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# SAM II Measurements of the Polar Stratospheric Aerosol

## Volume I - October 1978 to April 1979



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NASA
National Aeronautics and Space Administration

**Scientific and Technical Information Branch**

## PREFACE

This is the first in a series of reports presenting results obtained from the Stratospheric Aerosol Measurement (SAM) II sensor aboard the Nimbus 7 spacecraft. Each report will contain selected data products such as aerosol extinction profiles, aerosol extinction isopleths, temperature contours, and optical depths associated with 6 months of observations. The satellite was launched in late October 1978 and is still providing high-quality data. This report includes data through April 1979. It is intended for future reports to cover subsequent consecutive 6-month time periods.

All of the SAM II data and data products are being archived on magnetic tape at the National Space Sciences Data Center, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771, and are available to interested researchers. Because of the large volume of data retrieved by the SAM II system, it is impossible to present all of the results in hard-copy form. Consequently, this series of reports is intended to give, in a ready-to-use visual format, an overview of the data products being archived. It contains a large enough sampling of the results to allow for any analysis not requiring the entire data base. No attempt has been made in this report, however, to provide any scientific analysis with the data set. Some investigations have been already initiated by the SAM II Science Team, which is made up of the following people: G. W. Grams, Georgia Institute of Technology; B. M. Herman, University of Arizona; T. J. Pepin, University of Wyoming; P. B. Russell, SRI International; and M. P. McCormick, NASA Langley Research Center.

The following SAM II Staff contributed to this report: Helen M. Steele, Patrick Hamill, Thomas J. Swissler, W. H. Mitchell, A. B. Graham, and M. T. Osborn of Systems and Applied Sciences Corporation, Hampton, Virginia; and W. P. Chu and L. R. McMaster of NASA Langley Research Center.

CONTENTS

## SUMMARY

The Stratospheric Aerosol Measurement (SAM) II sensor is flying aboard the Earth-orbiting Nimbus 7 spacecraft providing extinction measurements of the Antarctic and Arctic stratospheric aerosol with a vertical resolution of 1 km. This report presents representative examples and weekly averages of these aerosol data as well as corresponding temperature profiles provided by the National Meteorological Center of the National Oceanic and Atmospheric Administration (NOAA) for the time and place of each SAM II measurement during the first 6 months of satellite flight, October 1978 through April 1979. From the aerosol extinction-profile data, contours of aerosol extinction as a function of altitude and longitude or time are plotted. Also, aerosol optical depths are calculated for each week. Seasonal variations and variations in space (altitude and longitude) for both polar regions are easily seen. Typical values of aerosol extinction at the SAM II wavelength of 1.0 μm for this time period are 1 to 3 times $10^{-4}$ $km^{-1}$ in the main stratospheric aerosol layer. Optical depths for the stratosphere are about 0.002. Polar stratospheric clouds (PSC's) at altitudes of about 22 km were observed during the Arctic winter at various times and locations. No attempt has been made in this report to give any detailed explanations or interpretations of these data. The intent of this report is to provide, in a ready-to-use format, a representative sample of the first 6 months of data to be used in atmospheric and climatic studies.

## INTRODUCTION

The SAM II sensor is aboard the Earth-orbiting Nimbus 7 spacecraft, and is designed to measure solar irradiances that have been attenuated by aerosol particles in the Arctic and Antarctic stratosphere. A principal goal of this mission is to map these polar aerosol layers and to generate a long-term data base or aerosol climatology. This data base will allow for studies of aerosol changes due to seasonal and short-term meteorological variations, atmospheric chemistry and mirophysics, and volcanic activity and other perturbations. The results obtained will be useful in a number of applications, particularly the evaluation of any potential climate effect caused by stratospheric aerosols.

## SAM II INSTRUMENT

The SAM II instrument consists of a single-channel Sun photometer with a 0.04-μm passband centered at a wavelength of 1.0 μm. This is a region of the spectrum where absorption by atmospheric gases is negligible; consequently, any extinction is due to scattering by aerosol particles and air molecules.

In operation, the instrument is activated shortly before each sunrise or sunset encountered by the satellite. A sensor with a wide field of view is used to indicate the Sun's presence. Two similar sensors then point the SAM II to within ±0.03° in azimuth (left and right). A mirror begins a rapid vertical scan until the Sun image is acquired by the SAM II telescope. The mirror then slowly scans vertically across the Sun at a rate of 0.25 degrees per second reversing itself each time a Sun-limb crossing occurs. The entrance window to the SAM II telescope only passes sunlight of wavelength greater than 0.9 μm. A circular aperture placed at the image plane serves

to define the instrument's instantaneous field of view to be 0.5 minutes of arc. This corresponds to a vertical resolution in the atmosphere of approximately 0.5 km altitude. From the telescope the light is directed through an interference filter, which rejects all but the 1.0-μm-wavelength (±0.02 μm) passband, to a photodiode detector. Light intensity as a function of time is digitized, recorded, and telemetered back to Earth. These data are reduced to yield the transmissivity of the atmosphere as a function of altitude and then inverted to give the extinction coefficient as a function of altitude (extinction profile). The inversion procedures used are described in Chu and McCormick (ref. 1).

A description of the SAM II instrument, and the experiment in general, is given by McCormick et al. (ref. 2). Further descriptive and technical details are found in Russell et al. (ref. 3) and The Nimbus 7 User's Guide (ref. 4).

## THE NIMBUS 7 SATELLITE ORBIT AND SAM II MEASUREMENTS

The SAM II instrument, along with a number of other sensors, is mounted on the Nimbus 7 Earth-orbiting satellite. The orbital characteristics of this satellite determine the measurement opportunities and geographic locations of the SAM II measurements. Recall that the mode of operation of the instrument is such that it takes data during each sunrise and sunset encountered. The Nimbus 7 satellite has an orbital period of 104 minutes, which means that it circles the Earth nearly 14 times per day. Each time the satellite enters into or emerges from the Earth's shadow, there is a measurement opportunity for the SAM II. Consequently, the instrument takes data during approximately 14 sunrises and 14 sunsets each Earth day. The orbit of the satellite is a high-noon, Sun-synchronous one, that is, each time the satellite crosses the equator, the center of the Earth, the satellite, and the center of the Sun all fall along a straight line. In general terms, this means that the orbital plane of the satellite is fixed with respect to the Sun and that all sunsets occur in the Arctic region whereas all sunrises occur in the Antarctic region. In the course of a single day, measurements of the stratospheric aerosol will be obtained at 14 points spaced 26° apart in longitude in the Northern Hemisphere, and similarly for the Southern Hemisphere. All of the points obtained during 1 day in a given hemisphere will be at very nearly the same latitude, but as time progresses, the latitude of the measurements will slowly change with the season by 1 to 2 degrees per week, gradually sweeping out the area from 64° to 80°. Figure 1 shows this latitudinal coverage for the period covered by this report. Lowest latitude coverage occurs at the solstices whereas the highest latitudes are measured at the equinoxes.

In the course of 1 week, therefore, the instrument makes about 98 measurements in each region, all in a band of latitude of approximately 1°. These measurements give a fairly dense set of data points. When the locations of all the measurements obtained in 1 week are plotted on a geographic set of axes, one finds that the separation between the points is only about 4° in longitude. In a 6-month period of time, the total number of observations is of the order of 5000.

## DATA PRODUCTS

The basic data product is the extinction profile obtained during each measurement opportunity, which can be analyzed to determine the latitudinal, longitudinal, and temporal variations in the stratospheric aerosol. A detailed description of all of the data products that are scheduled for routine archiving is given in section 5 of The Nimbus 7 User's Guide (ref. 4). These include tapes of the following: raw

radiance as a function of time for each sunrise and sunset; aerosol extinction coefficient, molecular extinction coefficient, and modeled aerosol number density as a function of altitude; and stereographic polar maps and cross sections of latitude (or longitude) as a function of altitude. The archived products also include 18 different types of output products produced on 16-mm film and consisting of profiles, cross sections, maps, and histories.

This report presents a portion of these data. Specifically, it contains the first 6-month's data of the following: weekly averages of SAM II extinction profiles; a 1-day sample for each week of aerosol extinction as a function of altitude and longitude; isopleths of weekly averaged extinction profiles plotted against time; and tables of weekly averaged stratospheric optical depth. These and the many data products generated represent far too much material to present in a reasonably sized report. It was decided, therefore, to present instead averages and representative samples of the data products. Where appropriate, the temperature profile or average temperature profile for the location at which the SAM II measurements were made is given with the aerosol data. The temperature data were supplied by the National Meteorological Center of the National Weather Service of NOAA, and are interpolated from their gridded global data sets (ref. 5). The optical-depth data are calculated directly from the aerosol extinction profile, which gives aerosol extinction coefficient as a function of altitude, by integrating between the altitude levels of interest. These data are presented in the form of tables.

## EXTINCTION PROFILES

The average of all extinction profiles measured by SAM II for a given week and the corresponding average temperature profiles are presented in figures 2 to 11. The temperatures at given pressure levels of 1000, 500, 300, 150, 100, 70, 50, and 10 millibars (1 millibar = 100 Pa) are provided by NOAA for each SAM II measurement. These are averaged to give a temperature at each pressure level and plotted at the average altitude of that level. The horizontal bars on both the extinction and temperature profiles show the one-standard-deviation range in the data. When available the tropopause height (averaged over each week) is indicated by a horizontal arrow near the left ordinate. The average latitude for the week is given on each plot.

## EXTINCTION ISOPLETHS

Figures 12 to 63 present isopleths of aerosol extinction and temperature contours for a 1-day sample taken from each week of the 6-month period. The extinction isopleths are plotted as extinction as a function of altitude and longitude and were generated from the 14 individual extinction profiles for the particular day by using a cubic-spline contouring program. The tension of the cubic-spline fit was set at 2.5. Once again, because of the large amount of data, all of the isopleths obtained are not presented. Instead, 1 day from each week has been randomly chosen for presentation. The dates for the day are indicated in the legends as they are given in the computer. The decimal fraction refers to the time of day. (For example, Oct. 29.97 means 11:14 p.m. on Oct. 29.) The values labeled on the extinction isopleths are scaled by $10^5$, and the value of the kth contour is equal to 1.32 times the value of the $k - 1$ contour. The isopleth marked "12" corresponds to an extinction of $1.20 \times 10^{-4}$ $km^{-1}$, which is typical of the stratosphere. The plotting routine used truncates decimal points, so that the lines marked "1" correspond to $1.32 \times 10^{-5}$ $km^{-1}$. The tick marks on the horizontal axes of each figure indicate the longitude of the individual profile measurement that was incorporated into the

isopleth. The vertical line indicates the prime meridian (0° E). The tropopause height, when available, is indicated with a circle containing a plus sign ( ⊕ ). The lines between the extinction values at the tick marks are interpolations between one extinction profile and the next. This should be kept in mind when interpreting the data. Note that in some of the plots all 14 data profiles for the day were not available.

The temperature contours are labelled in kelvin and are separated by 3 K. Local minimum values are marked with an "L" and maximum values with an "H".

Figures 12 to 37 show the Arctic measurements and figures 38 to 63 show the Antarctic measurements. The plots show rather interesting variations in the aerosol as a function of longitude. These variations have not been observed in measurements obtained with other methods because this satellite system is the first to obtain a high density of measurements in a short time interval, thus allowing such plots to be made. This set of plots also enables one to observe the correlations which exist between the aerosol extinction and the temperature. For example, some of the plots reveal the presence of polar stratospheric clouds (PSC's), which occur occasionally in the Arctic in the winter. (See figs. 21, 22, and 24.) Later data indicate that PSC's occur frequently in the Antarctic in the winter. The corresponding temperature fields show very low temperatures at the location of the PSC's. Finally, the presence of tropospheric clouds and aerosols extending up to the tropopause are easily seen.

## SIX-MONTH AVERAGE OF AEROSOL EXTINCTION

Figures 64 and 65 present contours of the weekly average of aerosol extinction as a function of time. The corresponding weekly average of temperature is also shown.

In each figure the average weekly aerosol extinction at 1-km altitude intervals is plotted as a function of altitude and time. Each average weekly aerosol value can be regarded as a zonal mean since the latitude coverage is only about 1 degree per week and measurements made during a week span 360° longitude, with a spacing of about 4°. The temperature plots were generated by evaluating the weekly average temperature at 1-km intervals and plotting isotherms as a function of altitude and time. Figure 64 is for the Northern Hemisphere and figure 65 is for the Southern Hemisphere. Further descriptions and analyses of these plots are found in McCormick et al. (ref. 6).

## OPTICAL DEPTH

Tables I and II contain weekly averaged values of the aerosol optical depth for the Arctic and Antarctic measurements. The optical-depth value depends critically on the method used for its evaluation. The optical depths are obtained by evaluating the integral of each extinction profile from a given altitude to 30 km. These profiles were evaluated from the tropopause, from 2 km above the tropopause, and from a fixed altitude of 11 km, all up to 30 km. The optical depths obtained from all of the extinction profiles during a given week are then averaged and the resultant values are presented in the tables, week by week, for the period covered by this report. An optical-depth value of 100 is $100 \times 10^{-5}$, or 0.001. Also included in the tables are the average latitude of the measurement point and the average tropopause height for the particular week.

It can be seen from these tables that in some cases the optical depth from 11 km is greater than the optical depth evaluated from 2 km above the tropopause even when the average tropopause height for the week is at 9 km or below. For example, in table II for the week beginning December 3, 1978, the optical depth from 11 km is $186.9 \times 10^{-5}$ whereas the optical depth from the tropopause plus 2 km is $147.2 \times 10^{-5}$. The average tropopause height for the week is 8.78 km. This would appear to suggest that the optical depth from 10.78 km is less than that evaluated from 11 km, which cannot be so. This discrepancy can be attributed to the fact that there are local fluctuations in tropopause height. Thus, the average of all the optical depths in a given week, each evaluated from the local tropopause plus 2 km, is not equal to the average of all the optical depths each evaluated from the average tropopause plus 2 km.

In general, local fluctuations in tropopause height will often cause the average optical depth from 11 km to be greater than that from 2 km above the tropopause, even for tropopause heights less than or equal to 9 km. This occurs because very large values of extinction due to tropospheric aerosols or high clouds may be included in the integral from 11 km (if the local tropopause height is at 12 km, for example), whereas such tropospheric contributions will be excluded in an integral from the tropopause plus 2 km.

## CONCLUDING REMARKS

This report has presented a representative sample and summaries of the first 6 months (Oct. 29, 1978, to Apr. 29, 1979) of the Stratospheric Aerosol Measurement (SAM) II satellite data. It is divided into Arctic and Antarctic measurements and includes consecutive weekly averages of aerosol extinction profiles, a representative 1-day isopleth (contours of aerosol extinction as a function of altitude and longitude) for each week, and contours of the weekly average of aerosol extinction as a function of altitude and time for this 6 months. In addition, the stratospheric aerosol optical depth, averaged for each week, is given in tabular form. Temperature data, provided by the National Weather Service from their gridded analysis corresponding to the time and location of the SAM II measurement, are included with the aerosol extinction data. They are plotted as average temperature profiles, or contours, or tropopause heights.

At the time of this report, about 3 years after its launch in October 1978, SAM II continues to provide high-quality data. This report is intended to provide representative and summary data in a ready-to-use visual format for rapid use in atmospheric and climatic studies. It is intended that future 6-month reports using this same format be published.

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Hampton, VA 23665
October 9, 1981

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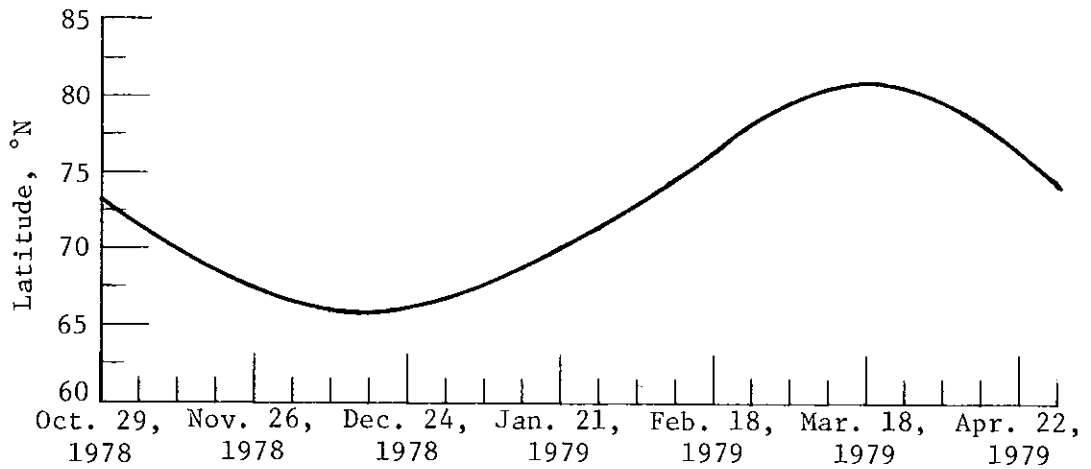
TABLE I.- AVERAGE OPTICAL DEPTH FOR ARCTIC REGION

| Week beginning - | Latitude, °N | Average tropopause height, km | Average optical depth measured from - | | |
|---|---|---|---|---|---|
| | | | Tropopause | Tropopause plus 2 km | 11 km |
| Oct. 29, 1978 | 72.5 | | | | $136.7 \times 10^{-5}$ |
| Nov. 5, 1978 | 70.7 | | | | 144.5 |
| Nov. 12, 1978 | 69.2 | | | | 162.2 |
| Nov. 19, 1978 | 67.8 | | | | 142.5 |
| Nov. 26, 1978 | 66.6 | 9.23 | $213.5 \times 10^{-5}$ | $142.6 \times 10^{-5}$ | 178.7 |
| Dec. 3, 1978 | 65.7 | 9.39 | 212.4 | 140.2 | 173.3 |
| Dec. 10, 1978 | 65.2 | 8.93 | 230.0 | 146.0 | 153.8 |
| Dec. 17, 1978 | 64.9 | 9.05 | 234.1 | 142.3 | 157.5 |
| Dec. 24, 1978 | 65.0 | 9.11 | 212.7 | 141.6 | 153.1 |
| Dec. 31, 1978 | 65.5 | 9.12 | 236.3 | 146.1 | 147.8 |
| Jan. 7, 1979 | 66.3 | 9.22 | 222.3 | 148.2 | 158.5 |
| Jan. 14, 1979 | 67.5 | 9.53 | 263.1 | 158.6 | 216.0 |
| Jan. 21, 1979 | 69.0 | 9.08 | 277.3 | 164.6 | 209.0 |
| Jan. 28, 1979 | 70.7 | | | | 148.0 |
| Feb. 4, 1979 | 72.6 | | | | 130.8 |
| Feb. 11, 1979 | 74.7 | | | | 146.8 |
| Feb. 18, 1979 | 76.9 | | | | 131.8 |
| Feb. 25, 1979 | 79.0 | 8.63 | 239.1 | 131.4 | 121.9 |
| Mar. 4, 1979 | 80.9 | 8.75 | 233.5 | 126.4 | 121.2 |
| Mar. 11, 1979 | 82.3 | 9.09 | 242.9 | 148.0 | 150.5 |
| Mar. 18, 1979 | 82.8 | 8.33 | 242.2 | 149.2 | 133.5 |
| Mar. 25, 1979 | 82.3 | 8.96 | 249.9 | 128.6 | 128.4 |
| Apr. 1, 1979 | 81.0 | 8.53 | 258.2 | 158.1 | 148.2 |
| Apr. 8, 1979 | 79.1 | 8.27 | 245.3 | 161.7 | 148.0 |
| Apr. 15, 1979 | 77.2 | 8.41 | 241.0 | 156.6 | 145.0 |
| Apr. 22, 1979 | 75.2 | 8.30 | 268.7 | 154.9 | 141.4 |

TABLE II.- AVERAGE OPTICAL DEPTH FOR ANTARCTIC REGION

| Week beginning - | Latitude, °S | Average tropopause height, km | Average optical depth measured from - | | |
|---|---|---|---|---|---|
| | | | Tropopause | Tropopause plus 2 km | 11 km |
| Oct. 29, 1978 | 74.0 | | | | $121.4 \times 10^{-5}$ |
| Nov. 5, 1978 | 72.2 | | | | 130.8 |
| Nov. 12, 1978 | 70.5 | | | | 138.6 |
| Nov. 19, 1978 | 68.9 | | | | 135.3 |
| Nov. 26, 1978 | 67.5 | 8.91 | $217.3 \times 10^{-5}$ | $174.7 \times 10^{-5}$ | 184.8 |
| Dec. 3, 1978 | 66.4 | 8.78 | 217.5 | 147.2 | 186.9 |
| Dec. 10, 1978 | 65.6 | 8.94 | 269.1 | 144.8 | 141.8 |
| Dec. 17, 1978 | 65.2 | 8.90 | 217.8 | 164.7 | 156.0 |
| Dec. 24, 1978 | 65.0 | 8.94 | 202.1 | 143.7 | 142.4 |
| Dec. 31, 1978 | 65.2 | 8.94 | 214.9 | 139.0 | 138.0 |
| Jan. 7, 1979 | 65.7 | 8.97 | 213.5 | 135.3 | 134.3 |
| Jan. 14, 1979 | 66.5 | 9.01 | 243.2 | 136.1 | 135.4 |
| Jan. 21, 1979 | 67.5 | 8.66 | 205.0 | 139.4 | 134.6 |
| Jan. 28, 1979 | 68.8 | | | | 130.4 |
| Feb. 4, 1979 | 70.4 | | | | 130.7 |
| Feb. 11, 1979 | 72.0 | | | | 129.2 |
| Feb. 18, 1979 | 73.8 | | | | 131.3 |
| Feb. 25, 1979 | 75.4 | 8.76 | 213.9 | 138.5 | 133.8 |
| Mar. 4, 1979 | 76.9 | 8.14 | 227.2 | 149.2 | 134.4 |
| Mar. 11, 1979 | 78.0 | 8.41 | 214.8 | 146.3 | 137.0 |
| Mar. 18, 1979 | 78.6 | 8.38 | 140.9 | 143.0 | 132.7 |
| Mar. 25, 1979 | 78.5 | 8.55 | 223.4 | 140.1 | 133.3 |
| Apr. 1, 1979 | 77.8 | 8.64 | 206.6 | 138.2 | 132.7 |
| Apr. 8, 1979 | 76.6 | 8.85 | 203.0 | 137.5 | 135.0 |
| Apr. 15, 1979 | 75.1 | 9.08 | 186.0 | 138.8 | 139.8 |
| Apr. 22, 1979 | 73.5 | 9.41 | 199.3 | 136.0 | 147.2 |



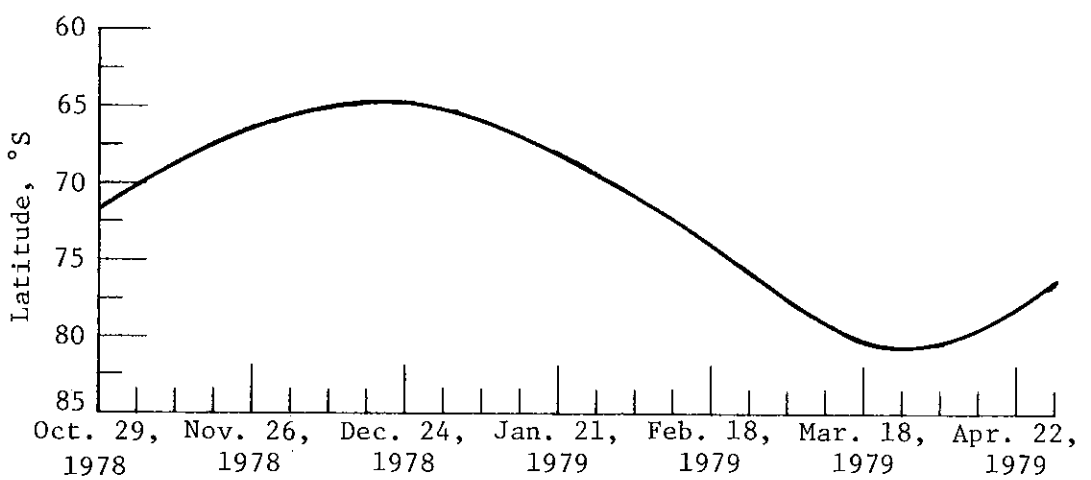




Figure 1.- Latitudinal coverage of SAM II measurements for October 1978 to April 1979.

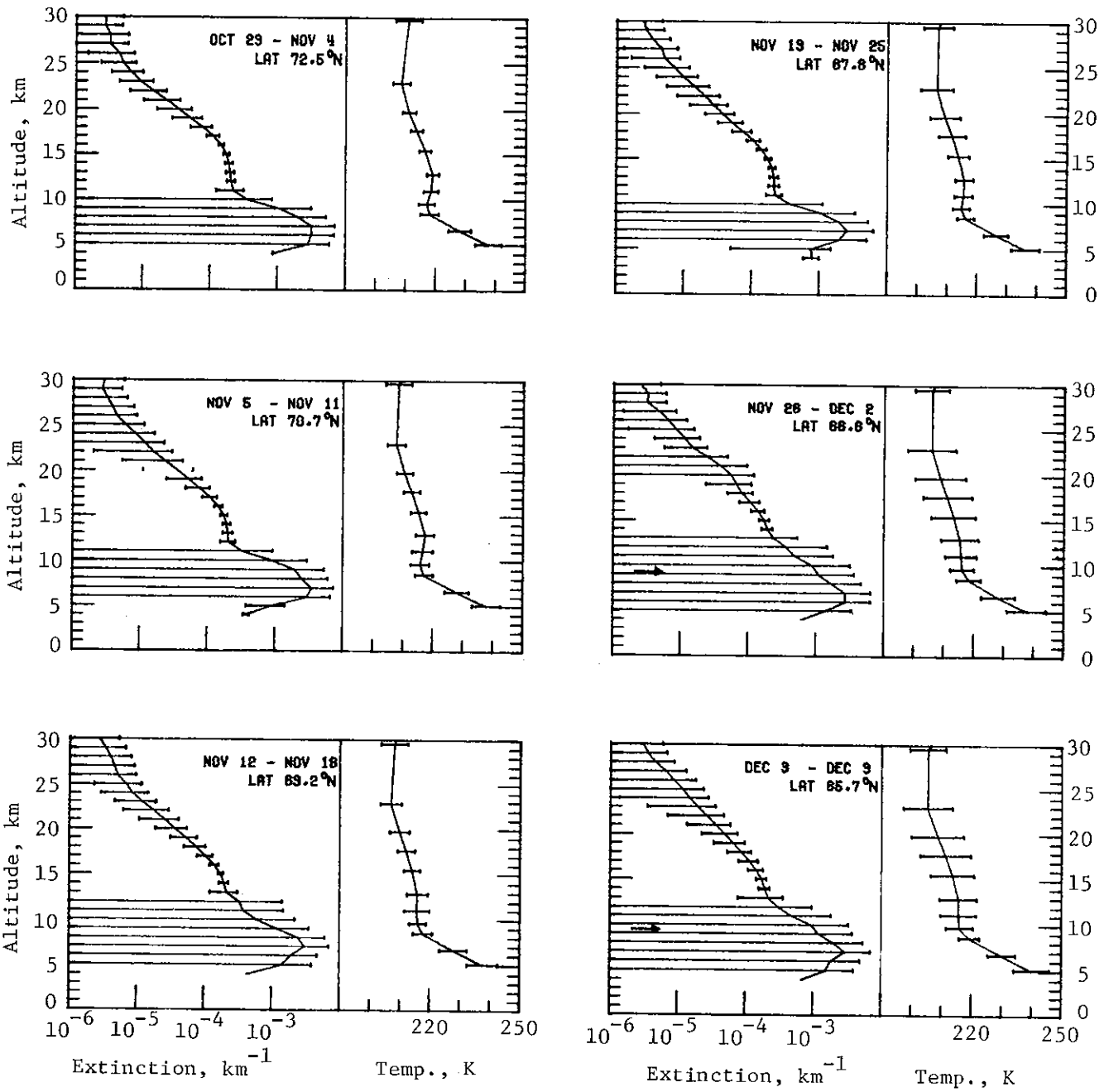



Figure 2.- Arctic extinction and temperature profiles for October 29 to December 9, 1978.

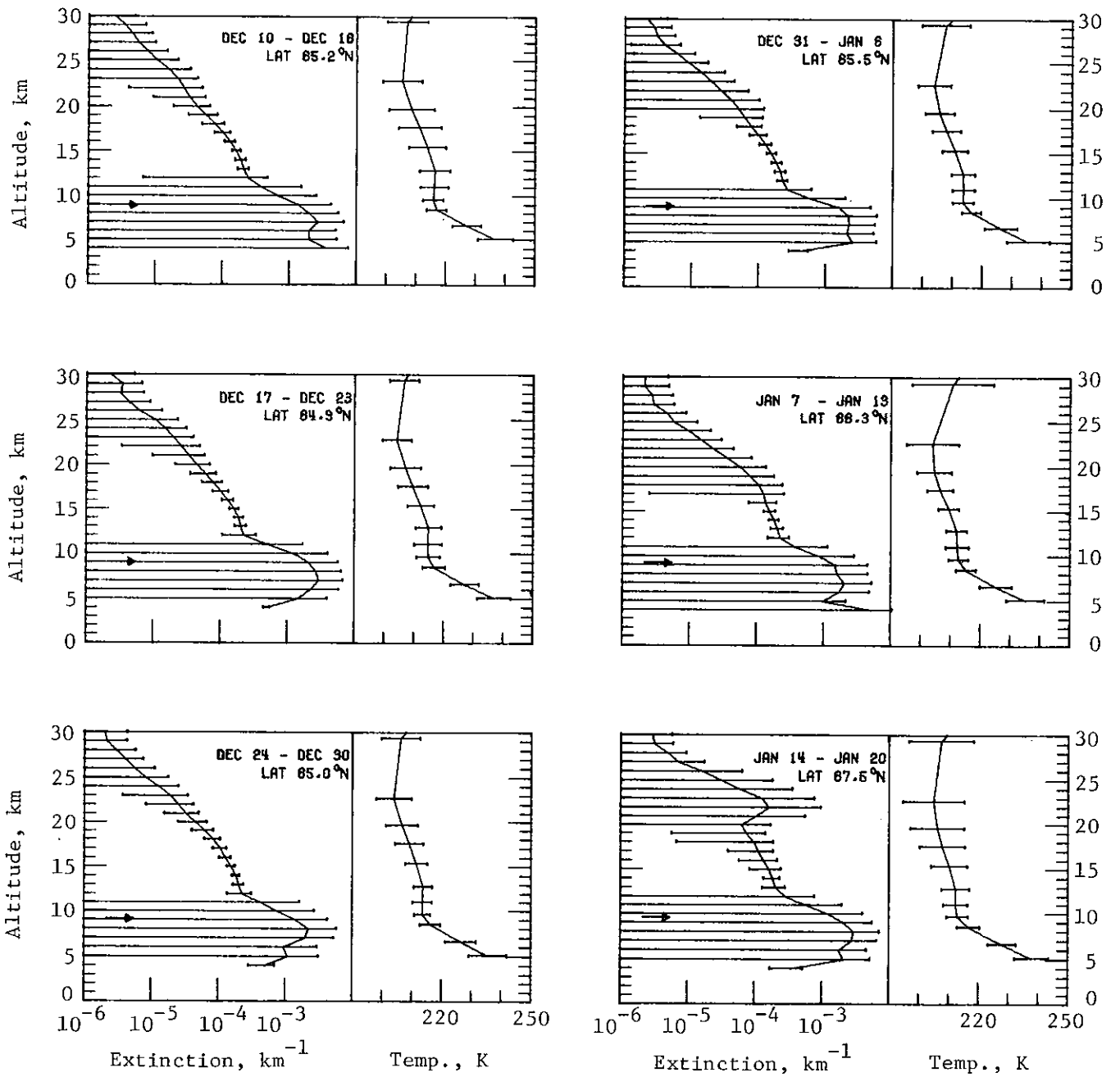



Figure 3.- Arctic extinction and temperature profiles for December 10, 1978, to January 20, 1979.

