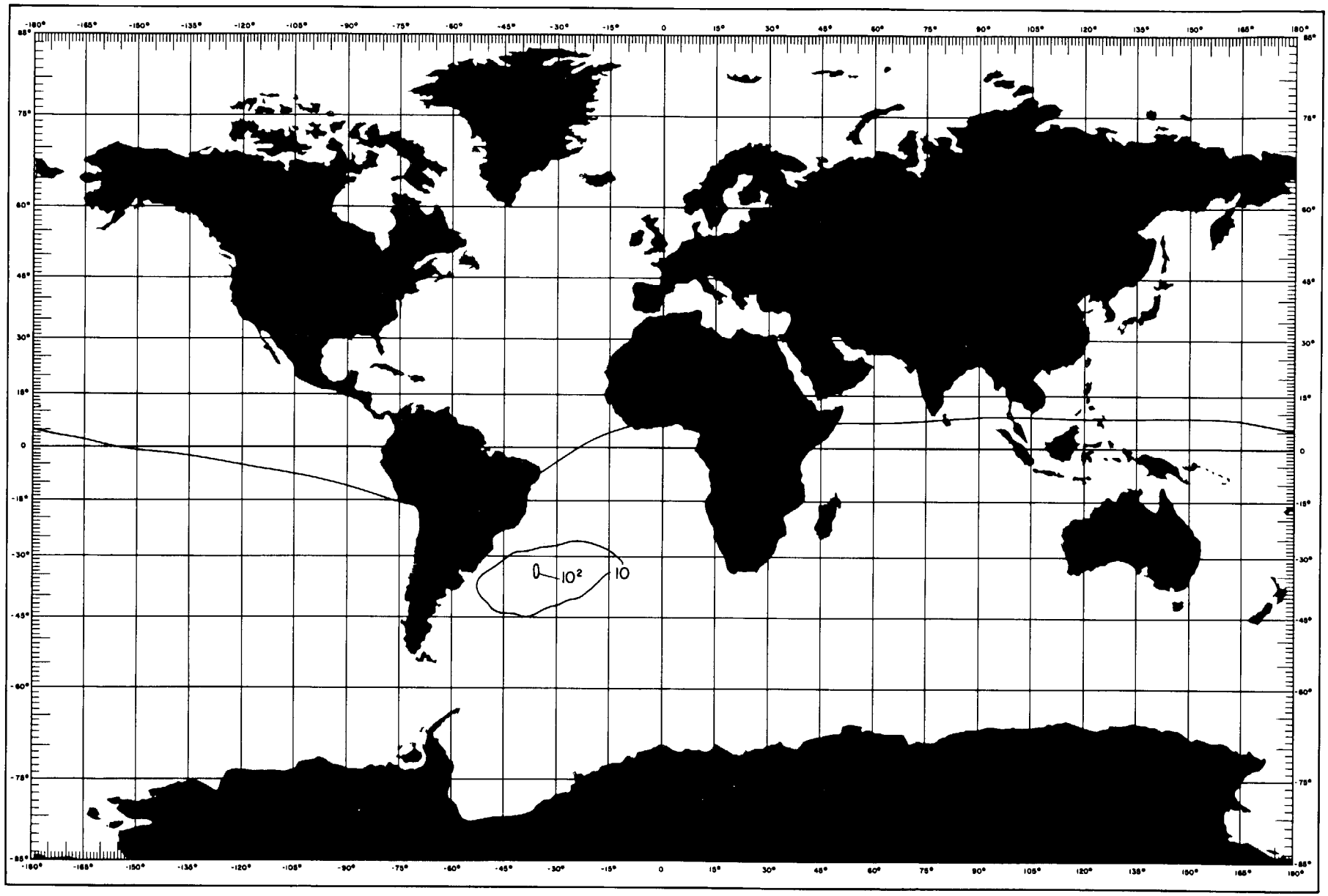

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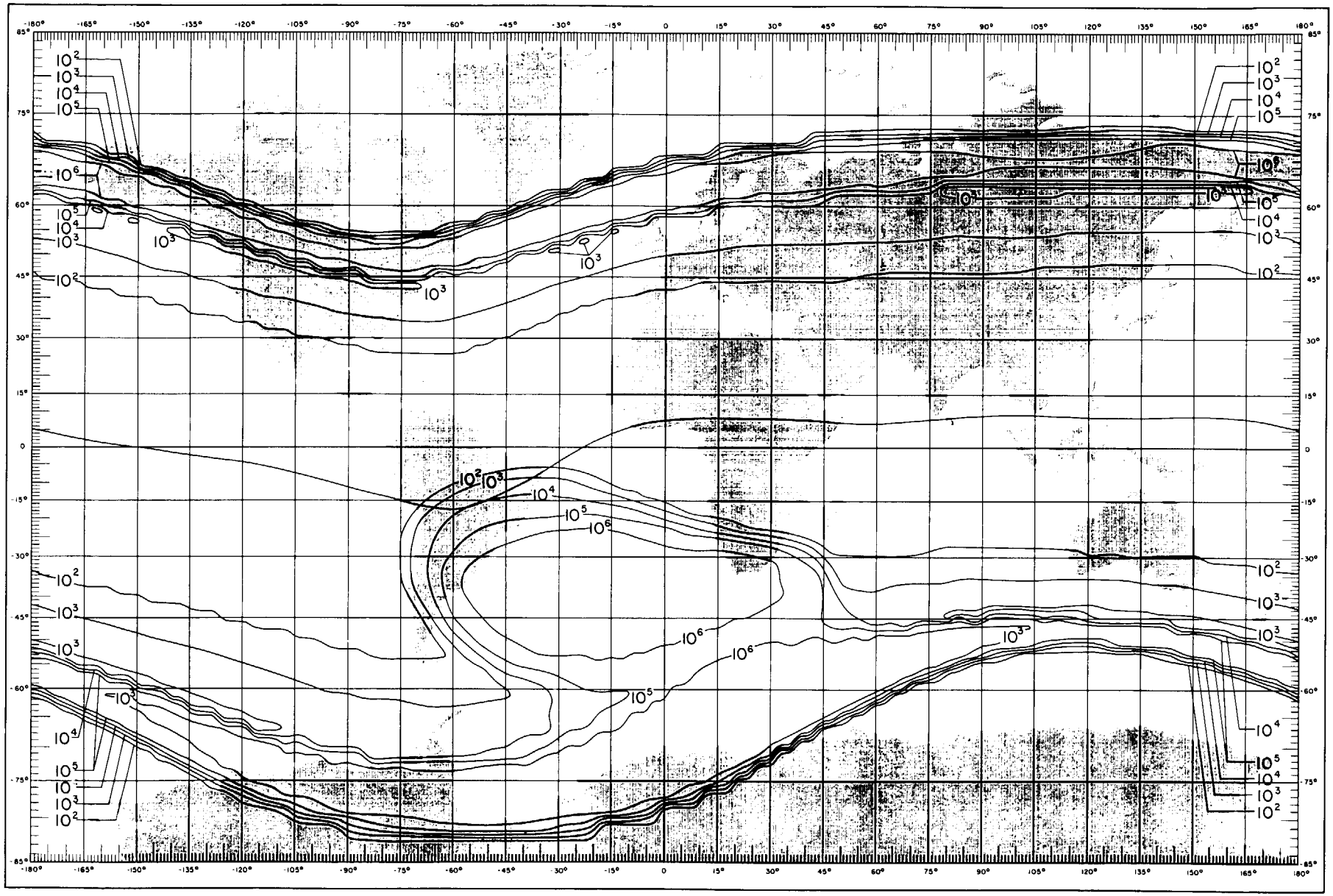

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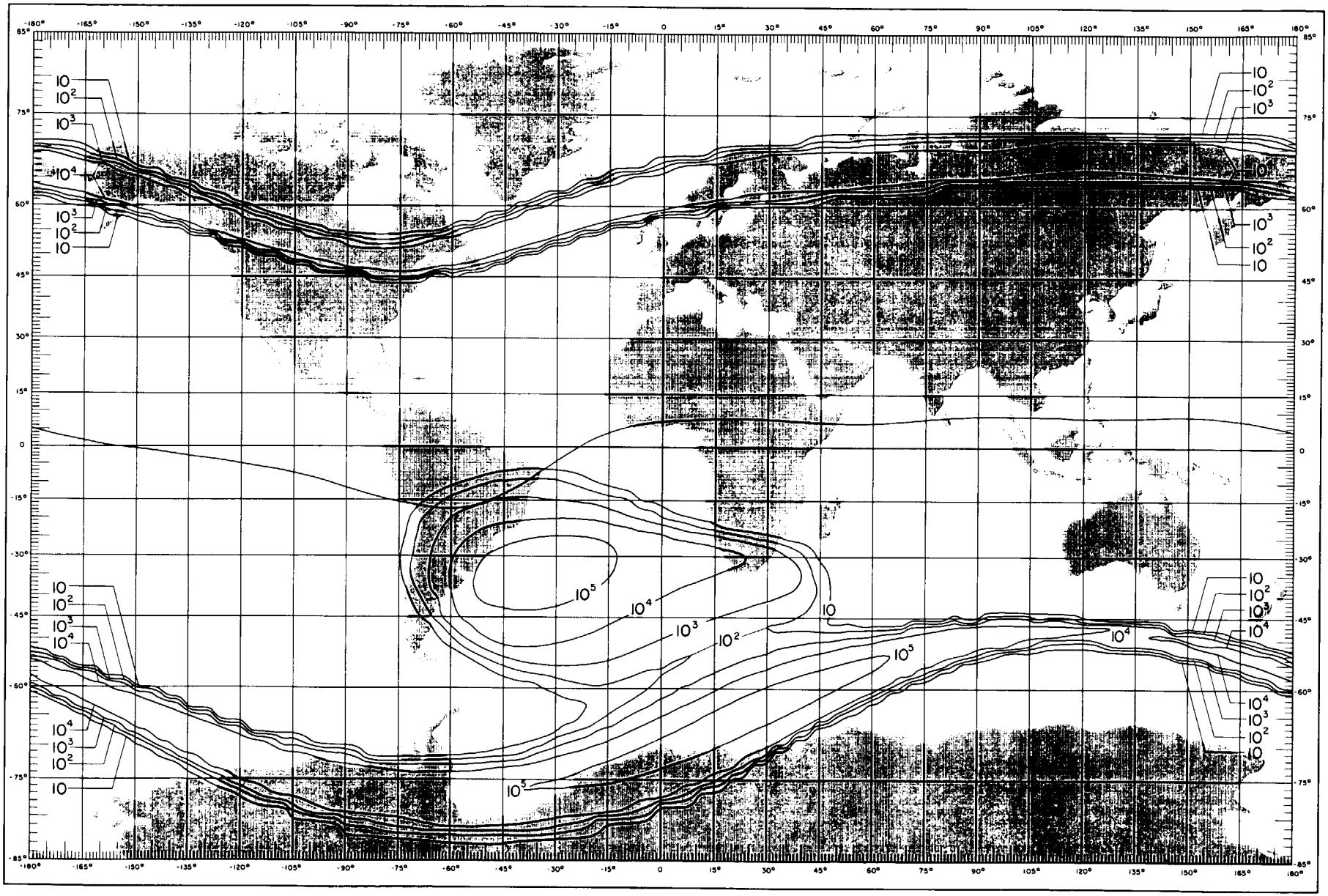

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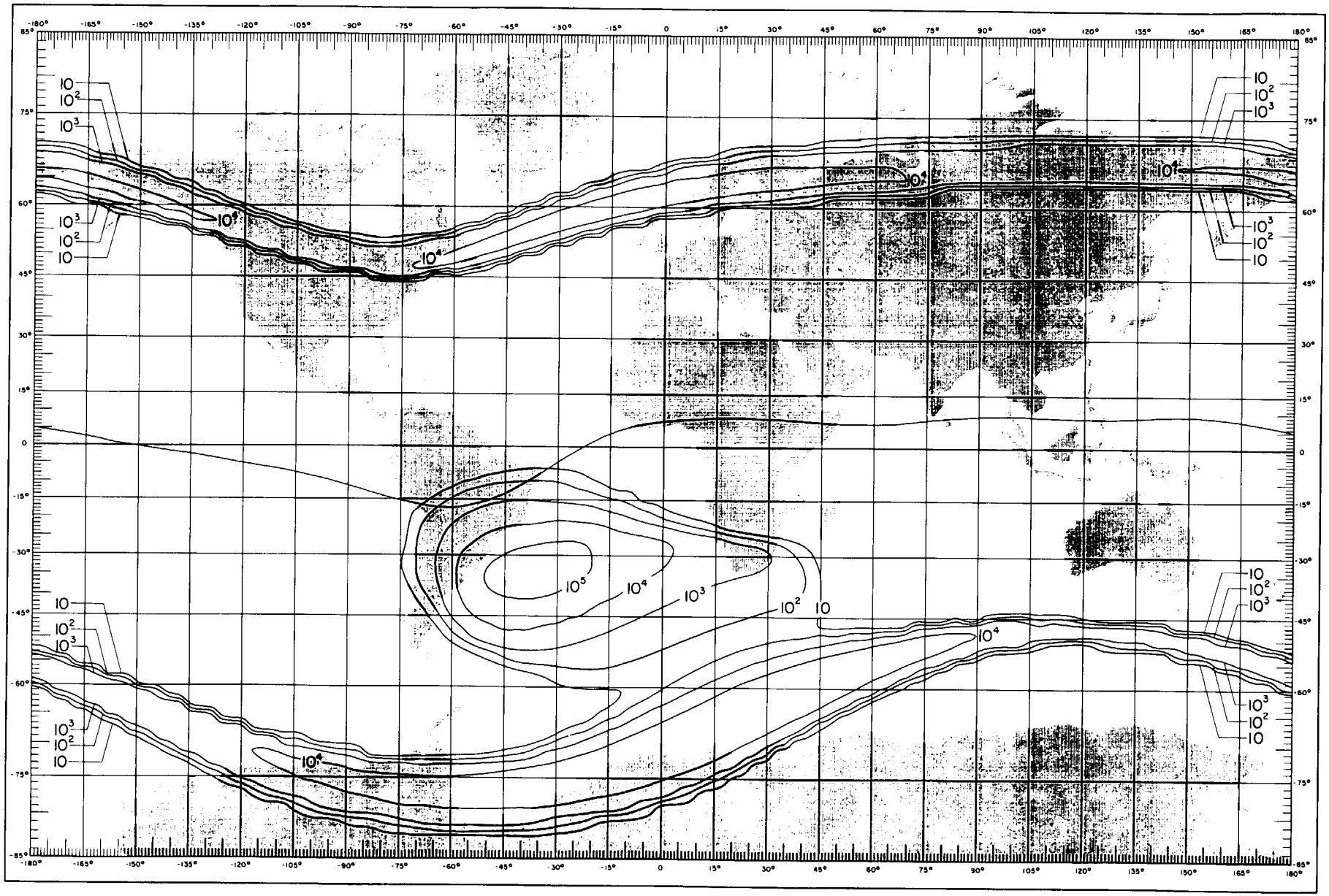

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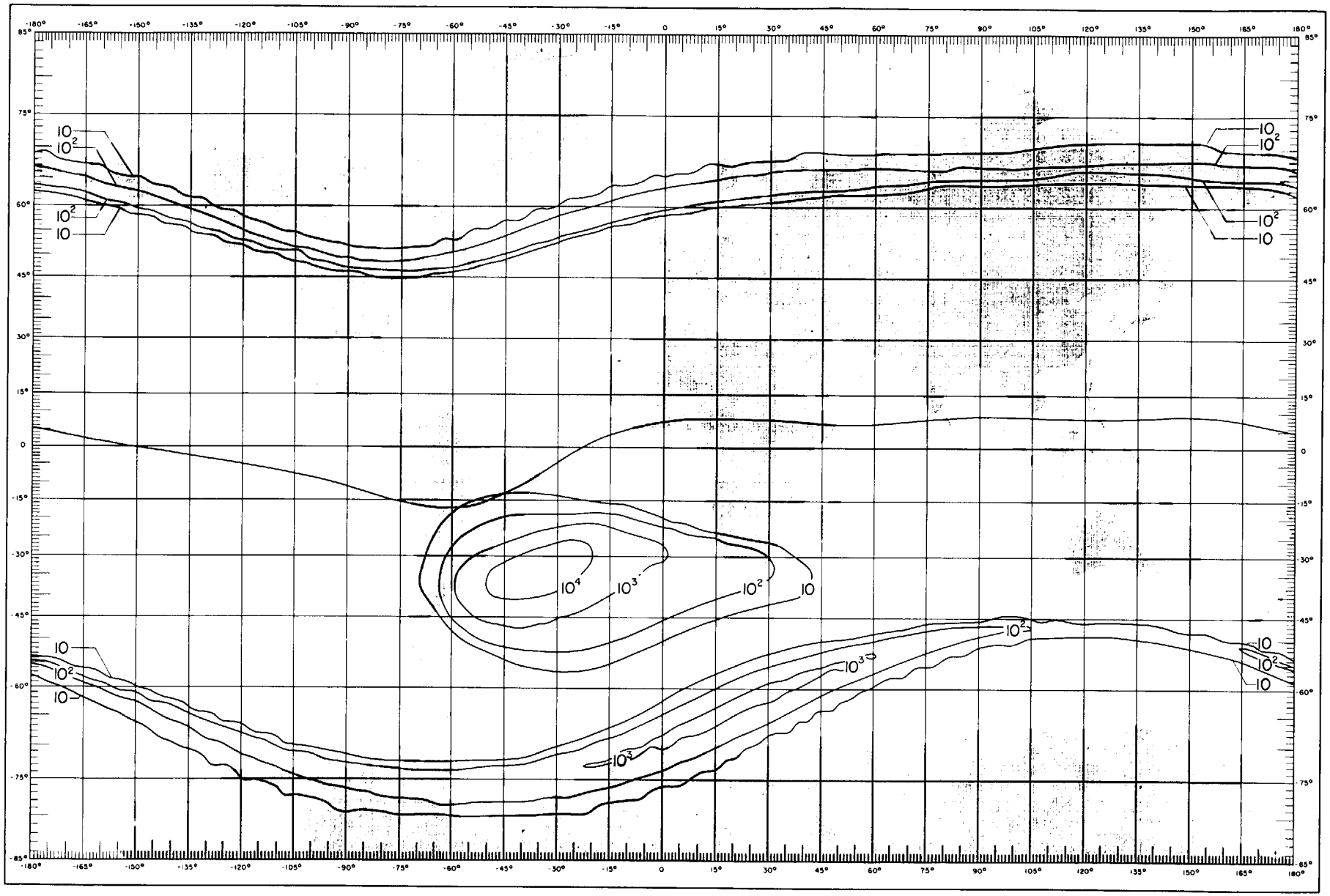

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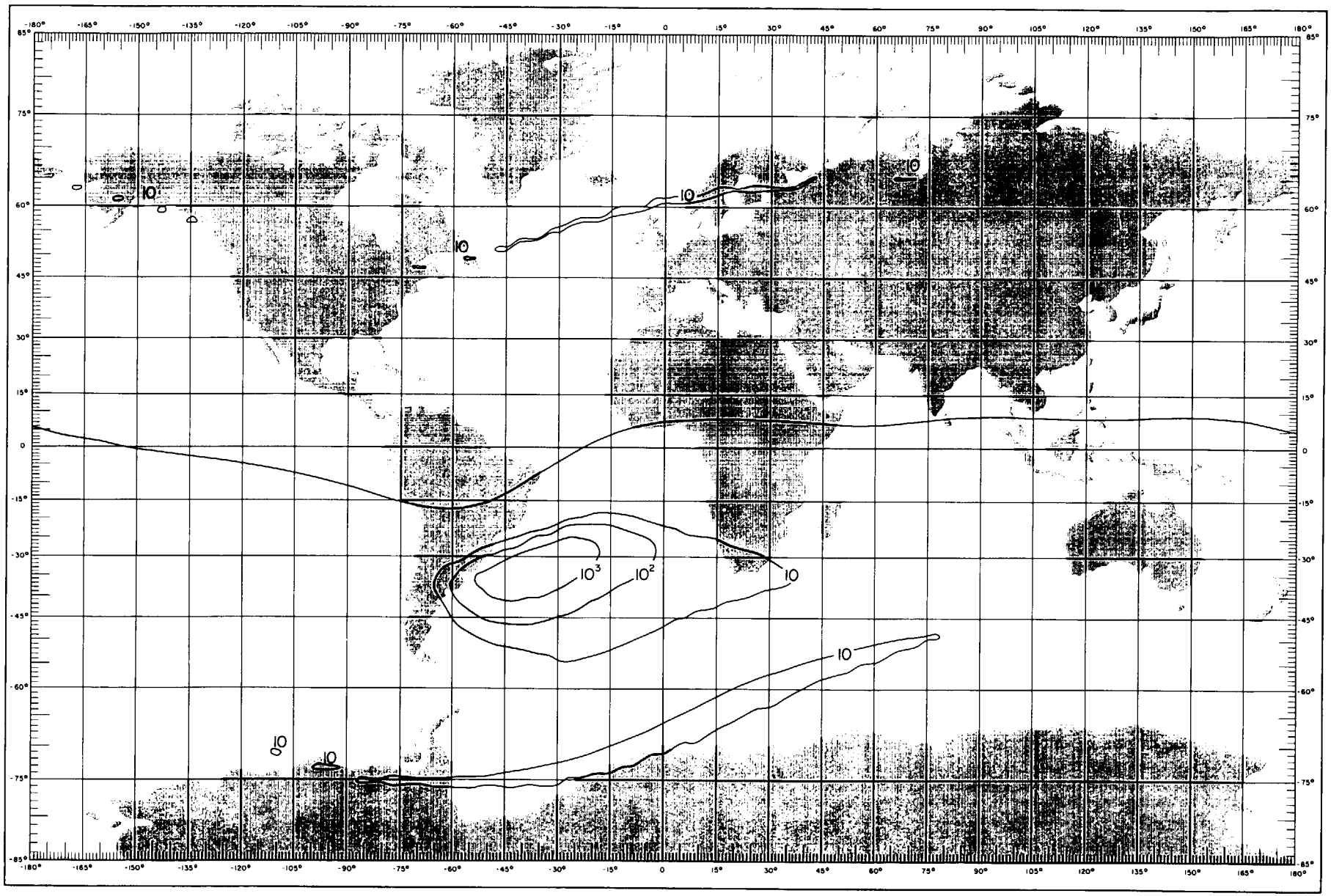

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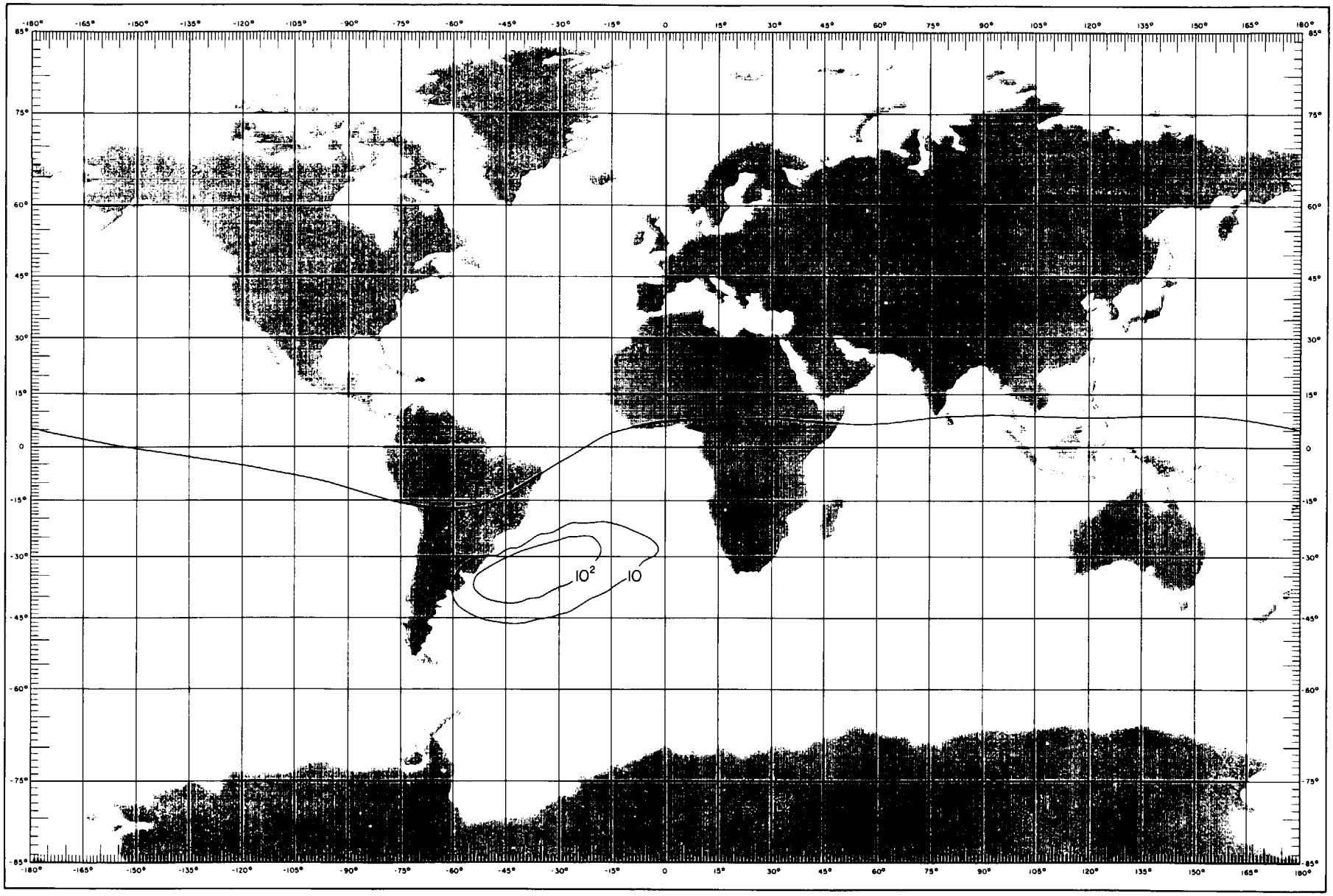

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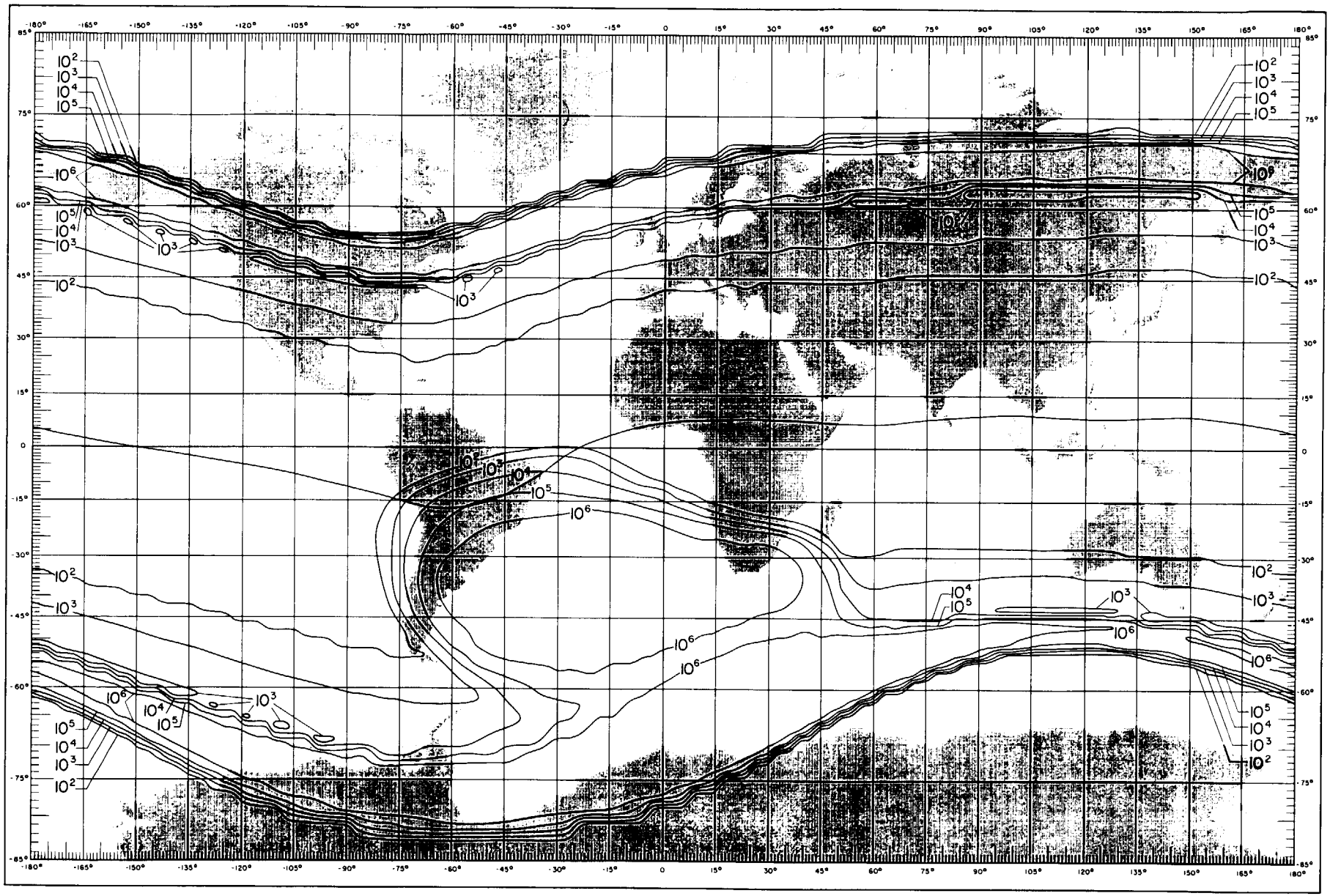

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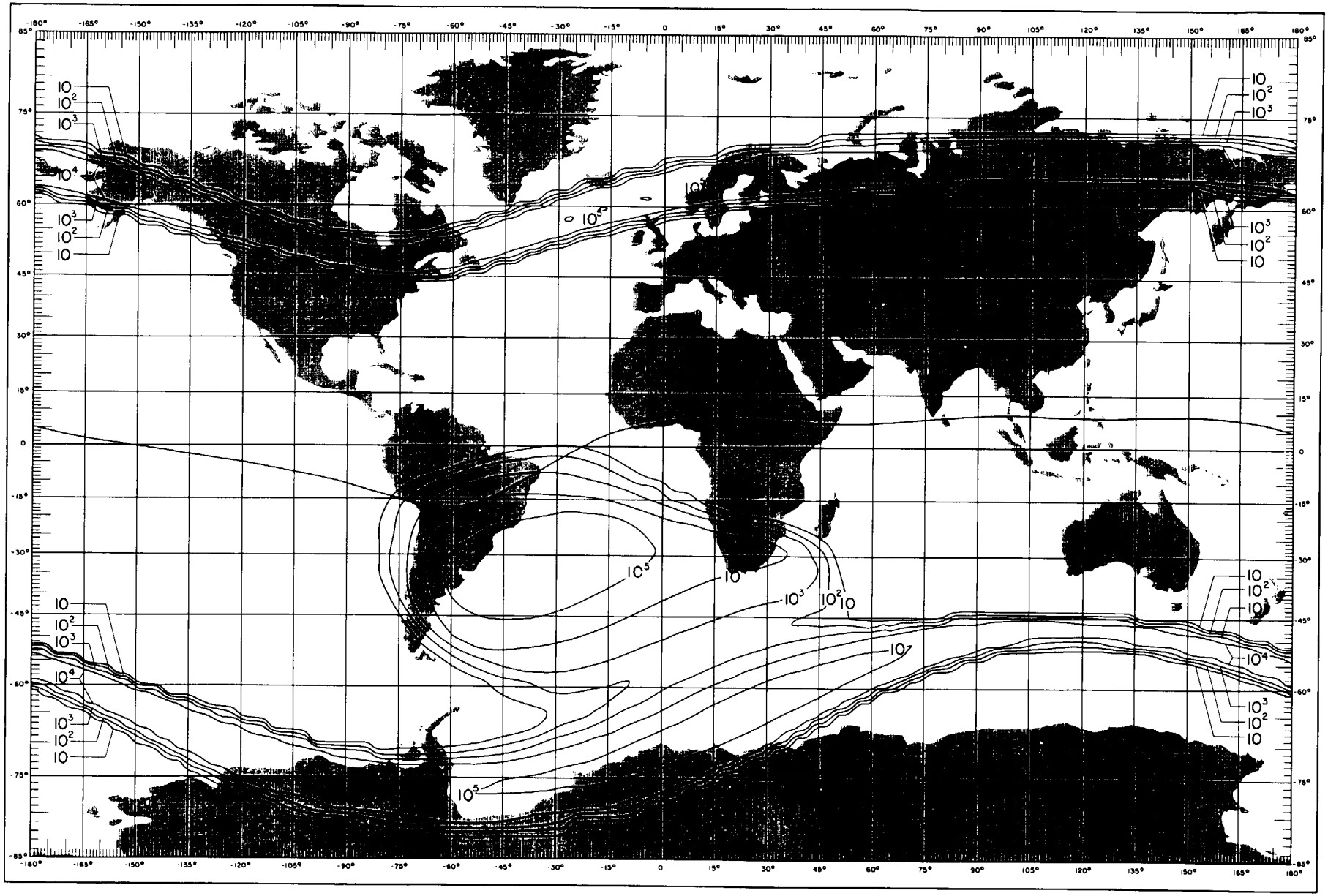

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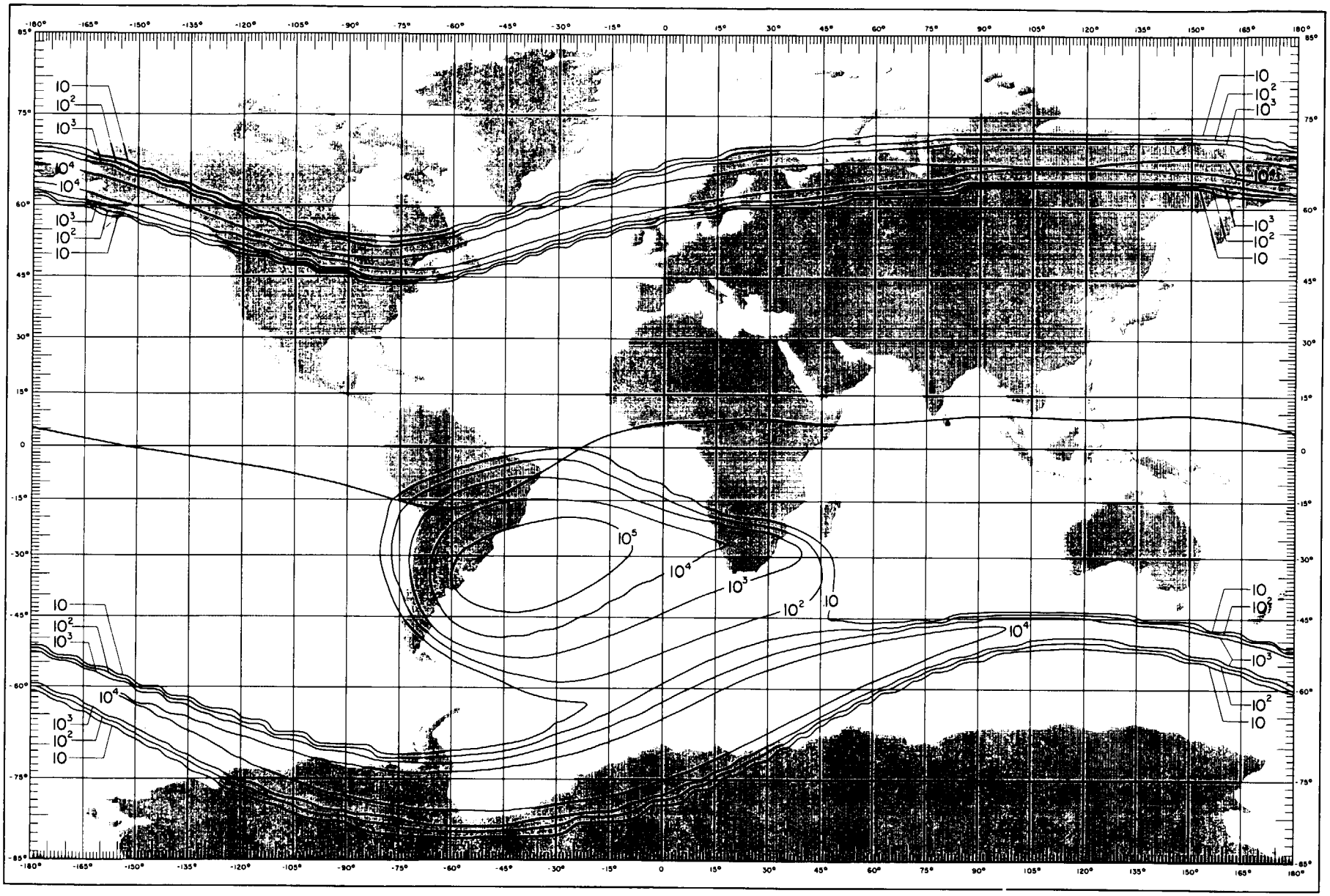

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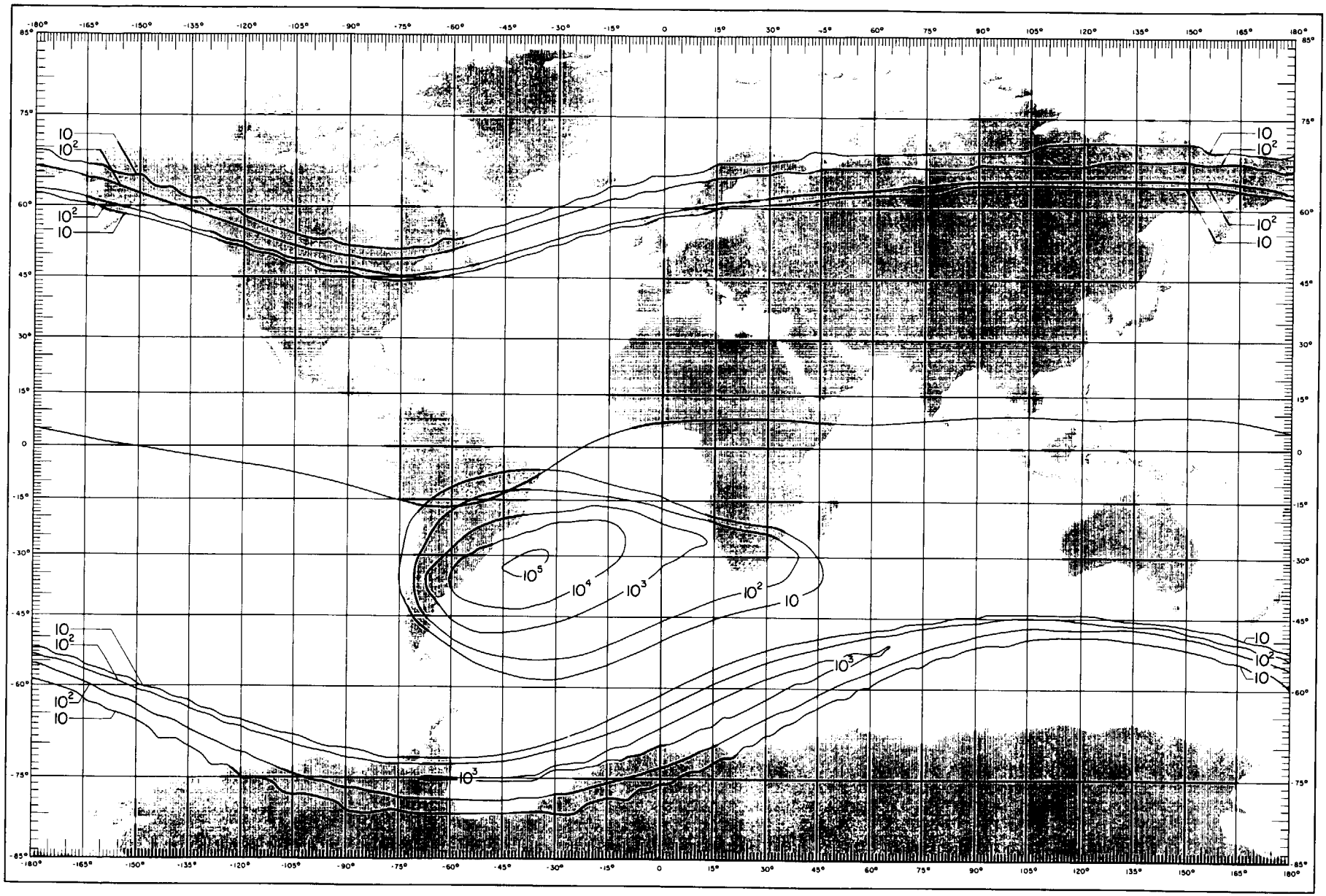

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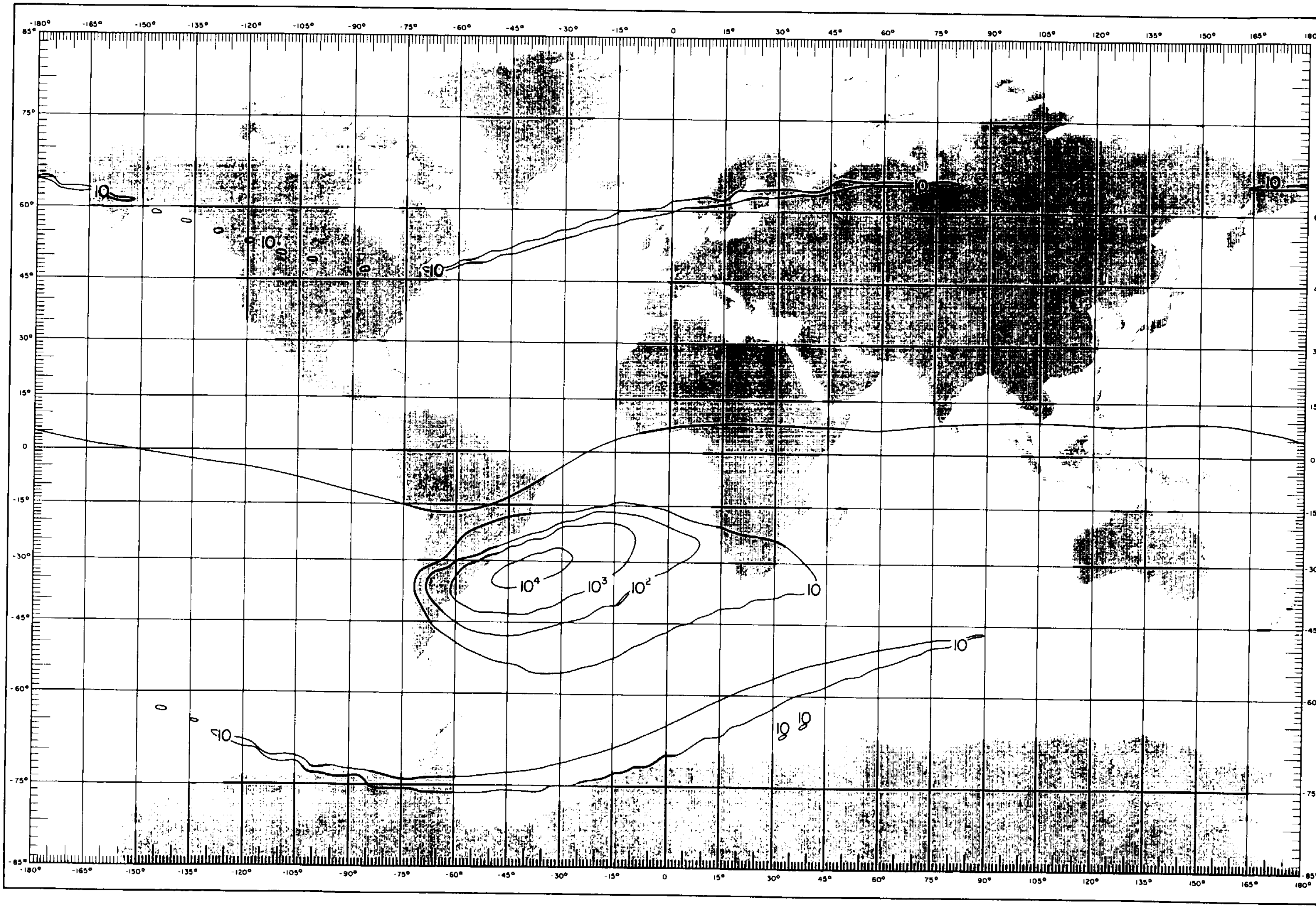

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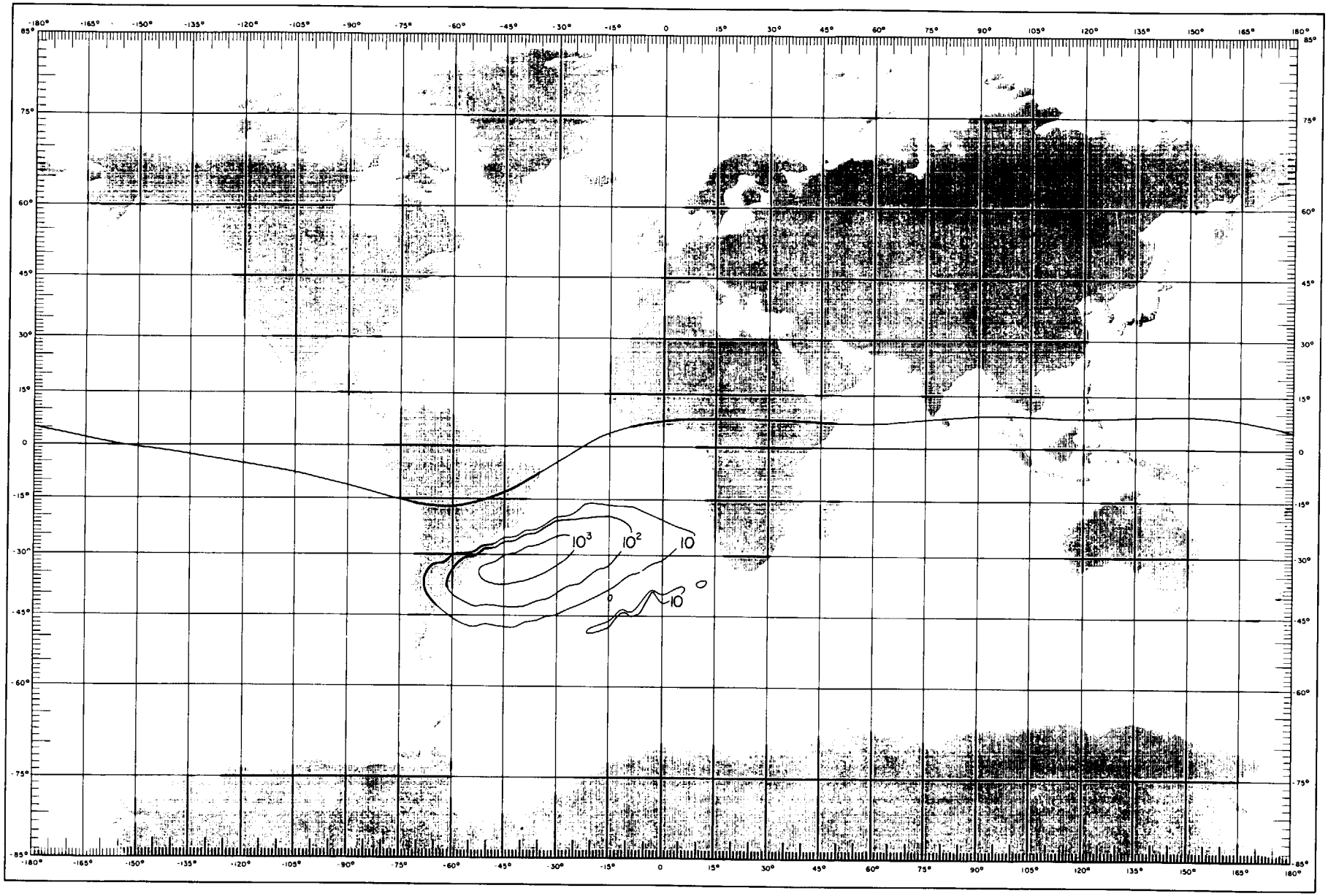

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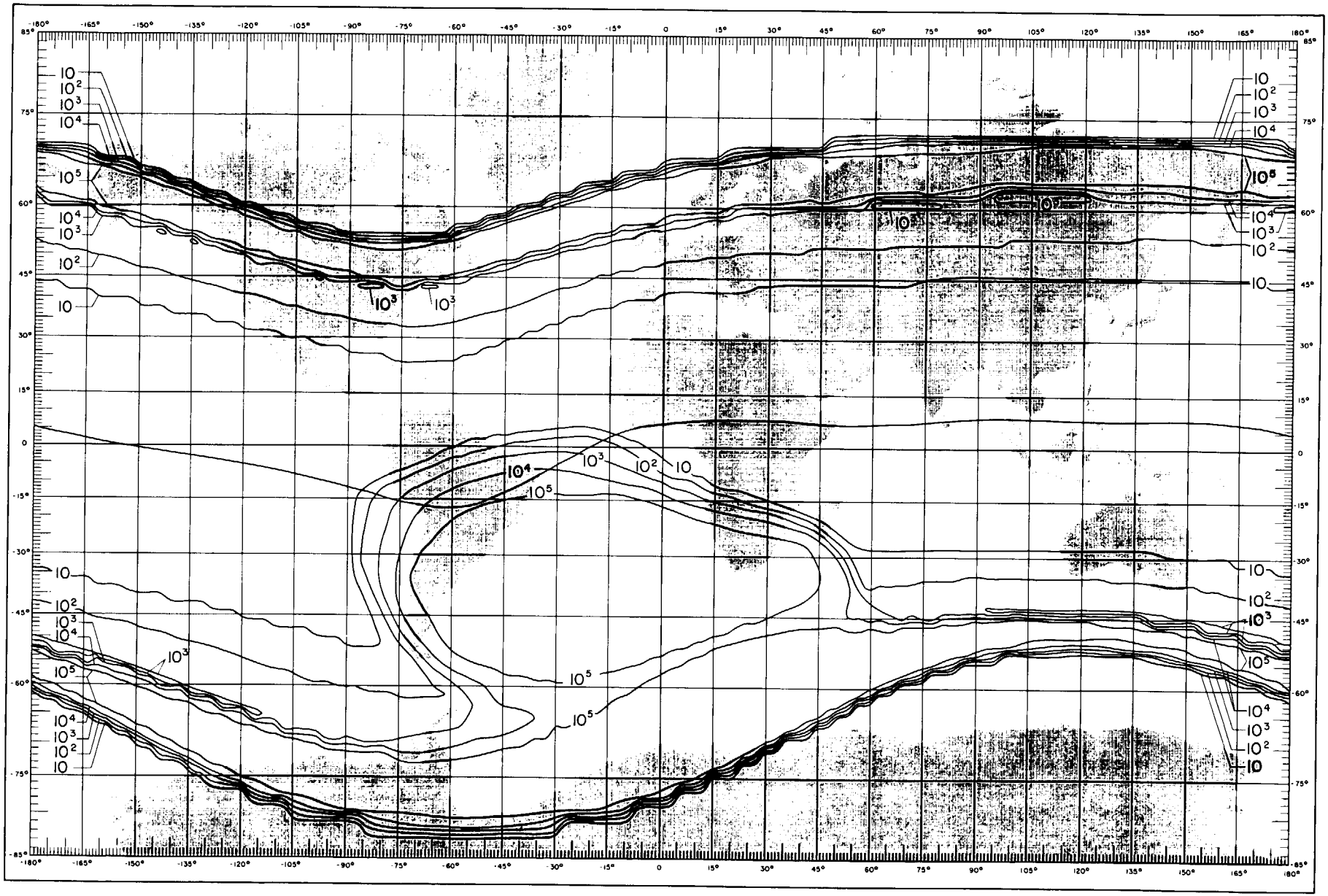

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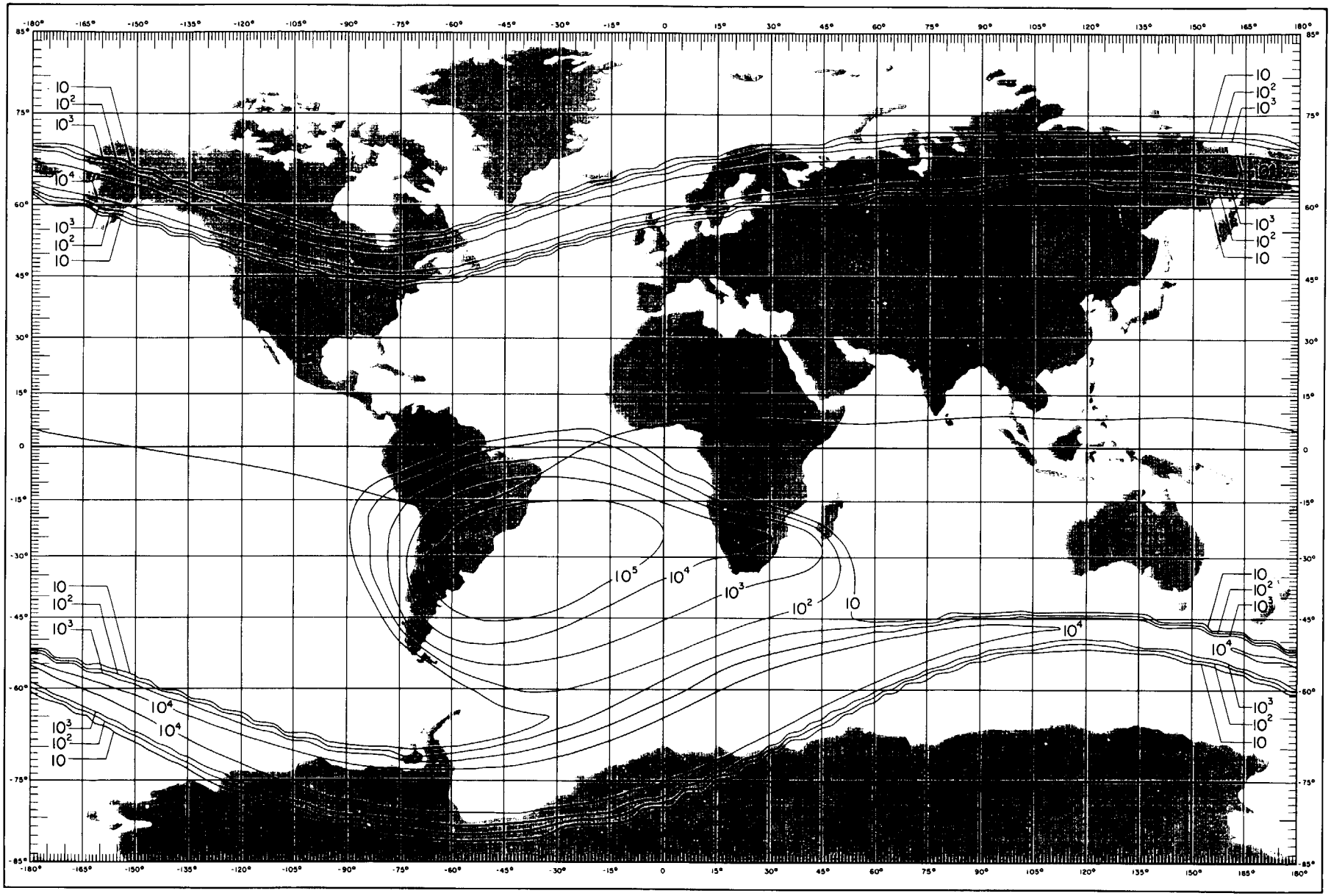

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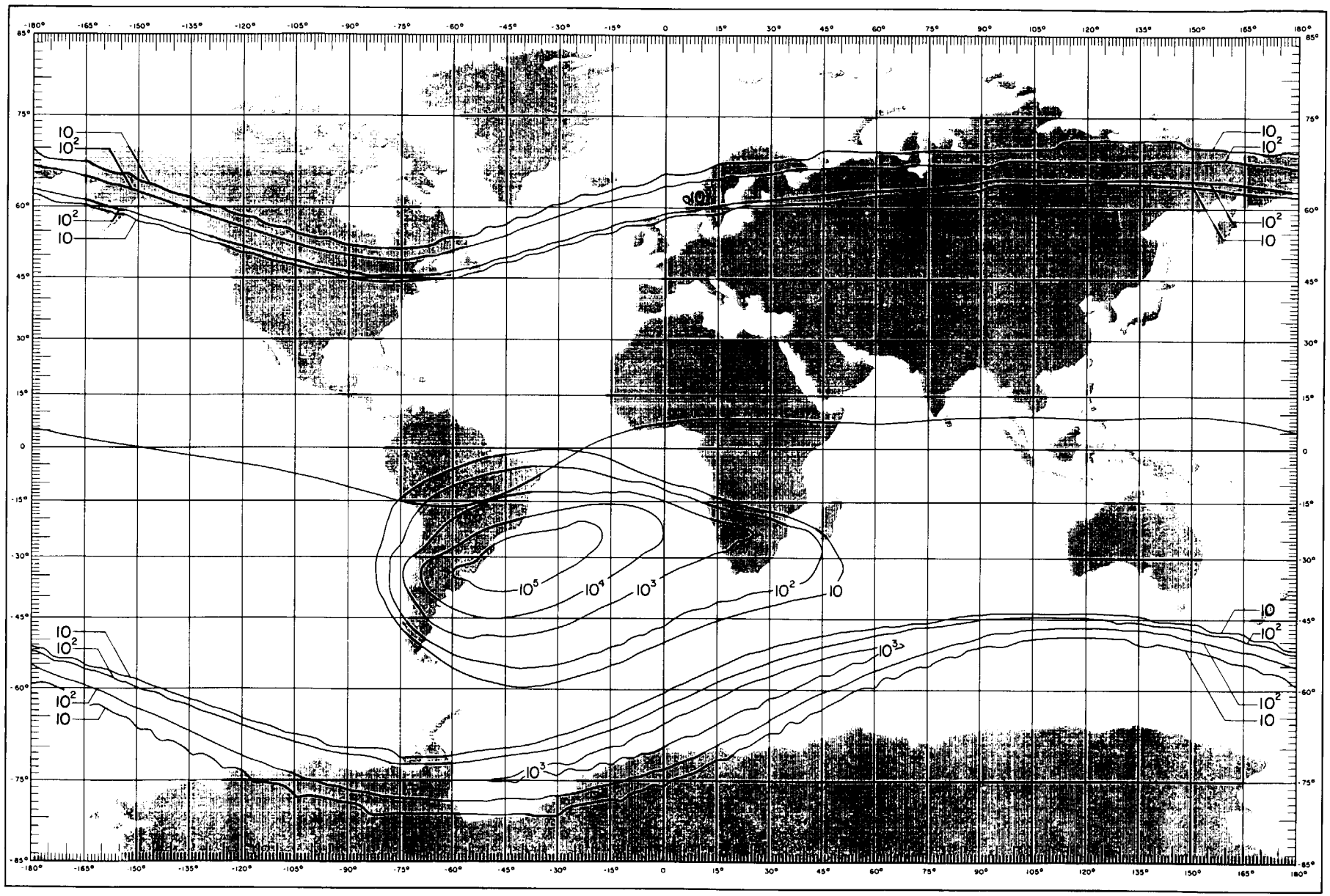

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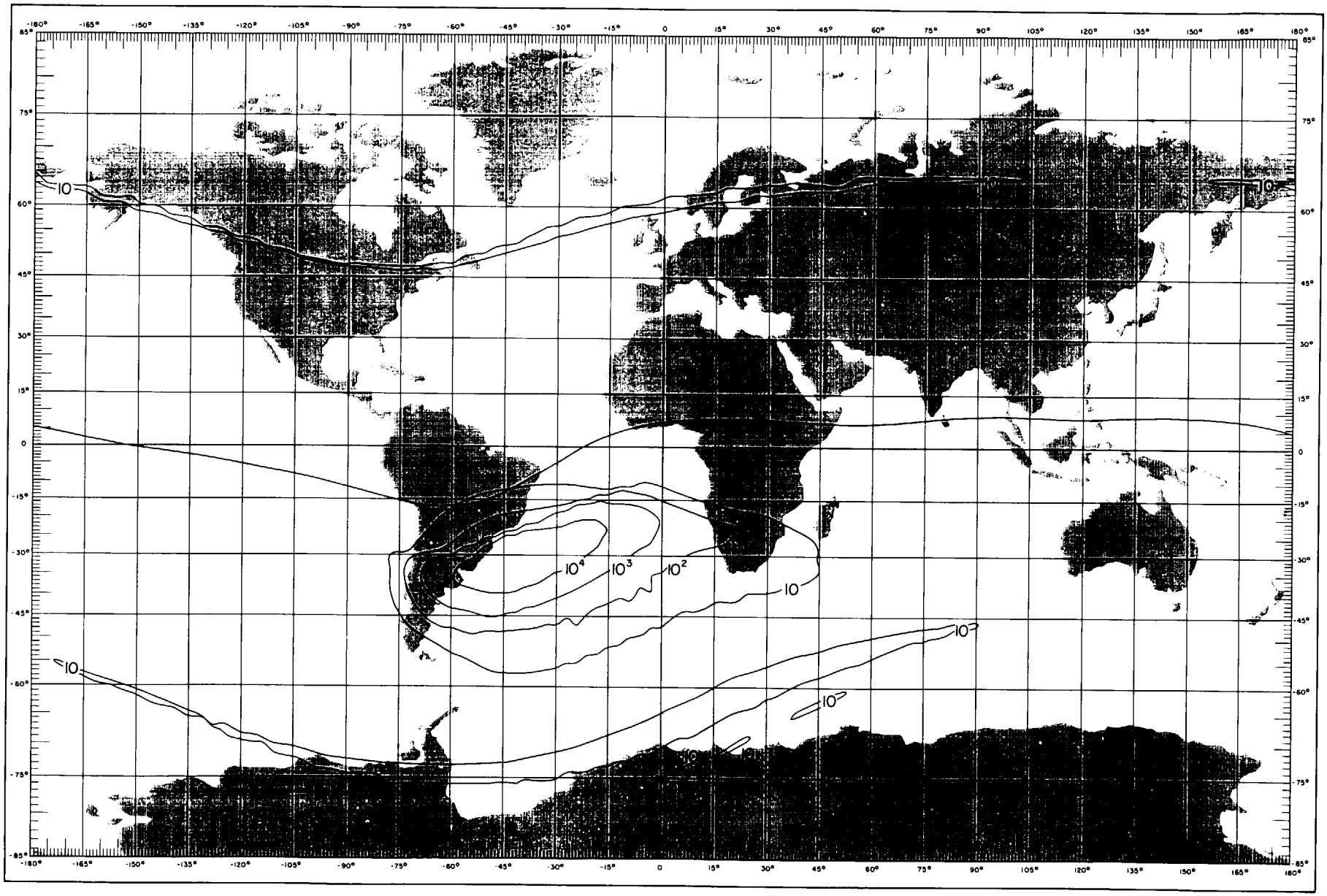

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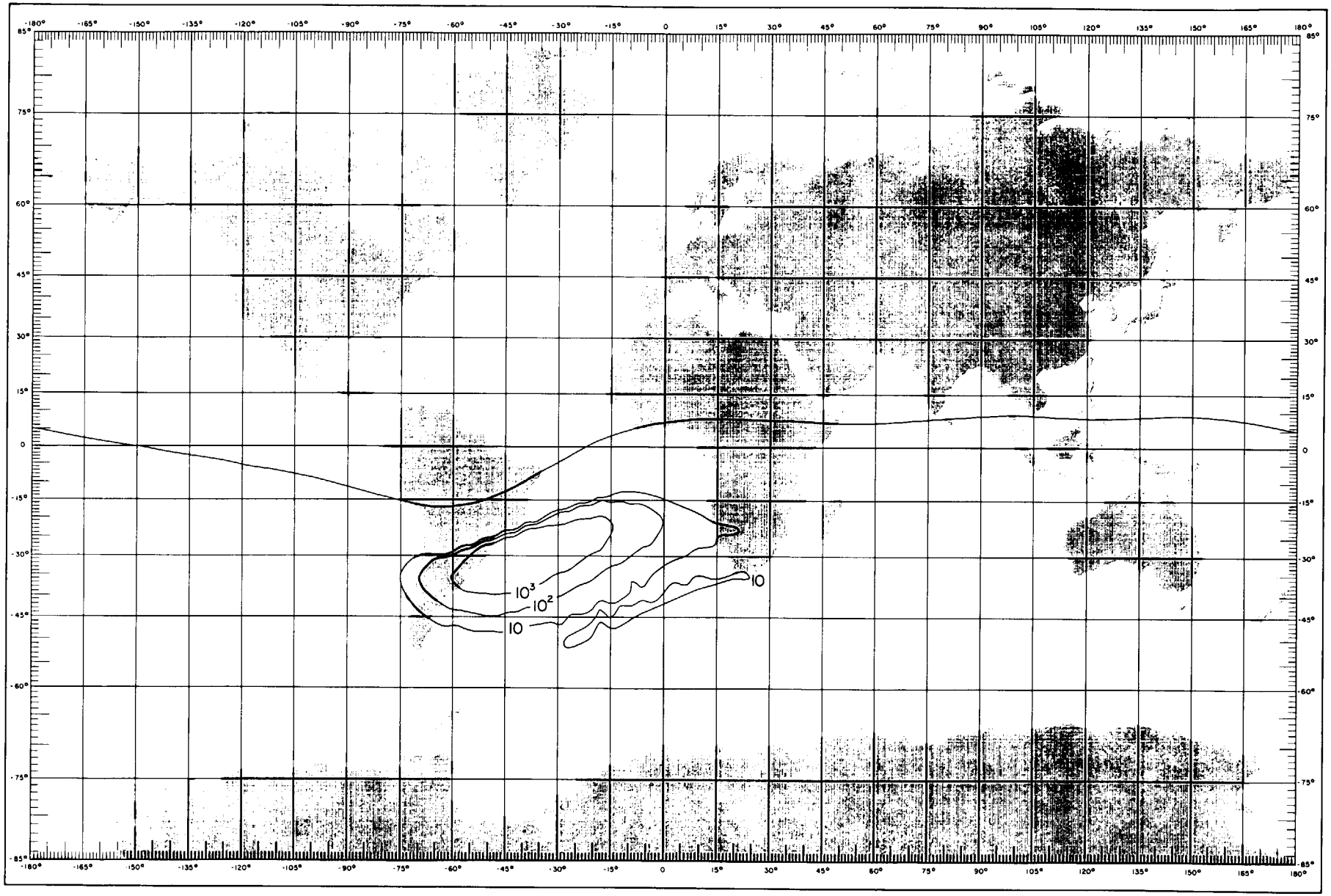

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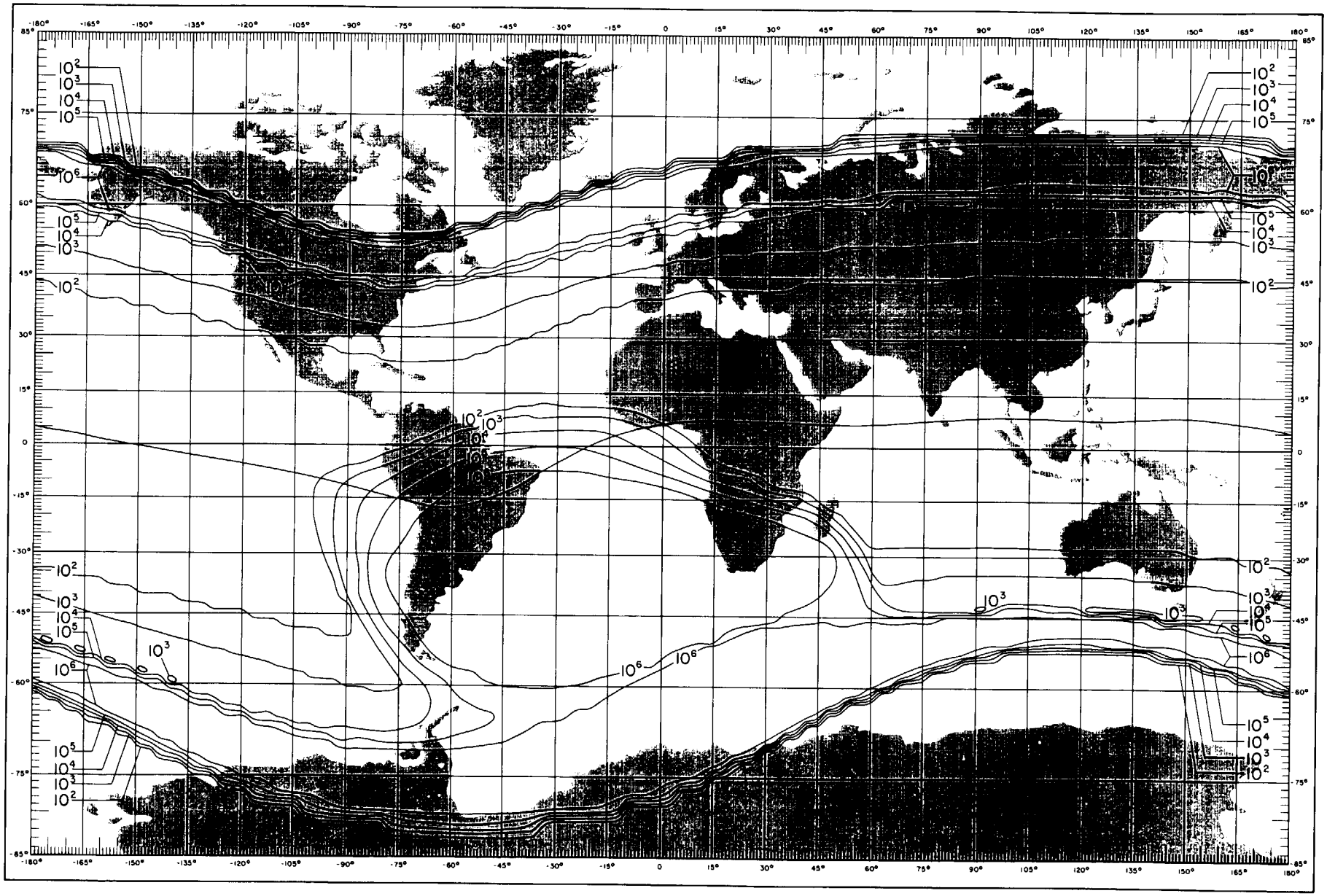

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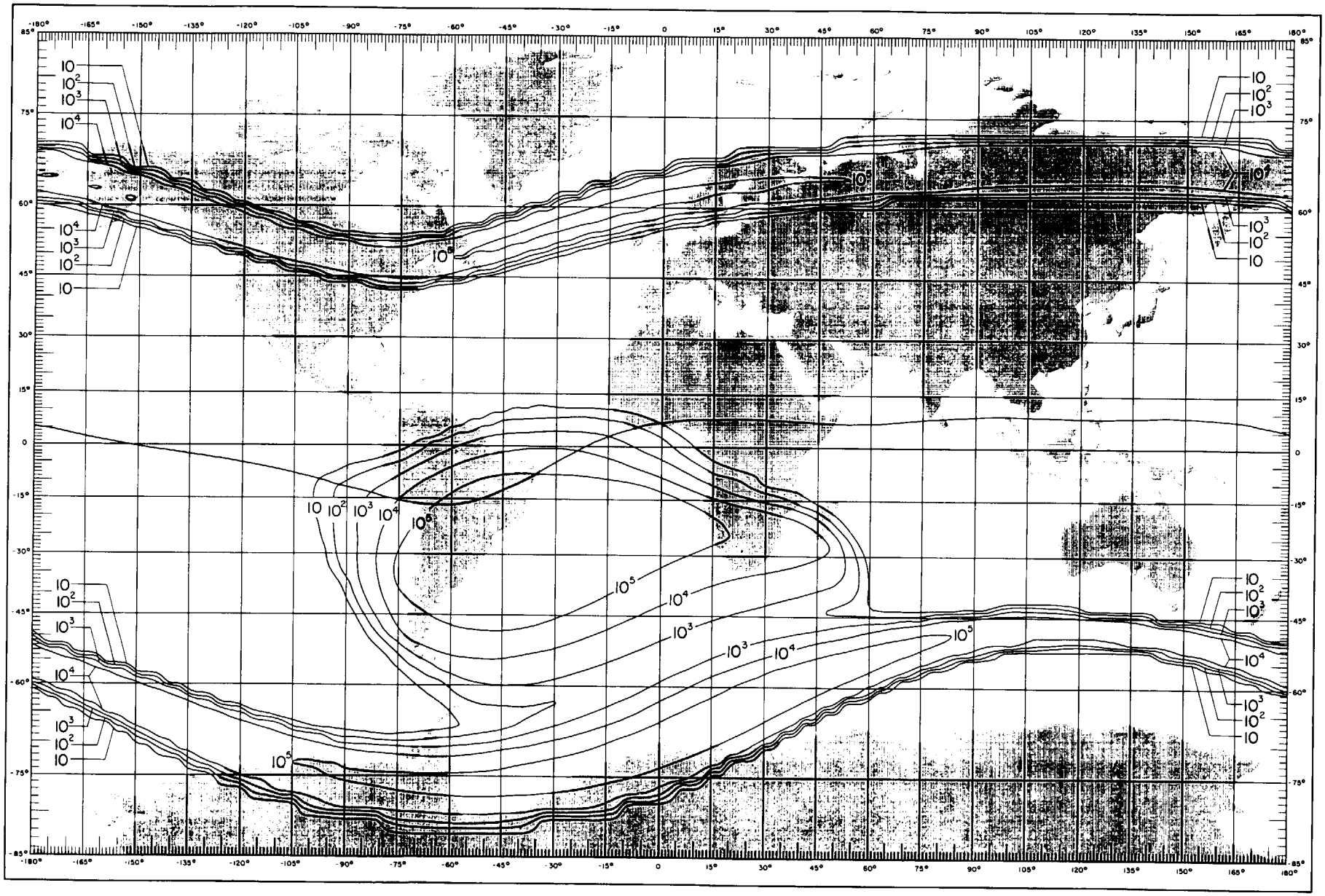

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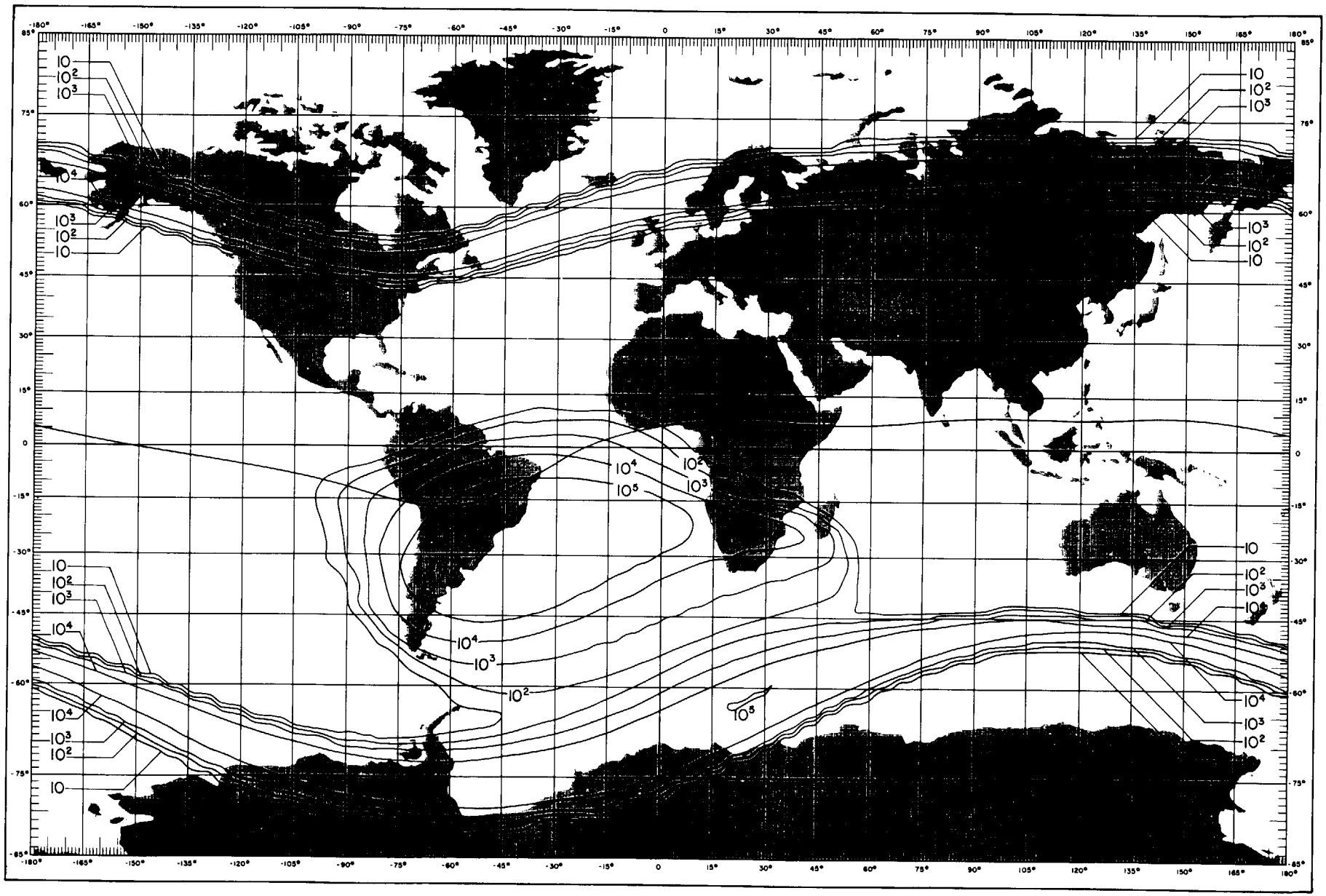

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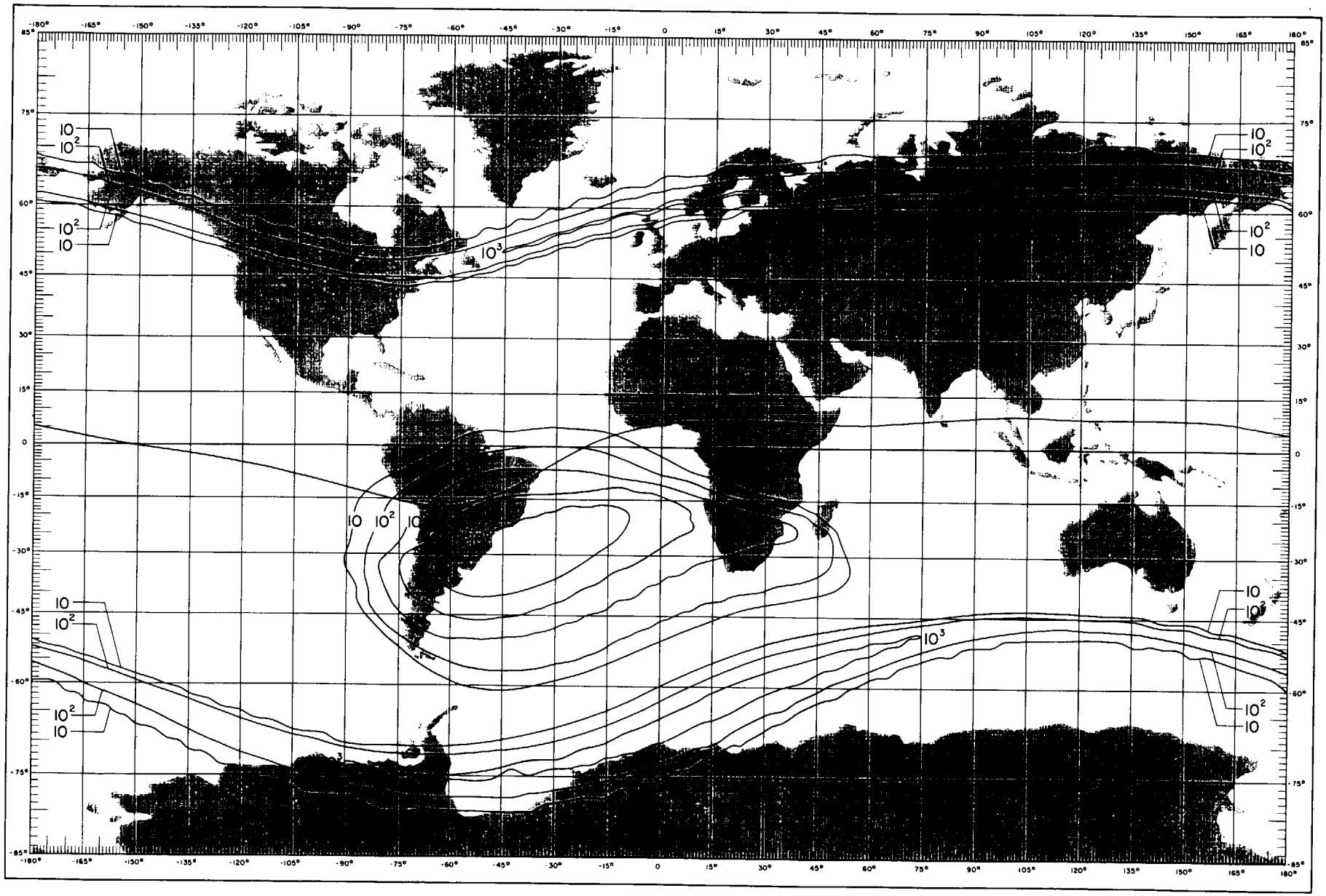