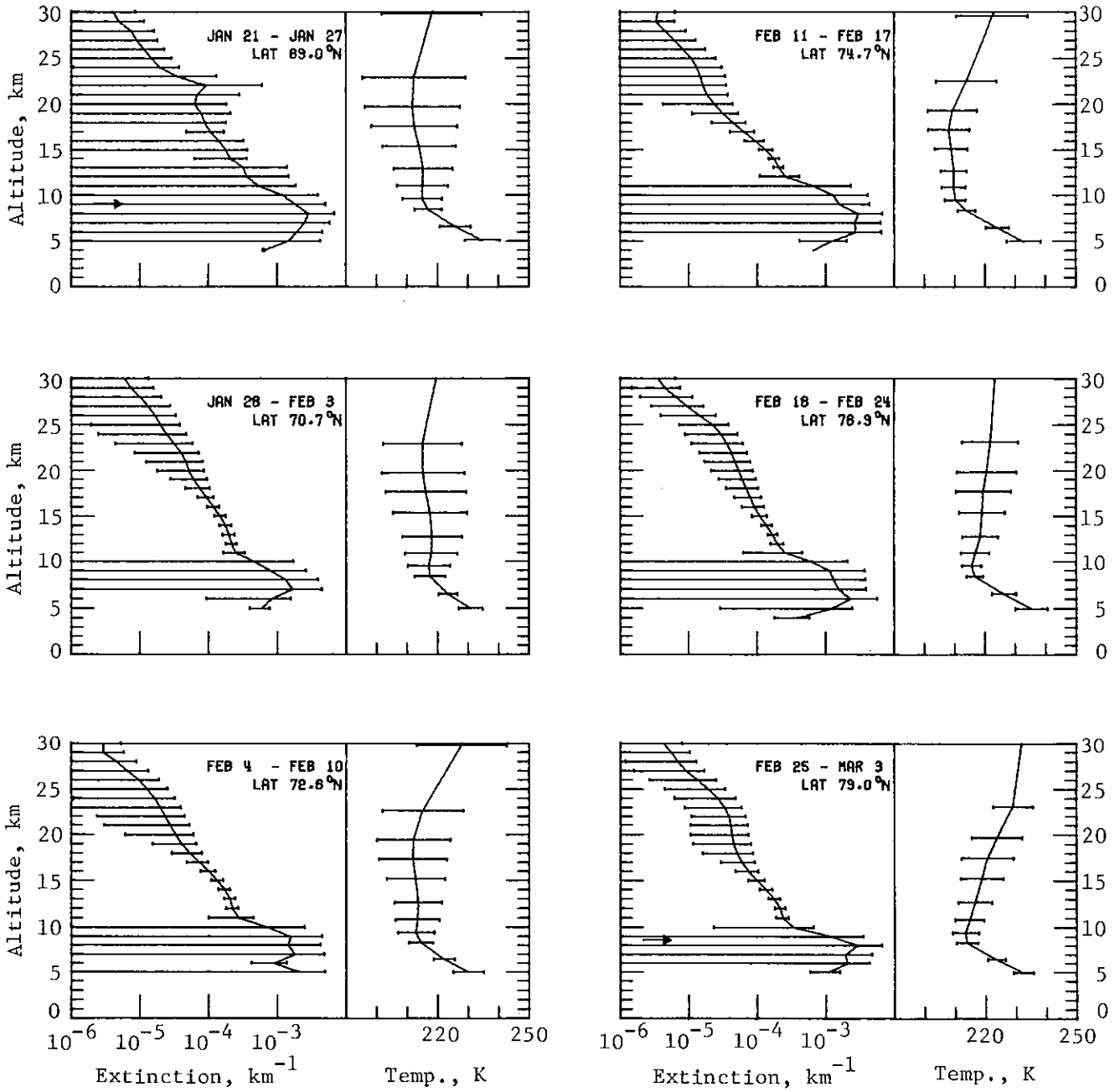



Figure 4.- Arctic extinction and temperature profiles for January 21 to March 3, 1979.

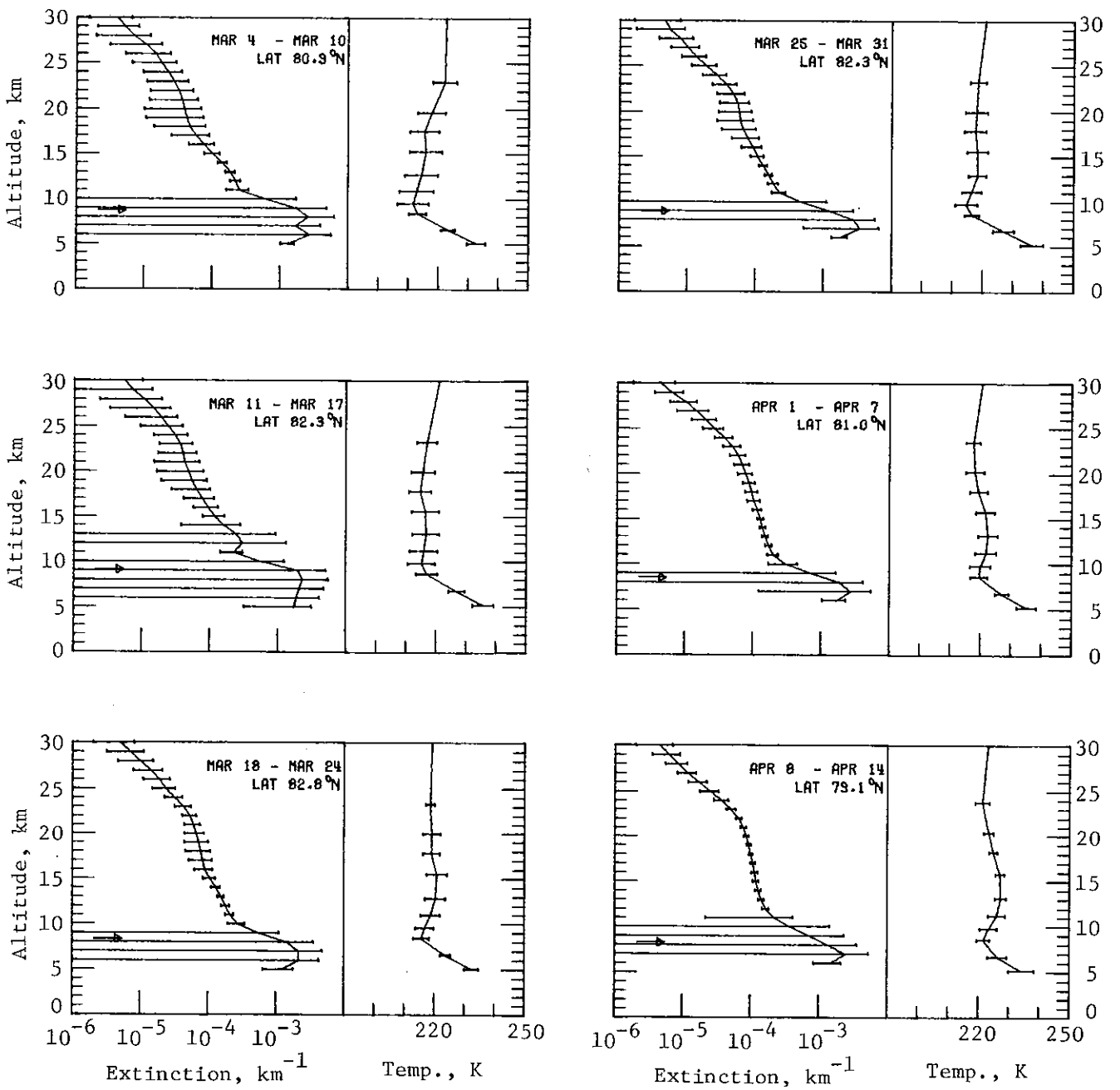



Figure 5.- Arctic extinction and temperature profiles for March 4 to April 14, 1979.

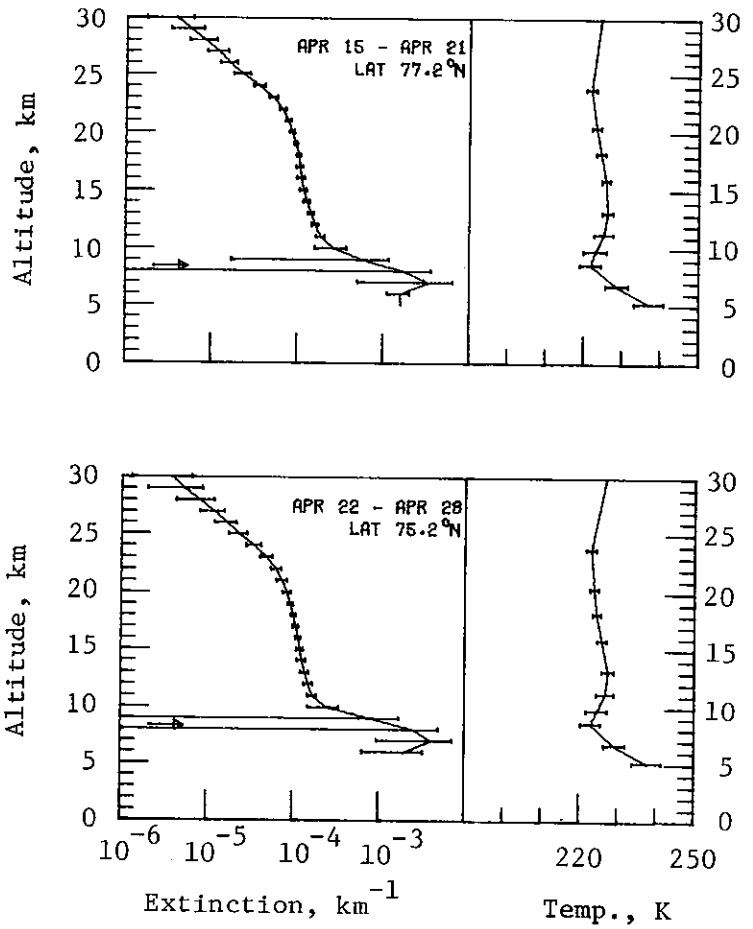



Figure 6.- Arctic extinction and temperature profiles for April 15 to April 28, 1979.

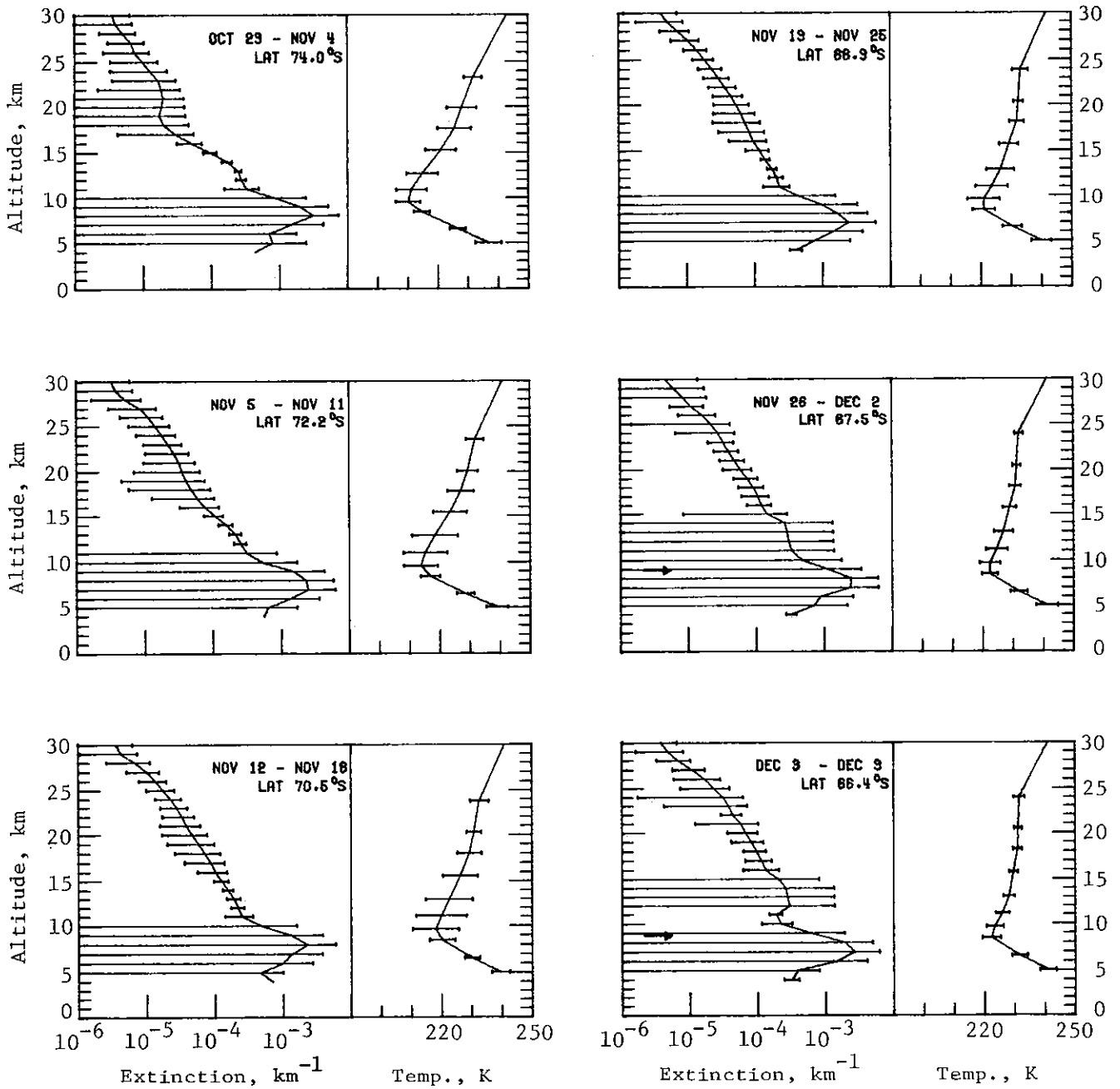



Figure 7.- Antarctic extinction and temperature profiles for October 29 to December 9, 1978.

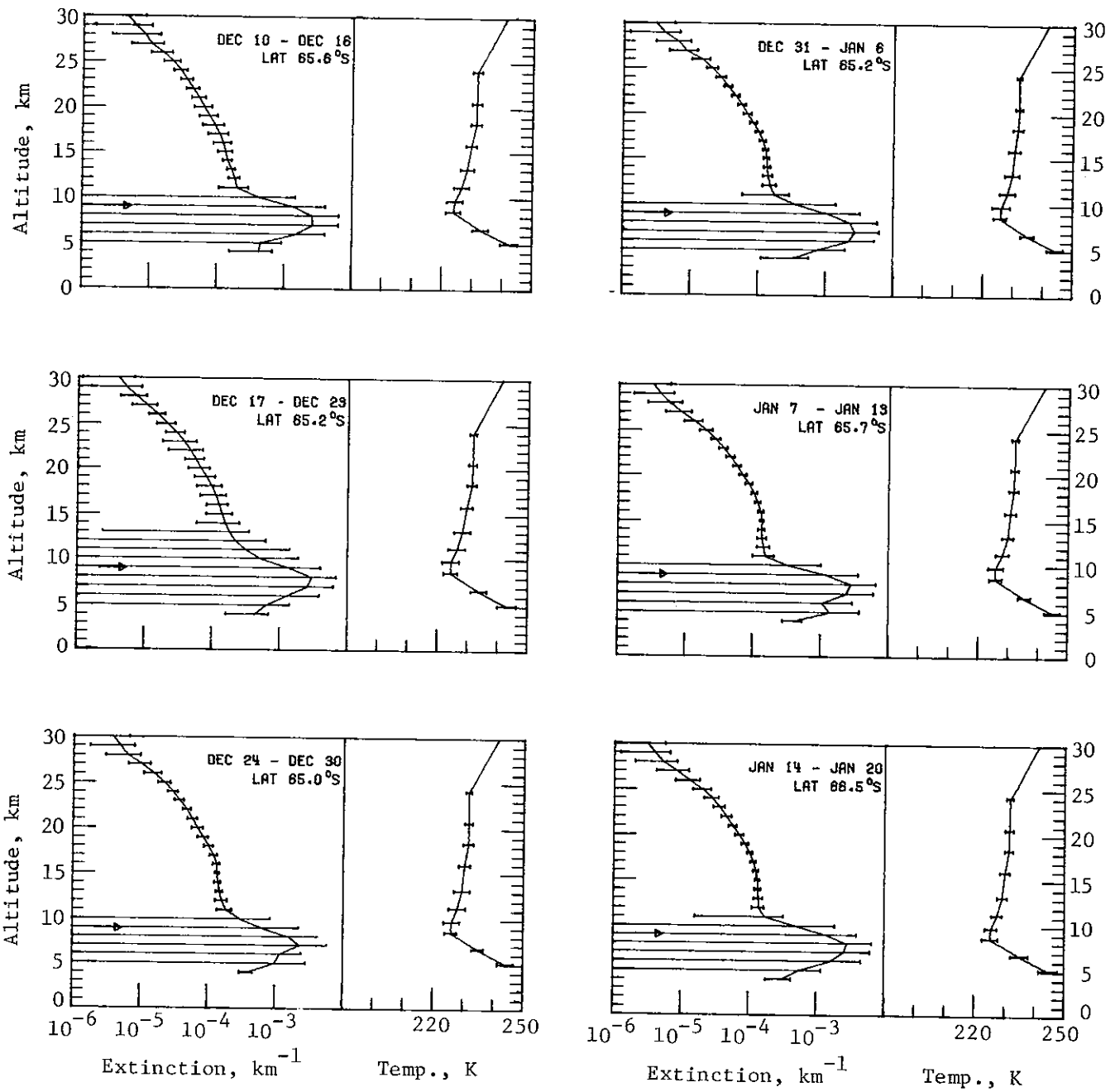



Figure 8.- Antarctic extinction and temperature profiles for December 10, 1978, to January 20, 1979.

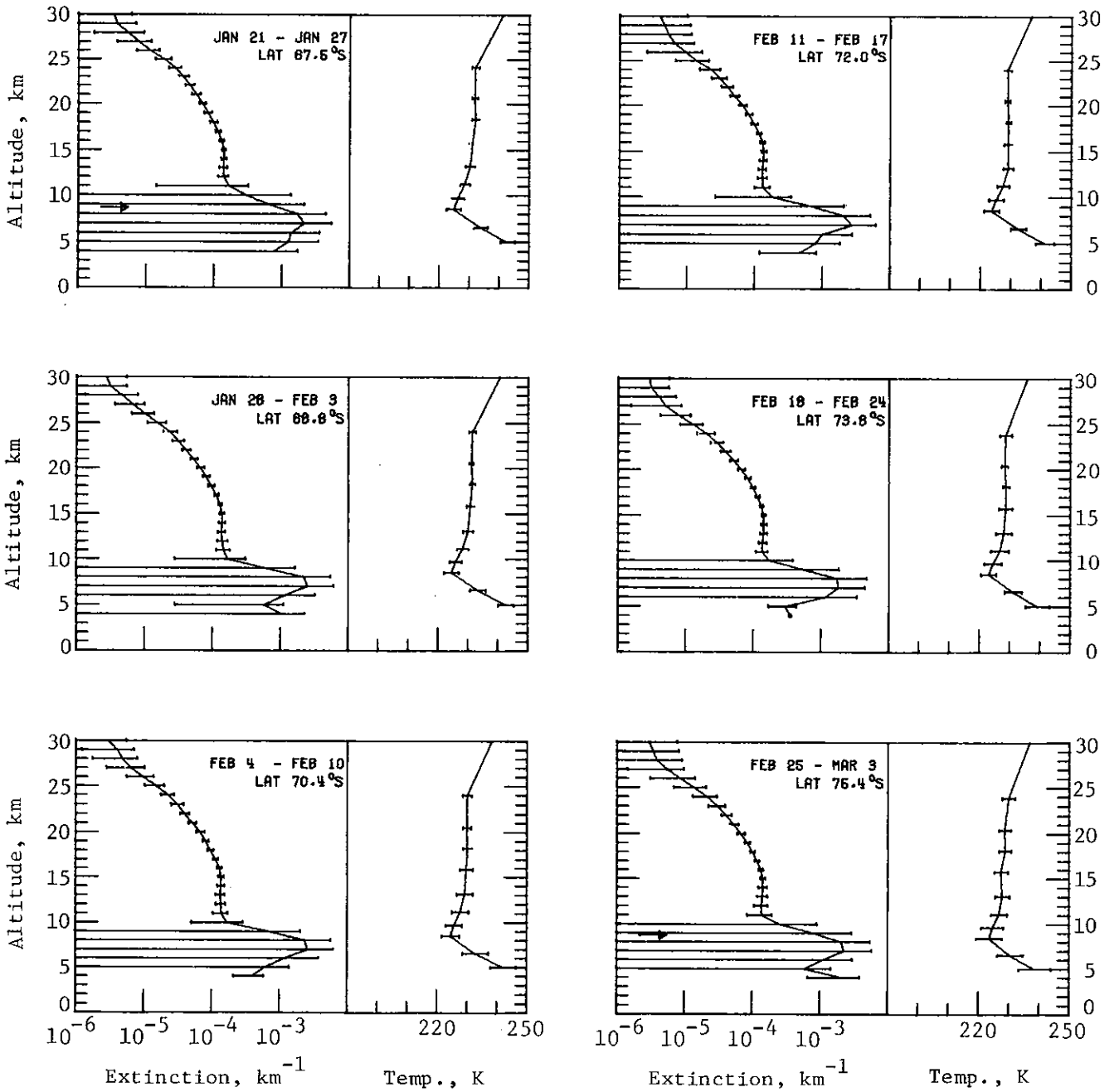



Figure 9.- Antarctic extinction and temperature profiles for January 21 to March 3, 1979.

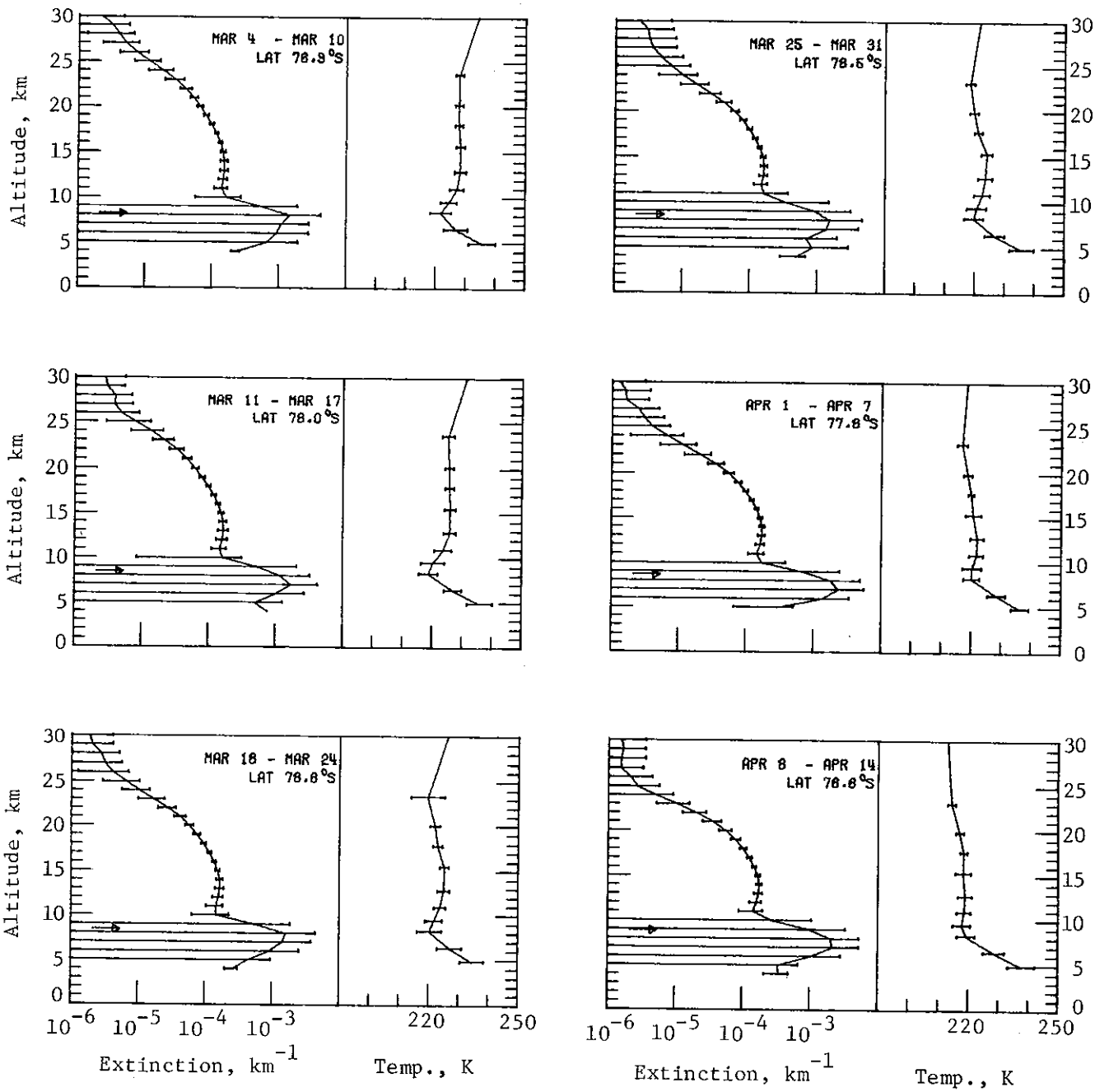



Figure 10.- Antarctic extinction and temperature profiles for March 4 to April 14, 1979.

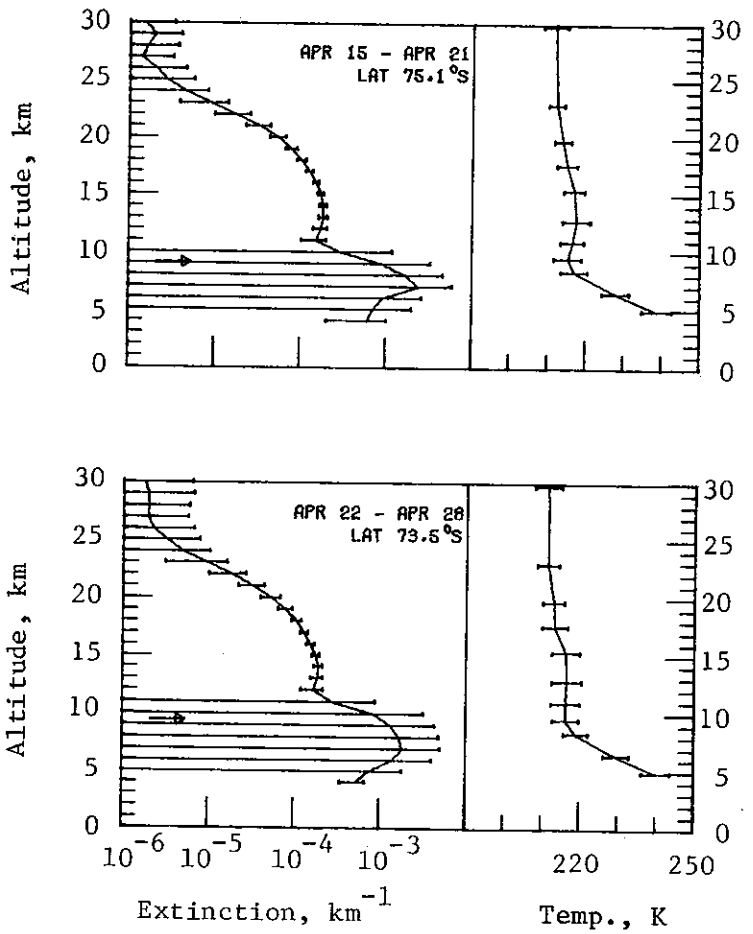
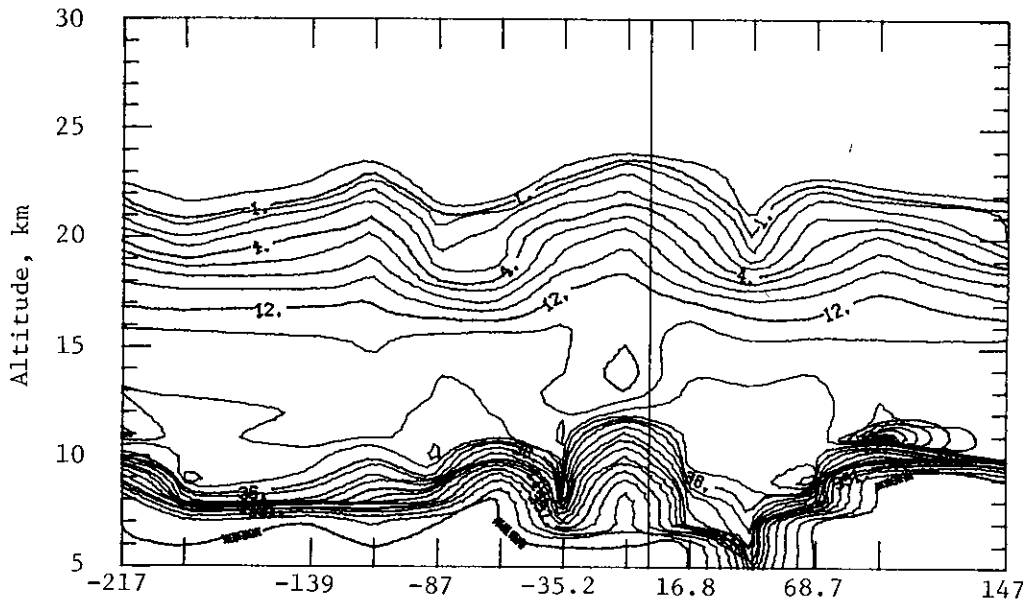
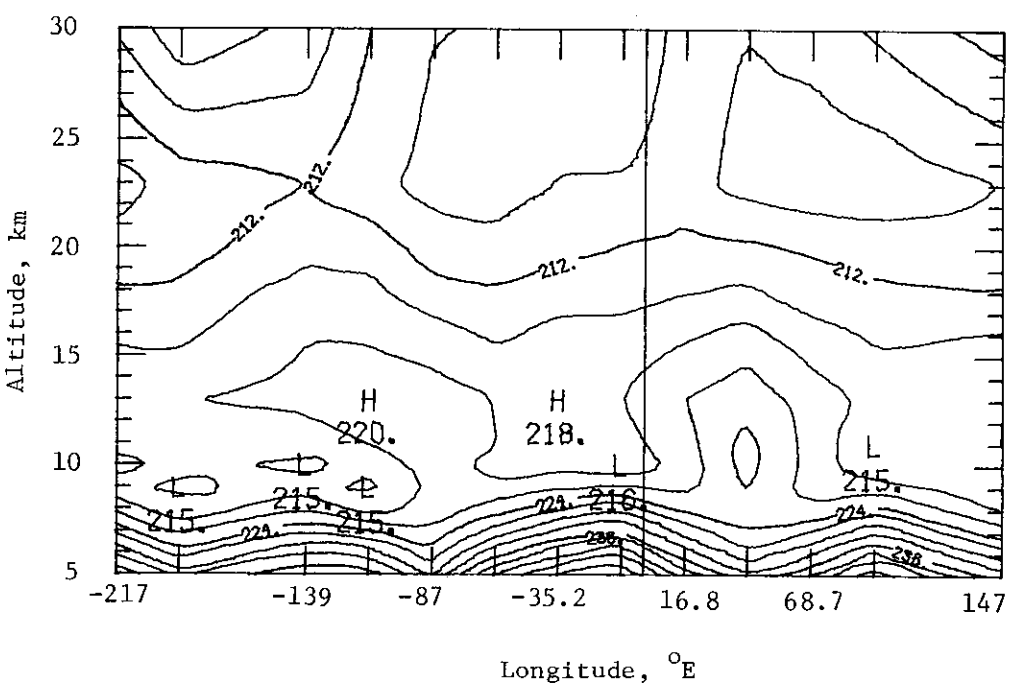



Figure 11.- Antarctic extinction and temperature profiles for April 15 to April 28, 1979.

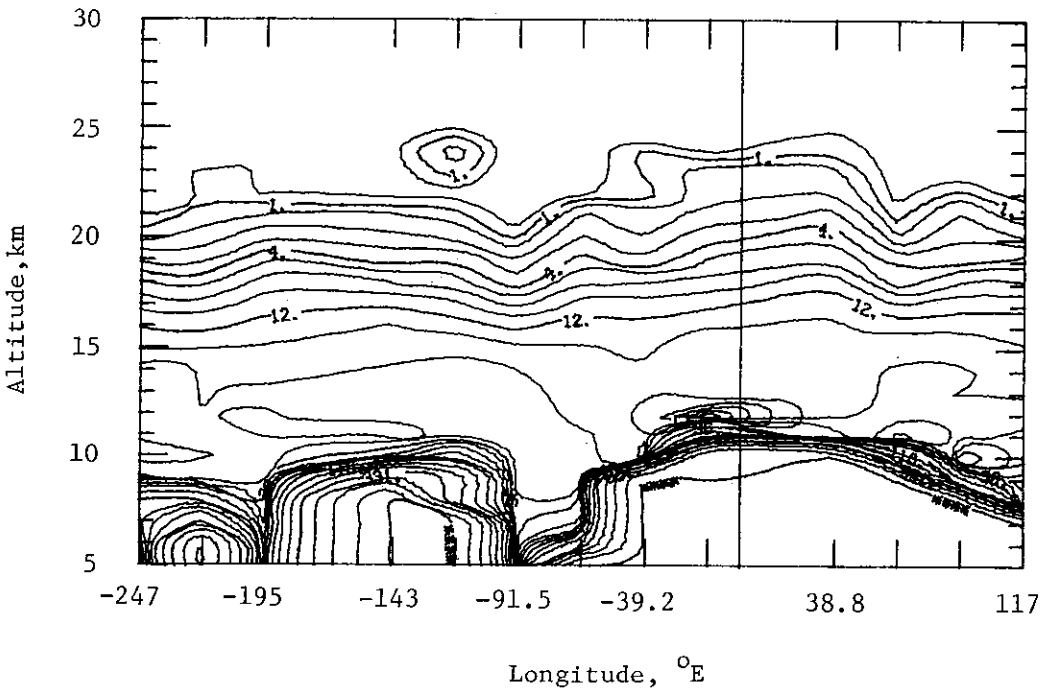



(a) Extinction isopleth.

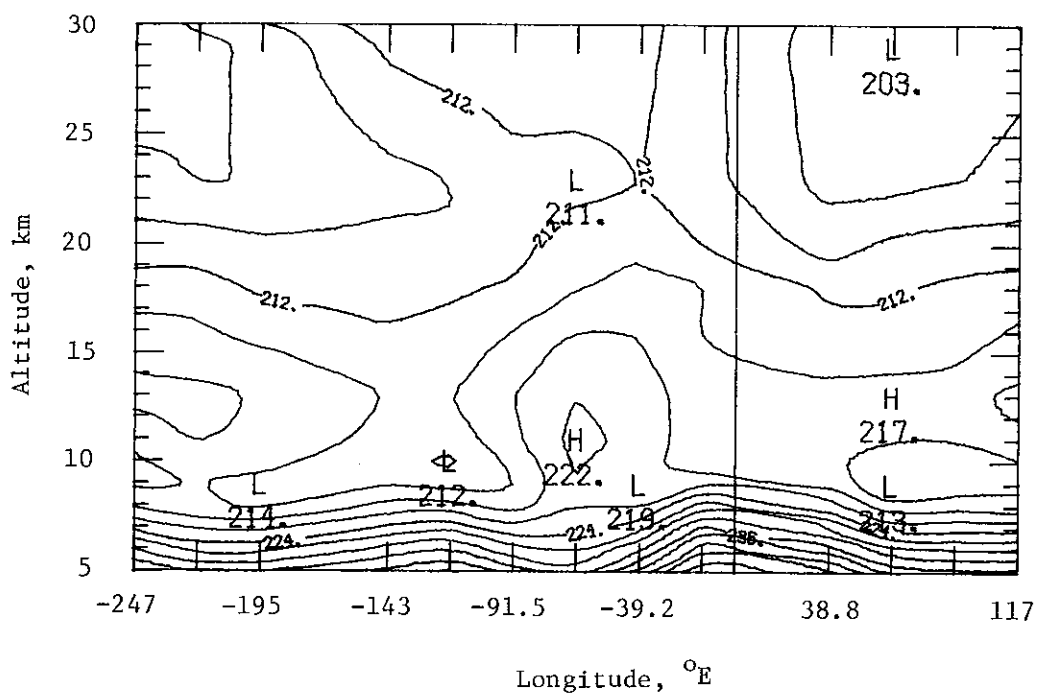



(b) Temperature contours.

Figure 12.- Arctic extinction isopleth and temperature contours for October 29.97 to 30.98, 1978, at latitudes from 73.2° to 72.9° N corresponding to orbits 78 to 92.

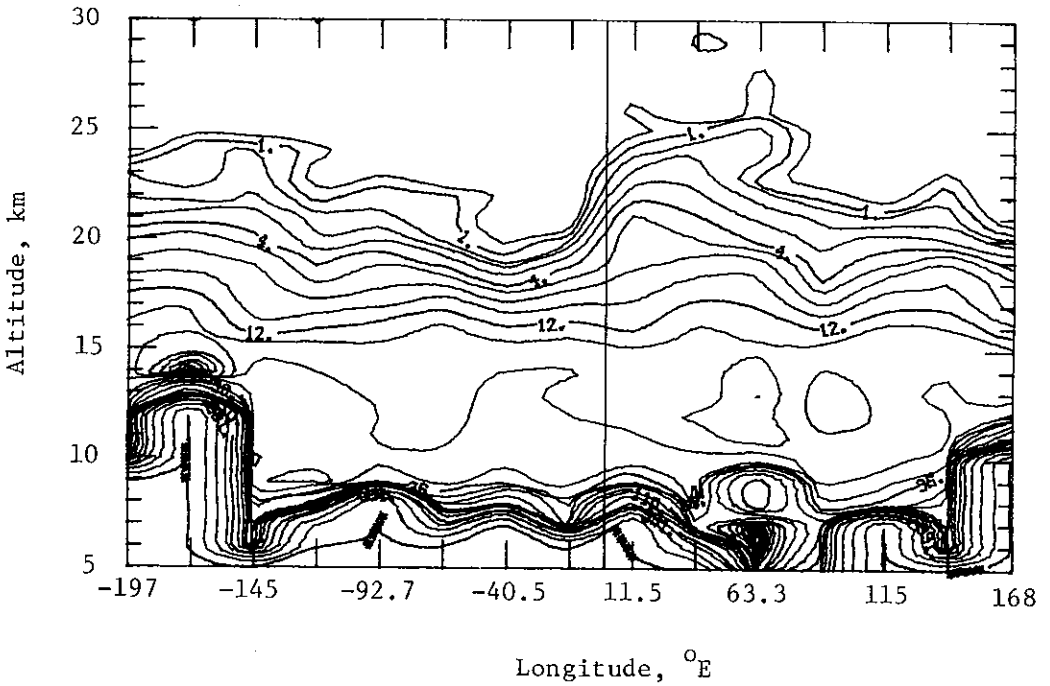



(a) Extinction isopleth.

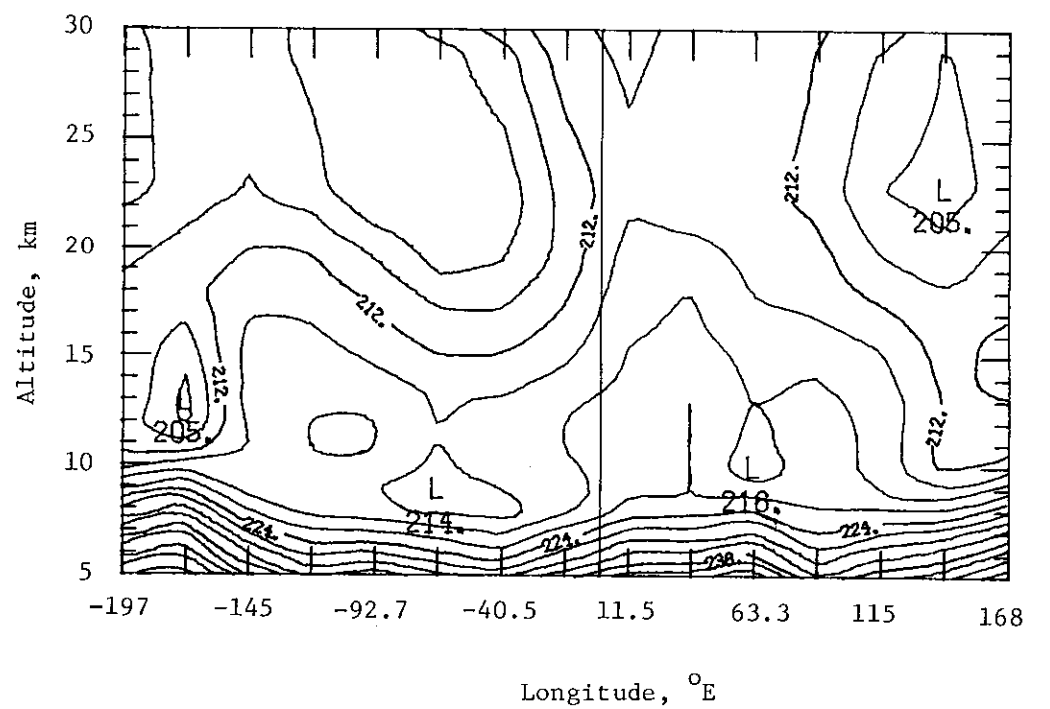



(b) Temperature contours.

Figure 13.- Arctic extinction isopleth and temperature contours for November 7.07 to 8.08, 1978, at latitudes from 71.1° to 70.8° N corresponding to orbits 190 to 204.

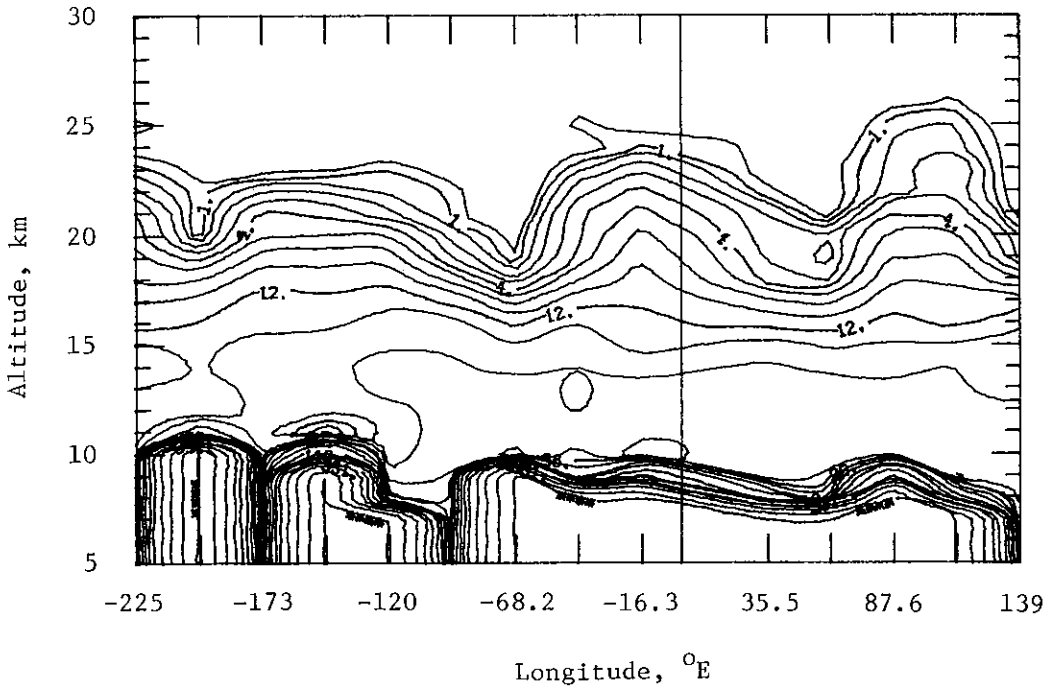



(a) Extinction isopleth.

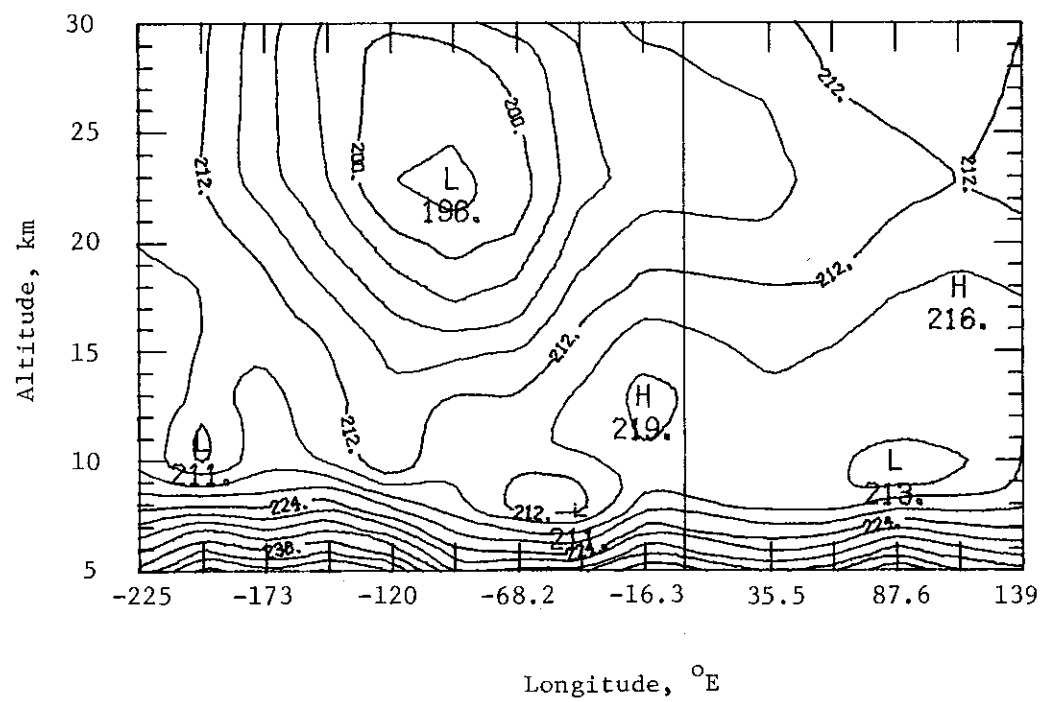



(b) Temperature contours.

Figure 14.- Arctic extinction isopleth and temperature contours for November 13.94 to 14.95, 1978, at latitudes from 69.5° to 69.3° N corresponding to orbits 285 to 299.

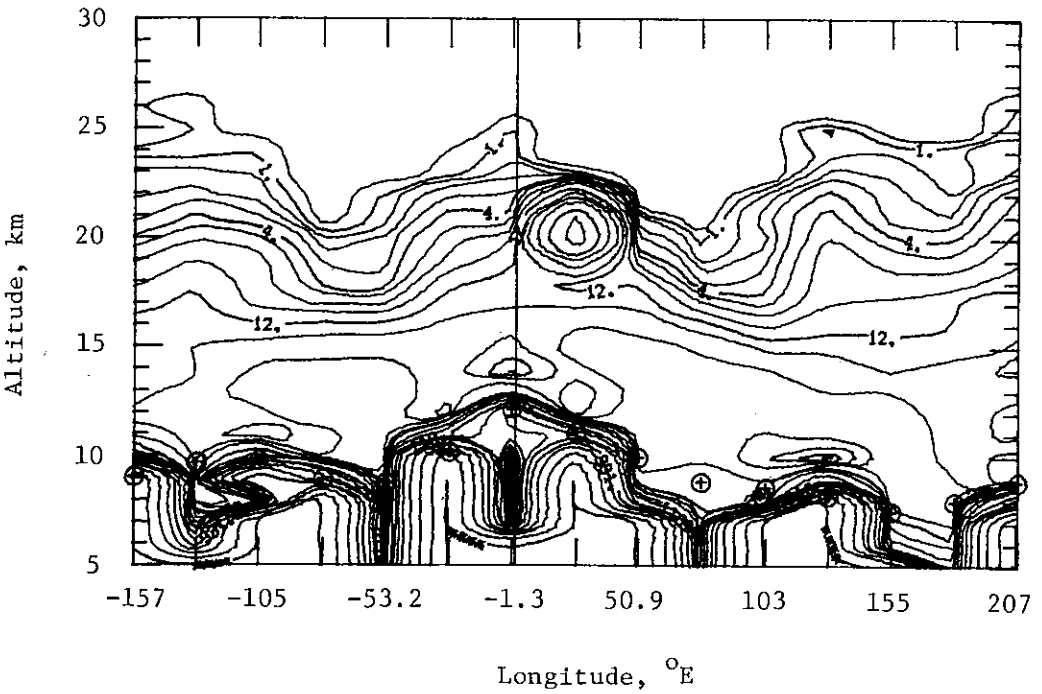



(a) Extinction isopleth.

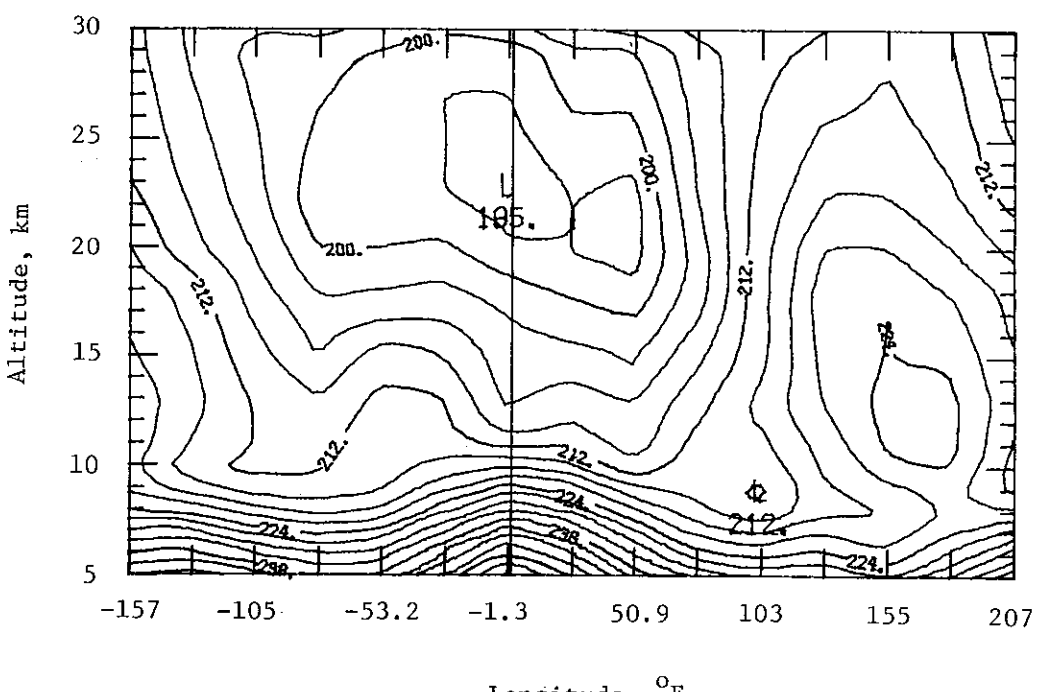



(b) Temperature contours.

Figure 15.- Arctic extinction isopleth and temperature contours for November 21.02 to 22.03, 1978, at latitudes from 68.0° to 67.8° N corresponding to orbits 383 to 397.

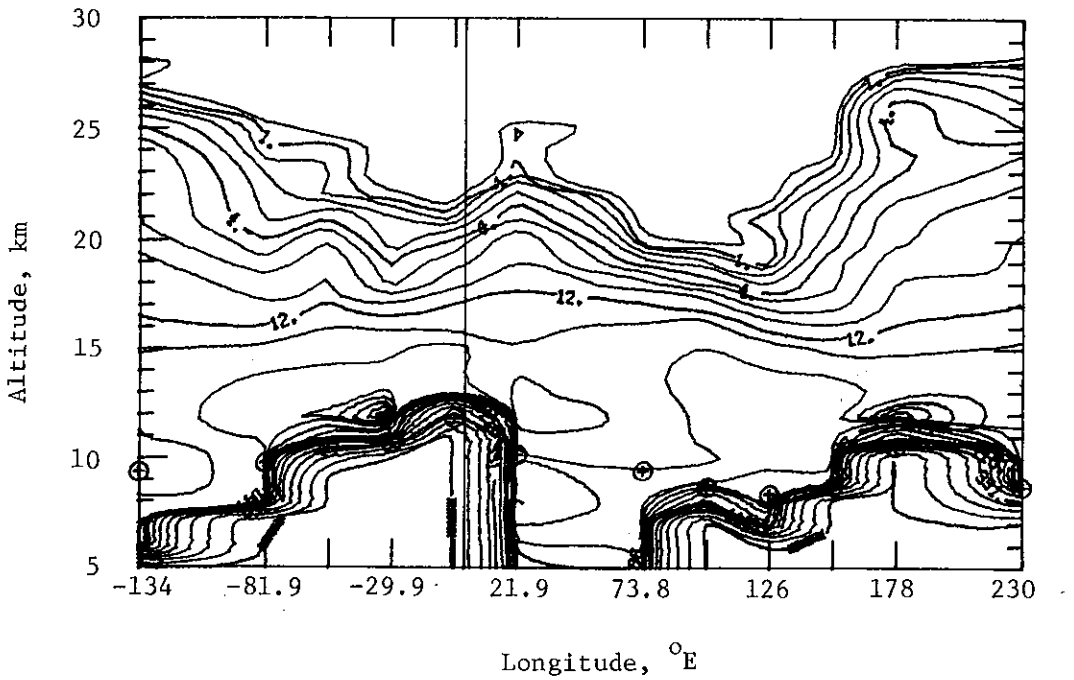



(a) Extinction isopleth.

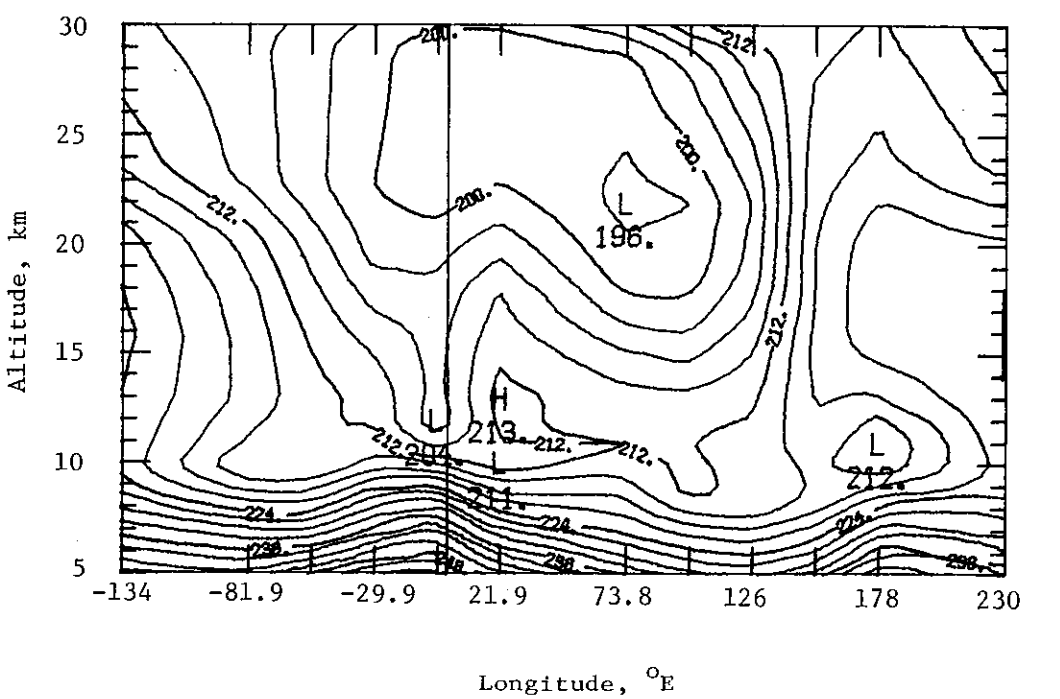



(b) Temperature contours.

Figure 16.- Arctic extinction isopleth and temperature contours for November 29.84 to 30.85, 1978, at latitudes from 66.5° to 66.4° N corresponding to orbits 505 to 519.

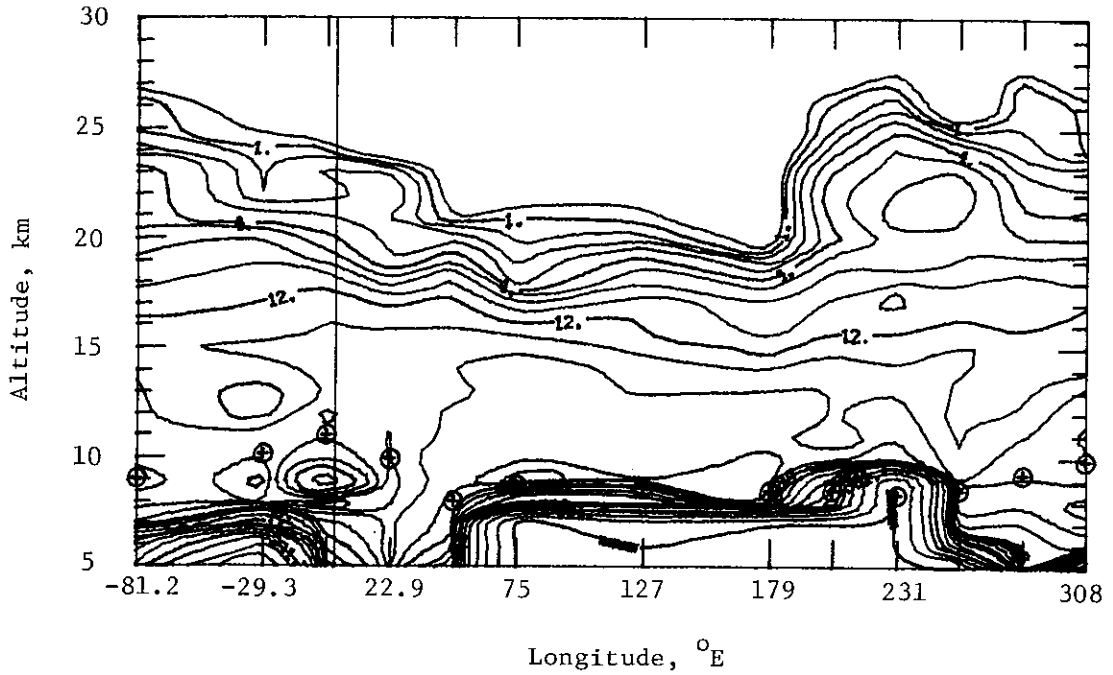



(a) Extinction isopleth.

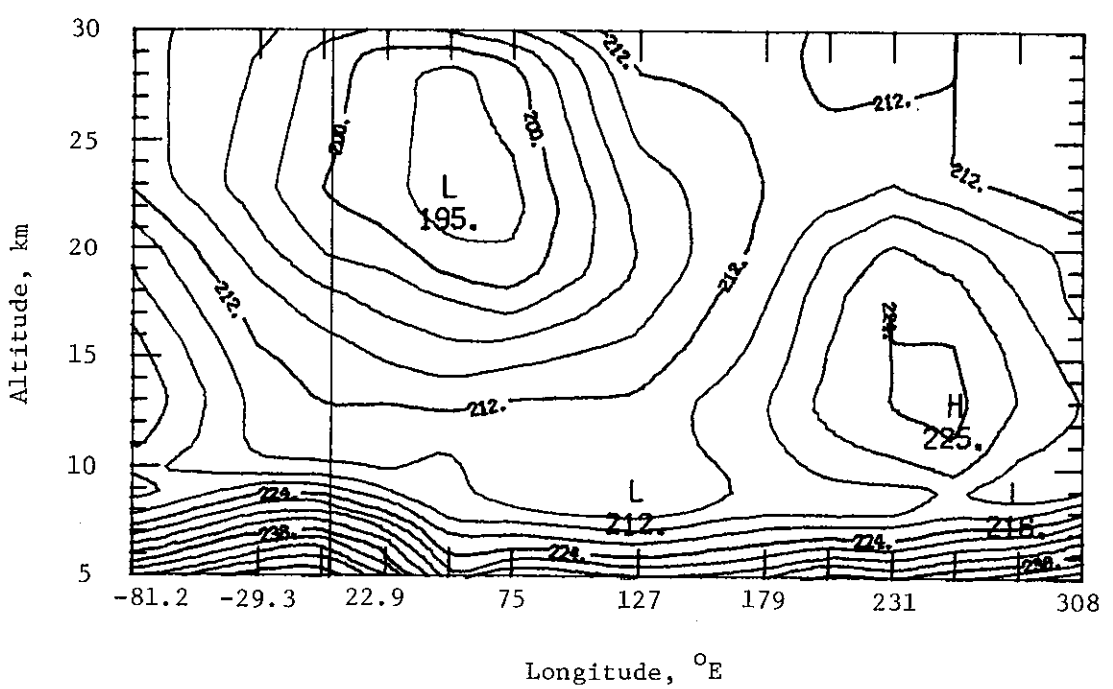



(b) Temperature contours.

Figure 17.- Arctic extinction isopleth and temperature contours for December 6.78 to 7.80, 1978, at latitudes from 65.7° to 65.6° N corresponding to orbits 601 to 615.

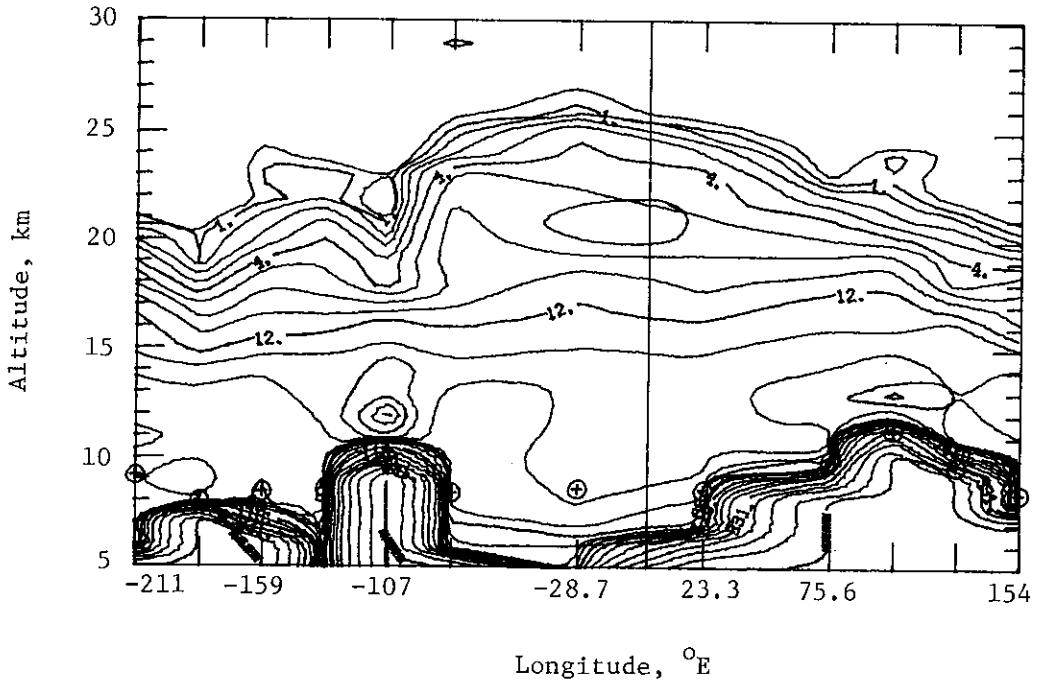



(a) Extinction isopleth.

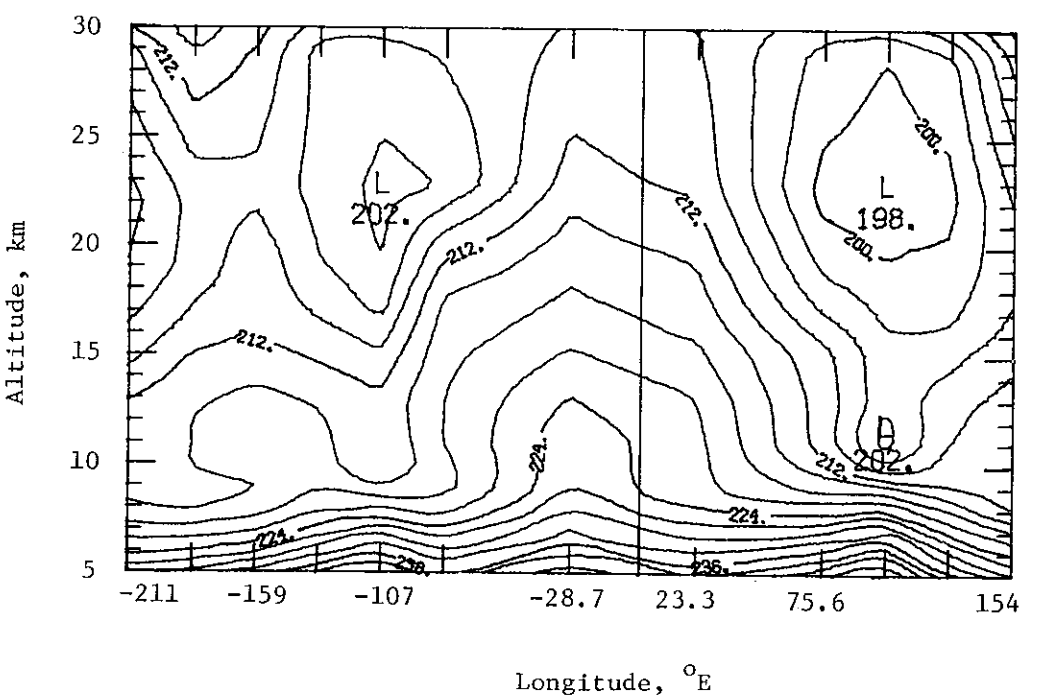



(b) Temperature contours.

Figure 18.- Arctic extinction isopleth and temperature contours for December 12.57 to 13.65, 1978, at latitudes from 65.2° to 65.1° N corresponding to orbits 681 to 696.

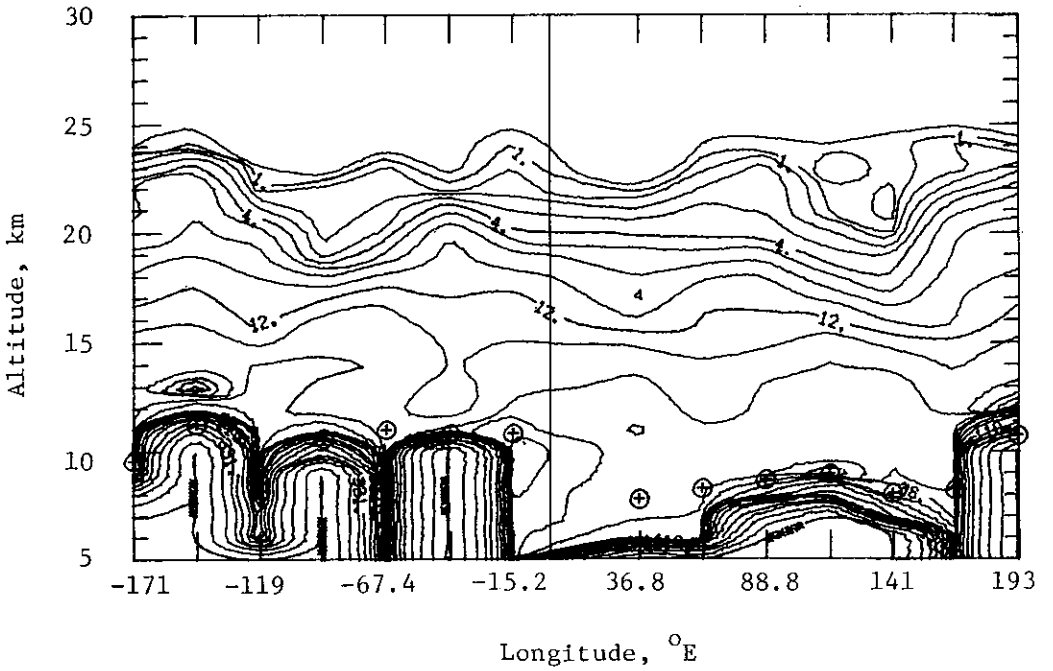



(a) Extinction isopleth.