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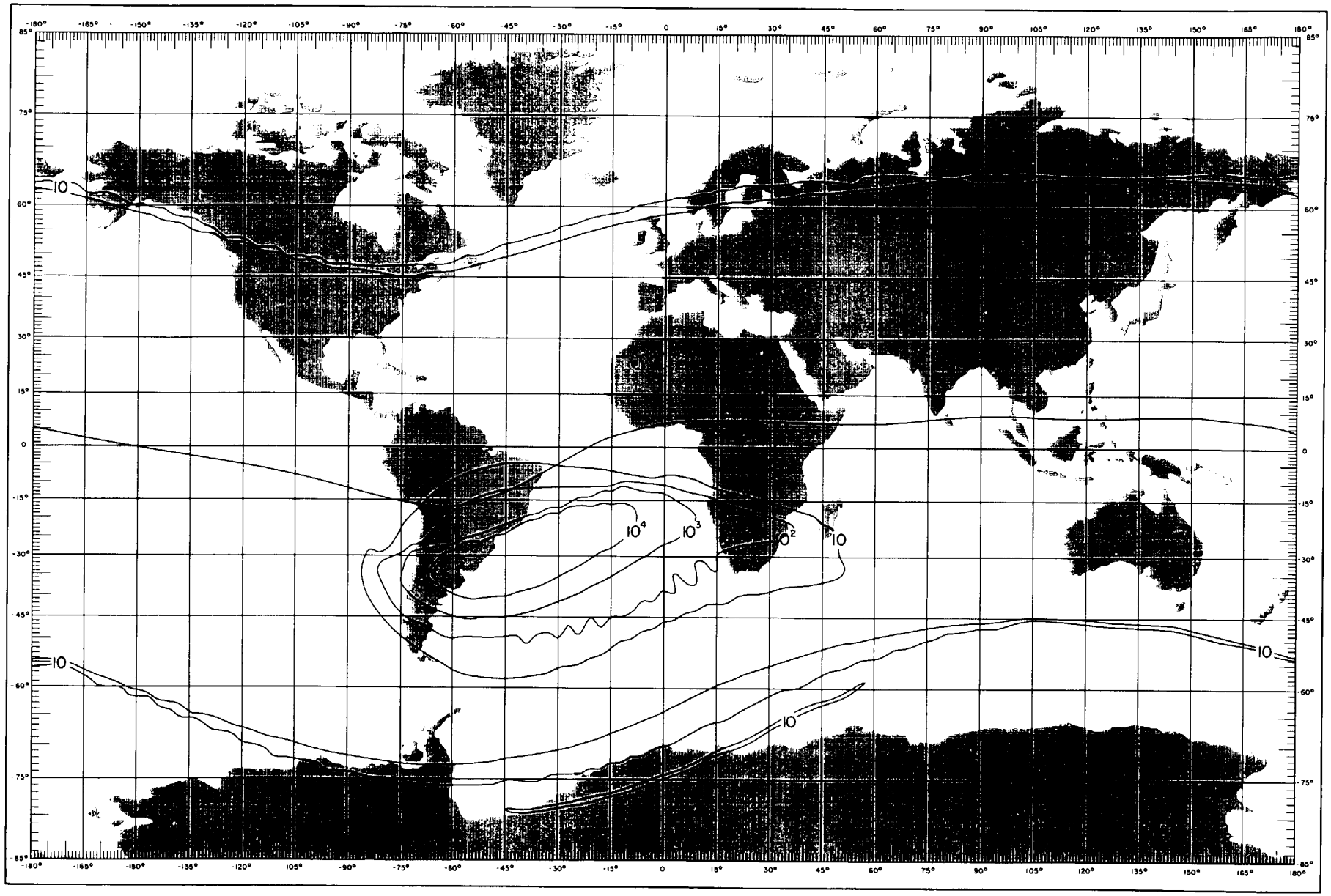

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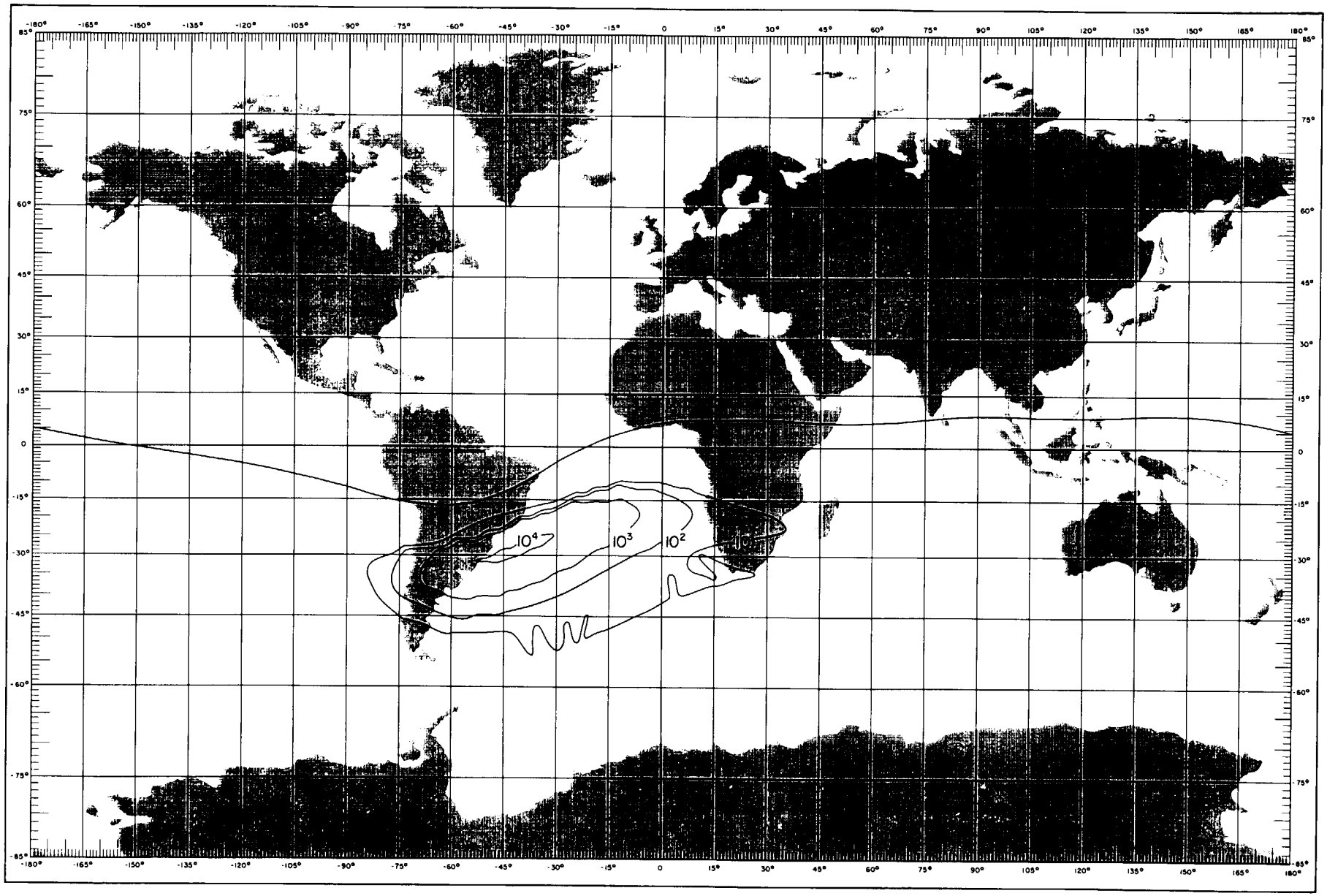

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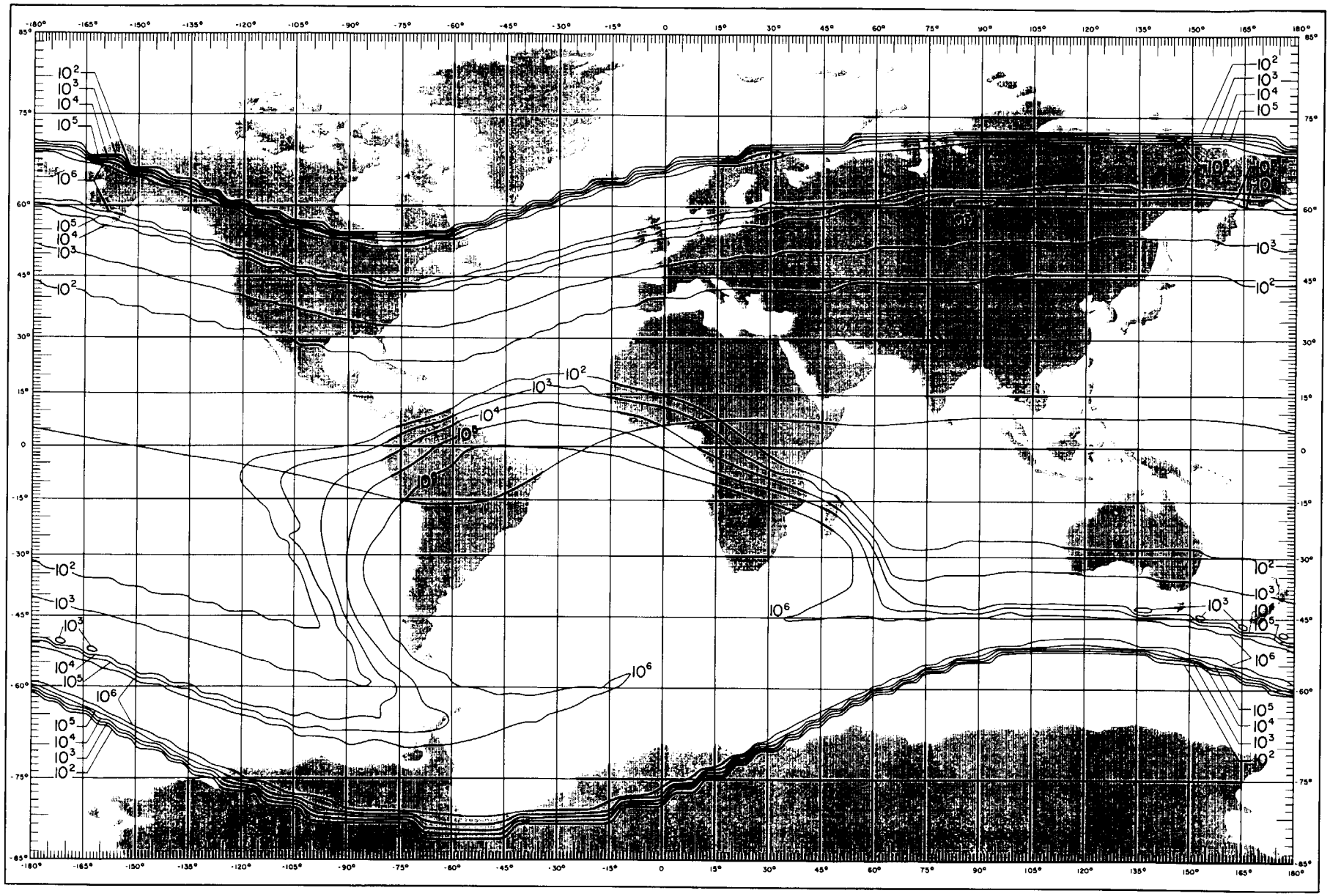

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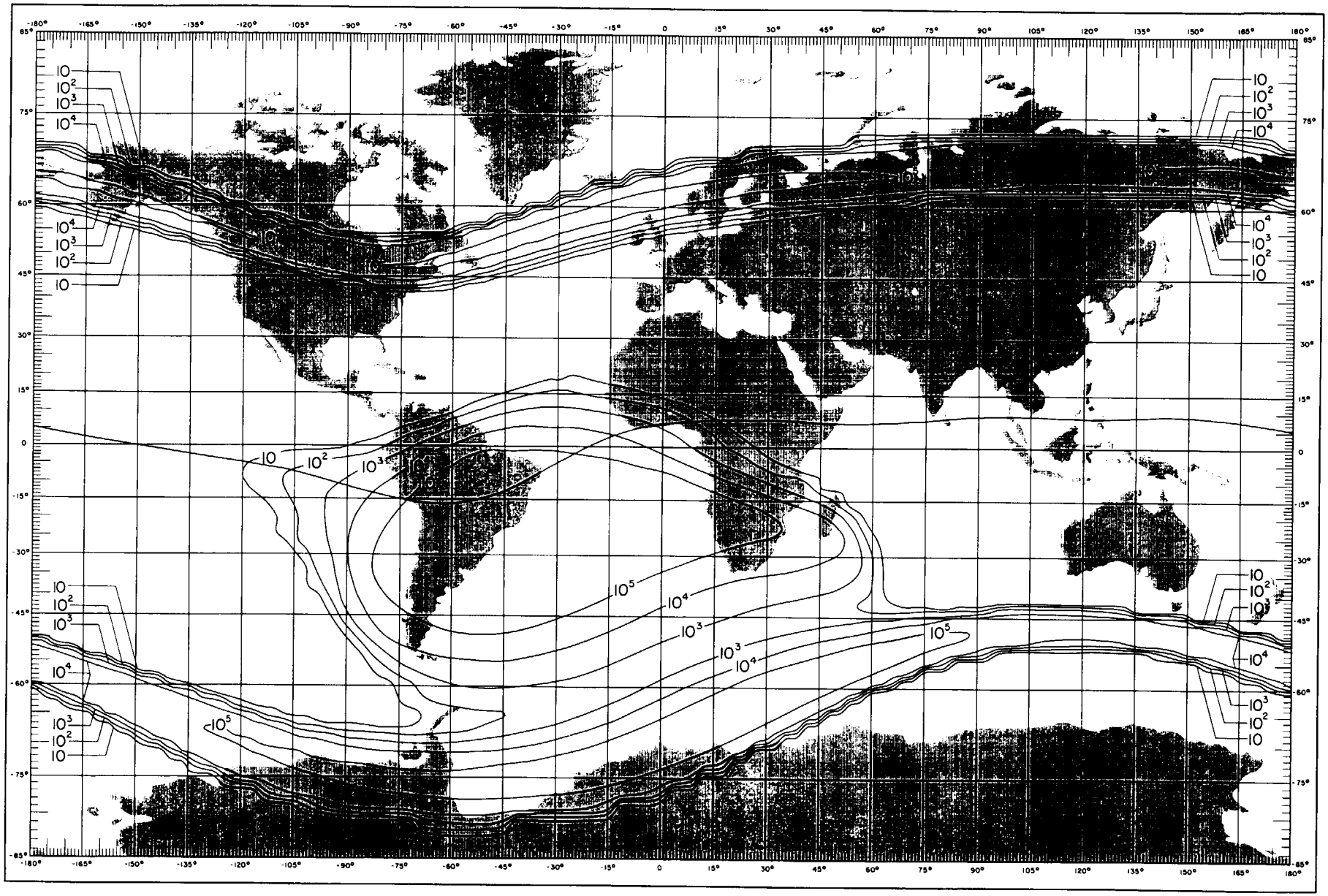

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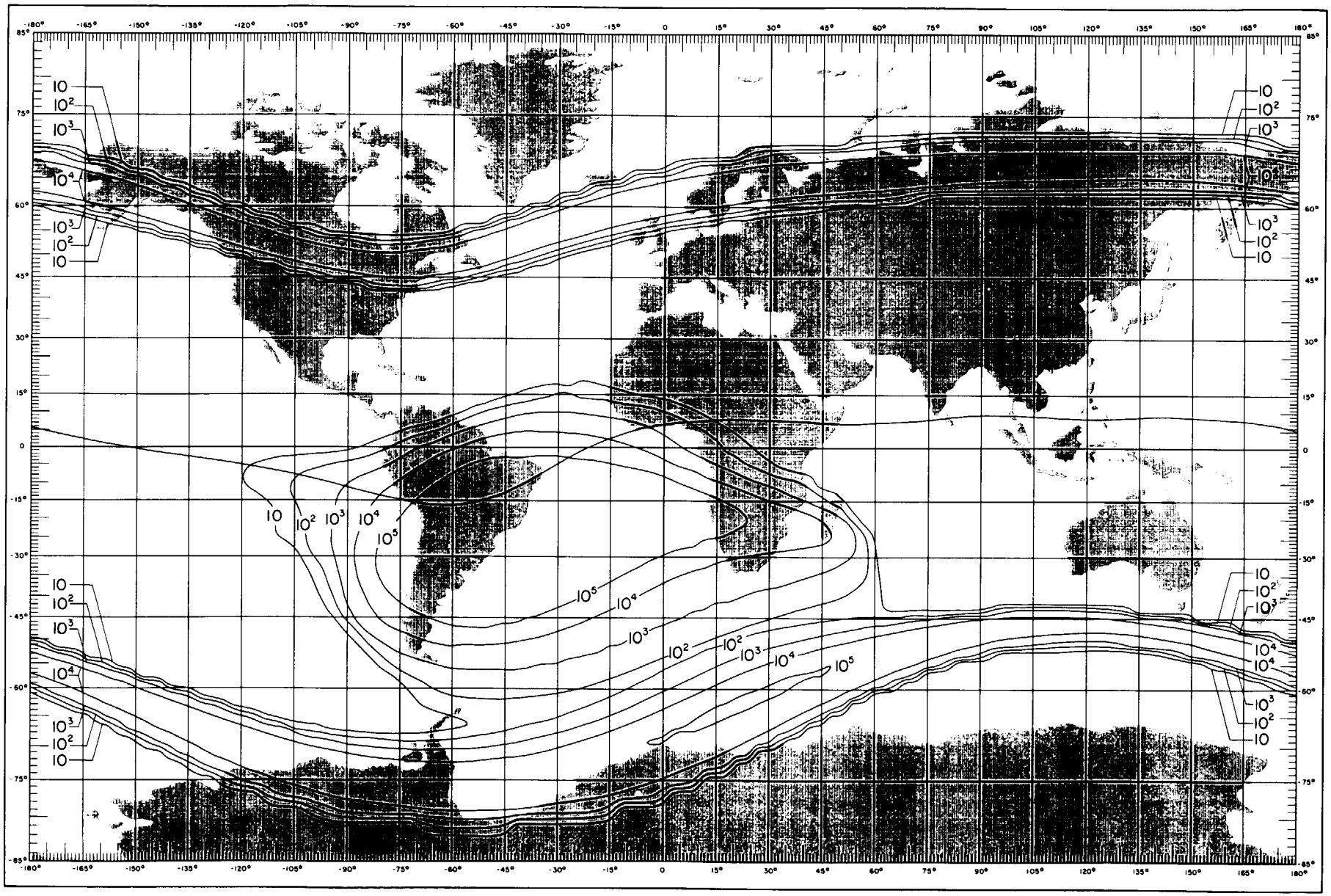

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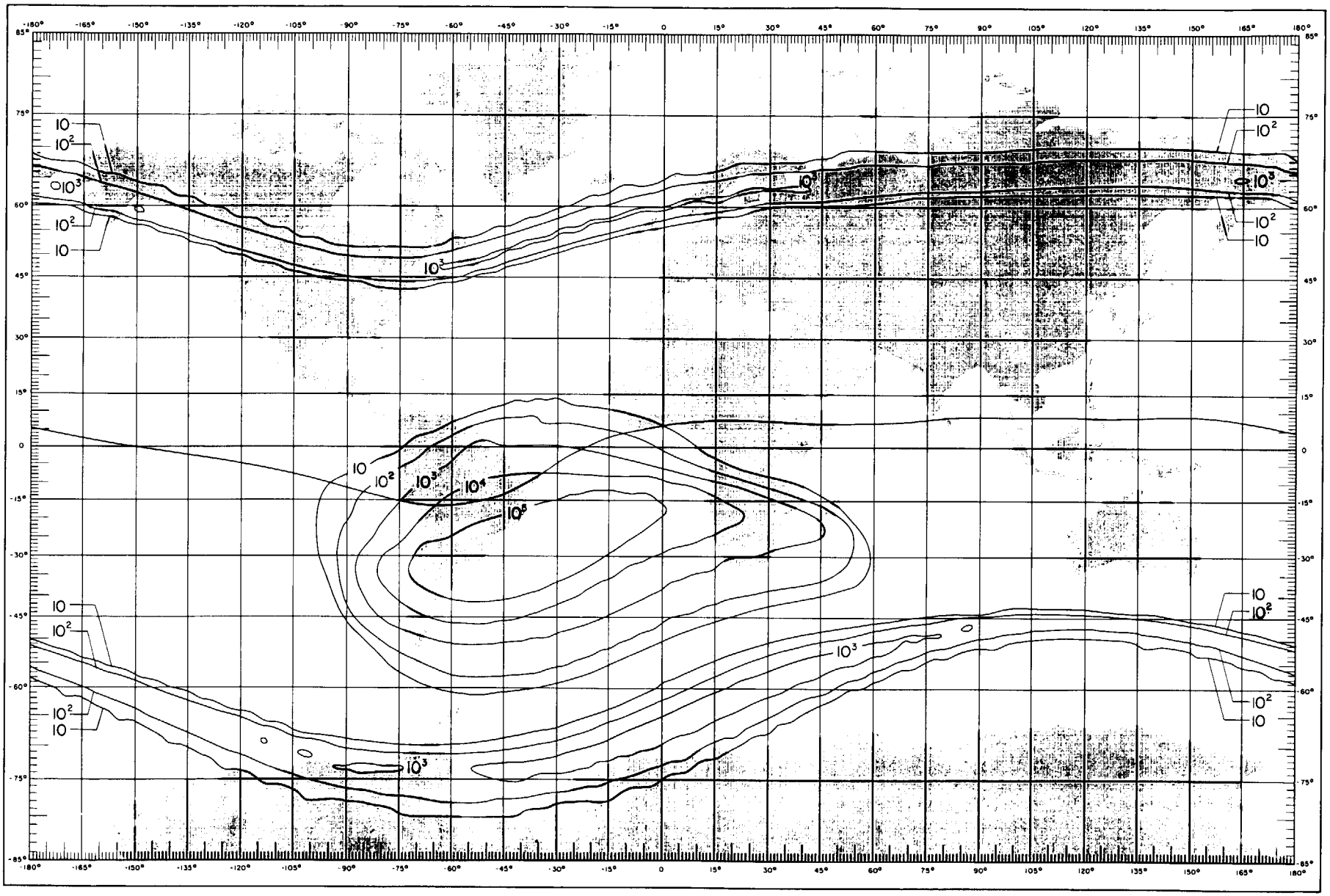

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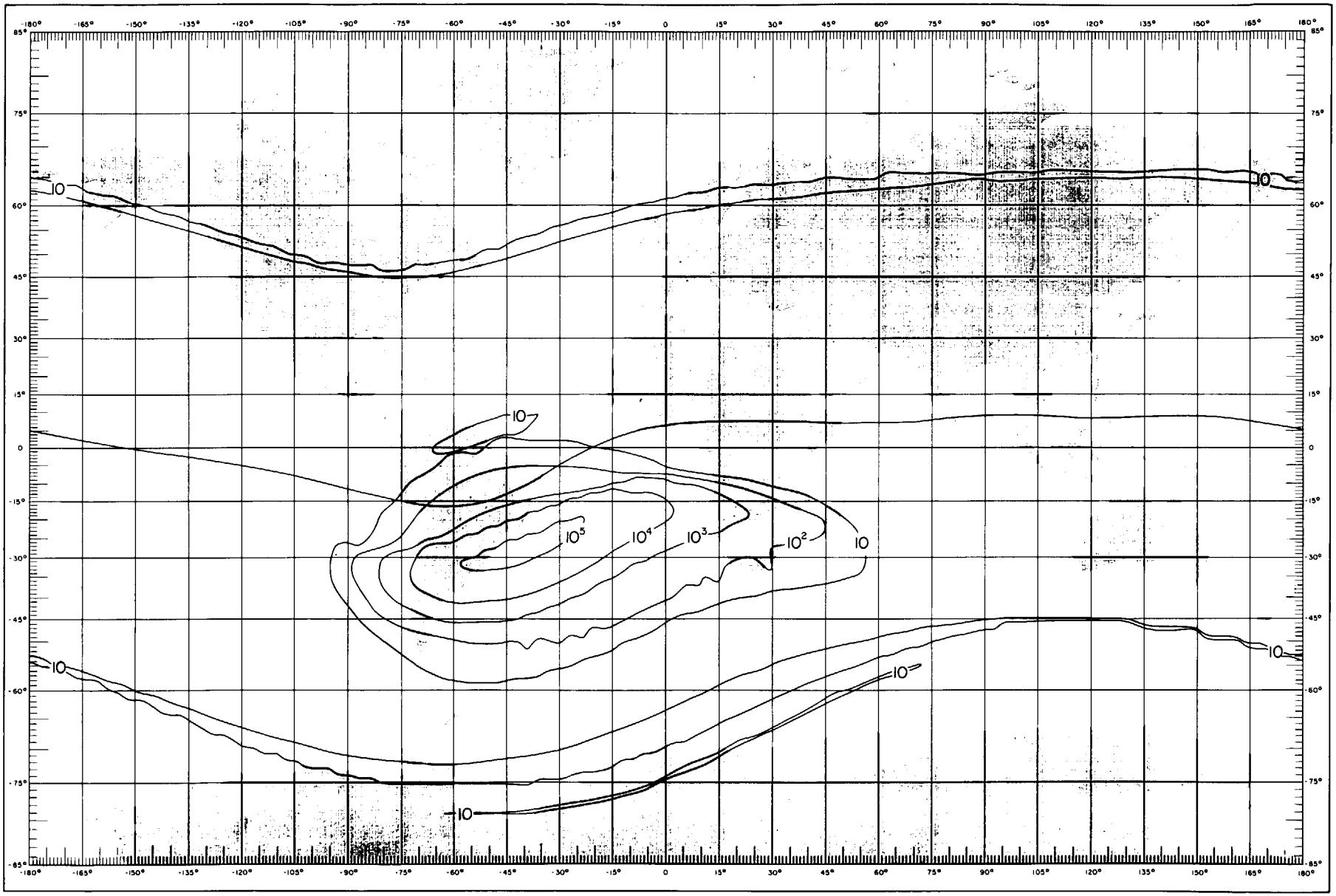

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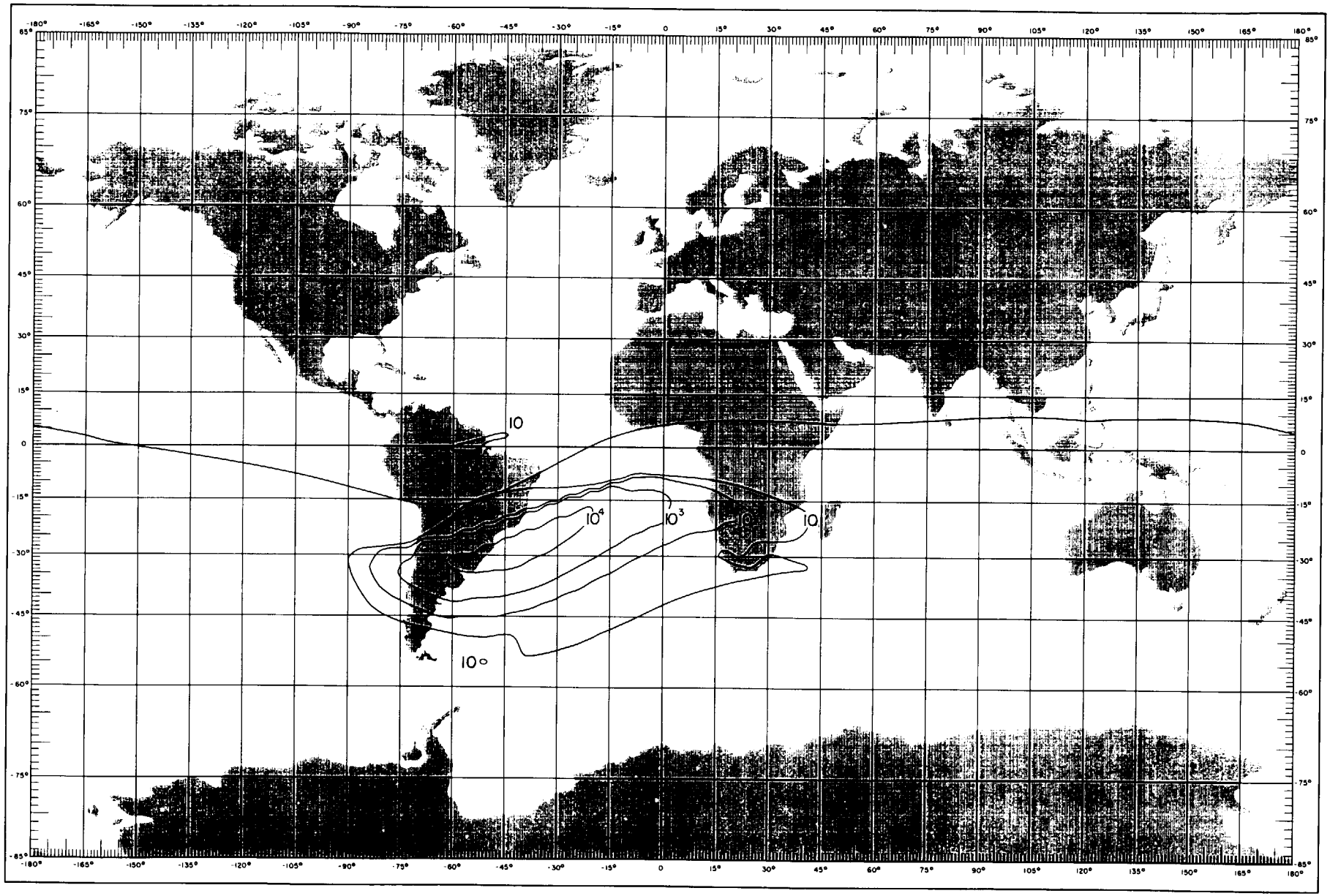
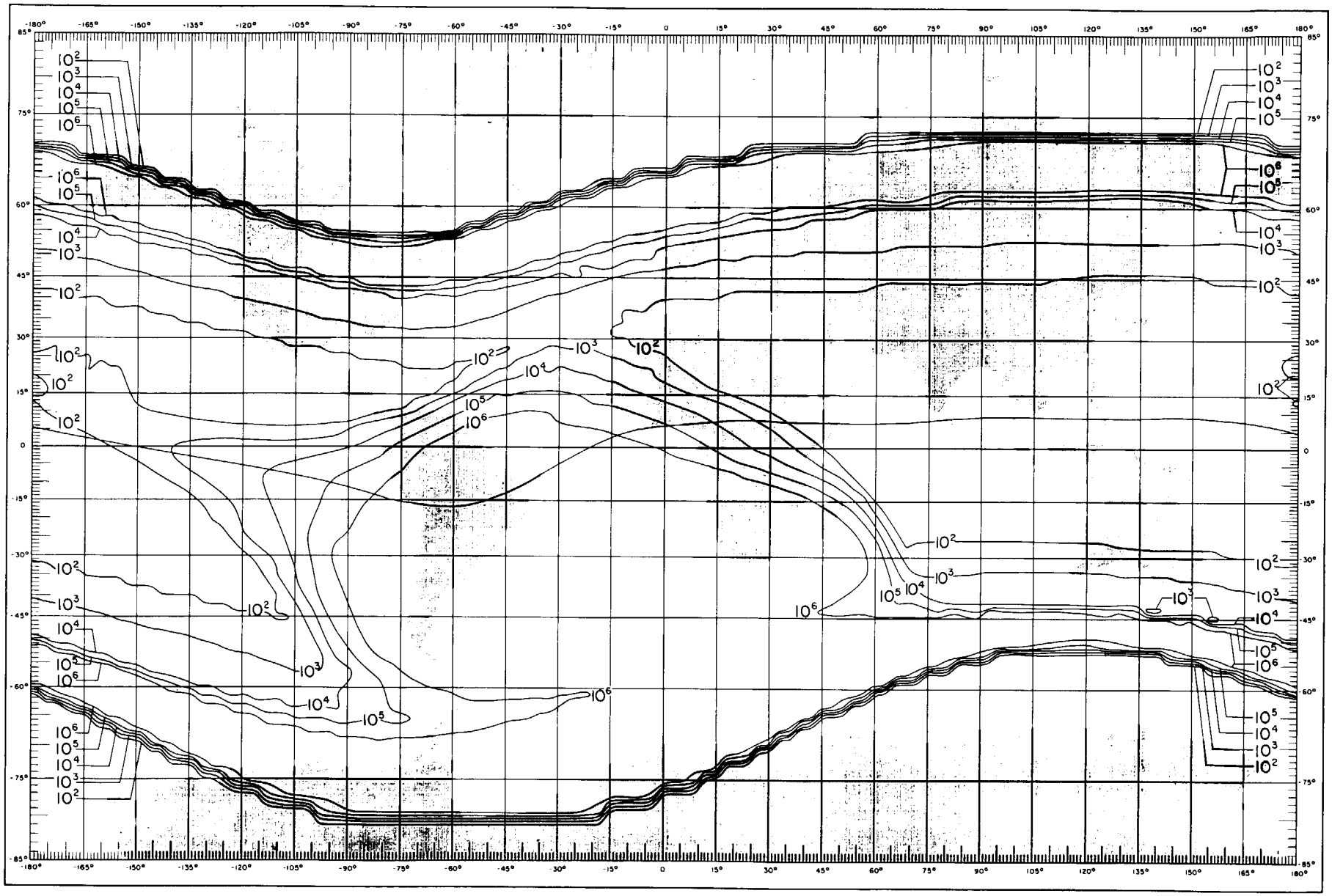


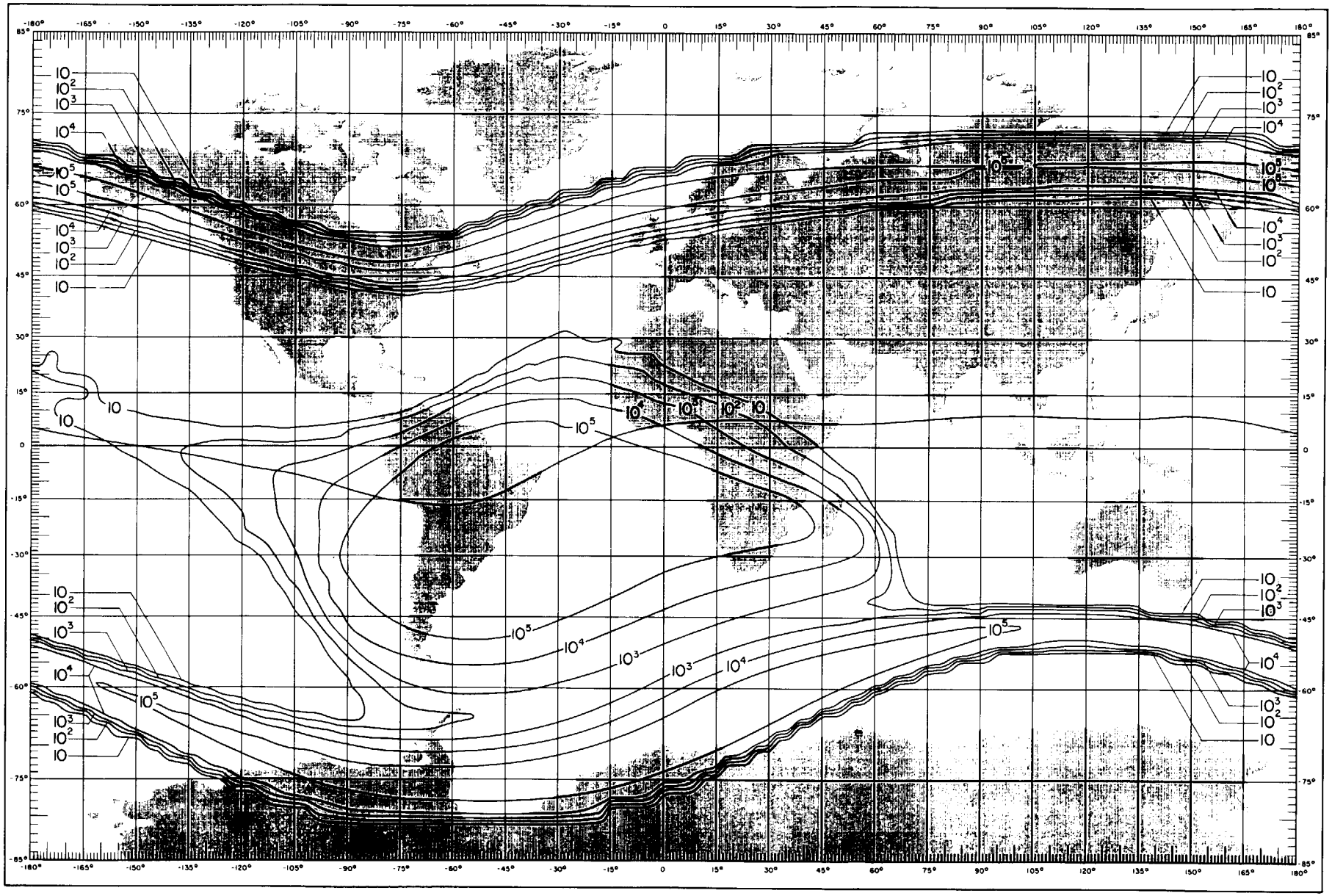
ALTITUDE = 700 KM

ELECTRON FLUX CONTOURS — E > 0 MEV



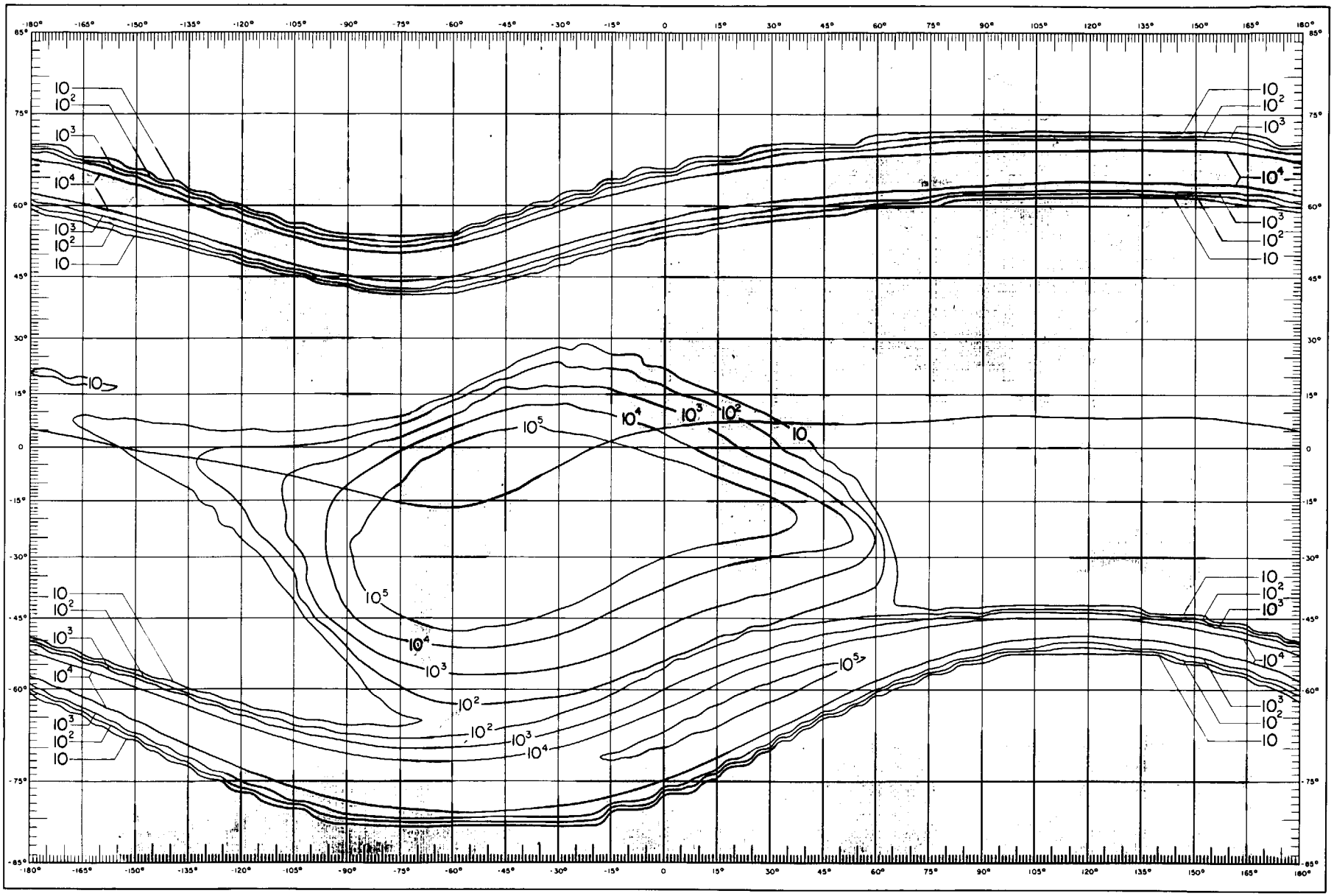
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS — E > .5 MEV



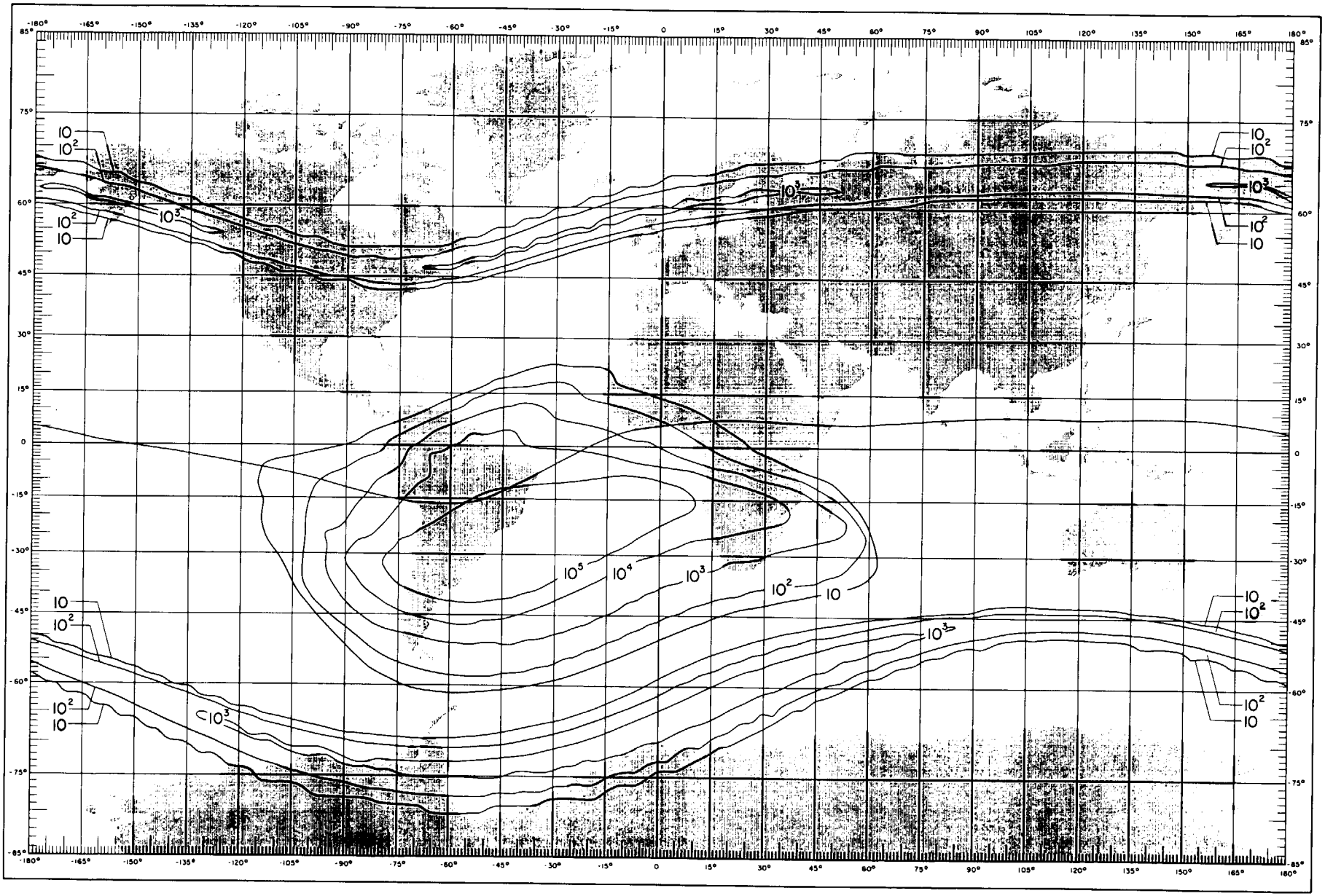
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS — E > 1 MEV



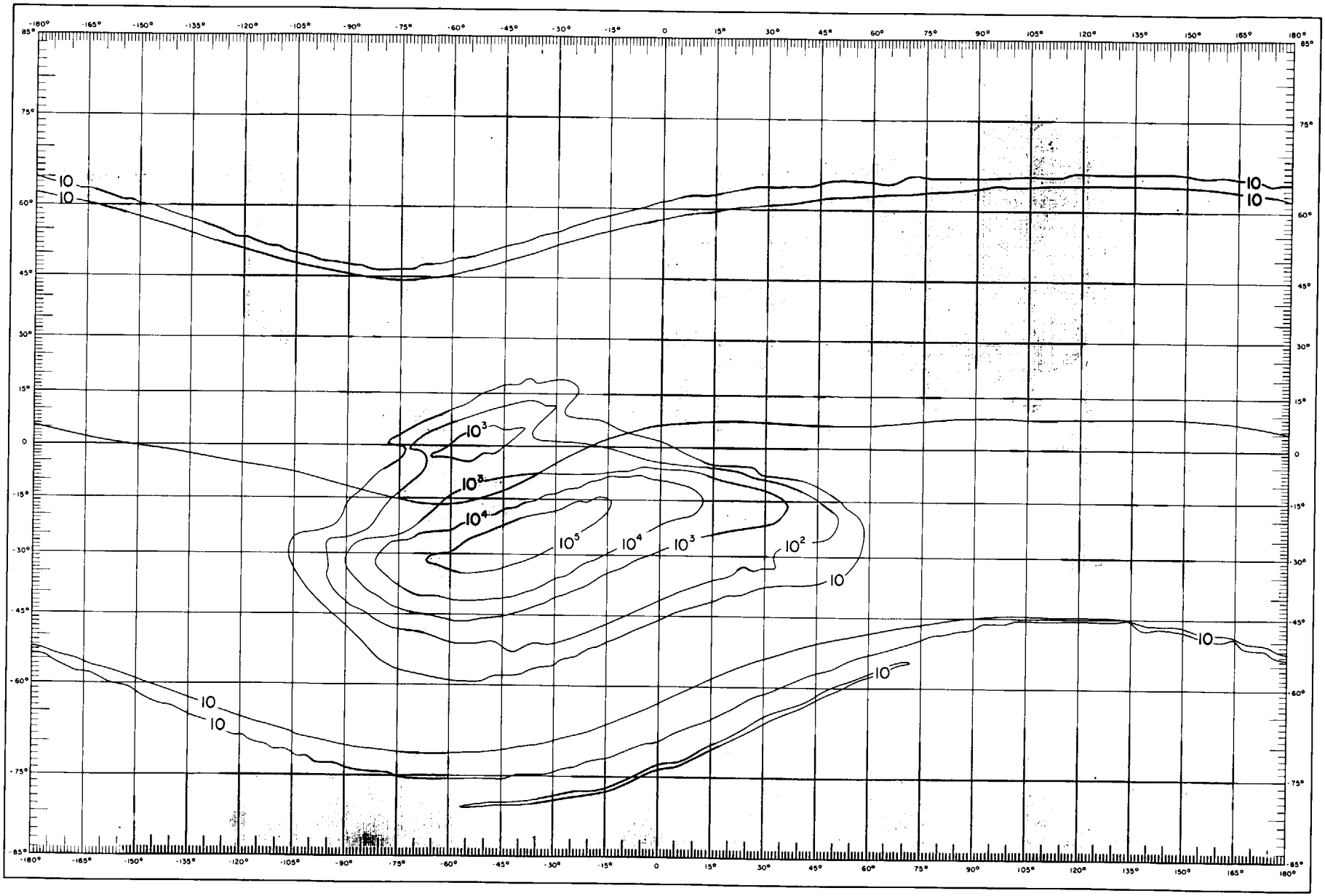
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS — E > 3 MEV



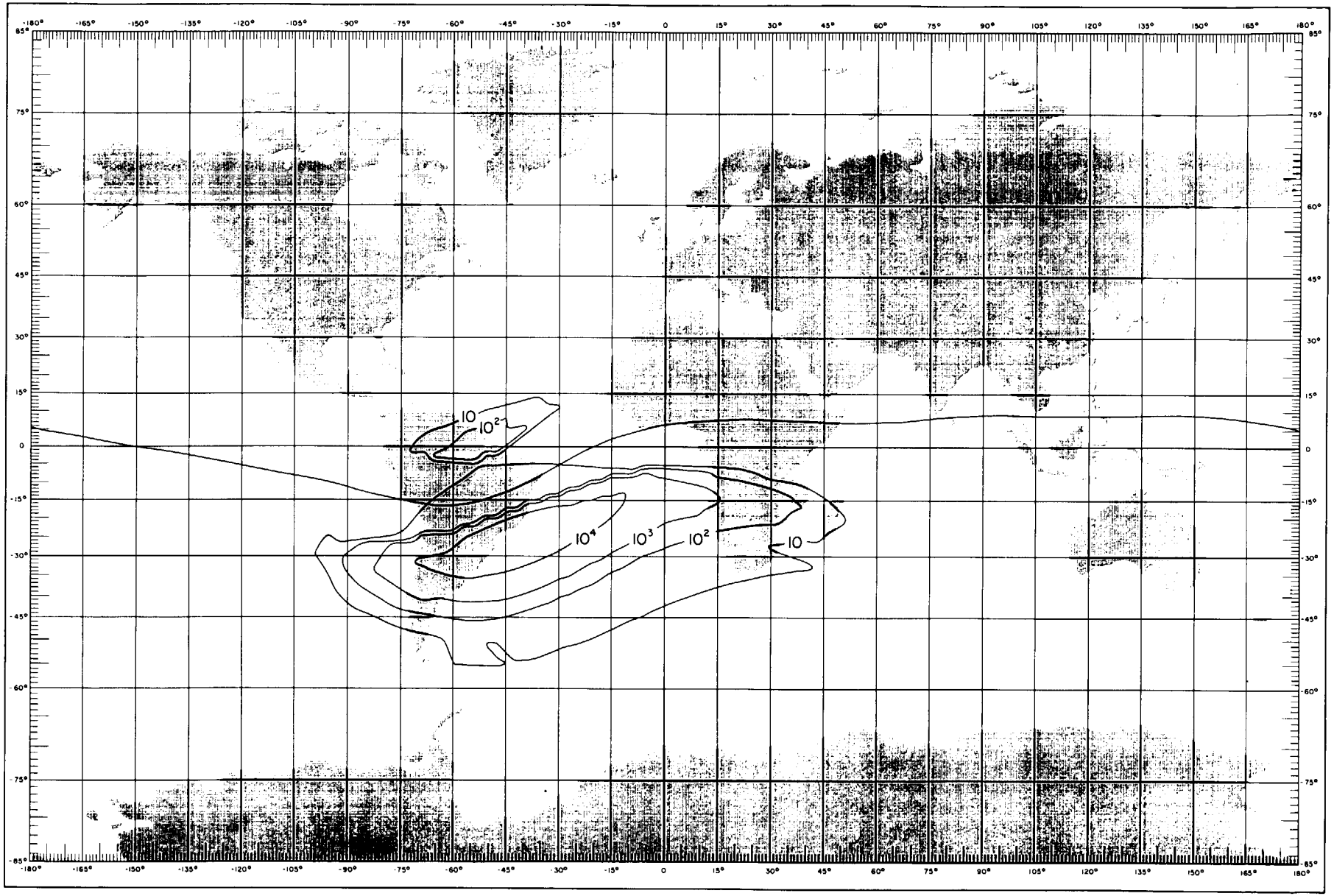
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS — E > 5 MEV



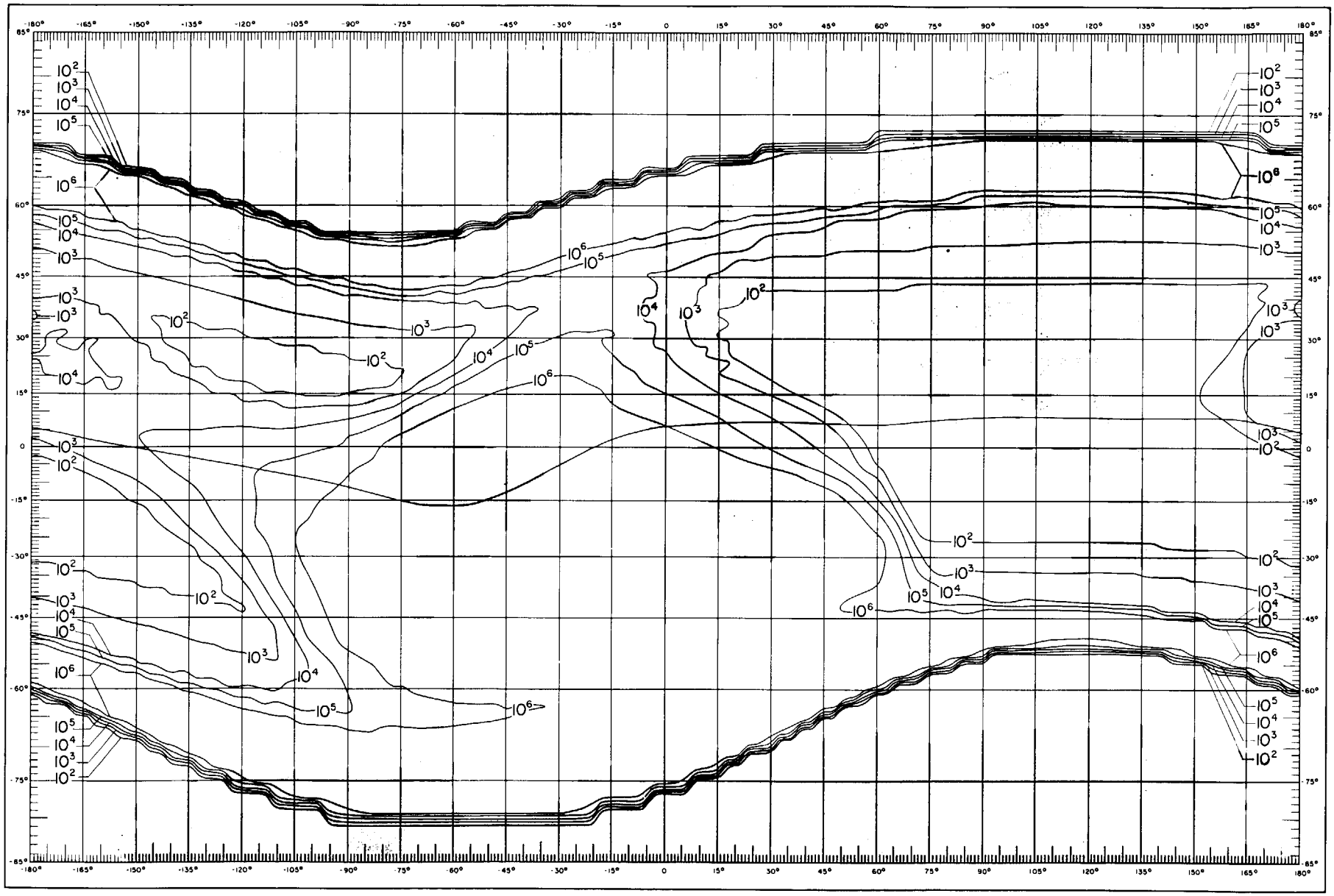
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS—E > 7 MEV



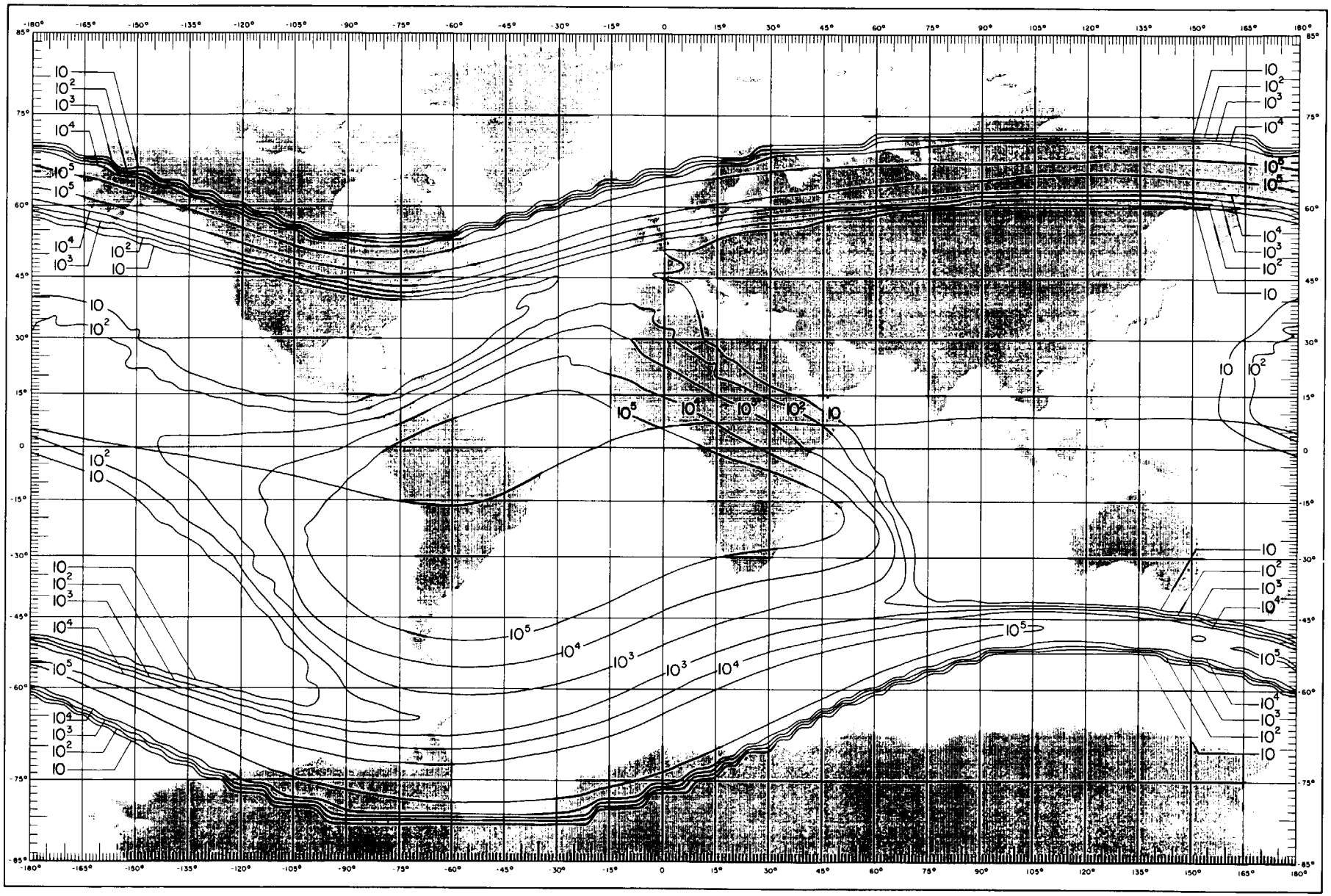
ALTITUDE = 800 KM

ELECTRON FLUX CONTOURS — E > 0 MEV



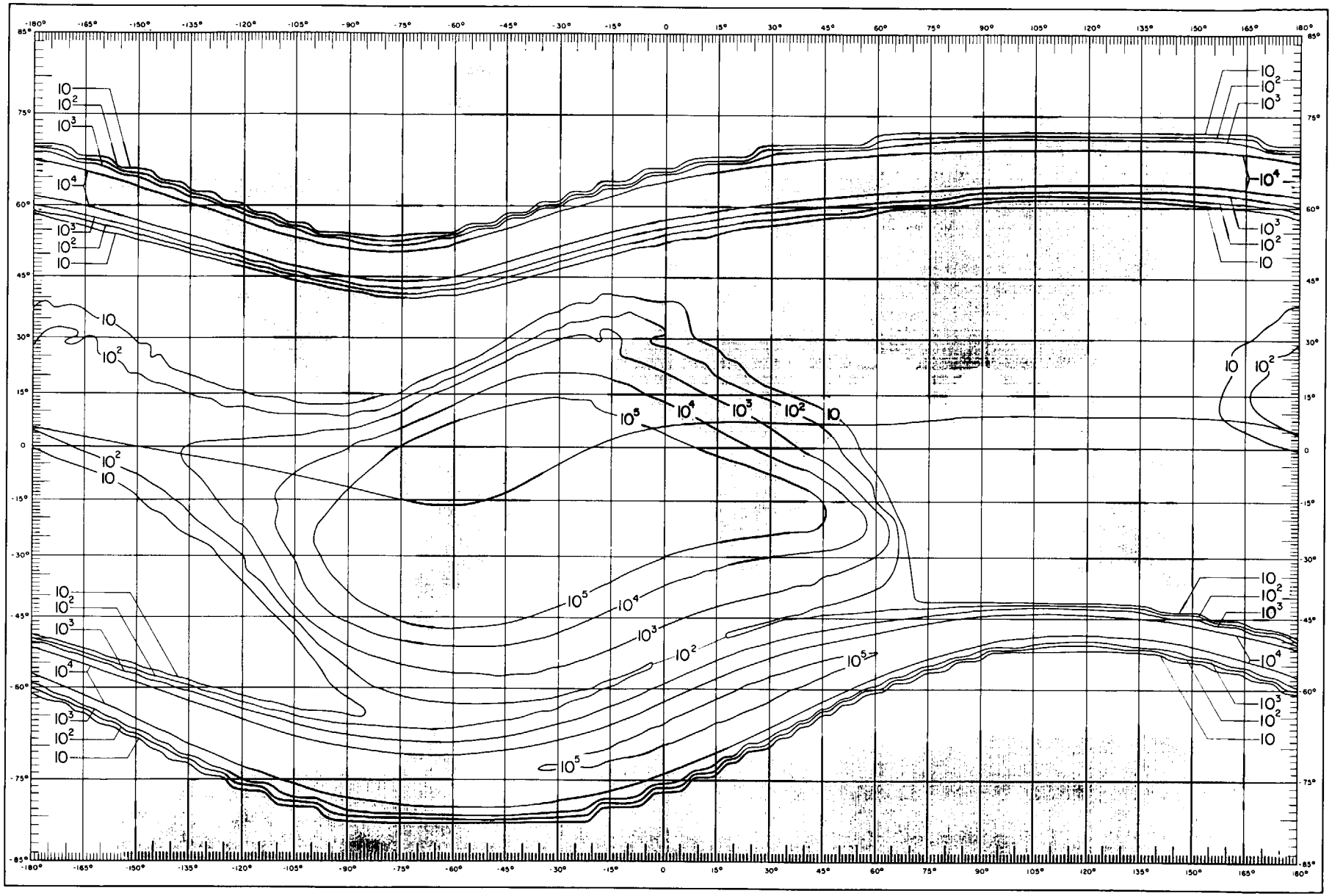
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS — E > .5 MEV



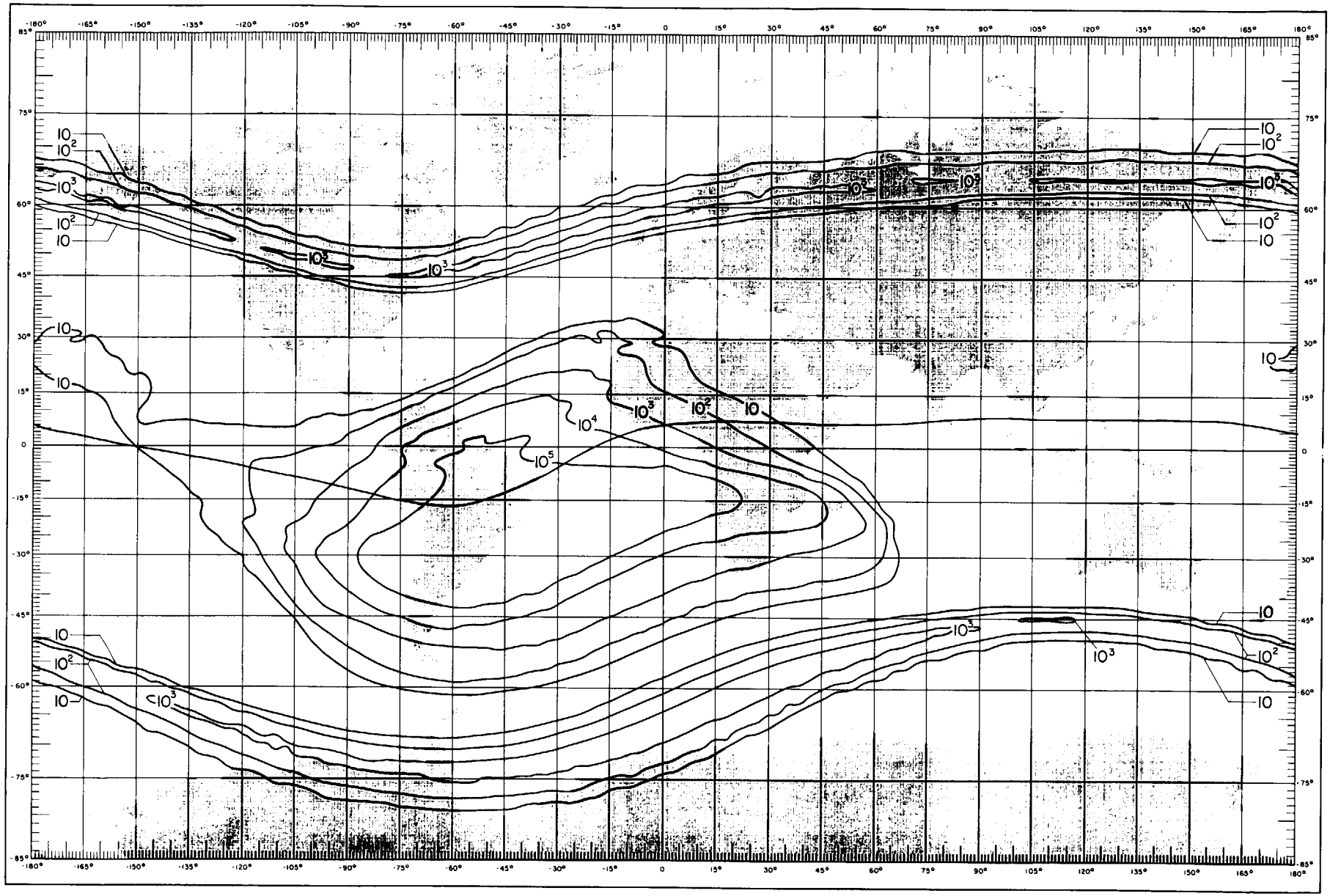
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS — E > 1 MEV



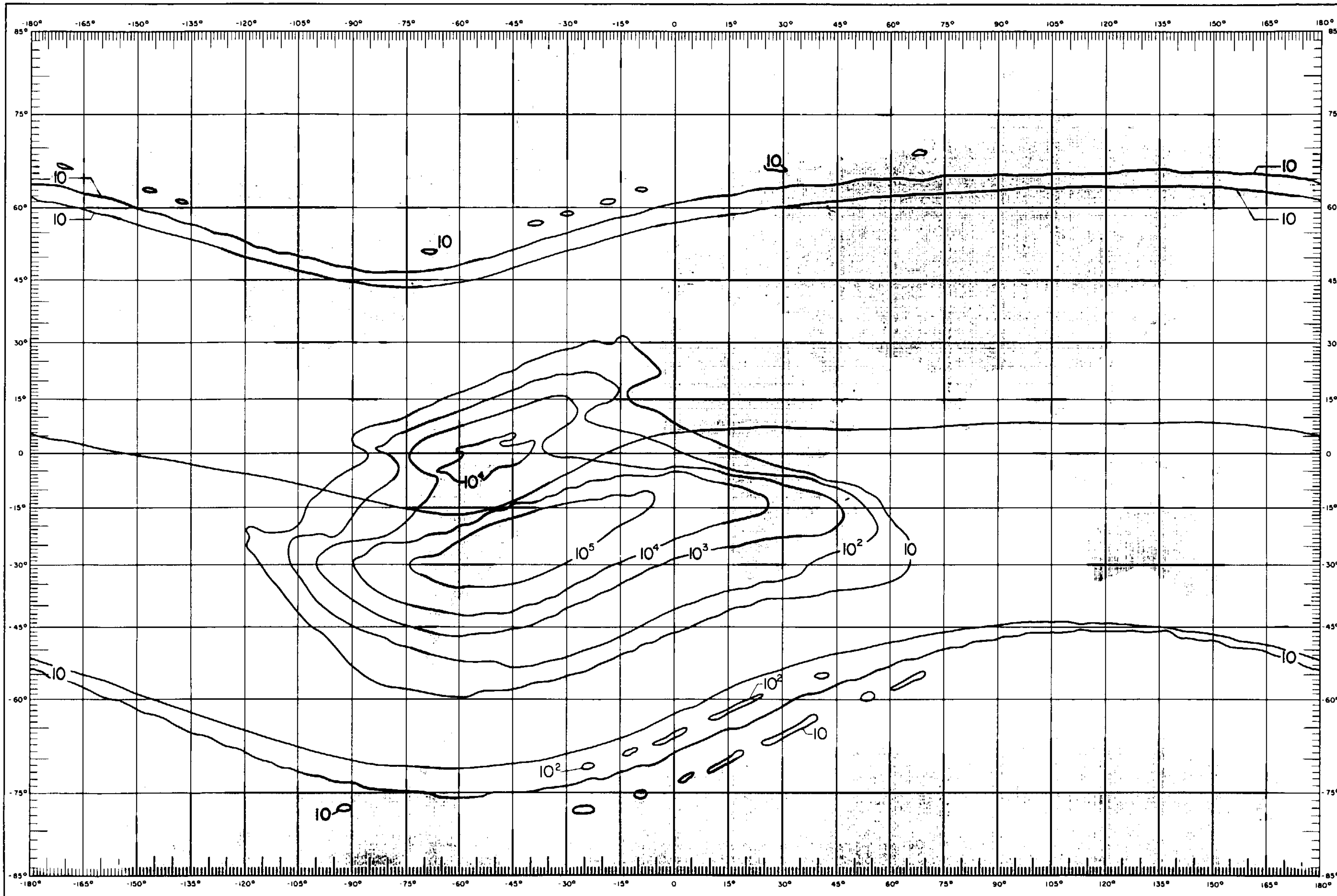
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS — E > 3 MEV



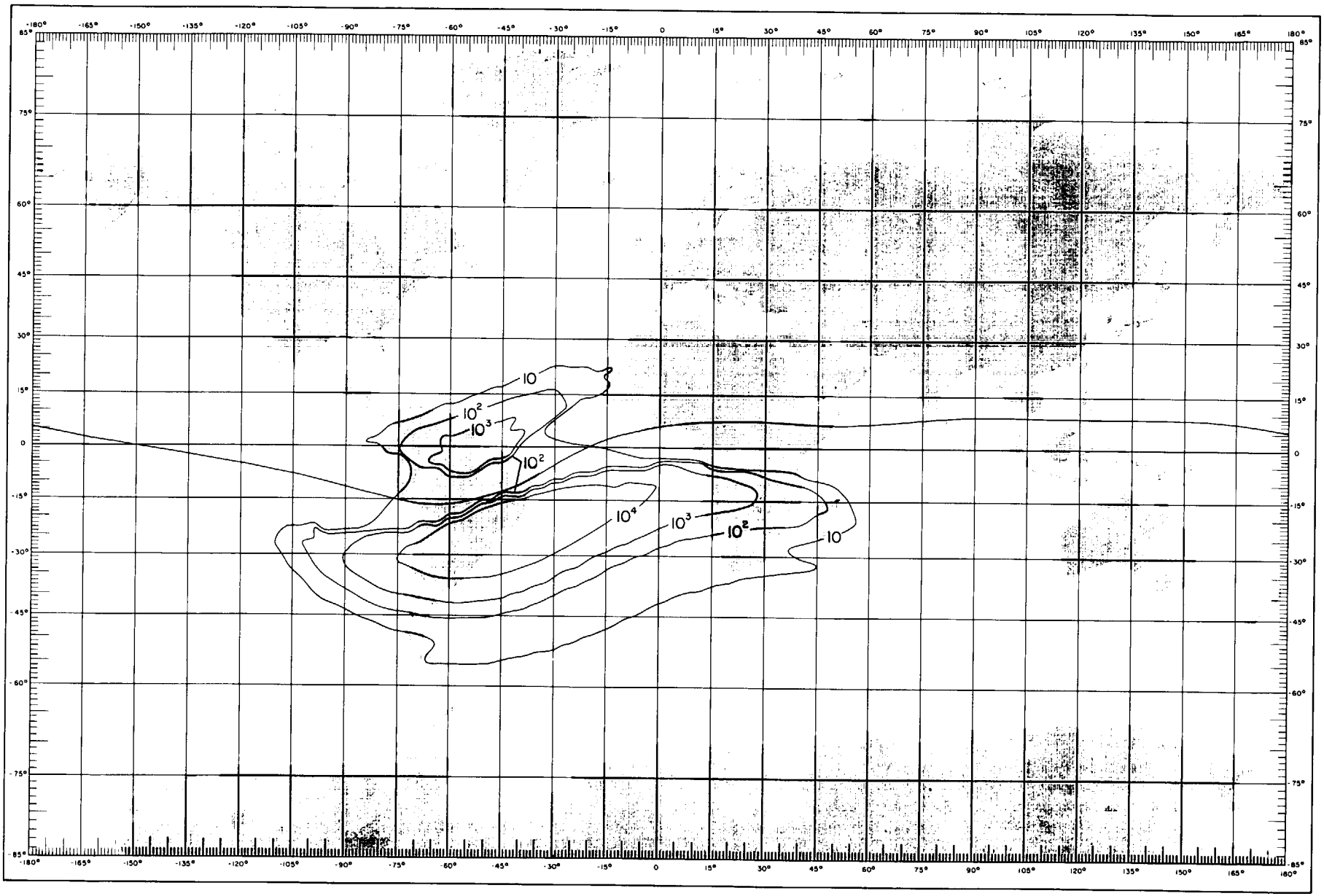
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS — E > 5 MEV



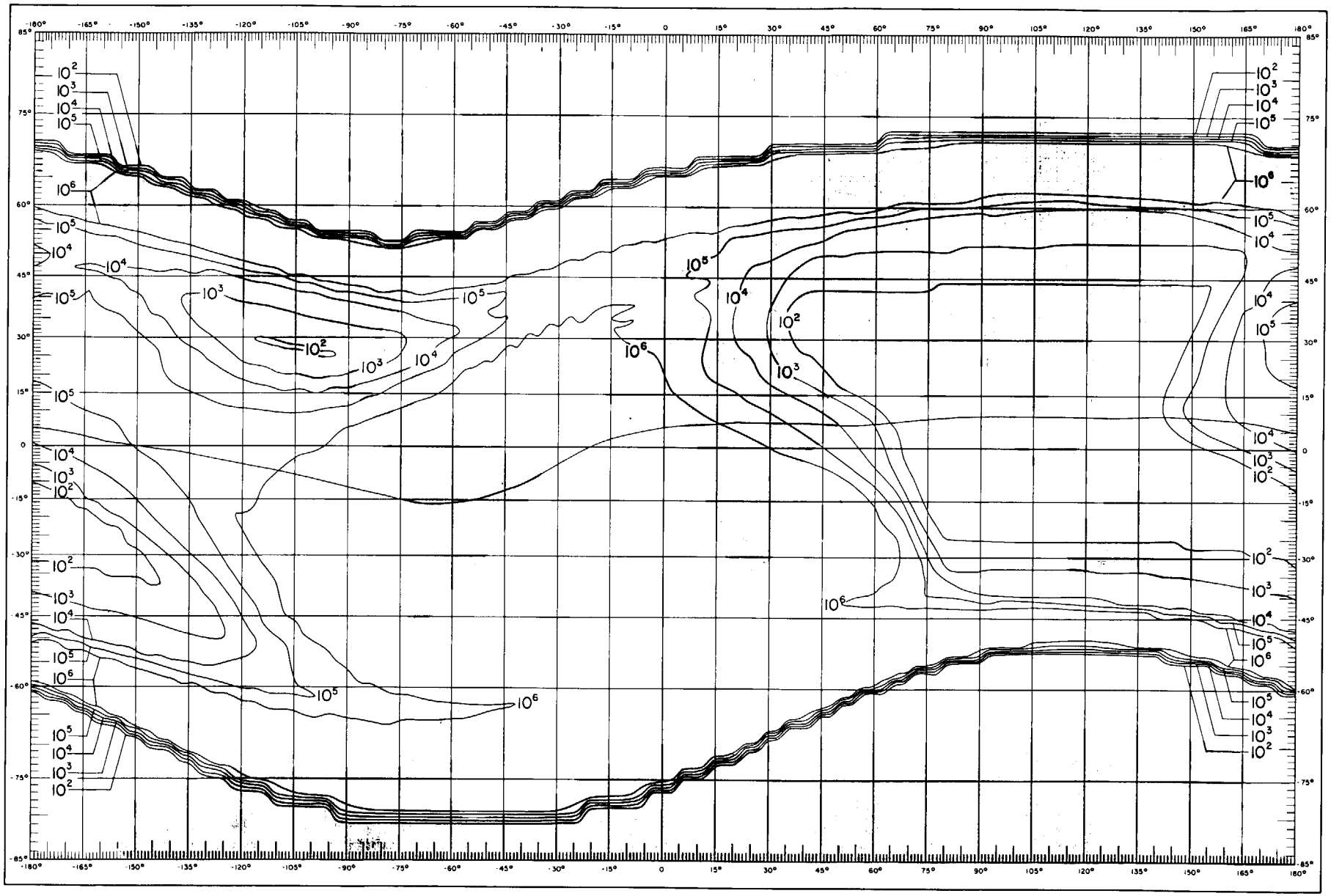
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS — E > 7 MEV



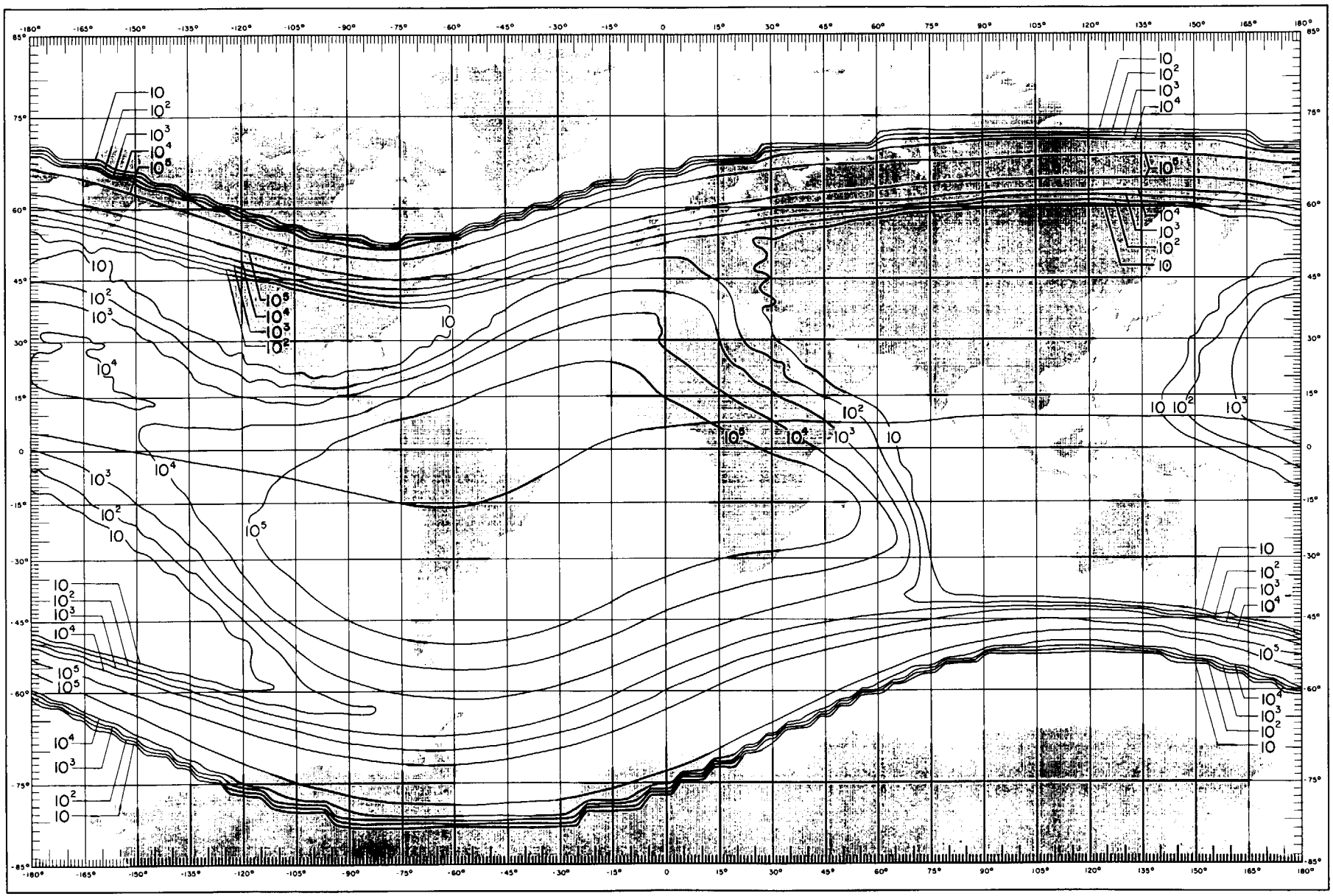
ALTITUDE = 900 KM

ELECTRON FLUX CONTOURS—E >0 MEV



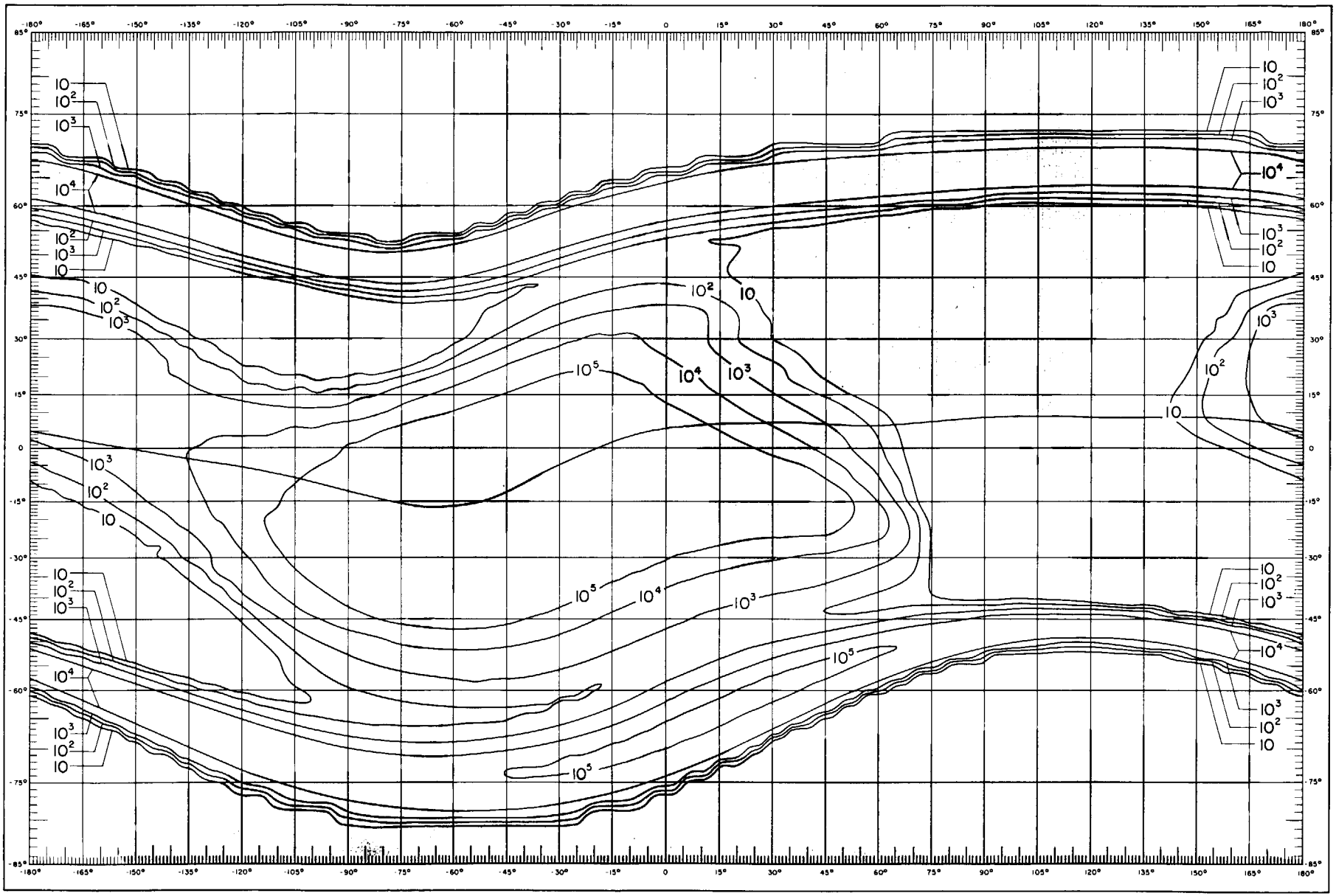
ALTITUDE = 1000 KM

ELECTRON FLUX CONTOURS — E > .5 MEV



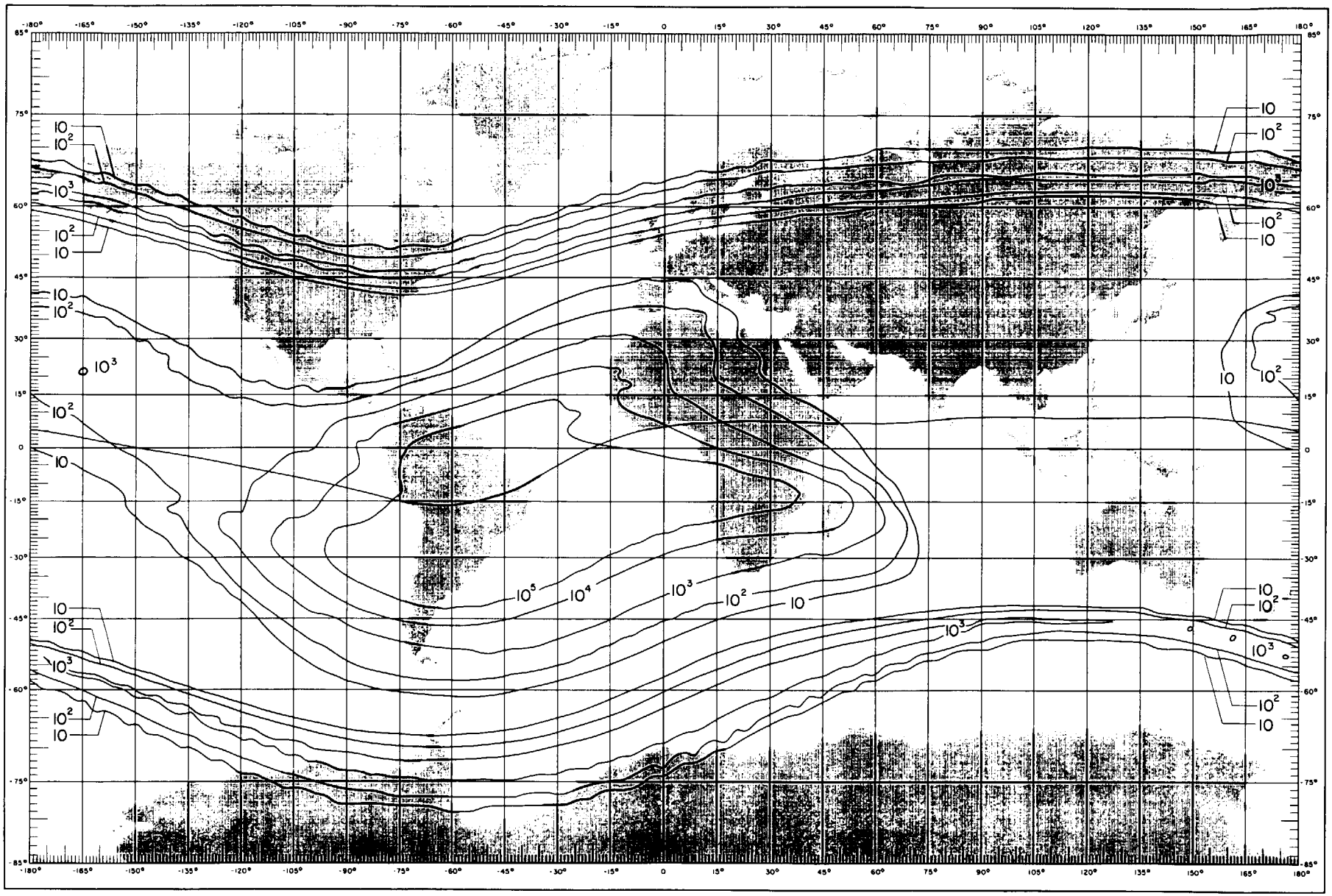
ALTITUDE = 1000 KM

ELECTRON FLUX CONTOURS—E > 1 MEV



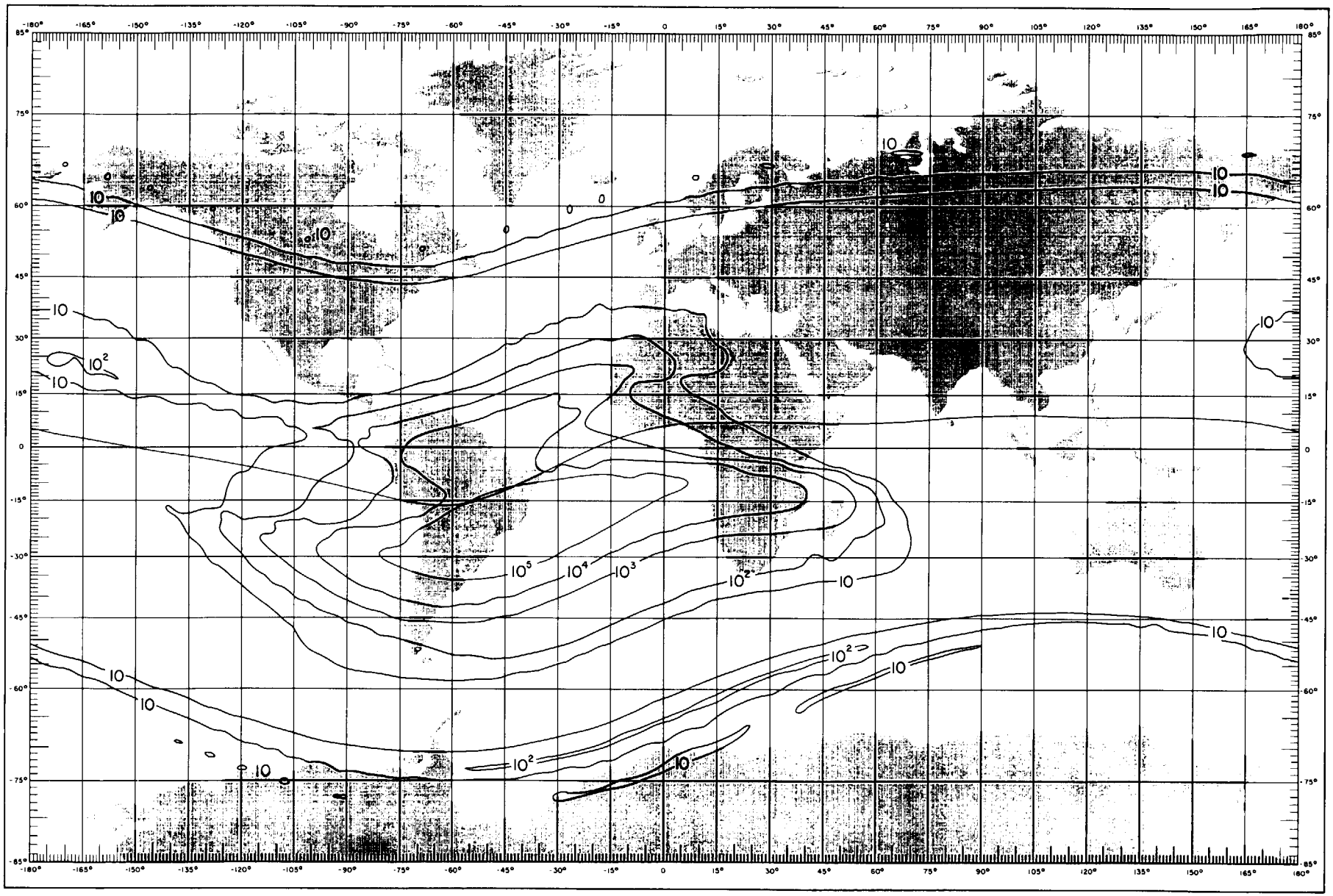
ALTITUDE=1000 KM

ELECTRON FLUX CONTOURS — E > 3 MEV



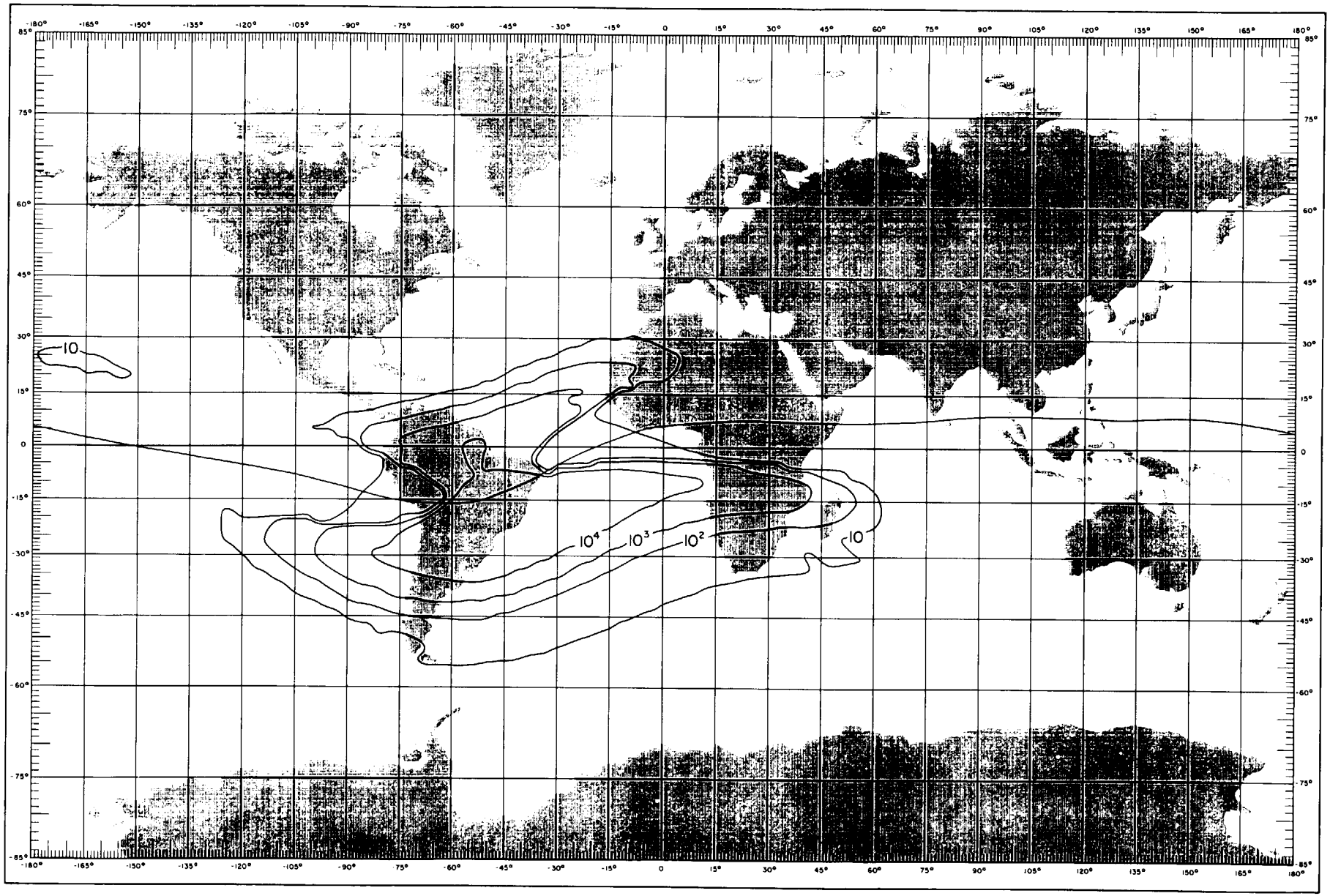
ALTITUDE=1000 KM

ELECTRON FLUX CONTOURS — E > 5 MEV



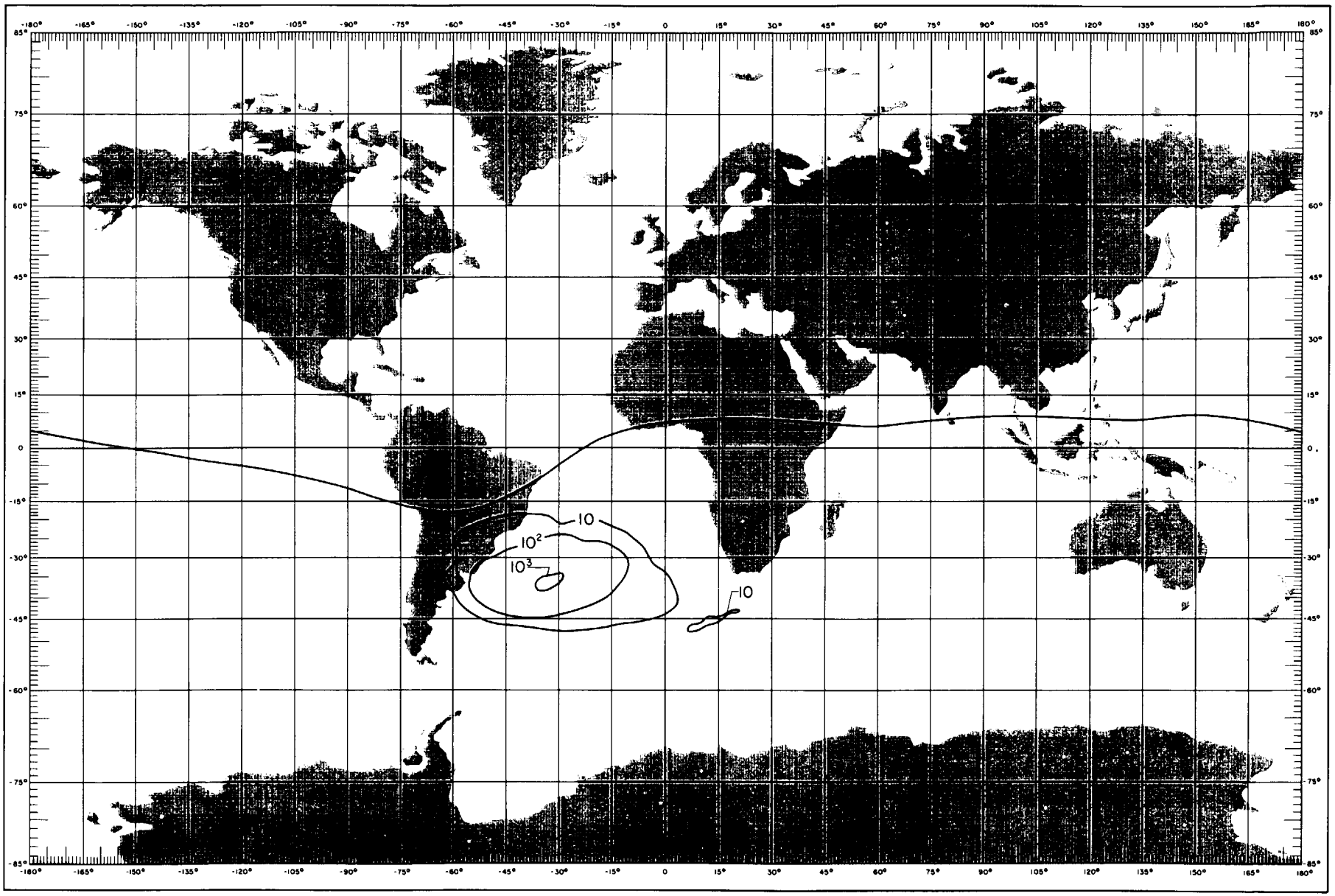
ALTITUDE = 1000 KM

ELECTRON FLUX CONTOURS — E > 7 MEV



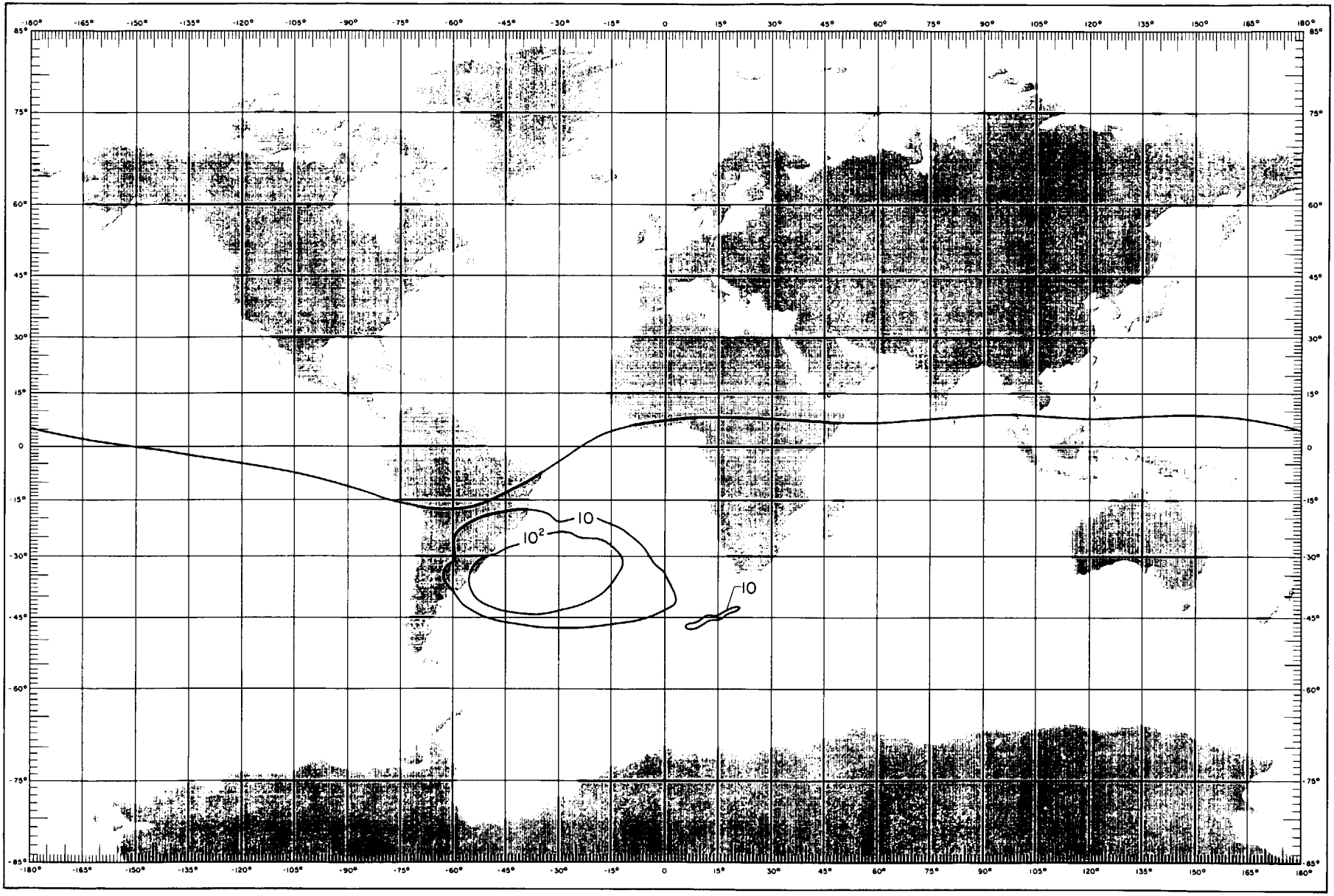
ALTITUDE = 1000 KM

PROTON FLUX CONTOURS—E > 3 MEV



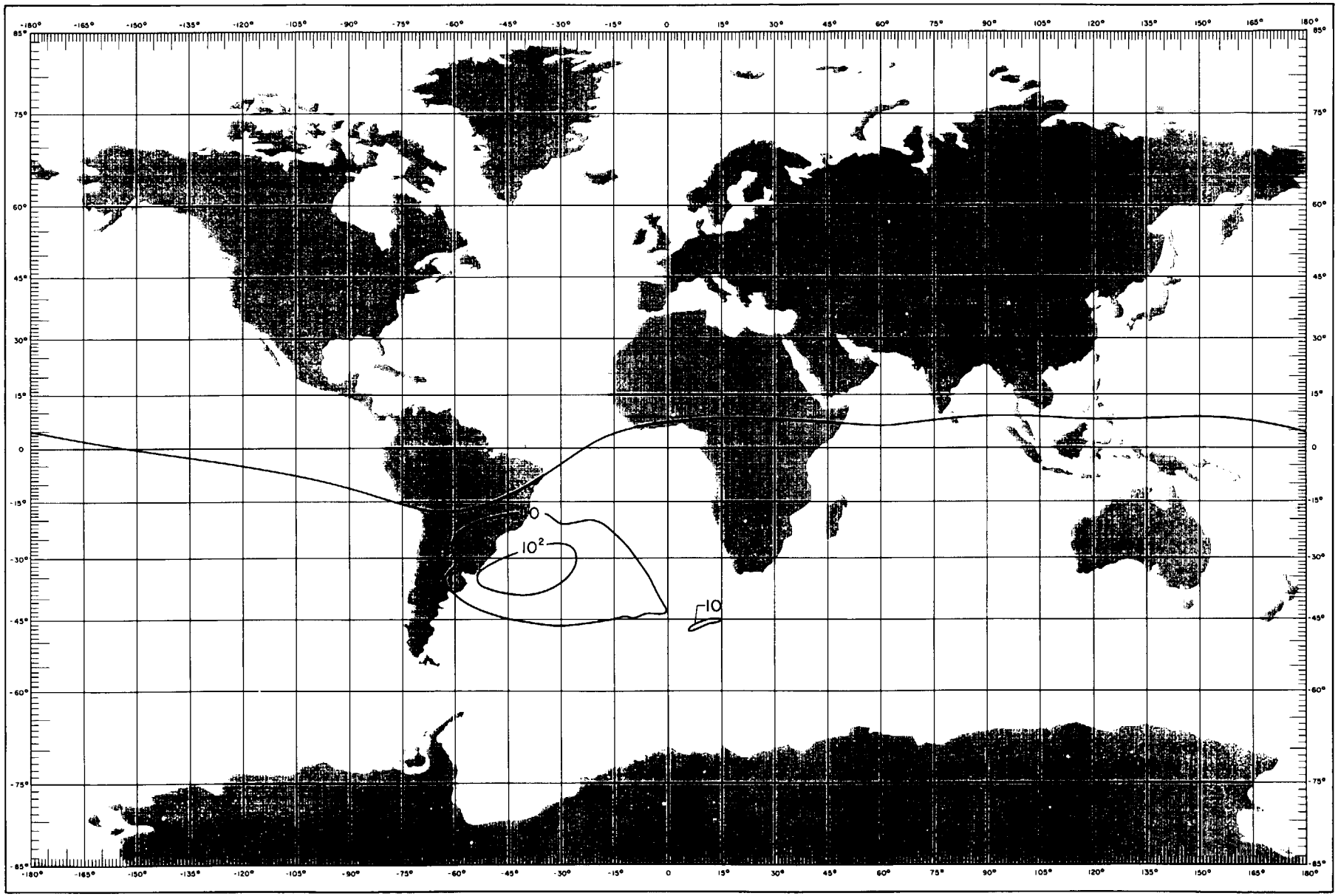
ALTITUDE = 200 KM

PROTON FLUX CONTOURS — E > 5 MEV



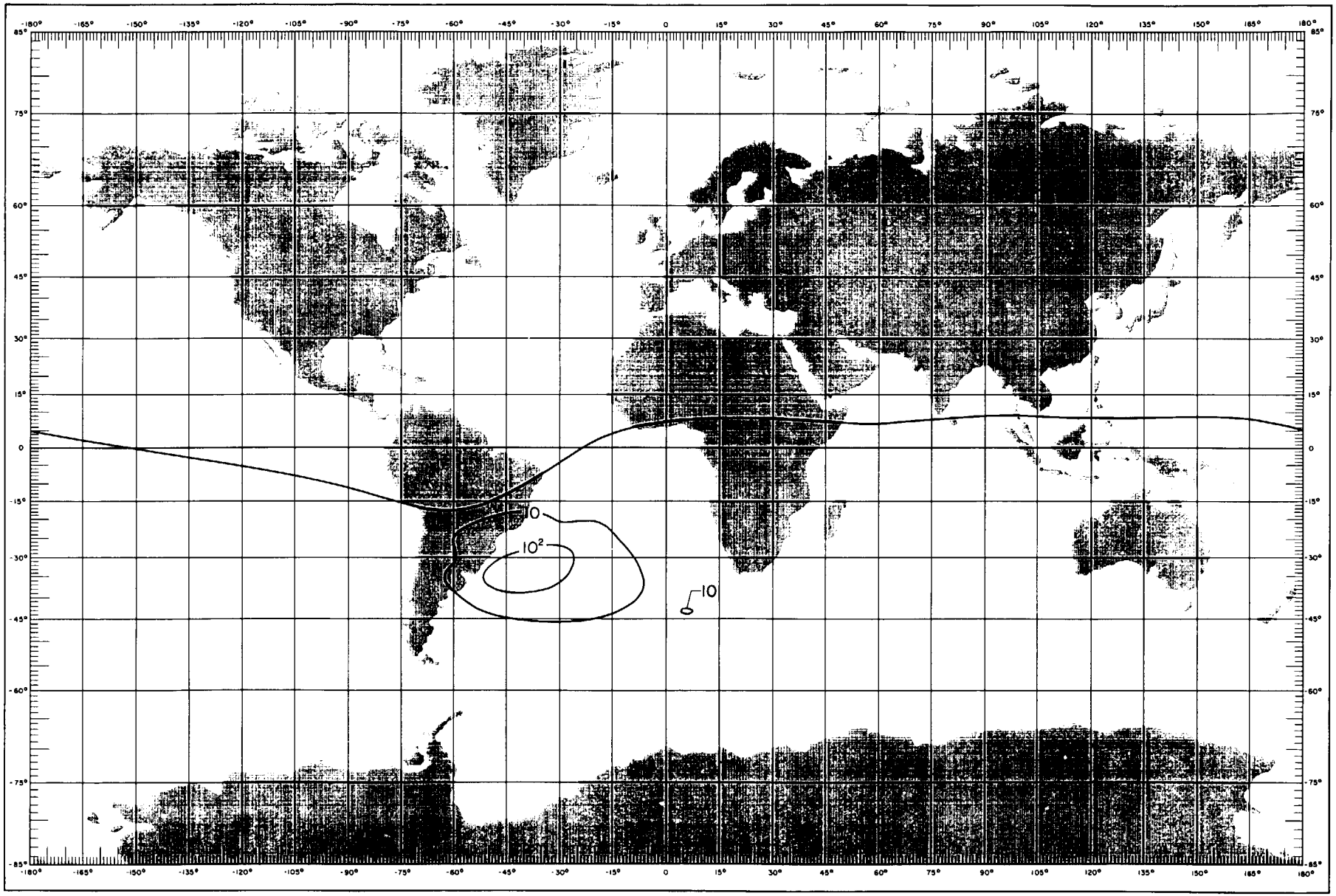
ALTITUDE = 200 KM

PROTON FLUX CONTOURS — E > 15 MEV



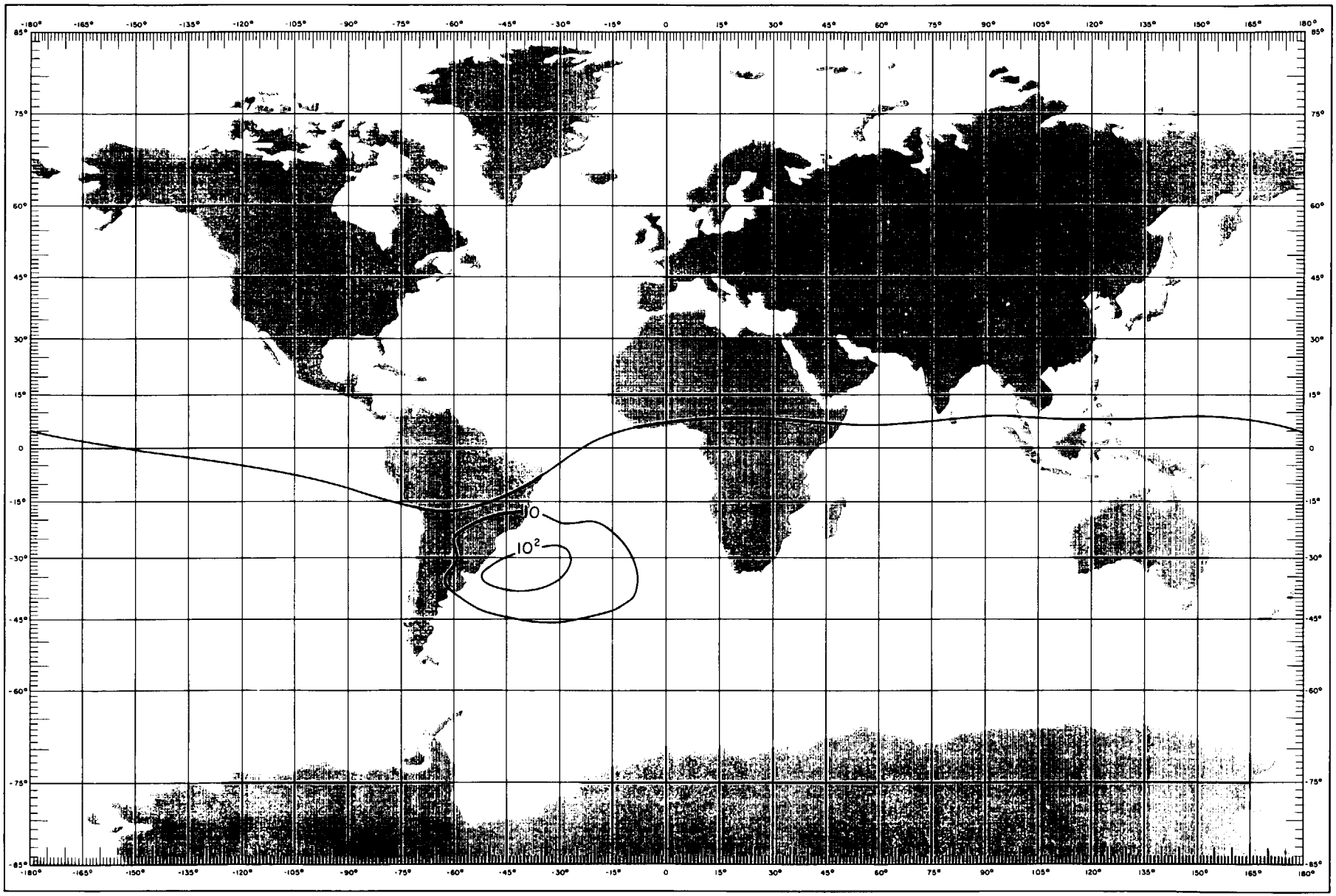
ALTITUDE = 200 KM

PROTON FLUX CONTOURS — E > 30 MEV



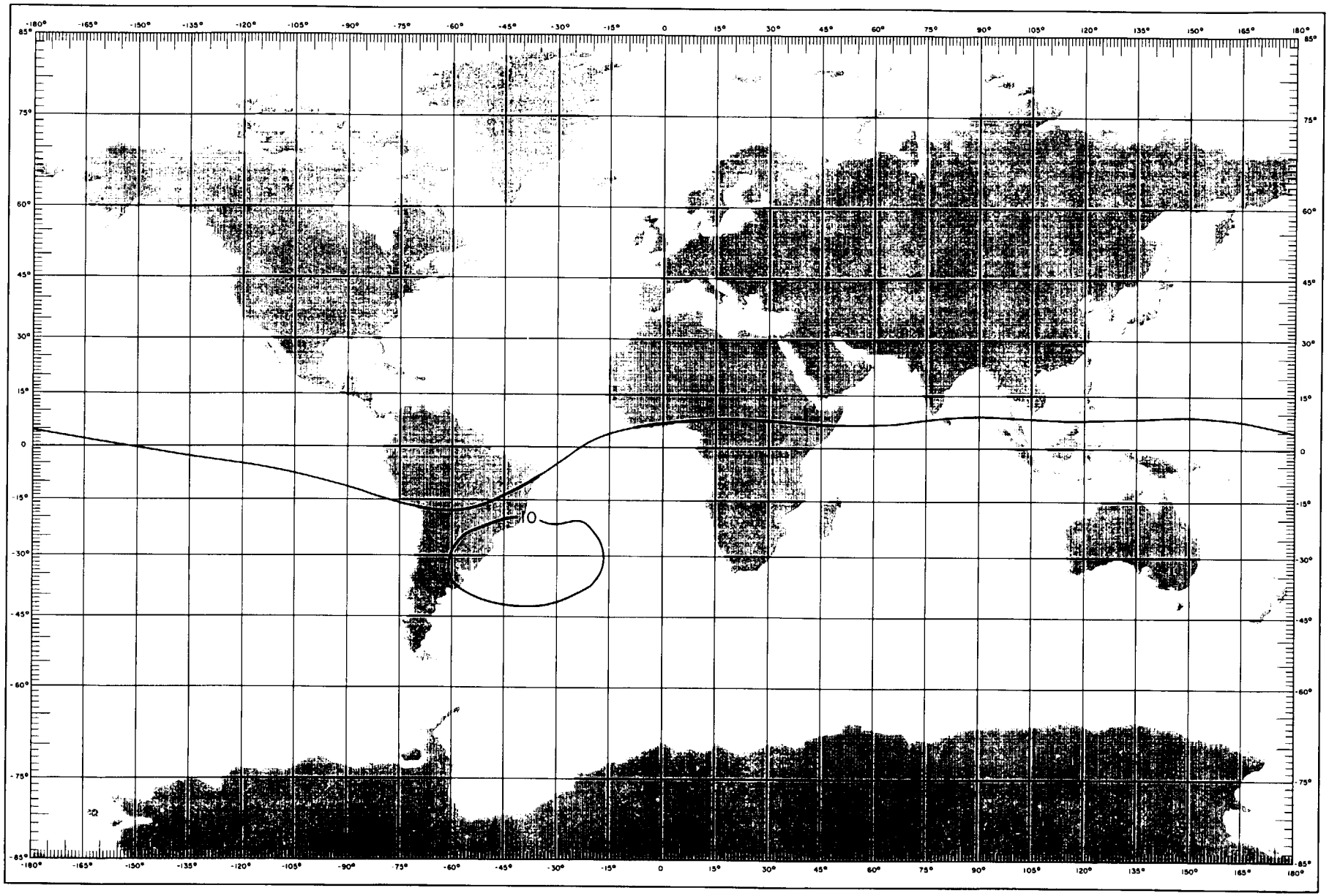
ALTITUDE = 200 KM

PROTON FLUX CONTOURS — E > 50 MEV



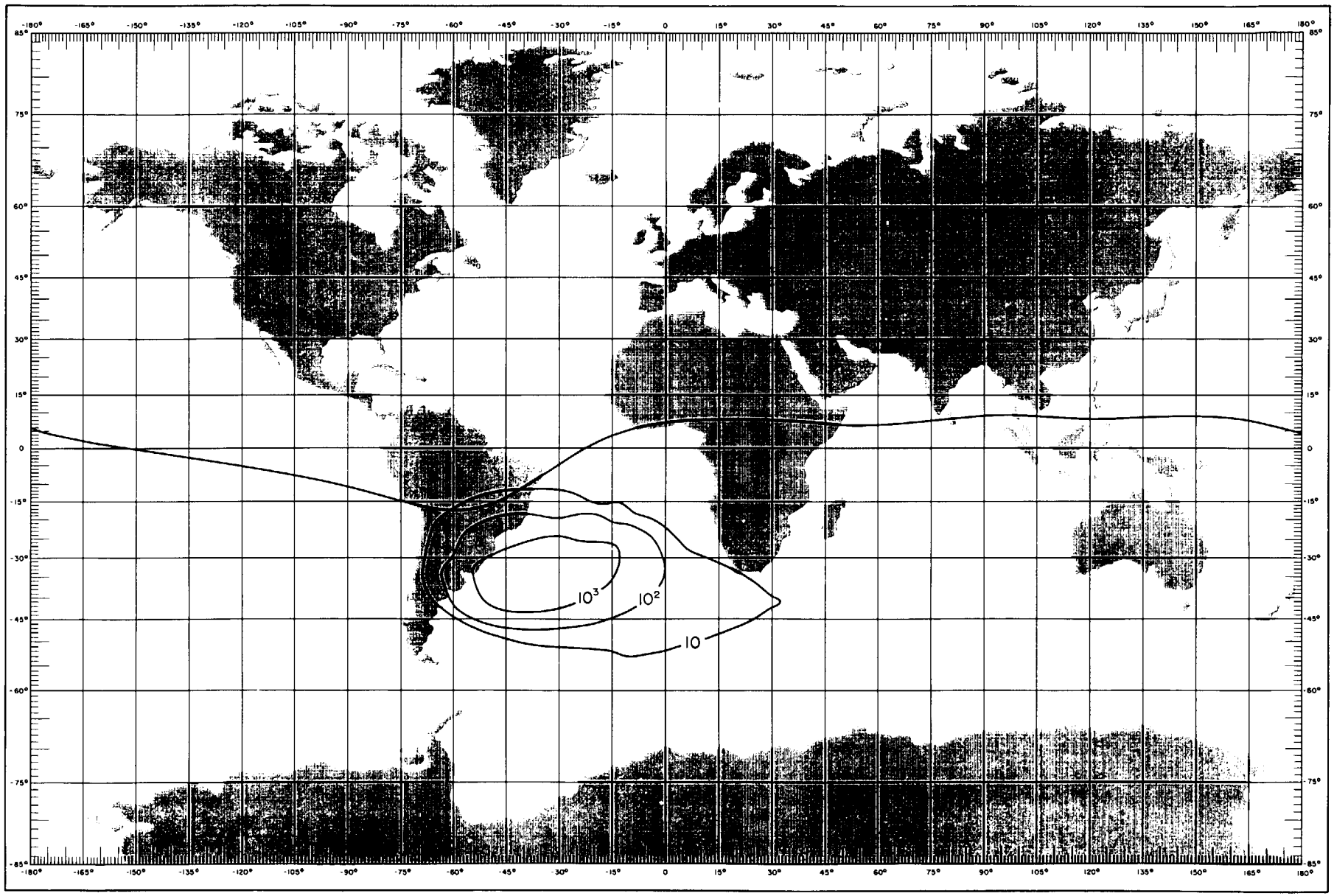
ALTITUDE = 200 KM

PROTON FLUX CONTOURS—E > 100 MEV



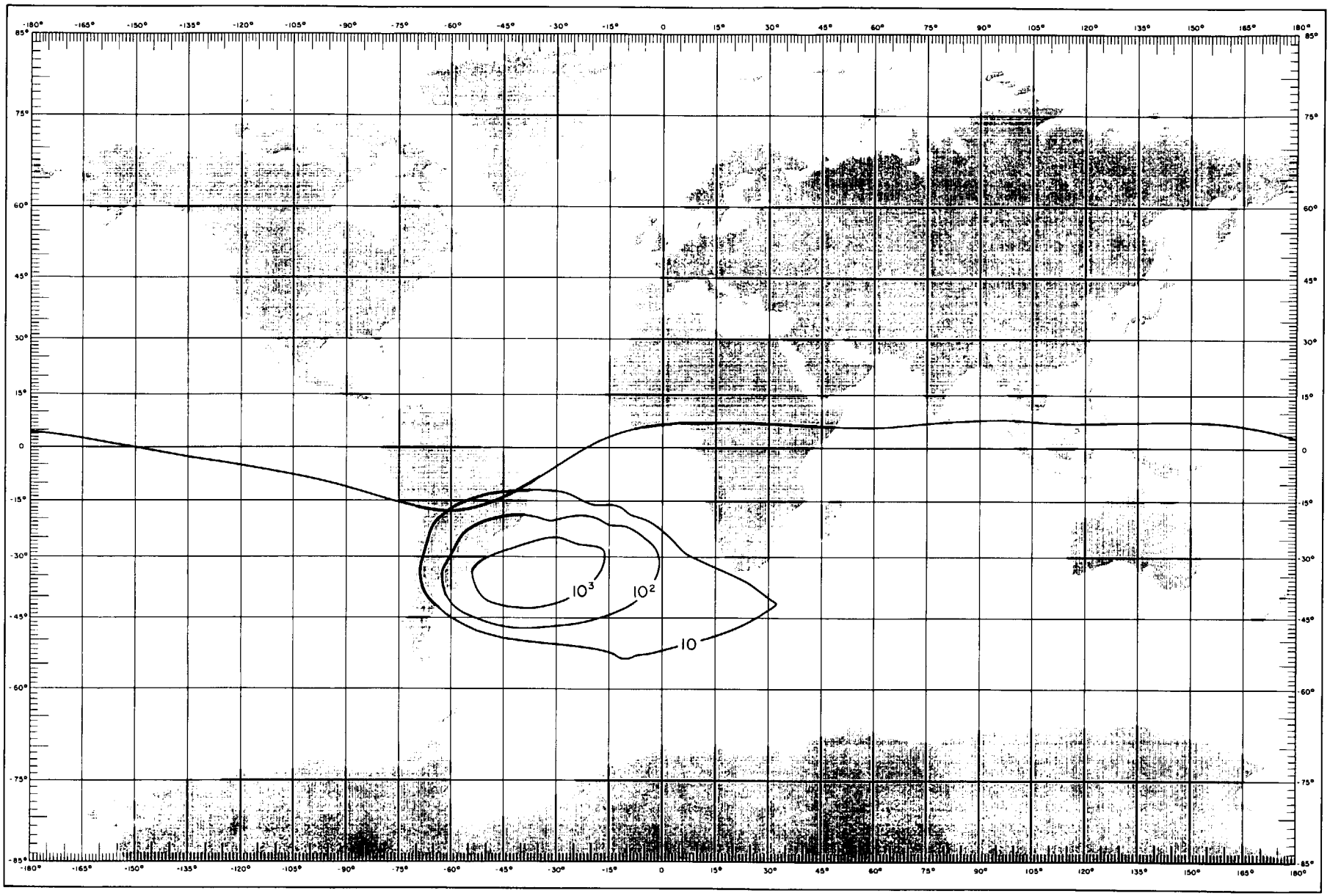
ALTITUDE = 200 KM

PROTON FLUX CONTOURS—E > 3 MEV



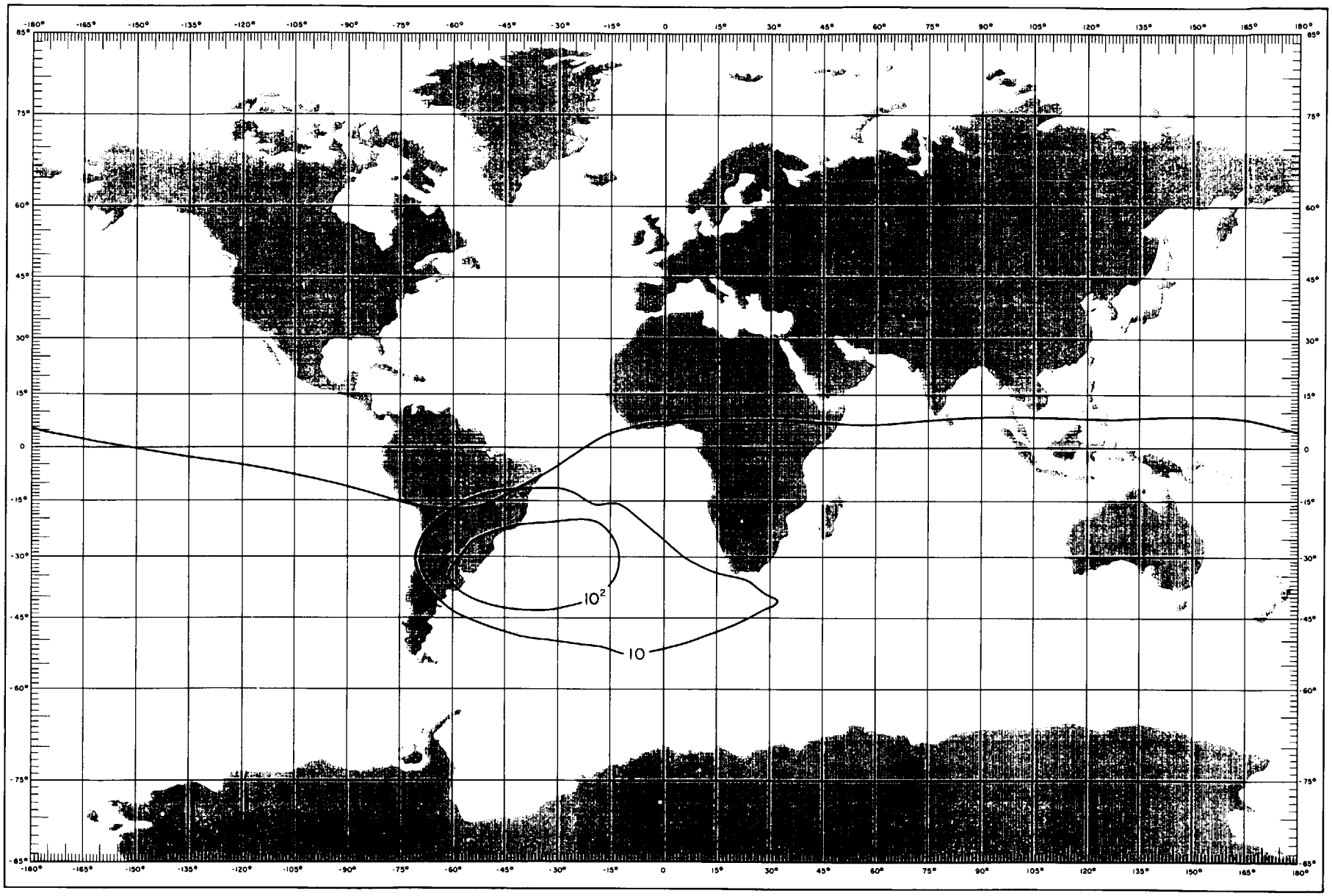
ALTITUDE = 300 KM

PROTON FLUX CONTOURS — E > 5 MEV



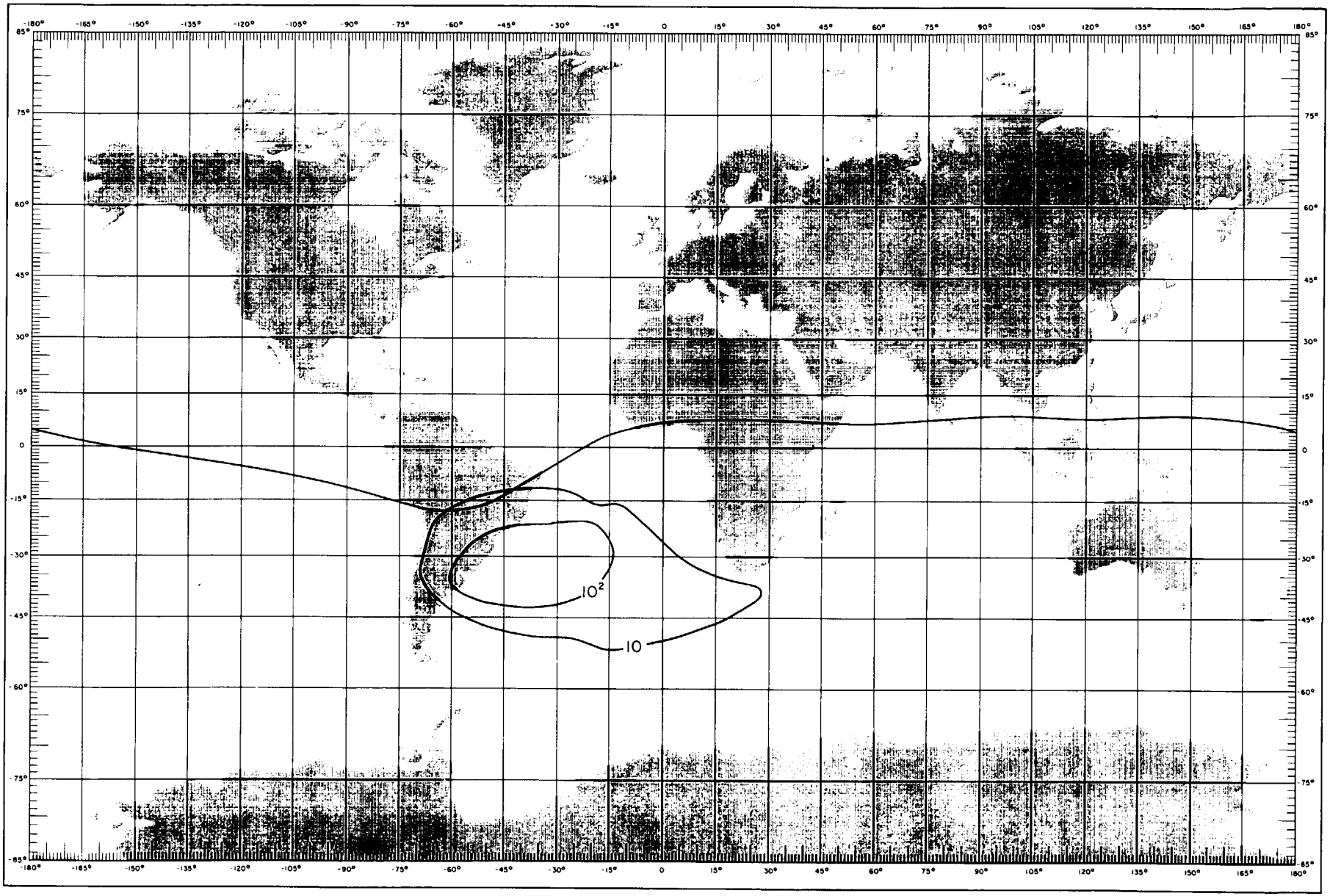
ALTITUDE = 300 KM

PROTON FLUX CONTOURS—E > 15 MEV



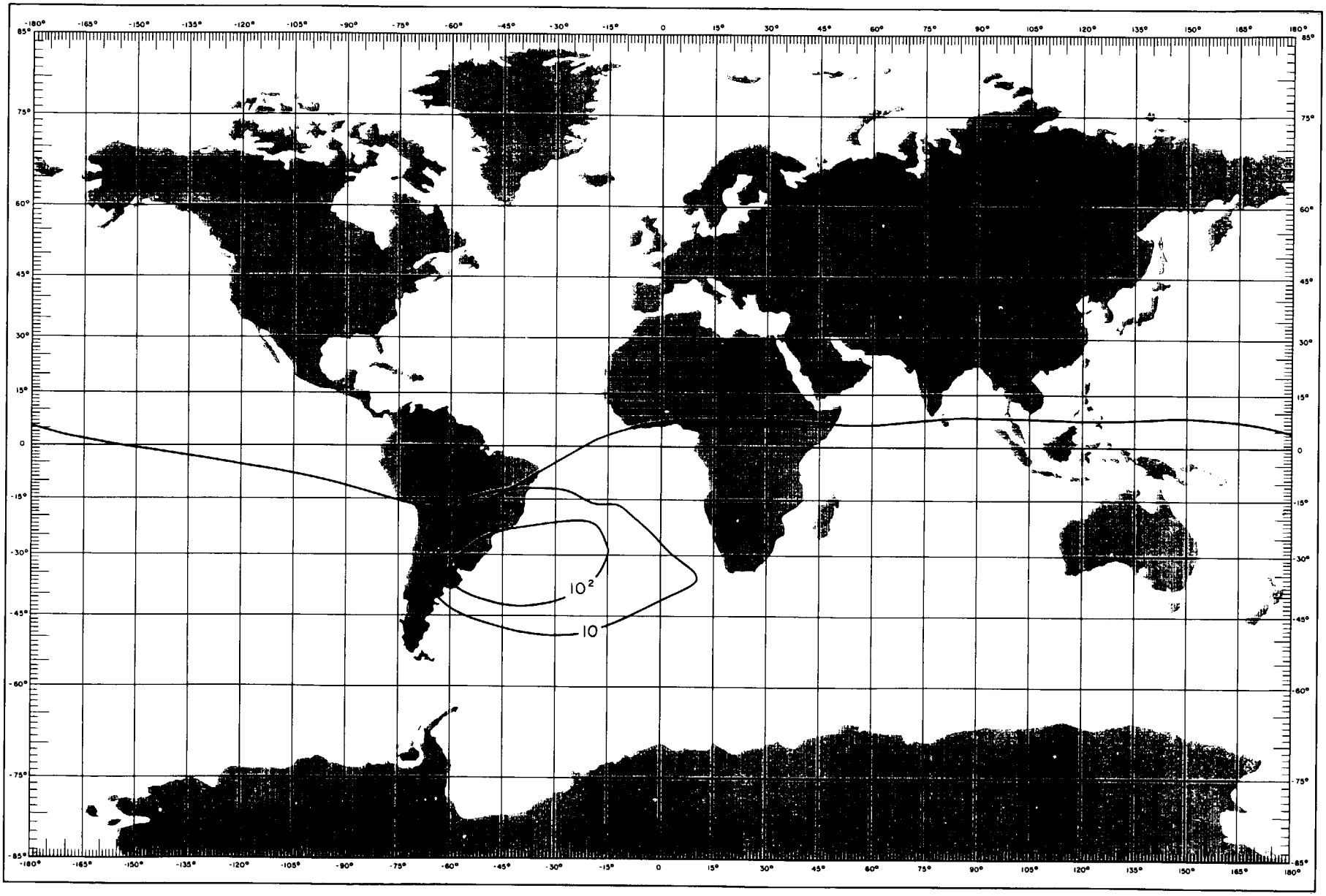
ALTITUDE = 300 KM

PROTON FLUX CONTOURS — E > 30 MEV



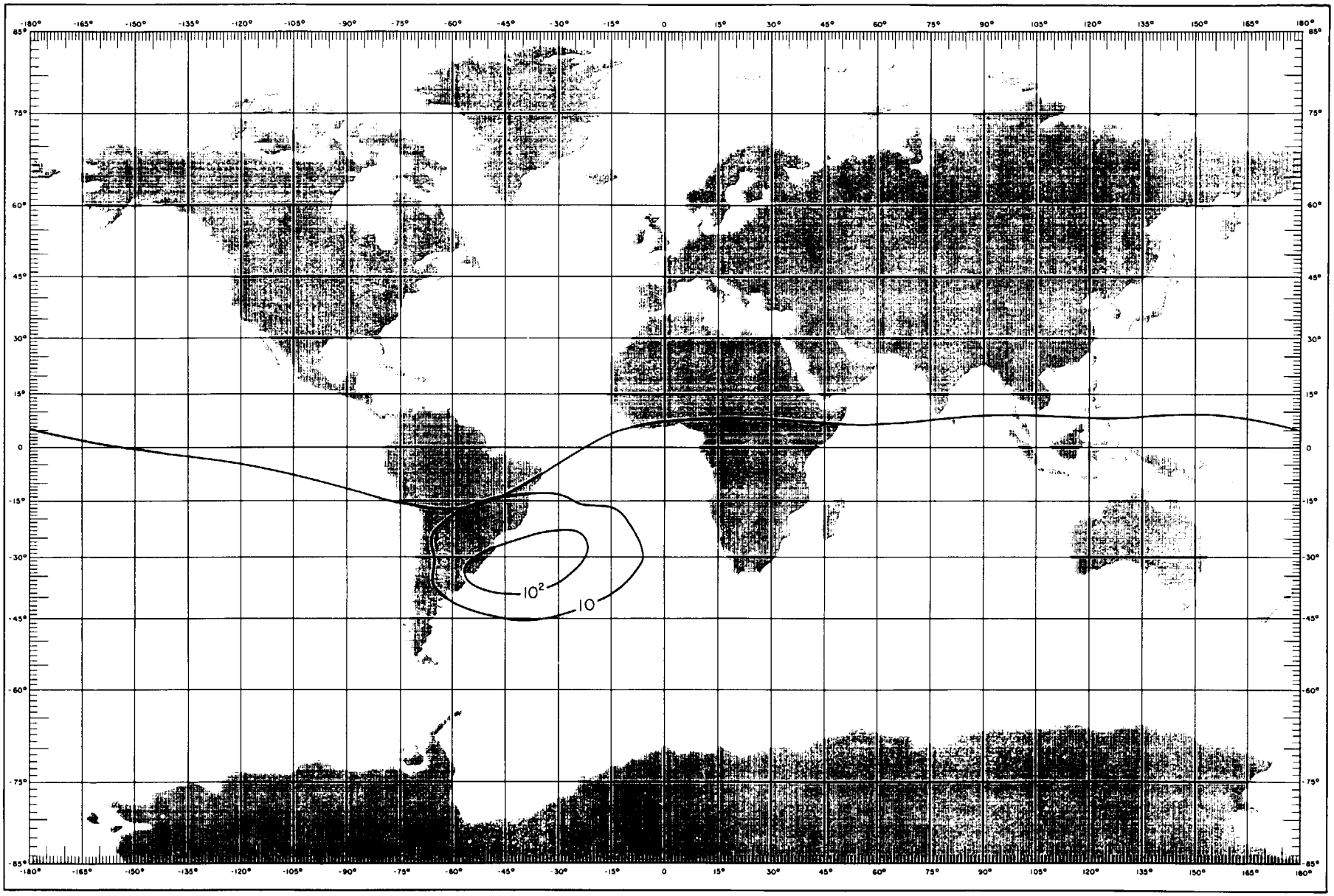
ALTITUDE = 300 KM

PROTON FLUX CONTOURS—E > 50 MEV



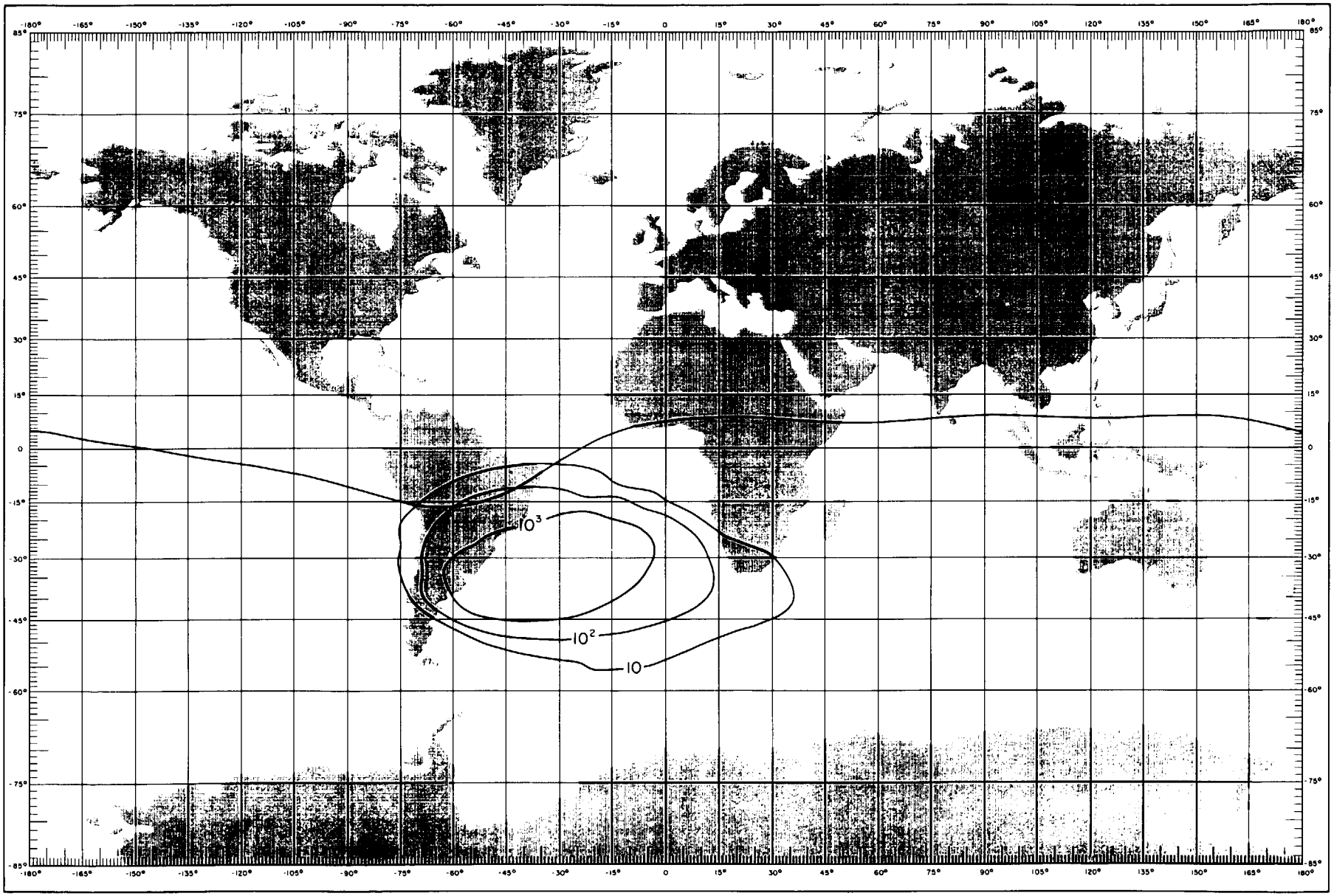
ALTITUDE = 300 KM

PROTON FLUX CONTOURS — E > 100 MEV



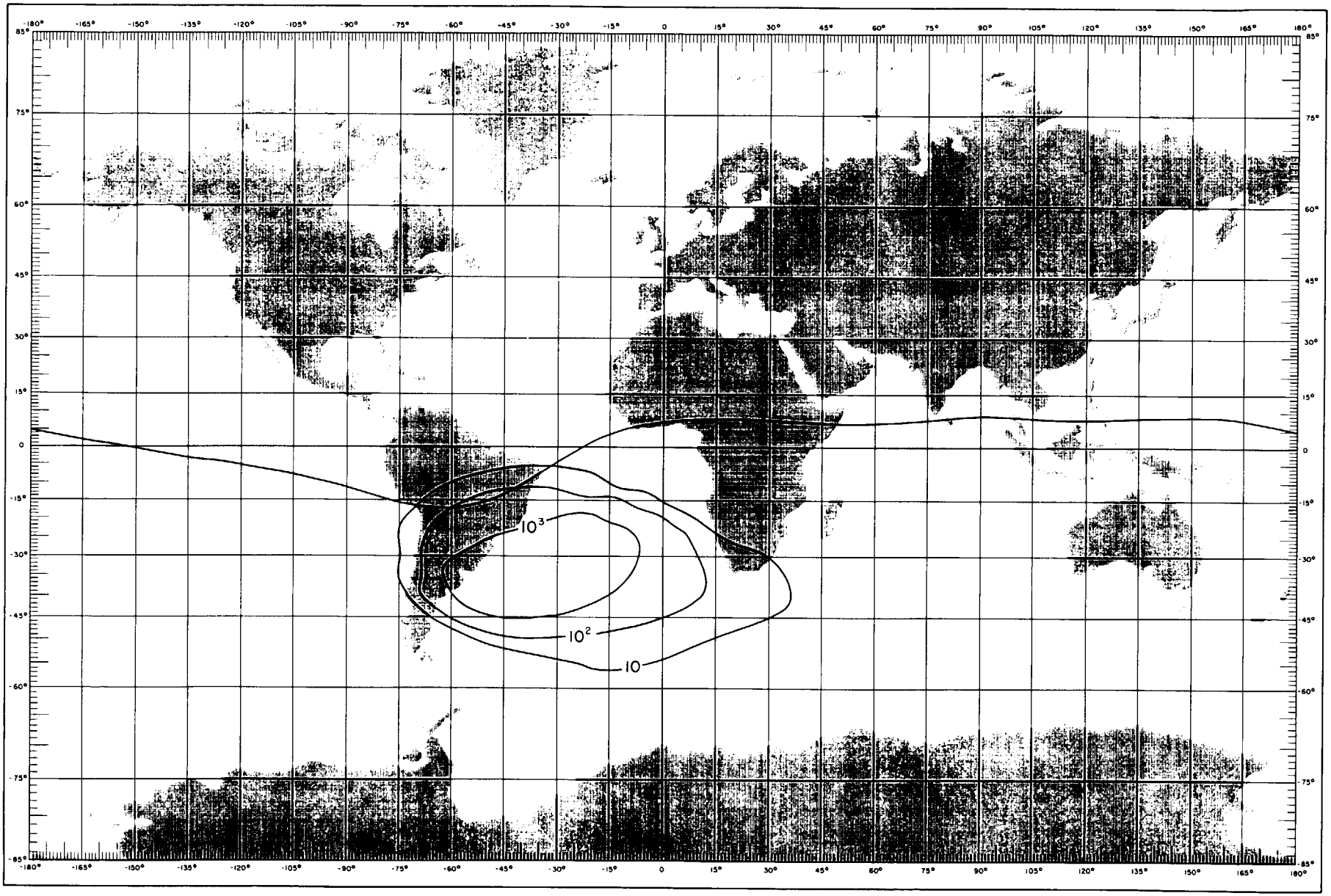
ALTITUDE = 300 KM

PROTON FLUX CONTOURS — E > 3 MEV



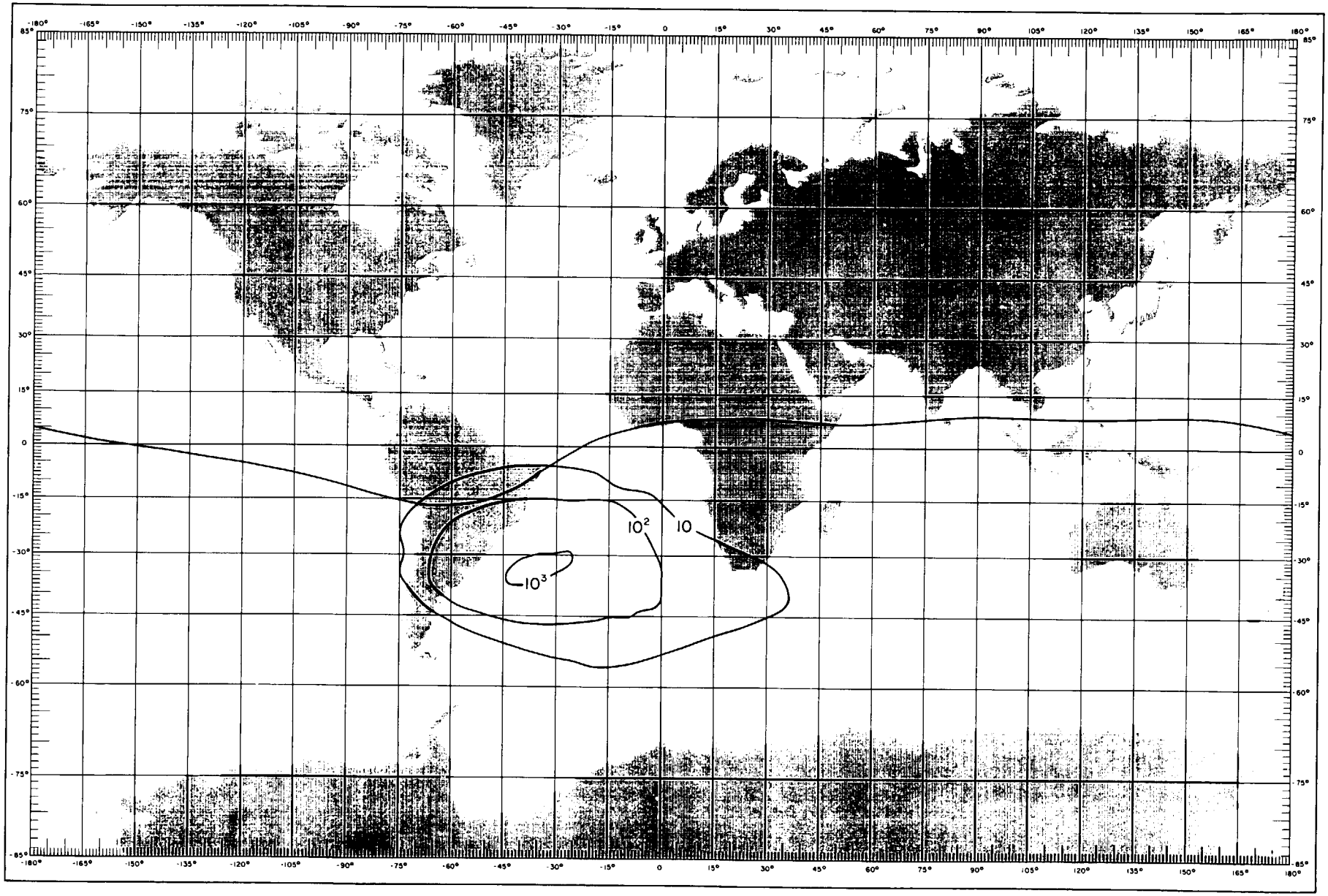
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 5 MEV



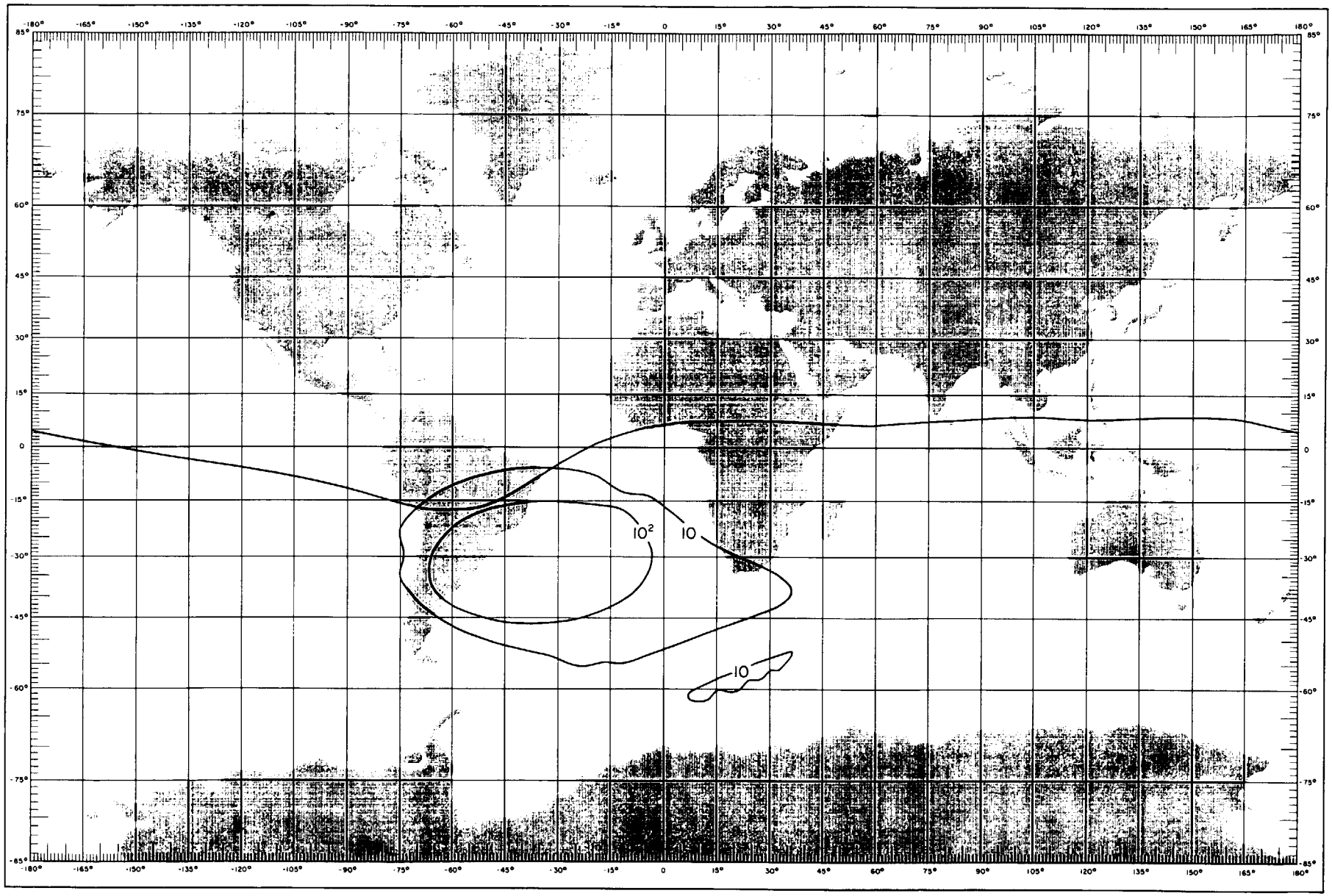
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 15 MEV