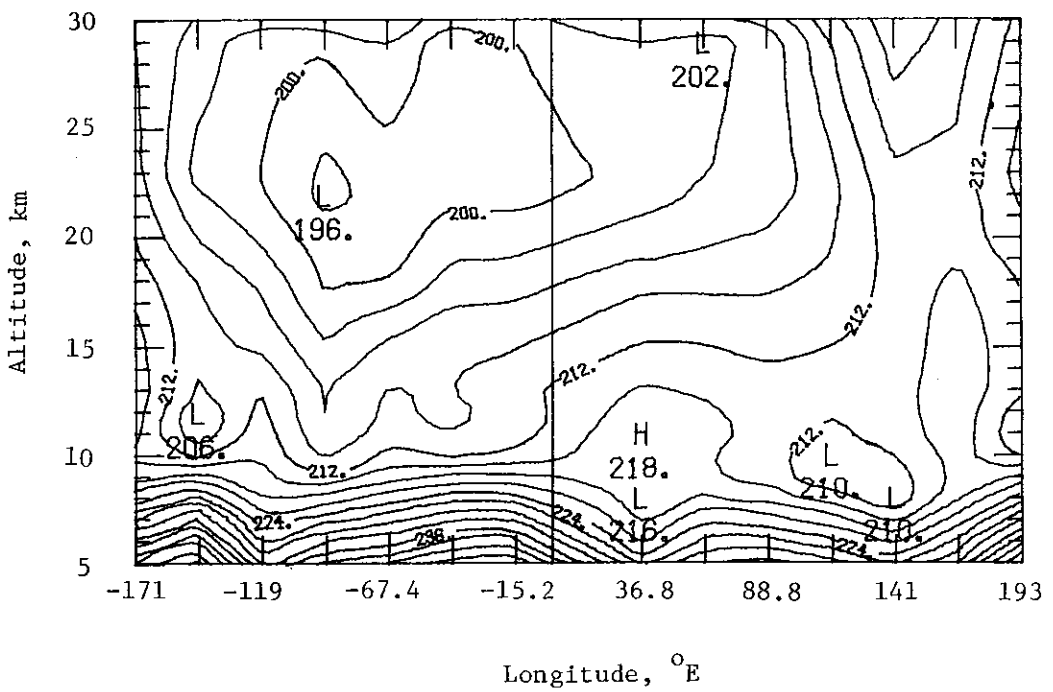



(b) Temperature contours.

Figure 19.- Arctic extinction isopleth and temperature contours for December 19.00 to 20.01, 1978, at a latitude of 64.9° N corresponding to orbits 770 to 784.

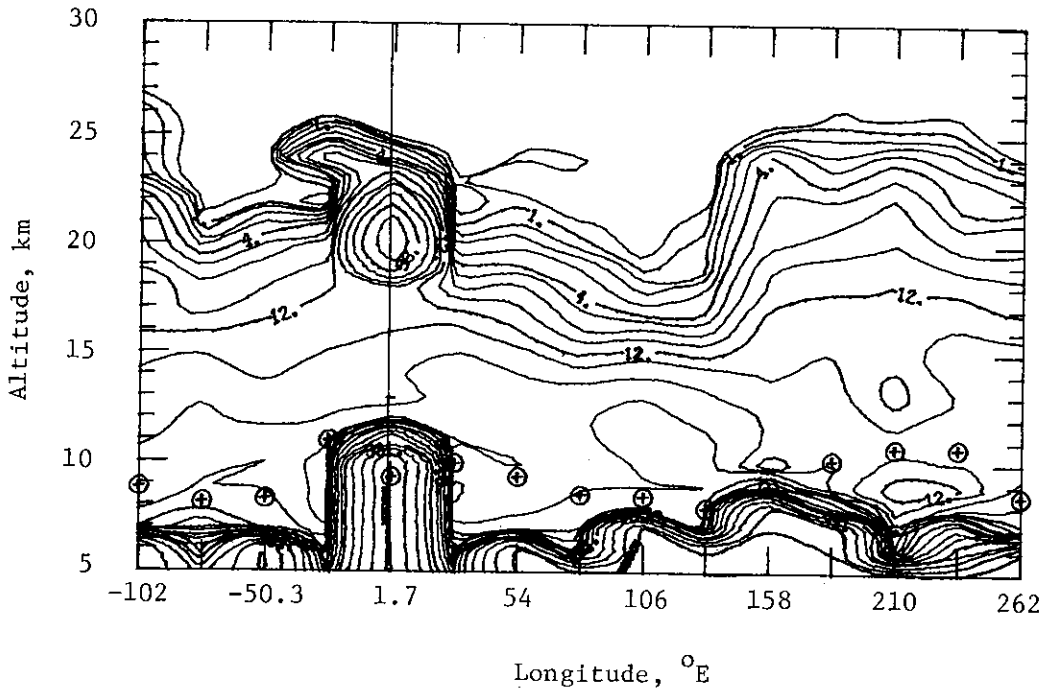



(a) Extinction isopleth.

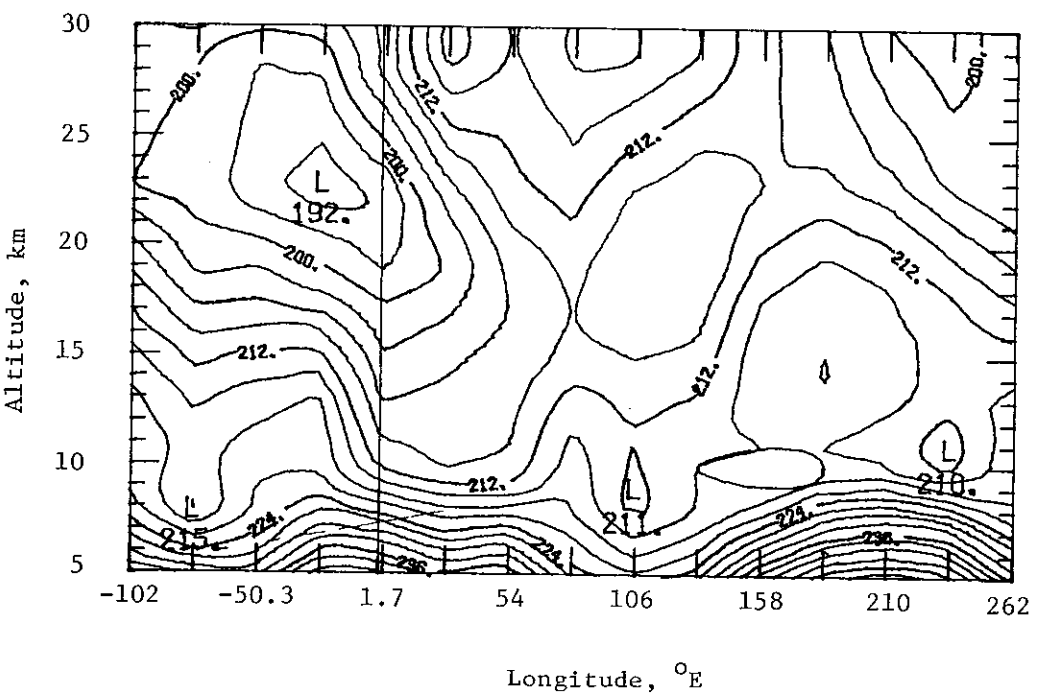



(b) Temperature contours.

Figure 20.- Arctic extinction isopleth and temperature contours for December 27.90 to 28.91 1978, at a latitude of 65.1° N corresponding to orbits 893 to 907.

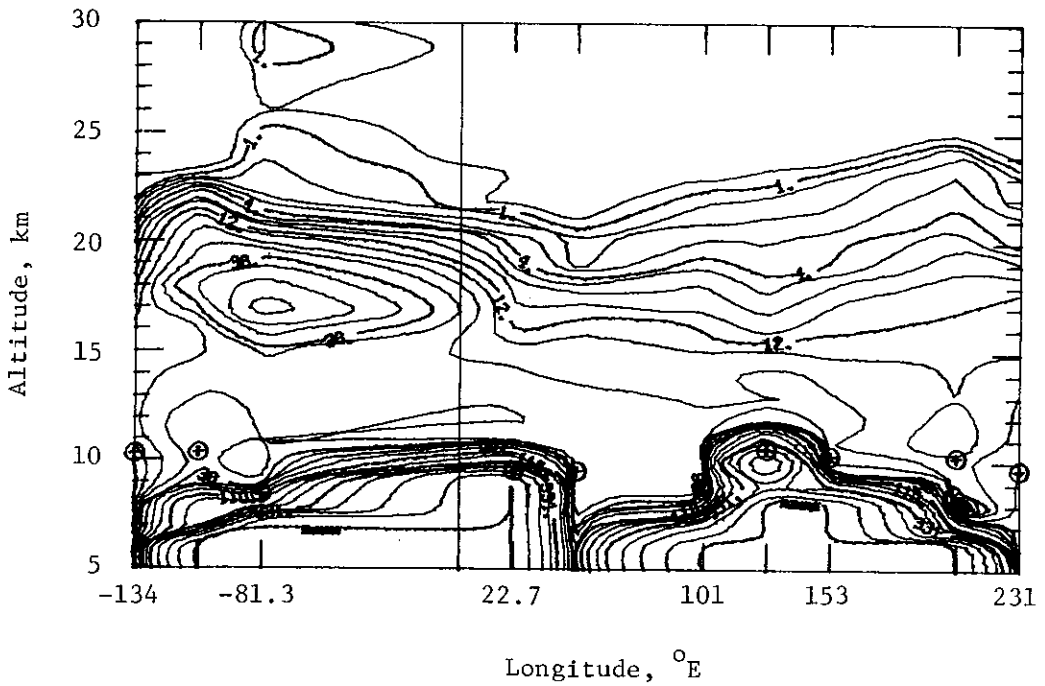



(a) Extinction isopleth.

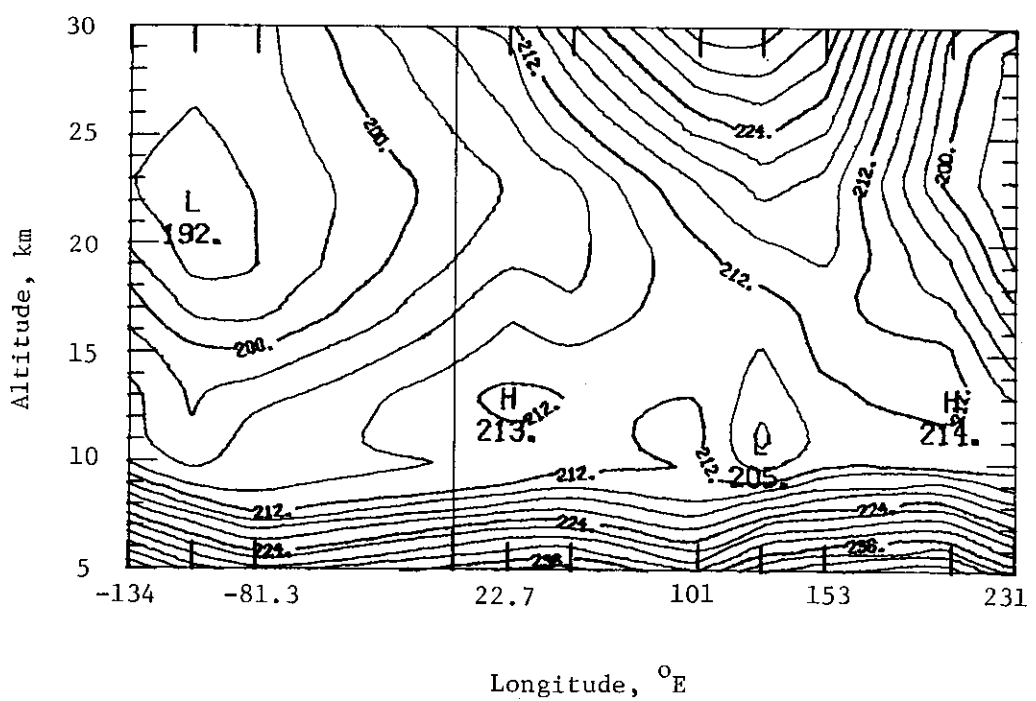



(b) Temperature contours.

Figure 21.- Arctic extinction isopleth and temperature contours for January 4.71 to 5.72, 1979, at latitudes from 65.6° to 65.7° N corresponding to orbits 1001 to 1015.

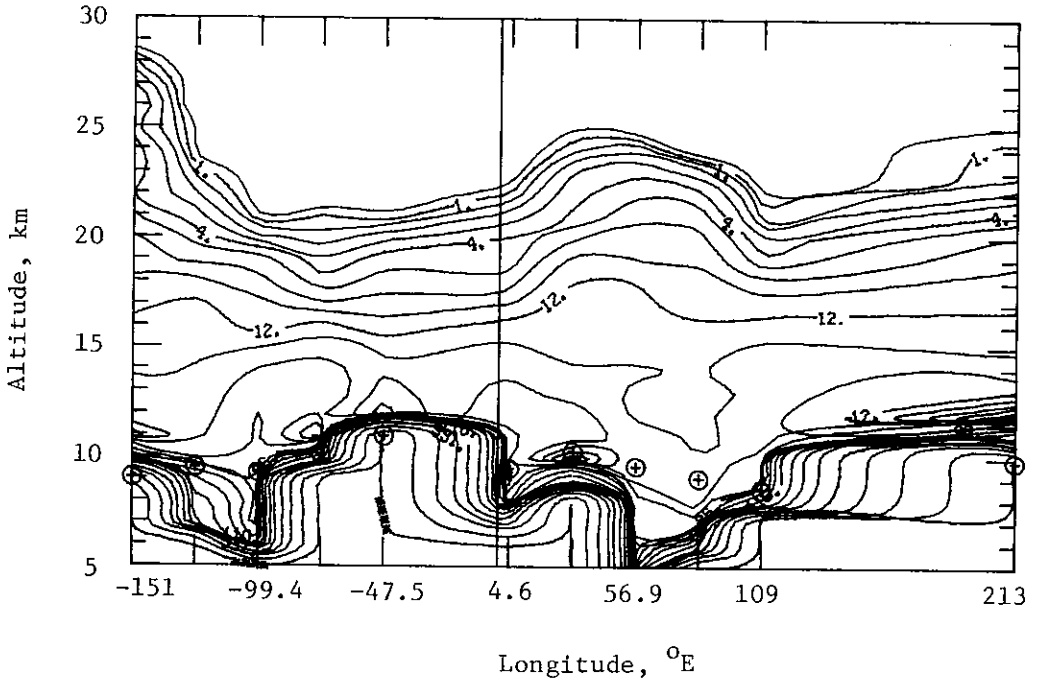



(a) Extinction isopleth.

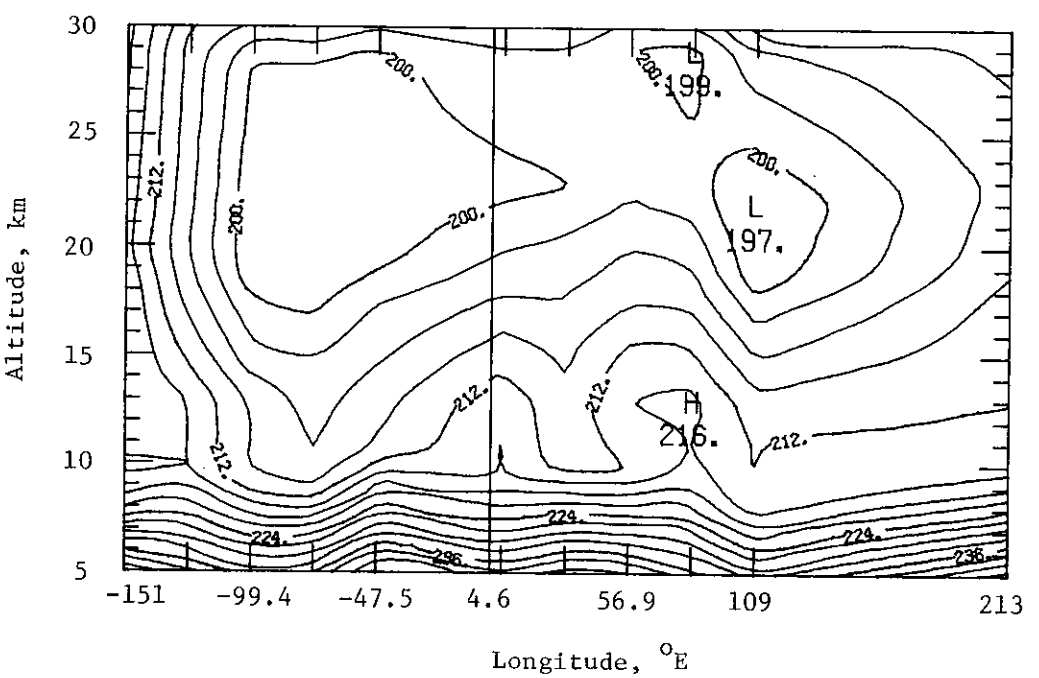



(b) Temperature contours.

Figure 22.- Arctic extinction isopleth and temperature contours for January 11.79 to 12.81, 1979, at latitudes from 66.5° to 66.7° N corresponding to orbits 1099 to 1113.

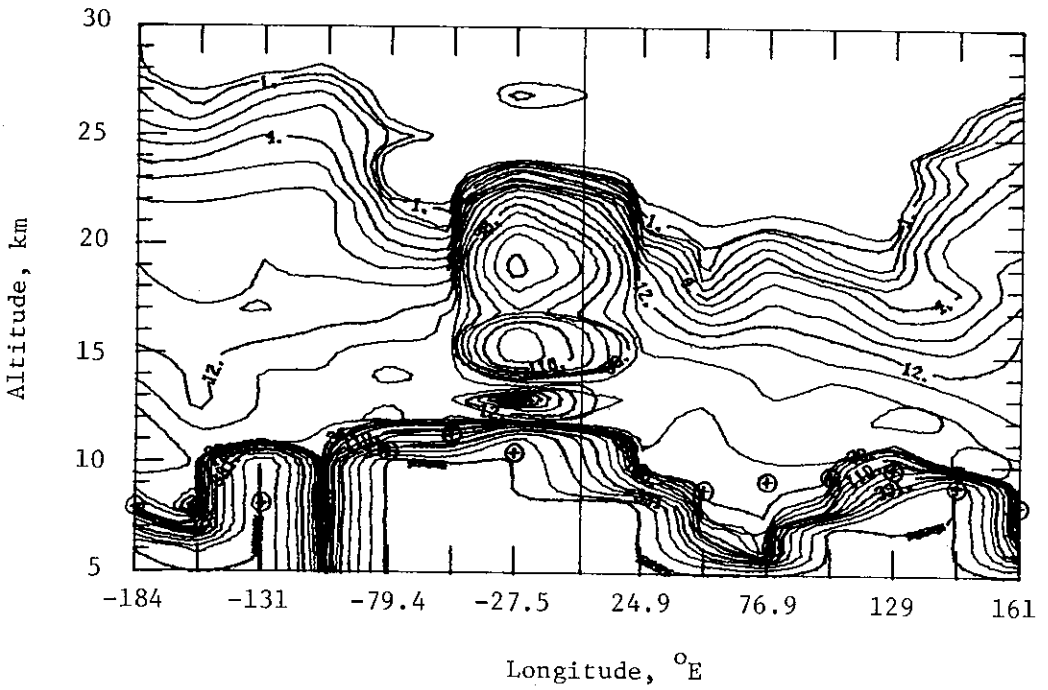



(a) Extinction isopleth.

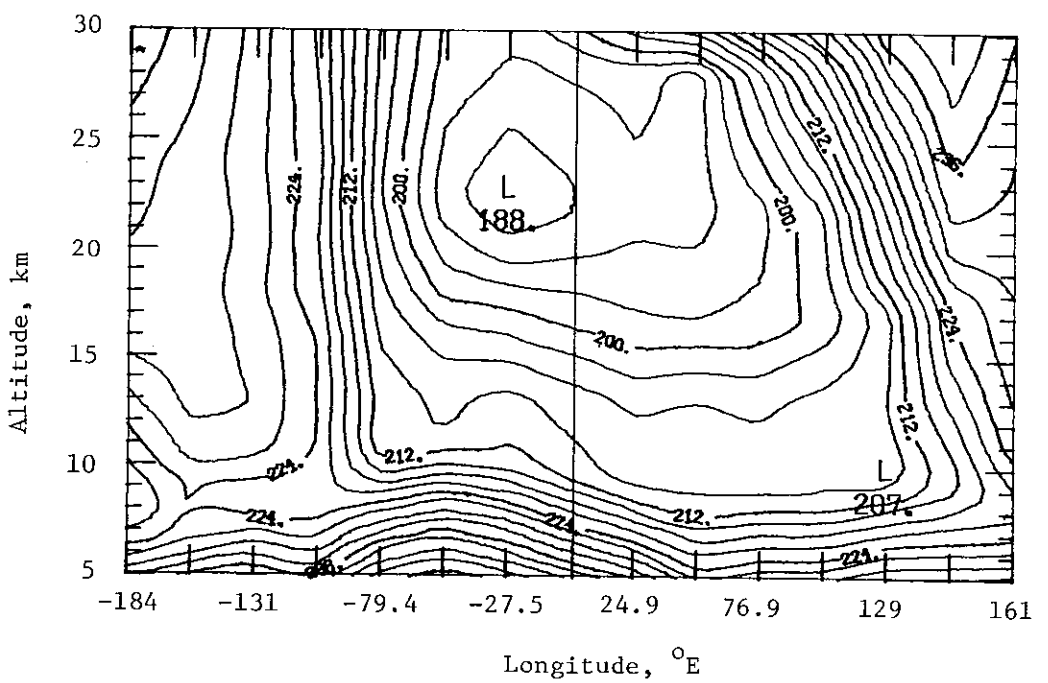



(b) Temperature contours.

Figure 23.- Arctic extinction isopleth and temperature contours for January 15.84 to 16.86, 1979, at latitudes from 67.2° to 67.4° N corresponding to orbits 1155 to 1169.

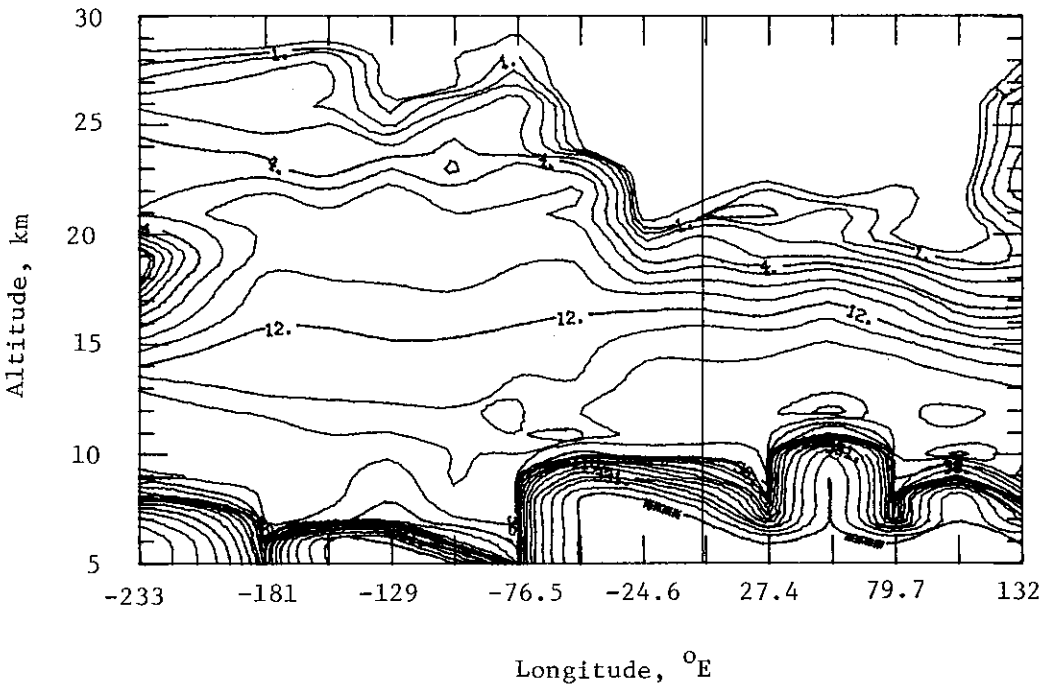



(a) Extinction isopleth.

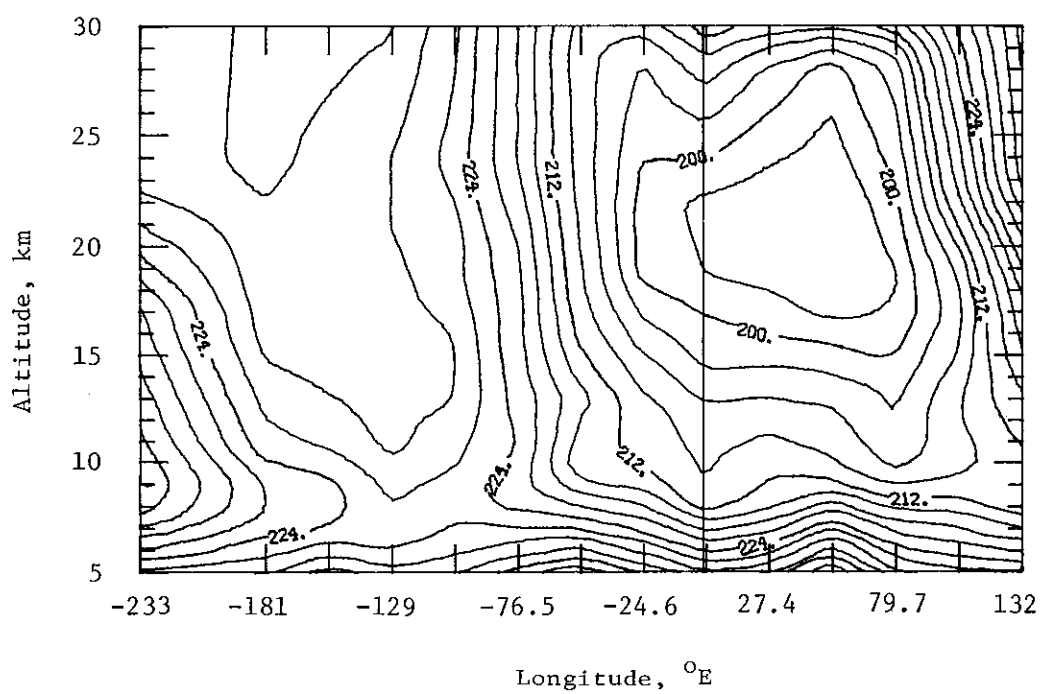



(b) Temperature contours.

Figure 24.- Arctic extinction isopleth and temperature contours for January 22.93 to 23.94, 1979, at latitudes from 68.6° to 68.8° N corresponding to orbits 1253 to 1267.

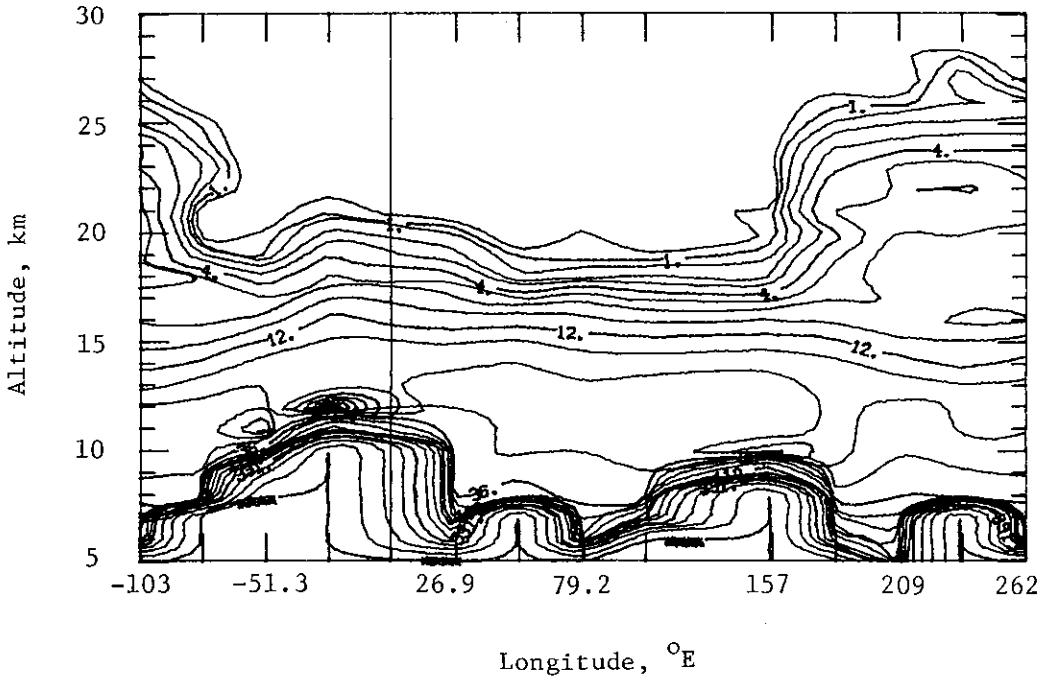



(a) Extinction isopleth.

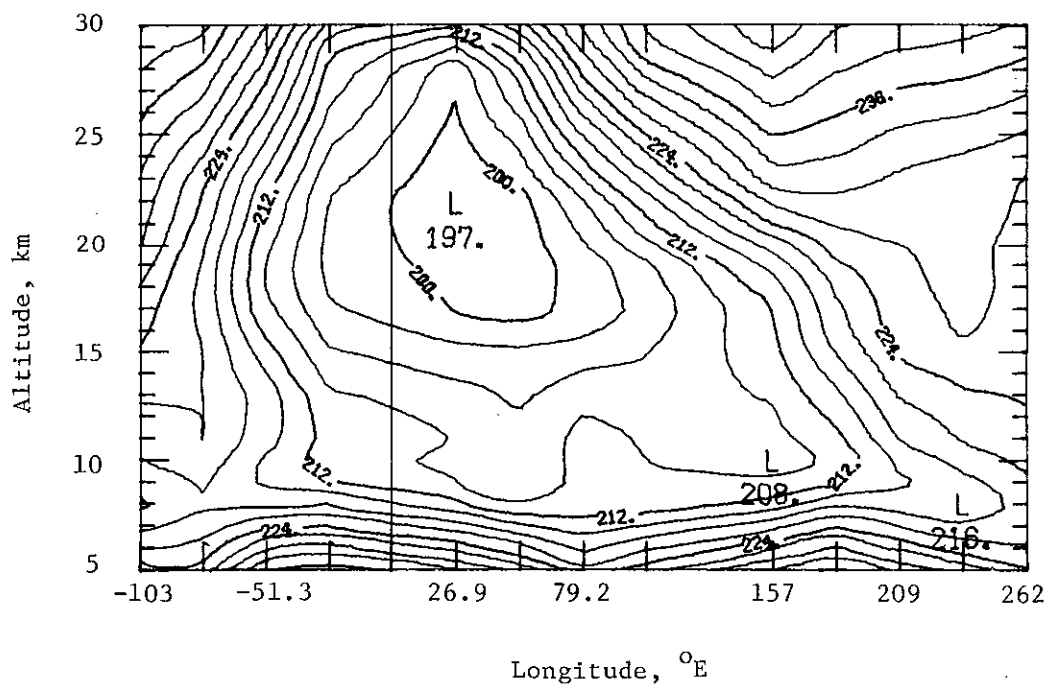



(b) Temperature contours.

Figure 25.- Arctic extinction isopleth and temperature contours for January 28.07 to 29.08, 1979, at latitudes from 69.8° to 70.1° N corresponding to orbits 1324 to 1338.