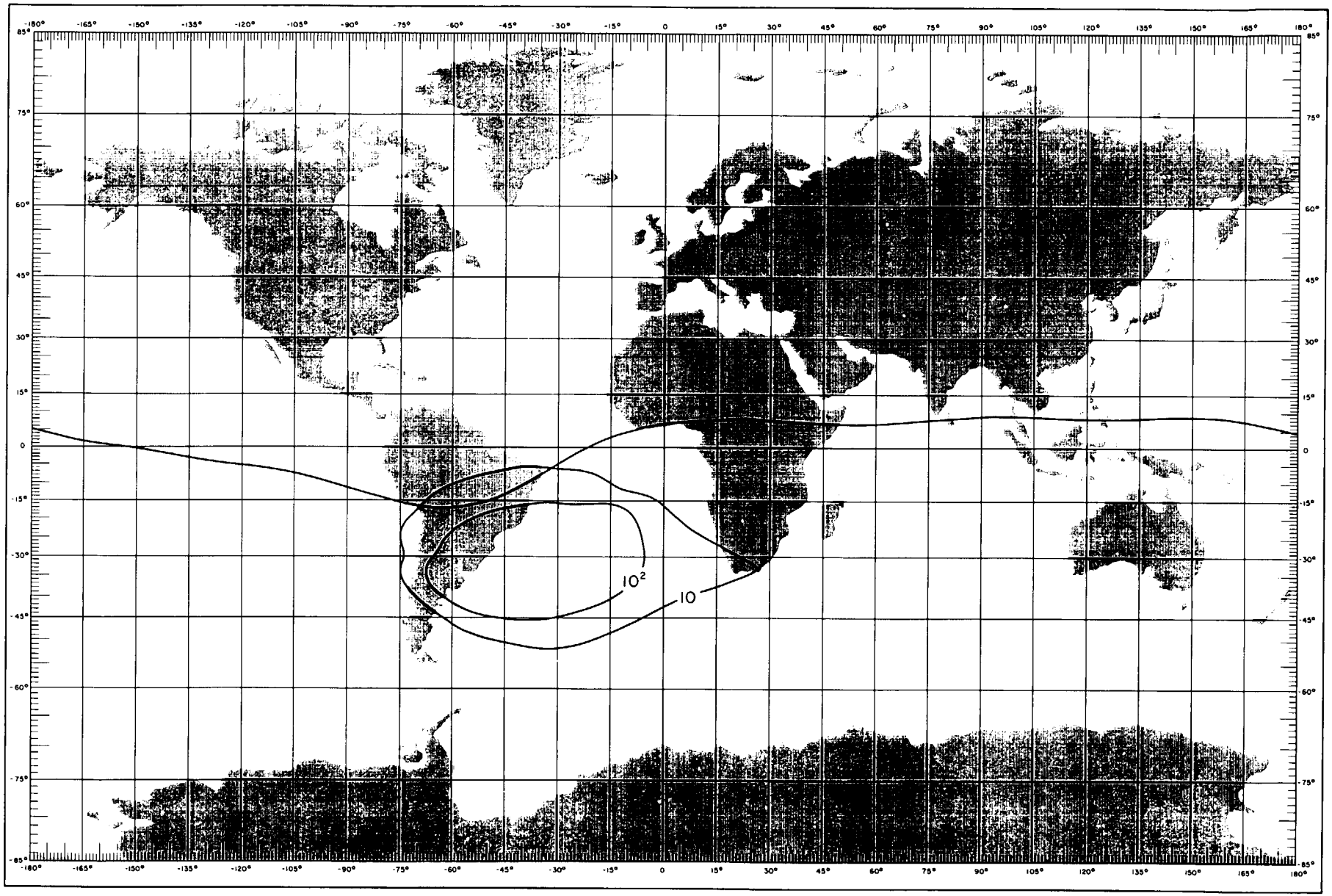
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 30 MEV



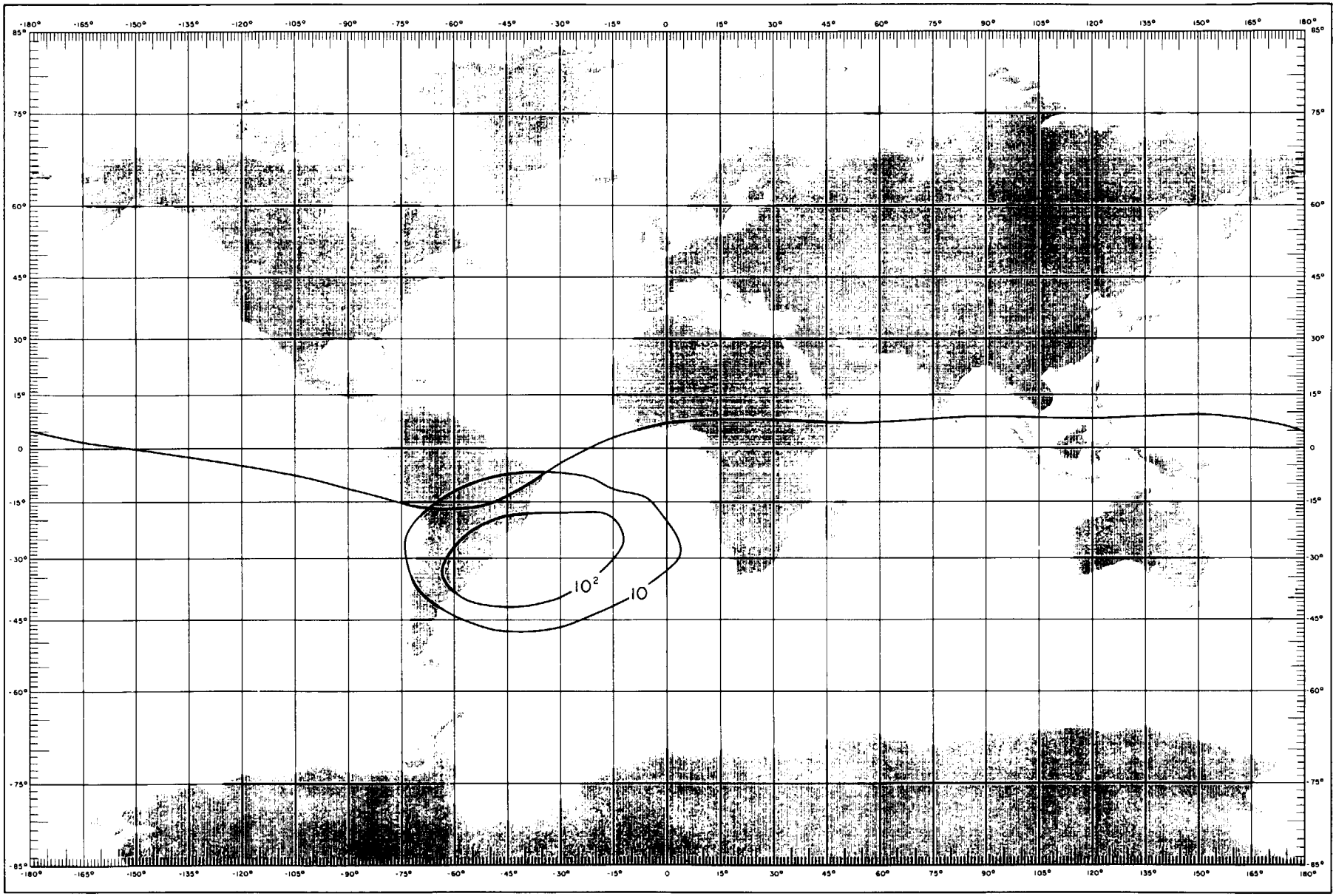
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 50 MEV



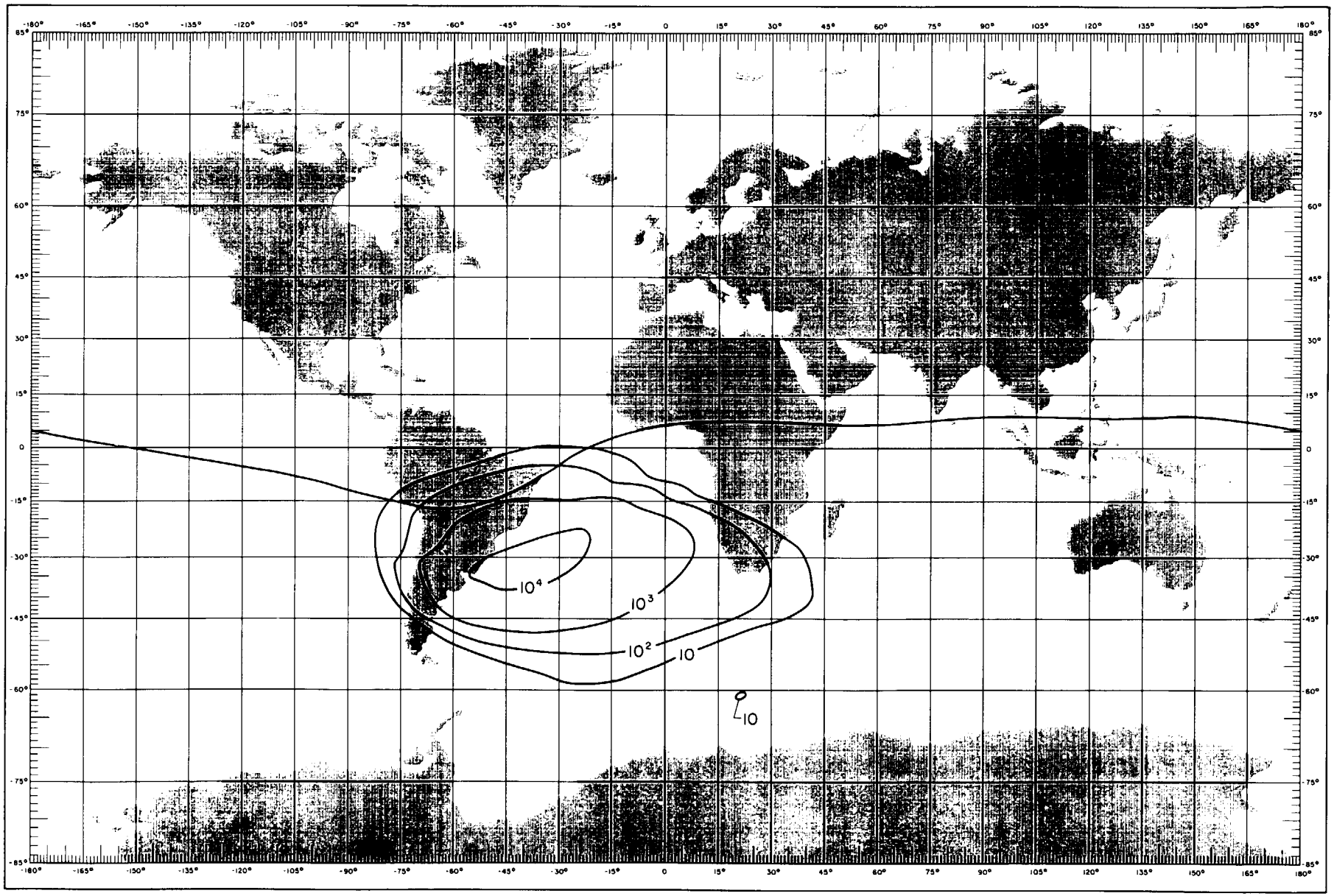
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 100 MEV



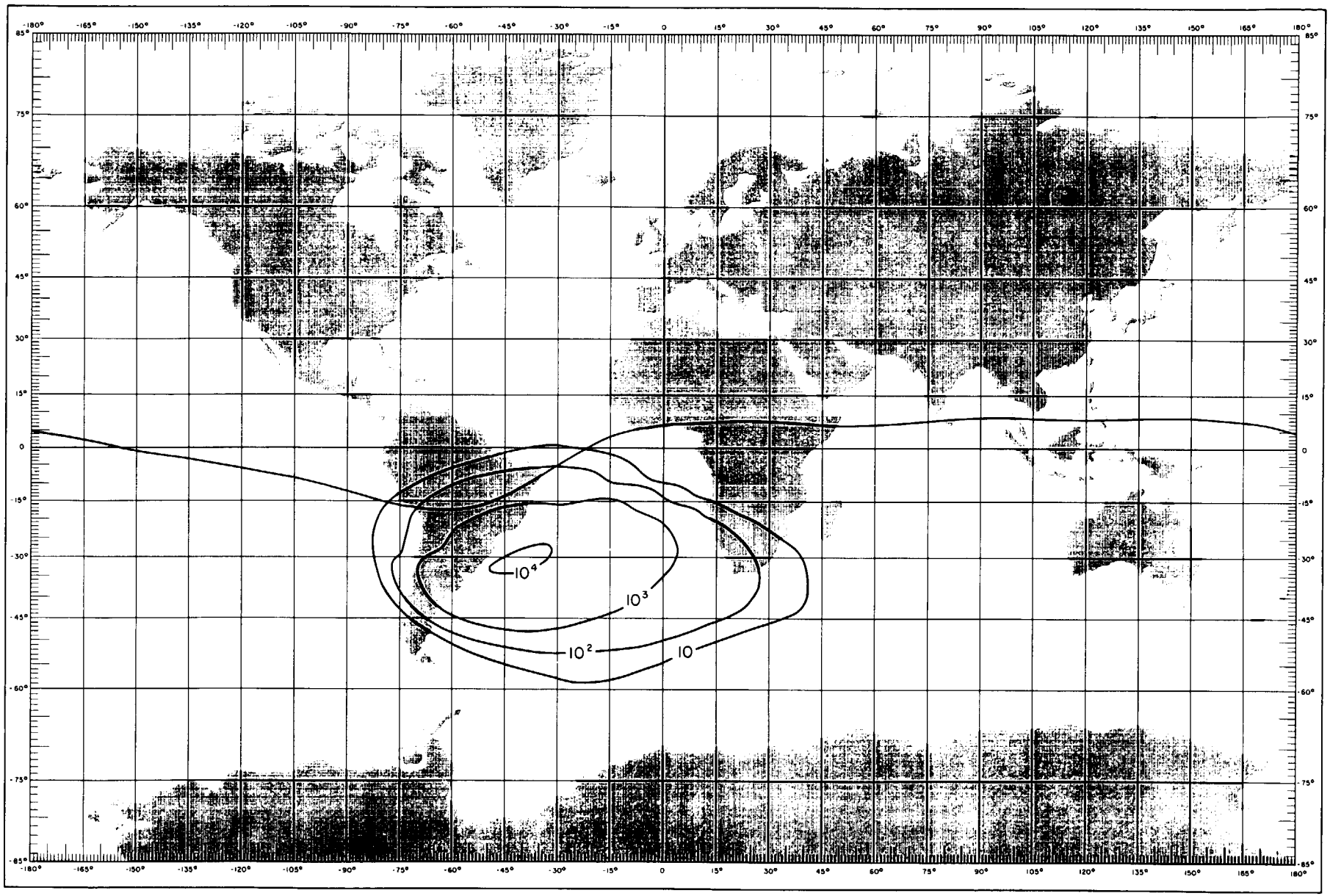
ALTITUDE = 400 KM

PROTON FLUX CONTOURS — E > 3 MEV



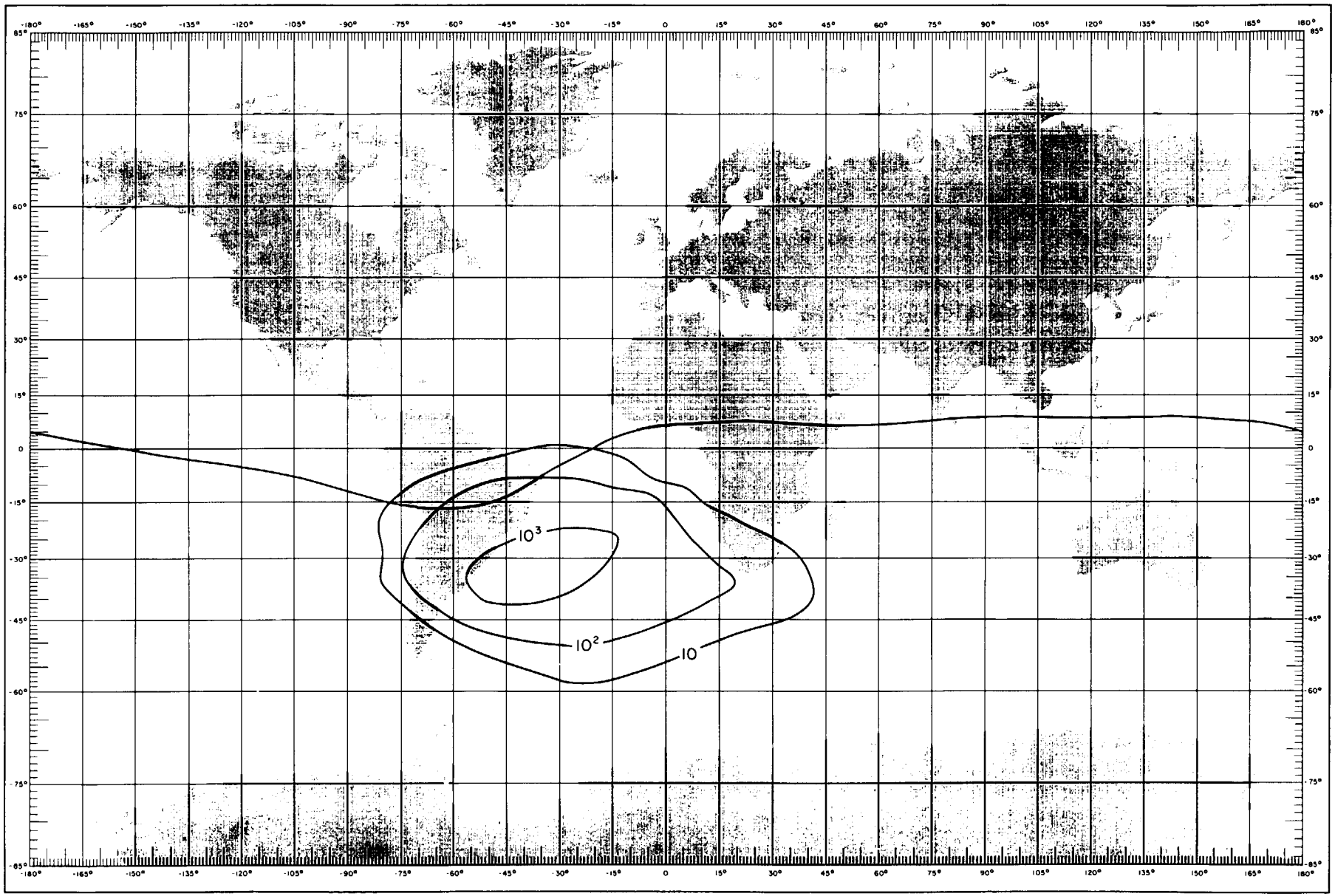
ALTITUDE = 500 KM

PROTON FLUX CONTOURS—E > 5 MEV



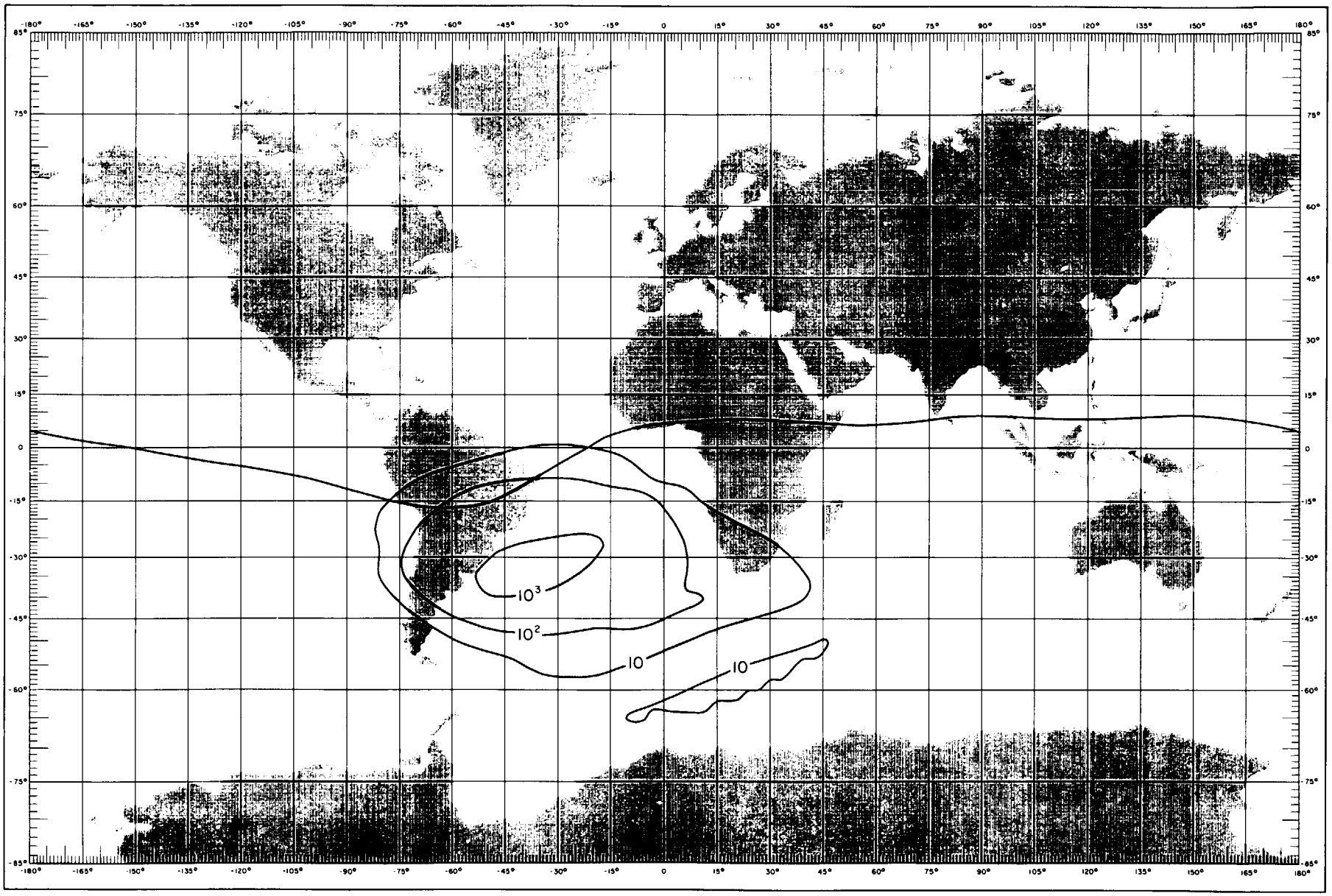
ALTITUDE = 500 KM

PROTON FLUX CONTOURS — E > 15 MEV



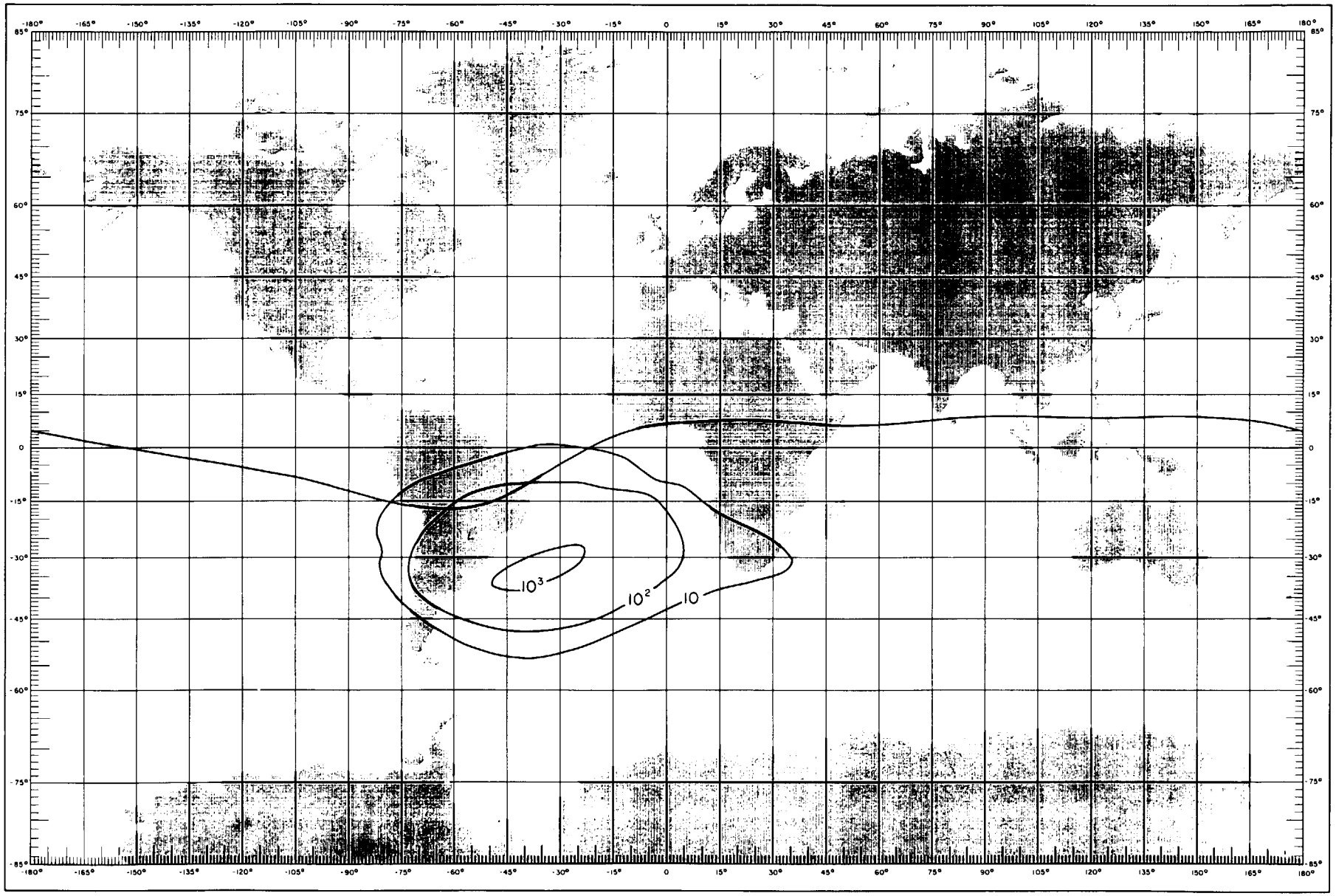
ALTITUDE = 500 KM

PROTON FLUX CONTOURS — E > 30 MEV



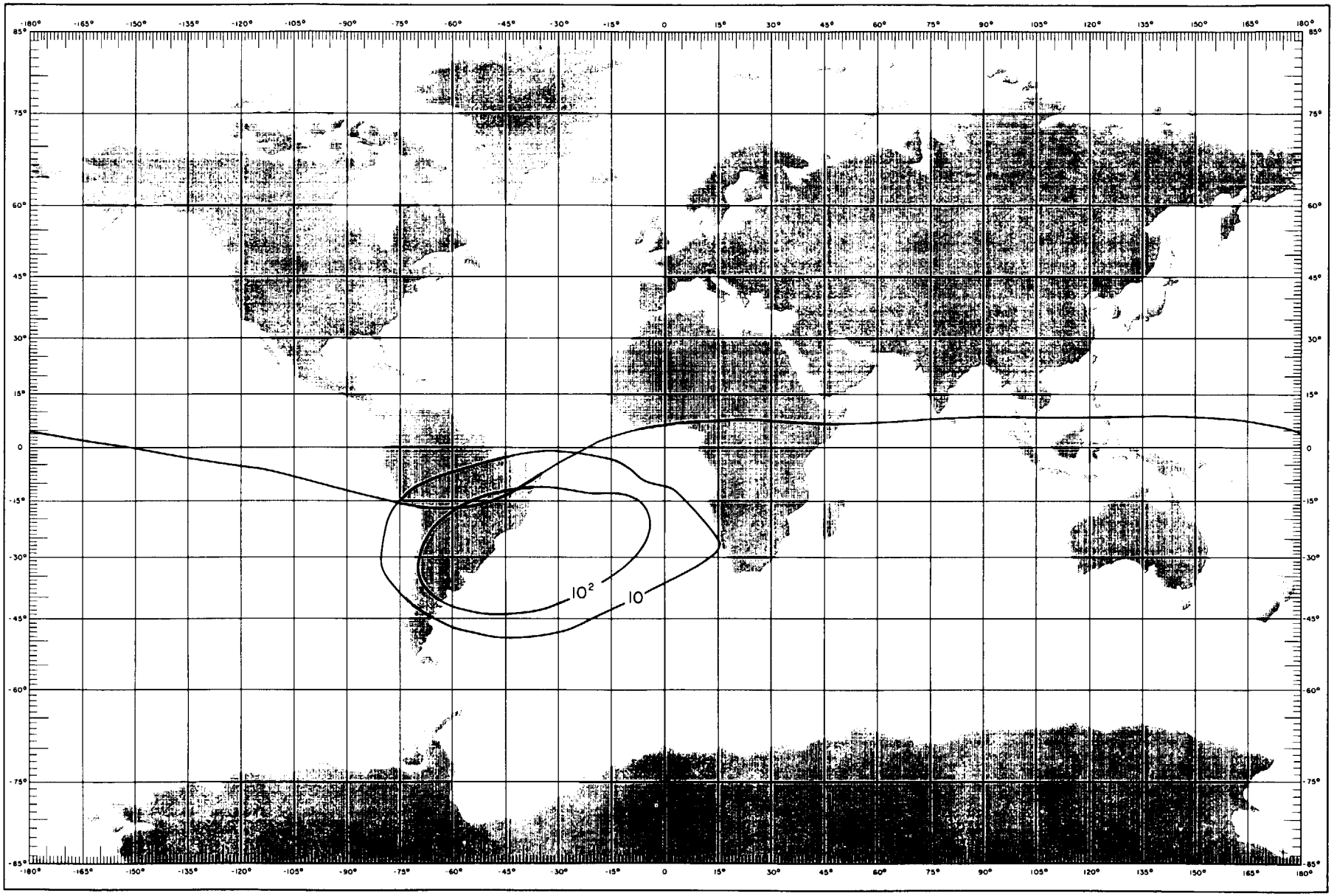
ALTITUDE = 500 KM

PROTON FLUX CONTOURS — E > 50 MEV



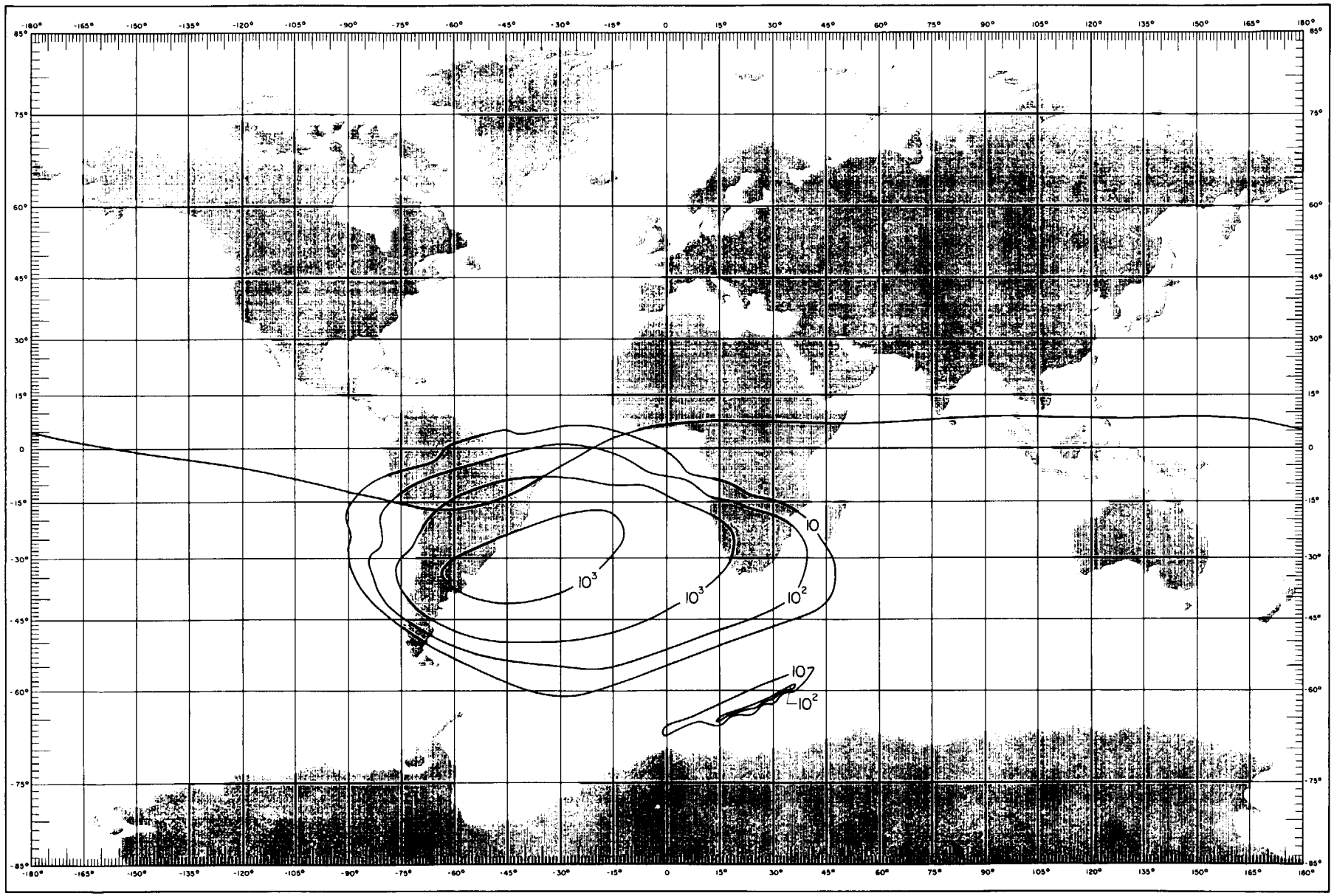
ALTITUDE = 500 KM

PROTON FLUX CONTOURS — E > 100 MEV



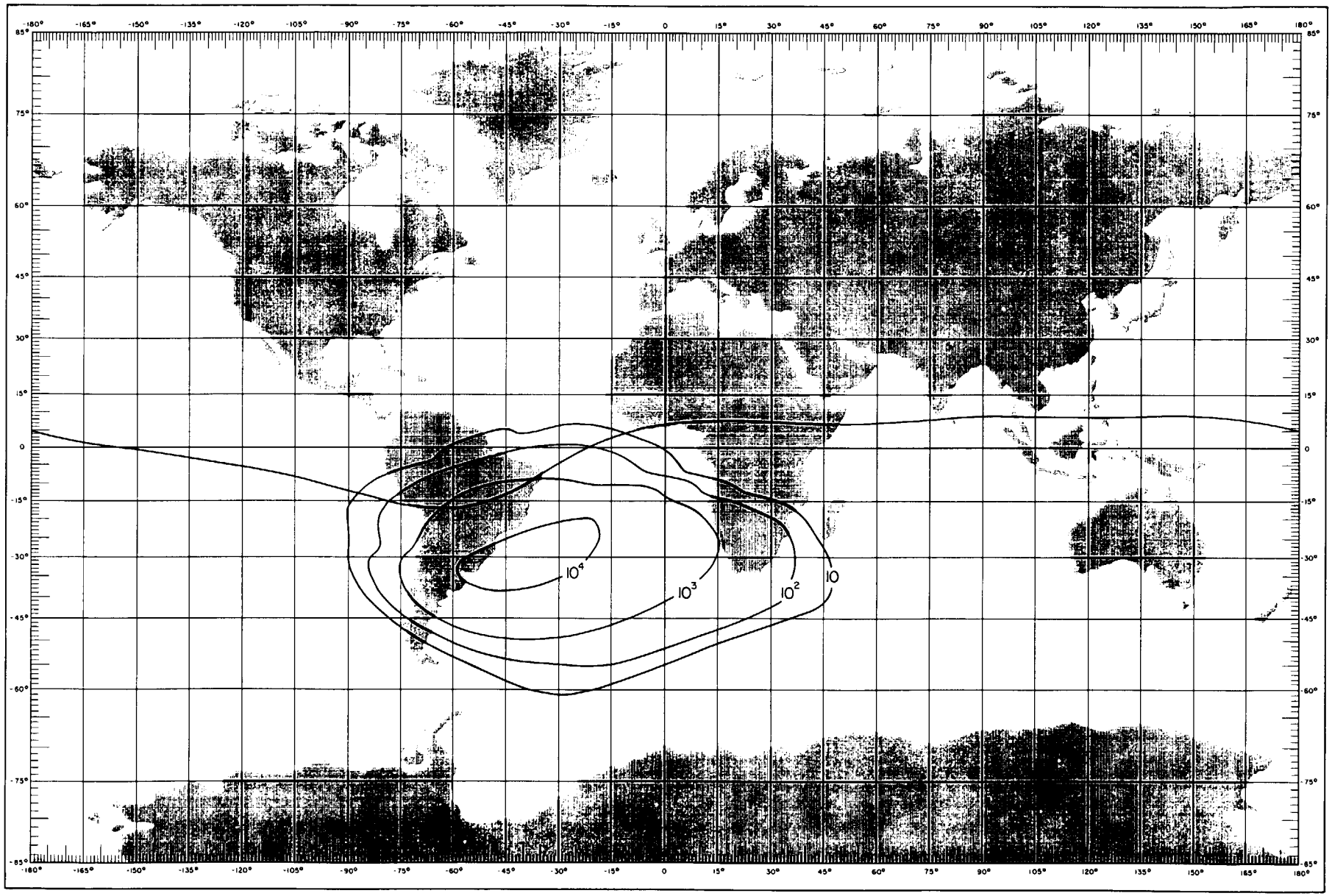
ALTITUDE = 500 KM

PROTON FLUX CONTOURS — E > 3 MEV



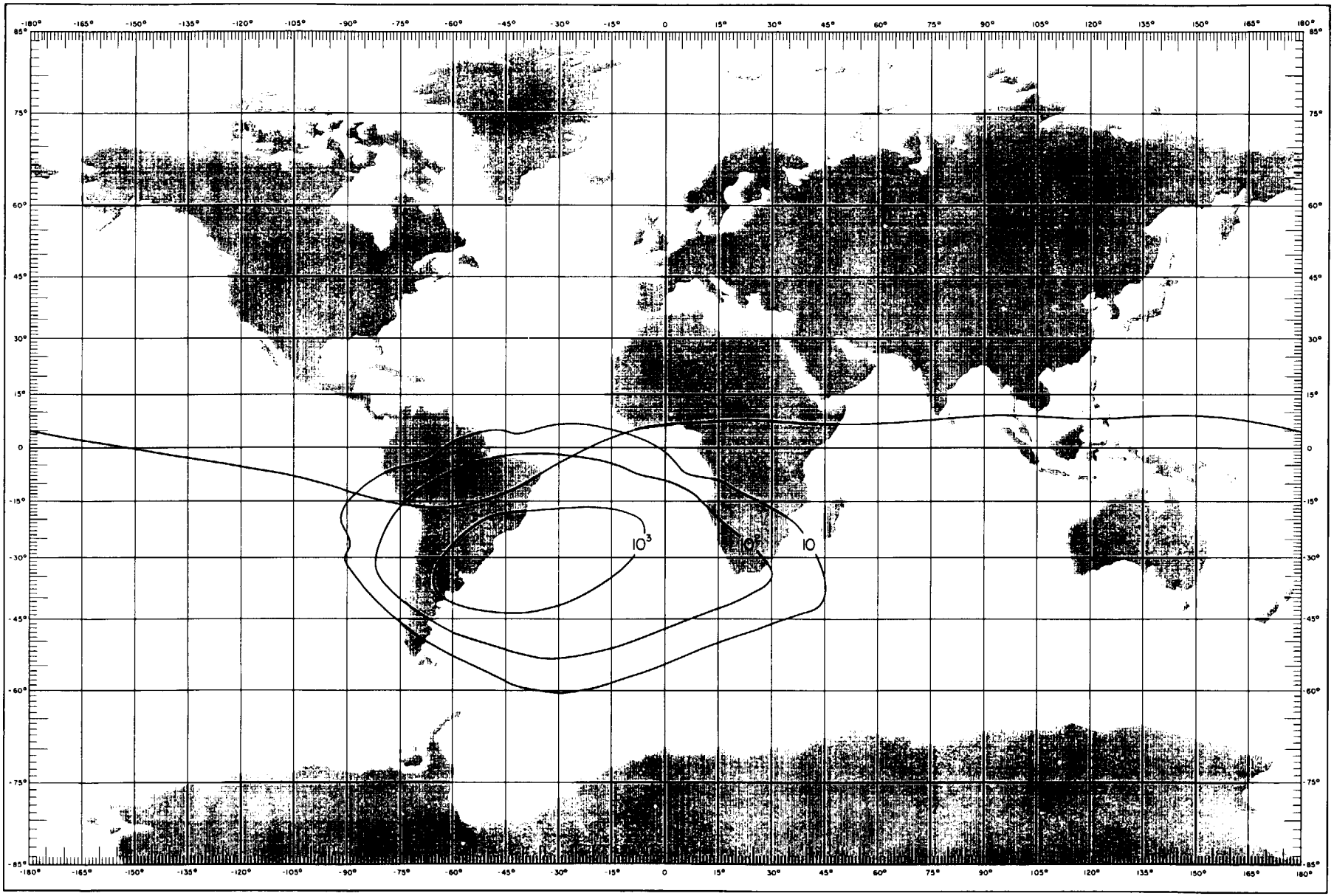
ALTITUDE = 600 KM

PROTON FLUX CONTOURS—E > 5 MEV



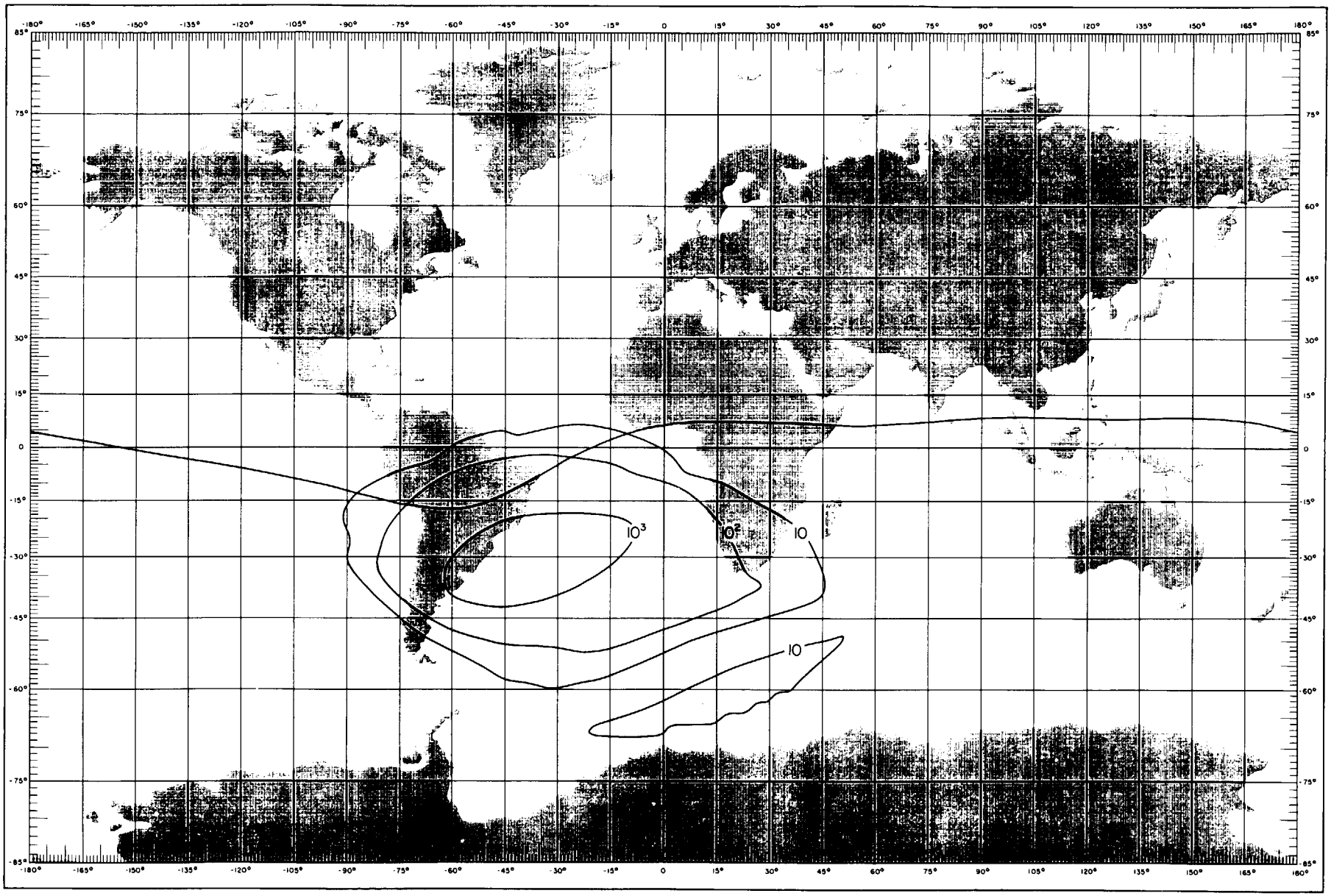
ALTITUDE=600 KM

PROTON FLUX CONTOURS — E > 15 MEV



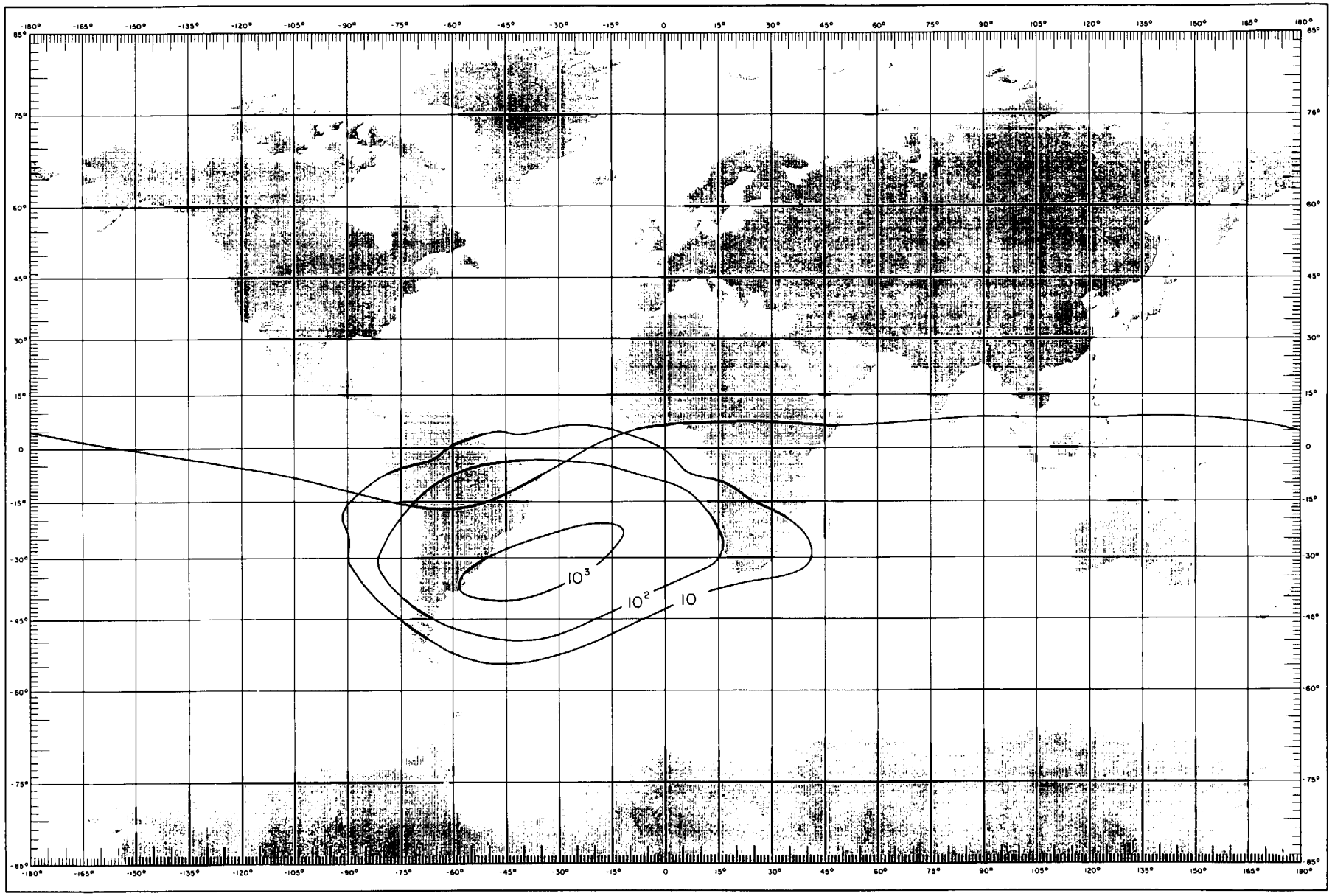
ALTITUDE = 600 KM

PROTON FLUX CONTOURS — E > 30 MEV



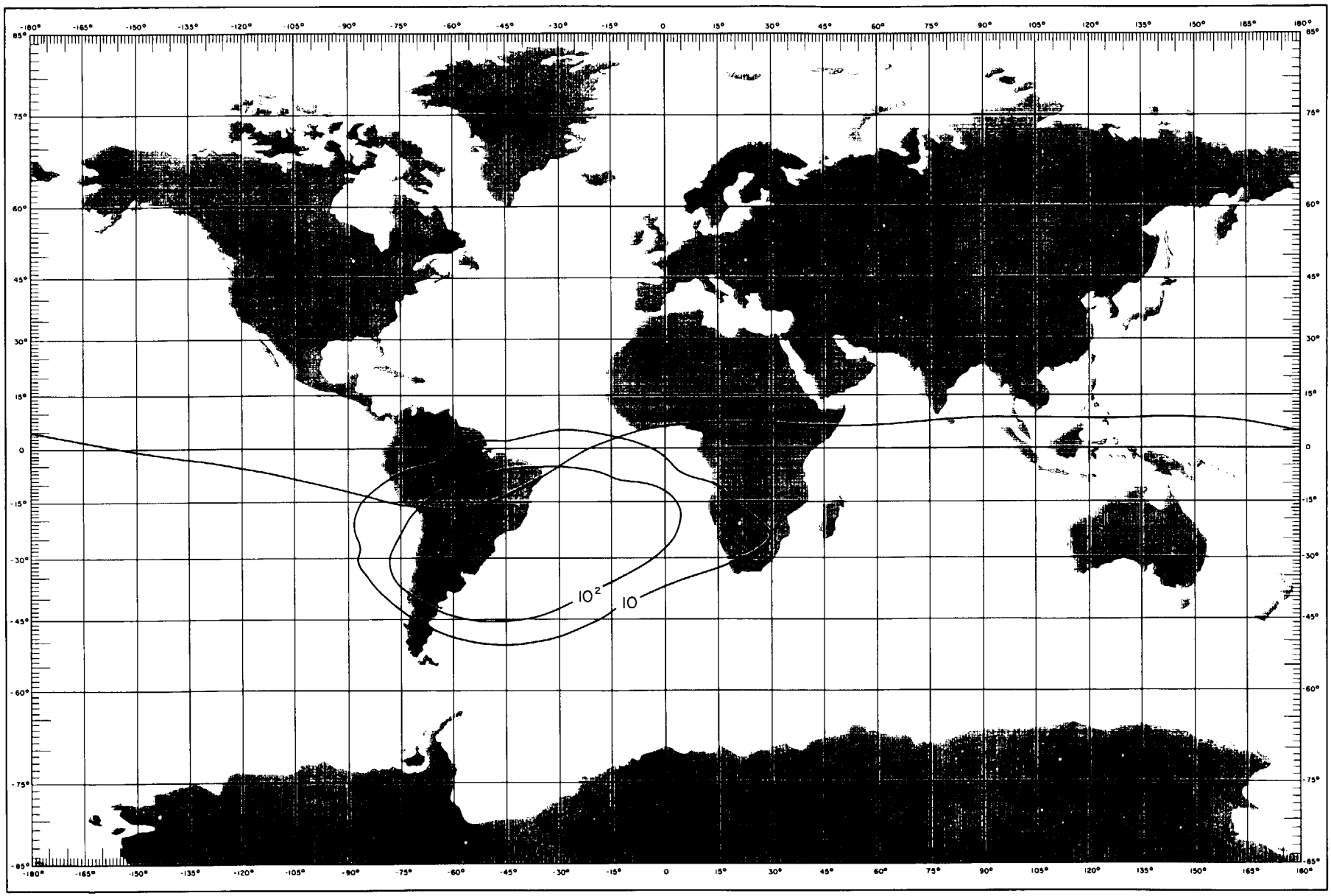
ALTITUDE = 600 KM

PROTON FLUX CONTOURS — E > 50 MEV



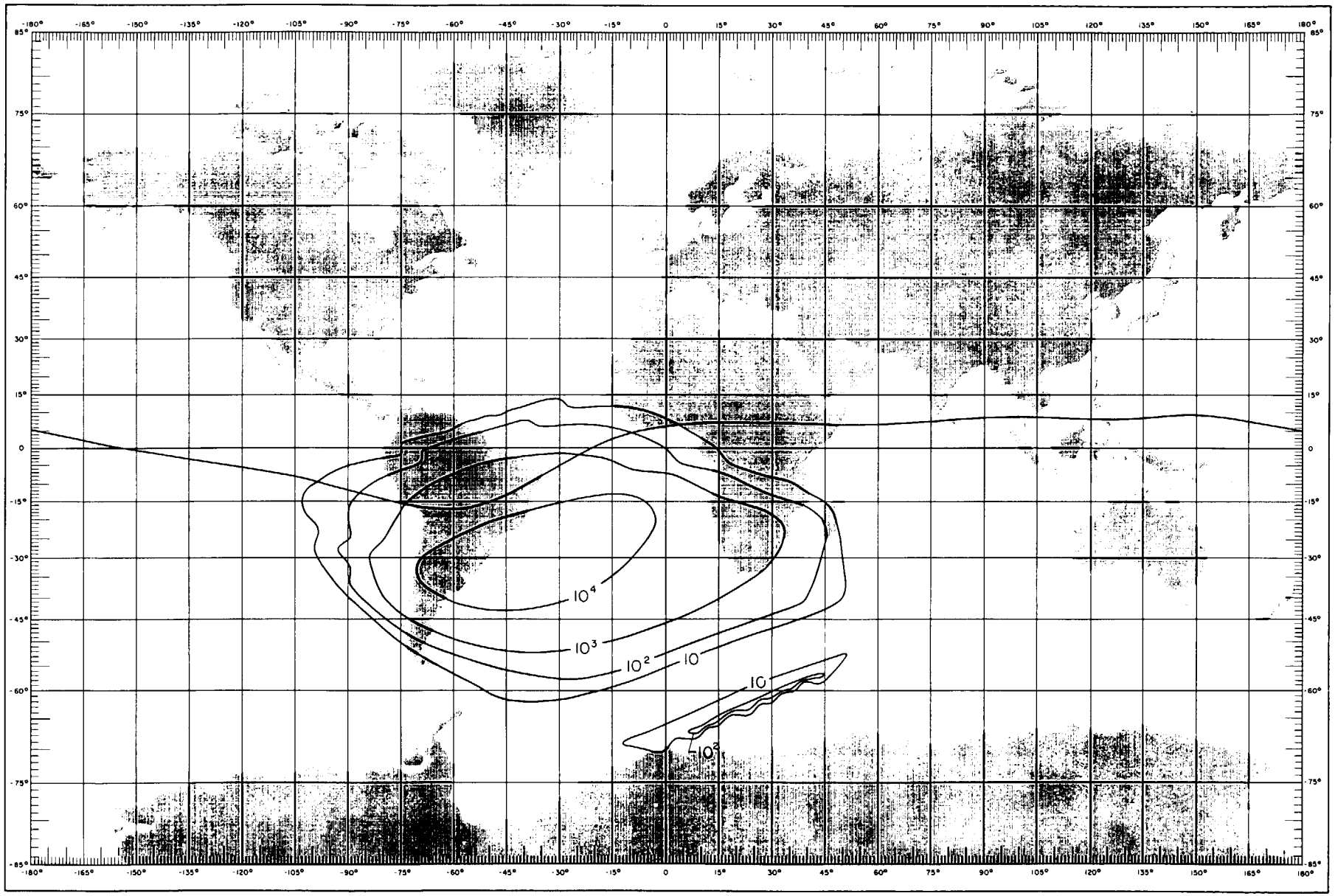
ALTITUDE = 600 KM

PROTON FLUX CONTOURS — E > 100 MEV



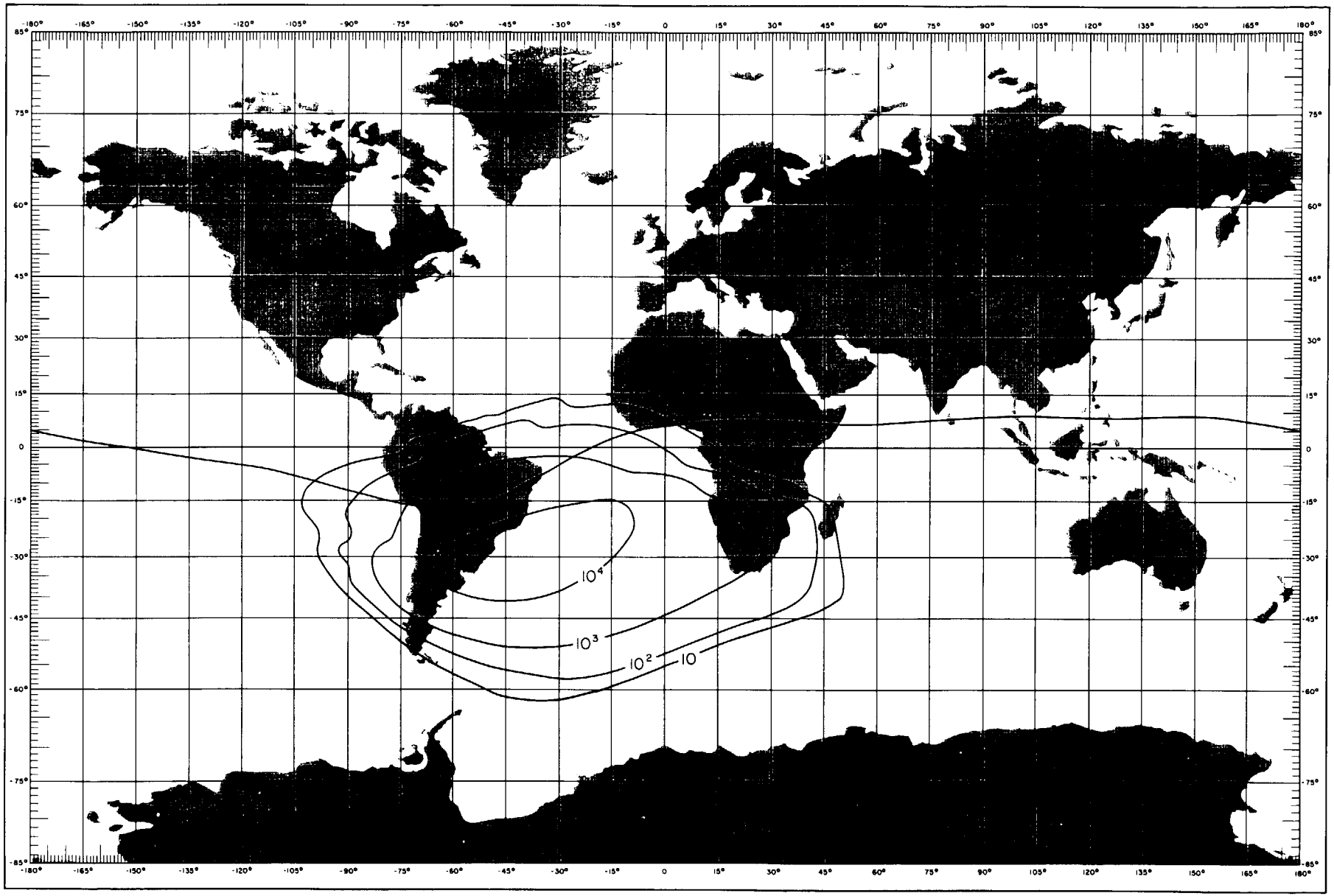
ALTITUDE = 600 KM

PROTON FLUX CONTOURS—E > 3 MEV



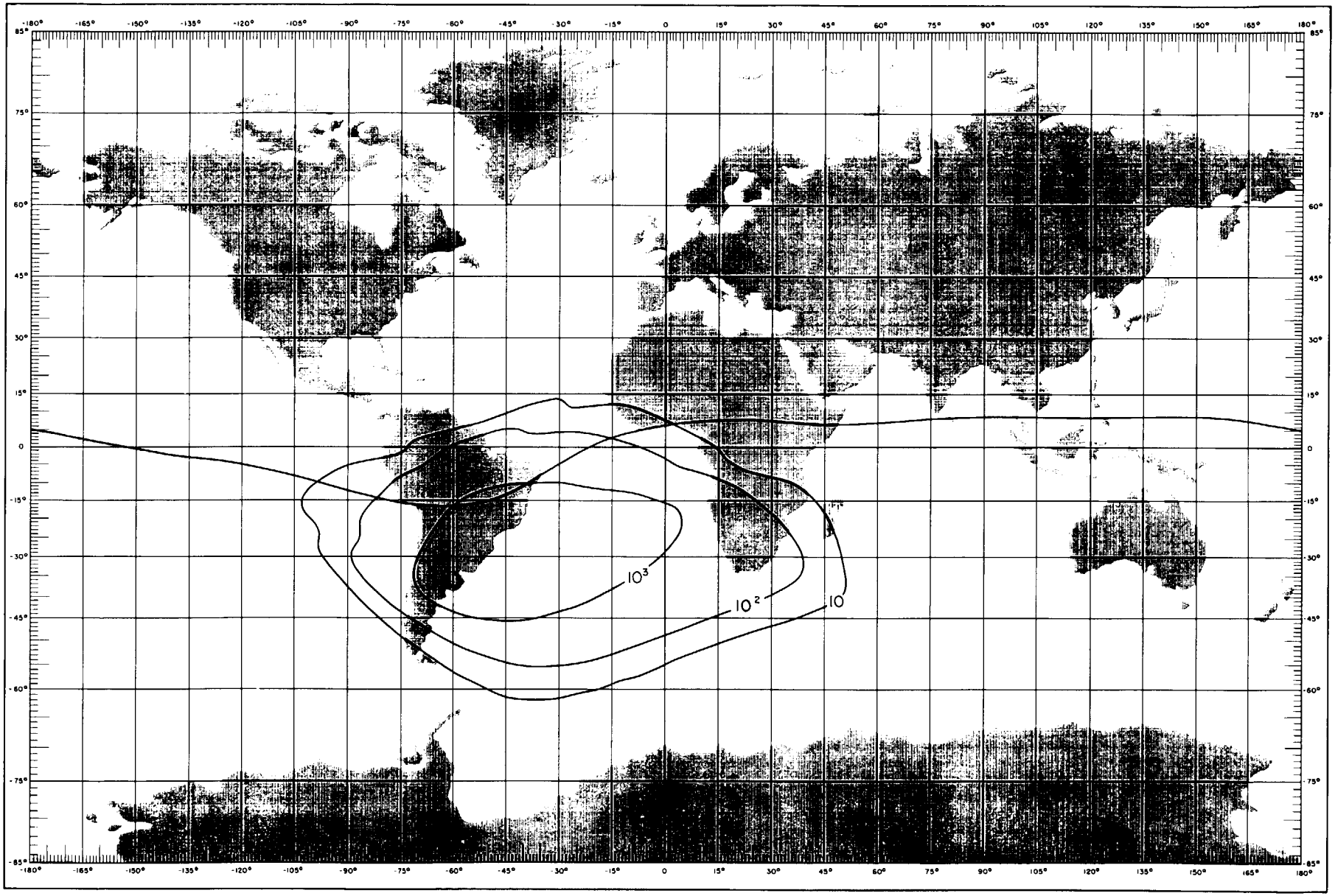
ALTITUDE = 700 KM

PROTON FLUX CONTOURS—E > 5 MEV



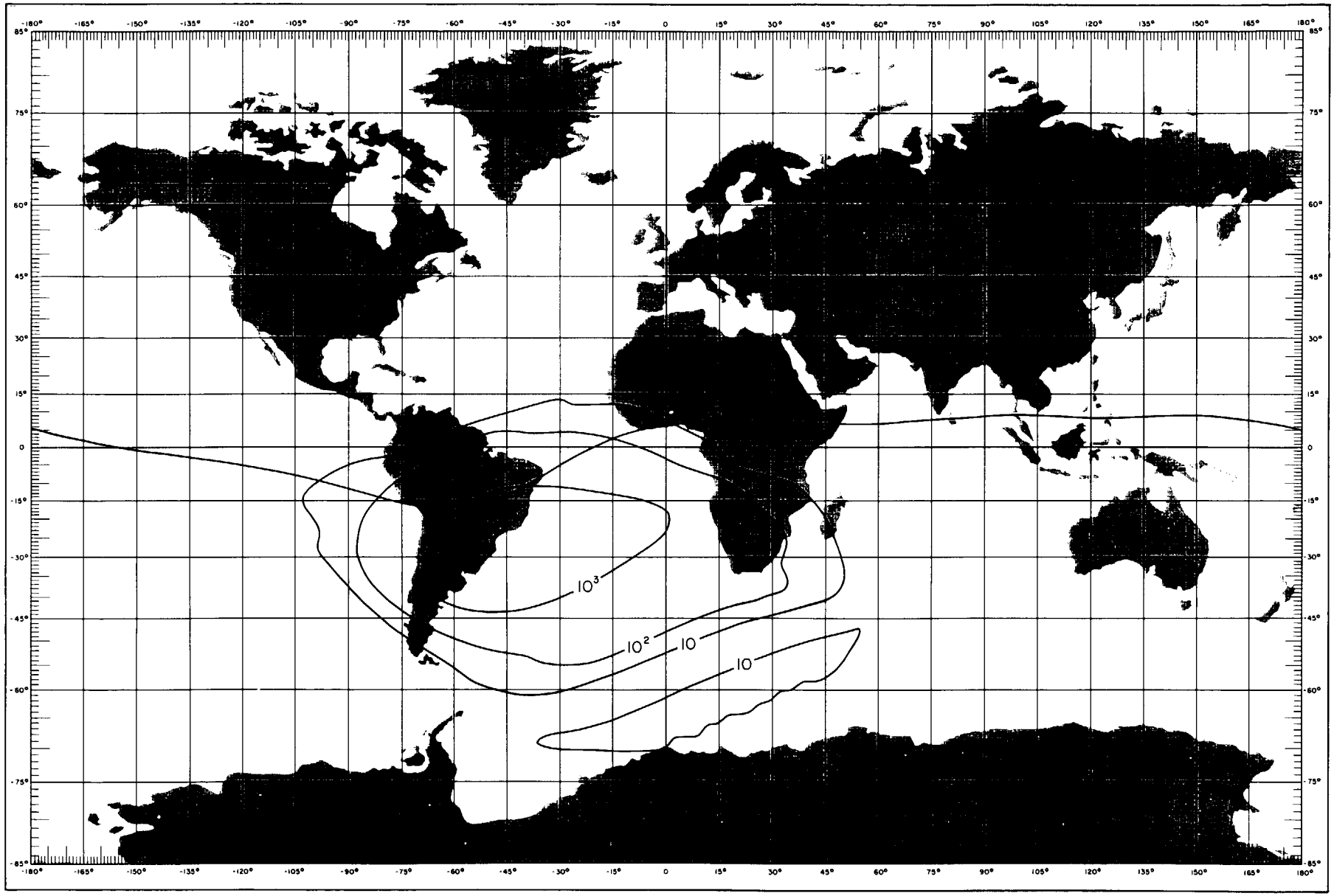
ALTITUDE = 700 KM

PROTON FLUX CONTOURS — E > 15 MEV



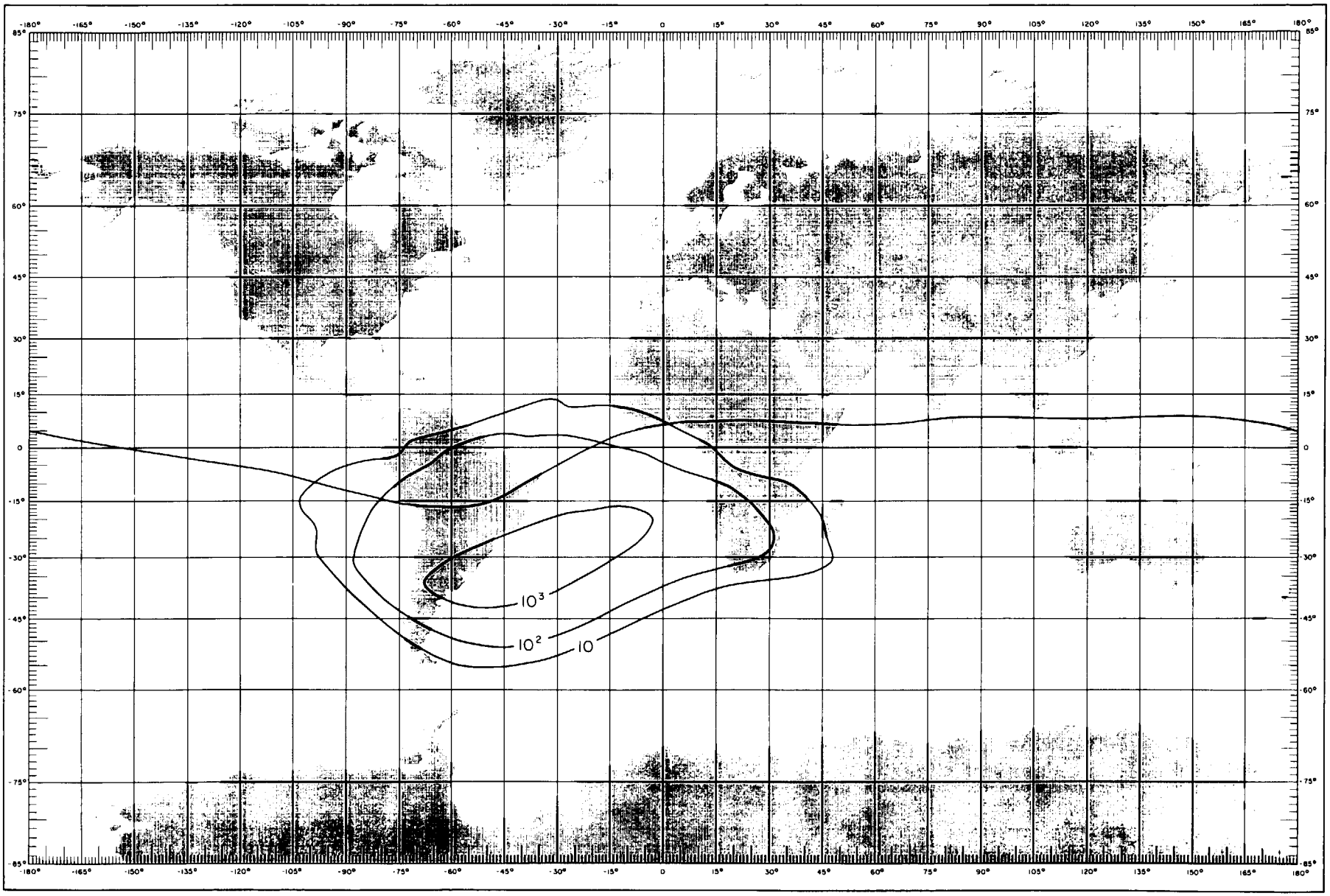
ALTITUDE = 700 KM

PROTON FLUX CONTOURS—E > 30 MEV



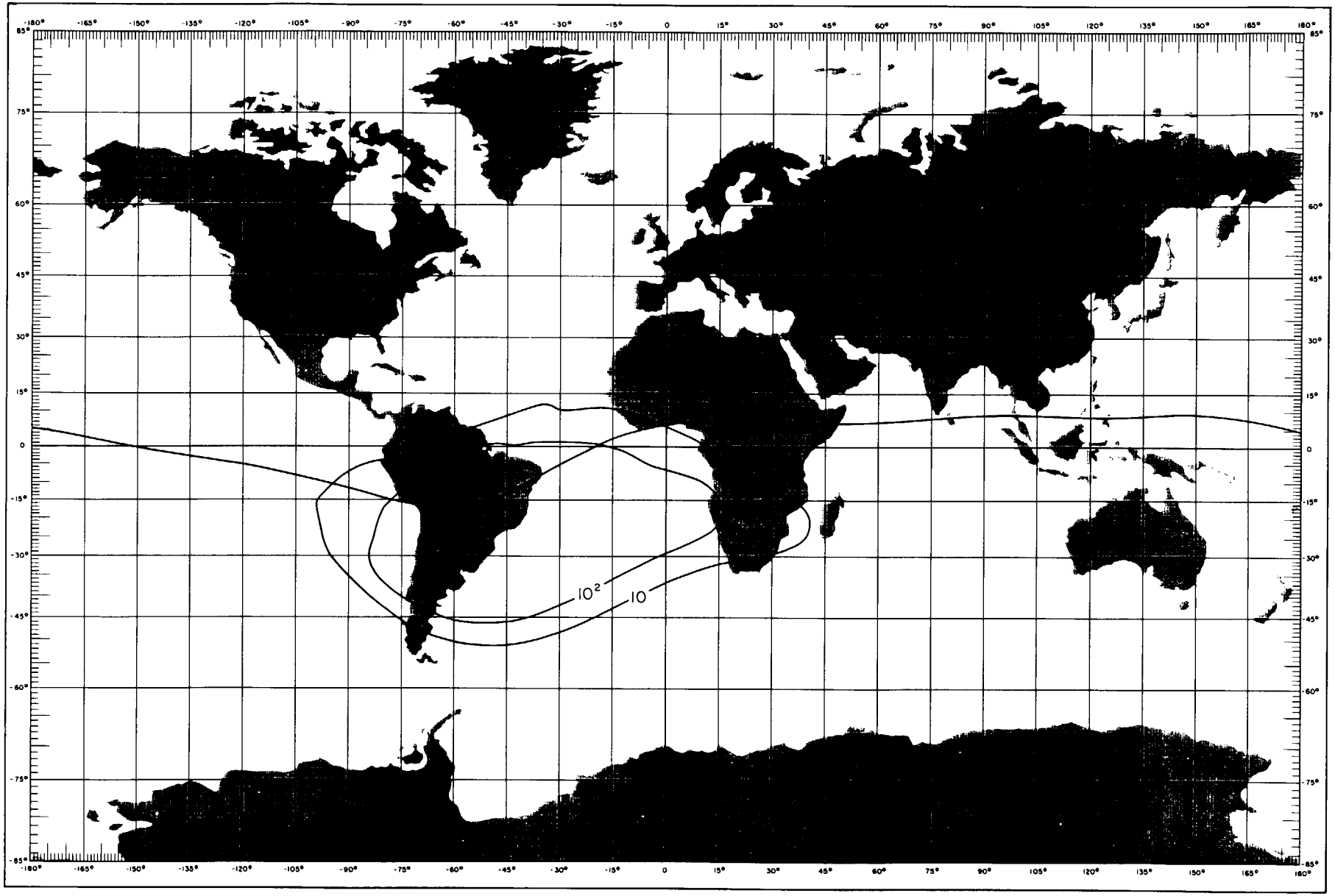
ALTITUDE = 700 KM

PROTON FLUX CONTOURS — E > 50 MEV



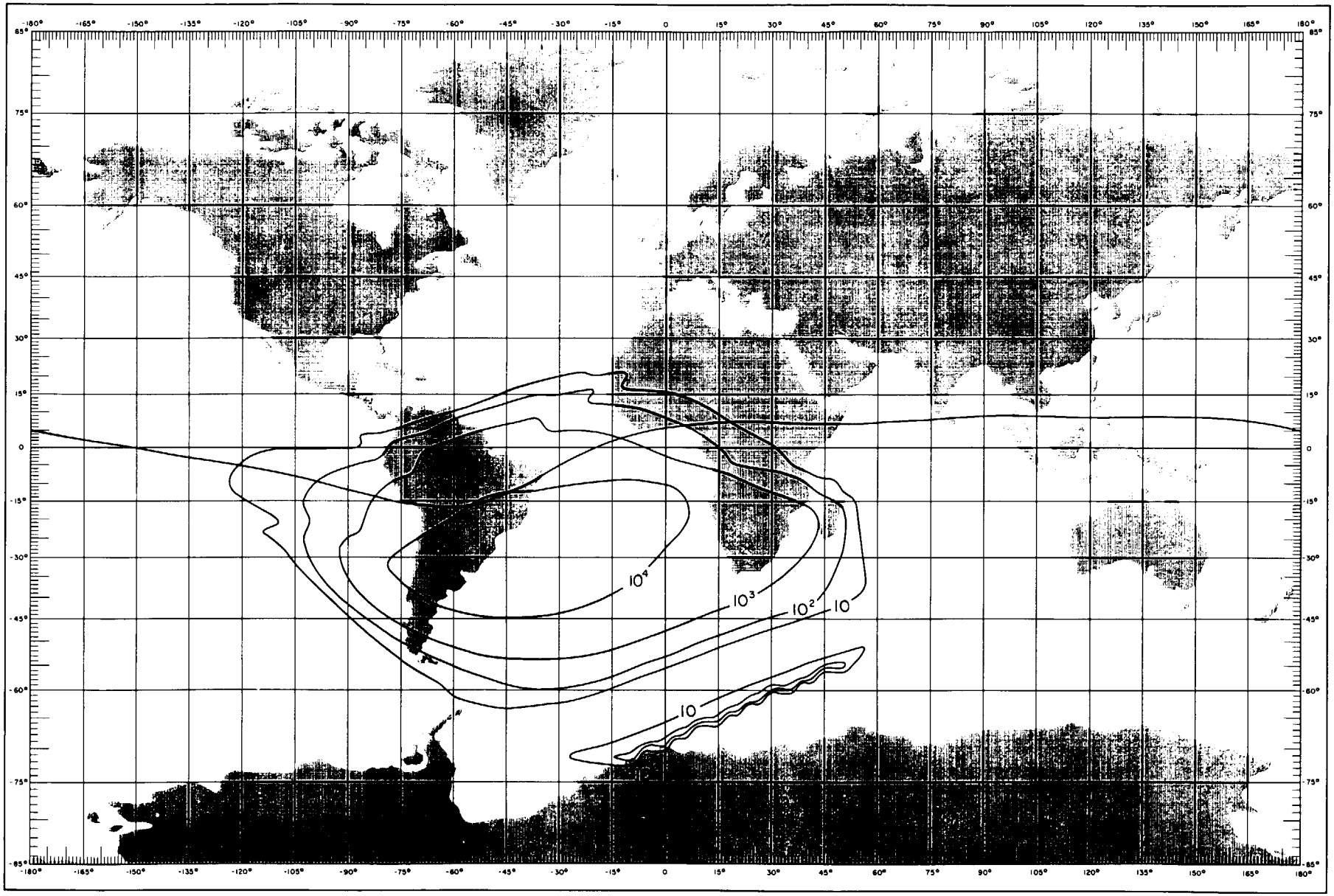
ALTITUDE = 700 KM

PROTON FLUX CONTOURS — E > 100 MEV



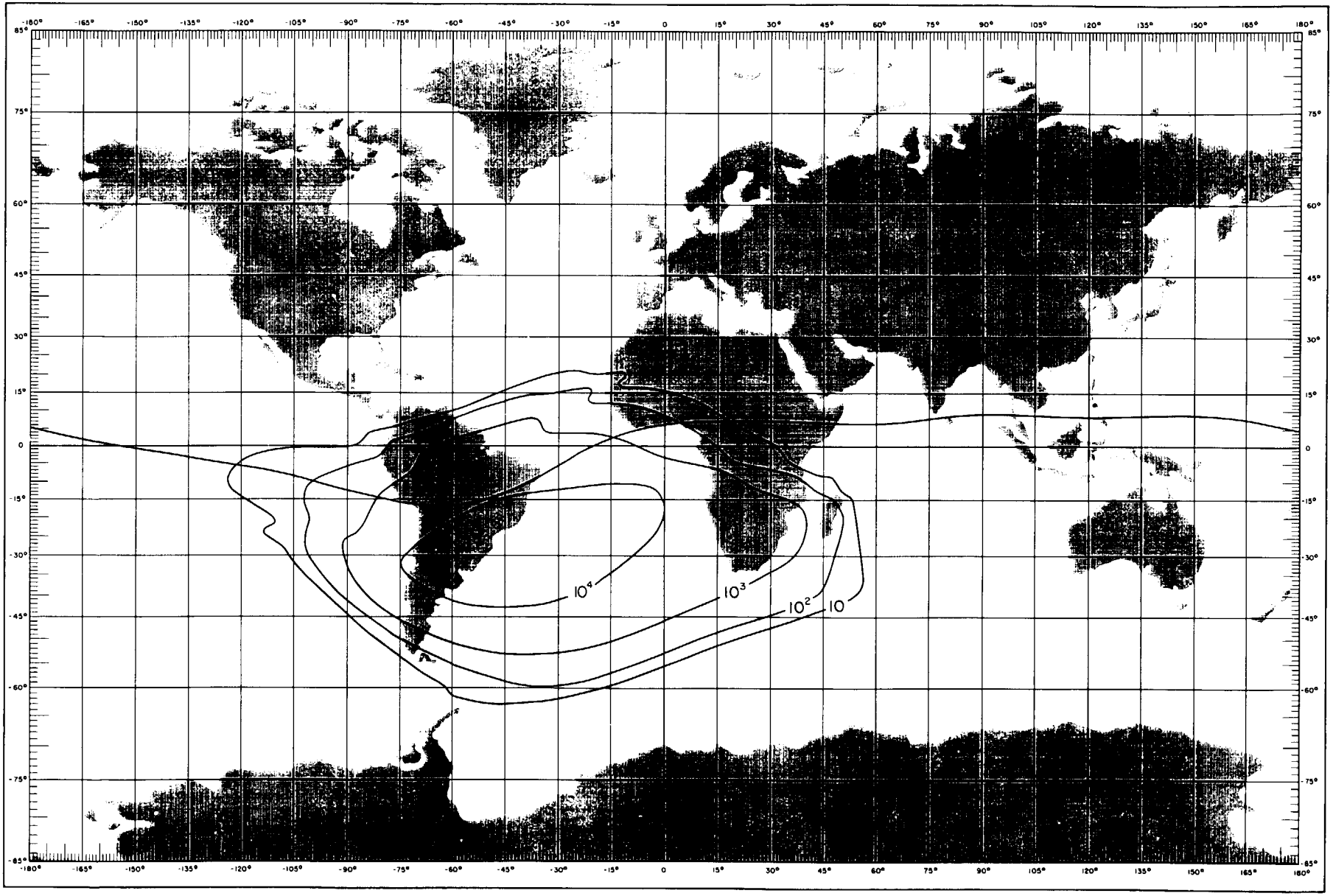
ALTITUDE = 700 KM

PROTON FLUX CONTOURS — E > 3 MEV



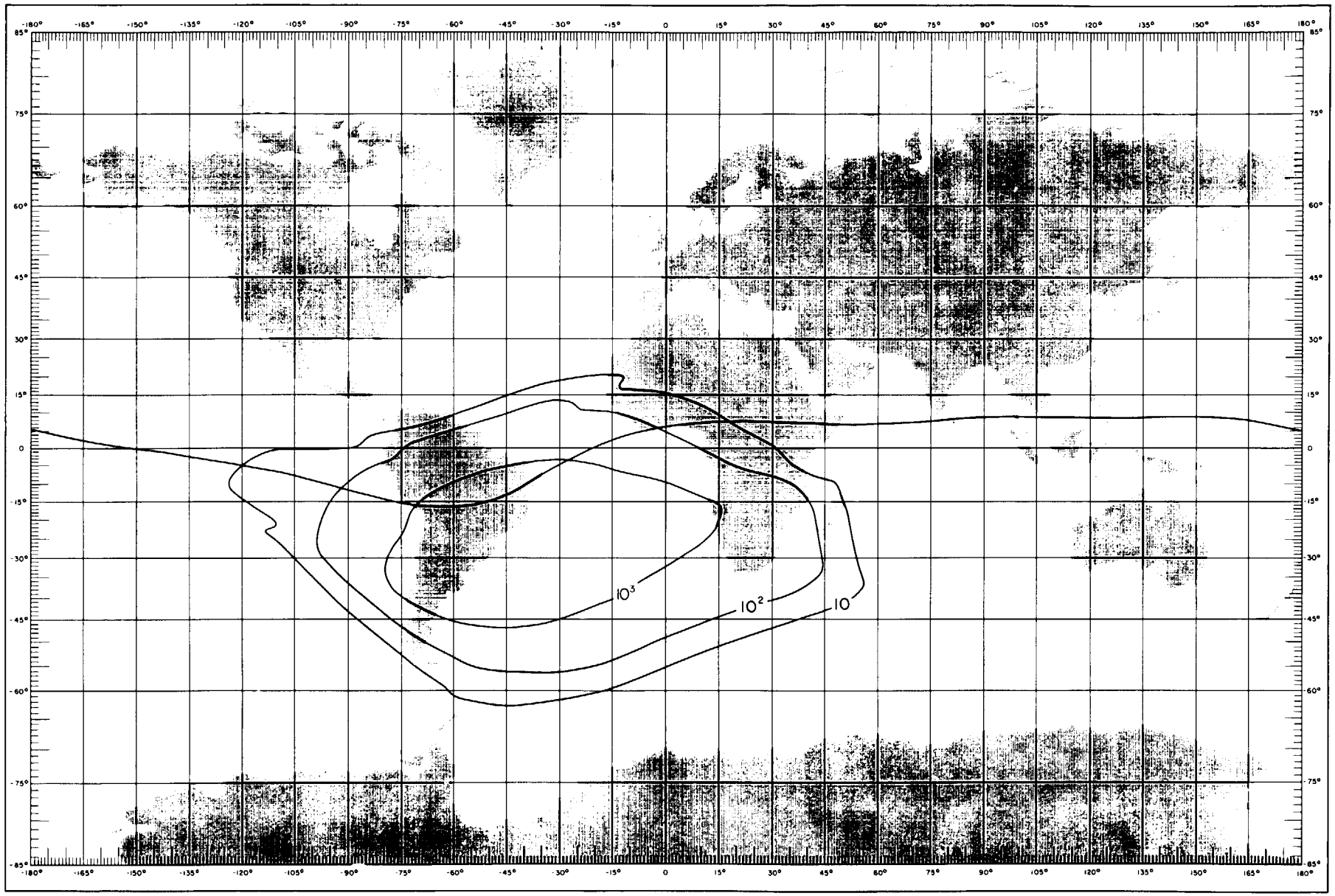
ALTITUDE = 800 KM

PROTON FLUX CONTOURS — E > 5 MEV



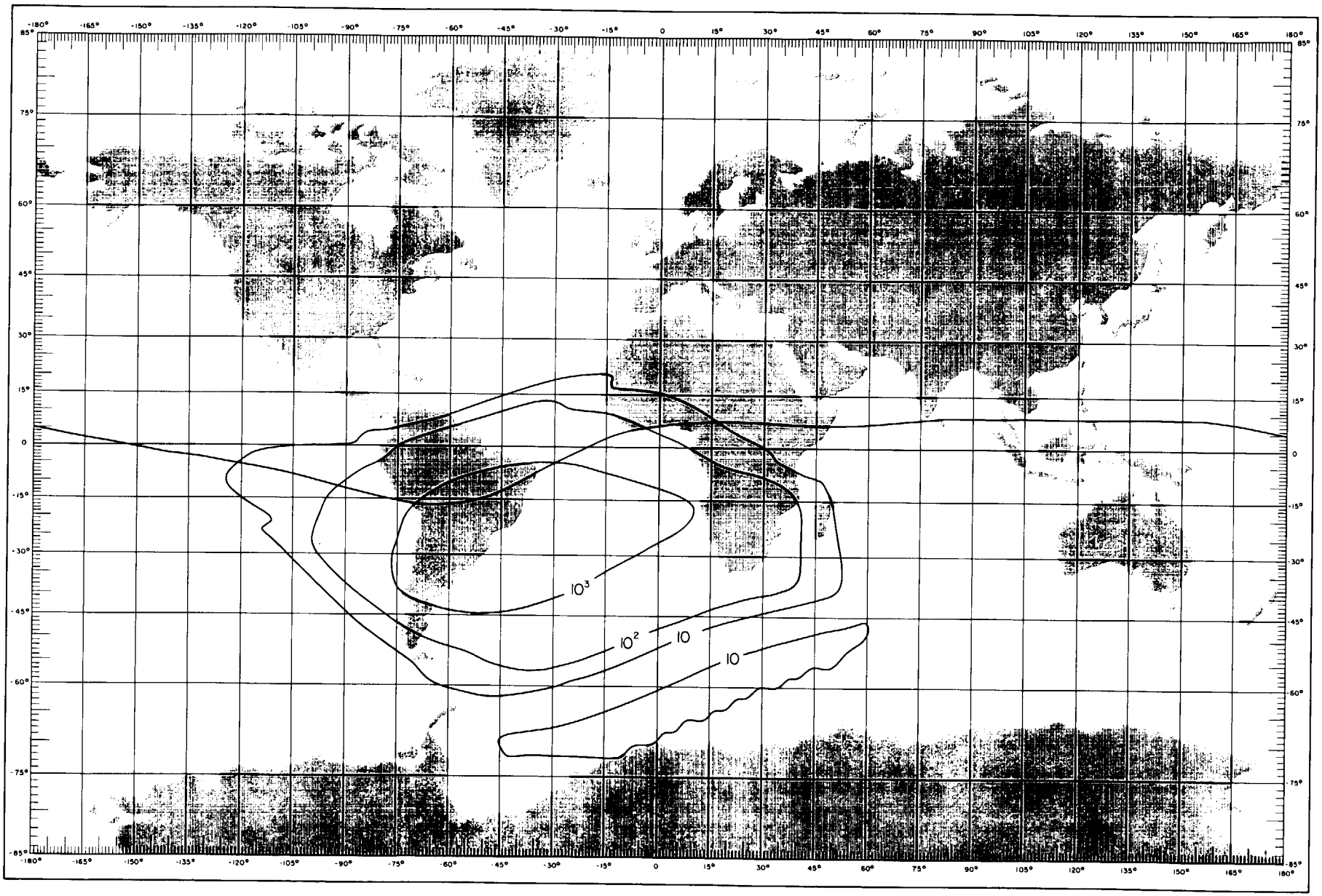
ALTITUDE = 800 KM

PROTON FLUX CONTOURS — E > 15 MEV



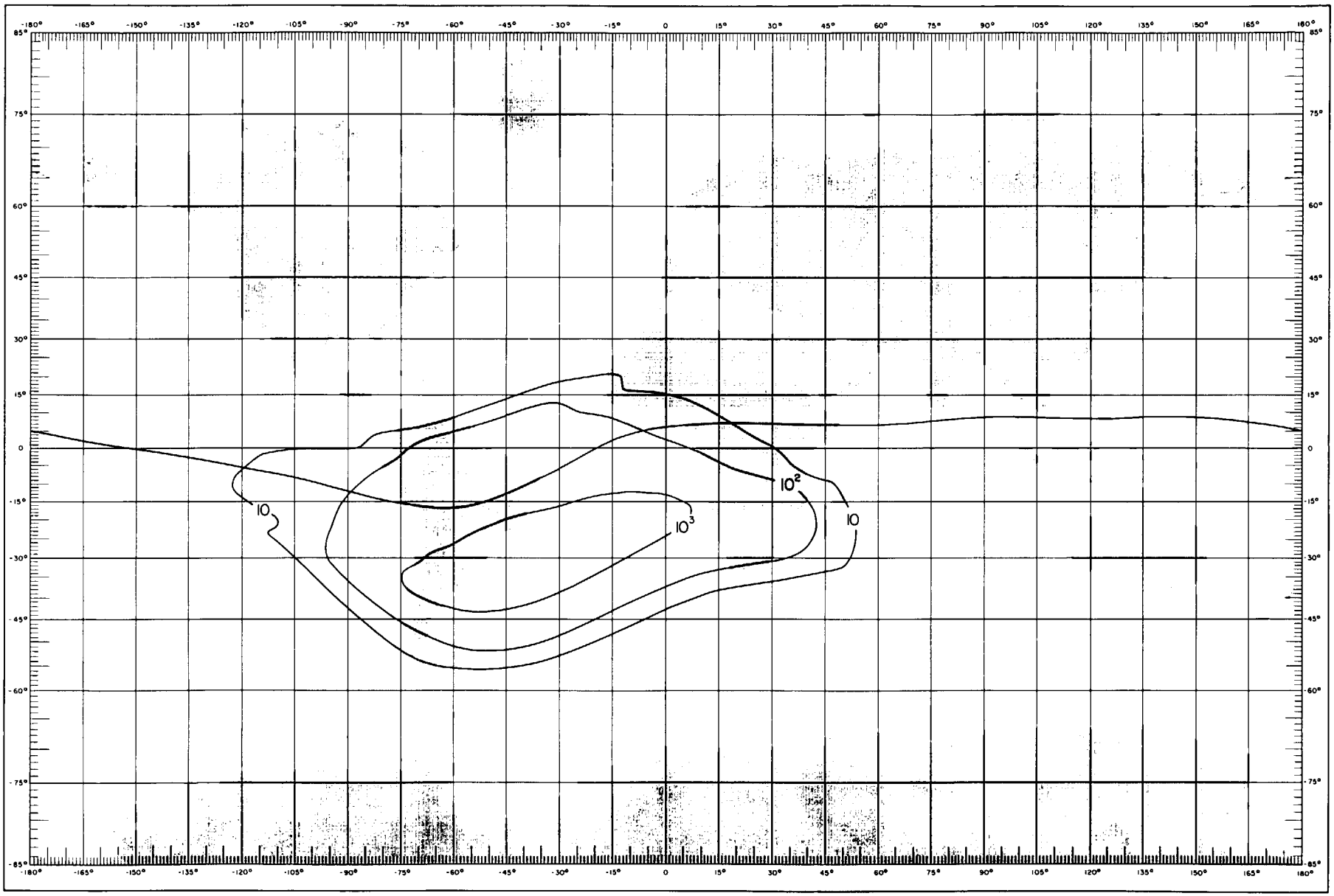
ALTITUDE = 800 KM

PROTON FLUX CONTOURS — E > 30 MEV



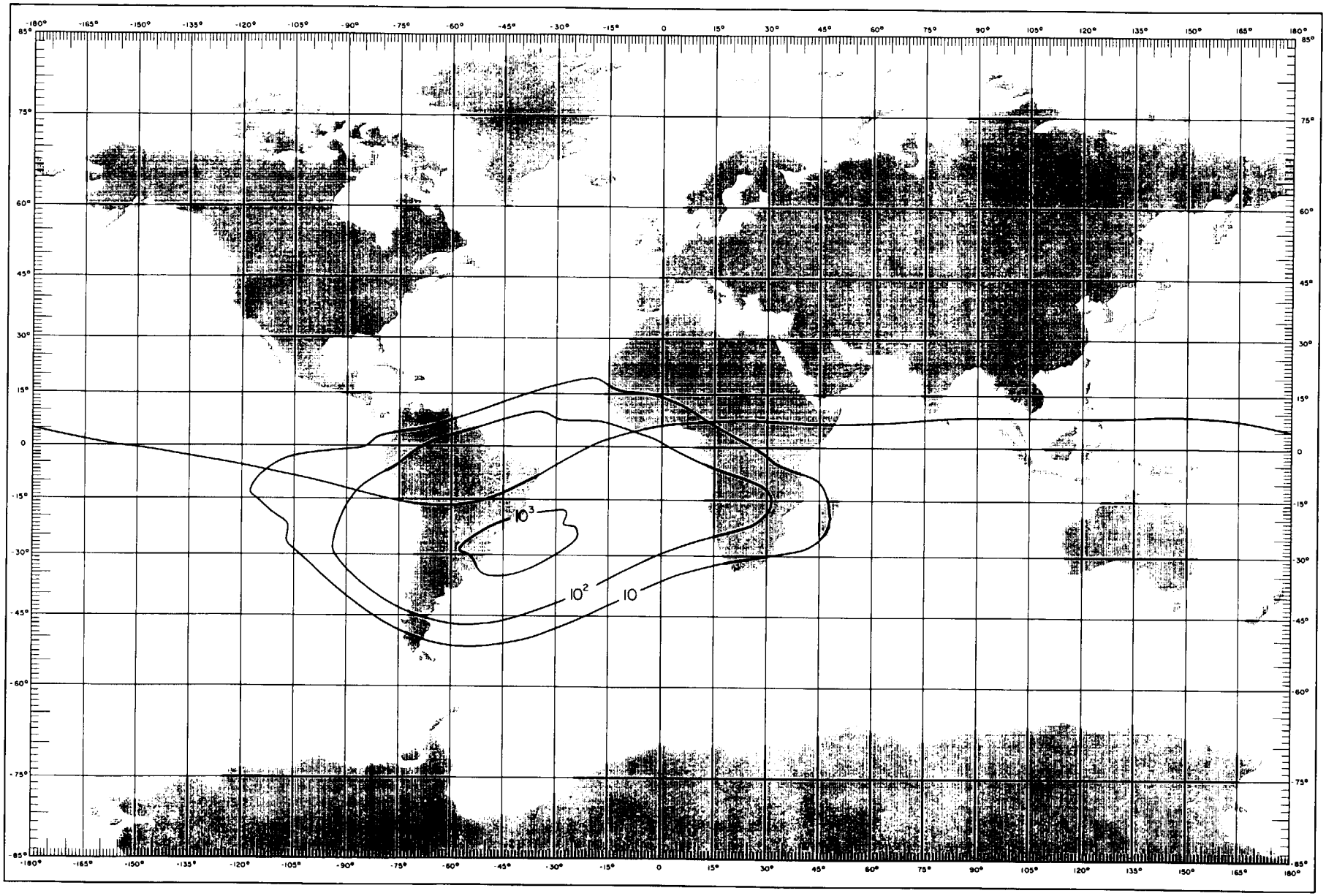
ALTITUDE = 800 KM

PROTON FLUX CONTOURS — E > 50 MEV



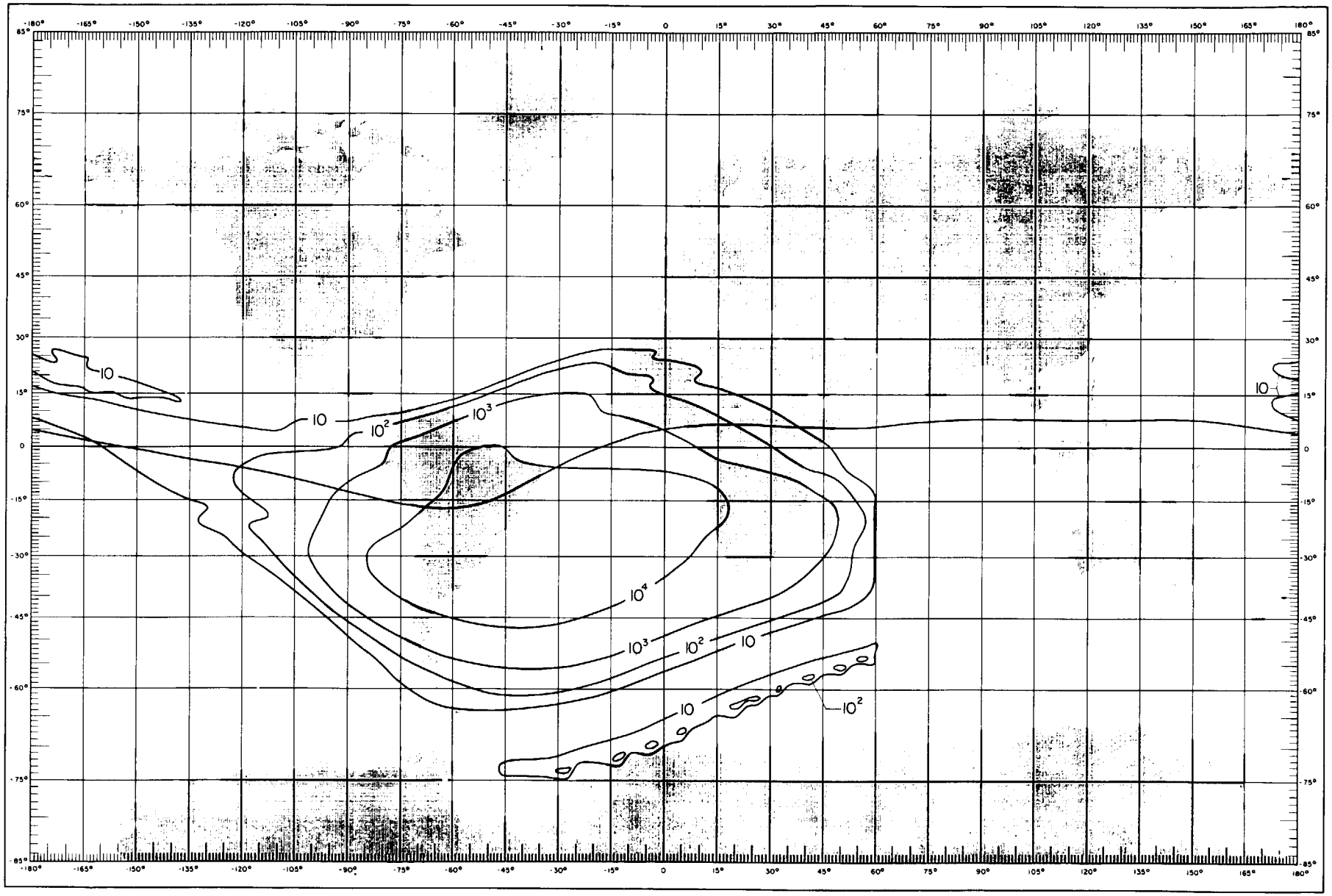
ALTITUDE = 800 KM

PROTON FLUX CONTOURS — E > 100 MEV



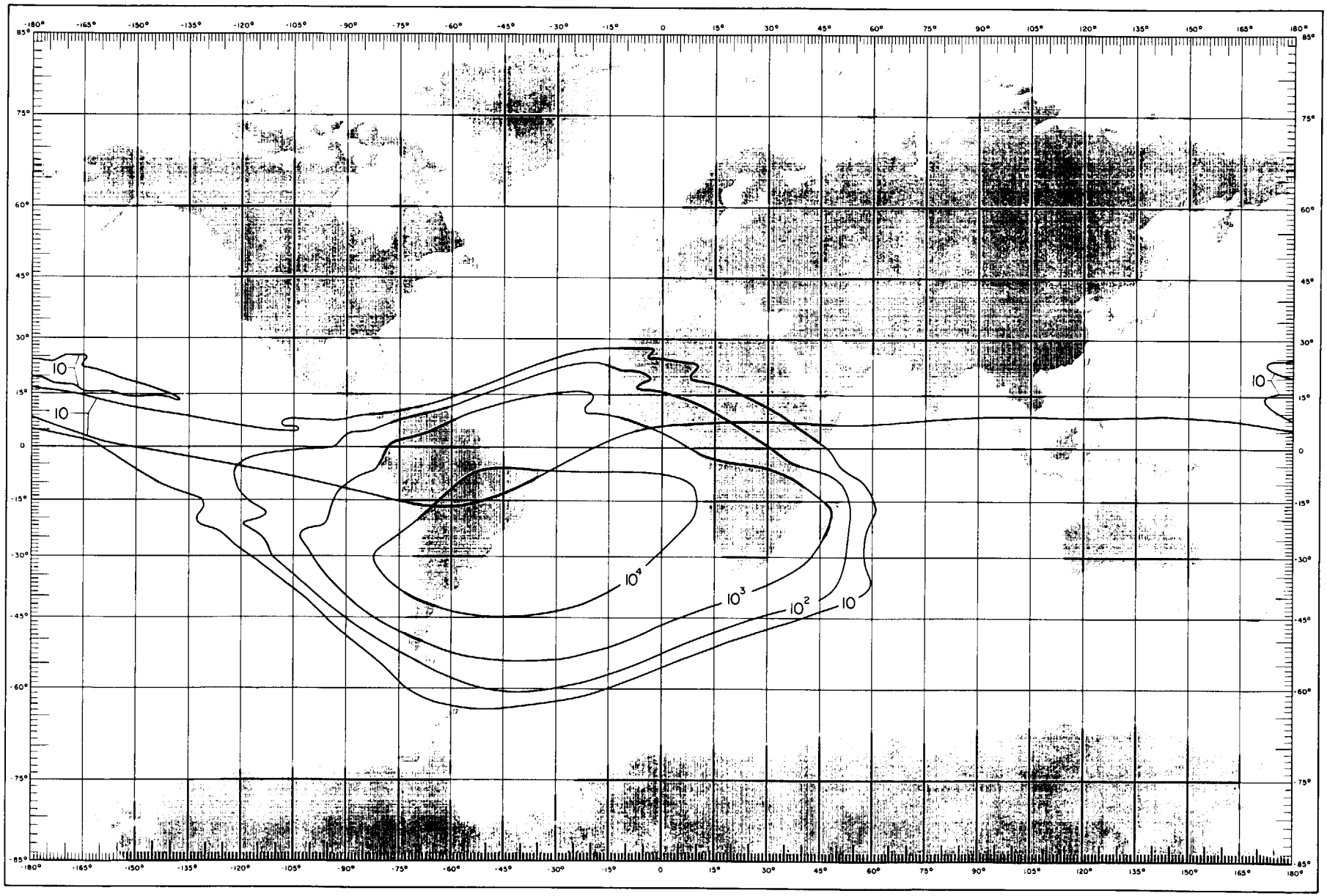
ALTITUDE = 800 KM

PROTON FLUX CONTOURS—E > 3 MEV



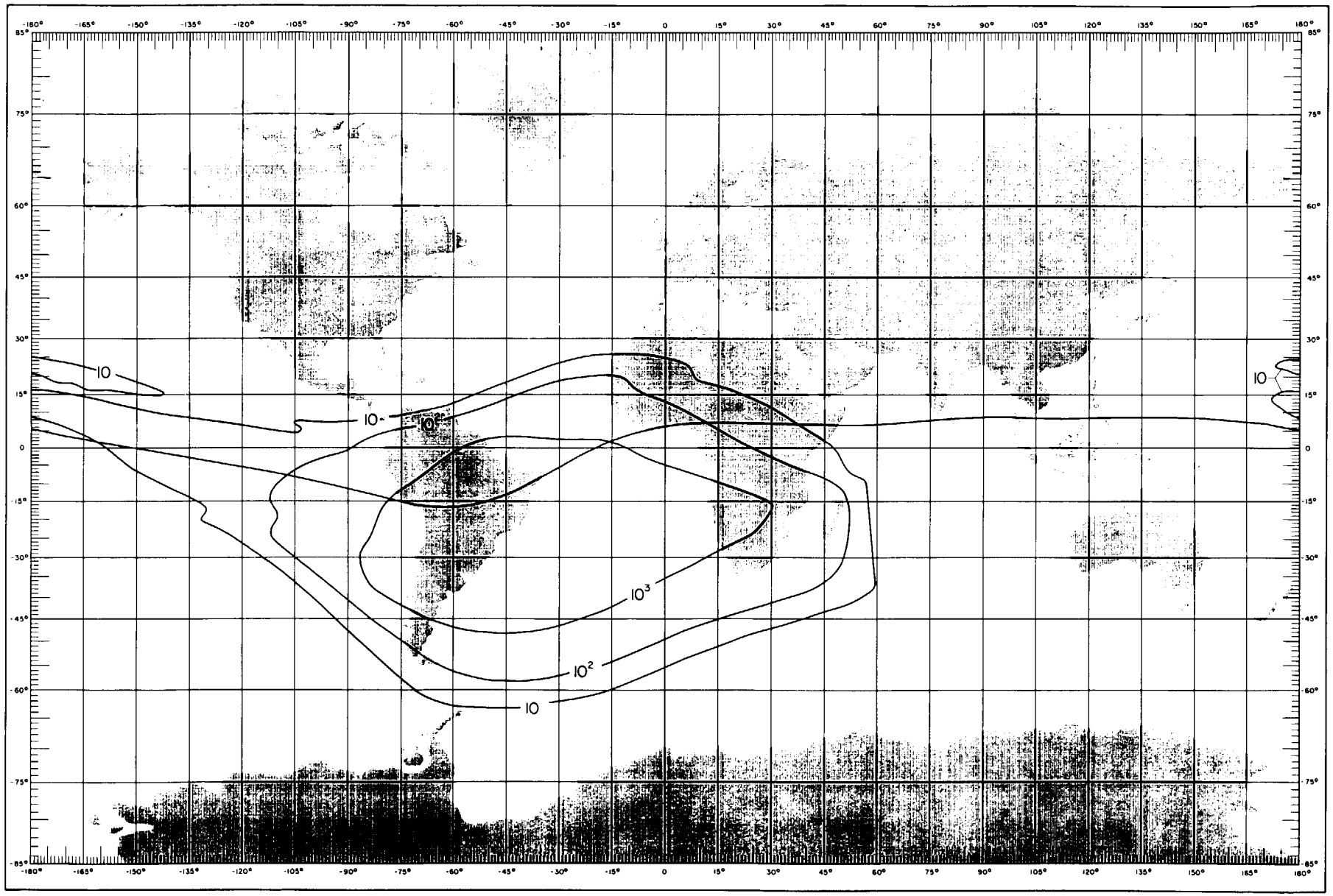
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E > 5 MEV



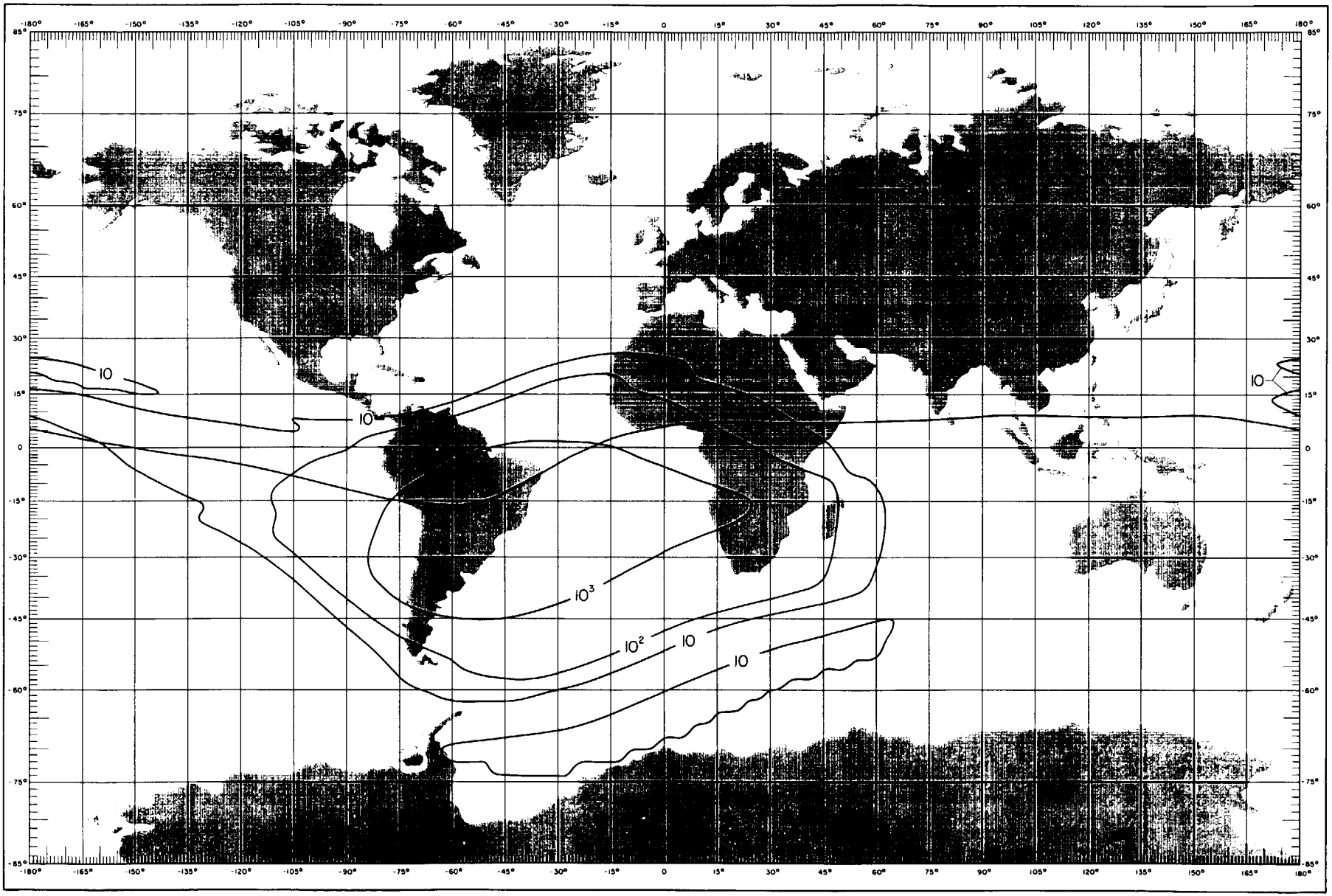
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E >15 MEV



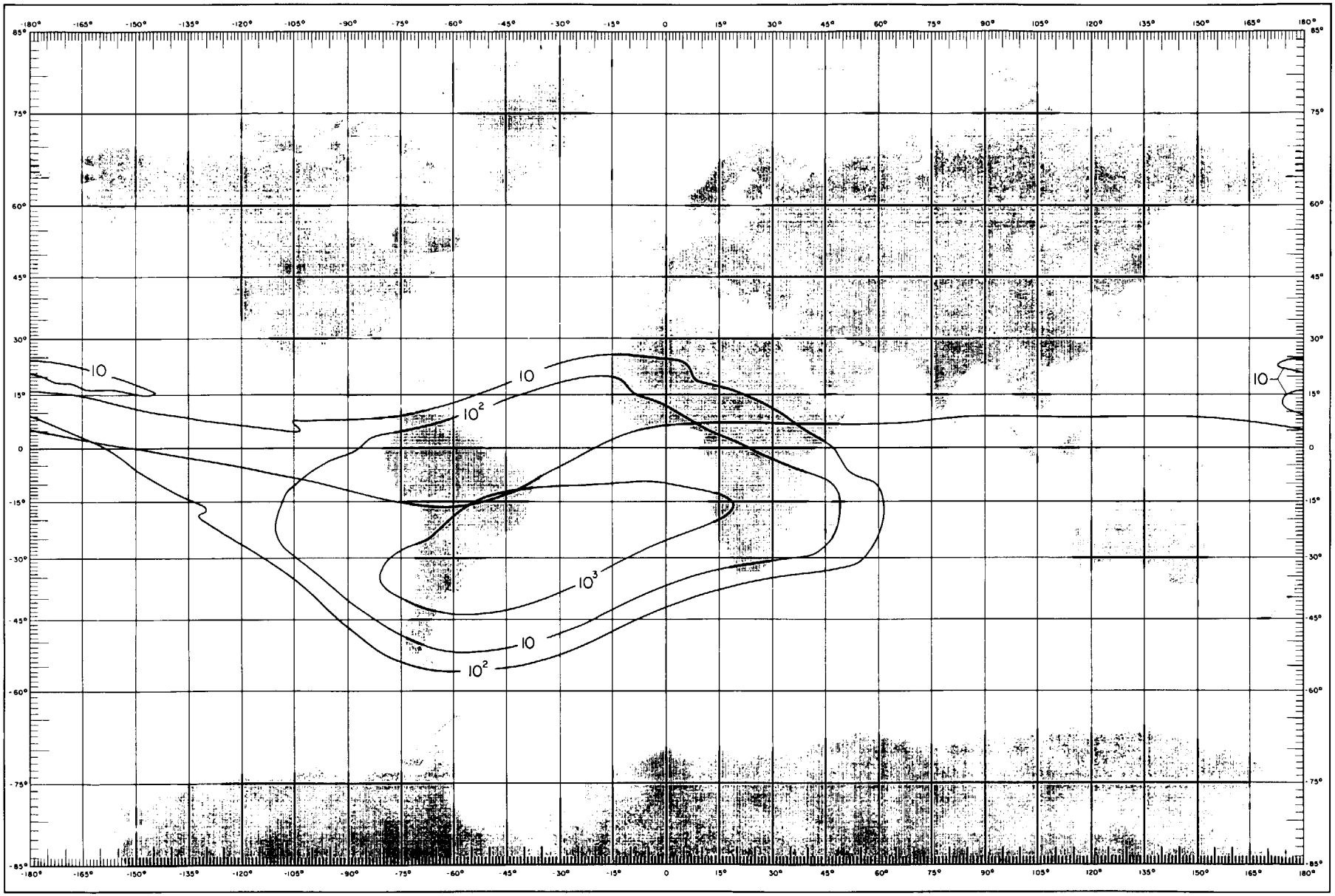
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E > 30 MEV



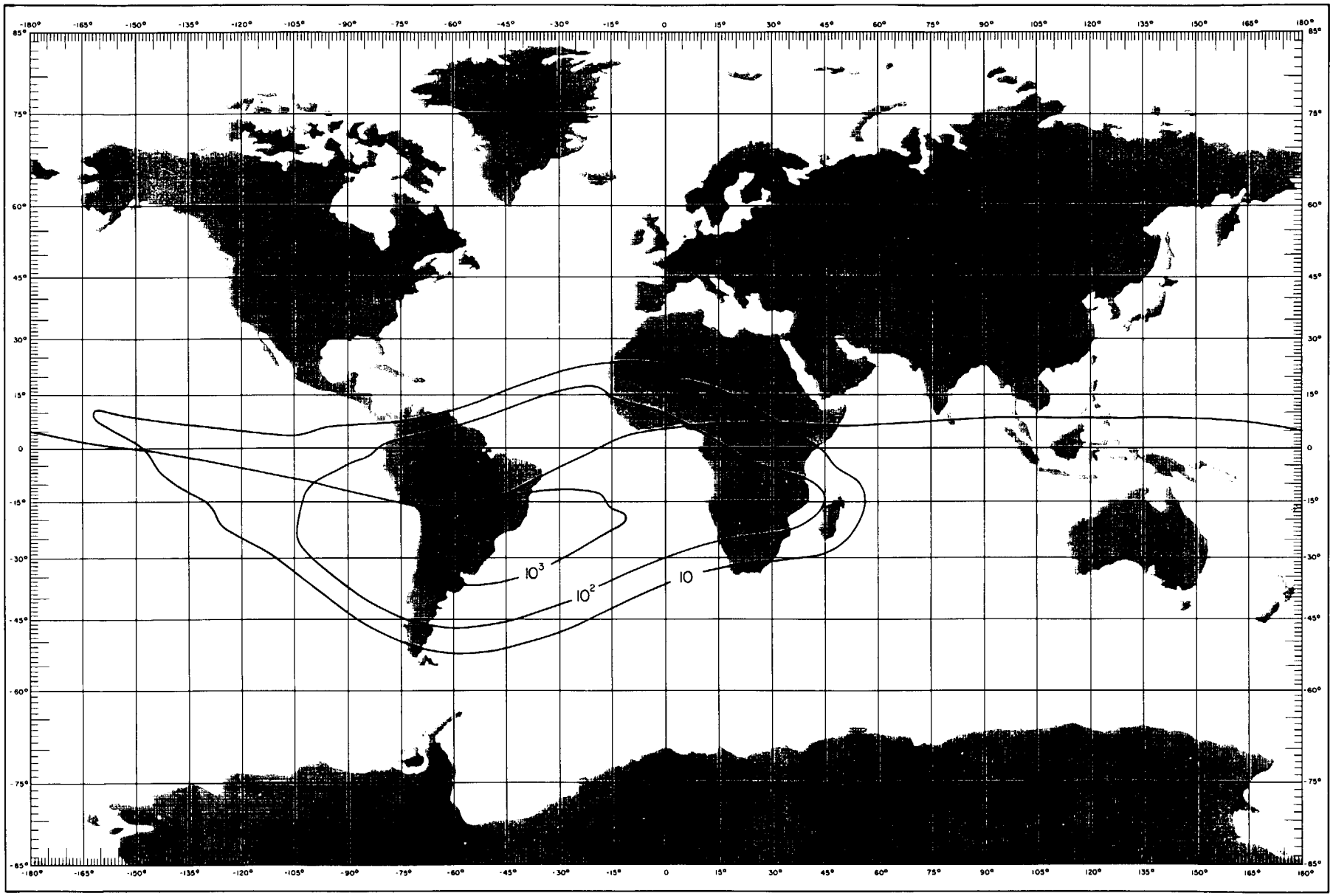
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E > 50 MEV



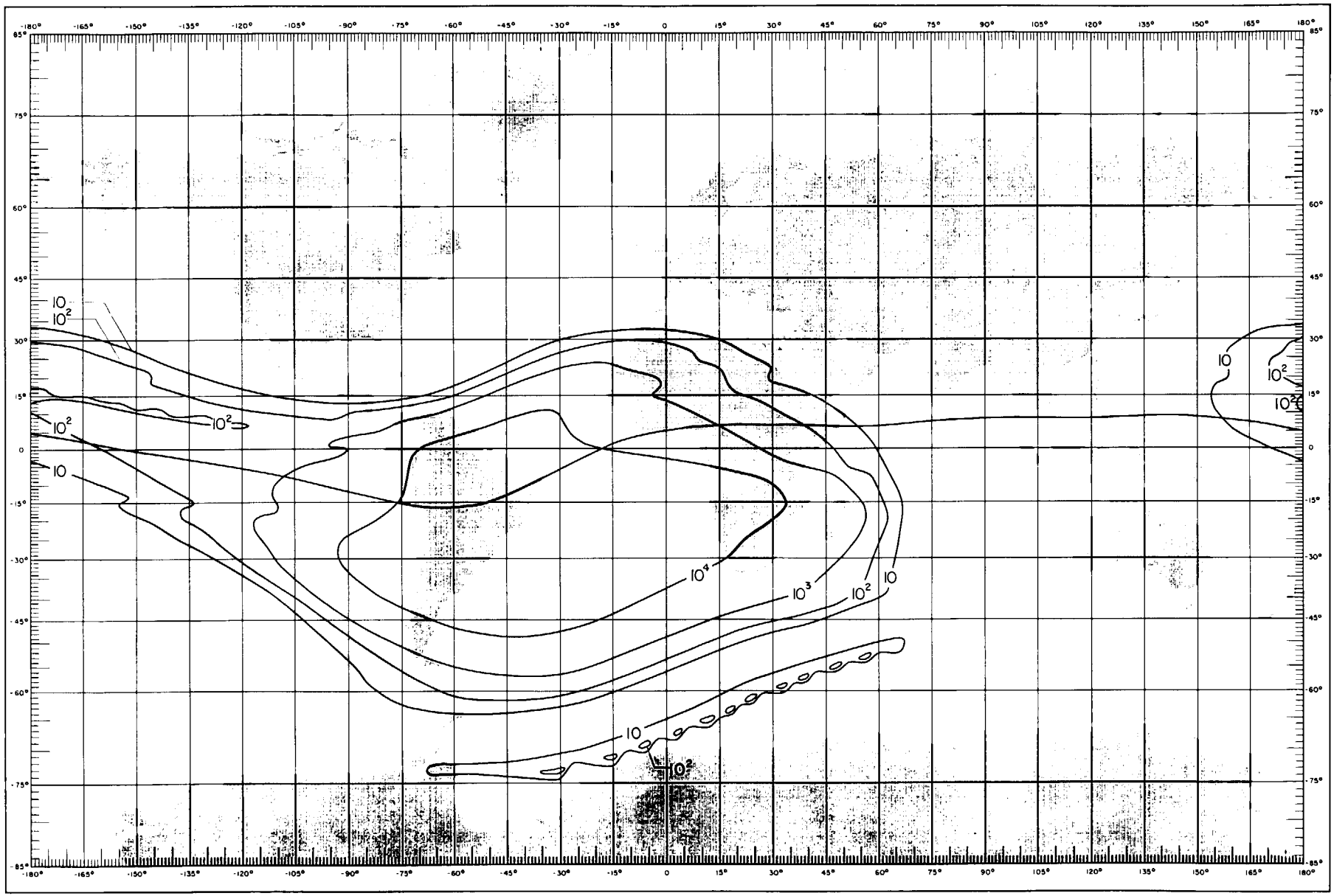
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E > 100 MEV



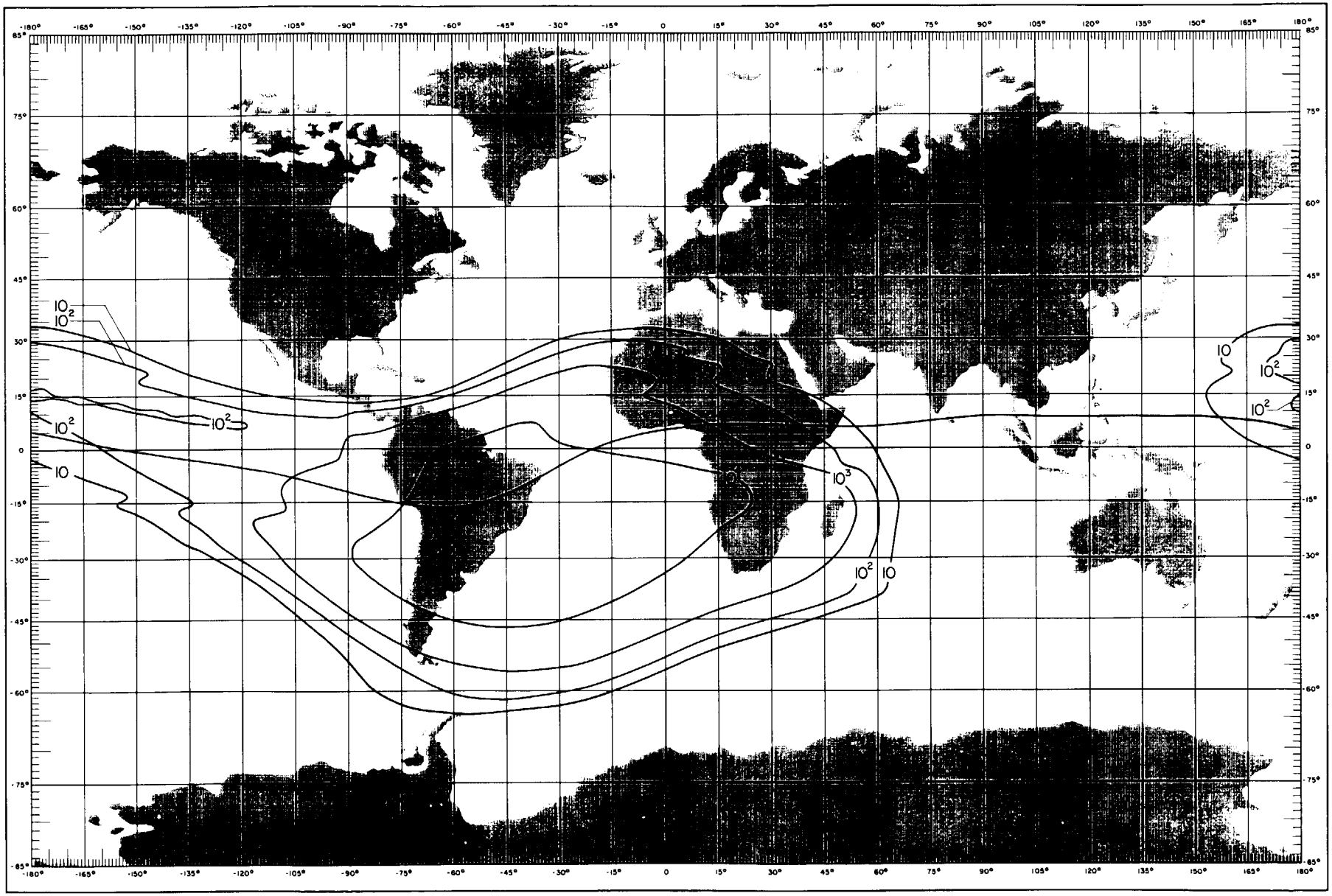
ALTITUDE = 900 KM

PROTON FLUX CONTOURS — E > 3 MEV



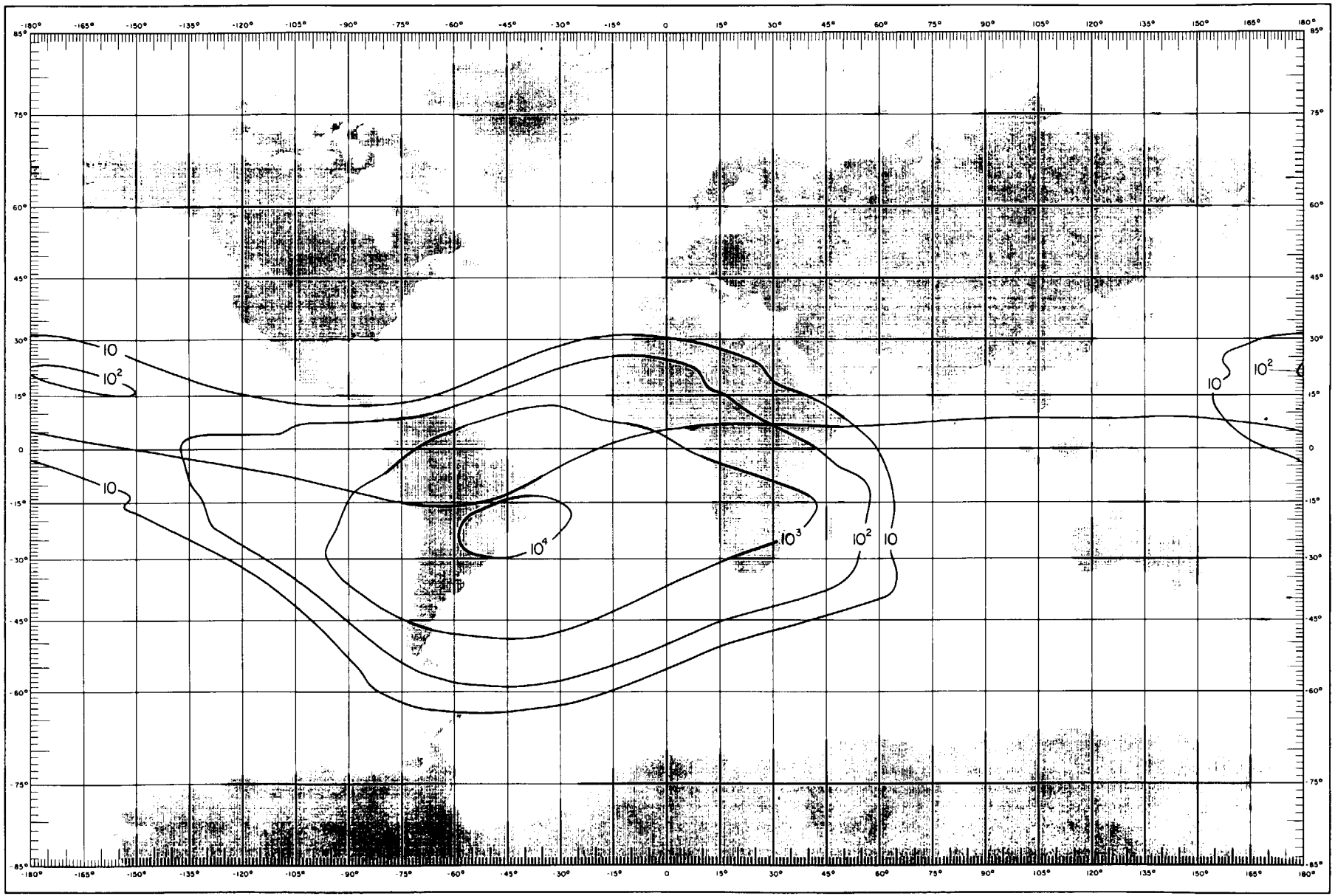
ALTITUDE = 1000 KM

PROTON FLUX CONTOURS — E > 5 MEV



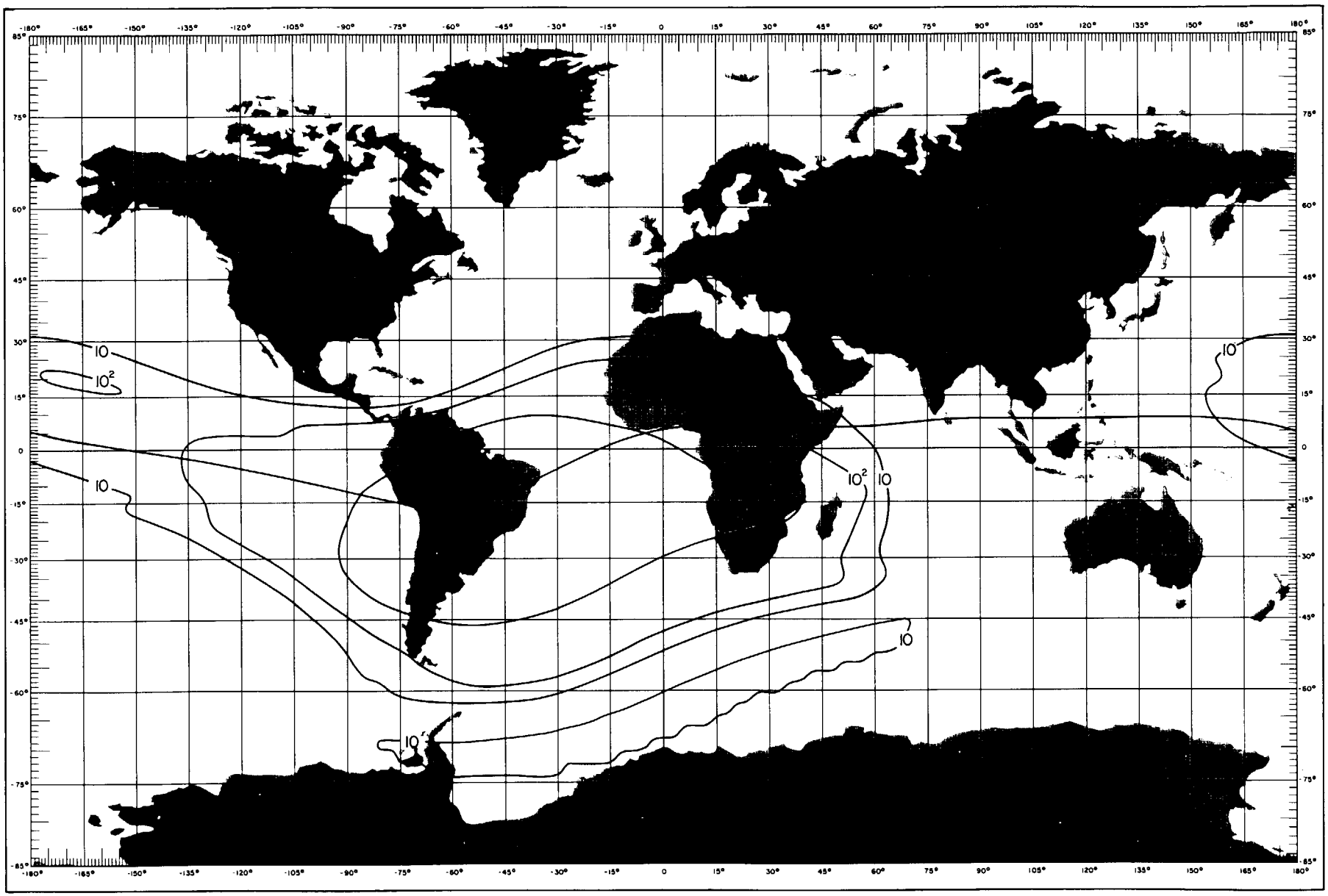
ALTITUDE = 1000 KM

PROTON FLUX CONTOURS — E > 15 MEV



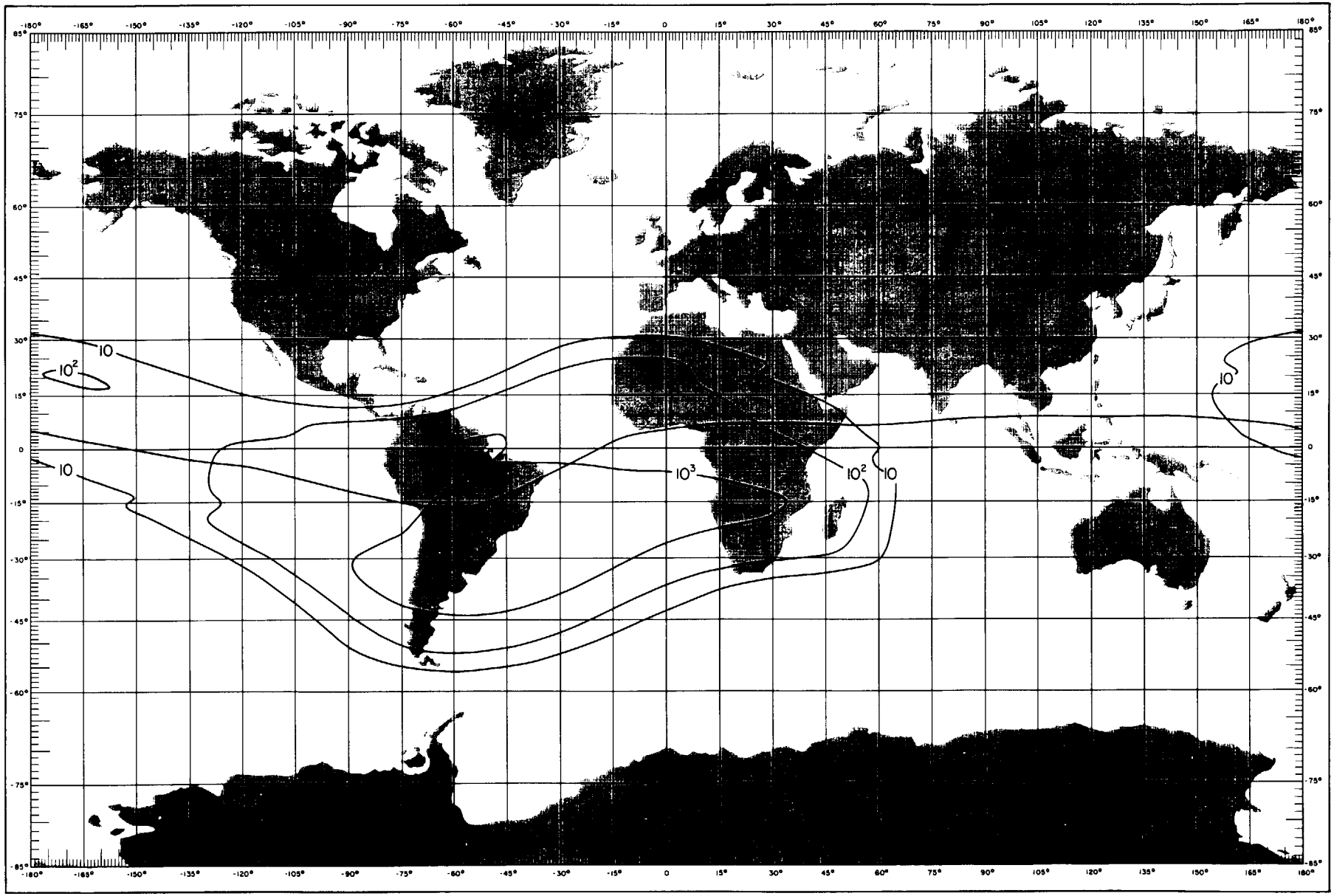
ALTITUDE=1000 KM

PROTON FLUX CONTOURS — E > 30 MEV



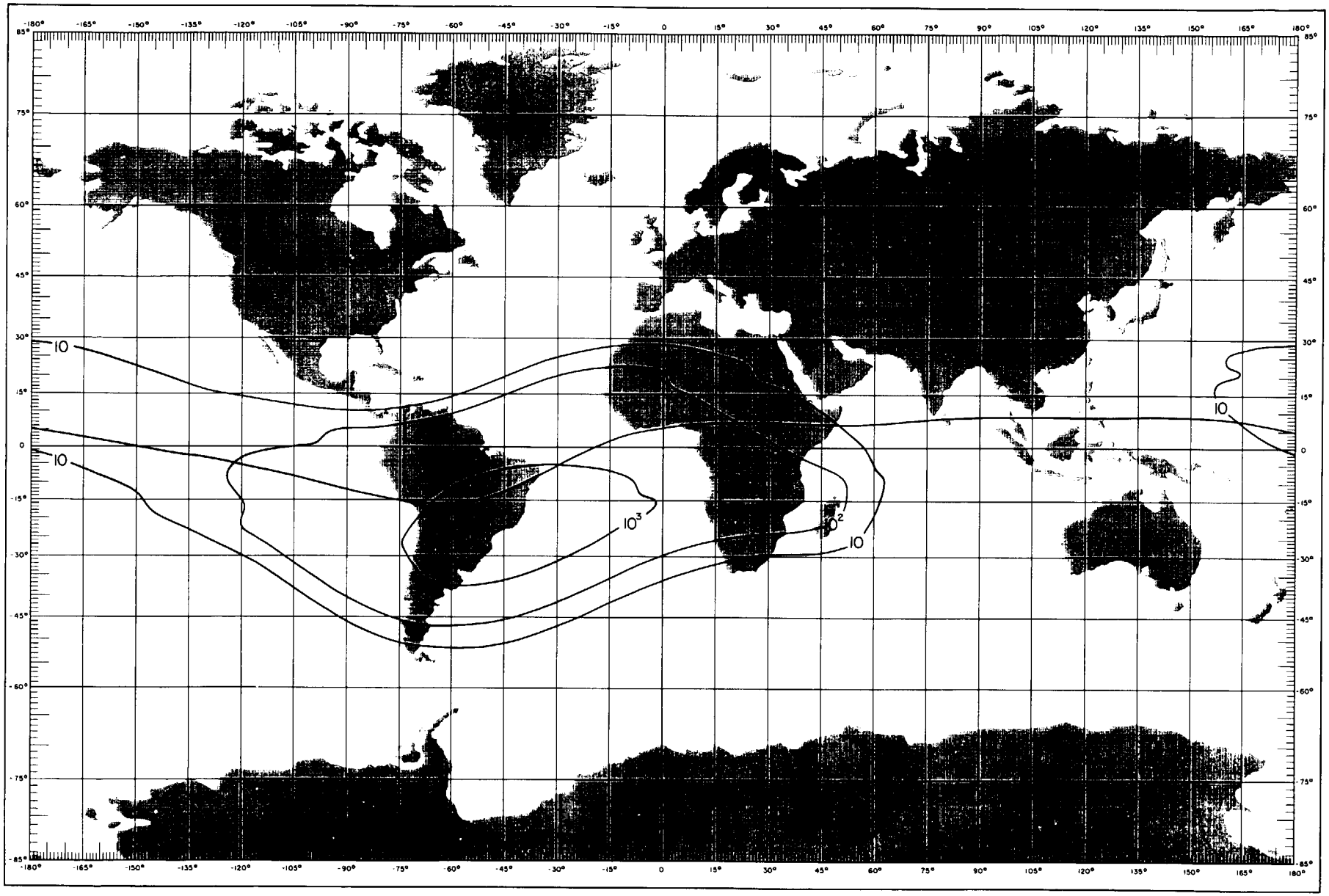
ALTITUDE = 1000 KM

PROTON FLUX CONTOURS — E > 50 MEV



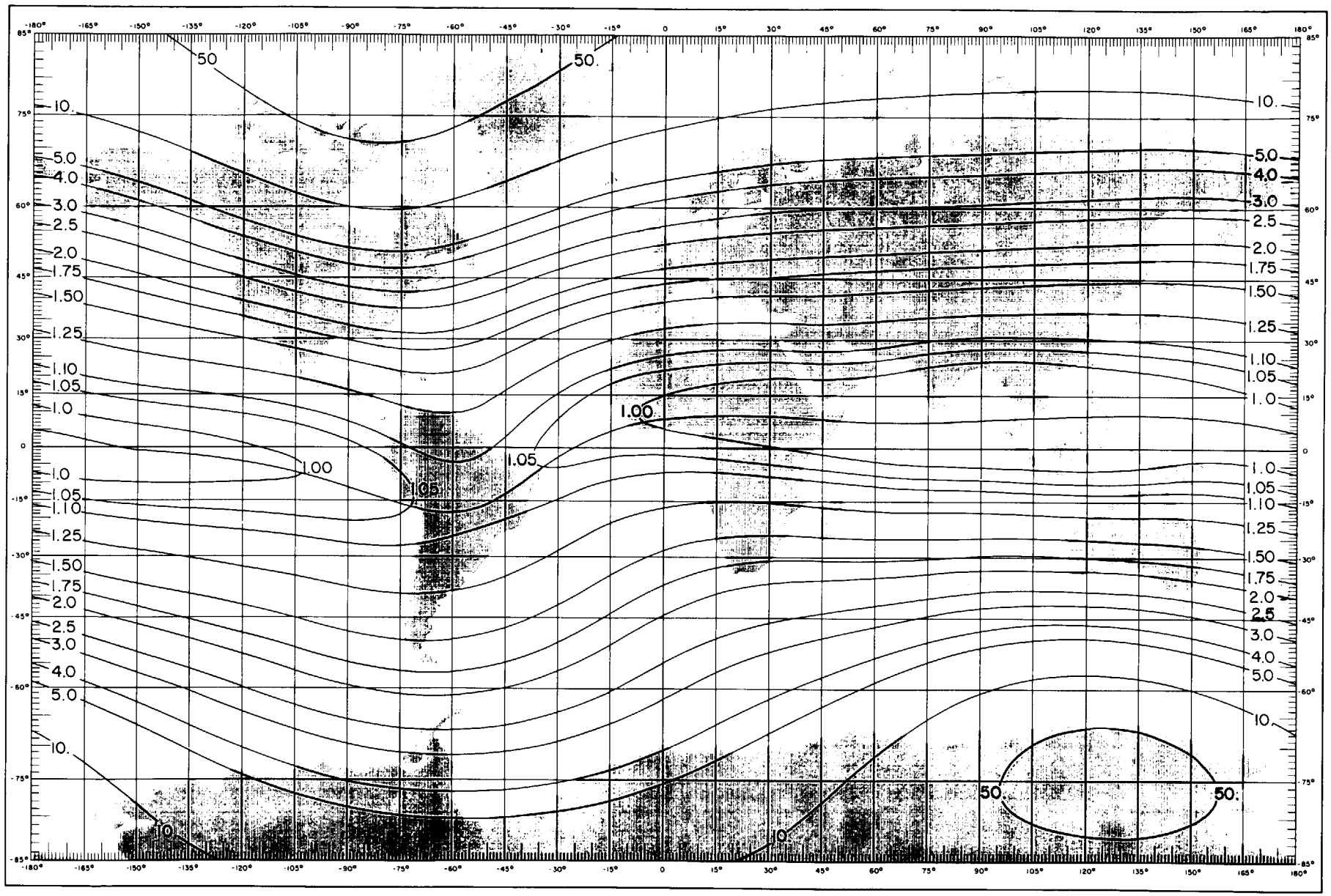
ALTITUDE = 1000 KM

PROTON FLUX CONTOURS — E > 100 MEV



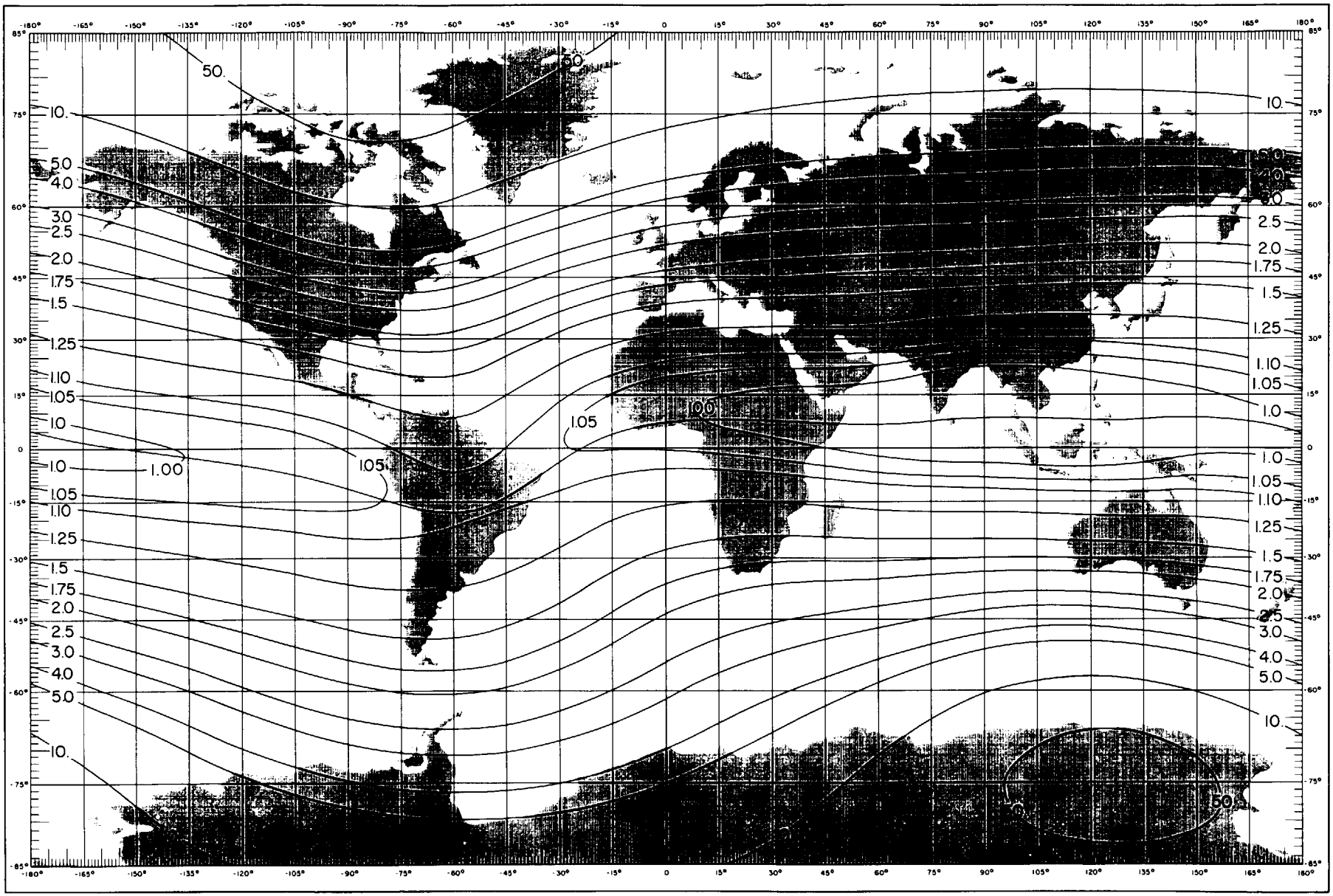
ALTITUDE = 1000 KM

LINES OF CONSTANT L (EARTH RADII)



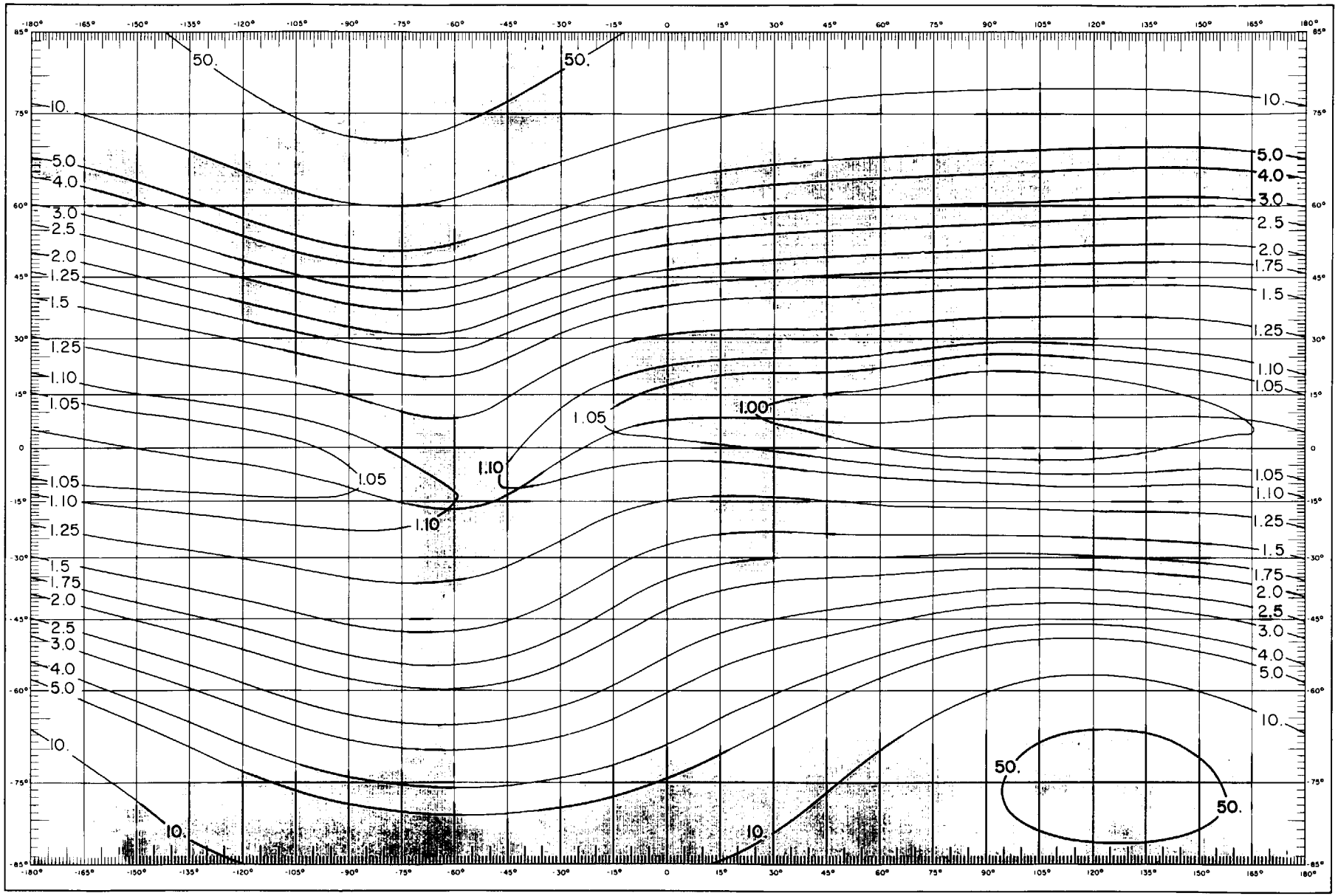
ALTITUDE = 0 KM

LINES OF CONSTANT L (EARTH RADII)



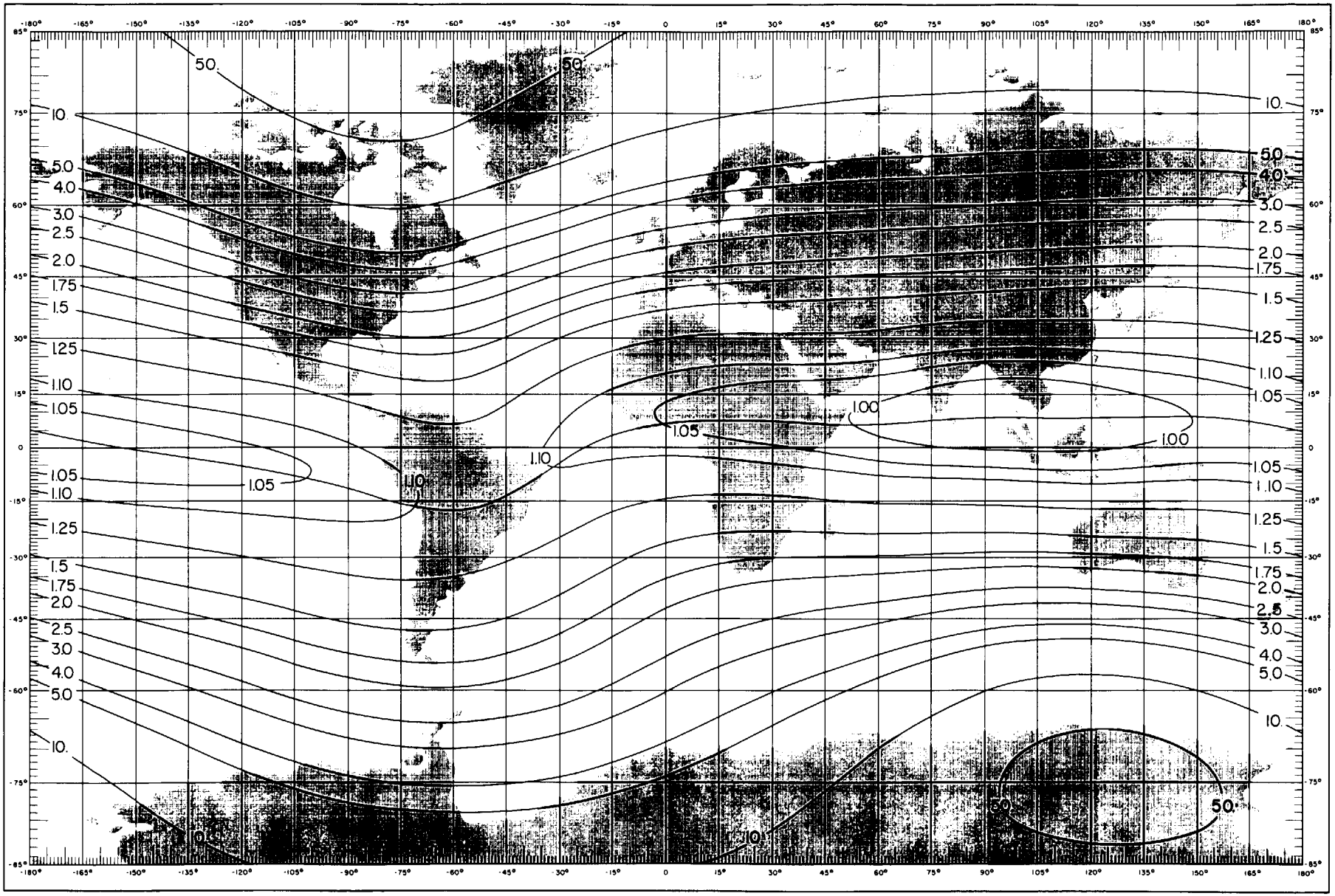
ALTITUDE= 100 KM

LINES OF CONSTANT L (EARTH RADII)



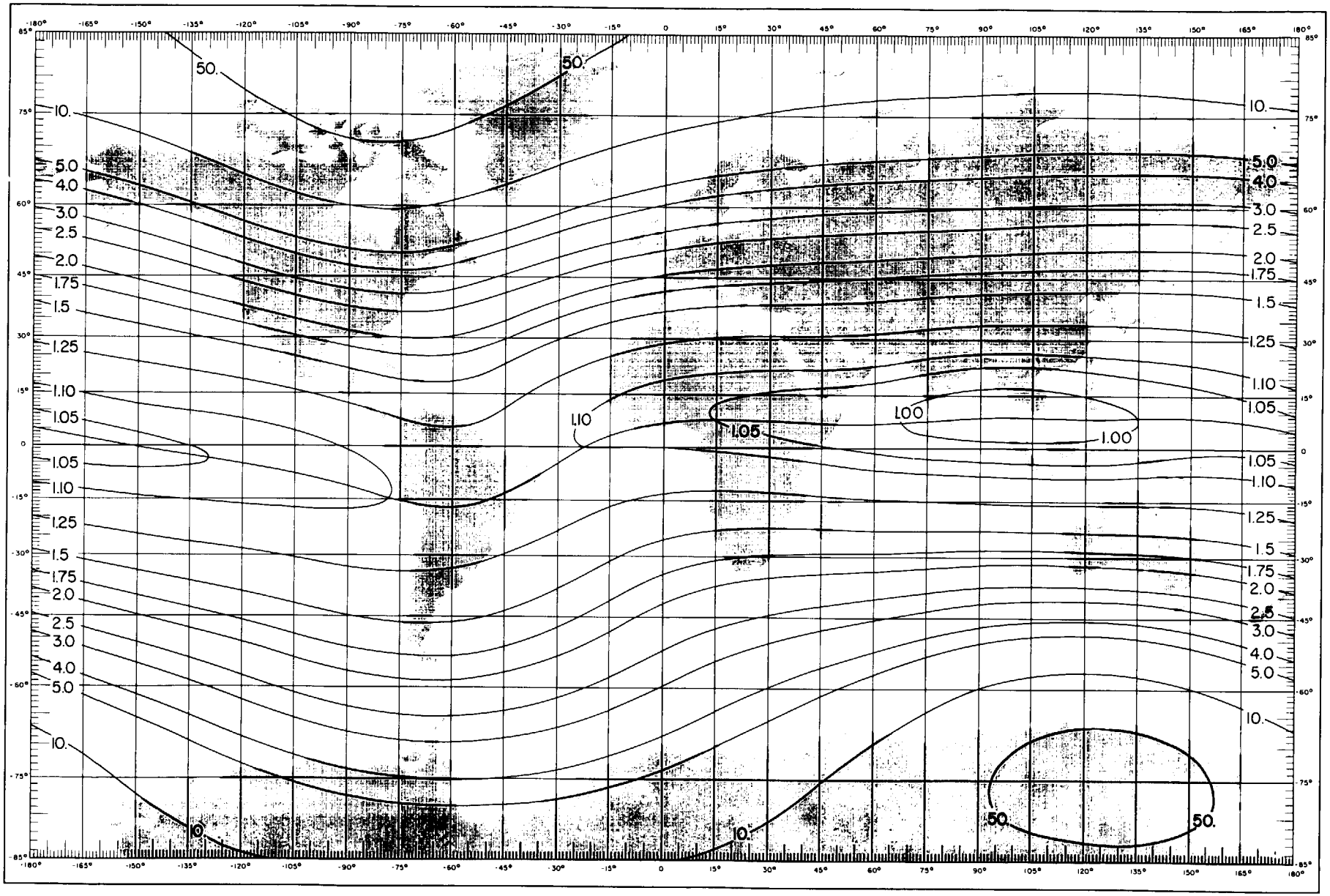
ALTITUDE = 200 KM

LINES OF CONSTANT L (EARTH RADII)