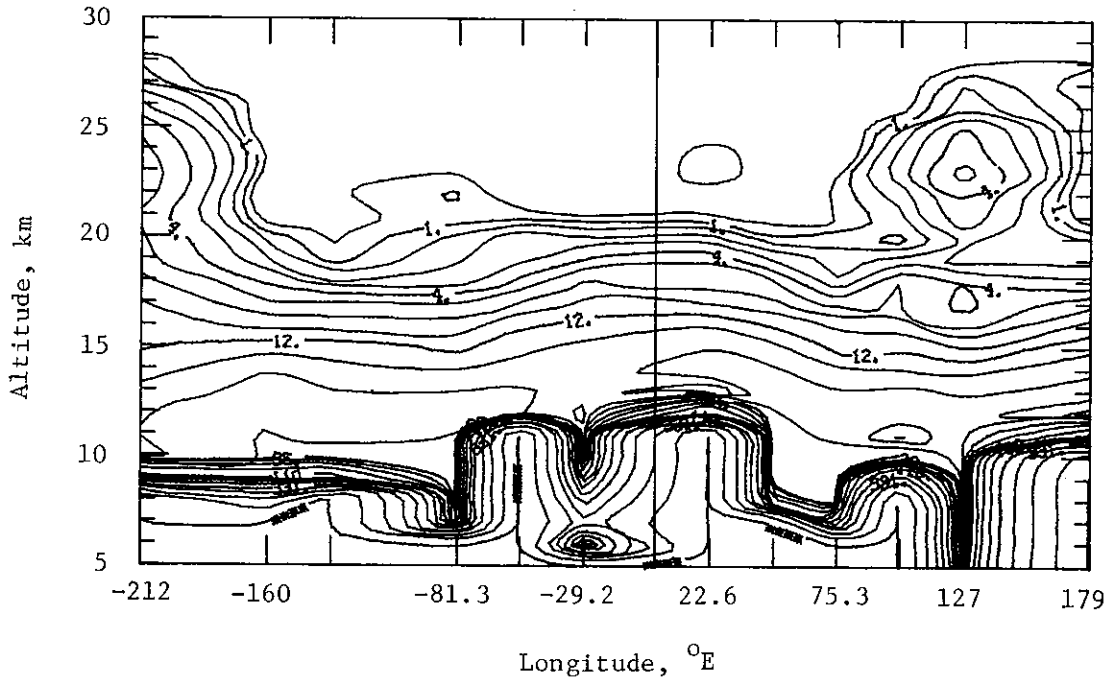



(a) Extinction isopleth.

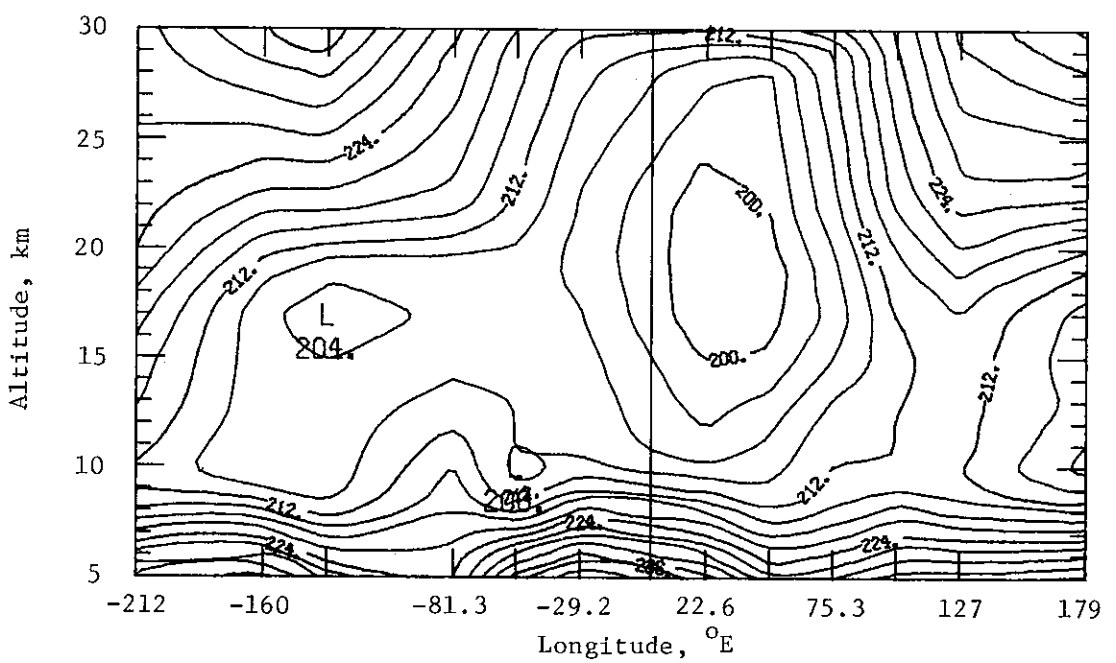



(b) Temperature contours.

Figure 26.- Arctic extinction isopleth and temperature contours for February 7.70 to 8.71, 1979, at latitudes from 72.7° to 73.0° N corresponding to orbits 1471 to 1485.

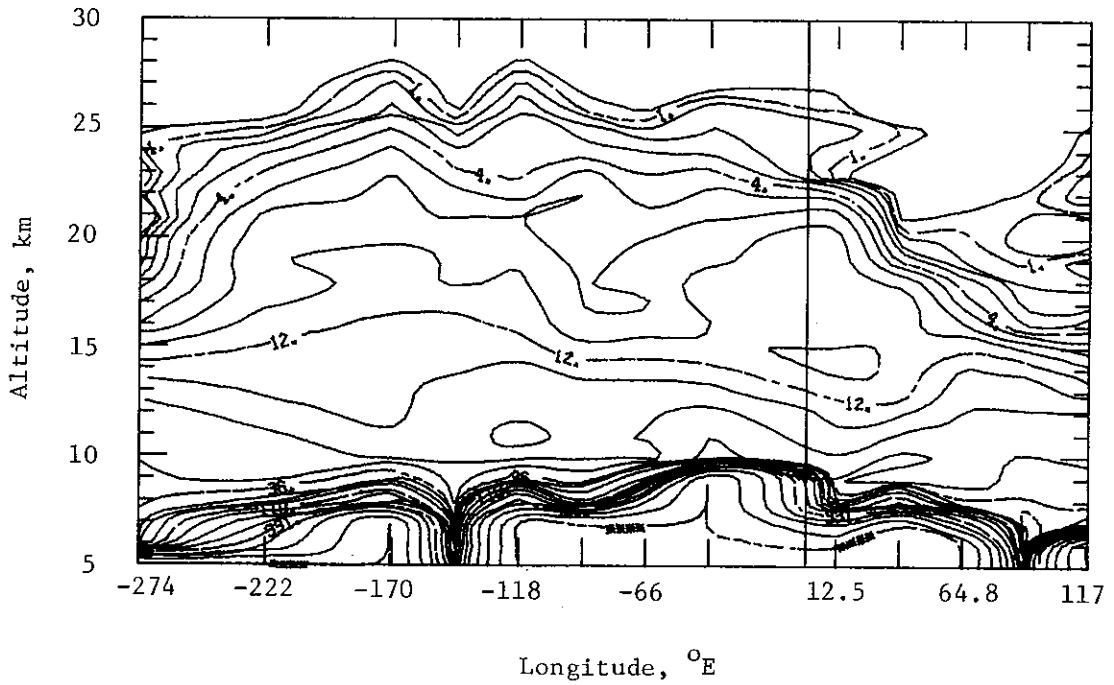



(a) Extinction isopleth.

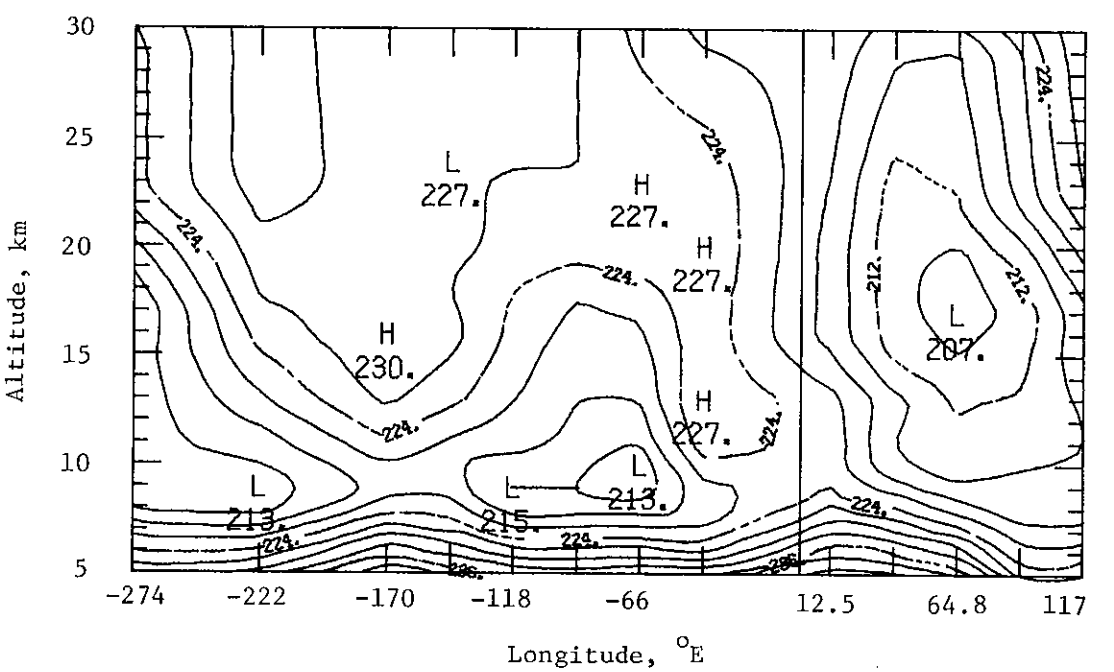



(b) Temperature contours.

Figure 27.- Arctic extinction isopleth and temperature contours for February 13.92 to 15.00, 1979, at latitudes from 74.5° to 74.9° N corresponding to orbits 1557 to 1572.

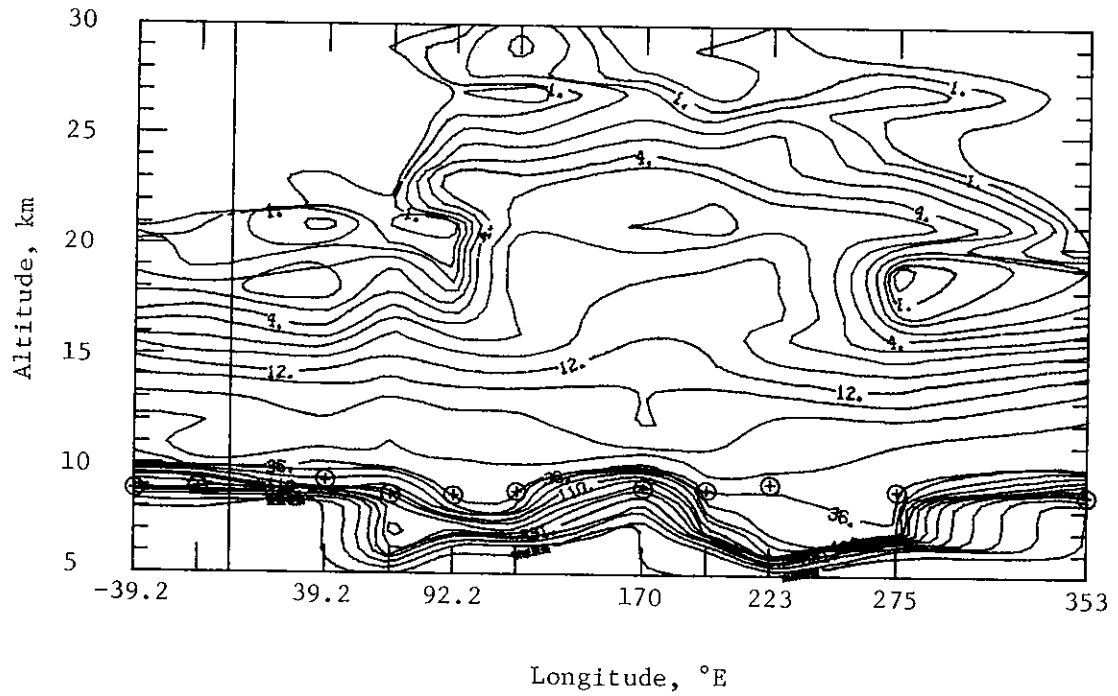



(a) Extinction isopleth.

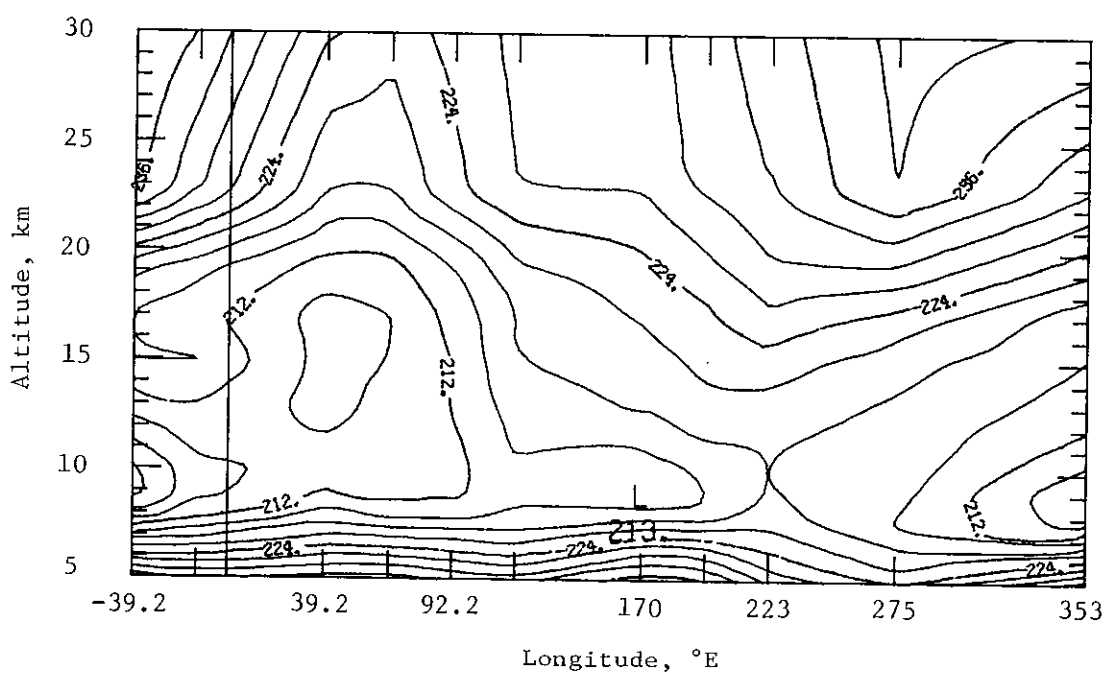



(b) Temperature contours.

Figure 28.- Arctic extinction isopleth and temperature contours for February 21.08 to 22.16, 1979, at latitudes from 76.8° to 77.1° N corresponding to orbits 1656 to 1671.

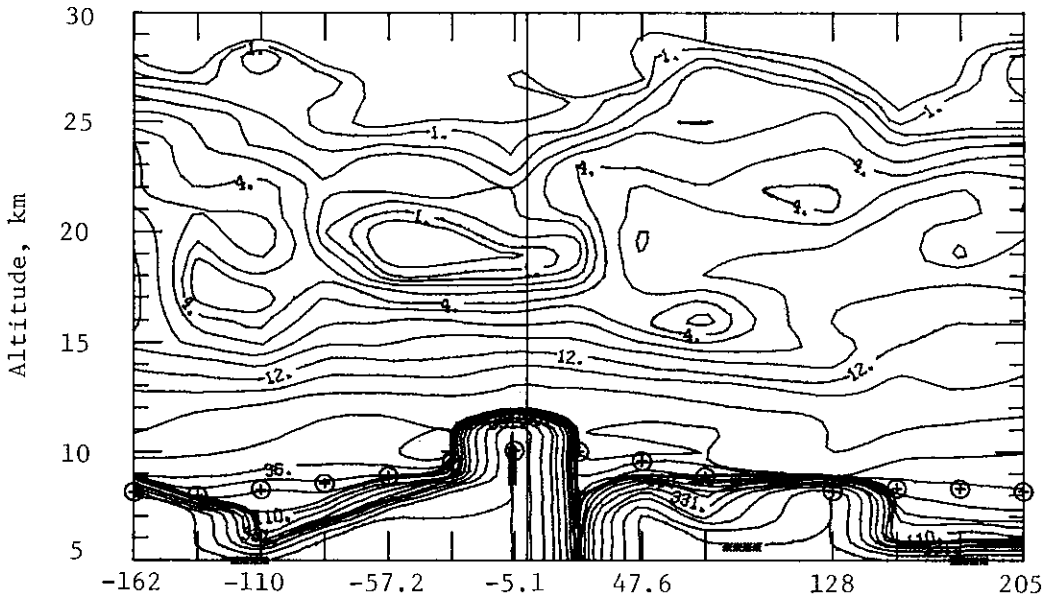



(a) Extinction isopleth.

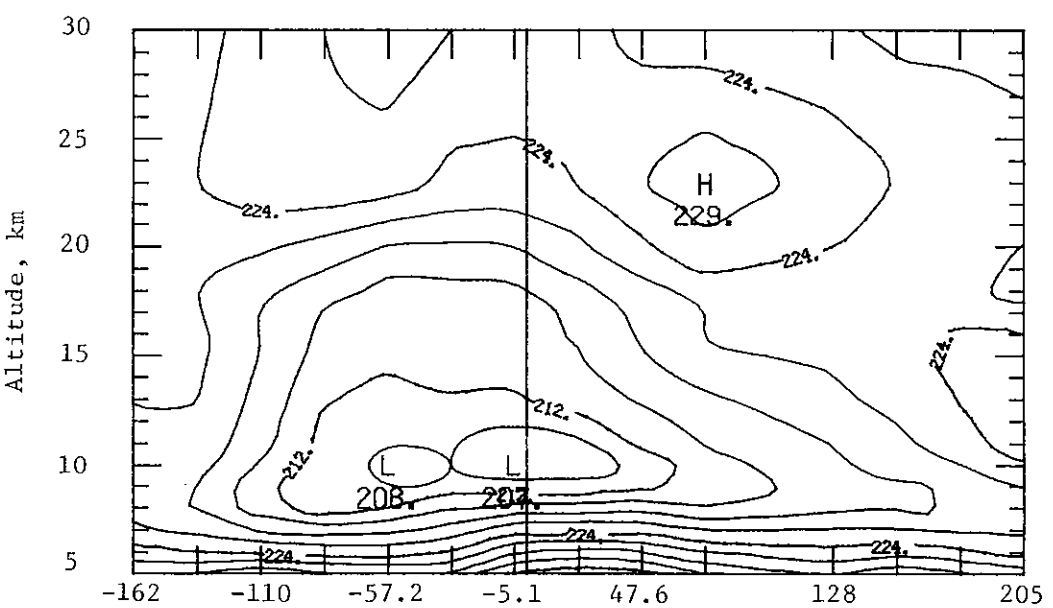



(b) Temperature contours.

Figure 29.- Arctic extinction isopleth and temperature contours for March 1.40 to 2.48, 1979, at latitudes from 79.3° to 79.6° N corresponding to orbits 1771 to 1786.

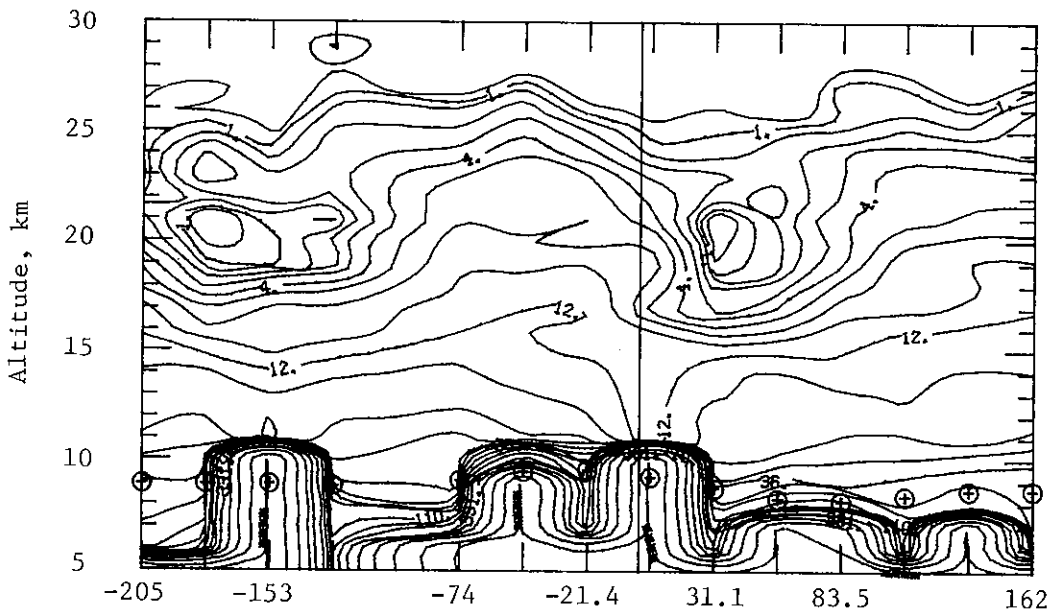



(a) Extinction isopleth.

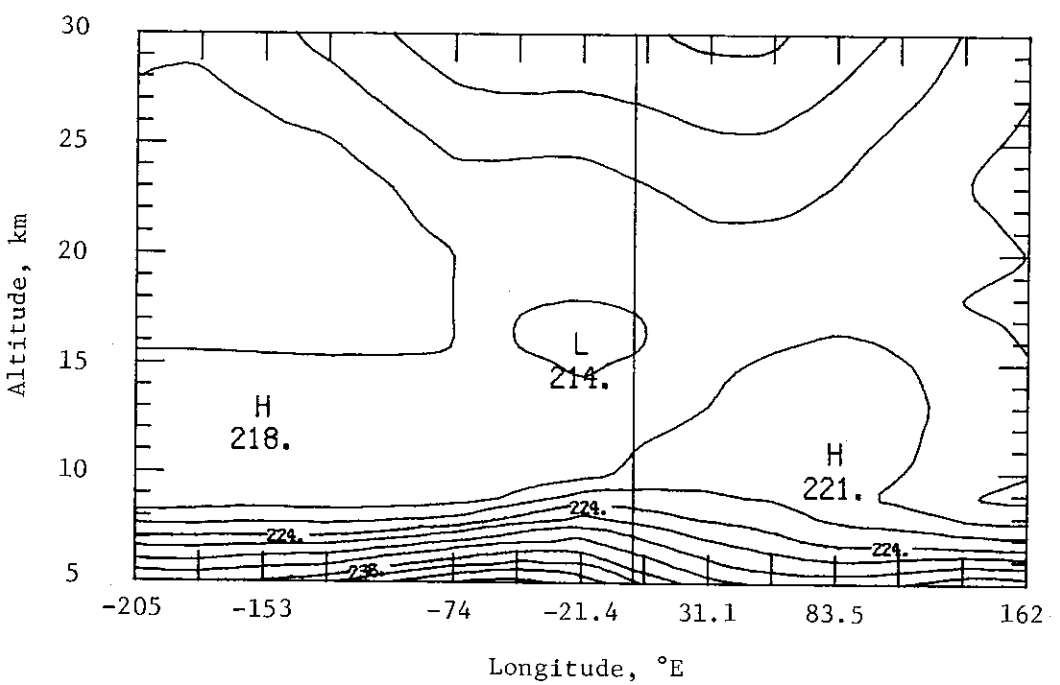



(b) Temperature contours.

Figure 30.- Arctic extinction isopleth and temperature contours for March 8.78 to 9.79, 1979, at latitudes from 81.3° to 81.4° N corresponding to orbits 1873 to 1887.

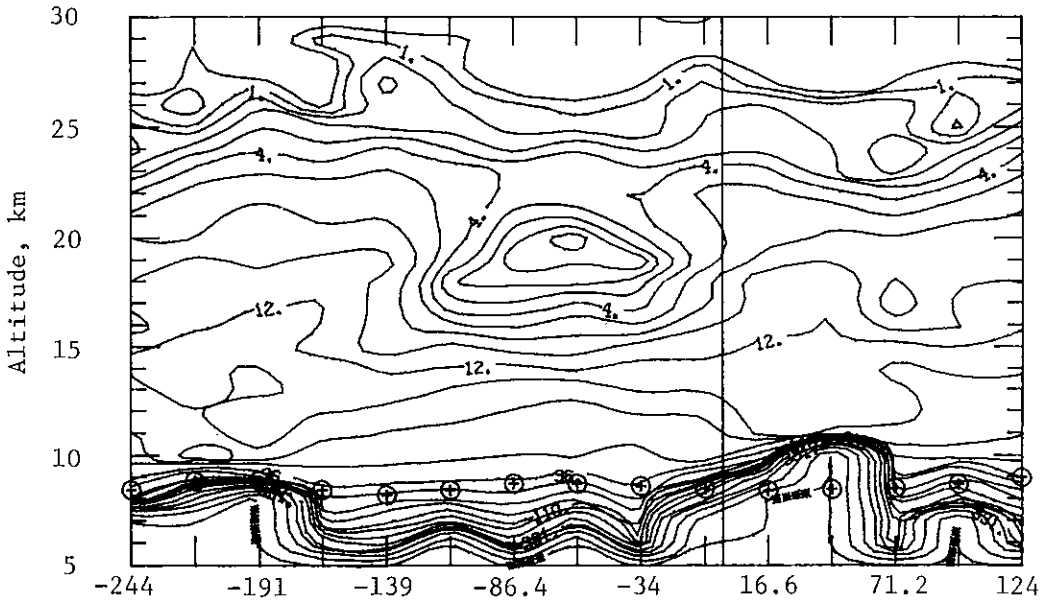



(a) Extinction isopleth.

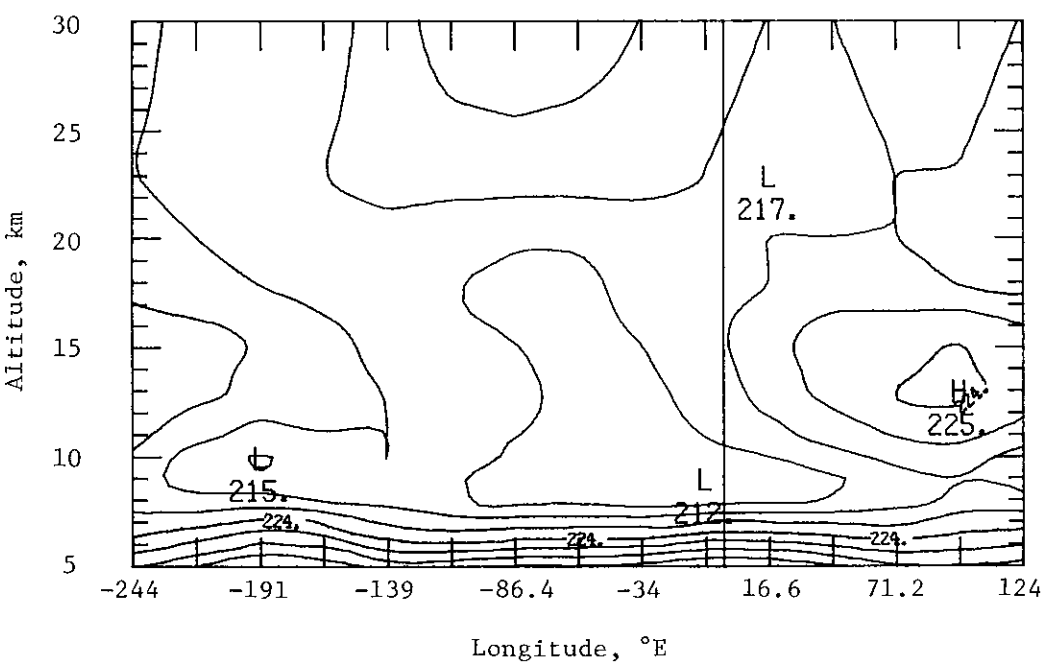



(b) Temperature contours.

Figure 31.- Arctic extinction isopleth and temperature contours for March 14.85 to 15.87, 1979, at latitudes from 82.4° to 82.6° N corresponding to orbits 1957 to 1971.

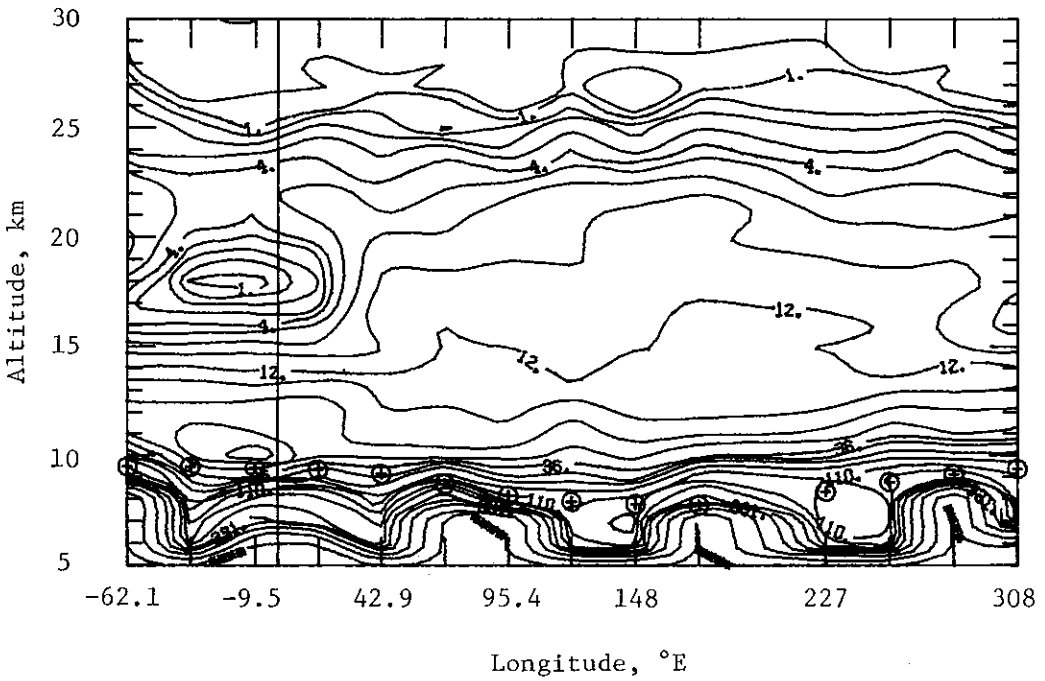



(a) Extinction isopleth.

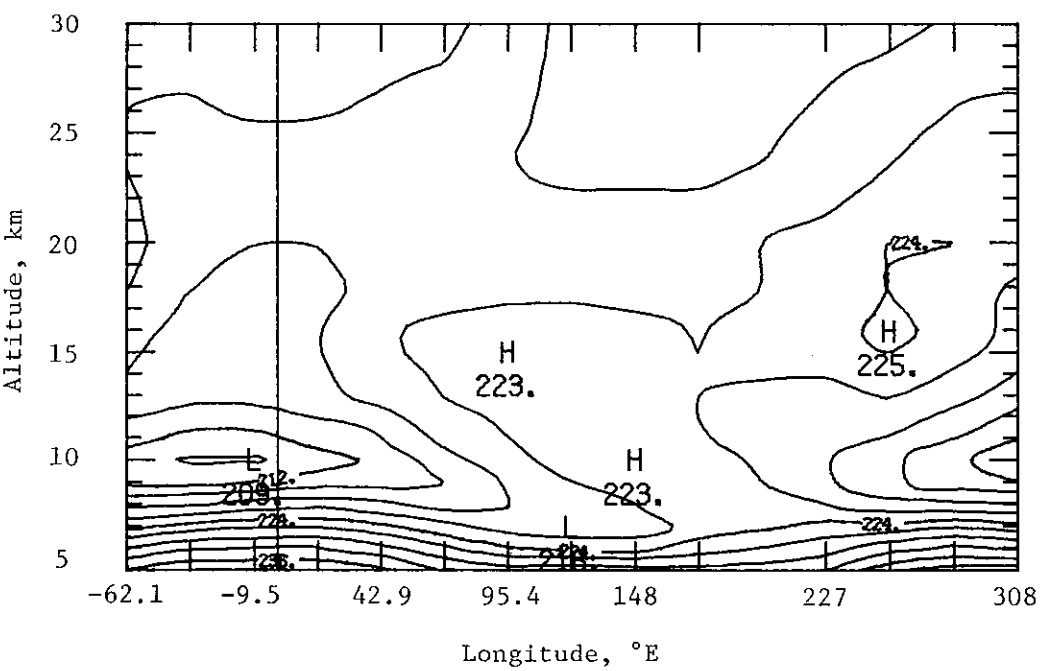



(b) Temperature contours.

Figure 32.- Arctic extinction isopleth and temperature contours for March 19.92 to 20.93, 1979, at a latitude of 82.9° N corresponding to orbits 2027 to 2041.