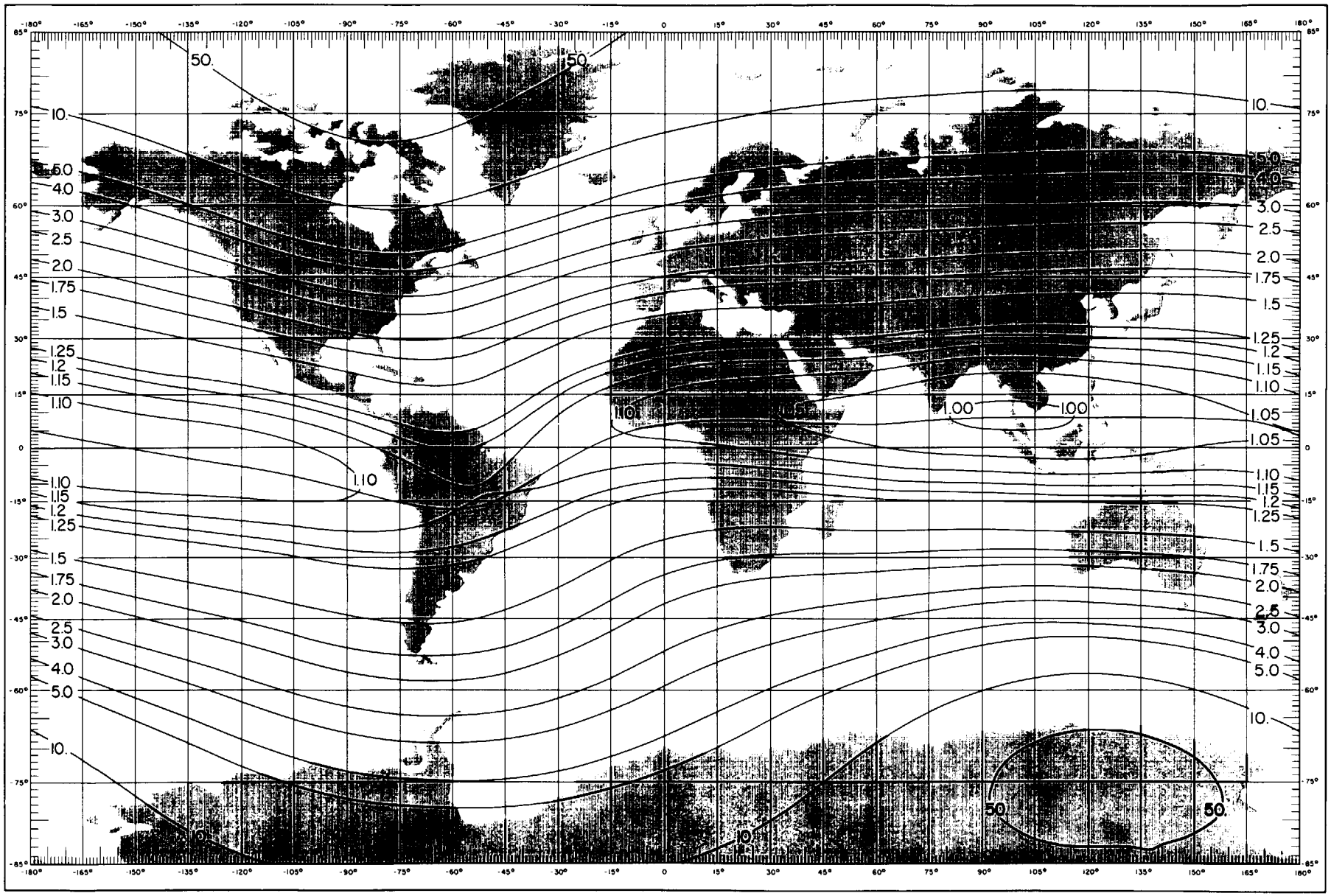
ALTITUDE = 300 KM

LINES OF CONSTANT L (EARTH RADII)



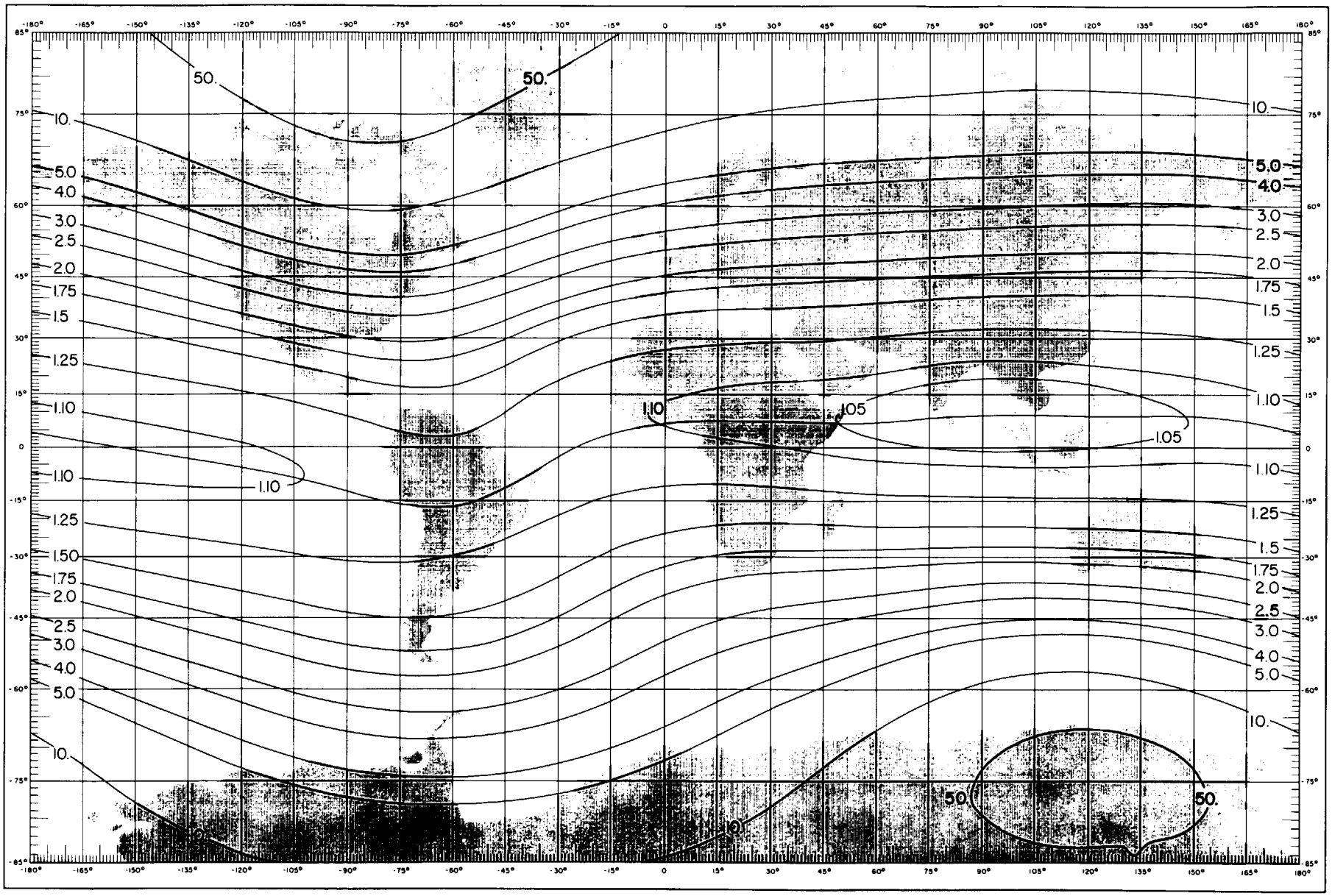
ALTITUDE = 400 KM

LINES OF CONSTANT L (EARTH RADII)



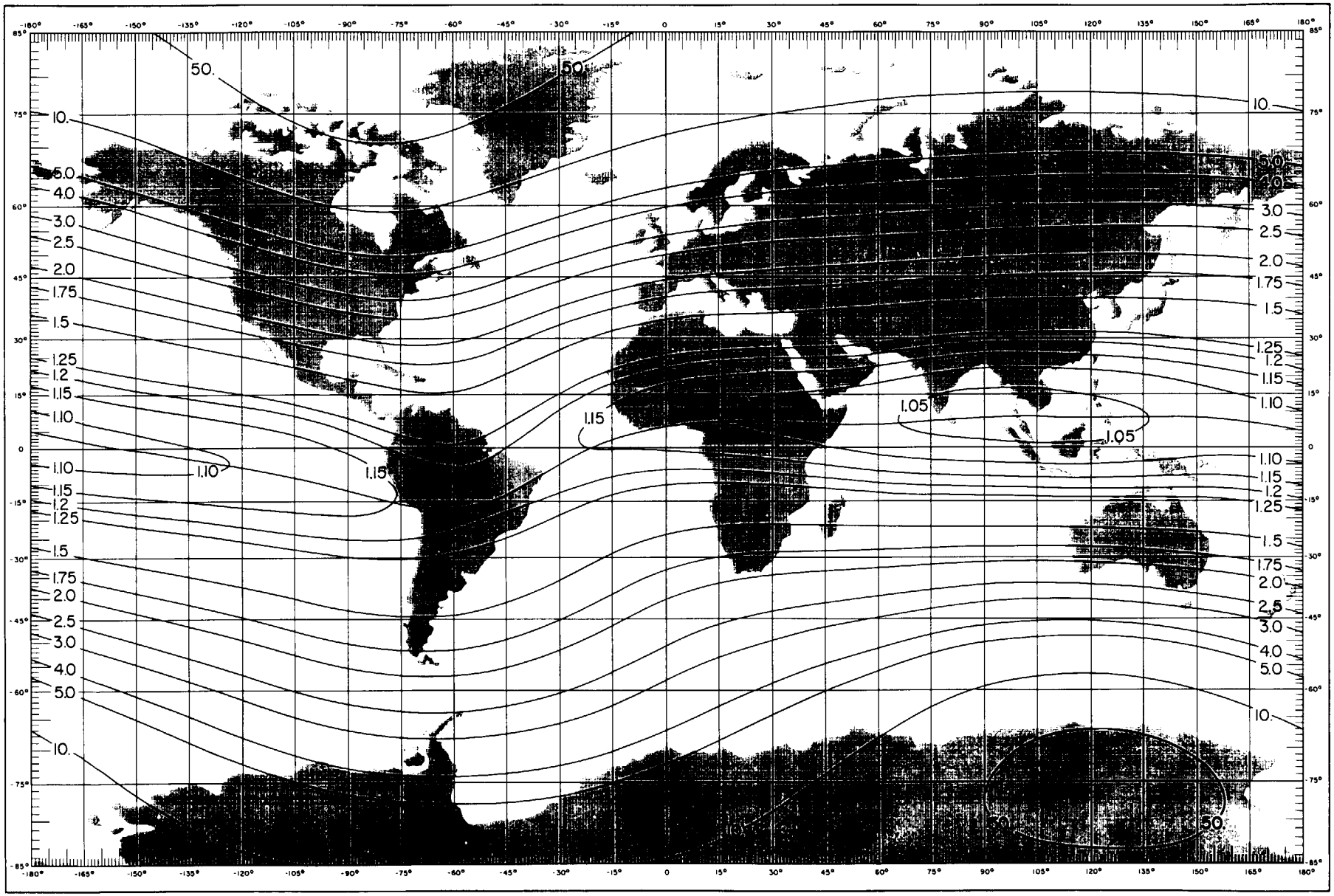
ALTITUDE = 500 KM

LINES OF CONSTANT L (EARTH RADII)



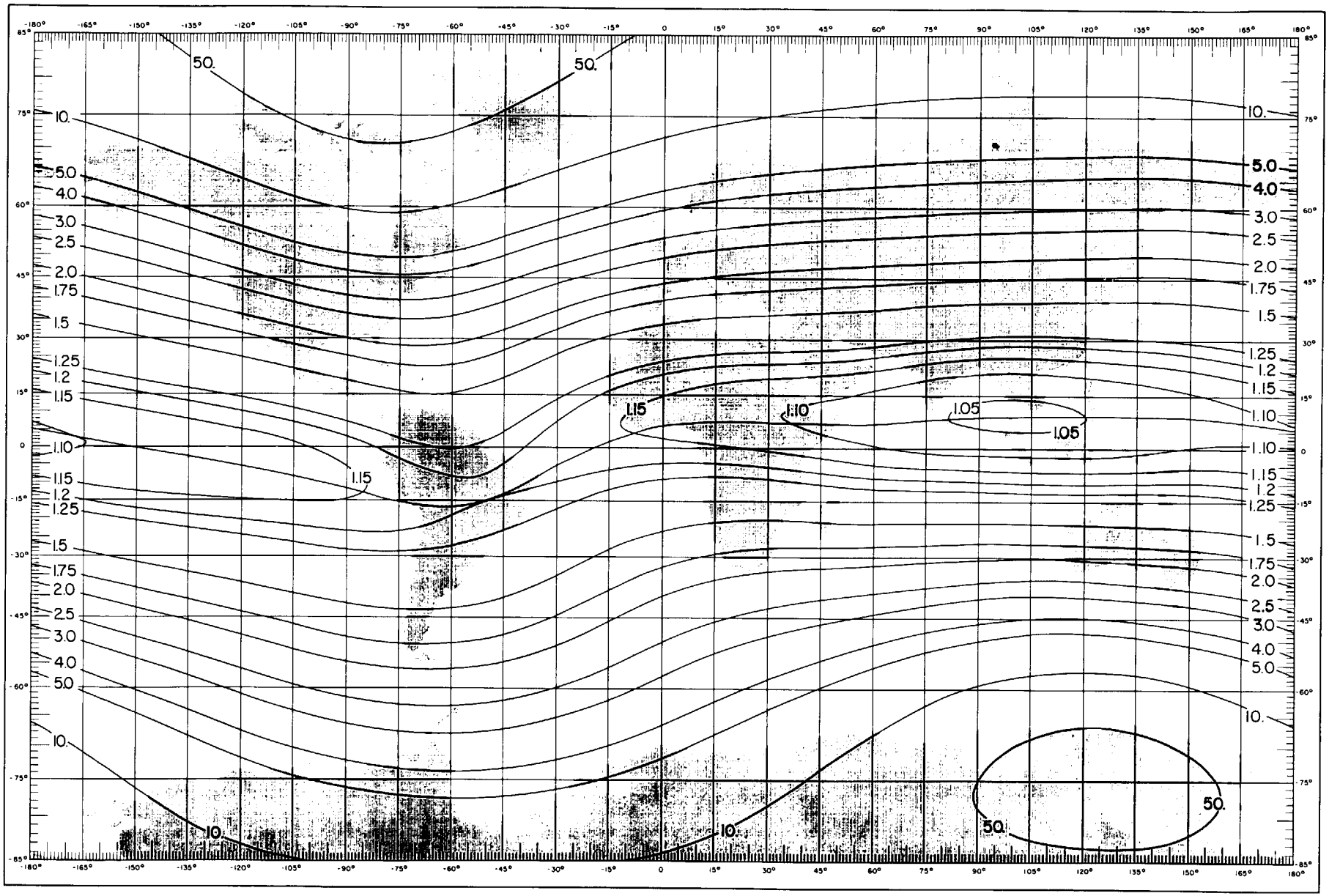
ALTITUDE = 600 KM

LINES OF CONSTANT L (EARTH RADII)



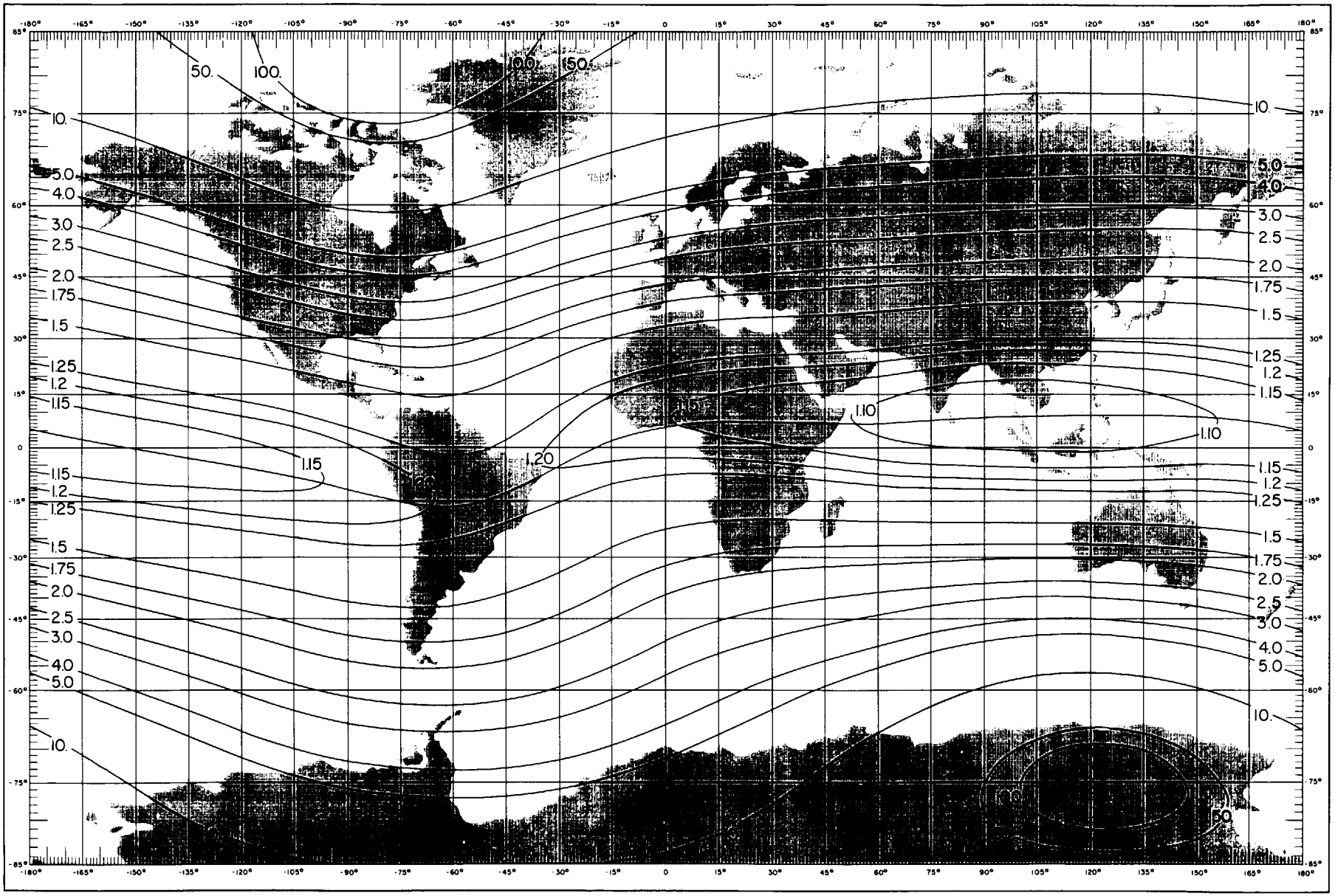
ALTITUDE = 700 KM

LINES OF CONSTANT L (EARTH RADII)



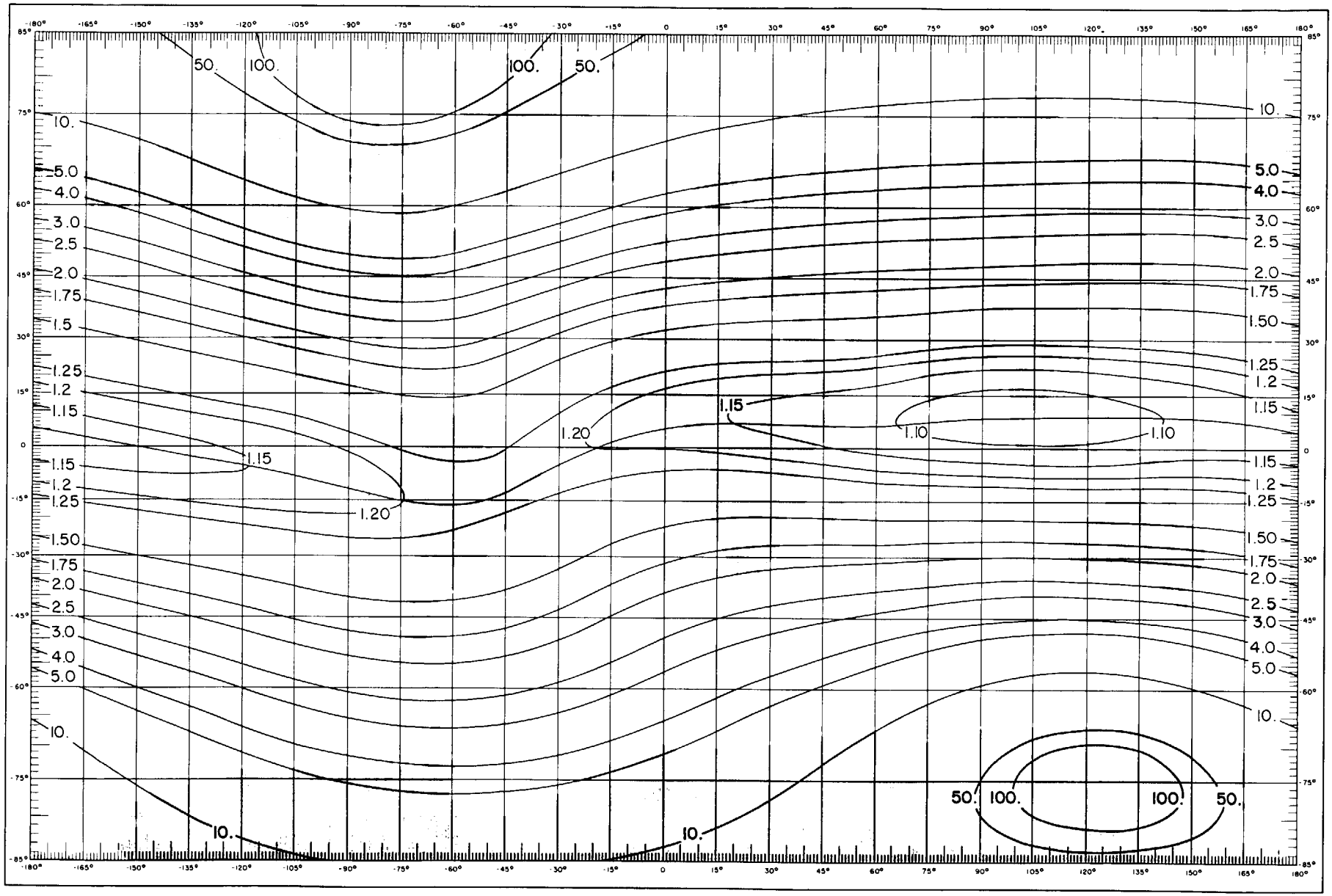
ALTITUDE = 800 KM

LINES OF CONSTANT L (EARTH RADII)



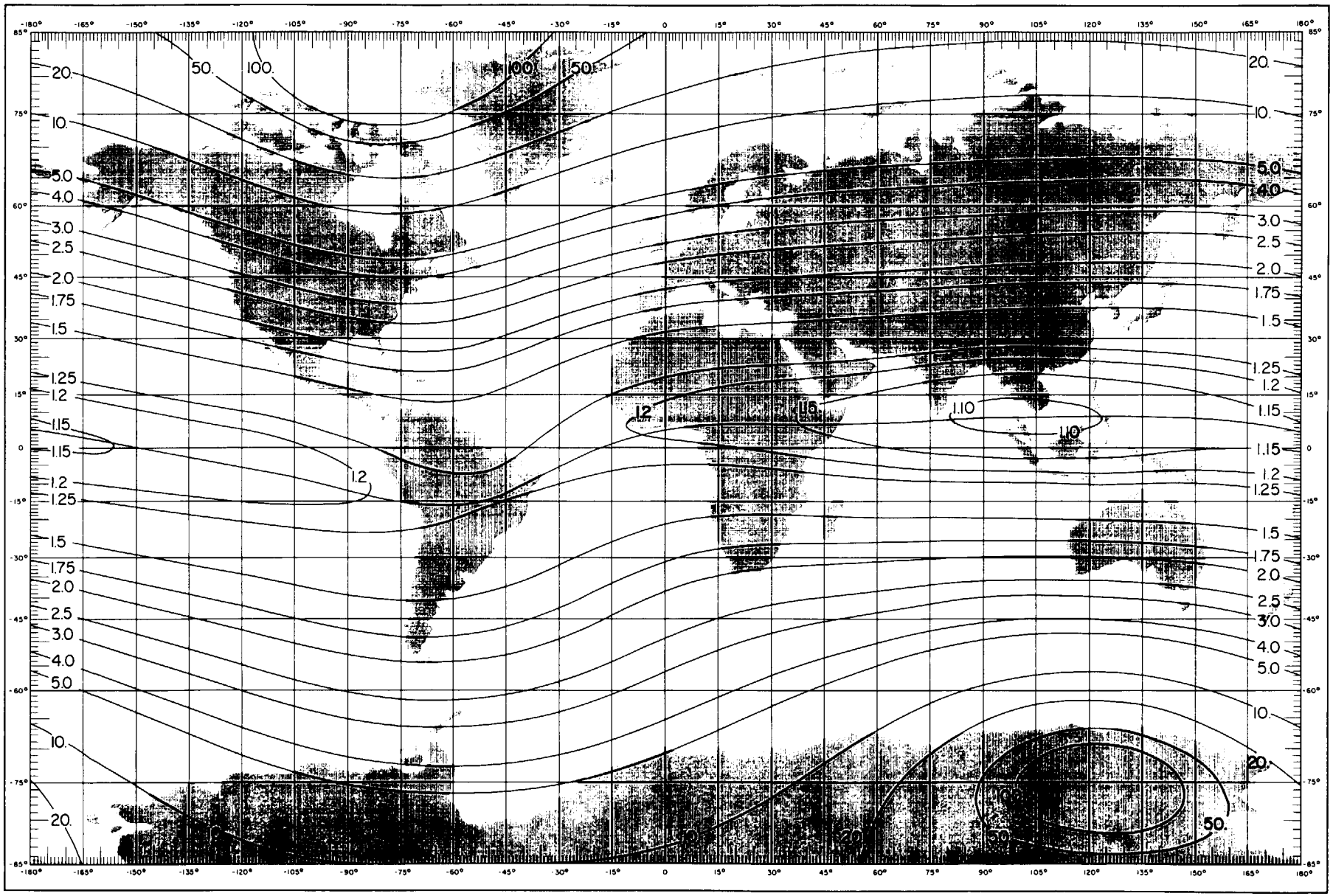
ALTITUDE = 900 KM

LINES OF CONSTANT L (EARTH RADII)



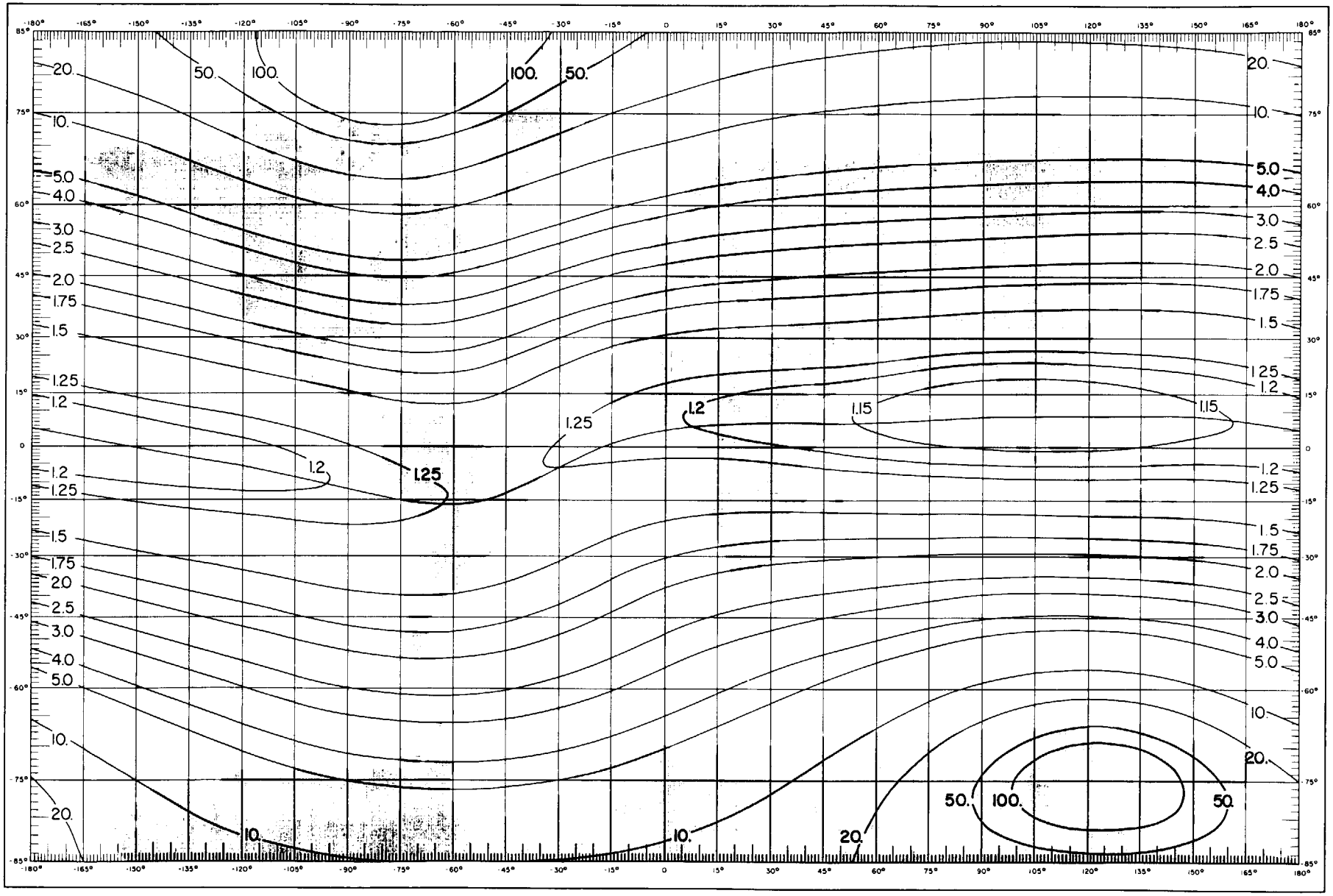
ALTITUDE = 1000 KM

LINES OF CONSTANT L (EARTH RADII)



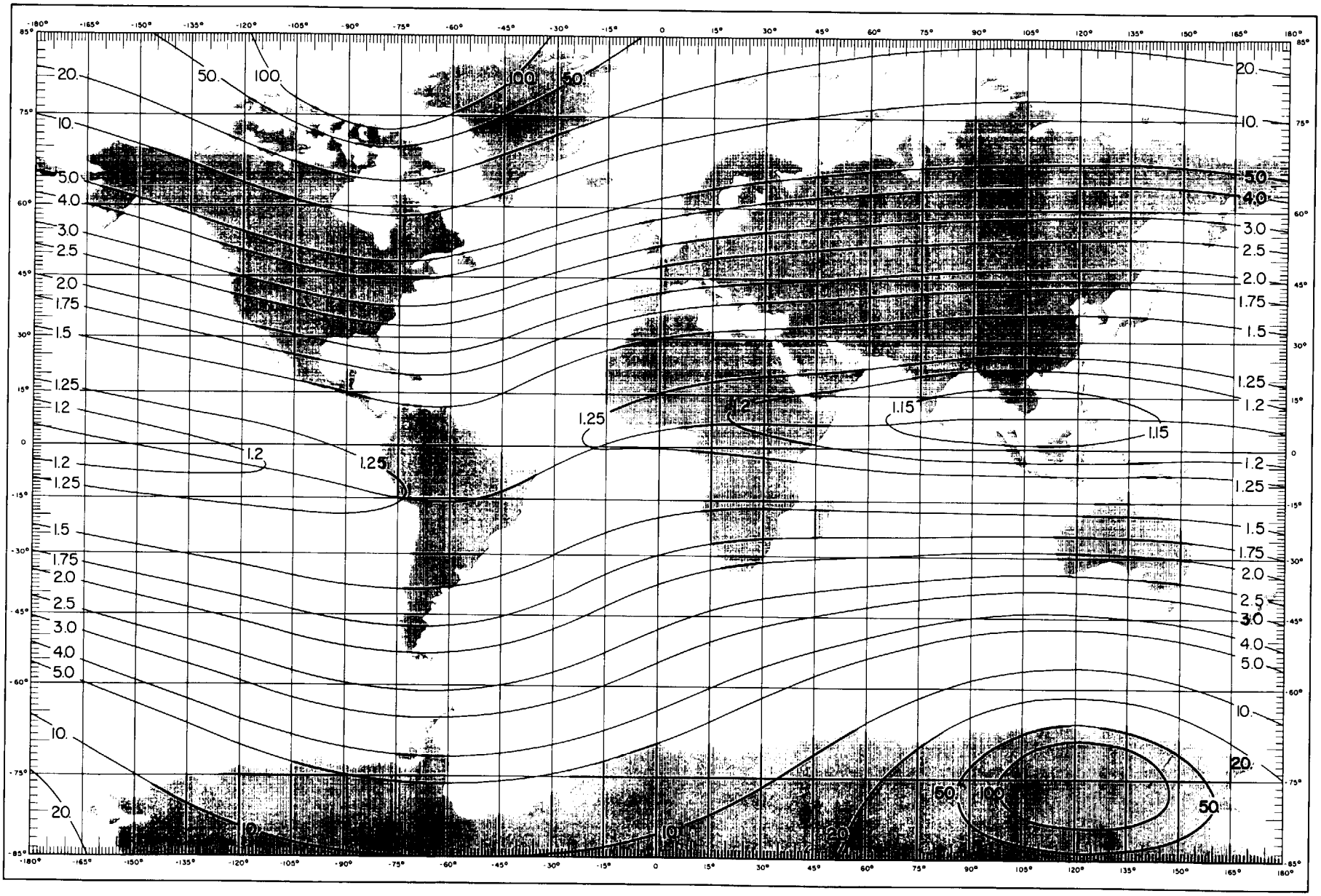
ALTITUDE = 1100 KM

LINES OF CONSTANT L (EARTH RADII)



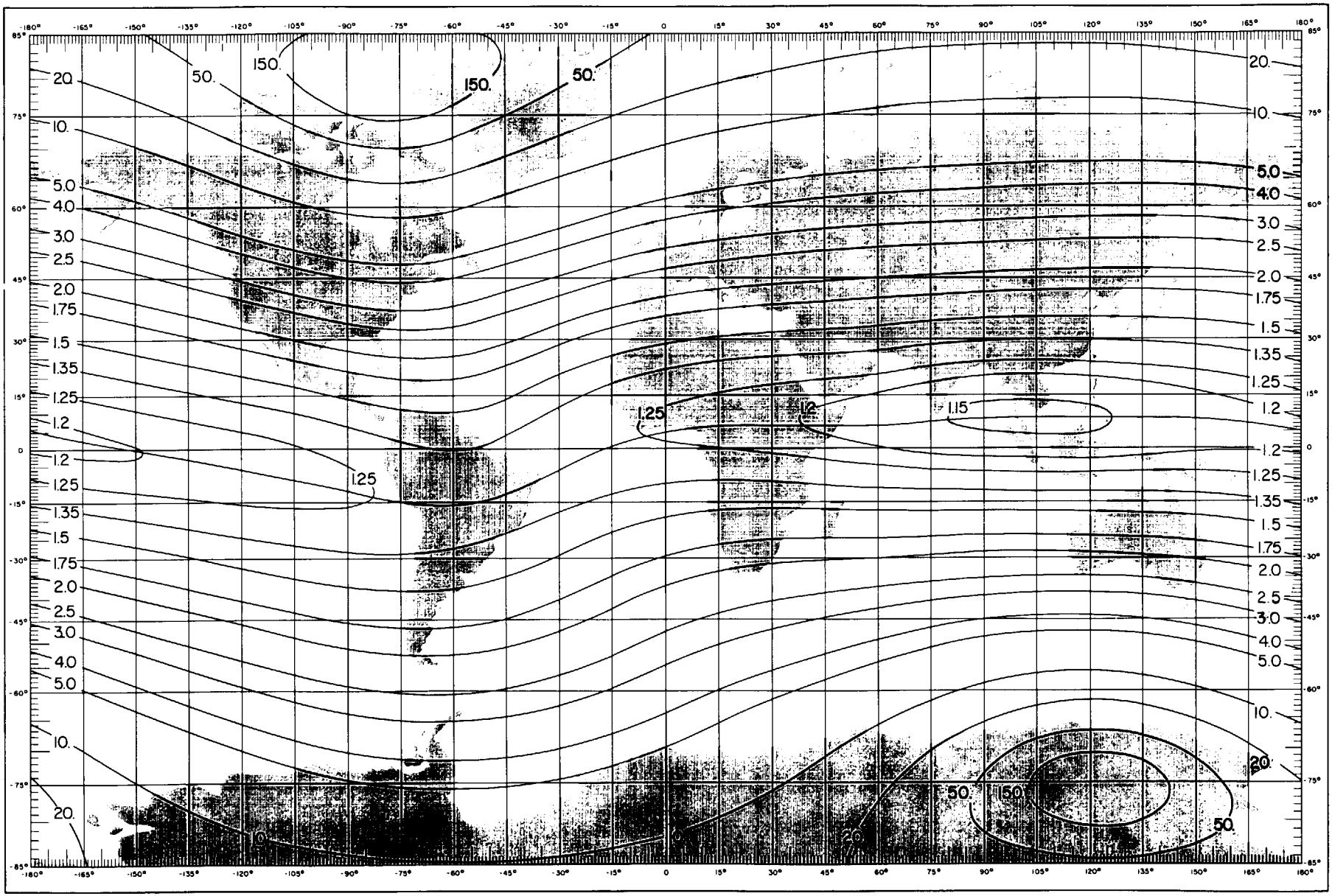
ALTITUDE = 1200 KM

LINES OF CONSTANT L (EARTH RADII)



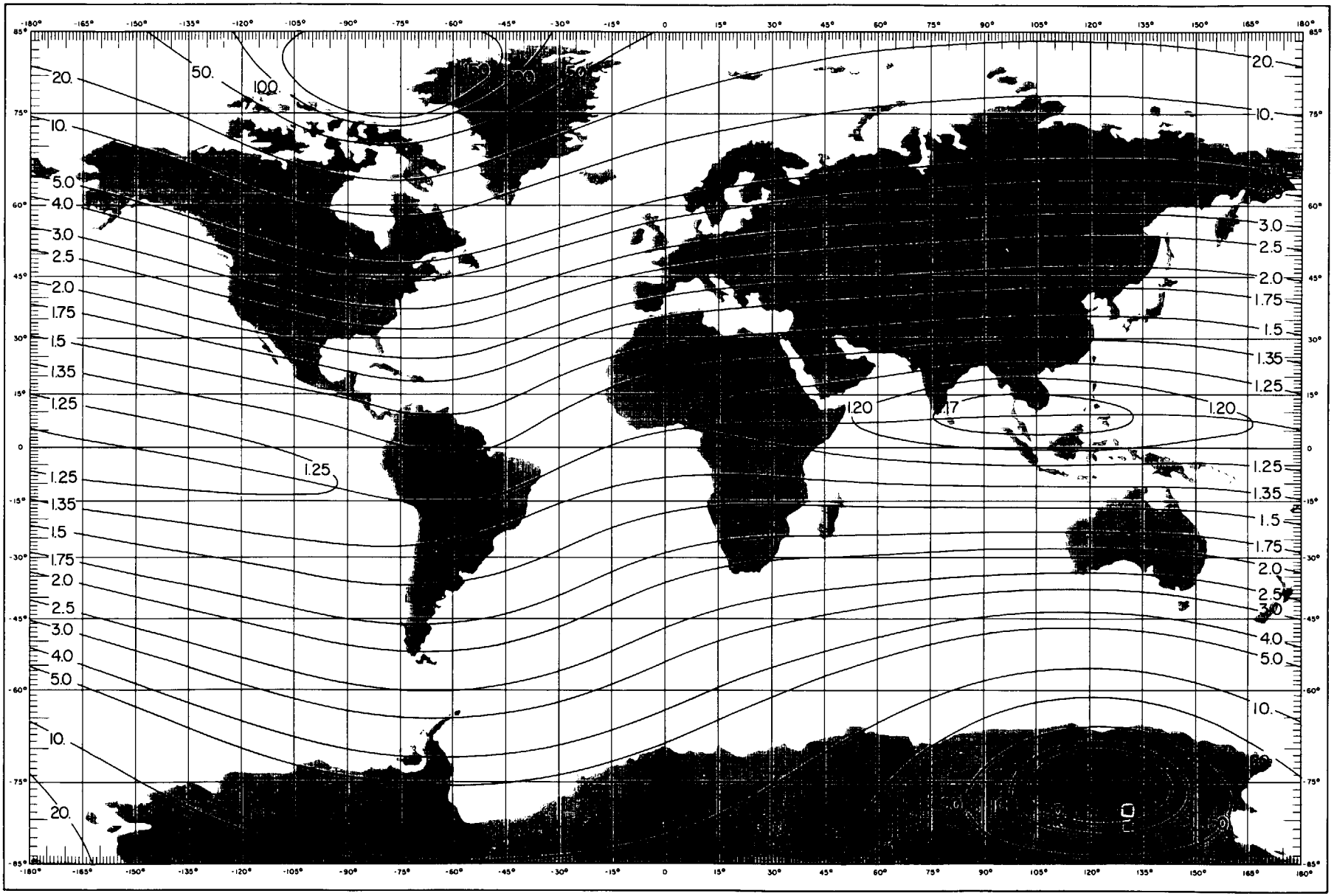
ALTITUDE = 1300 KM

LINES OF CONSTANT L (EARTH RADII)



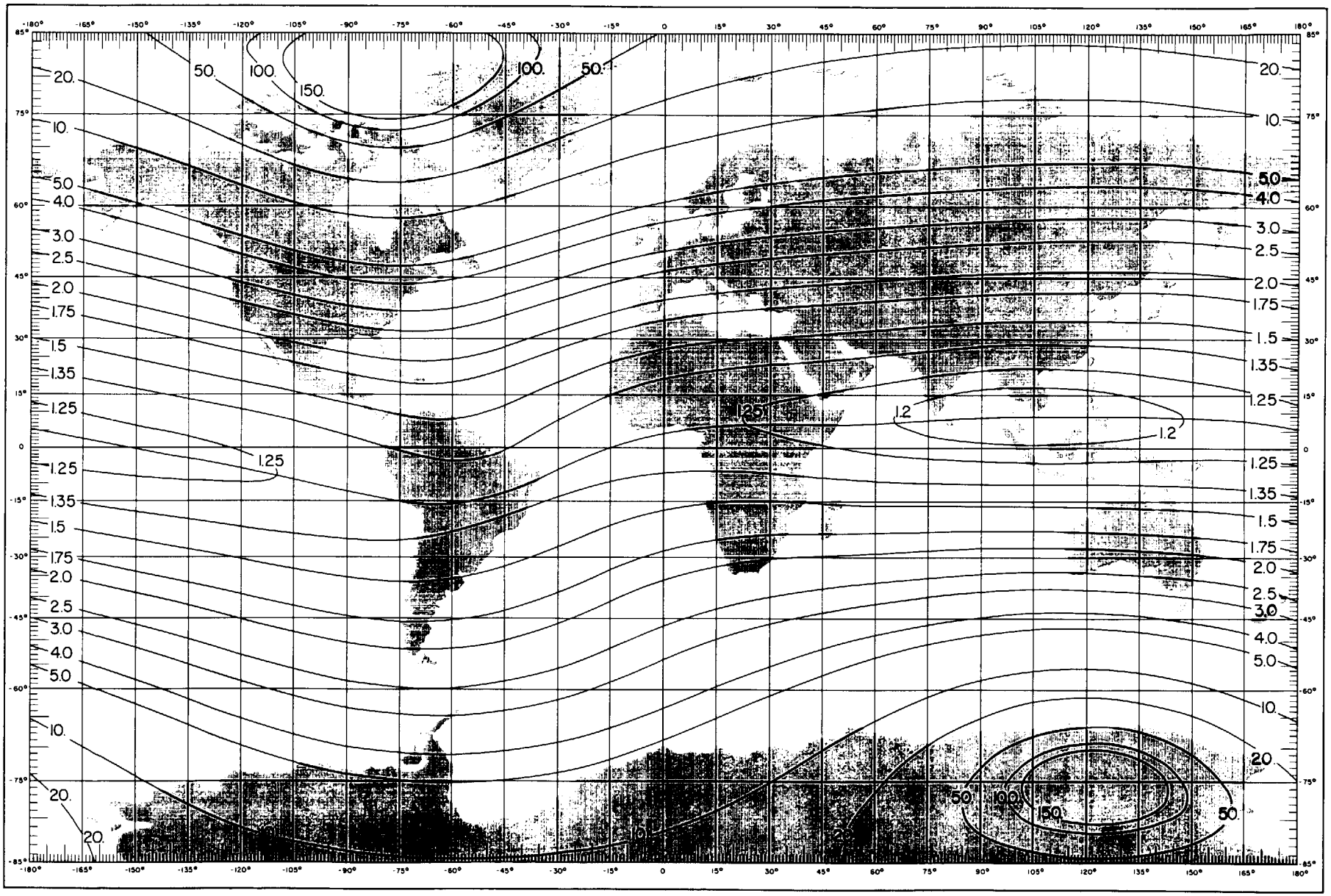
ALTITUDE = 1400 KM

LINES OF CONSTANT L (EARTH RADII)



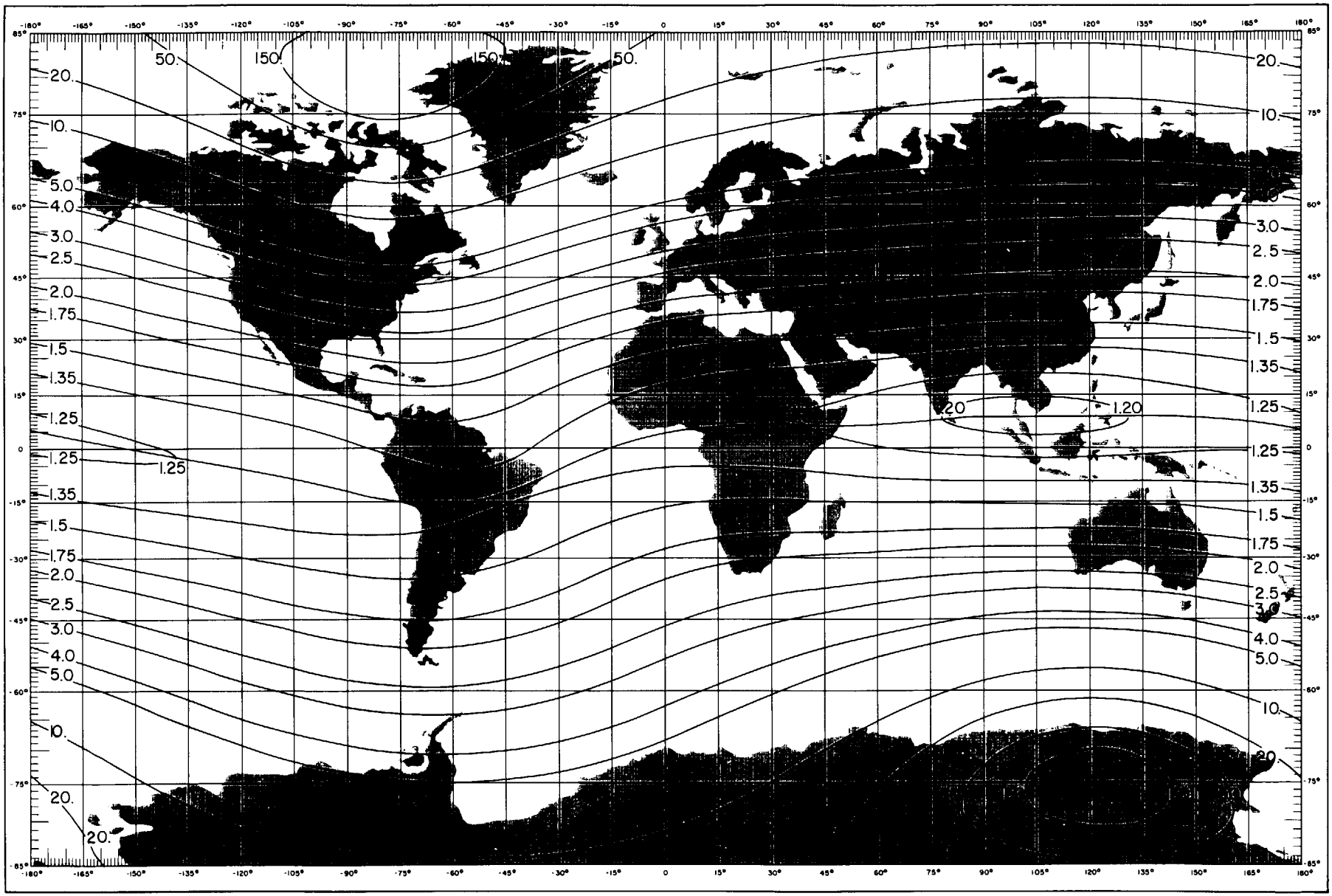
ALTITUDE = 1500 KM

LINES OF CONSTANT L (EARTH RADII)



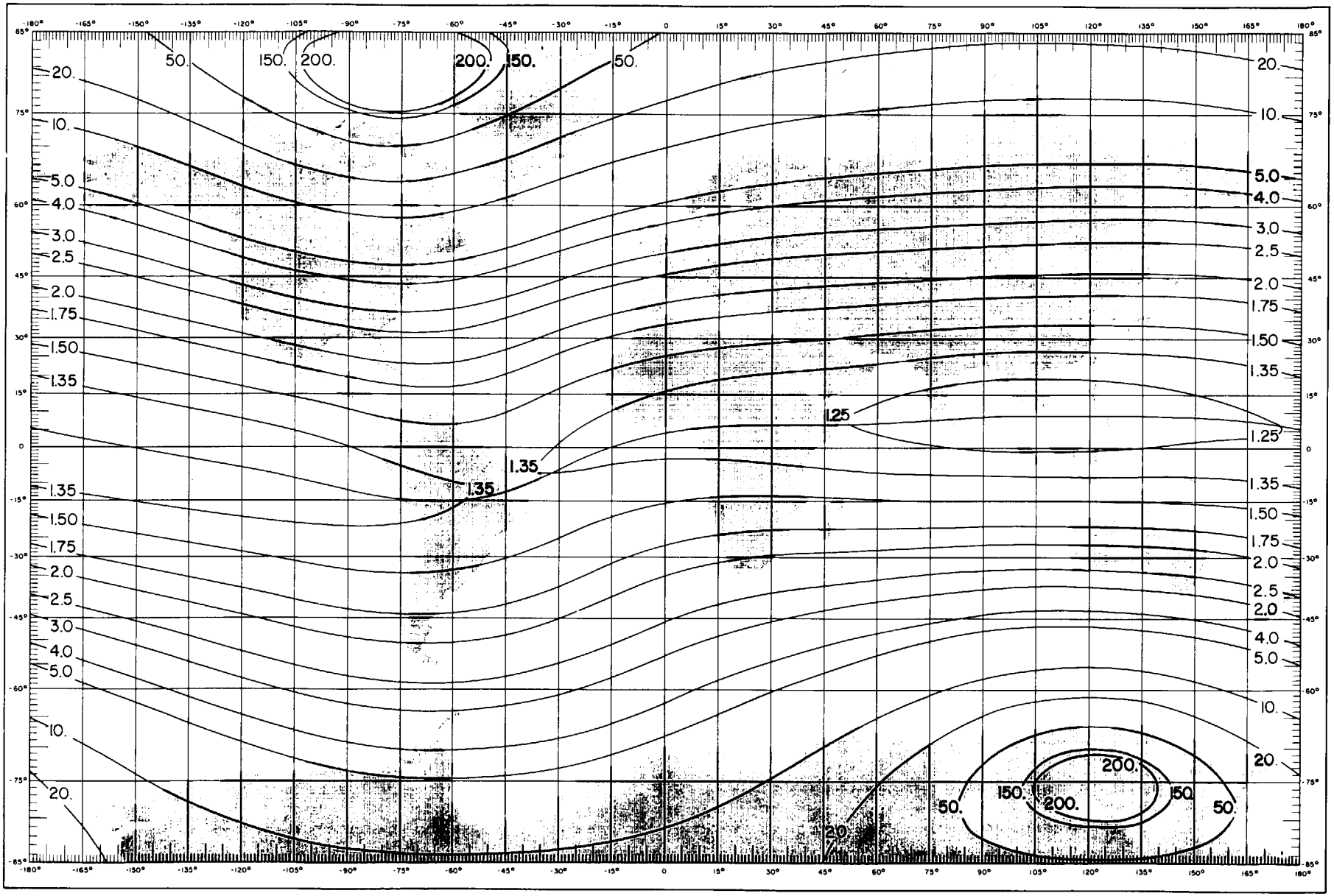
ALTITUDE = 1600 KM

LINES OF CONSTANT L (EARTH RADII)



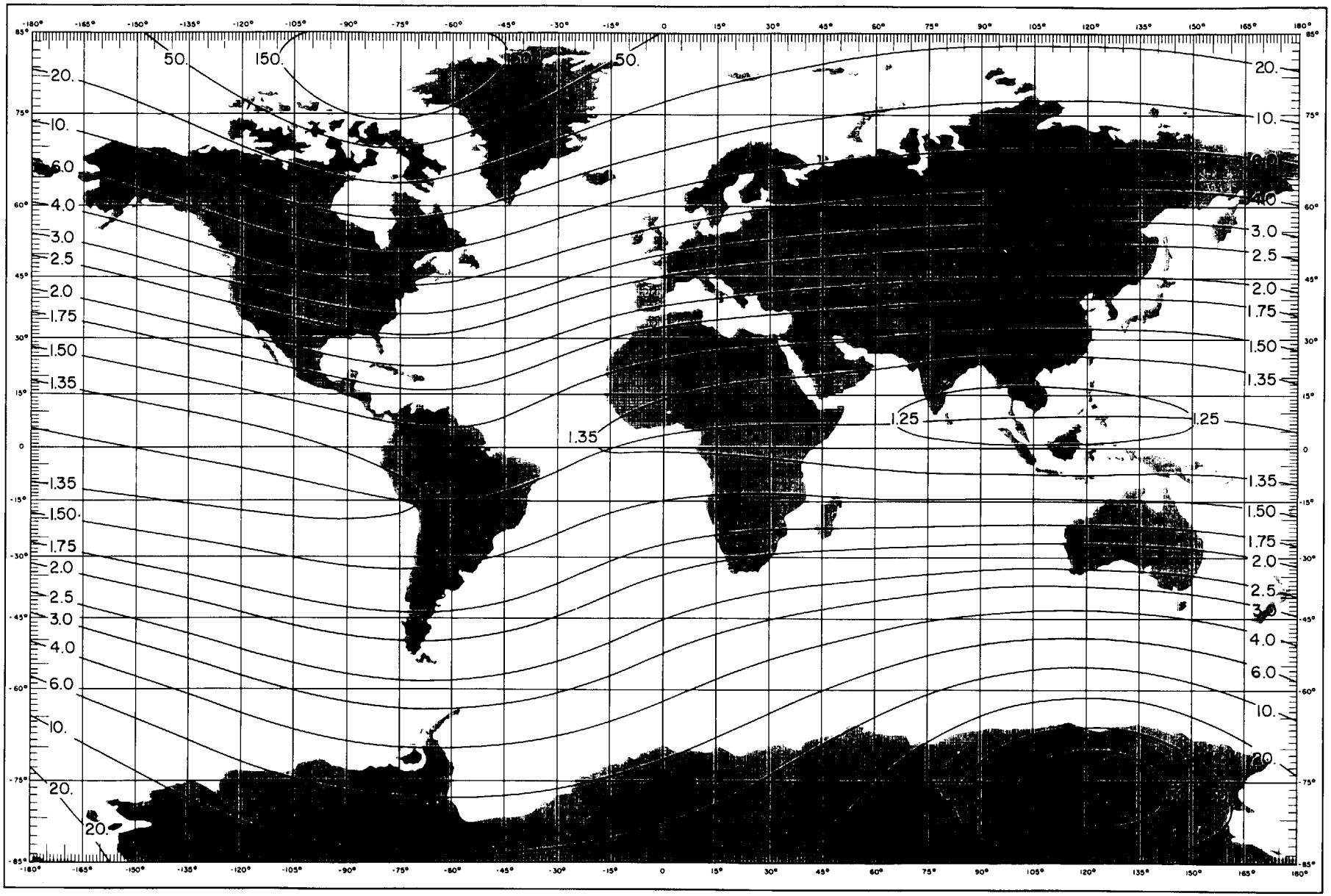
ALTITUDE = 1700 KM

LINES OF CONSTANT L (EARTH RADII)



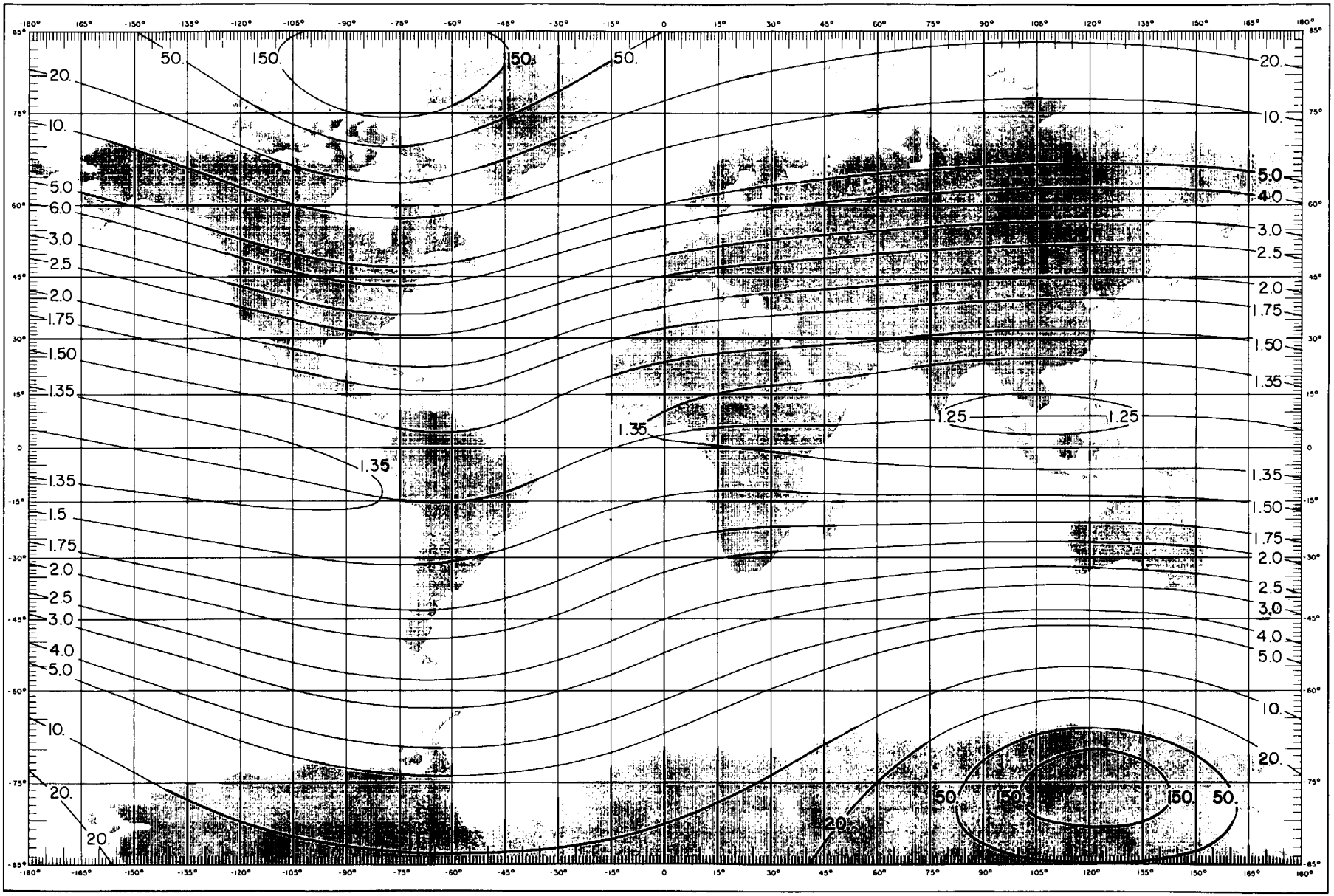
ALTITUDE = 1800 KM

LINES OF CONSTANT L (EARTH RADII)



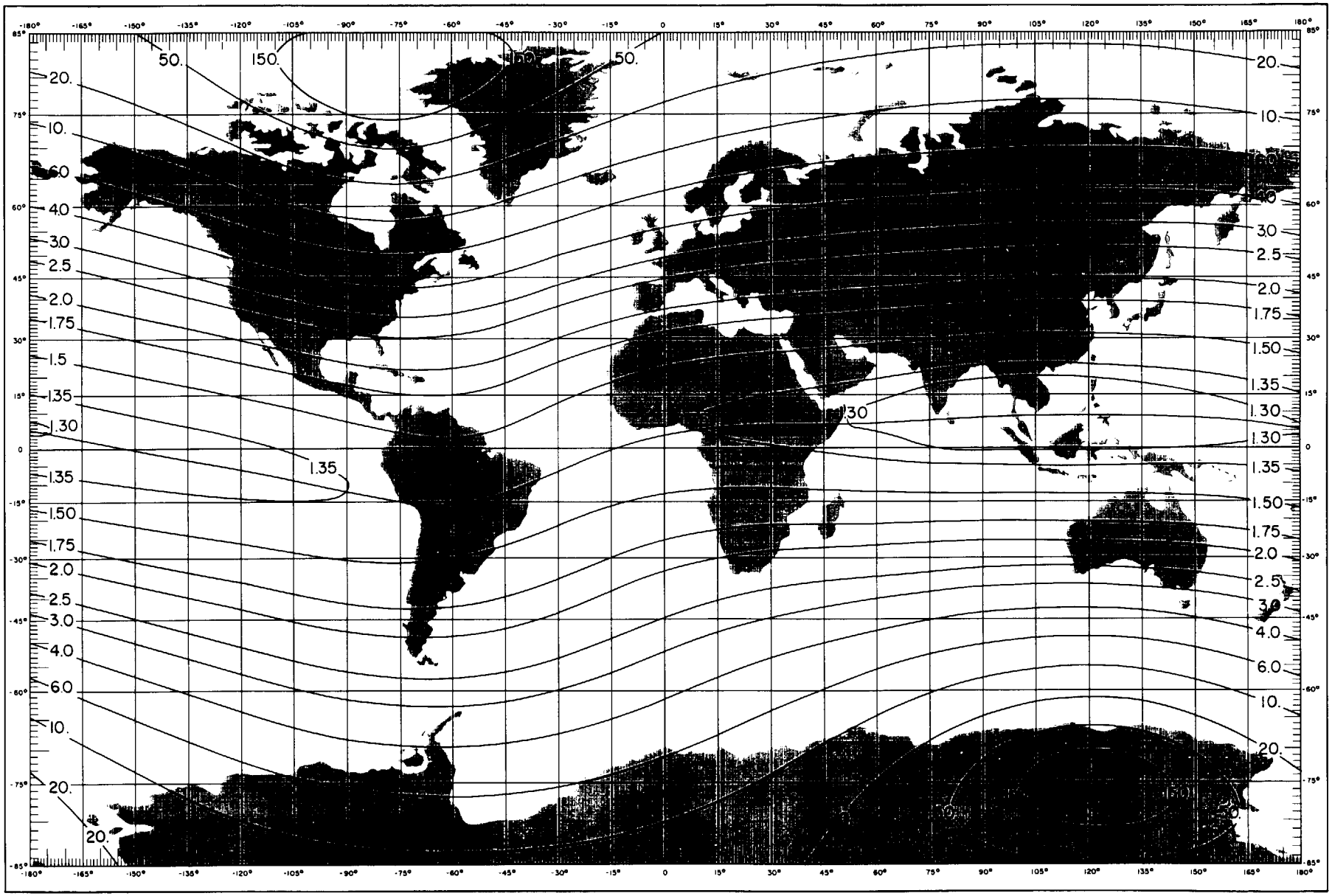
ALTITUDE = 1900 KM

LINES OF CONSTANT L (EARTH RADII)



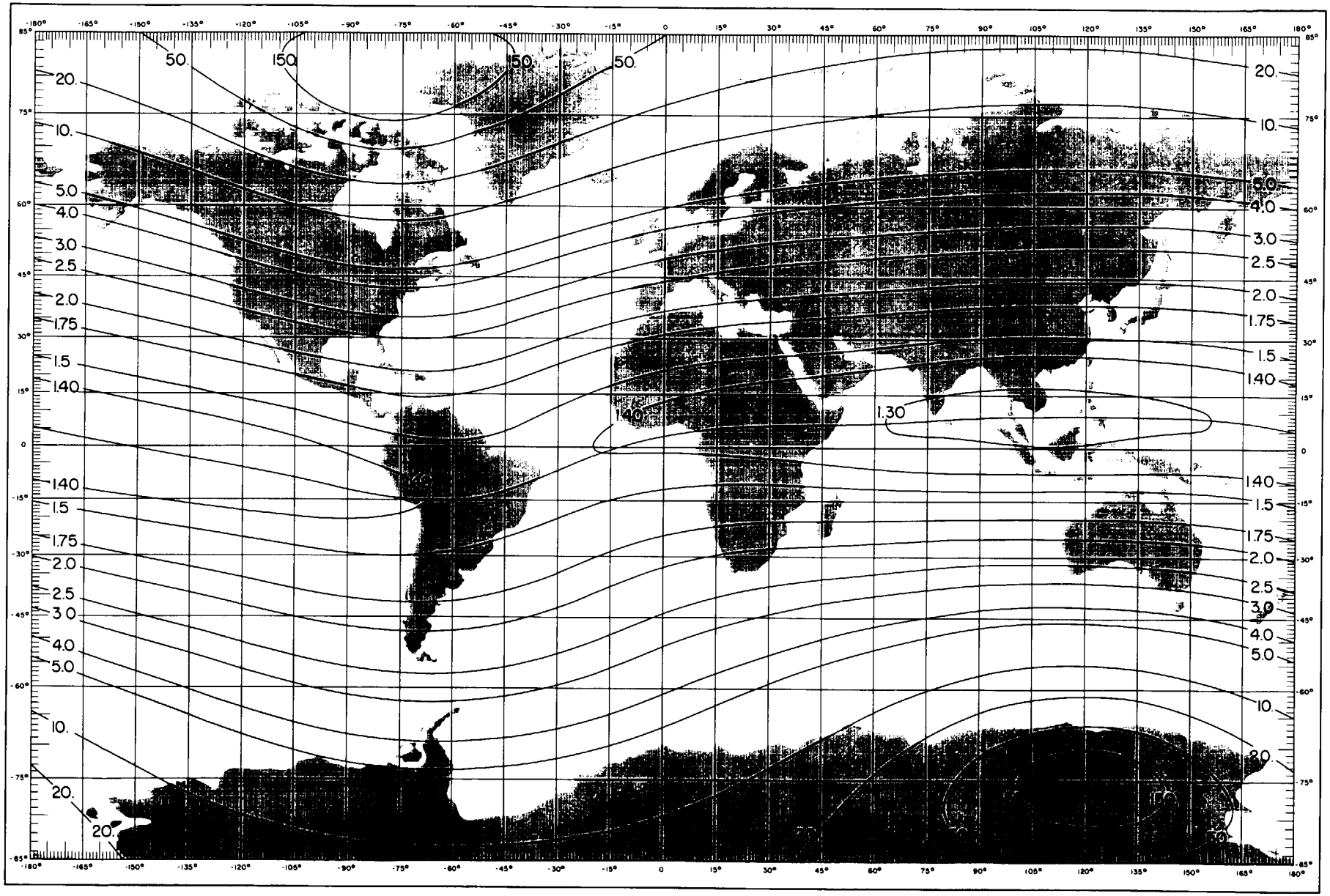
ALTITUDE = 2000 KM

LINES OF CONSTANT L (EARTH RADII)



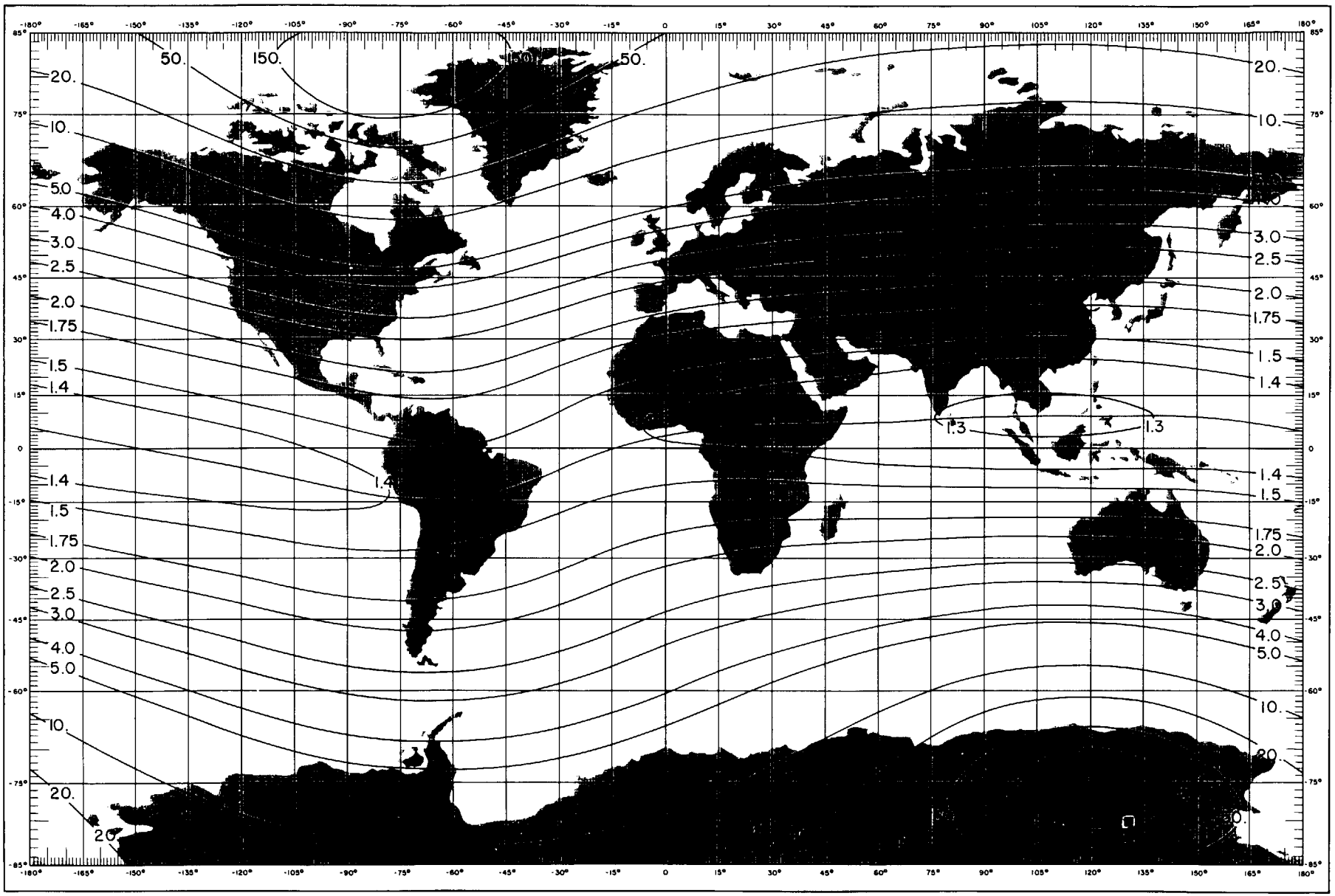
ALTITUDE = 2100 KM

LINES OF CONSTANT L (EARTH RADII)



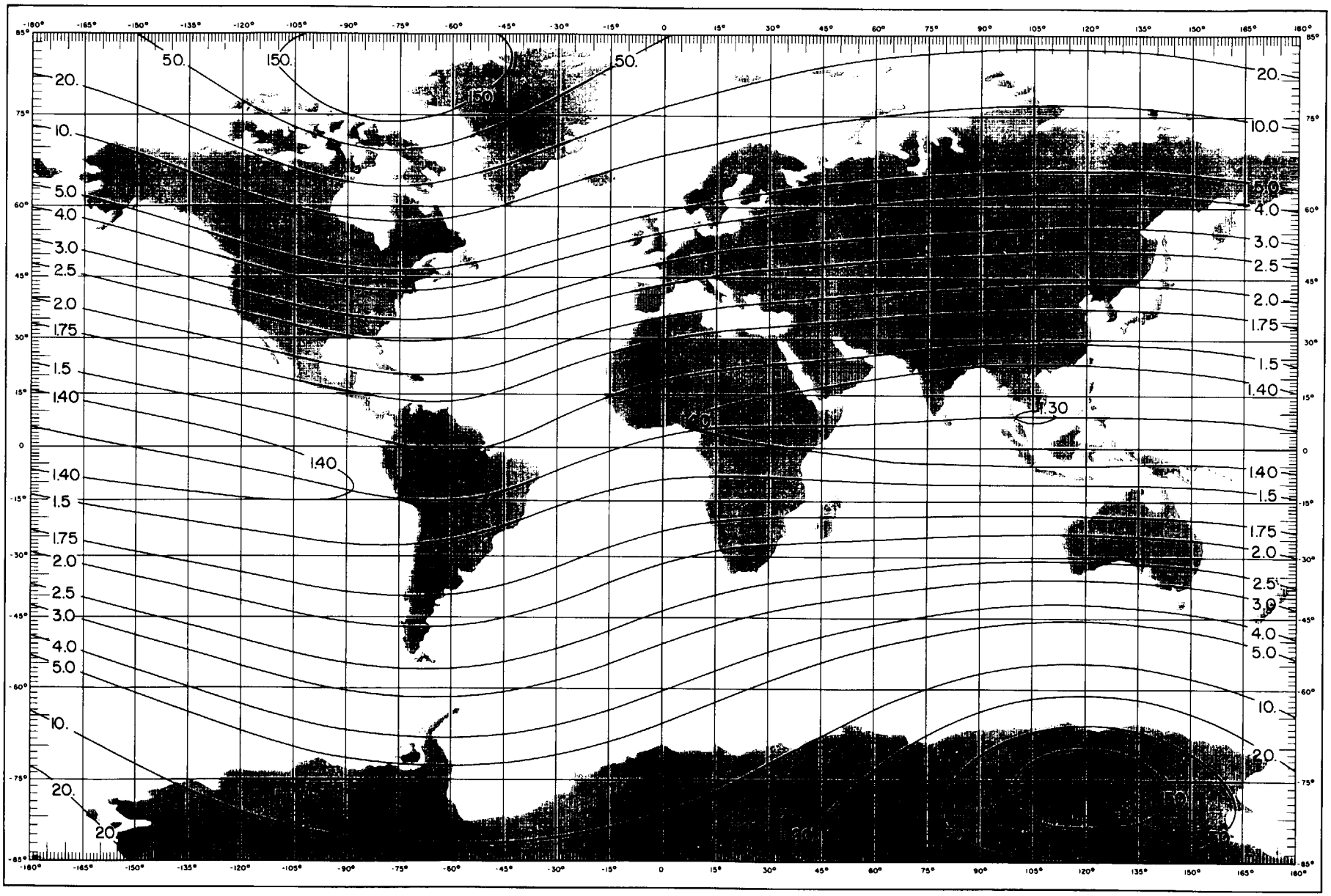
ALTITUDE = 2200 KM.