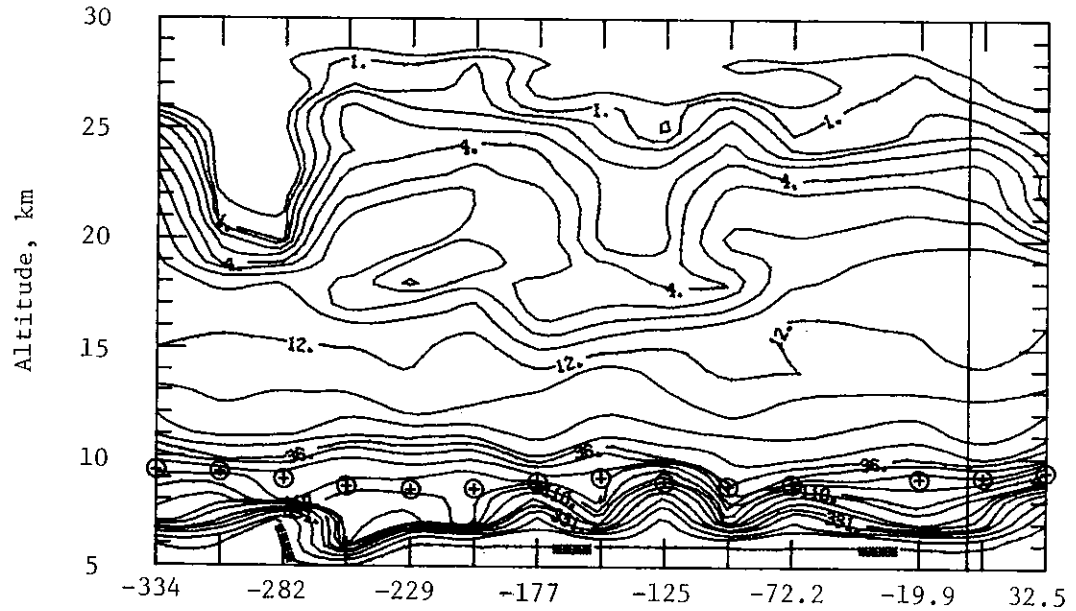



(a) Extinction isopleth.

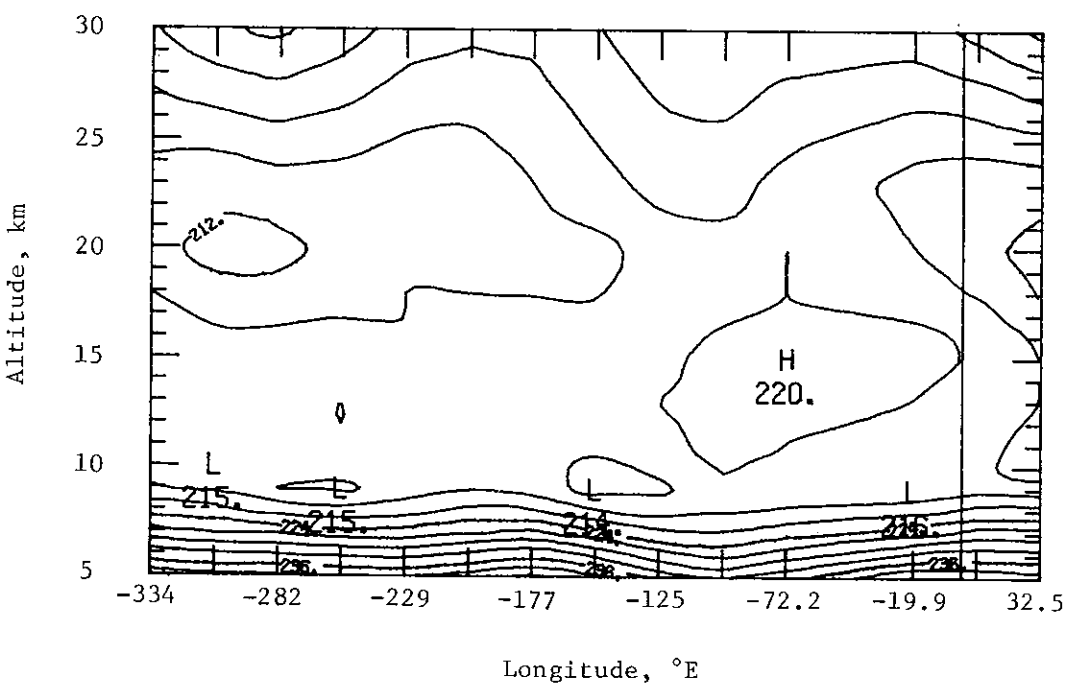



(b) Temperature contours.

Figure 33.- Arctic extinction isopleth and temperature contours for March 26.36 to 27.37, 1979, at latitudes from 82.6° to 82.5° N corresponding to orbits 2116 to 2130.

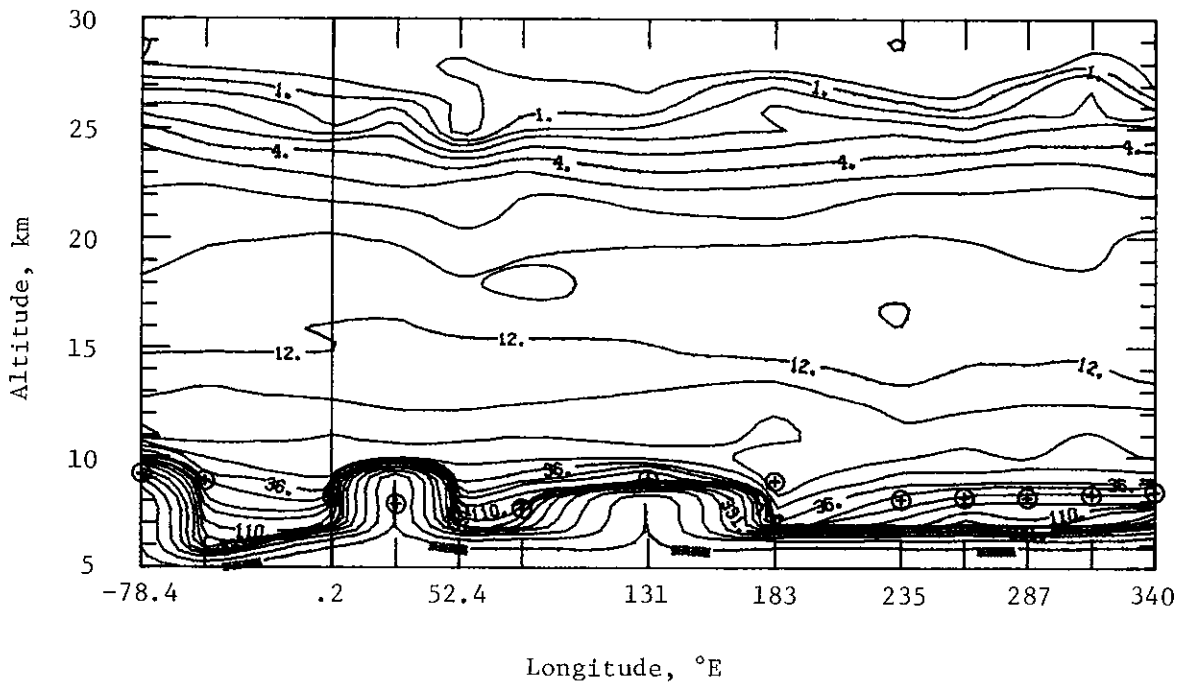



(a) Extinction isopleth.

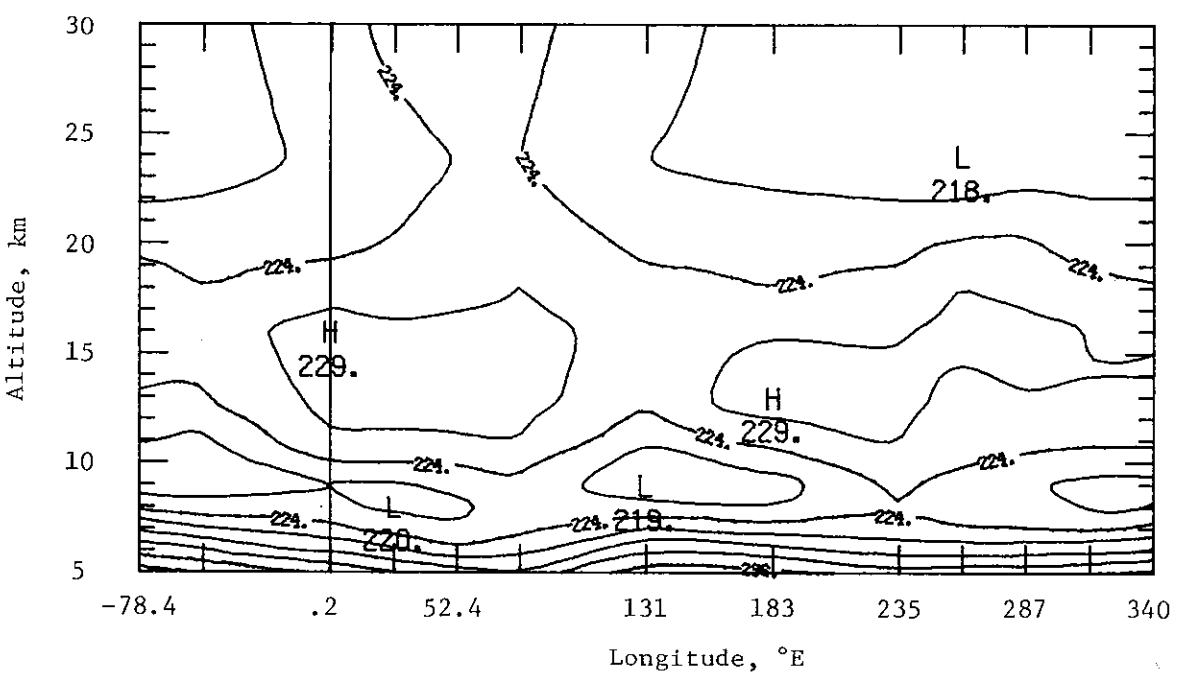



(b) Temperature contours.

Figure 34.- Arctic extinction isopleth and temperature contours for April 1.07 to 2.08, 1979, at latitudes from 81.8° to 81.5° N corresponding to orbits 2195 to 2209.

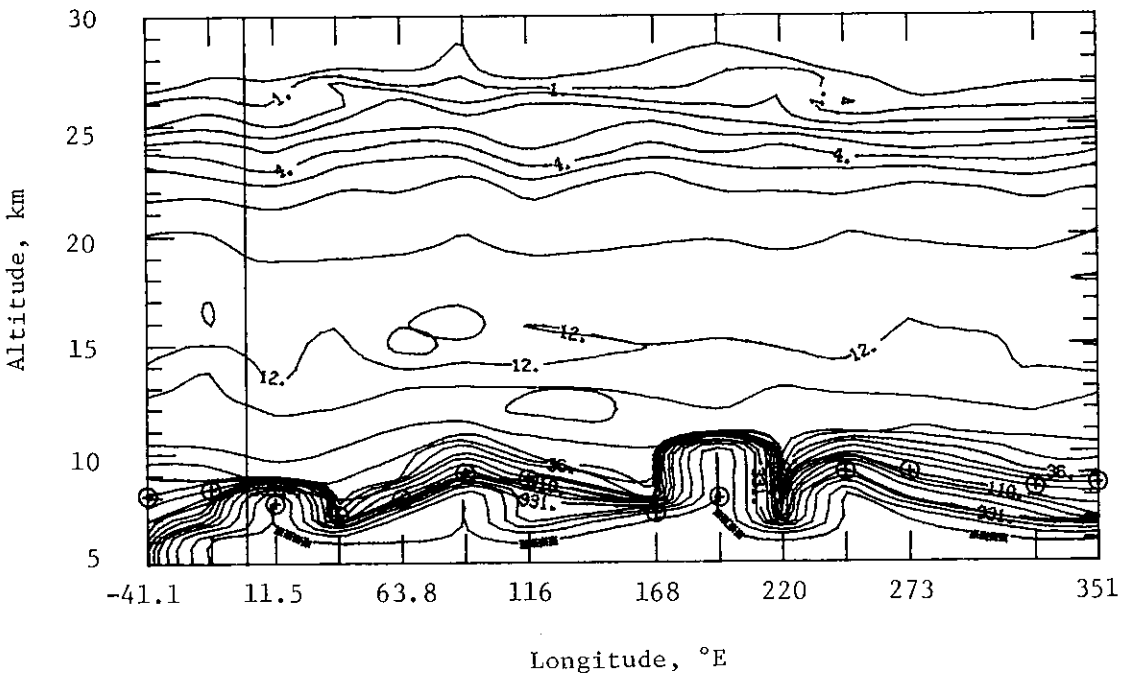



(a) Extinction isopleth.

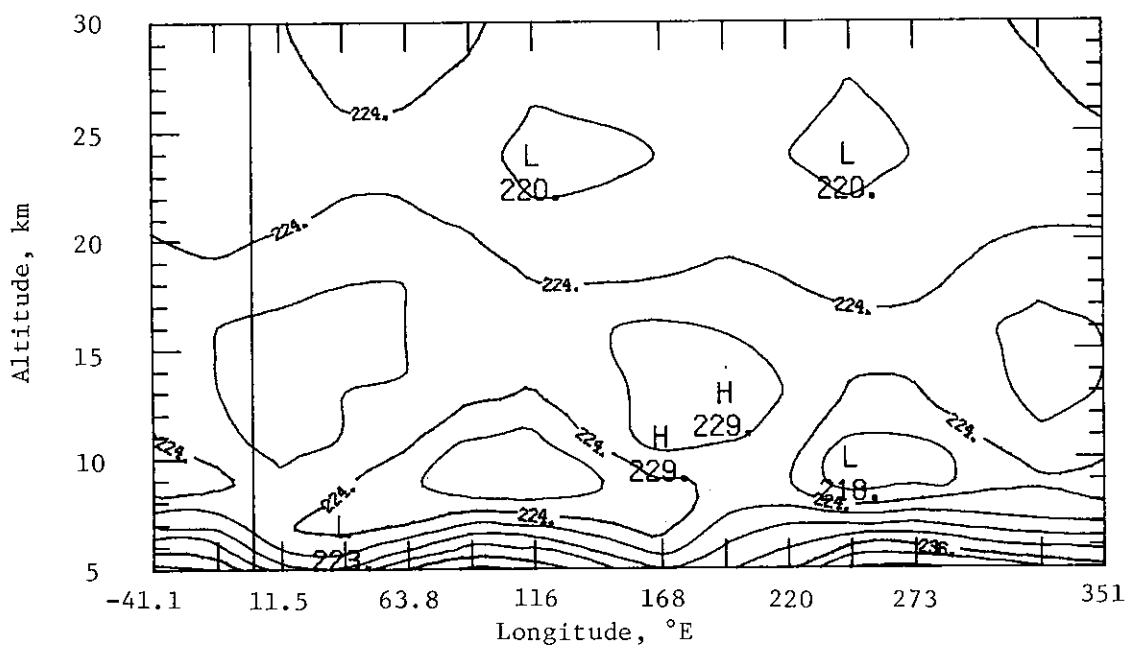



(b) Temperature contours.

Figure 35.- Arctic extinction isopleth and temperature contours for April 9.17 to 10.33, 1979, at latitudes from 79.9° to 79.5° N corresponding to orbits 2307 to 2323.

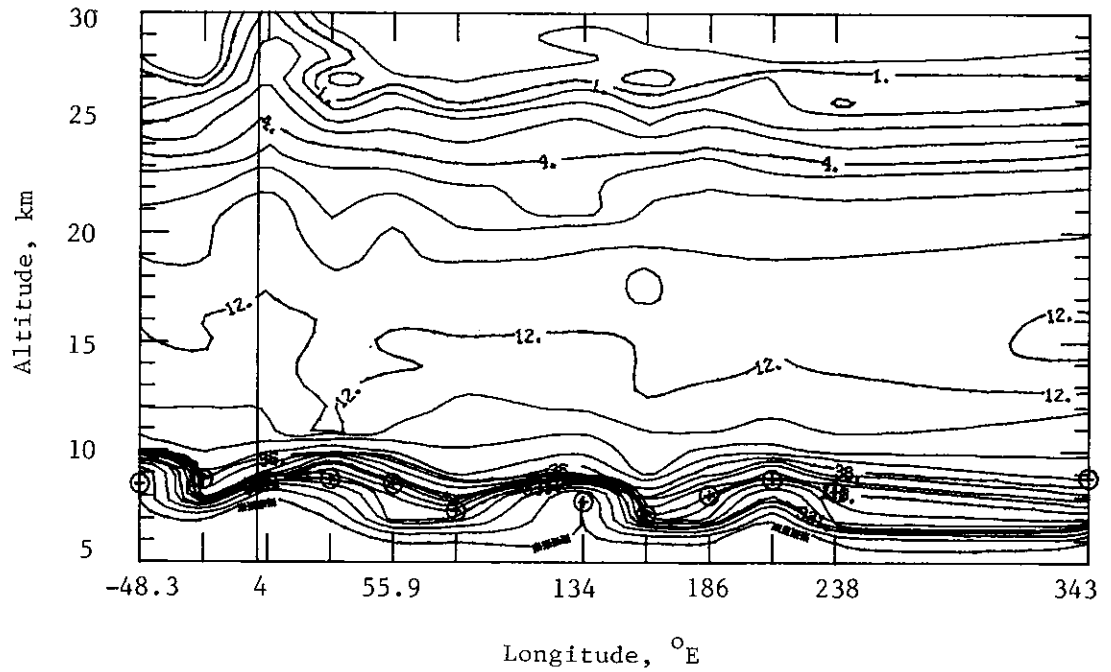



(a) Extinction isopleth.

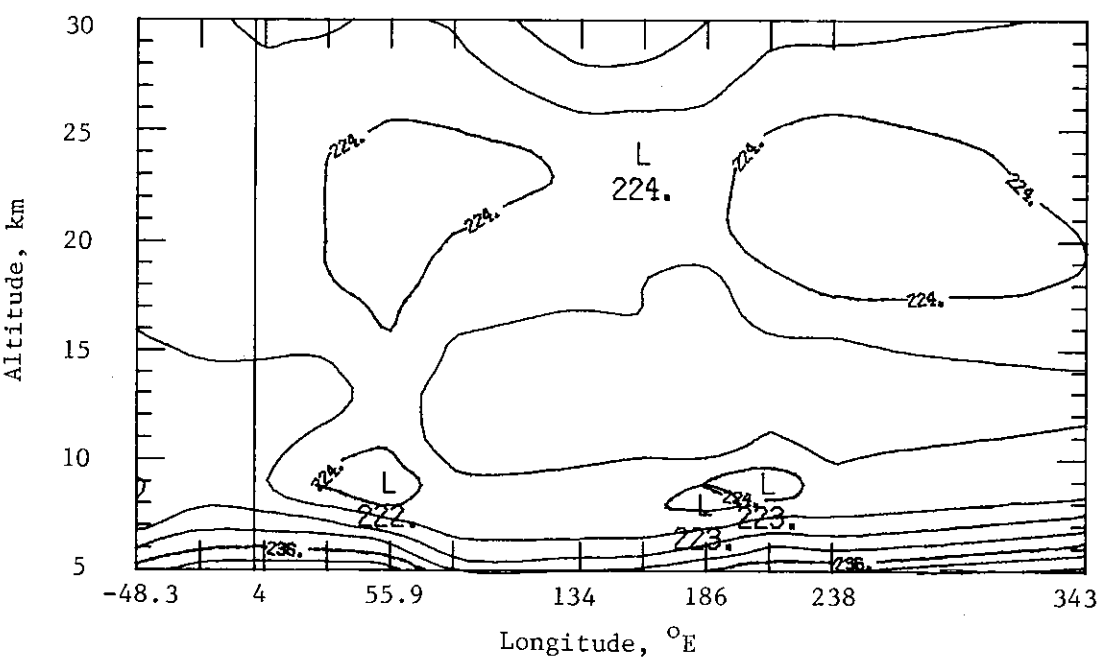



(b) Temperature contours.

Figure 36.- Arctic extinction isopleth and temperature contours for April 16.12 to 17.21, 1979, at latitudes from 77.9° to 77.6° N corresponding to orbits 2403 to 2418.

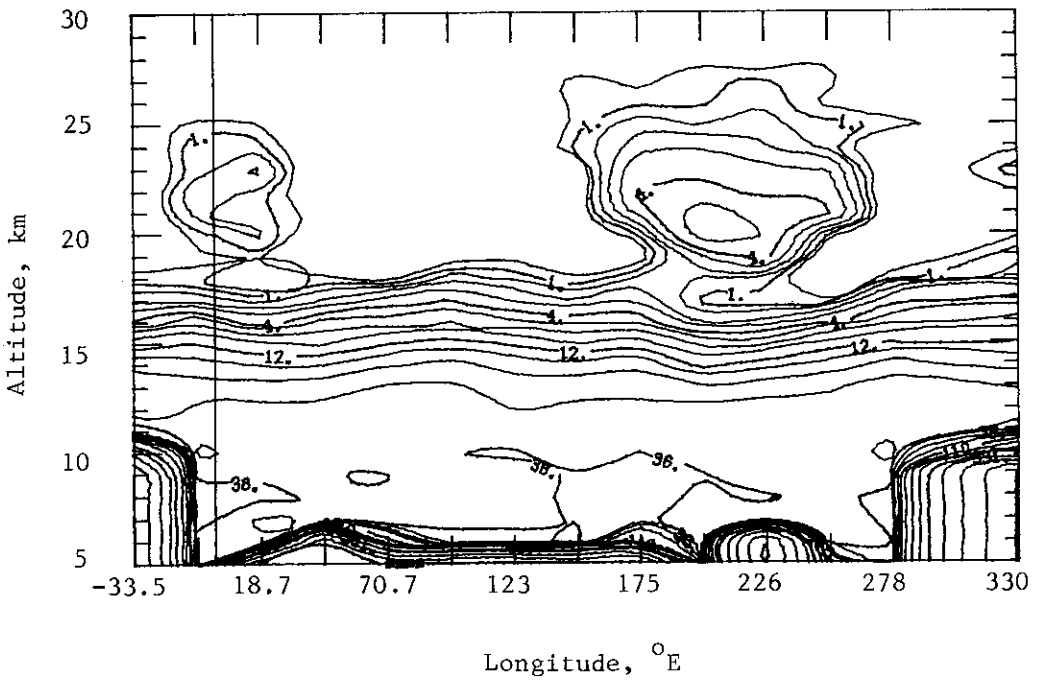



(a) Extinction isopleth.

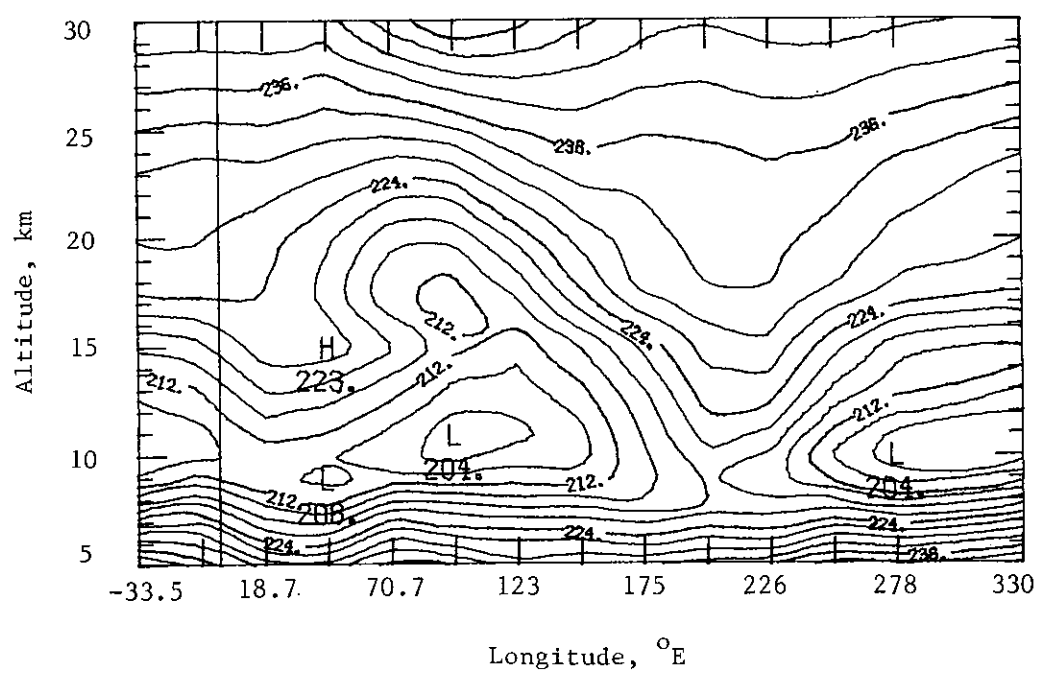



(b) Temperature contours.

Figure 37.- Arctic extinction isopleth and temperature contours for April 27.12 to 28.20, 1979, at latitudes from 74.7° to 74.4° N corresponding to orbits 2555 to 2570.

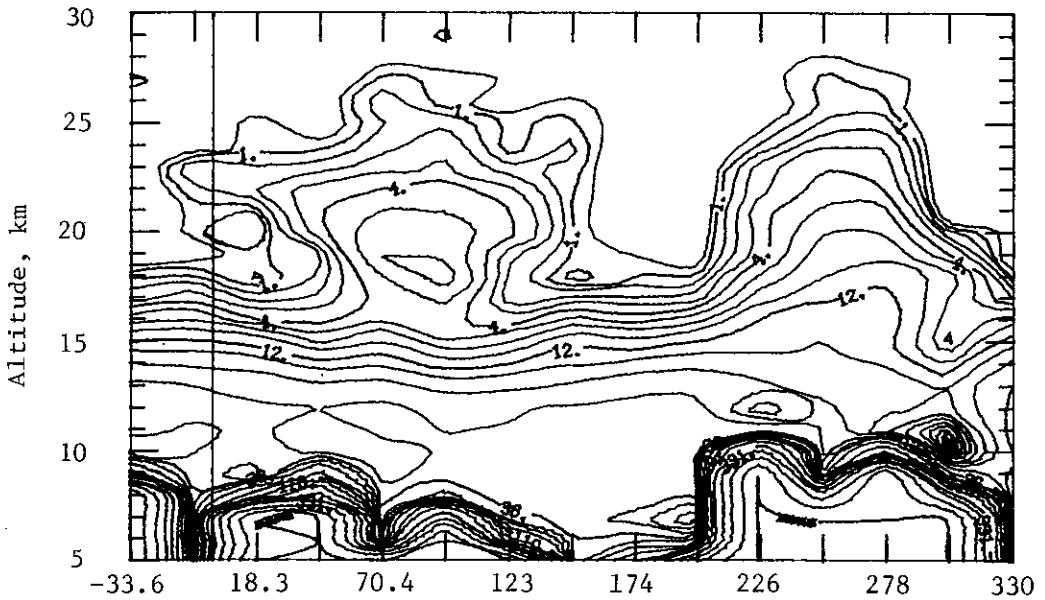



(a) Extinction isopleth.

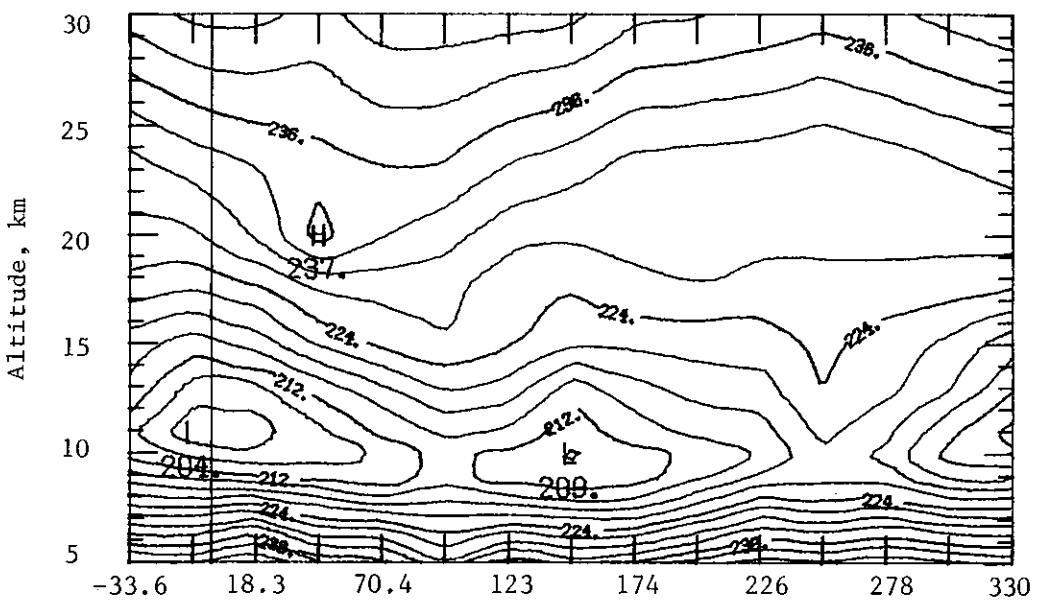



(b) Temperature contours.

Figure 38.- Antarctic extinction isopleth and temperature contours for October 30.00 to 31.01, 1978, at latitudes from 74.7° to 74.4° S corresponding to orbits 79 to 93.

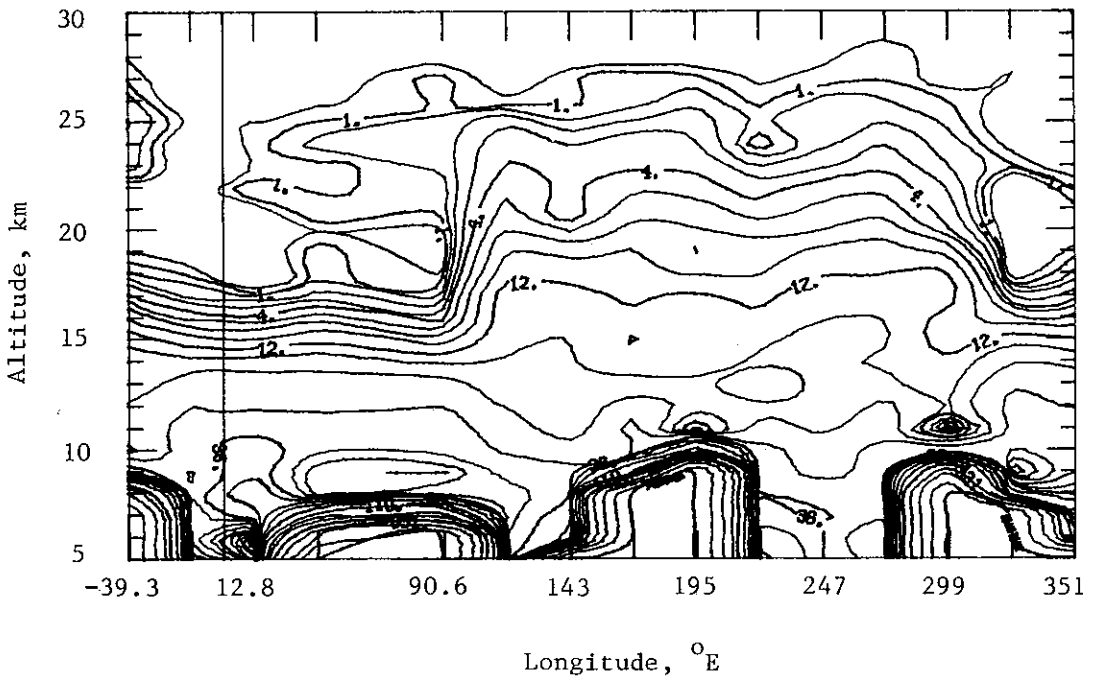



(a) Extinction isopleth.

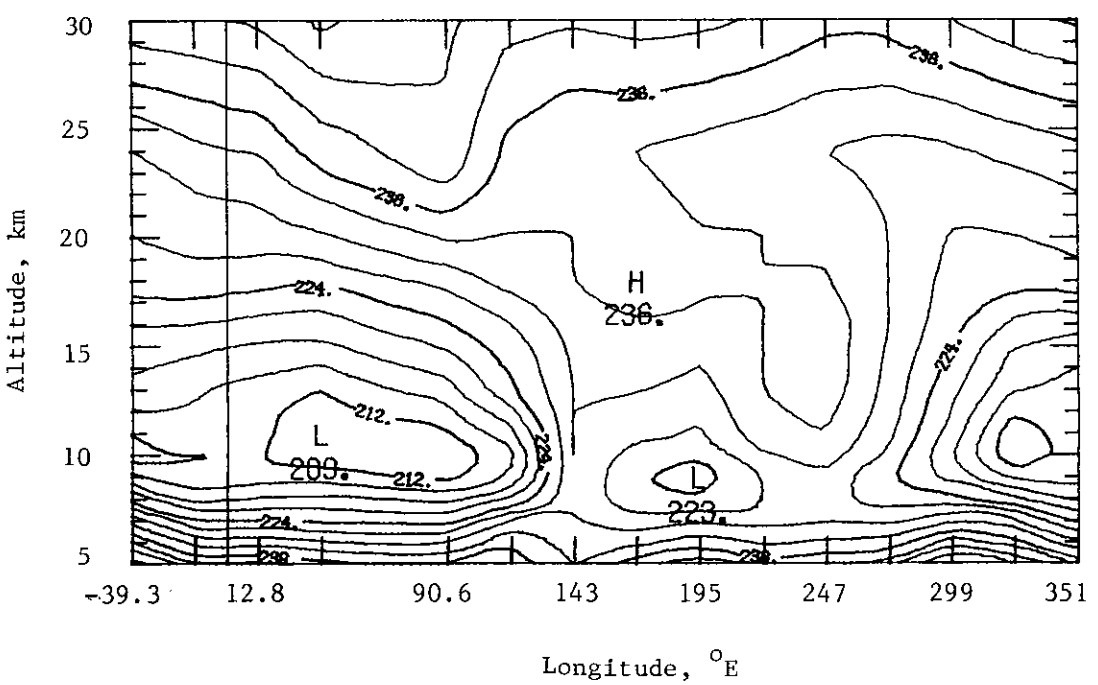



(b) Temperature contours.