LINES OF CONSTANT L (EARTH RADII)



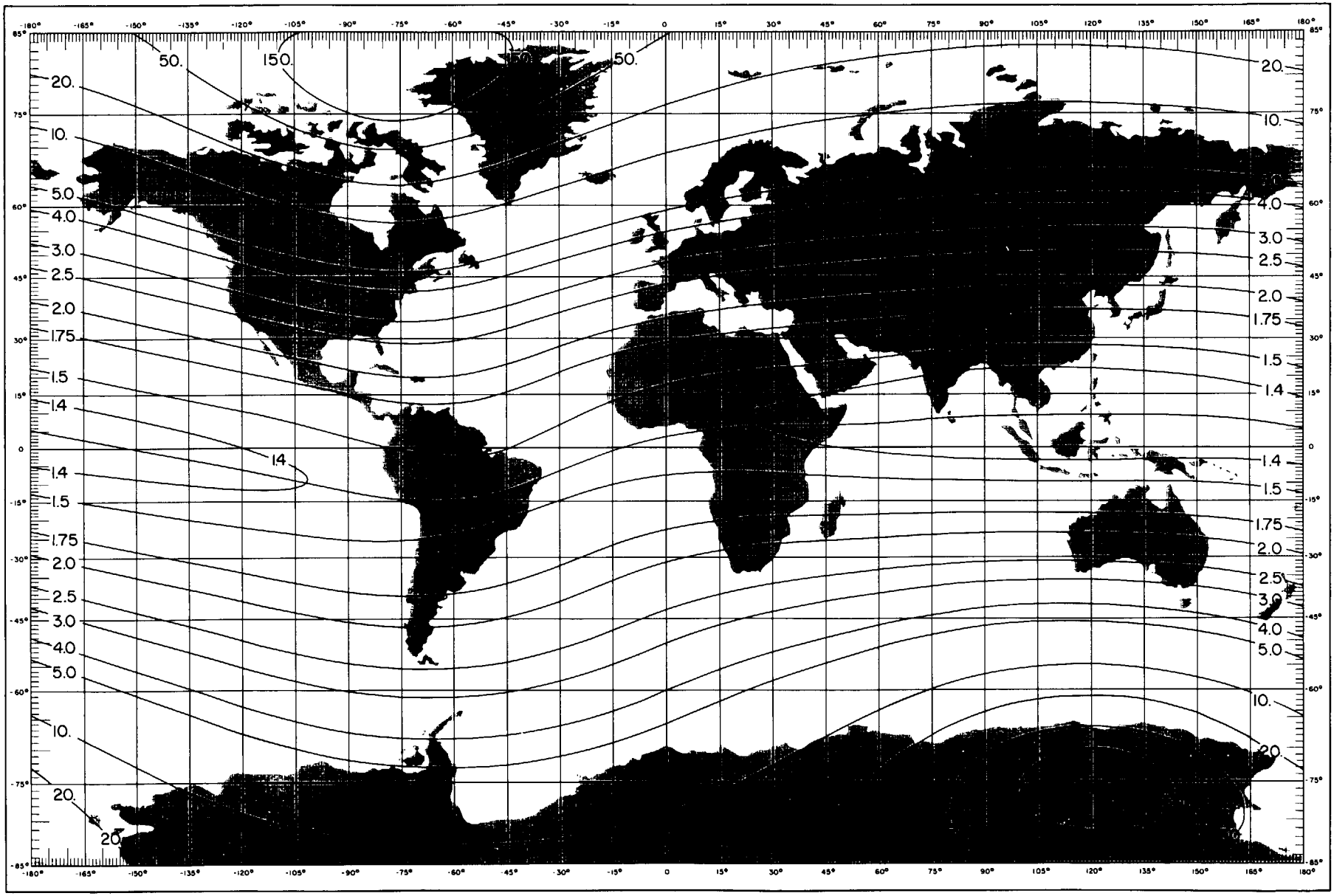
ALTITUDE = 2300 KM

LINES OF CONSTANT L (EARTH RADII)



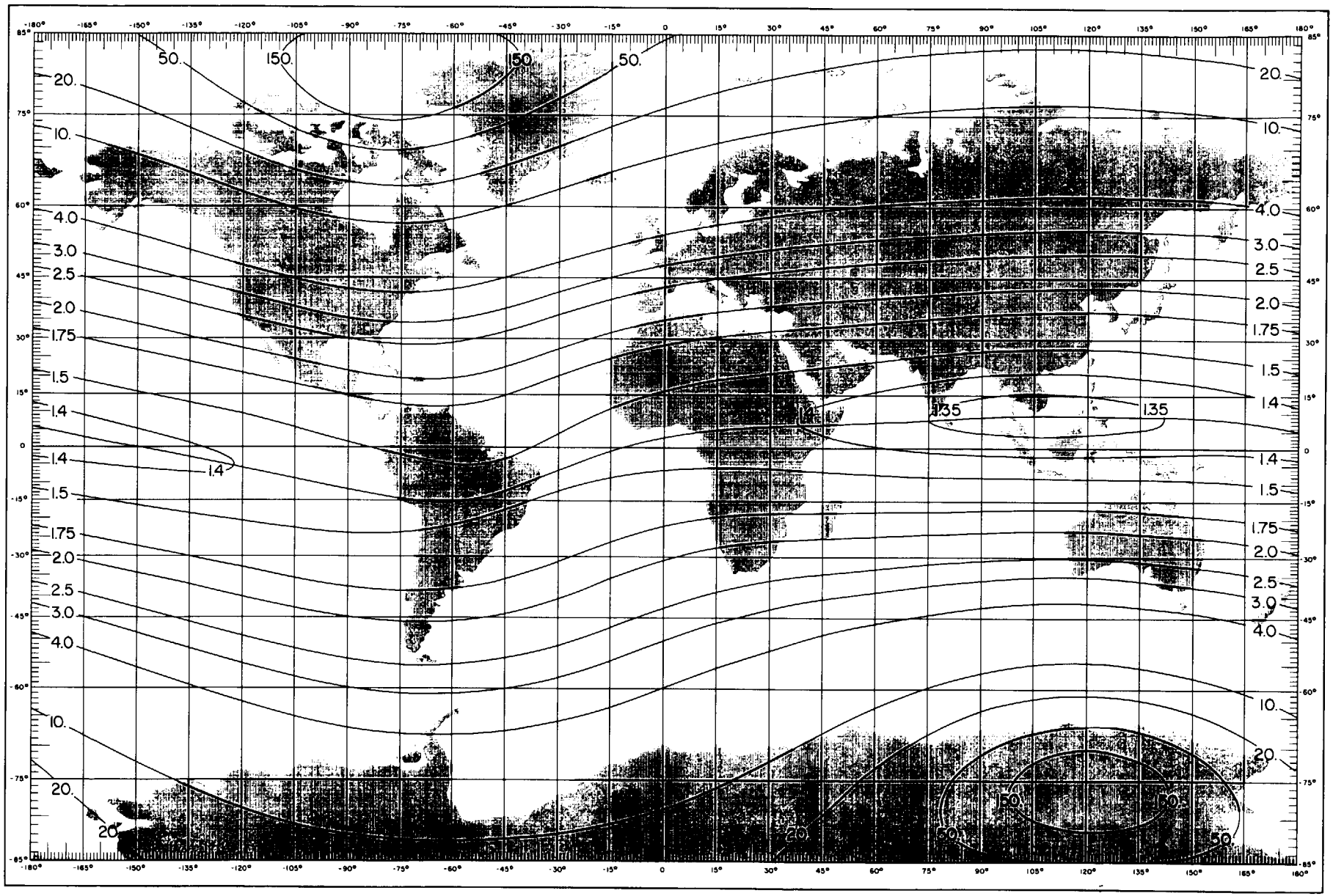
ALTITUDE = 2400 KM

LINES OF CONSTANT L (EARTH RADII)



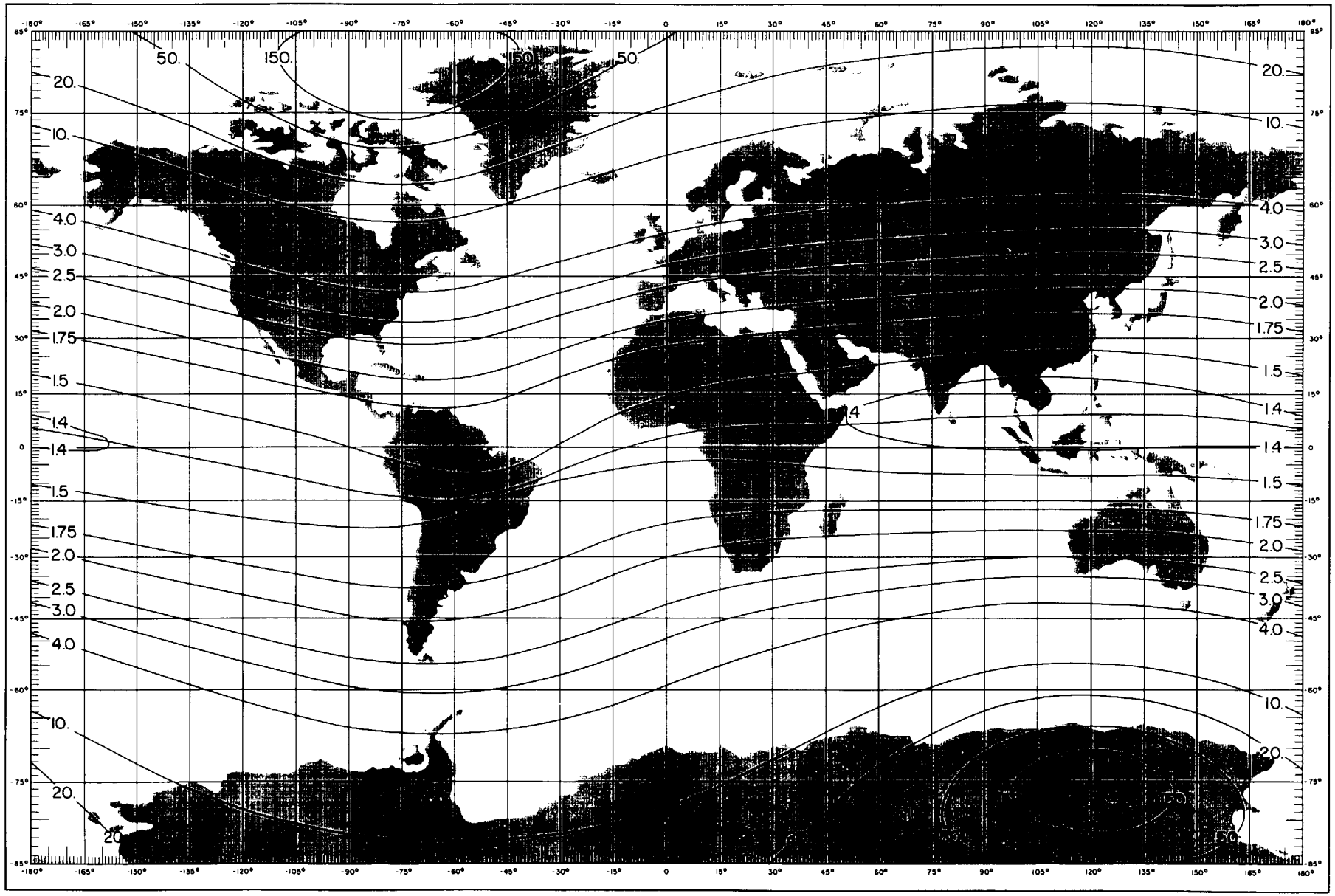
ALTITUDE = 2500 KM.

LINES OF CONSTANT L (EARTH RADII)



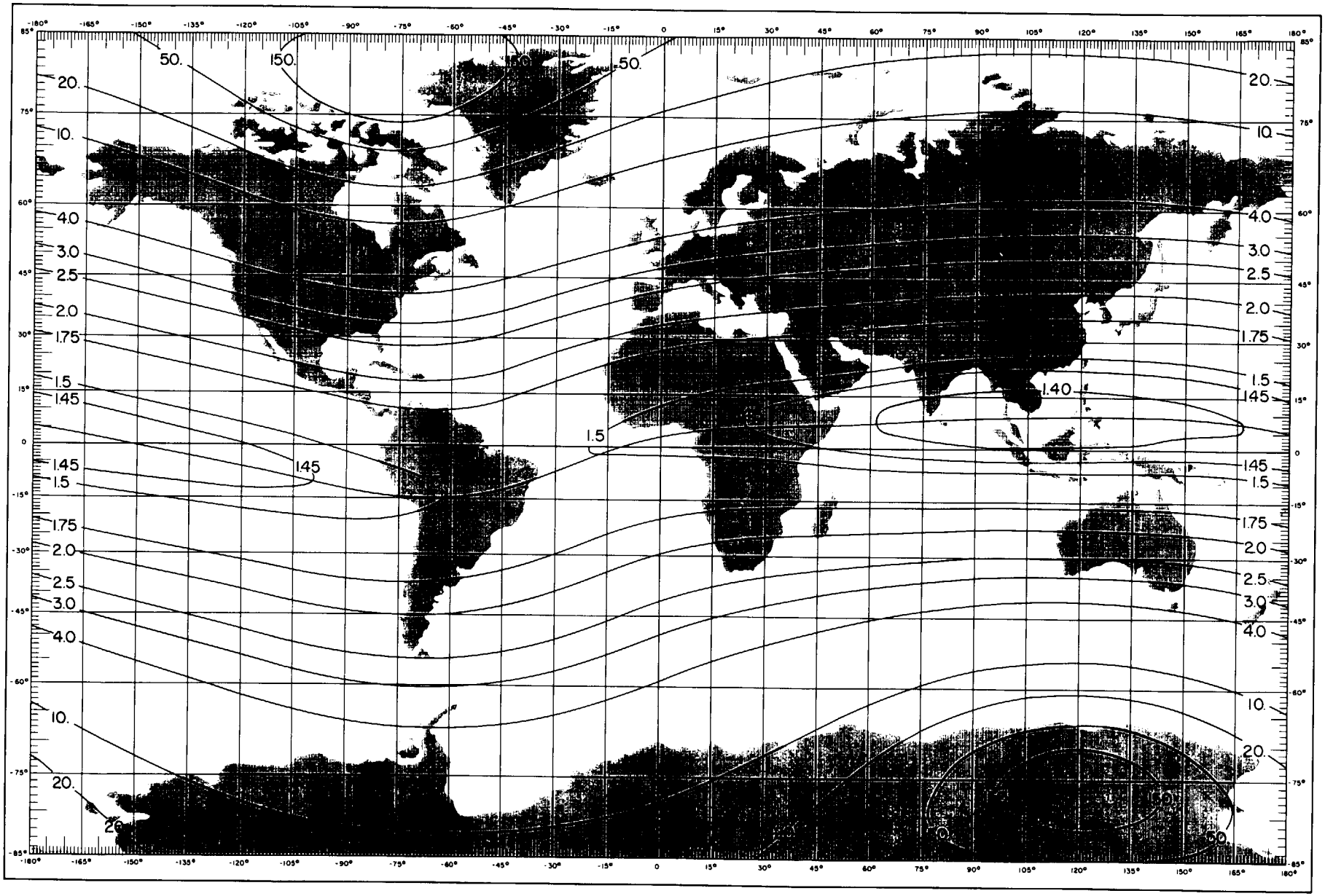
ALTITUDE = 2600 KM

LINES OF CONSTANT L (EARTH RADII)



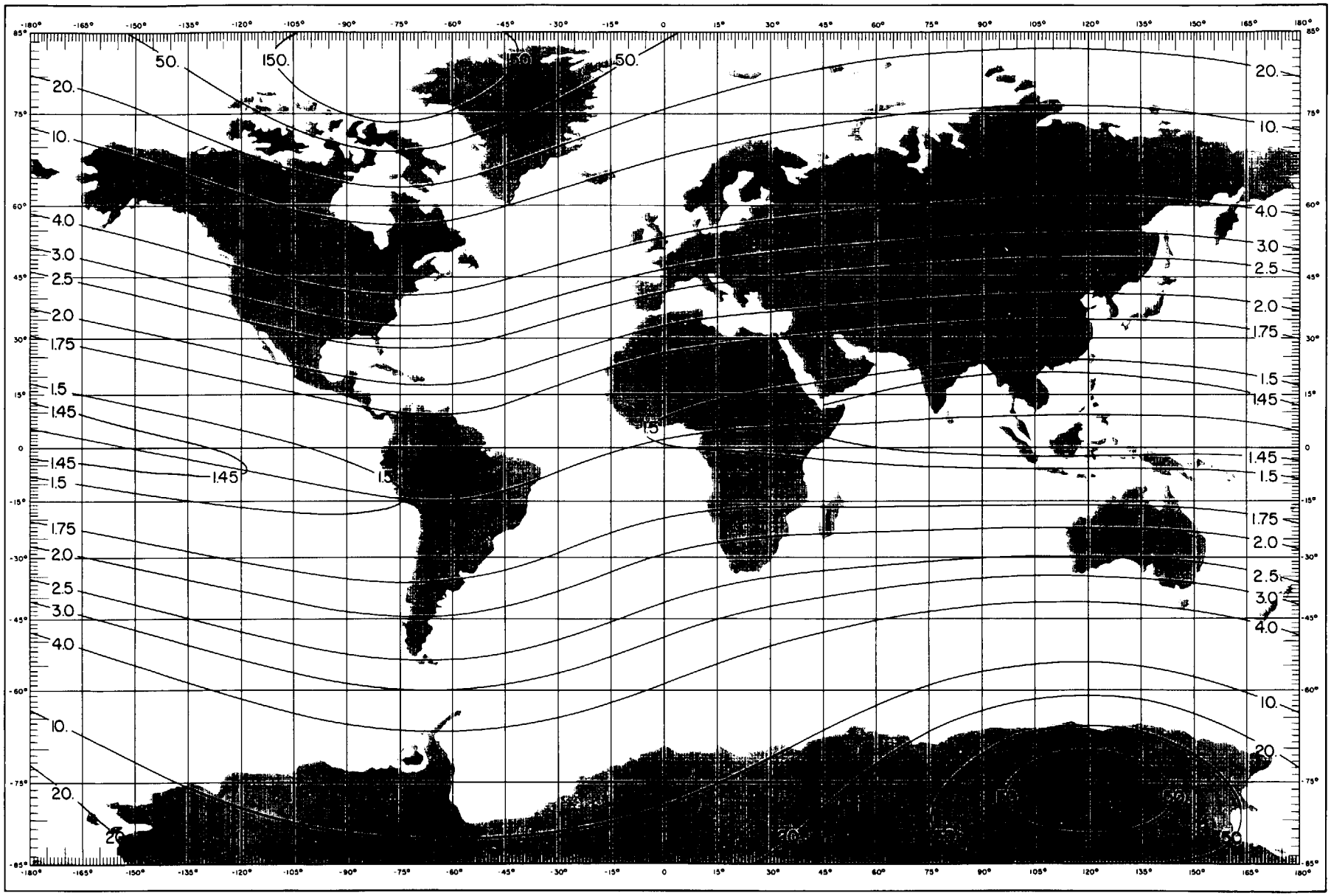
ALTITUDE = 2700 KM

LINES OF CONSTANT L (EARTH RADII)



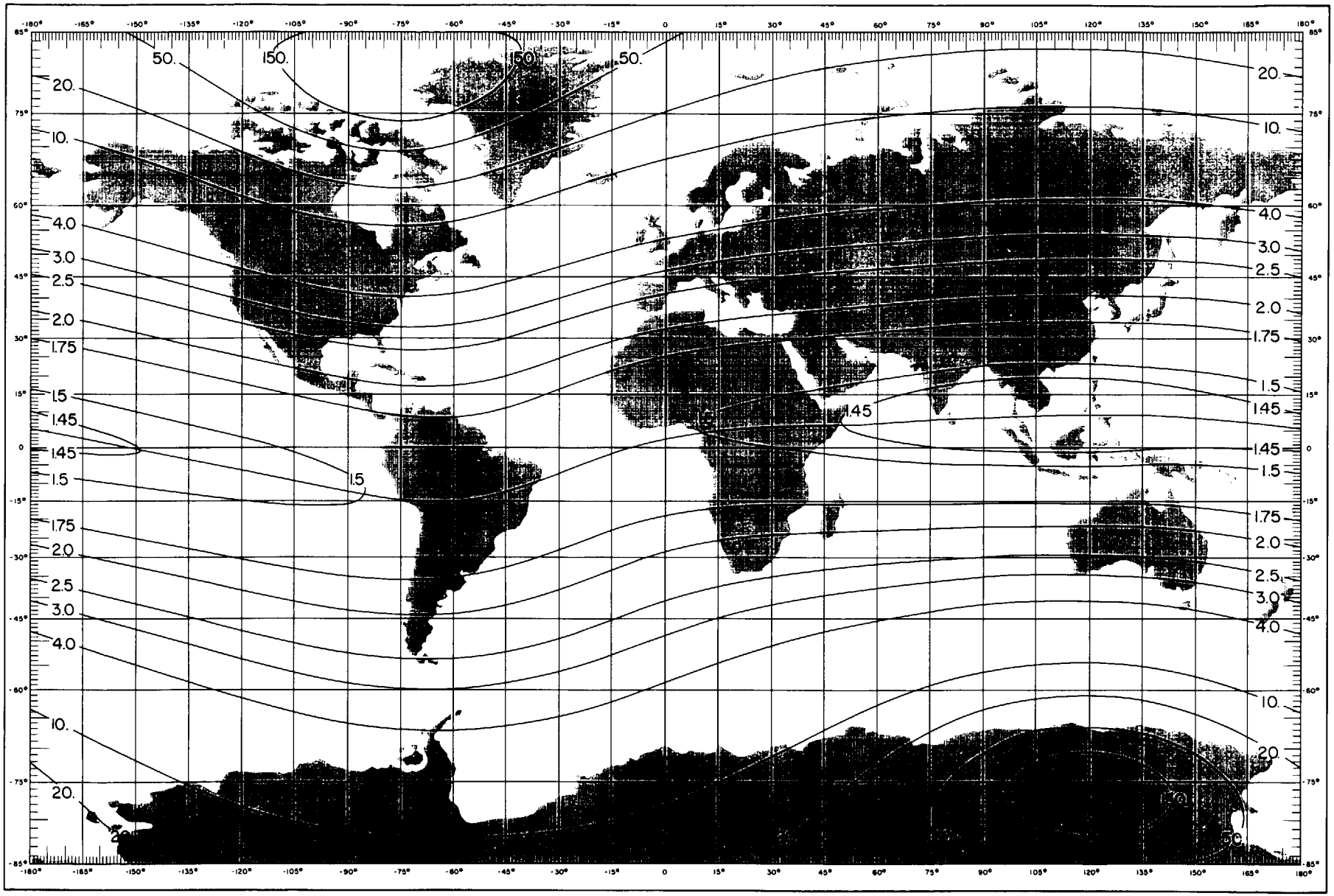
ALTITUDE = 2800 KM

LINES OF CONSTANT L (EARTH RADII)



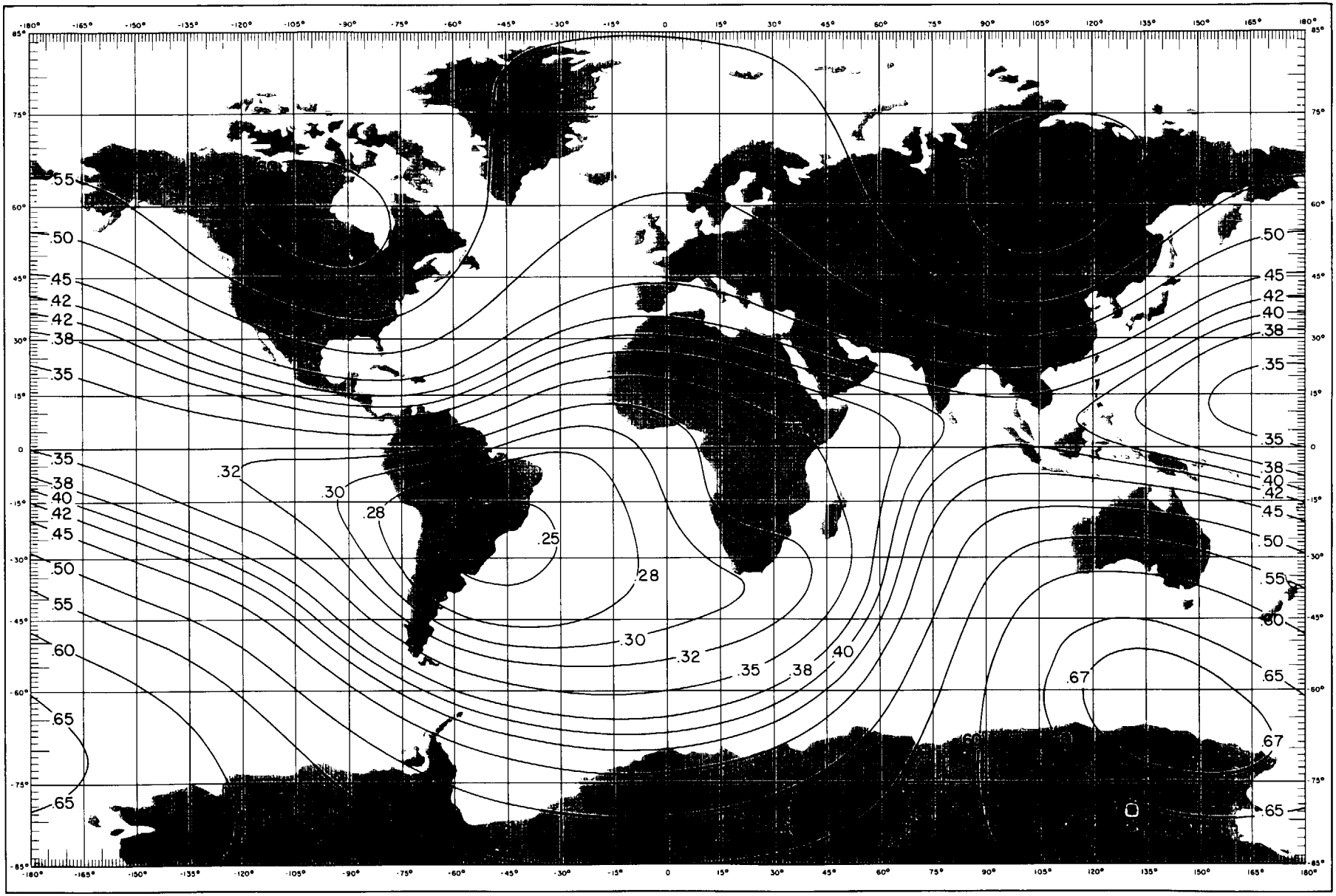
ALTITUDE = 2900 KM

LINES OF CONSTANT L (EARTH RADII)



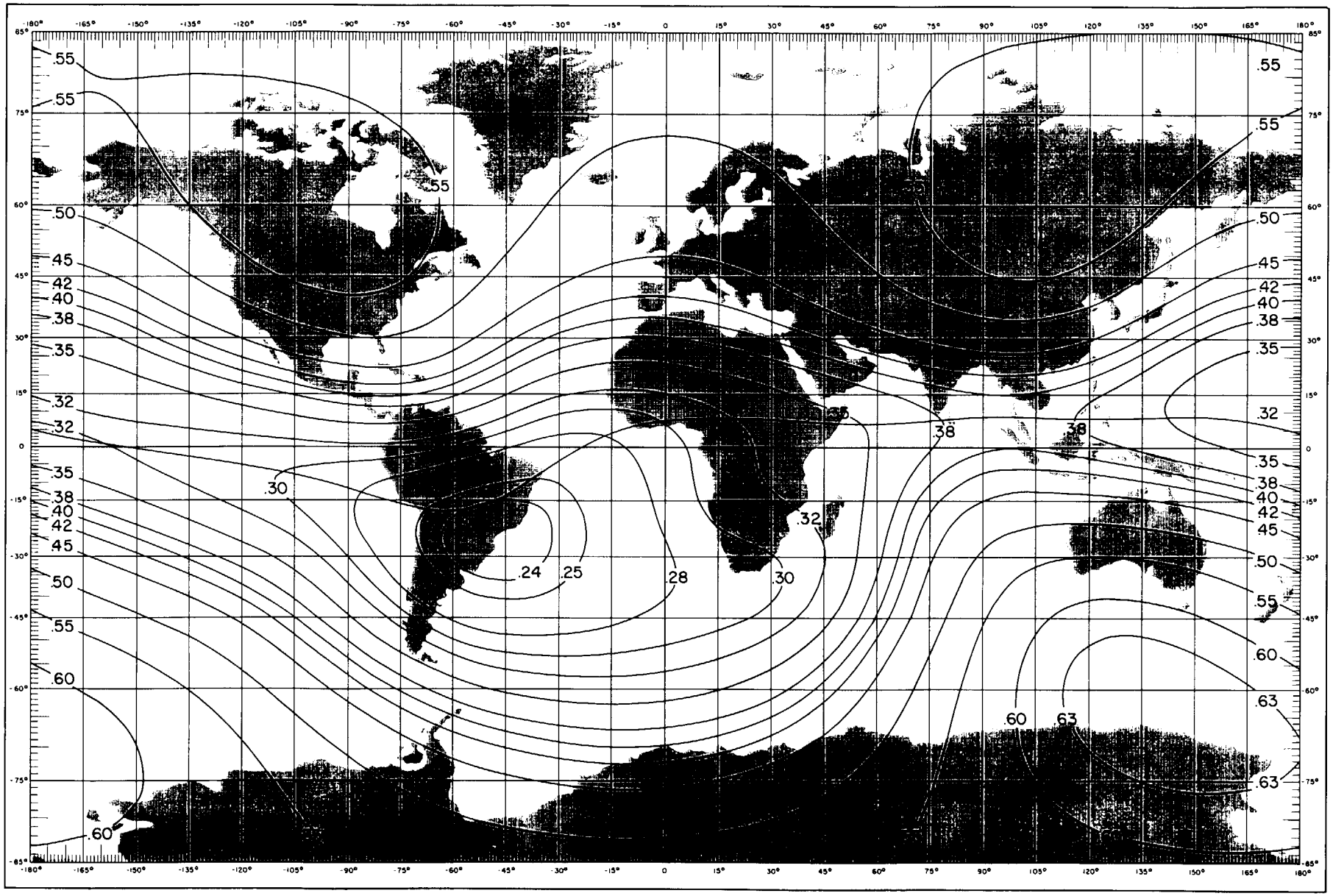
ALTITUDE = 3000 KM

LINES OF CONSTANT B (GAUSS)



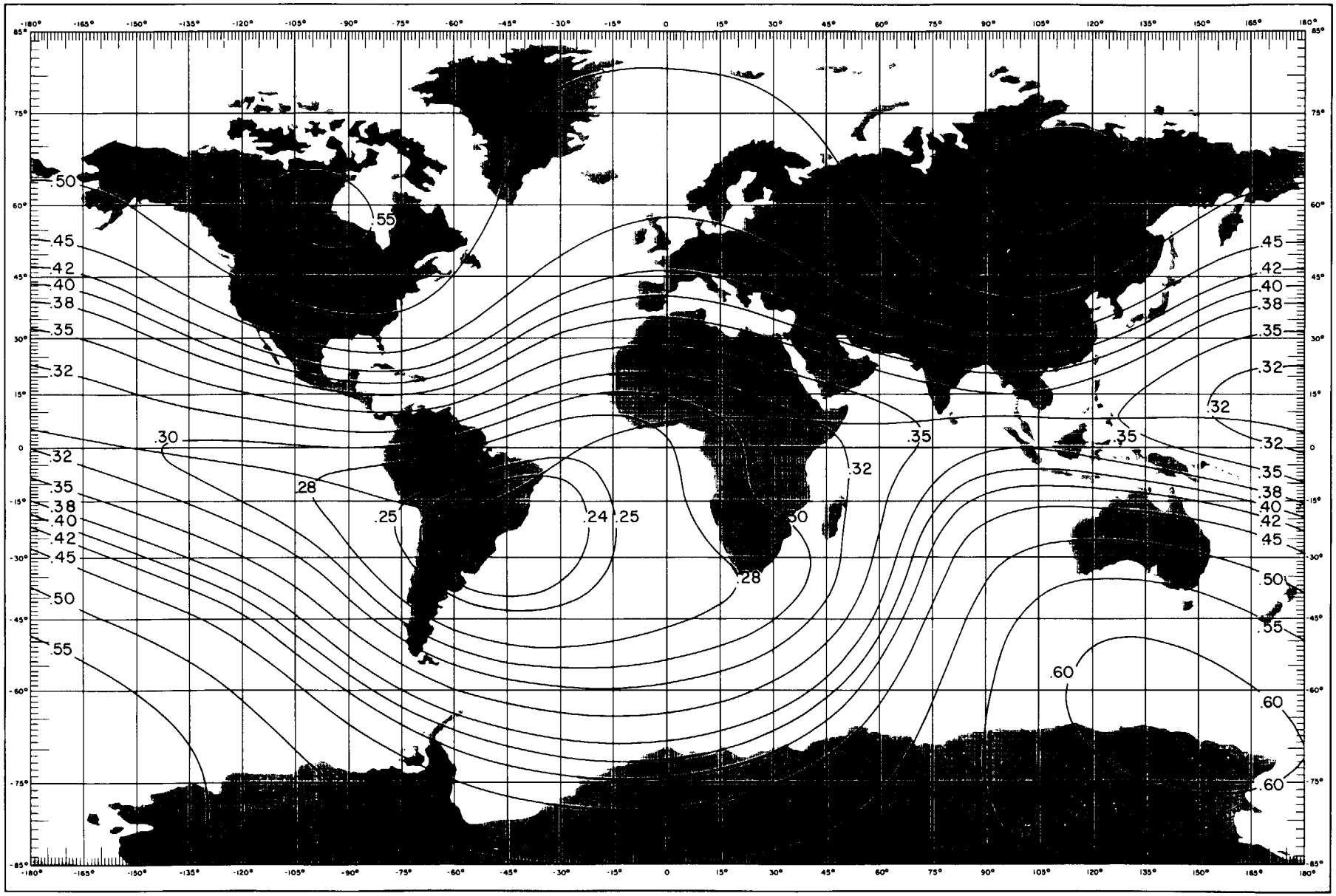
ALTITUDE = 0 KM

LINES OF CONSTANT B (GAUSS)



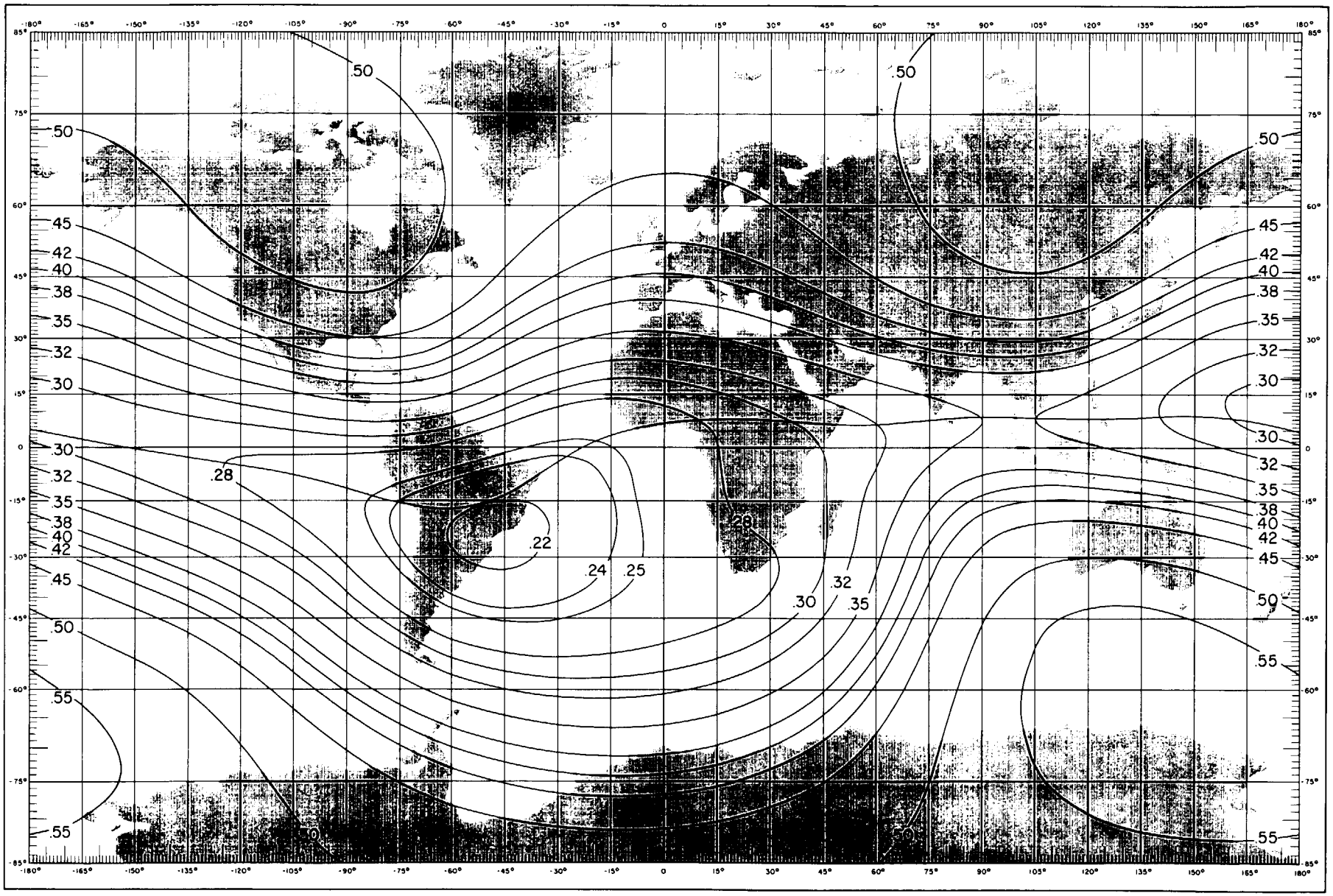
ALTITUDE=100 KM

LINES OF CONSTANT B (GAUSS)



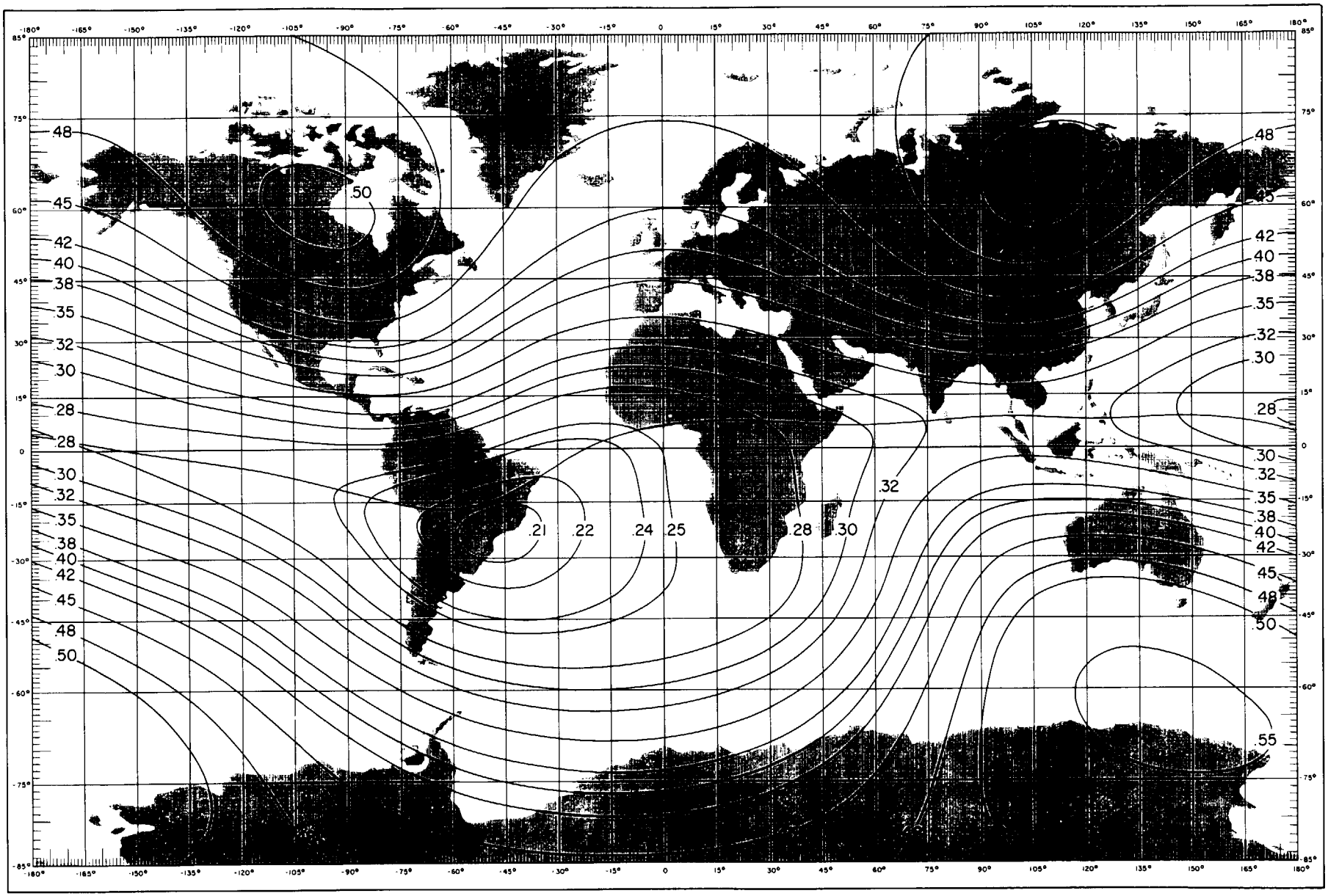
ALTITUDE=200 KM

LINES OF CONSTANT B (GAUSS)



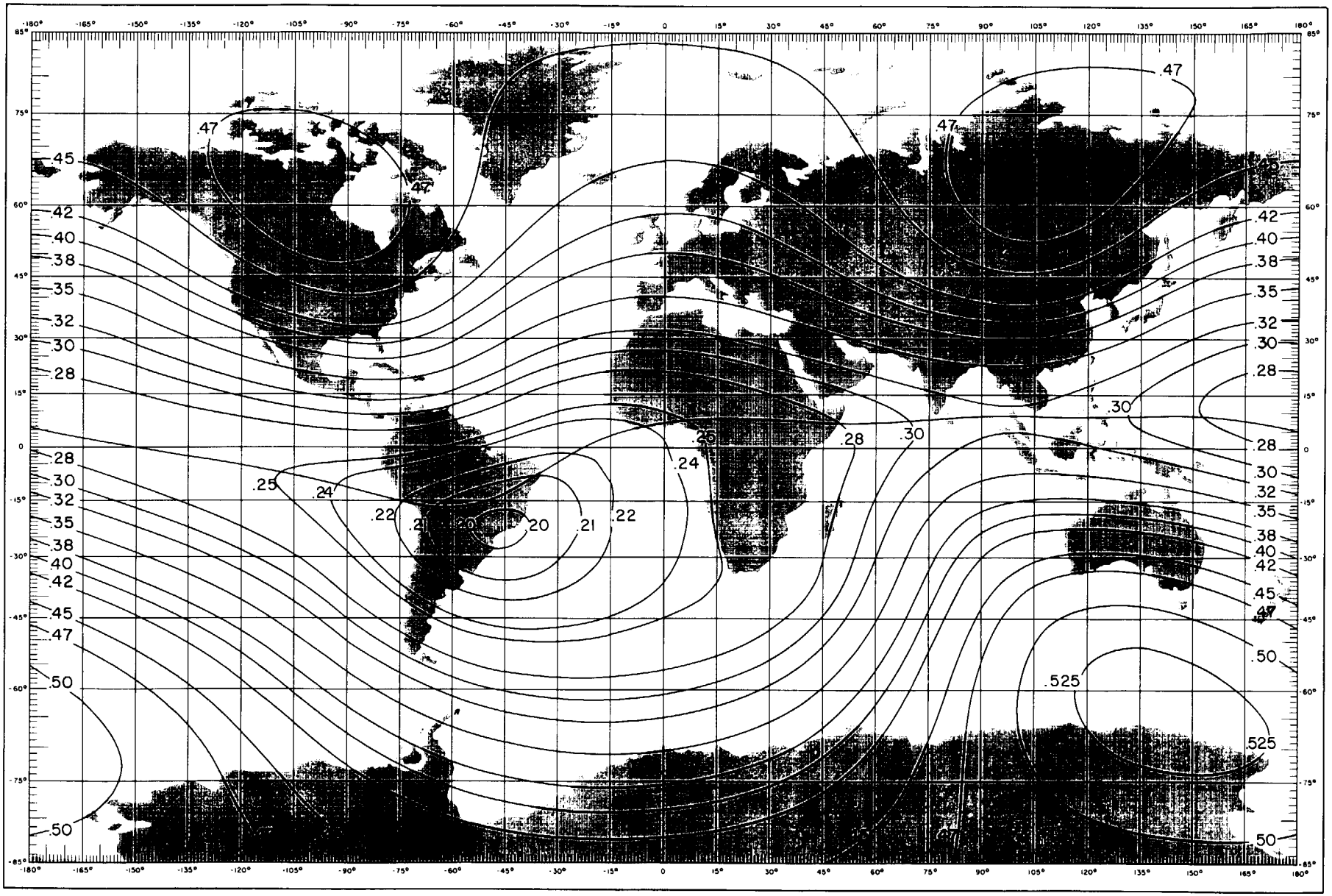
ALTITUDE=300 KM

LINES OF CONSTANT B (GAUSS)



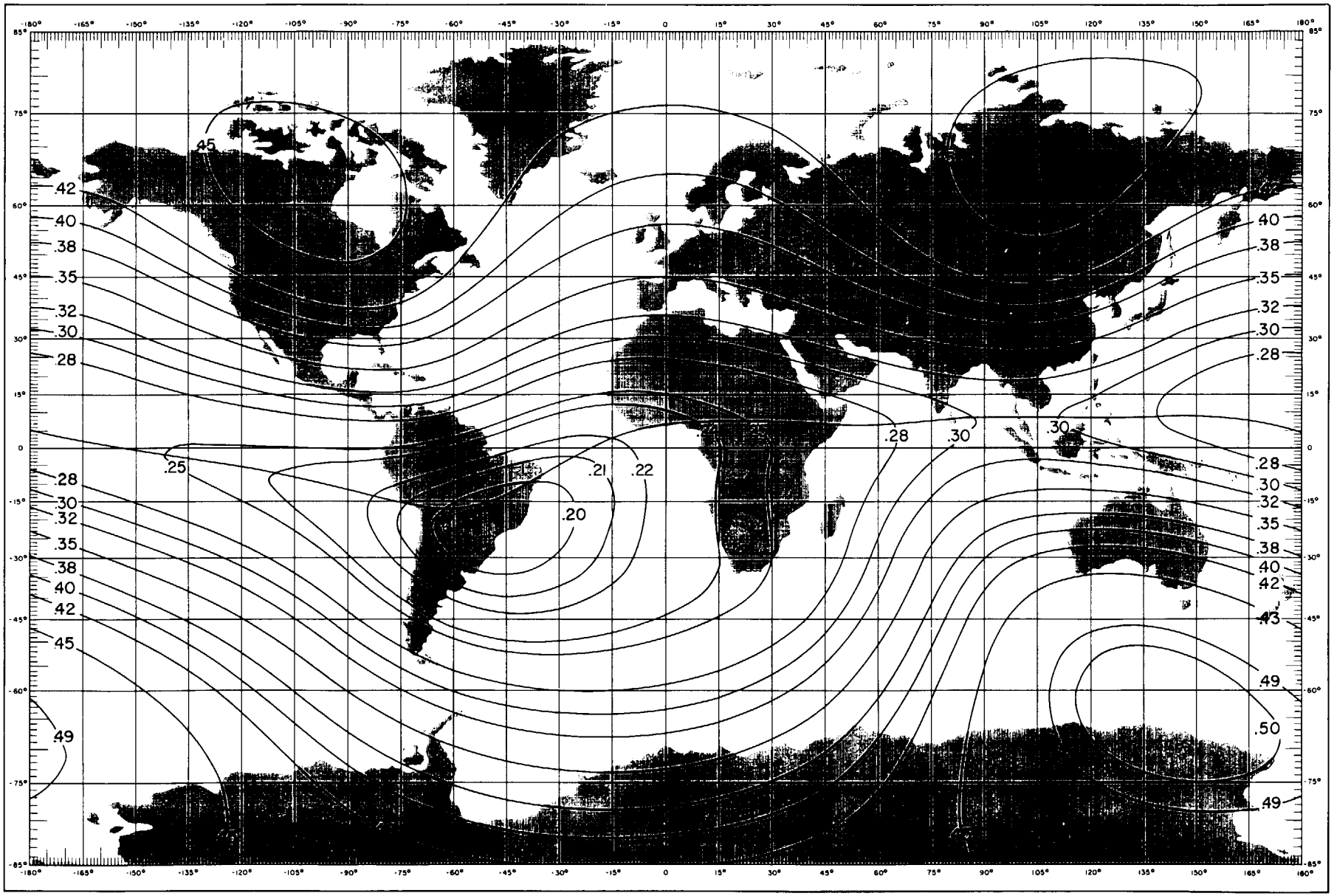
ALTITUDE=400KM

LINES OF CONSTANT B (GAUSS)



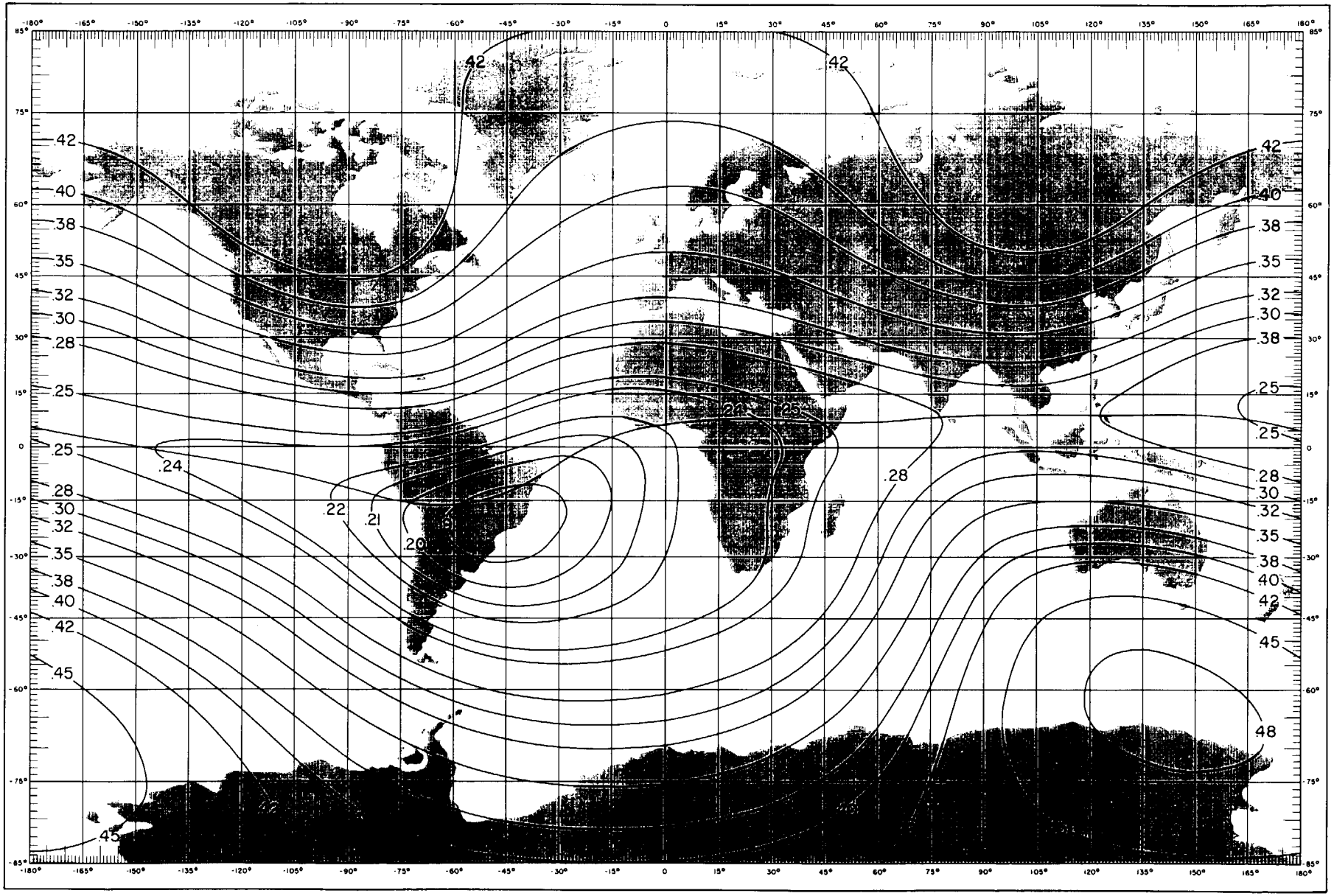
ALTITUDE=500KM

LINES OF CONSTANT B (GAUSS)



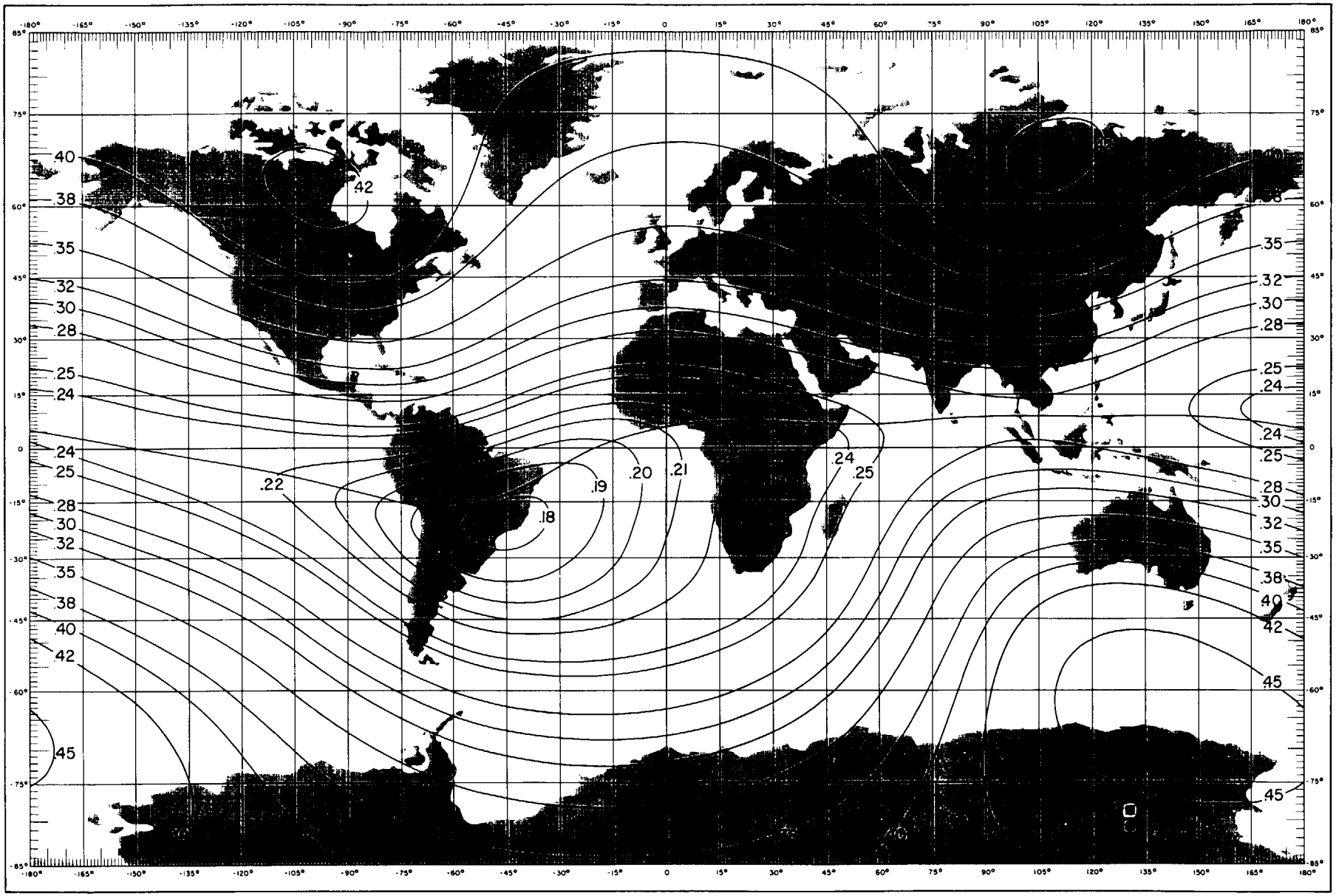
ALTITUDE=600 KM

LINES OF CONSTANT B (GAUSS)



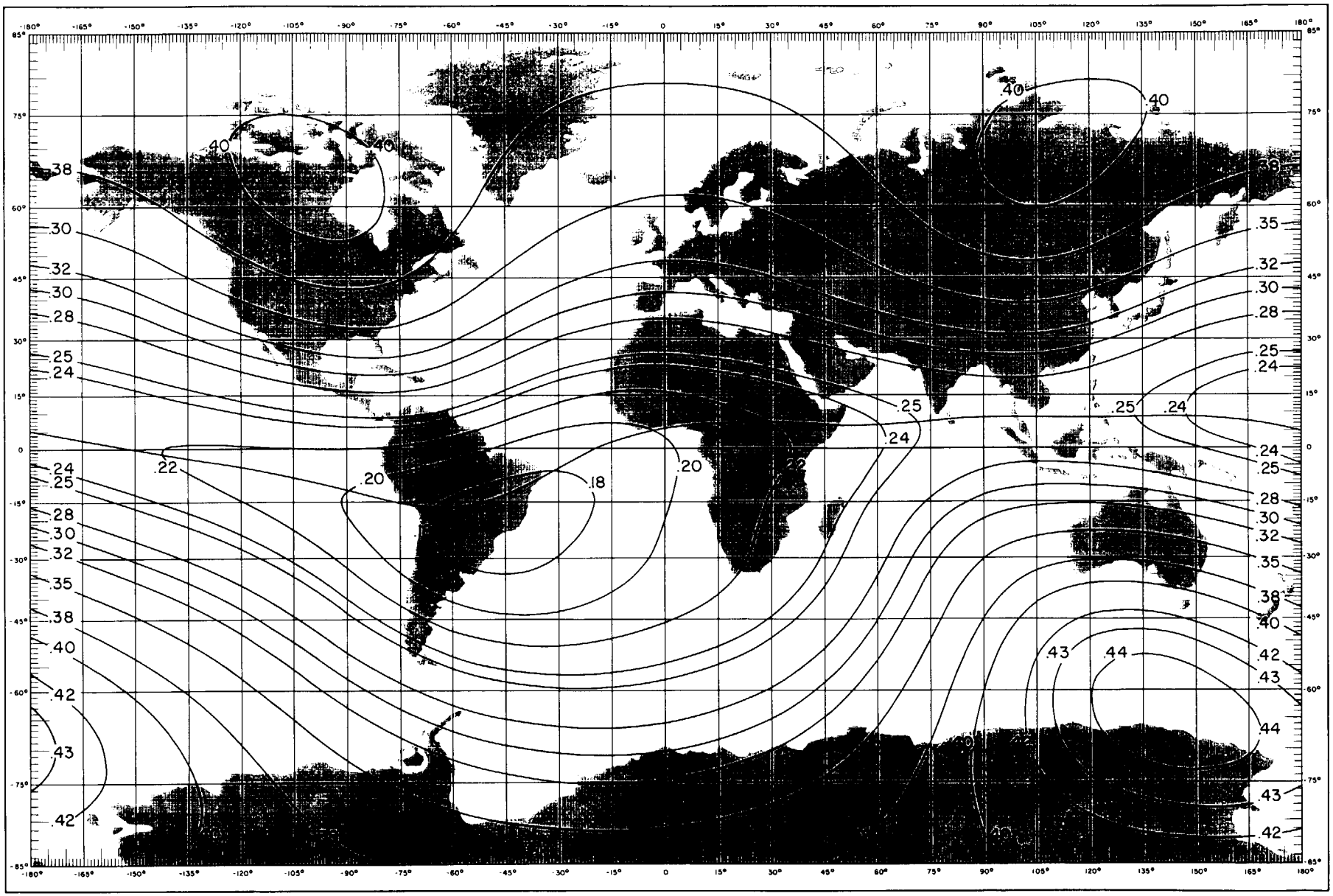
ALTITUDE = 700 KM

LINES OF CONSTANT B (GAUSS)



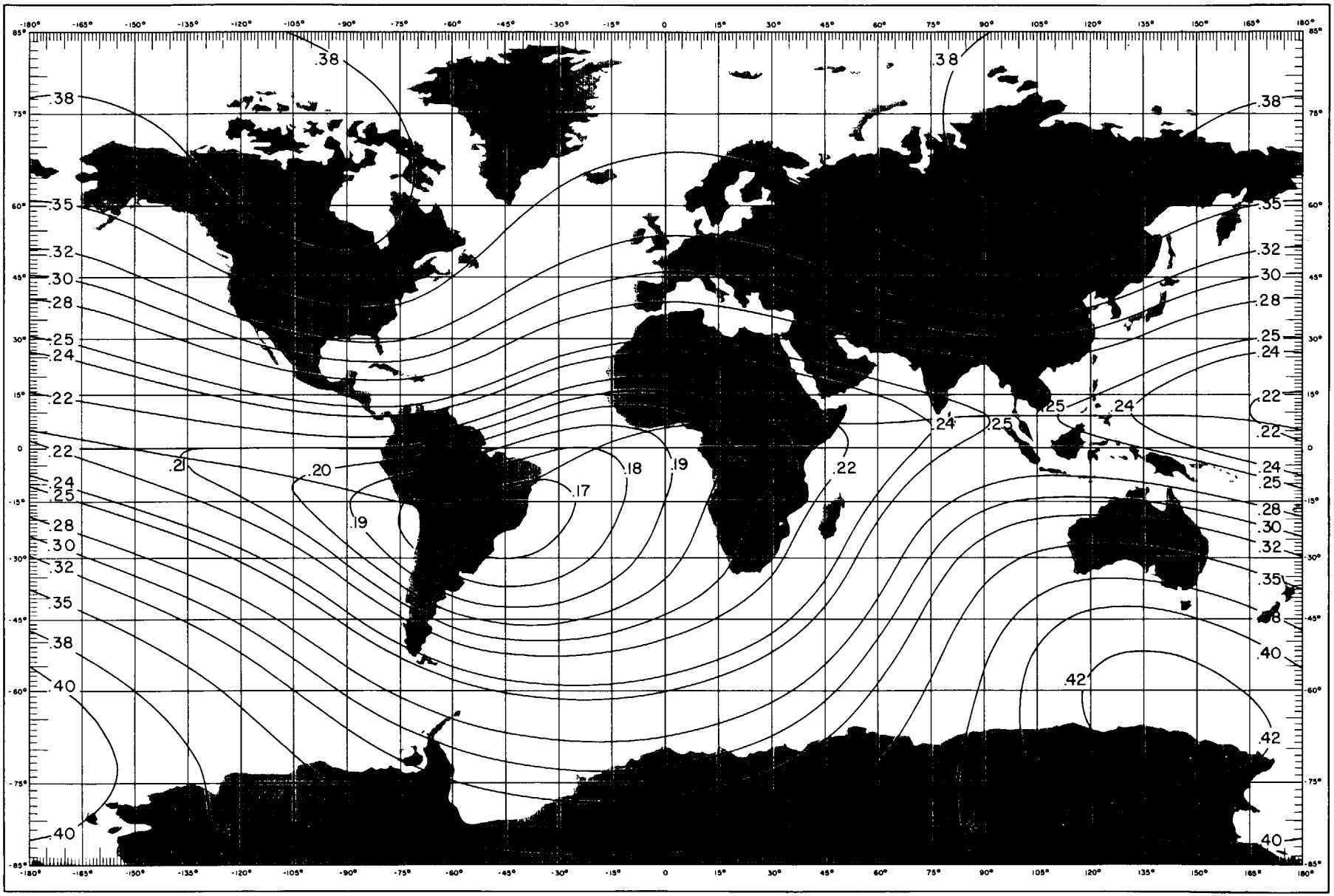
ALTITUDE=800 KM

LINES OF CONSTANT B (GAUSS)



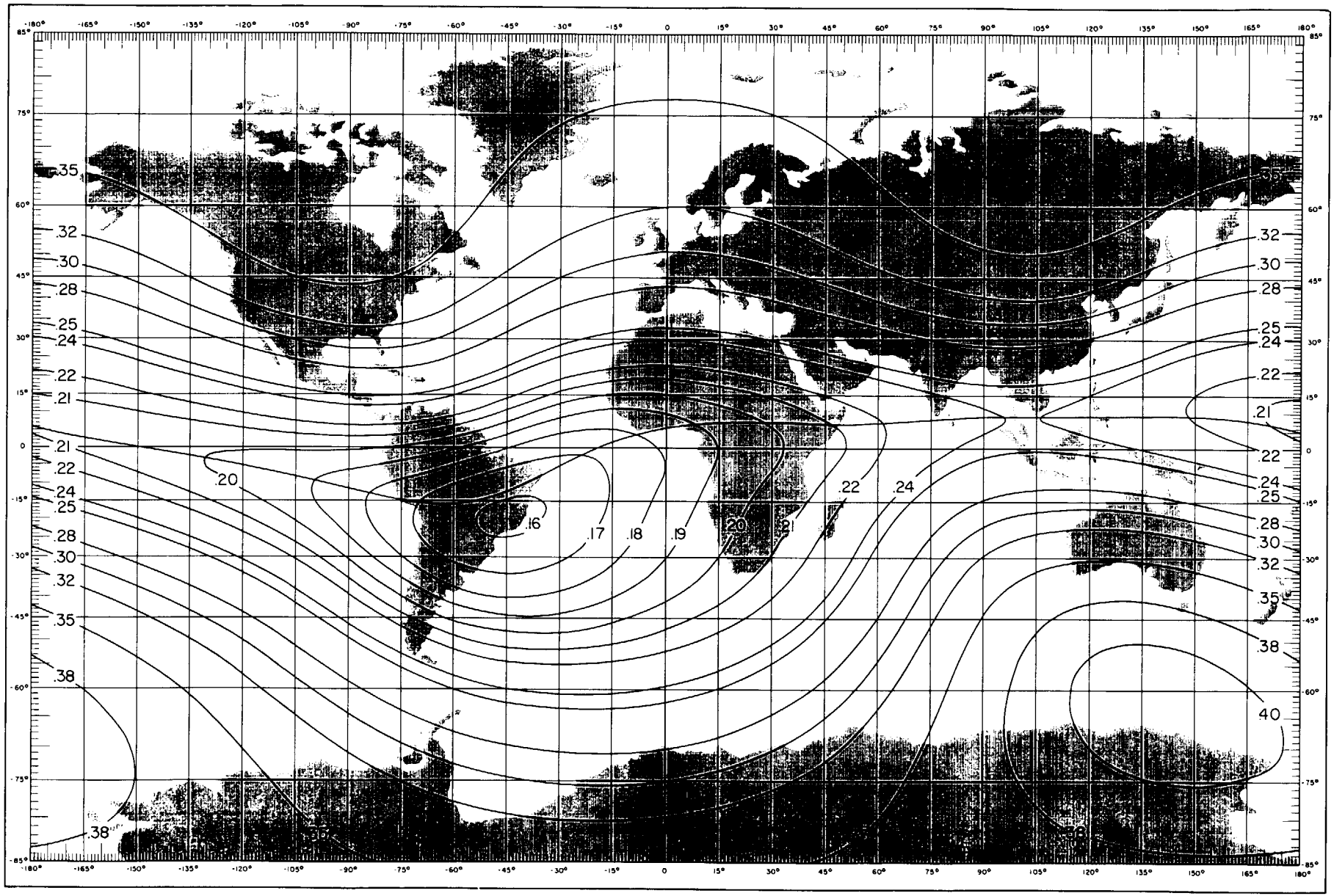
ALTITUDE = 900 KM

LINES OF CONSTANT B (GAUSS)



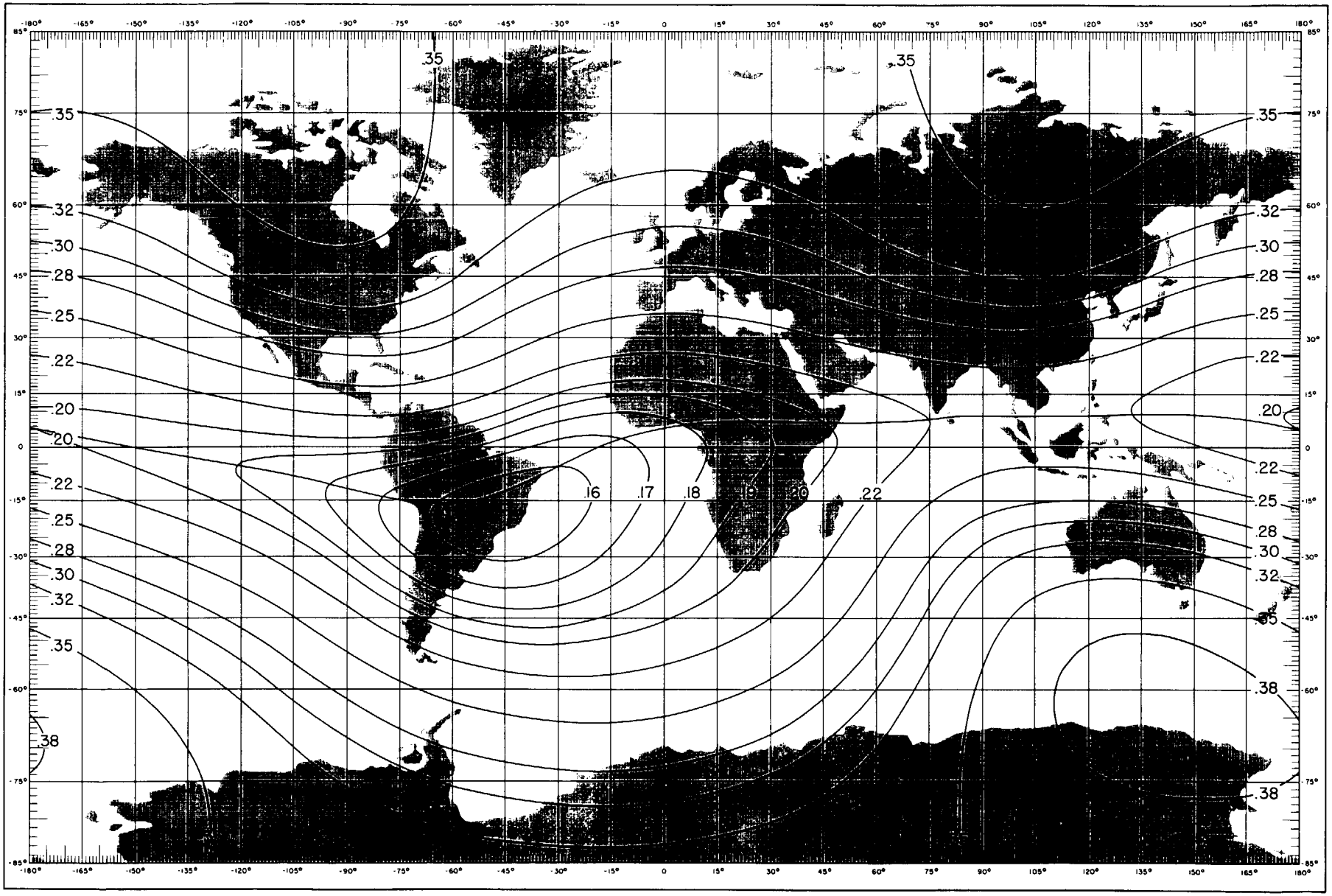
ALTITUDE=1000 KM

LINES OF CONSTANT B (GAUSS)



ALTITUDE=1100 KM

LINES OF CONSTANT B (GAUSS)



ALTITUDE=1200 KM

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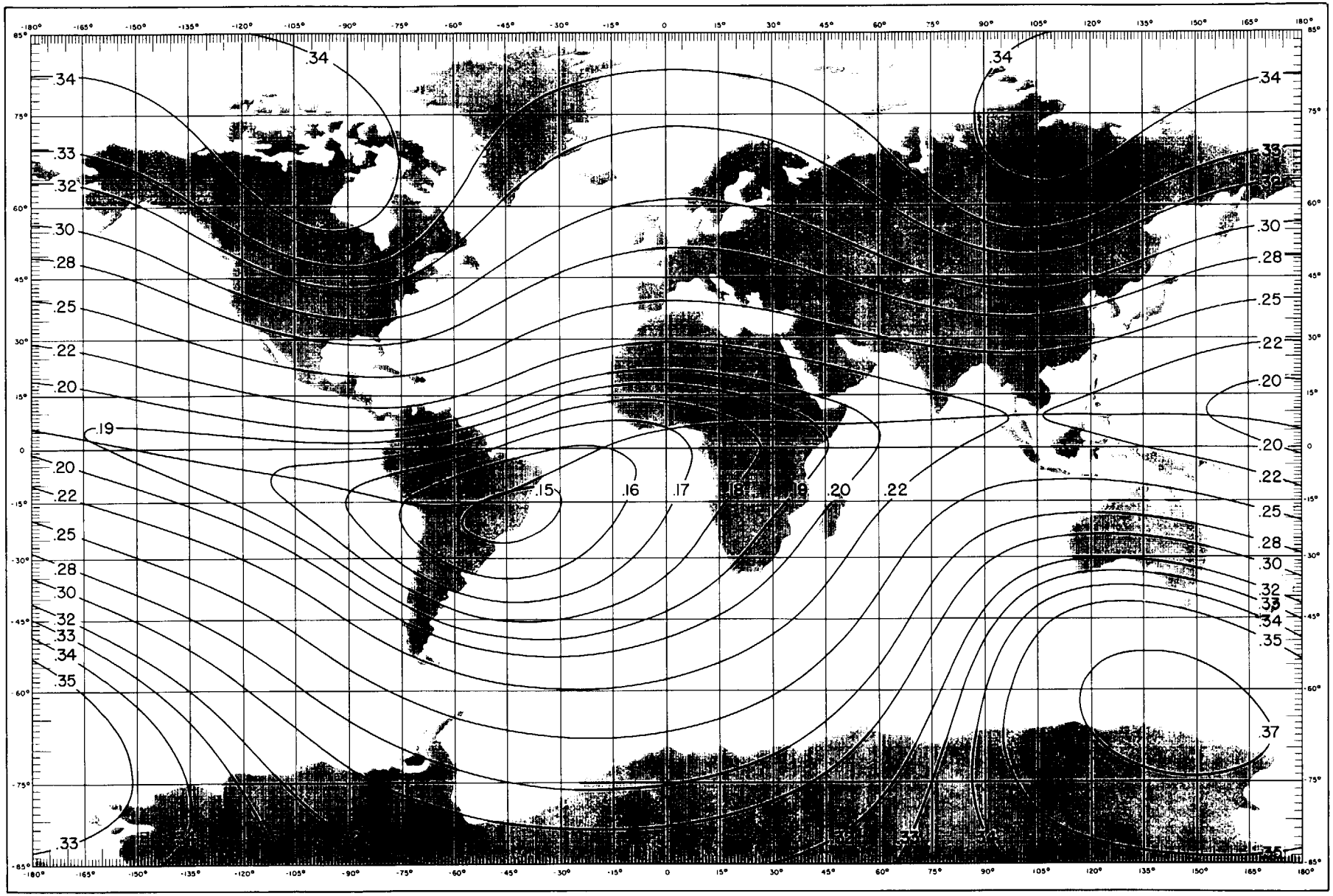
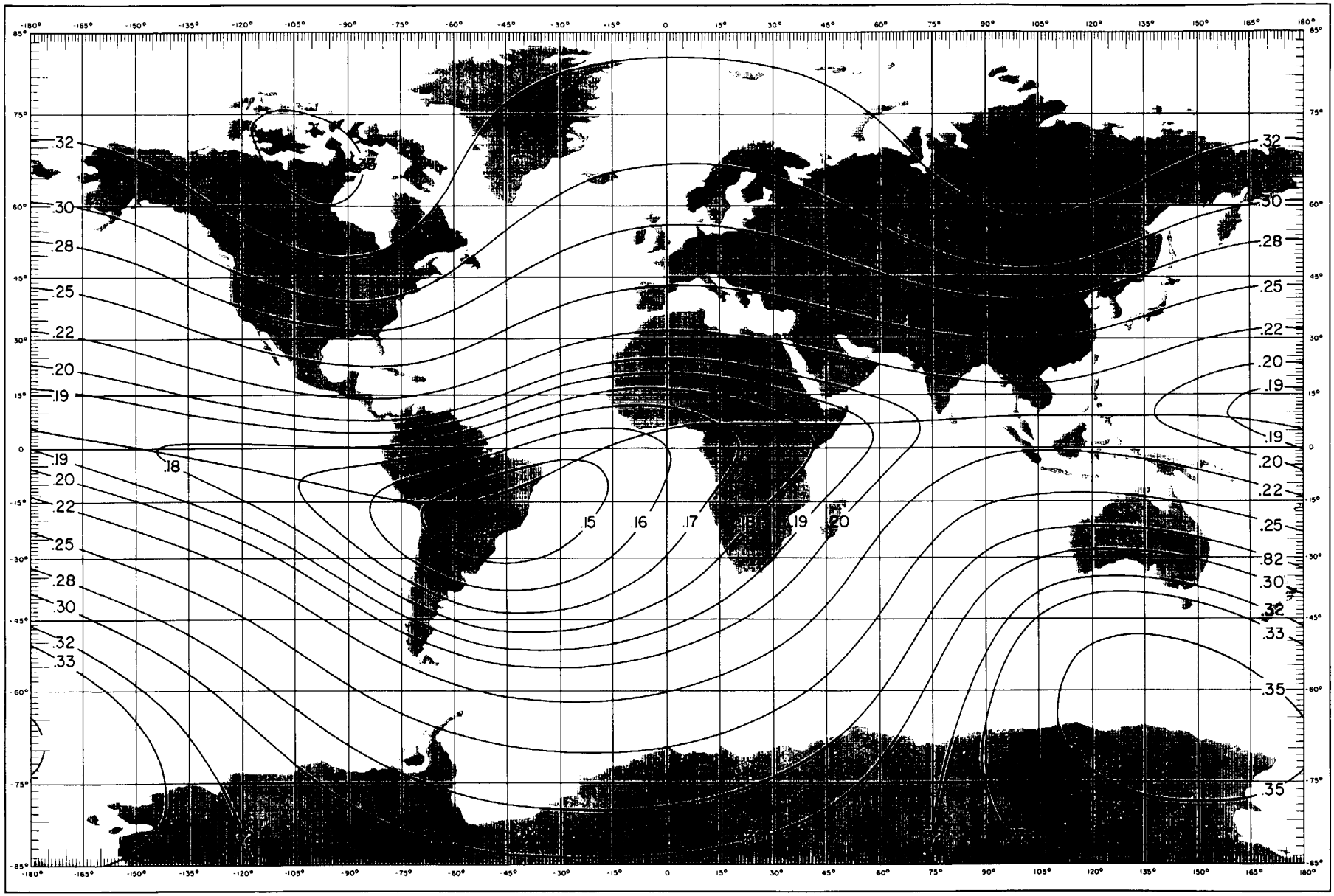


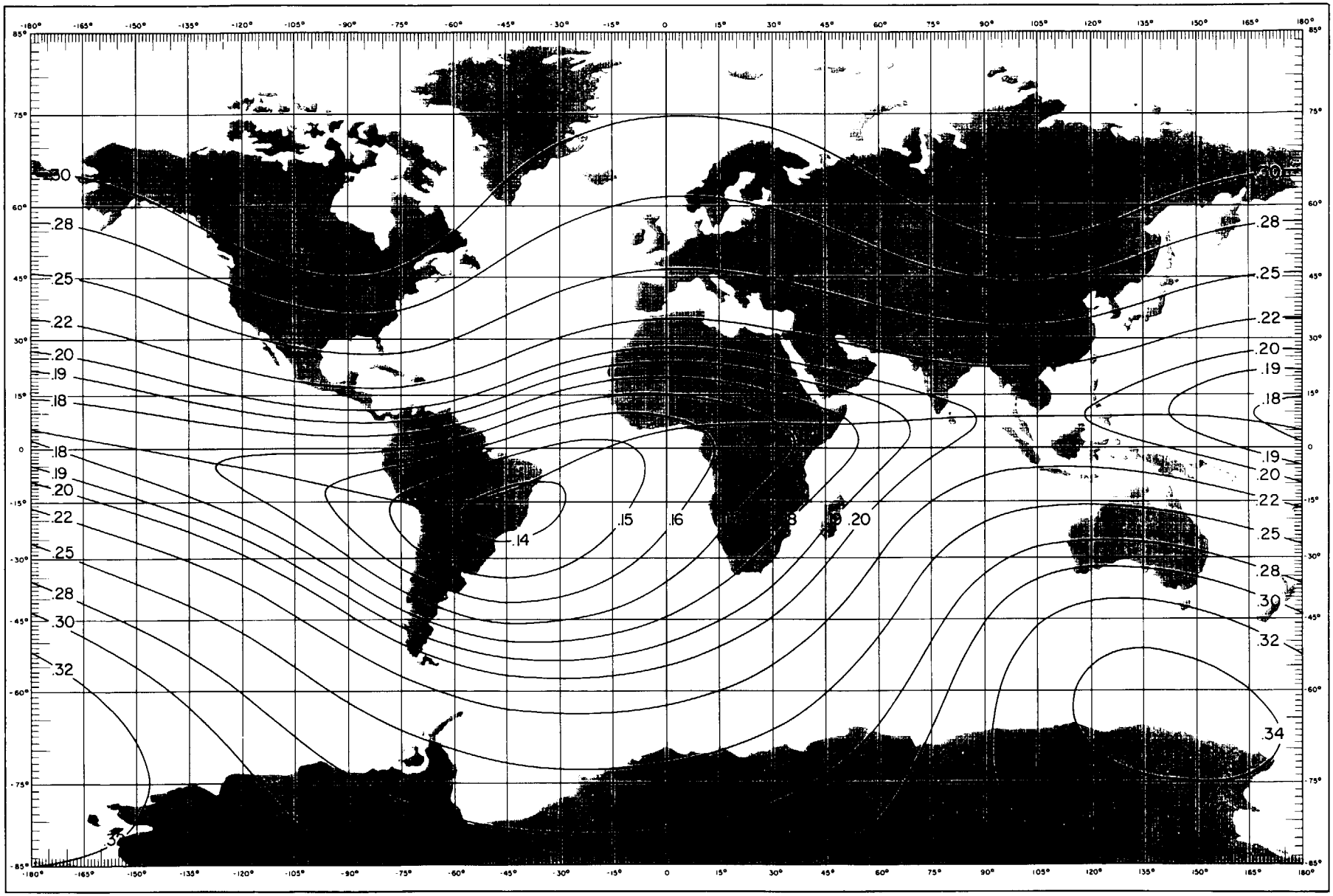
ALTITUDE=1300 KM

LINES OF CONSTANT B (GAUSS)



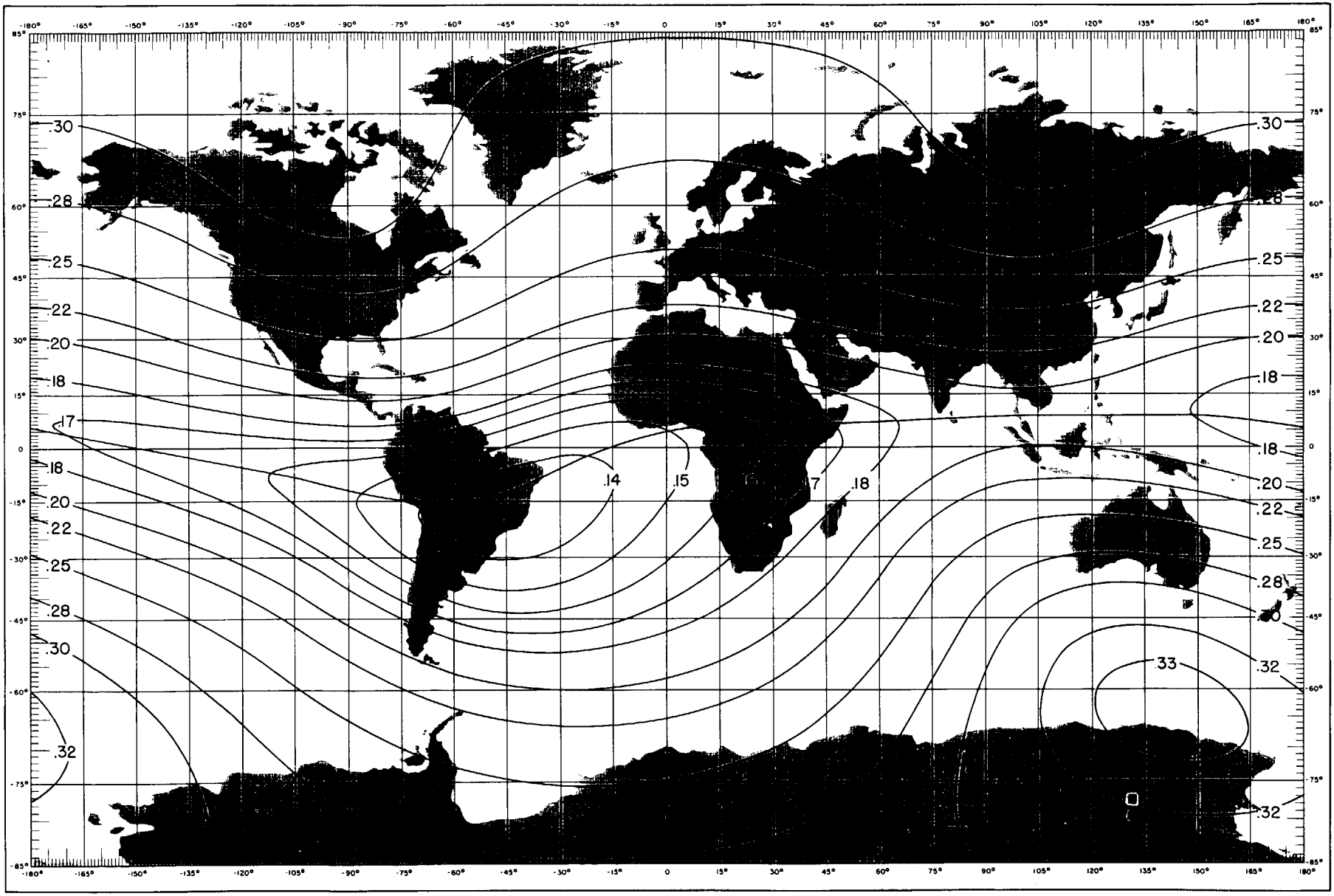
ALTITUDE=1400 KM

LINES OF CONSTANT B (GAUSS)



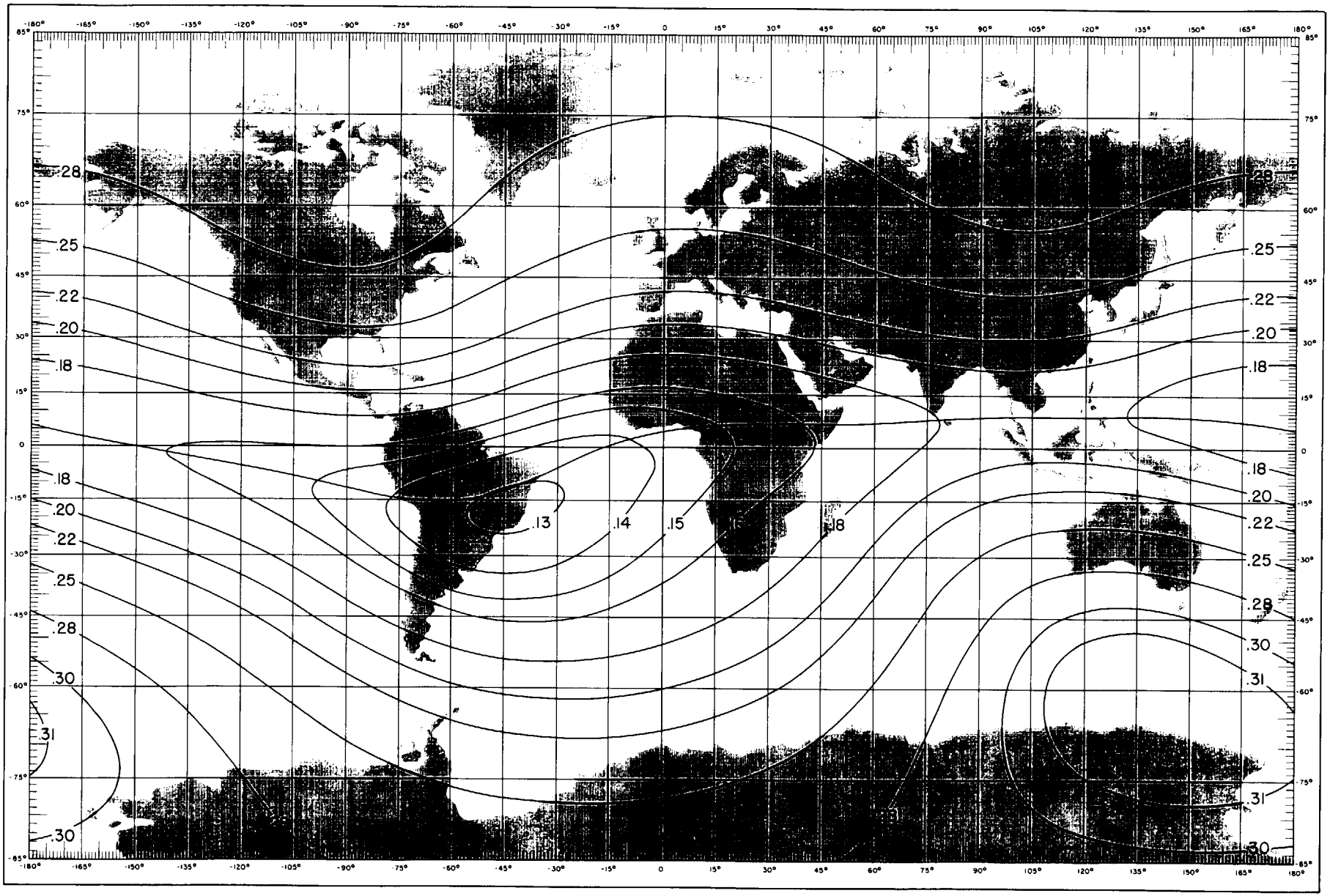
ALTITUDE=1500 KM

LINES OF CONSTANT B (GAUSS)



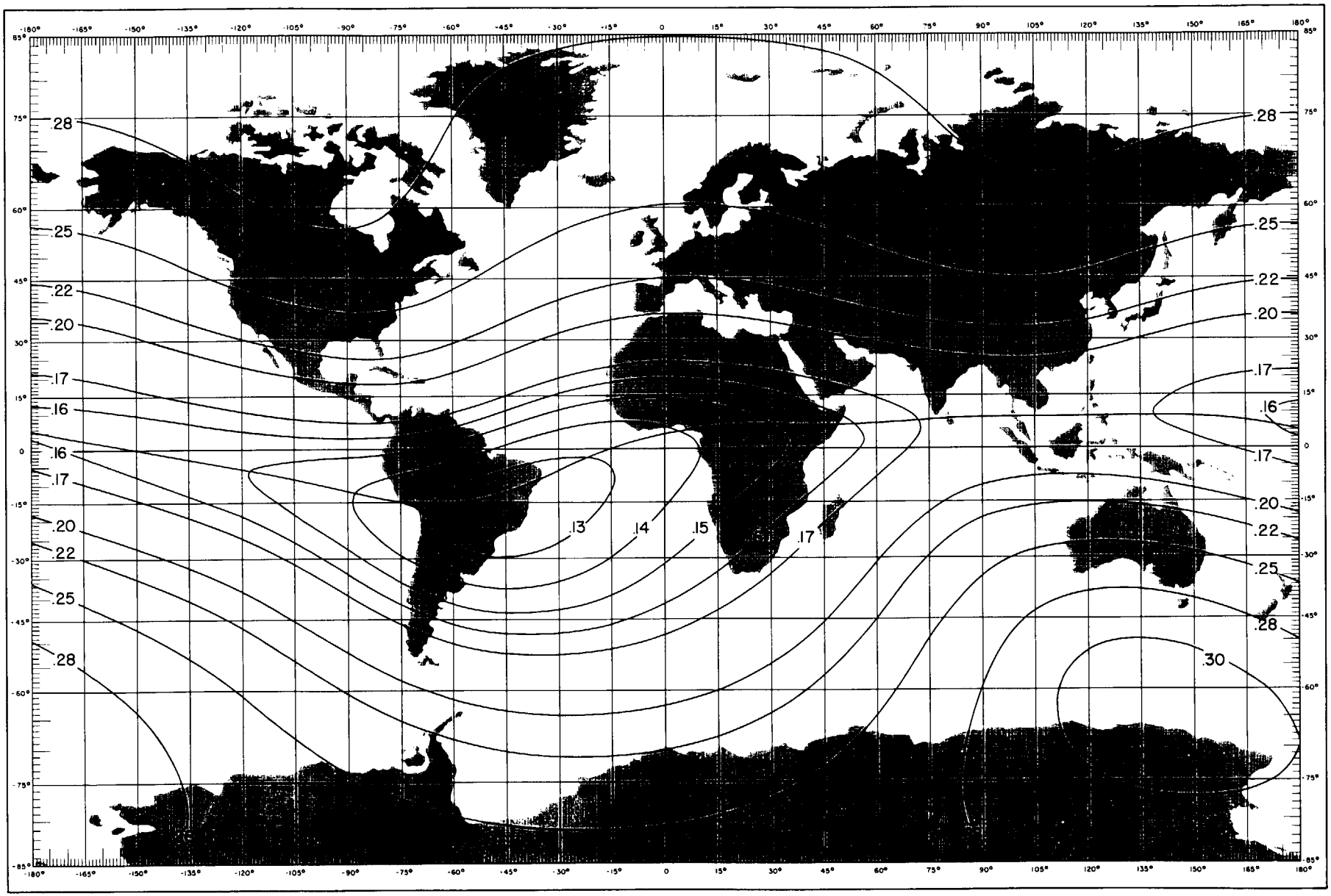
ALTITUDE = 1600 KM

LINES OF CONSTANT B (GAUSS)



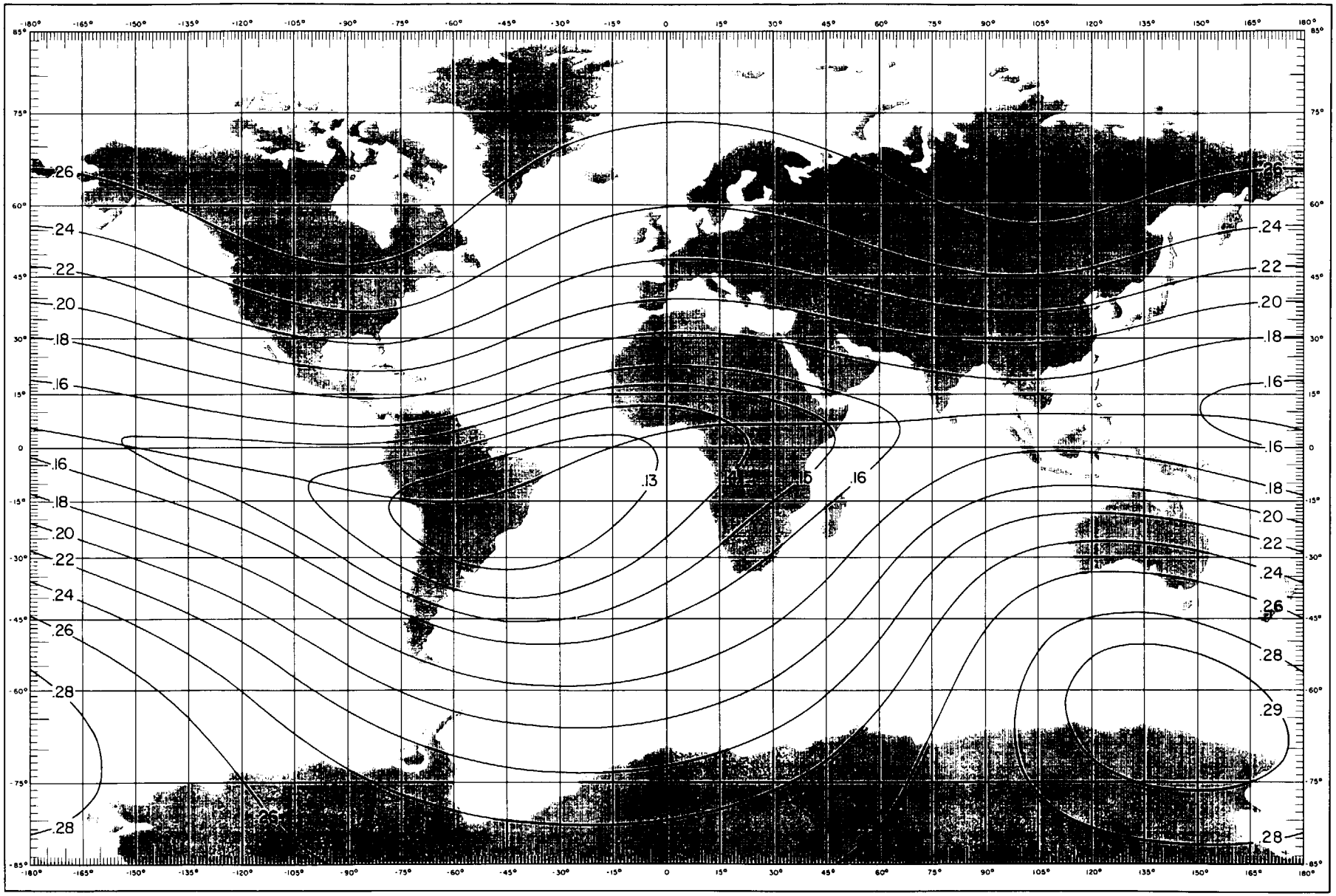
ALTITUDE=1700 KM

LINES OF CONSTANT B (GAUSS)



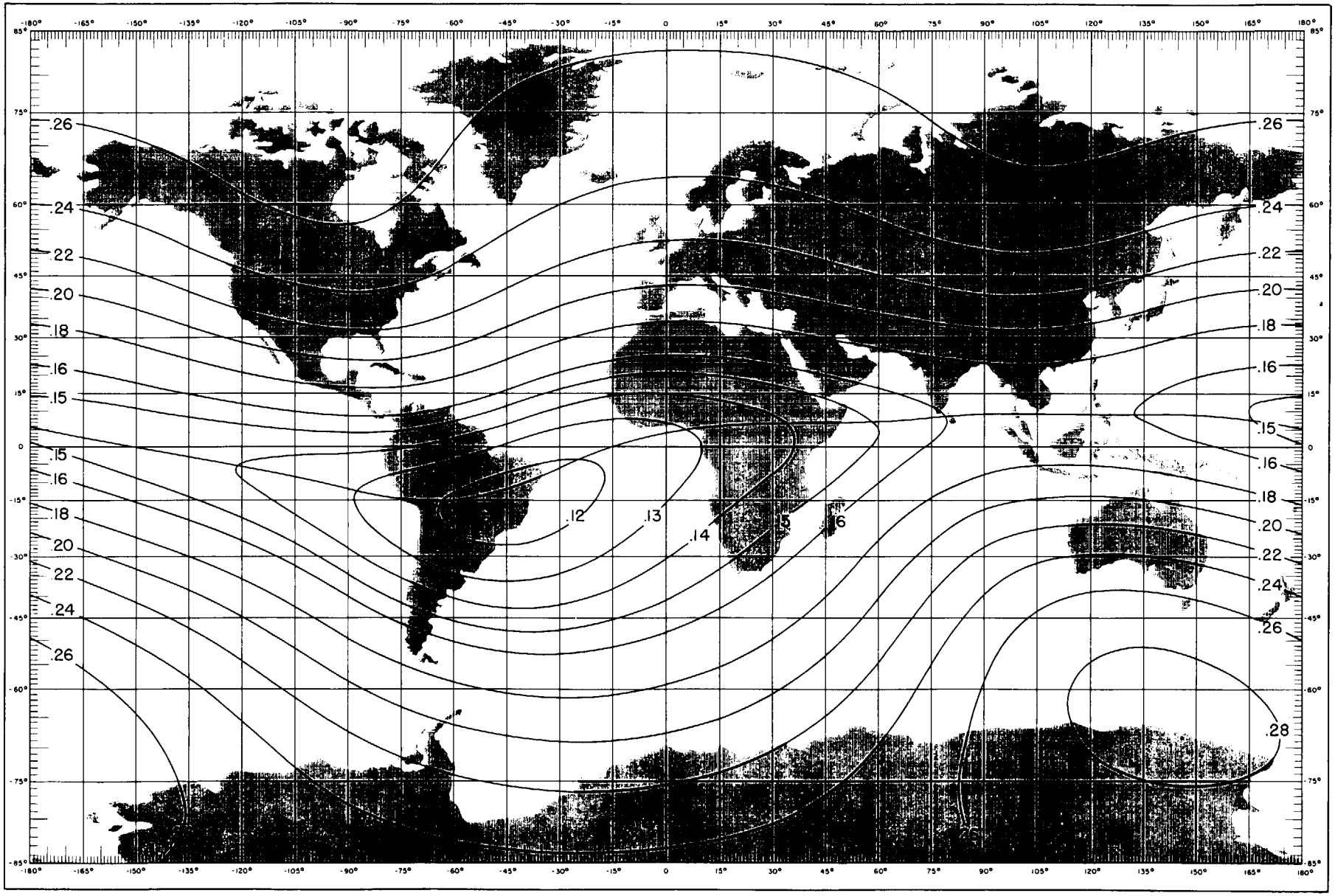
ALTITUDE=1800 KM

LINES OF CONSTANT B (GAUSS)



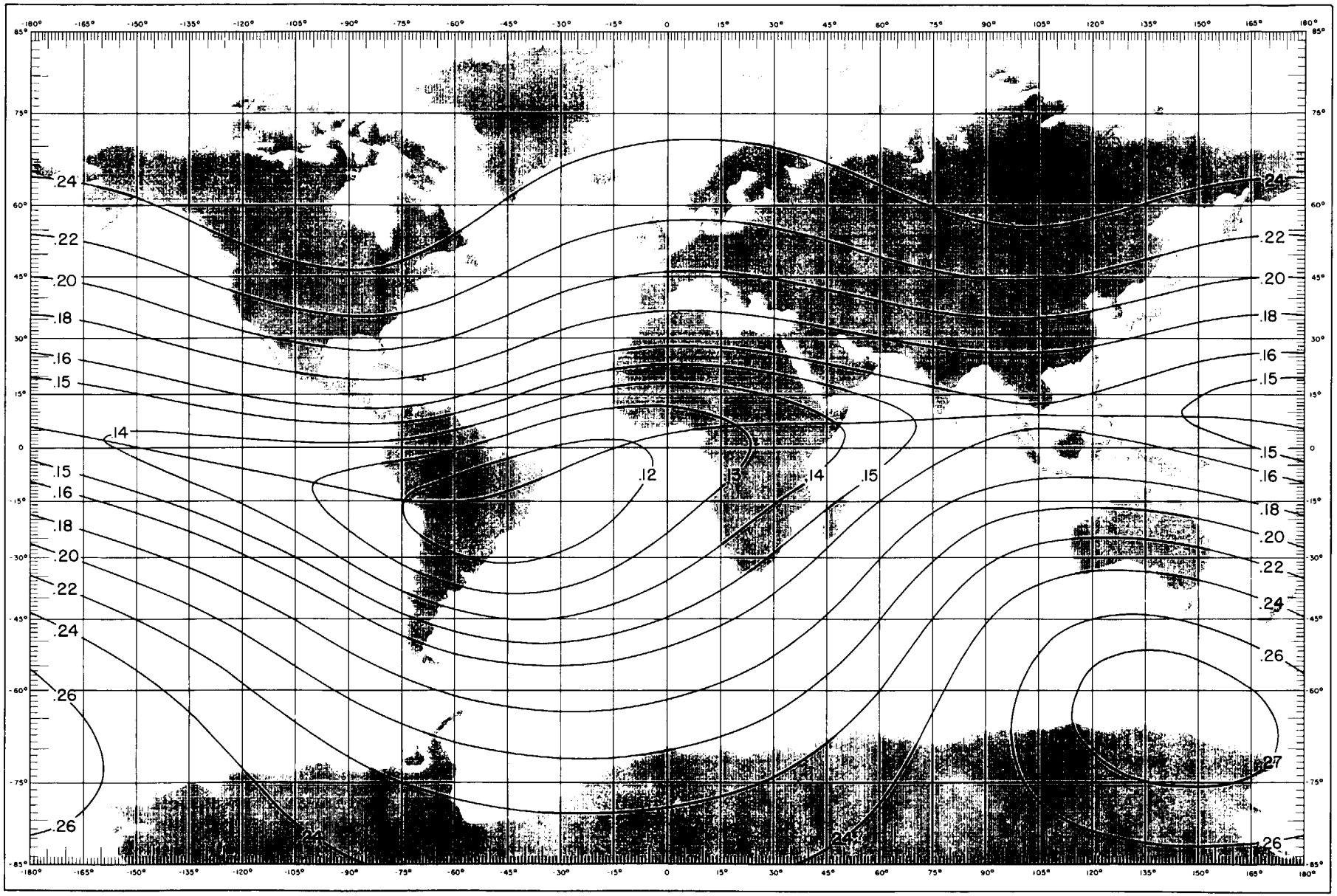
ALTITUDE=1900 KM

LINES OF CONSTANT B (GAUSS)



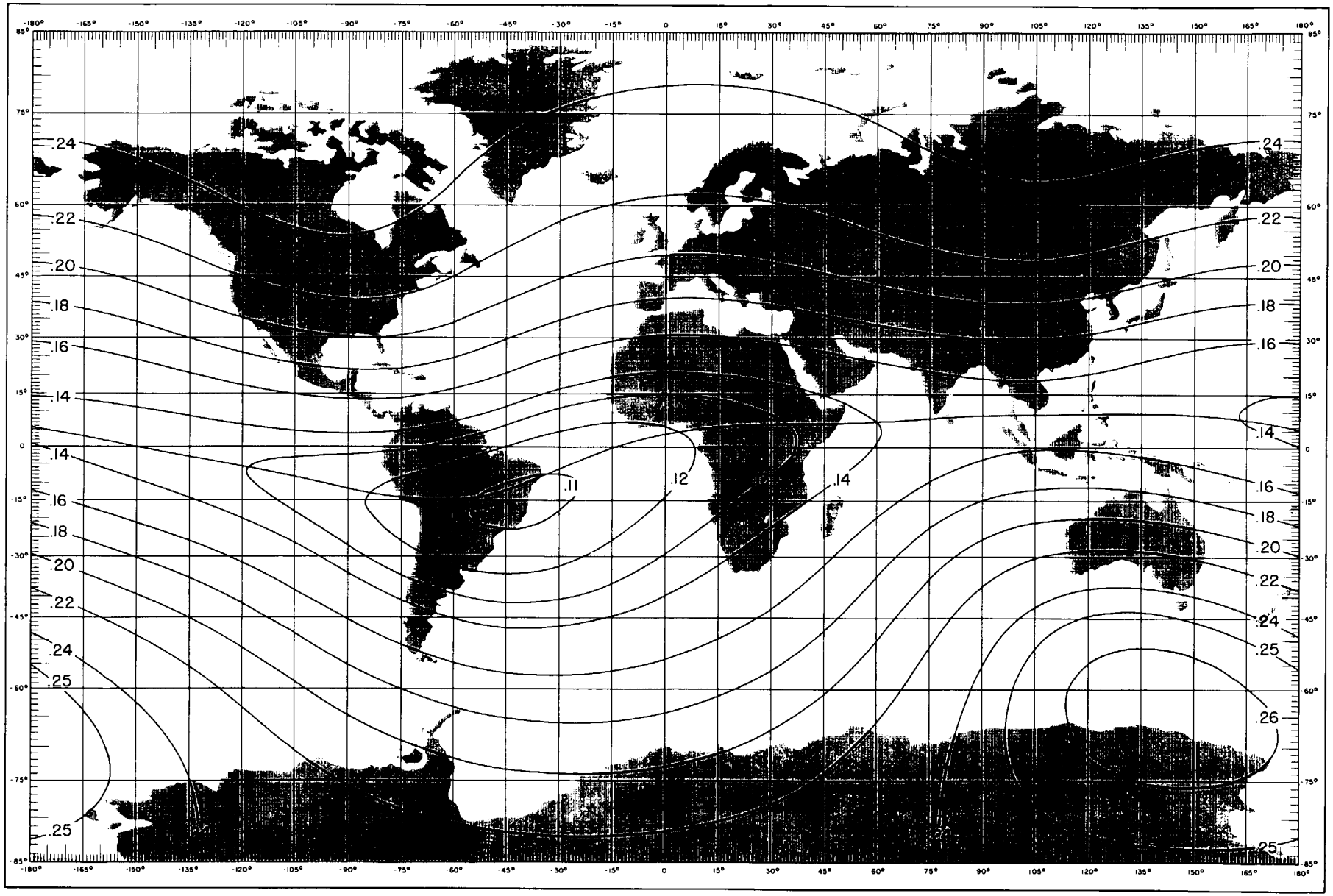
ALTITUDE=2000KM

LINES OF CONSTANT B (GAUSS)



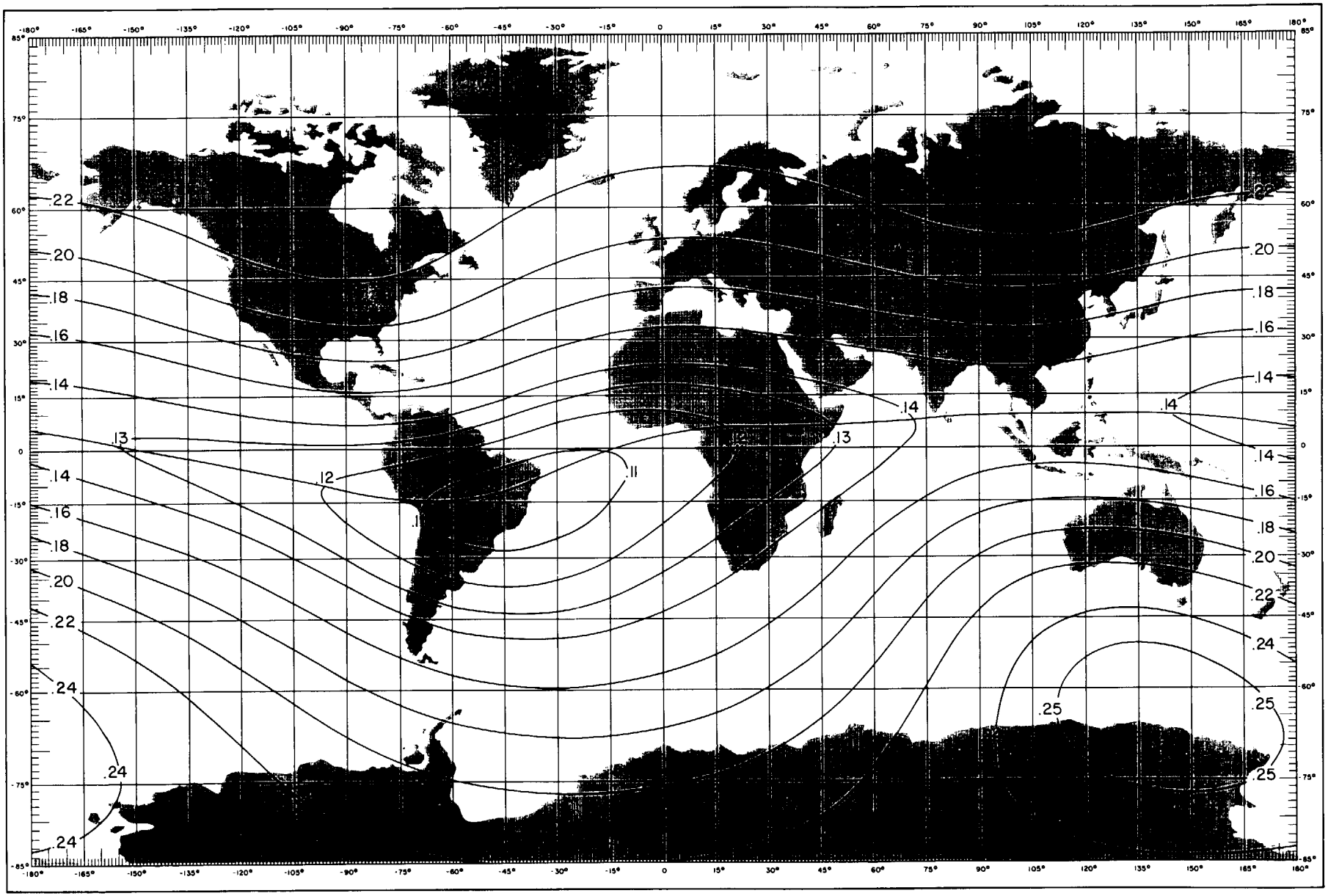
ALTITUDE=2100 KM

LINES OF CONSTANT B (GAUSS)



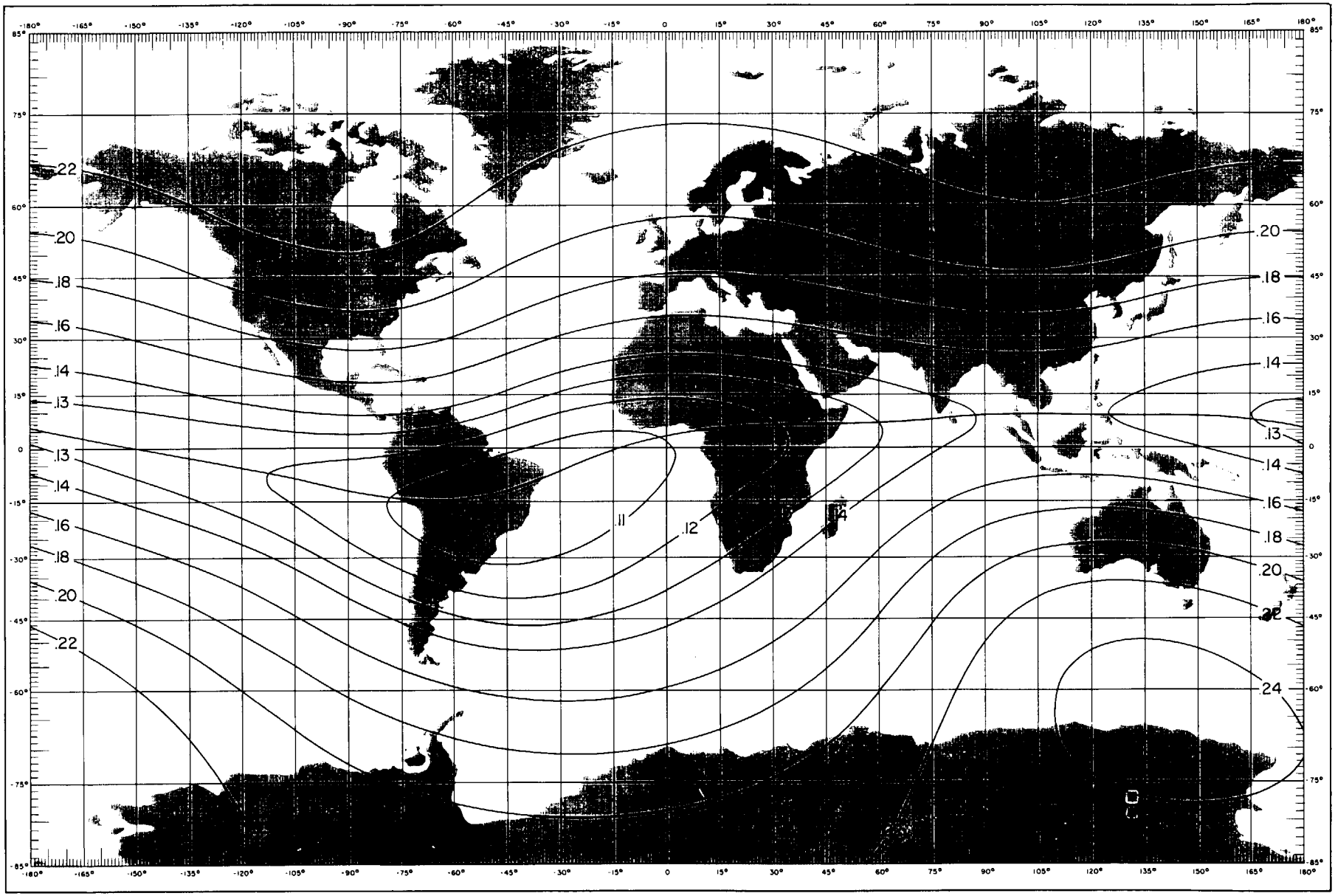
ALTITUDE=2200 KM

LINES OF CONSTANT B (GAUSS)



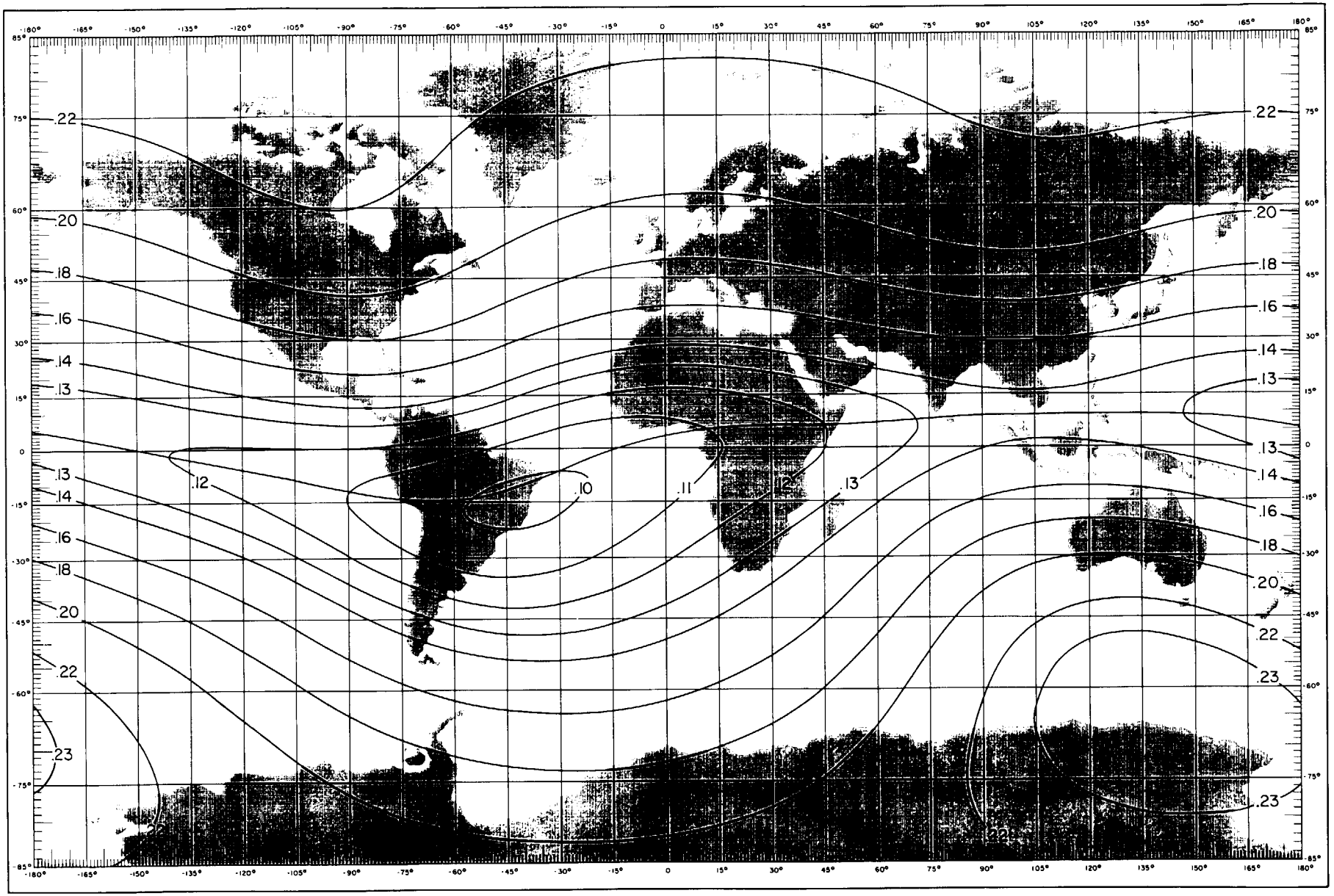
ALTITUDE=2300 KM

LINES OF CONSTANT B (GAUSS)



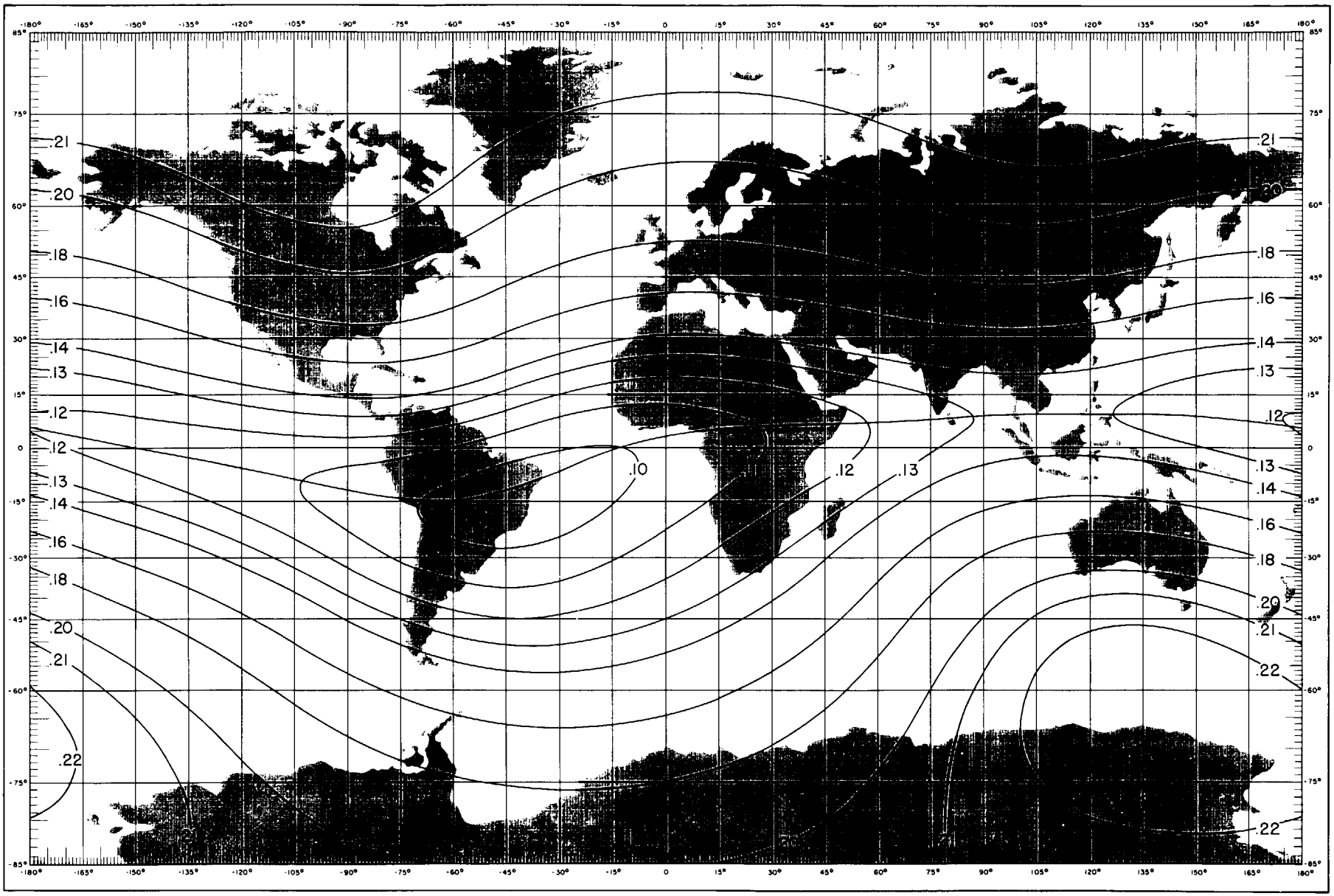
ALTITUDE=2400 KM

LINES OF CONSTANT B (GAUSS)



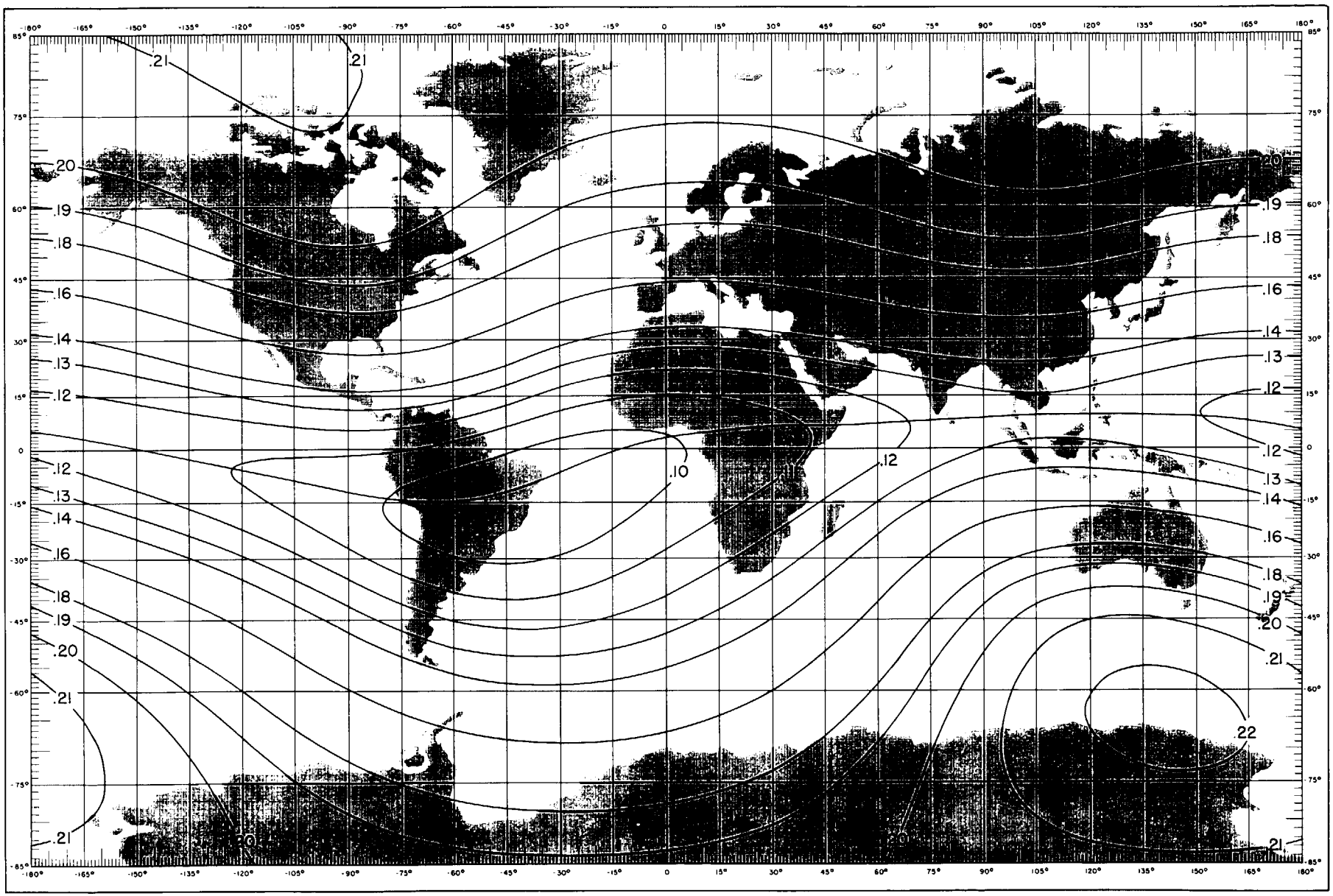
ALTITUDE=2500 KM

LINES OF CONSTANT B (GAUSS)



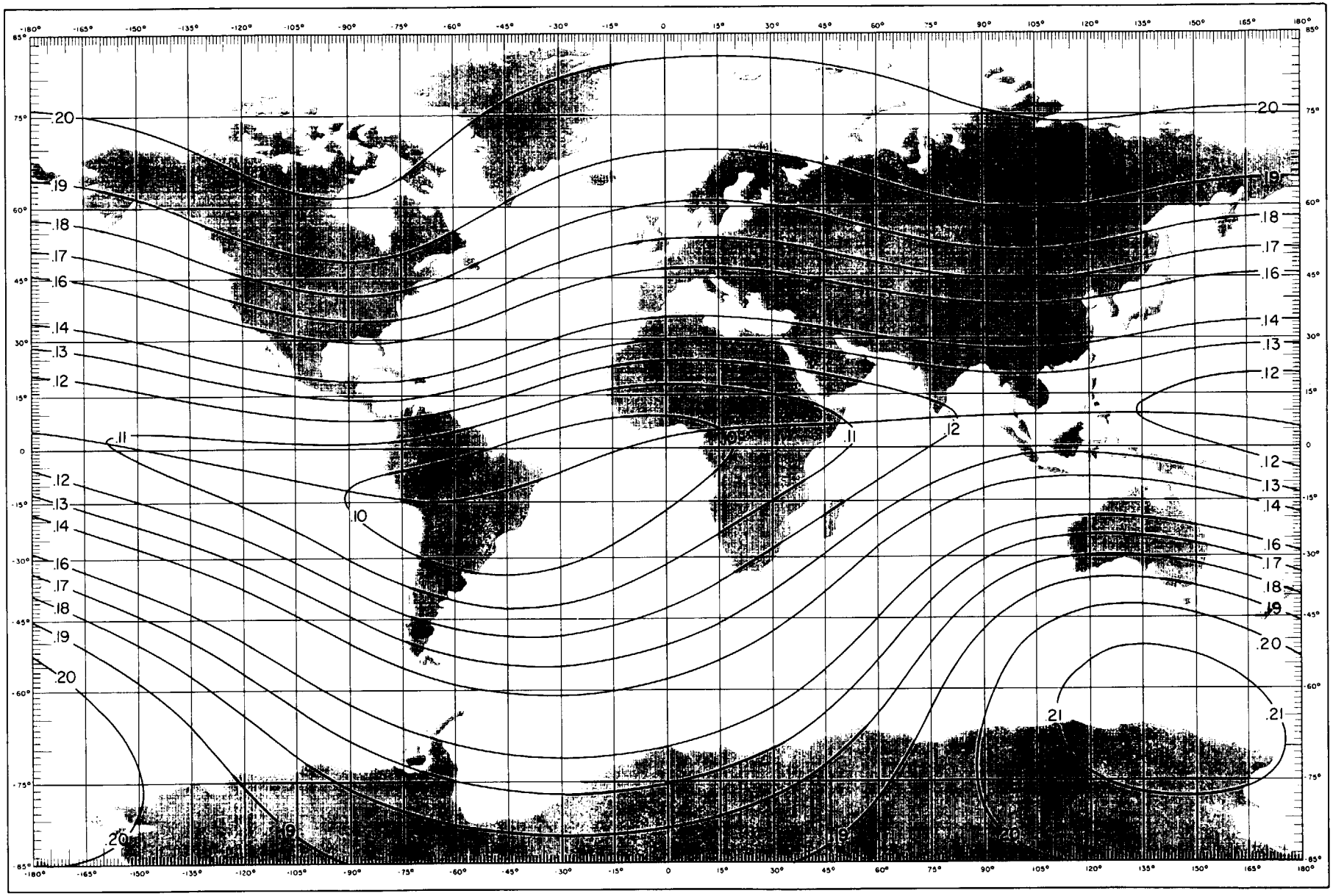
ALTITUDE=2600 KM

LINES OF CONSTANT B (GAUSS)



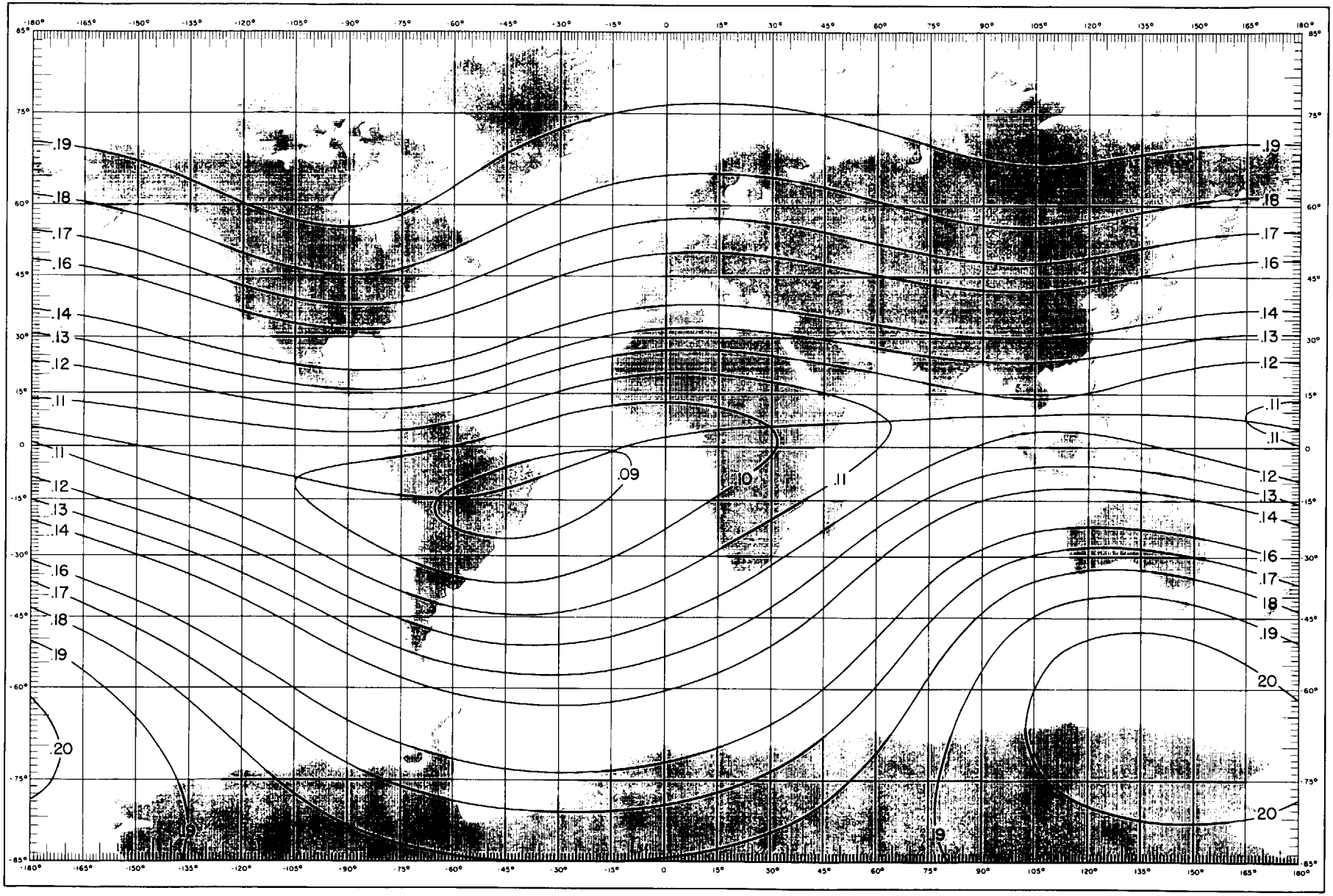
ALTITUDE = 2700 KM

LINES OF CONSTANT B (GAUSS)



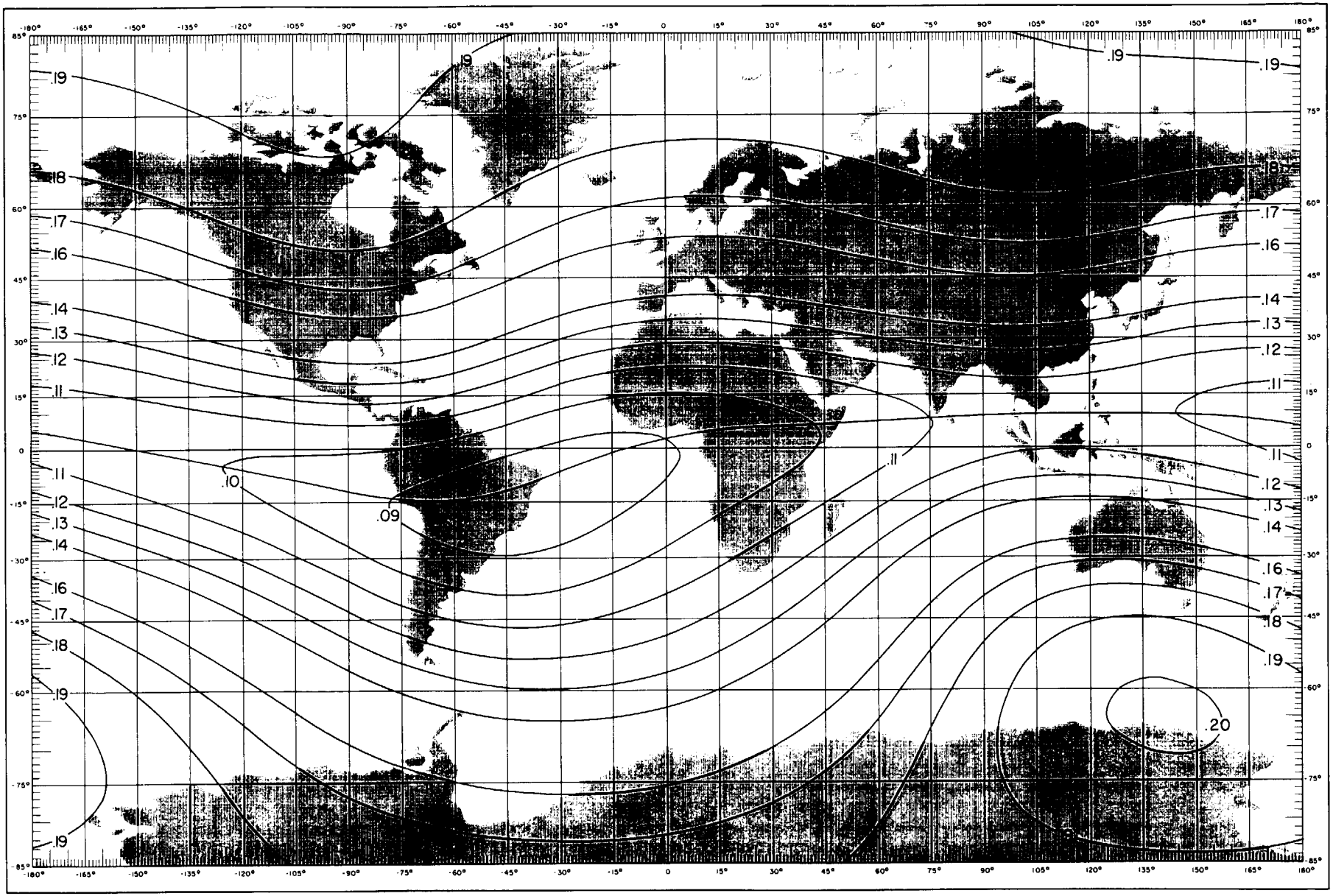
ALTITUDE=2800 KM

LINES OF CONSTANT B (GAUSS)



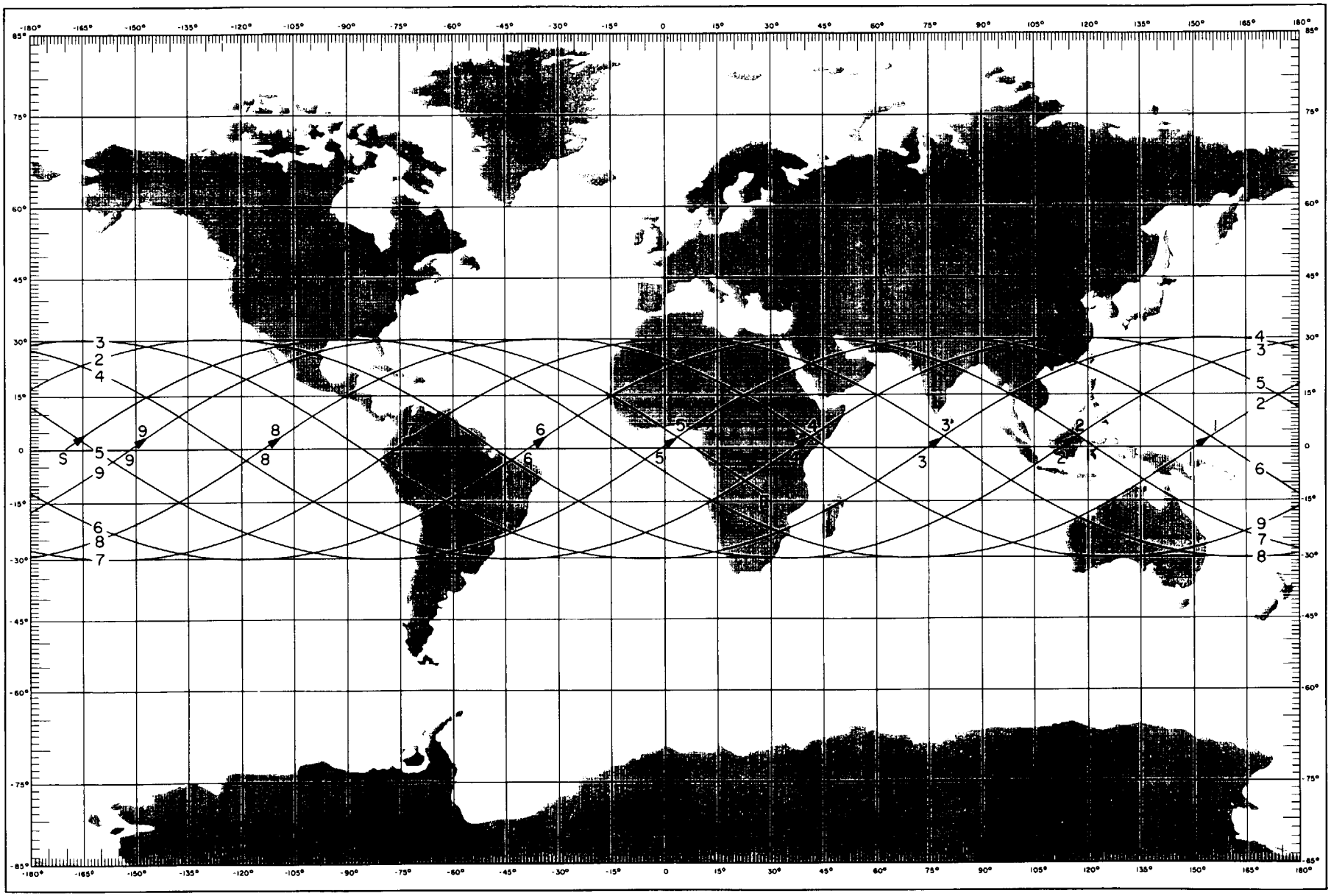
ALTITUDE = 2900 KM

LINES OF CONSTANT B (GAUSS)



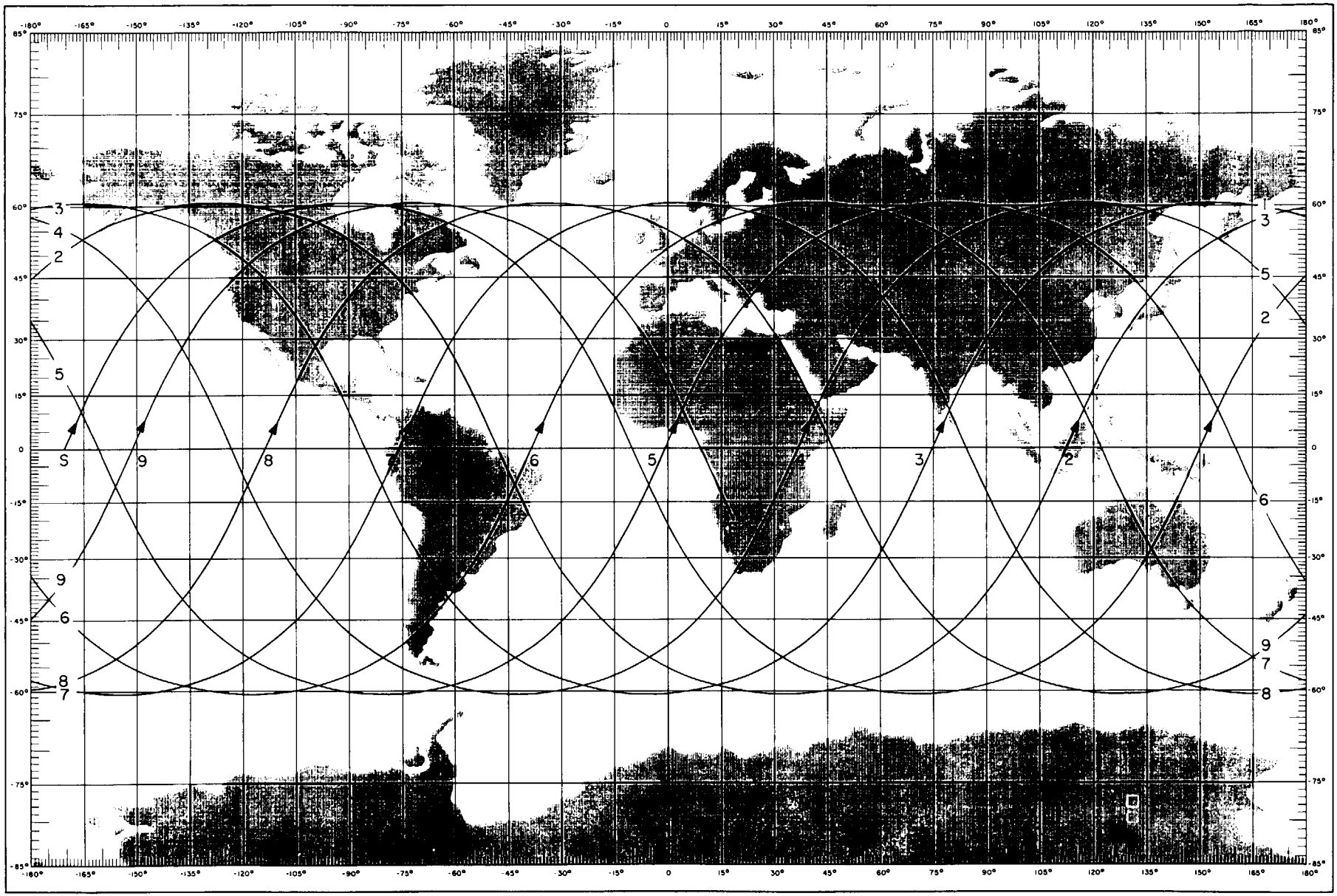
ALTITUDE = 3000 KM

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



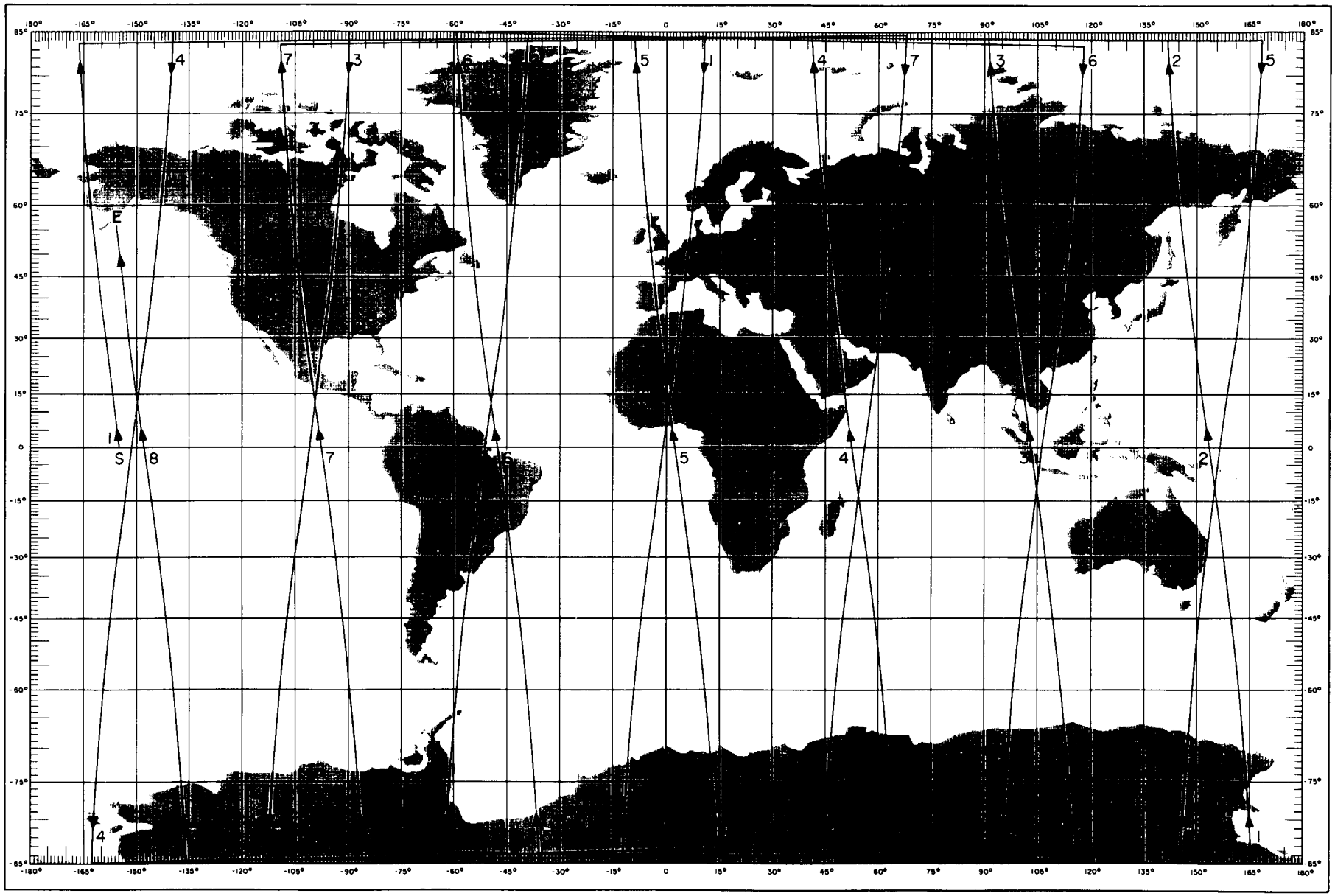
CIRCULAR ORBIT INCLINATION=30; ALTITUDE=3000KM; PERIOD=2.51063

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



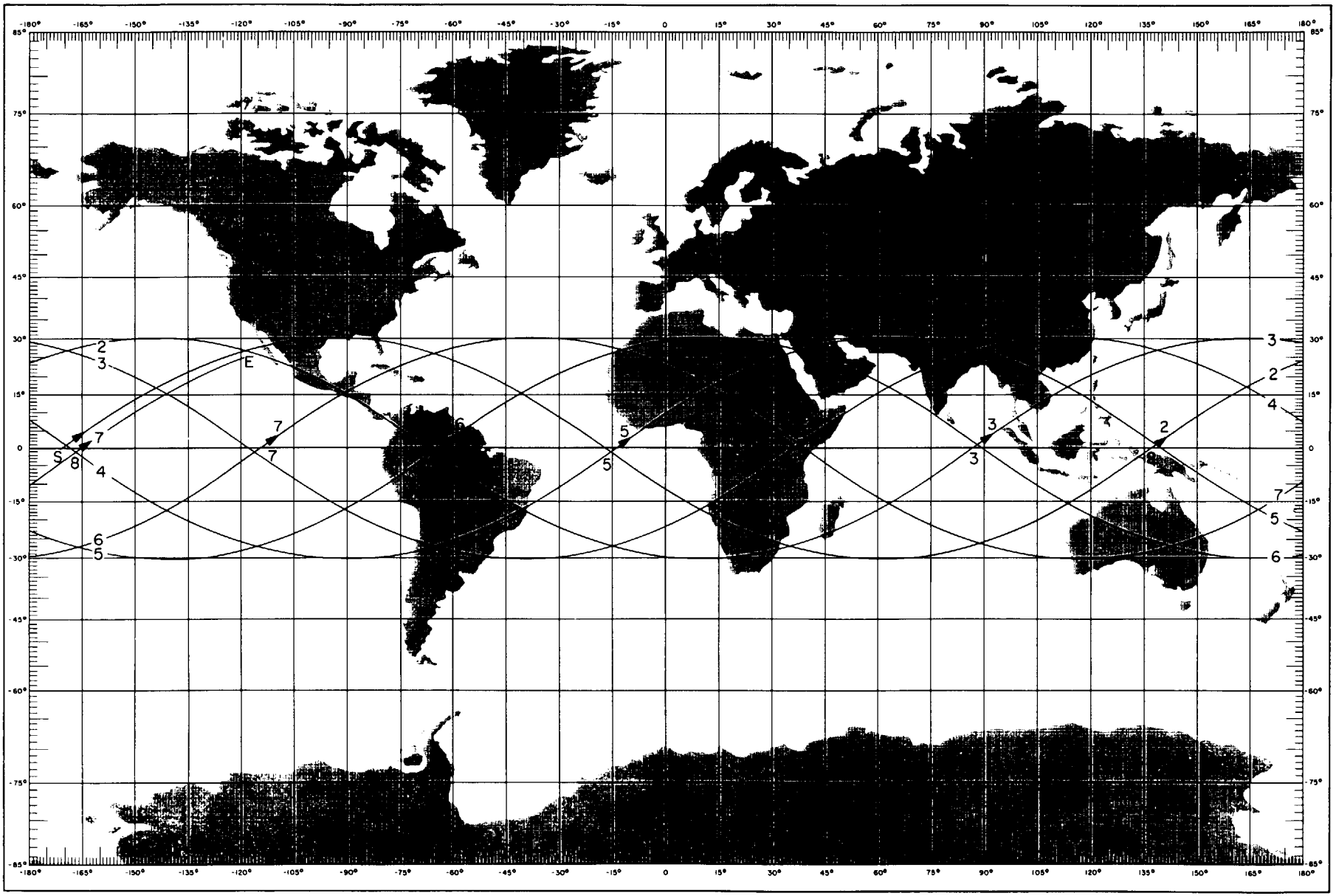
CIRCULAR ORBIT INCLINATION=60; ALTITUDE=3000KM; PERIOD=2.51063

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



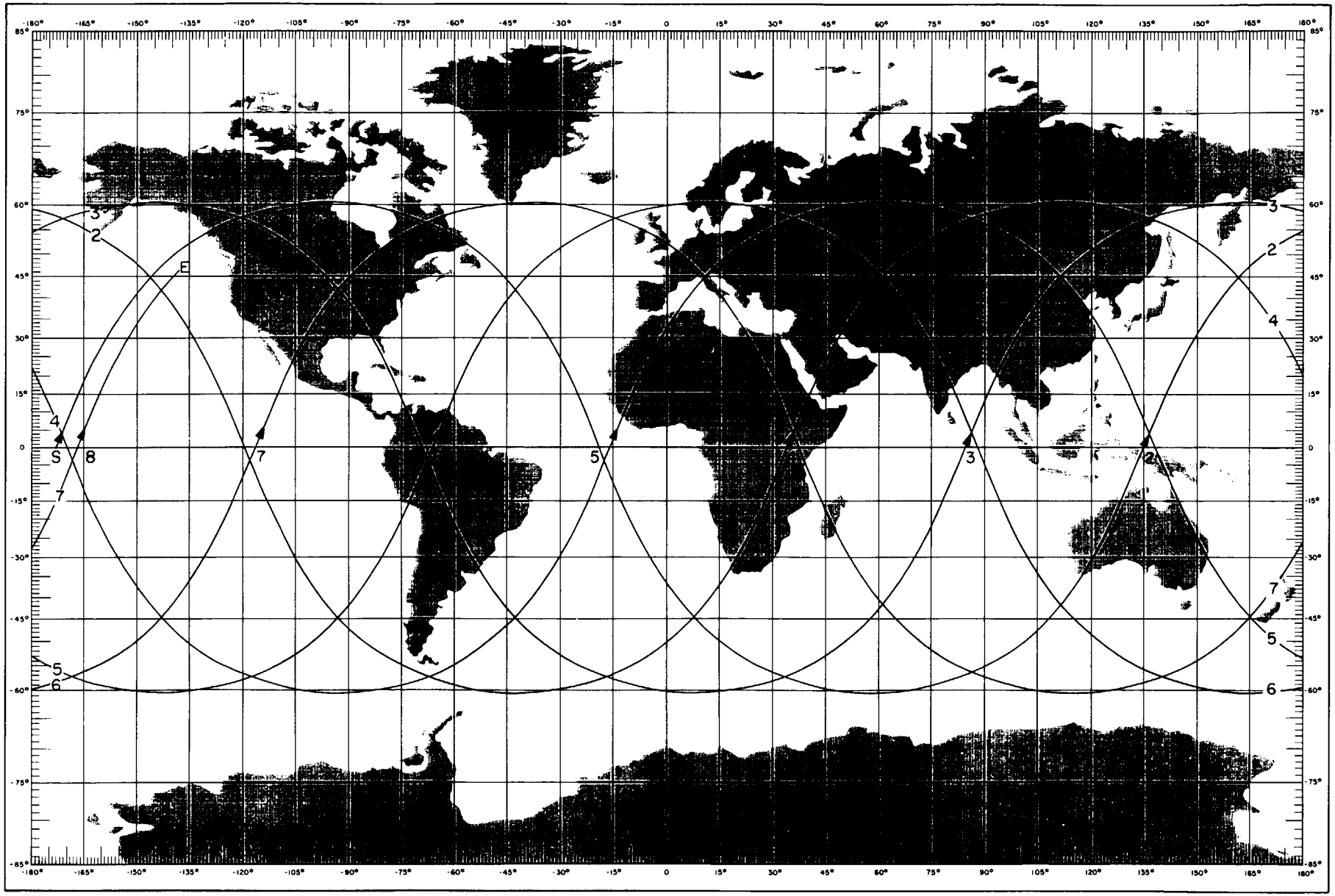
CIRCULAR ORBIT INCLINATION=90; ALTITUDE=5000KM; PERIOD=3.35517

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



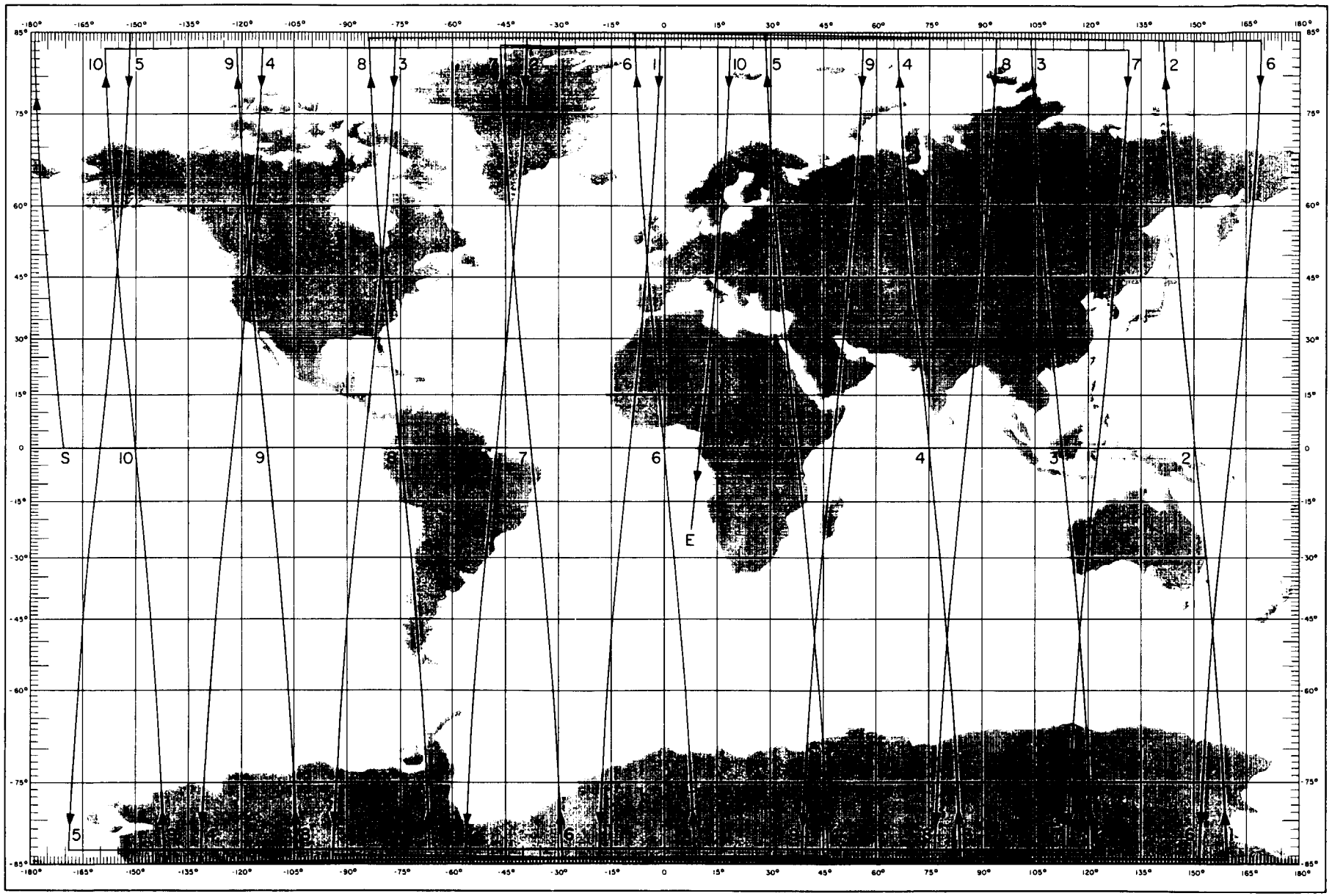
CIRCULAR ORBIT INCLINATION=30; ALTITUDE=5000 KM ; PERIOD=3.35517

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



CIRCULAR ORBIT INCLINATION=60; ALTITUDE=5000 KM.; PERIOD=3.35517

ORBITAL TRAJECTORY (MILLER CYLINDRICAL PROJECTION)



CIRCULAR ORBIT INCLINATION=90; ALTITUDE=3000KM, PERIOD=2.51063