Figure 39.- Antarctic extinction isopleth and temperature contours for November 6.01 to 7.02, 1978, at latitudes from 72.8° to 72.5° S corresponding to orbits 176 to 190.

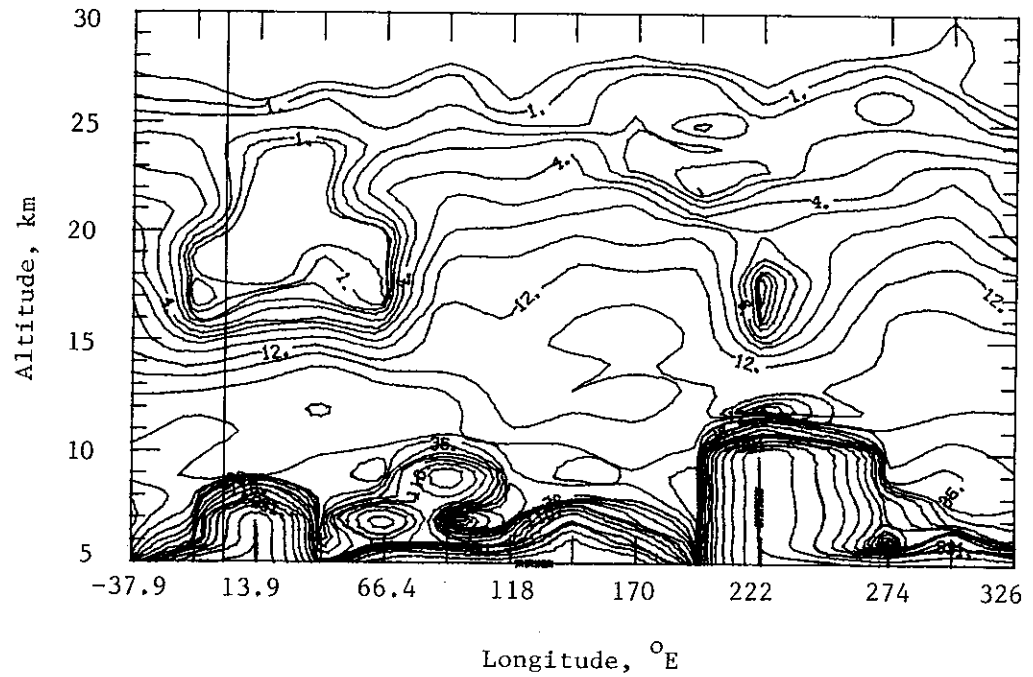



(a) Extinction isopleth.

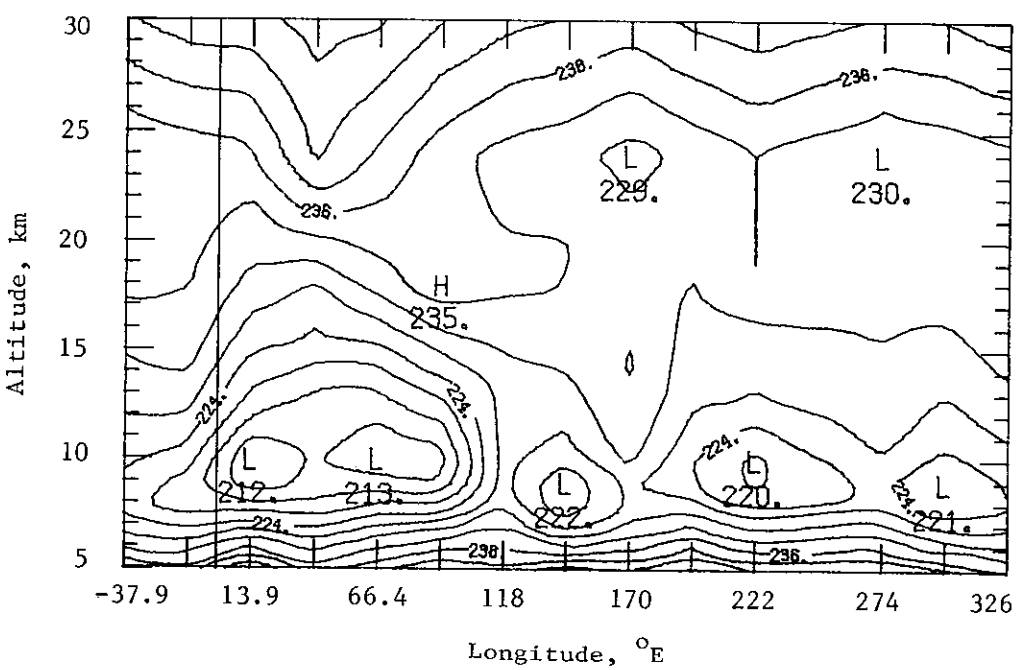



(b) Temperature contours.

Figure 40.- Antarctic extinction isopleth and temperature contours for November 13.96 to 15.05, 1978, at latitudes from 70.8° to 70.5° S corresponding to orbits 286 to 301.

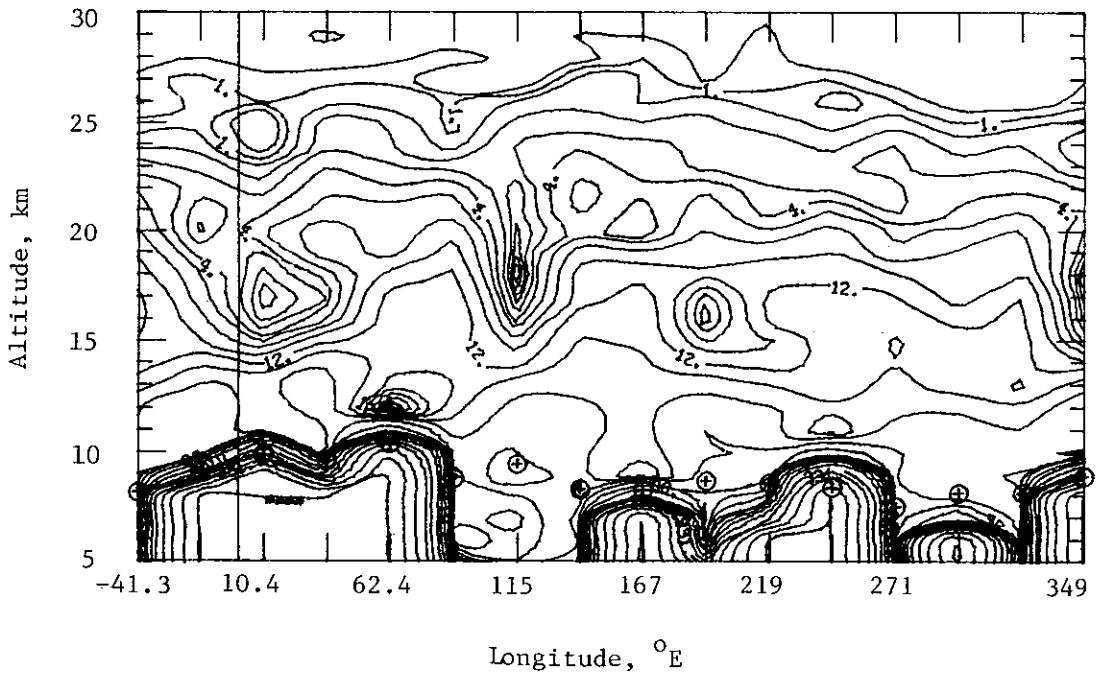



(a) Extinction isopleth.

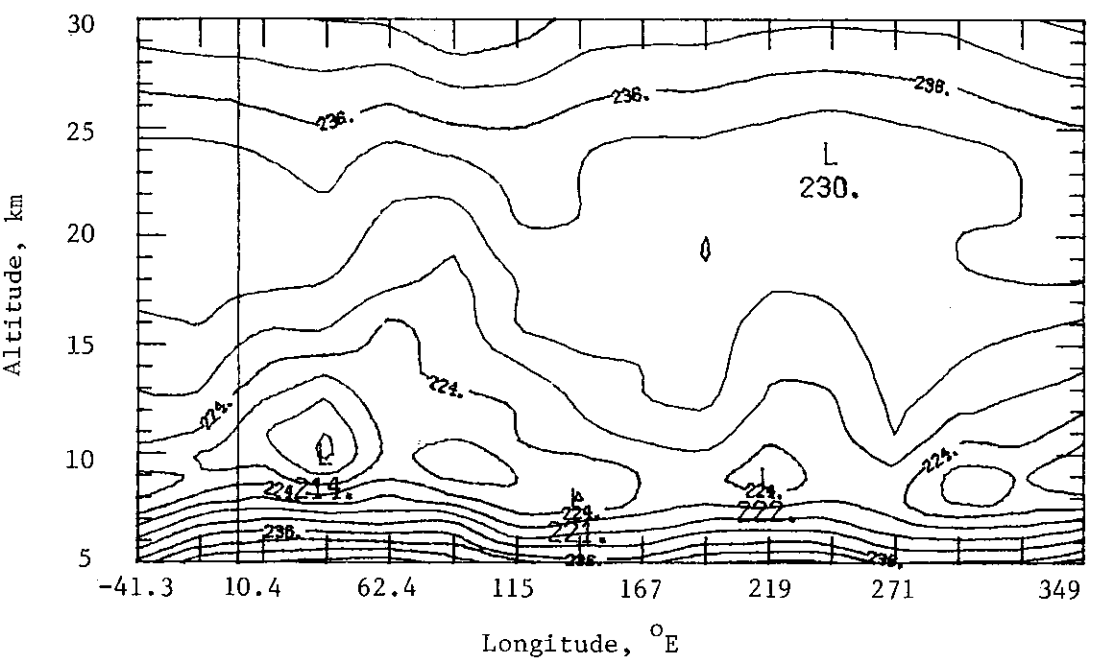



(b) Temperature contours.

Figure 41.- Antarctic extinction isopleth and temperature contours for November 20.03 to 21.05, 1978, at latitudes from 69.4° to 69.2° S corresponding to orbits 370 to 384.

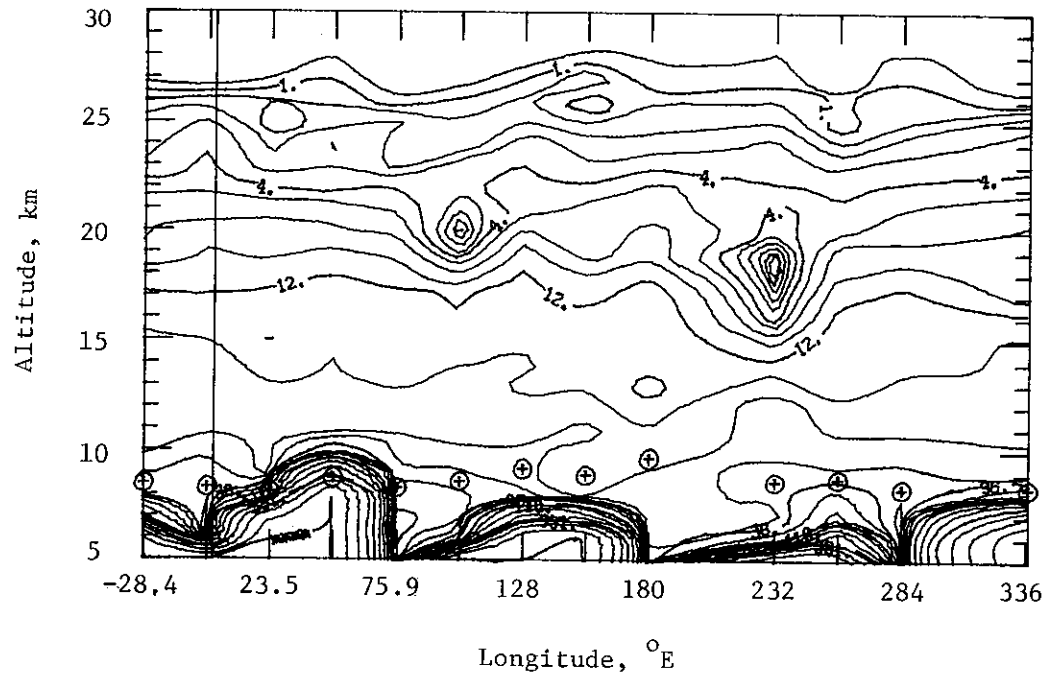



(a) Extinction isopleth.

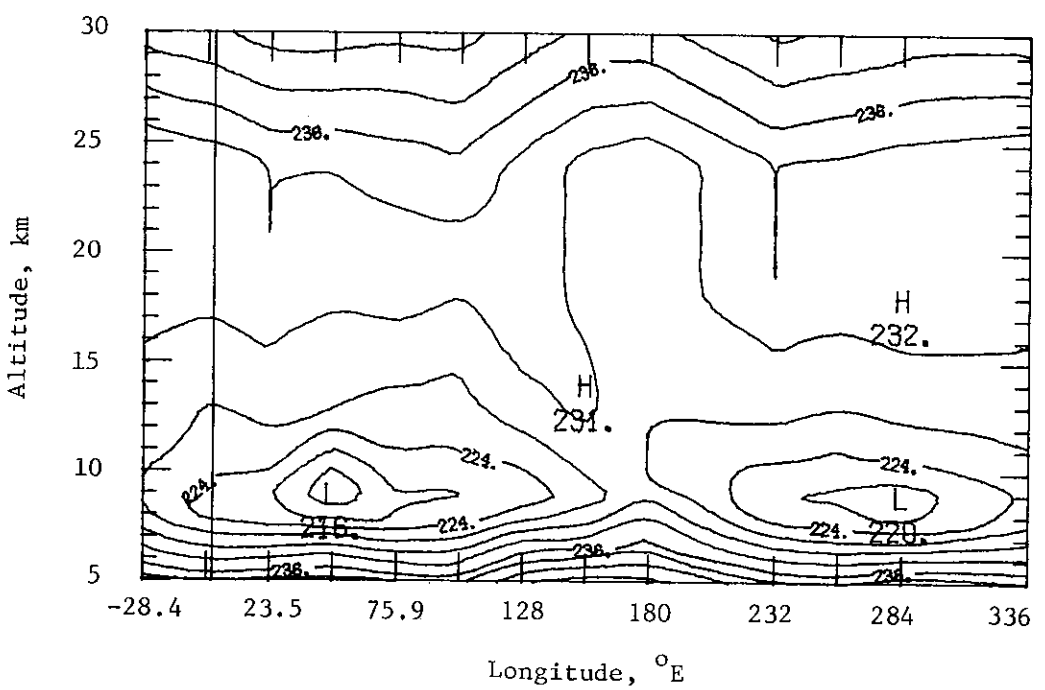



(b) Temperature contours.

Figure 42.- Antarctic extinction isopleth and temperature contours for November 26.98 to 28.06, 1978, at latitudes from 67.9° to 67.8° S corresponding to orbits 466 to 481.

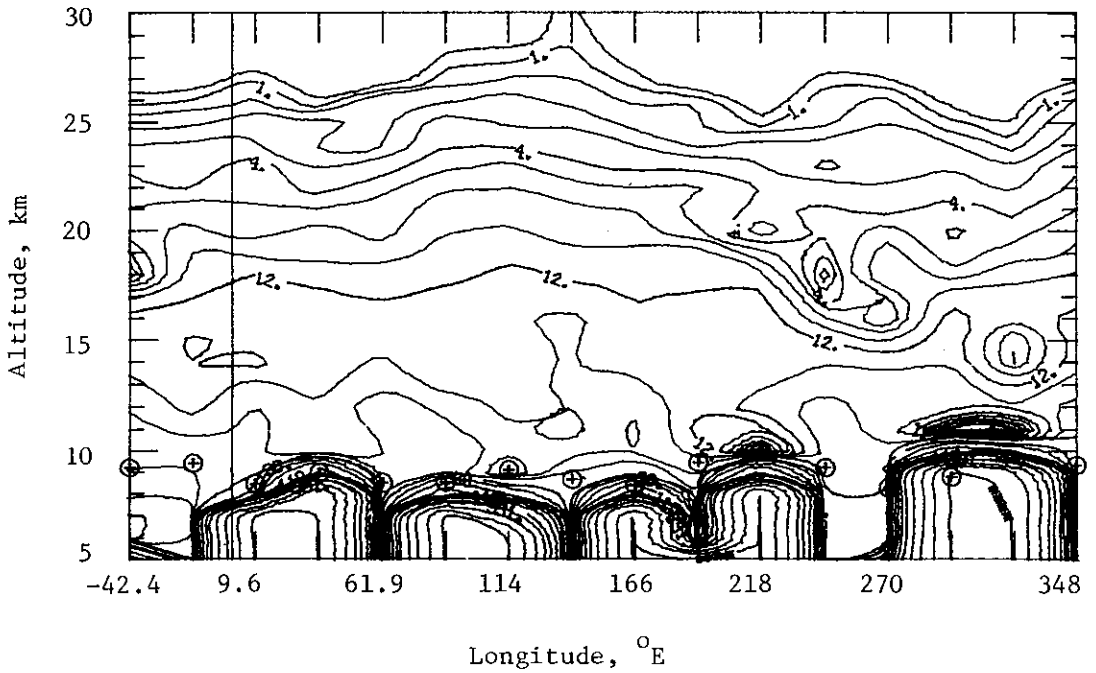



(a) Extinction isopleth.

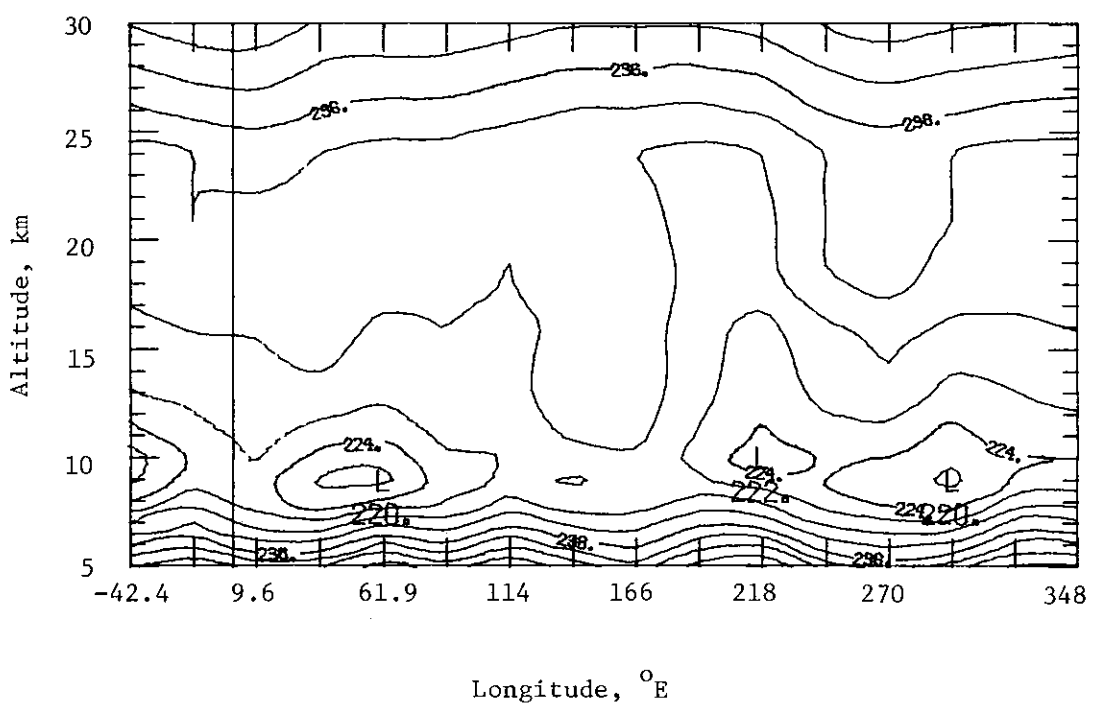



(b) Temperature contours.

Figure 43.- Antarctic extinction isopleth and temperature contours for December 6.01 to 7.02, 1978, at latitudes from 66.5° to 66.3° S corresponding to orbits 591 to 605.

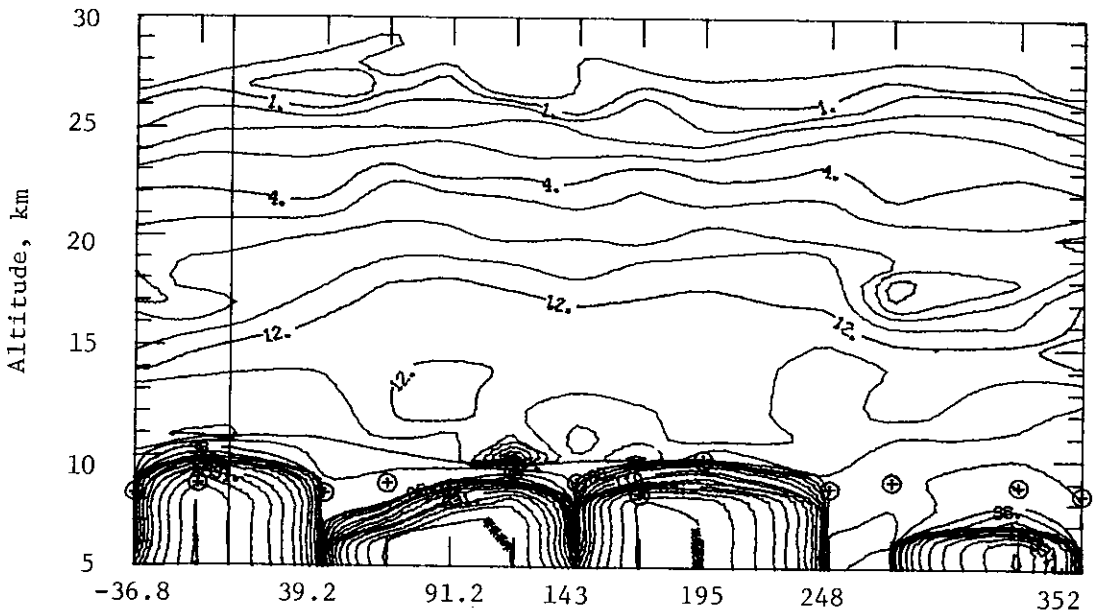



(a) Extinction isopleth.

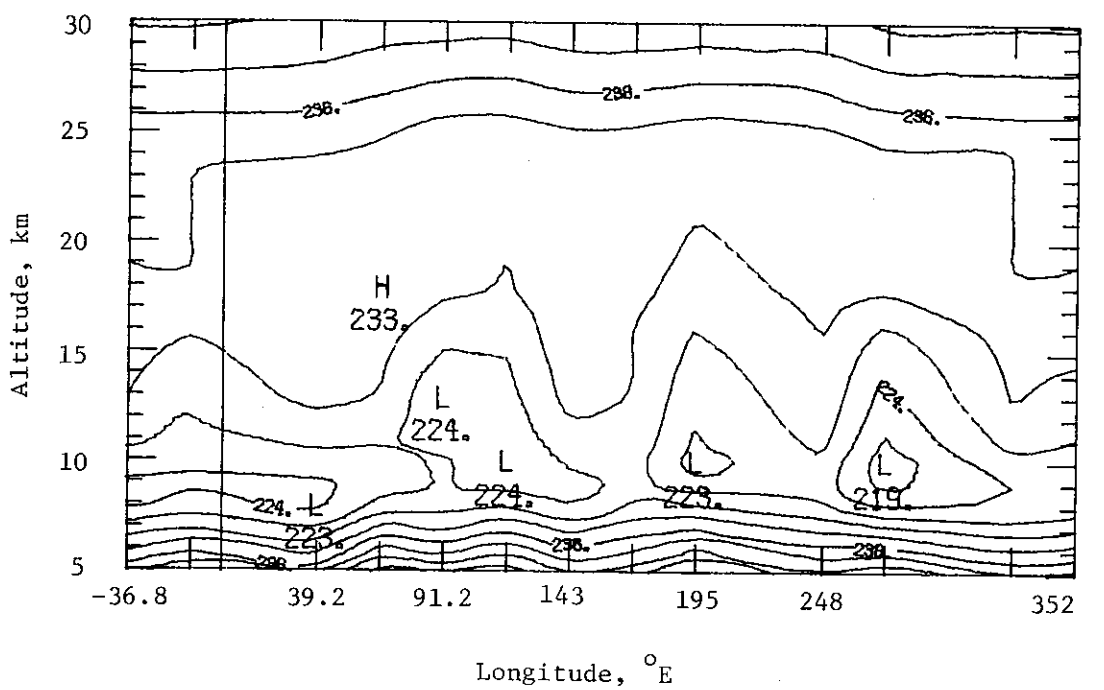



(b) Temperature contours.

Figure 44.- Antarctic extinction isopleth and temperature contours for December 14.98 to 16.06, 1978, at latitudes from 65.5° to 65.4° S corresponding to orbits 715 to 730.

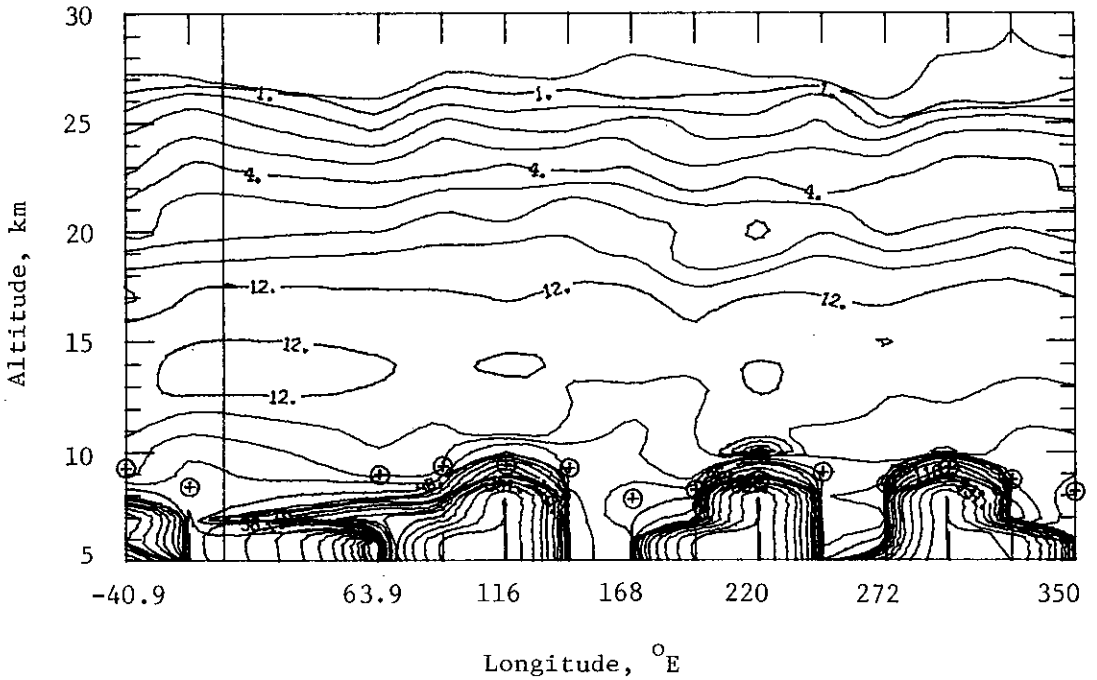



(a) Extinction isopleth.

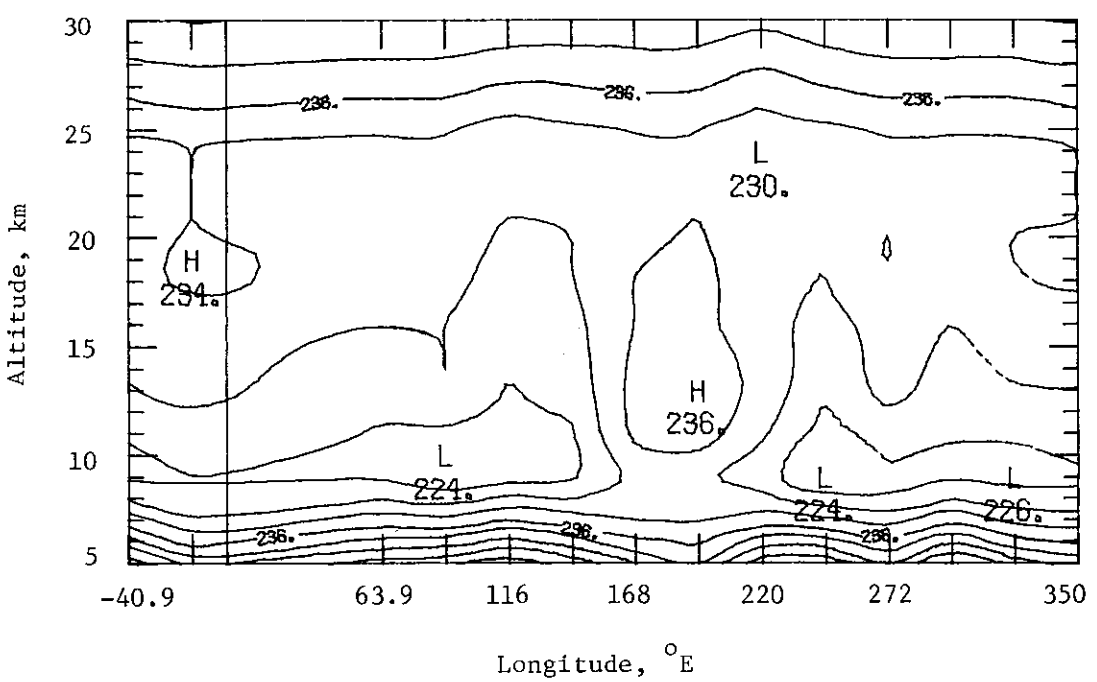



(b) Temperature contours.

Figure 45.- Antarctic extinction isopleth and temperature contours for December 19.97 to 21.05, 1978, at latitudes from 65.2° to 65.1° S corresponding to orbits 784 to 799.

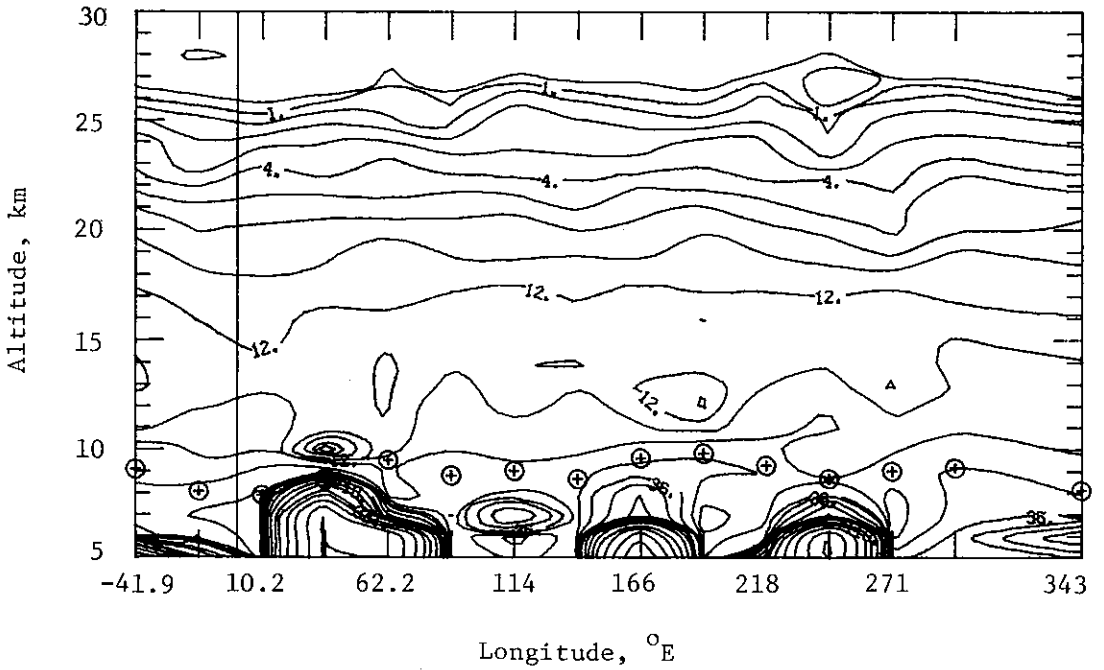



(a) Extinction isopleth.

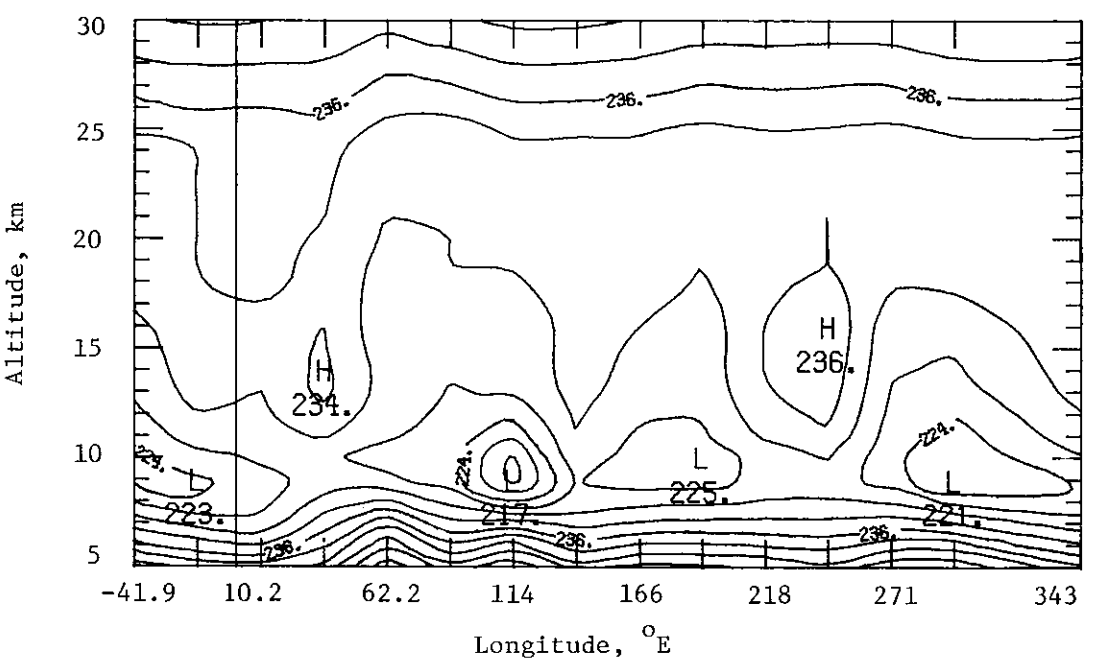



(b) Temperature contours.

Figure 46.- Antarctic extinction isopleth and temperature contours for December 25.97 to 27.05, 1978, at a latitude of 65.0° S corresponding to orbits 867 to 882.

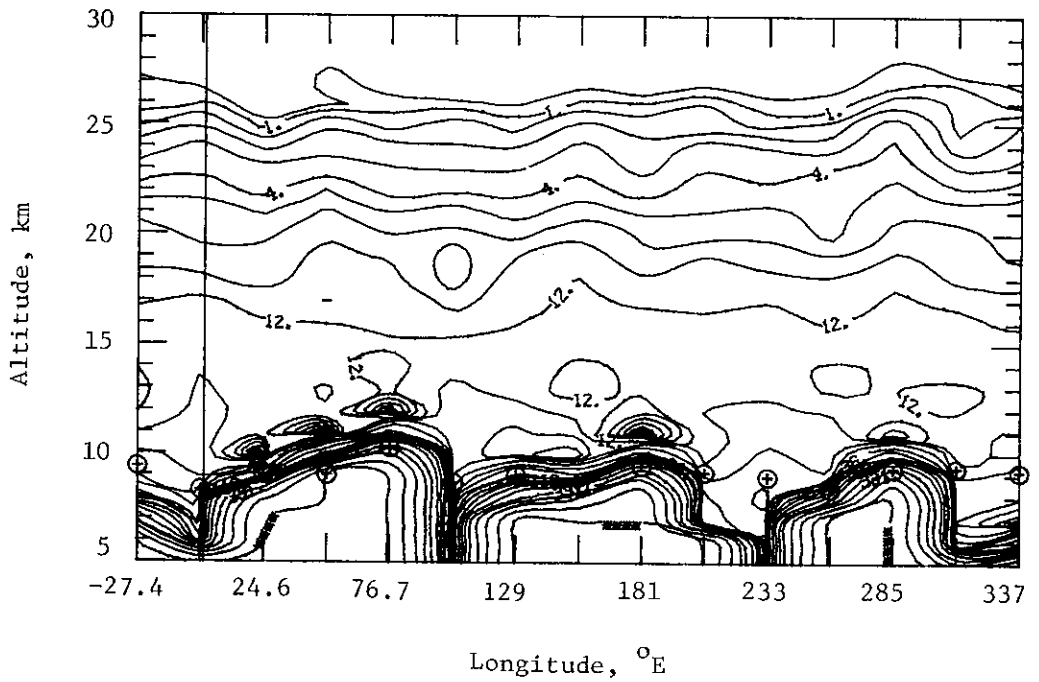



(a) Extinction isopleth.

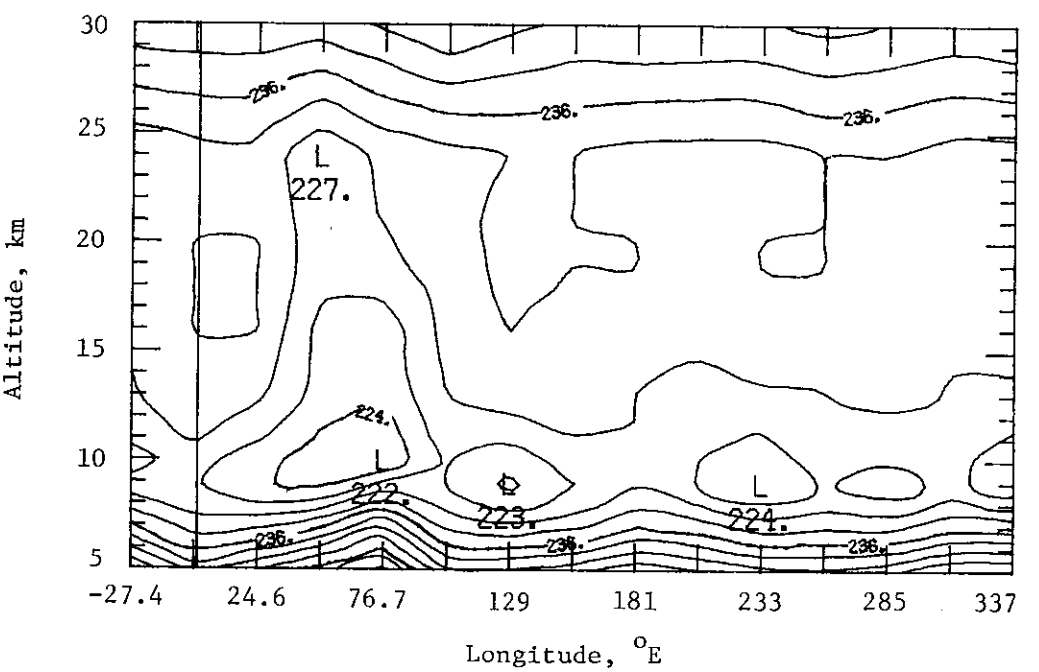



(b) Temperature contours.

Figure 47.- Antarctic extinction isopleth and temperature contours for December 31.97, 1978, to January 2.06, 1979, at a latitude of 65.1° S corresponding to orbits 950 to 965.

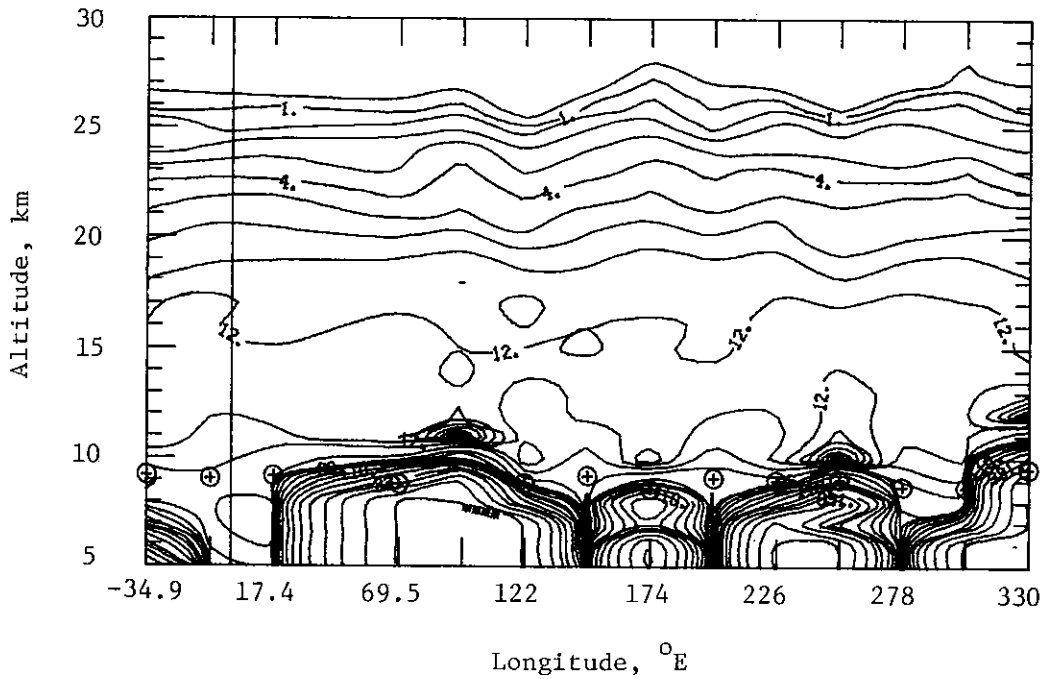



(a) Extinction isopleth.

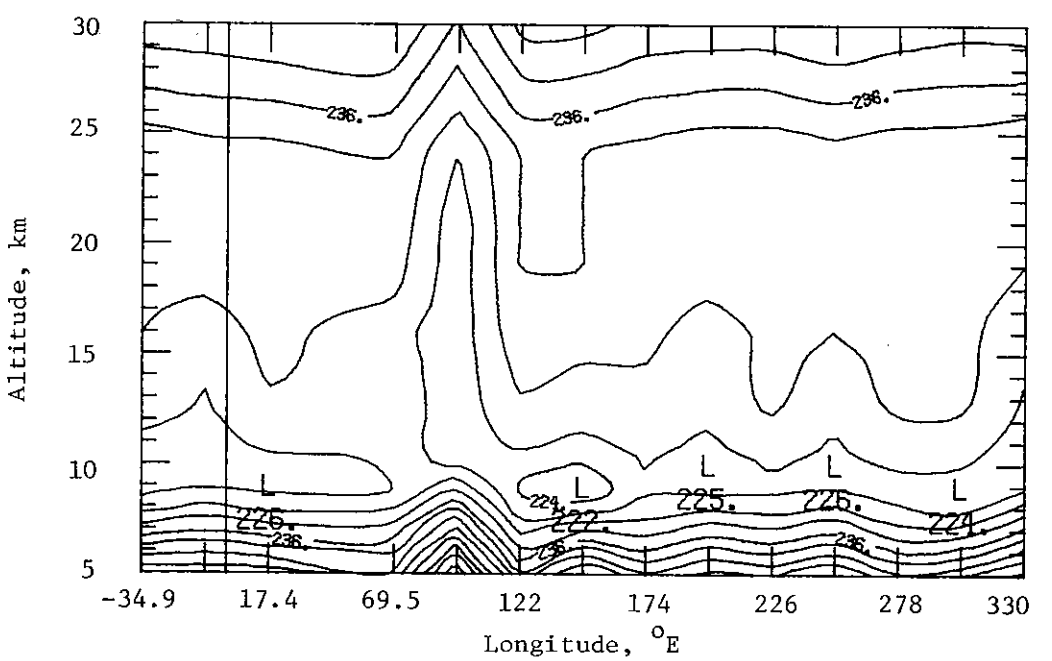



(b) Temperature contours.

Figure 48.- Antarctic extinction isopleth and temperature contours for January 9.00 to 10.01, 1979, at latitudes from 65.5° to 65.6° S corresponding to orbits 1061 to 1075.

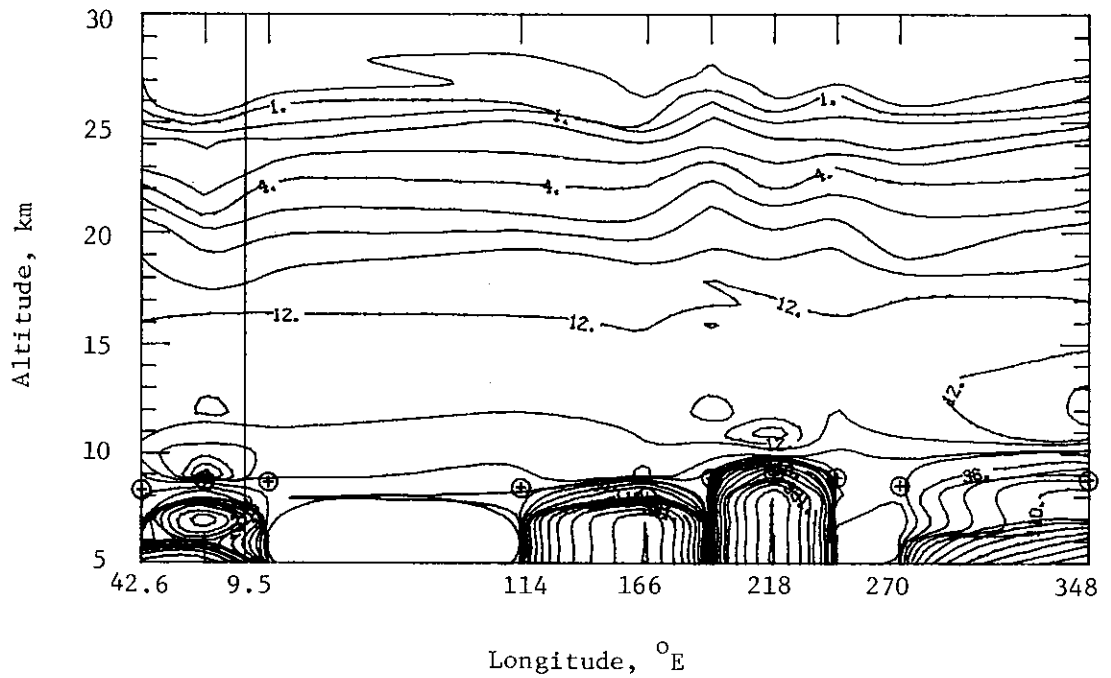



(a) Extinction isopleth.

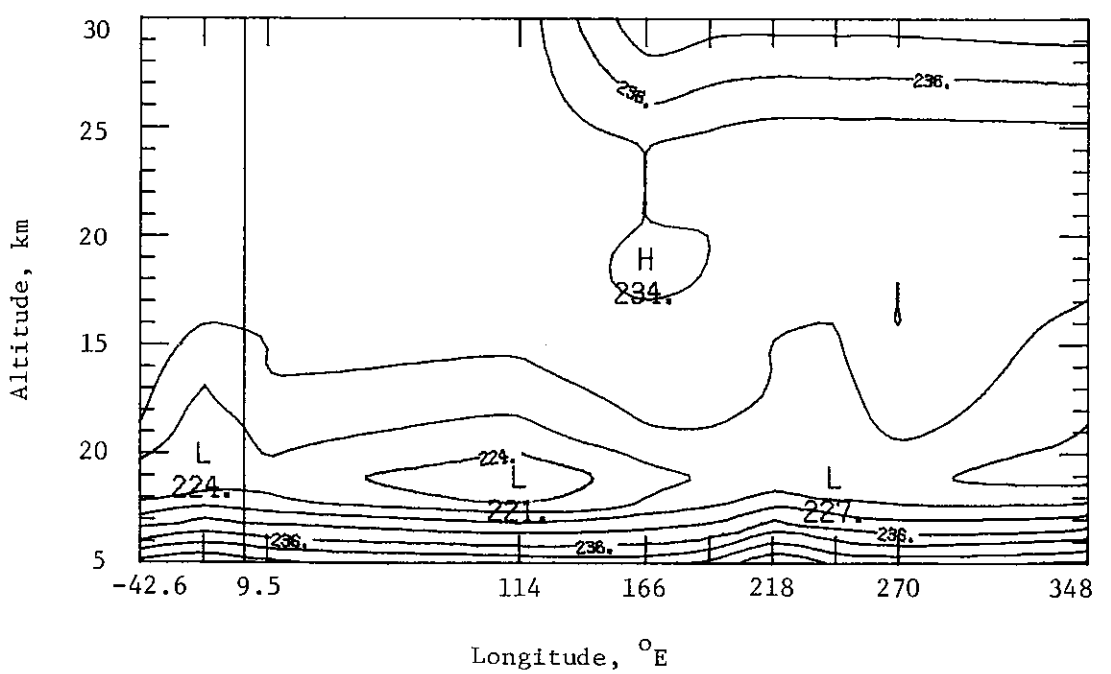



(b) Temperature contours.

Figure 49.- Antarctic extinction isopleth and temperature contours for January 16.01 to 17.03, 1979, at latitudes from 66.3° to 66.4° S corresponding to orbits 1158 to 1172.

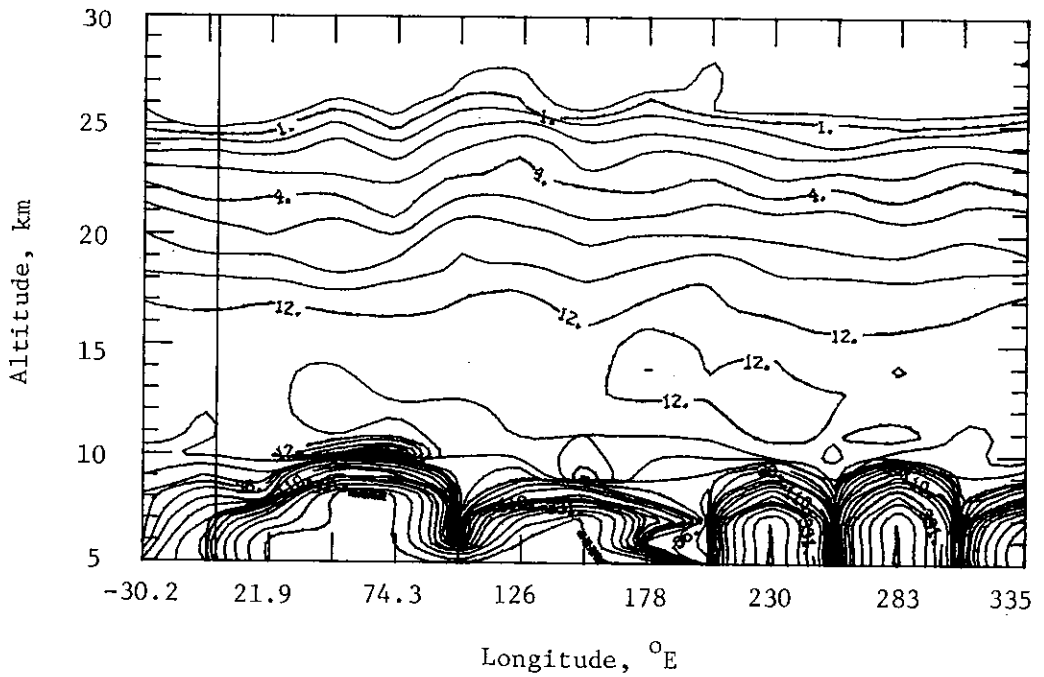



(a) Extinction isopleth.

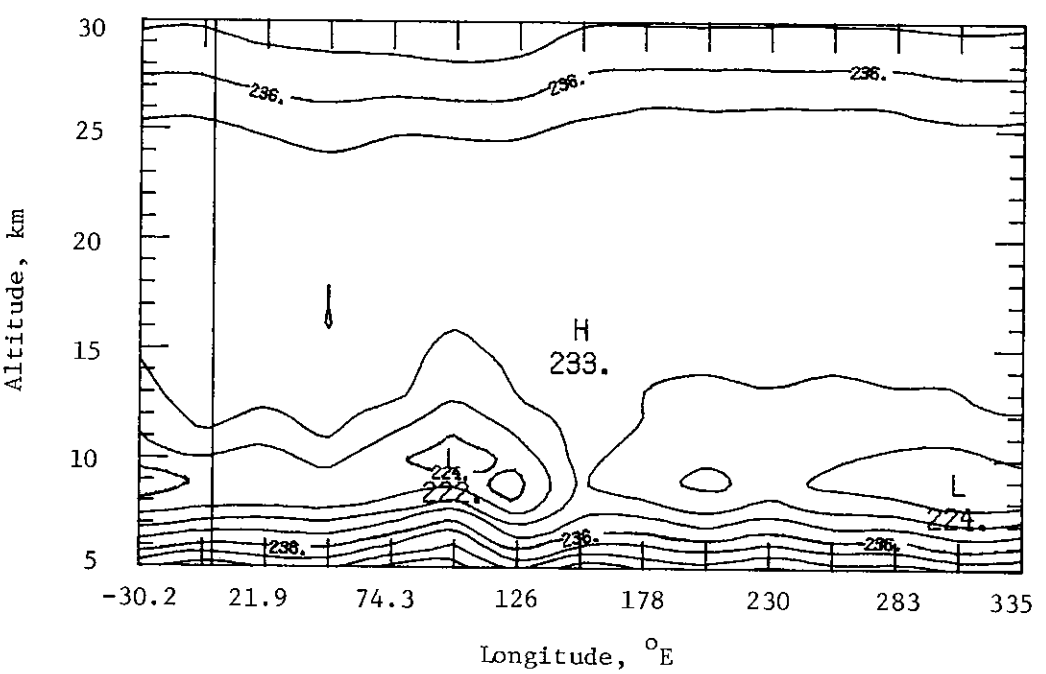



(b) Temperature contours.

Figure 50.- Antarctic extinction isopleth and temperature contours for January 22.96 to 24.04, 1979, at latitudes from 67.3 to 67.4° S corresponding to orbits 1254 to 1269.

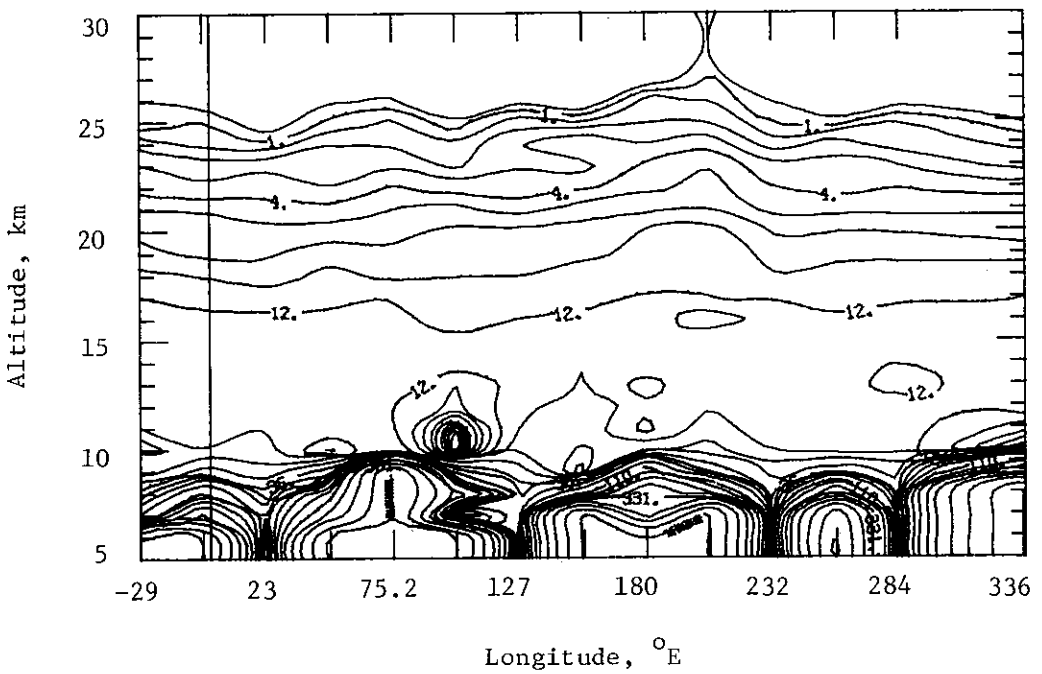



(a) Extinction isopleth.

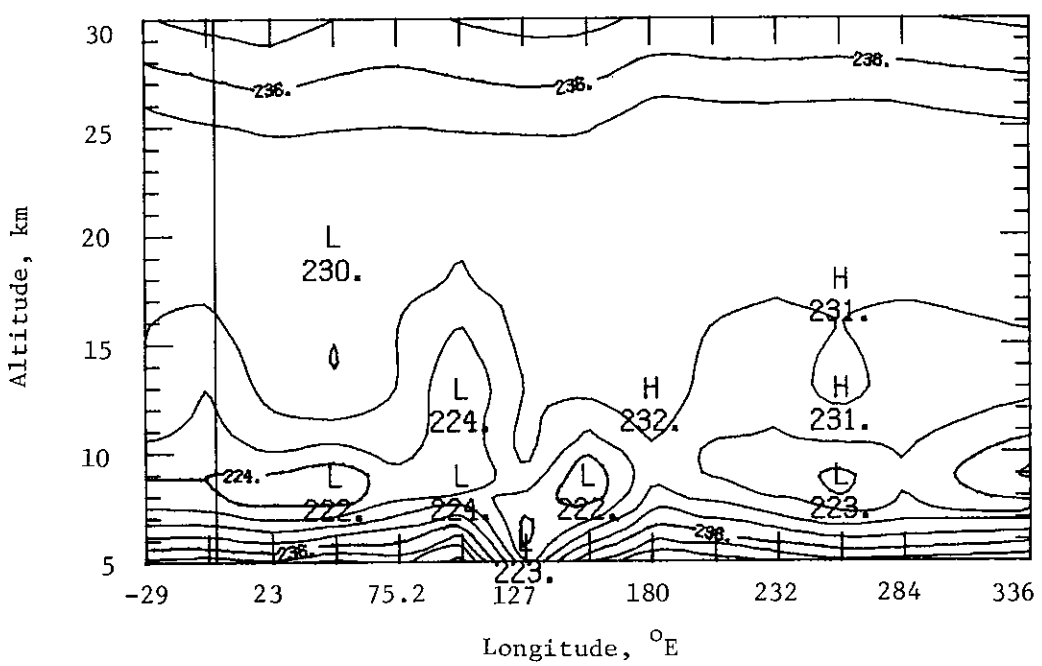



(b) Temperature contours.

Figure 51.- Antarctic extinction isopleth and temperature contours for January 30.98 to February 1.00, 1979, at latitudes from 68.7° to 68.9° S corresponding to orbits 1365 to 1379.

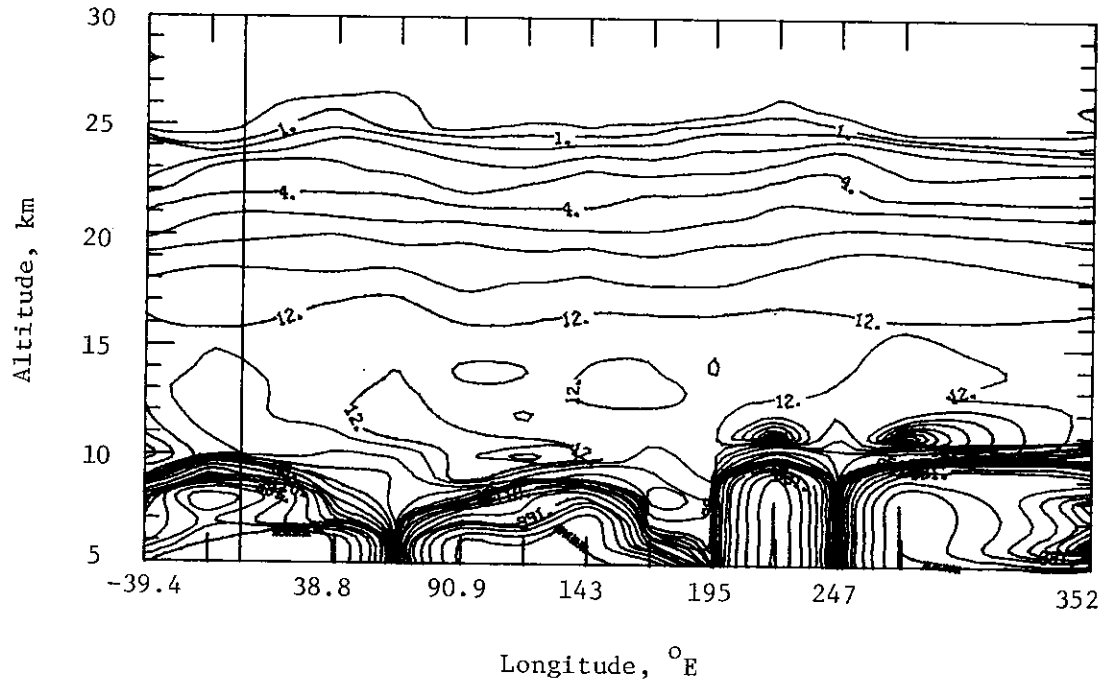



(a) Extinction isopleth.

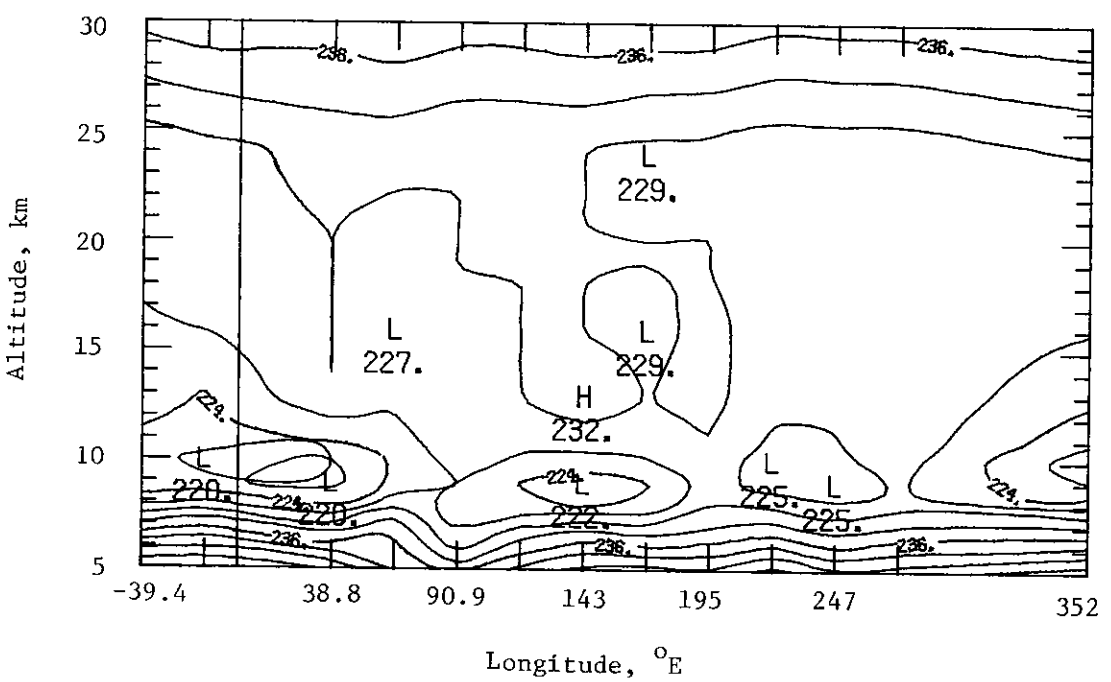



(b) Temperature contours.

Figure 52.- Antarctic extinction isopleth and temperature contours for February 4.97 to 5.99, 1979, at latitudes from 69.8° to 70.0° S corresponding to orbits 1434 to 1448.

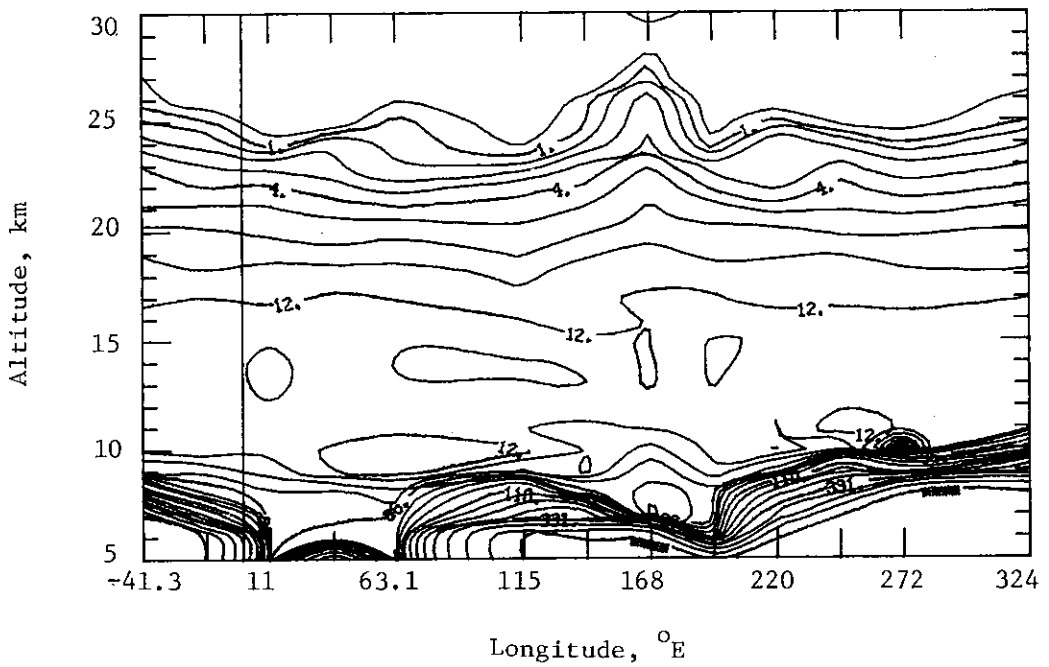



(a) Extinction isopleth.

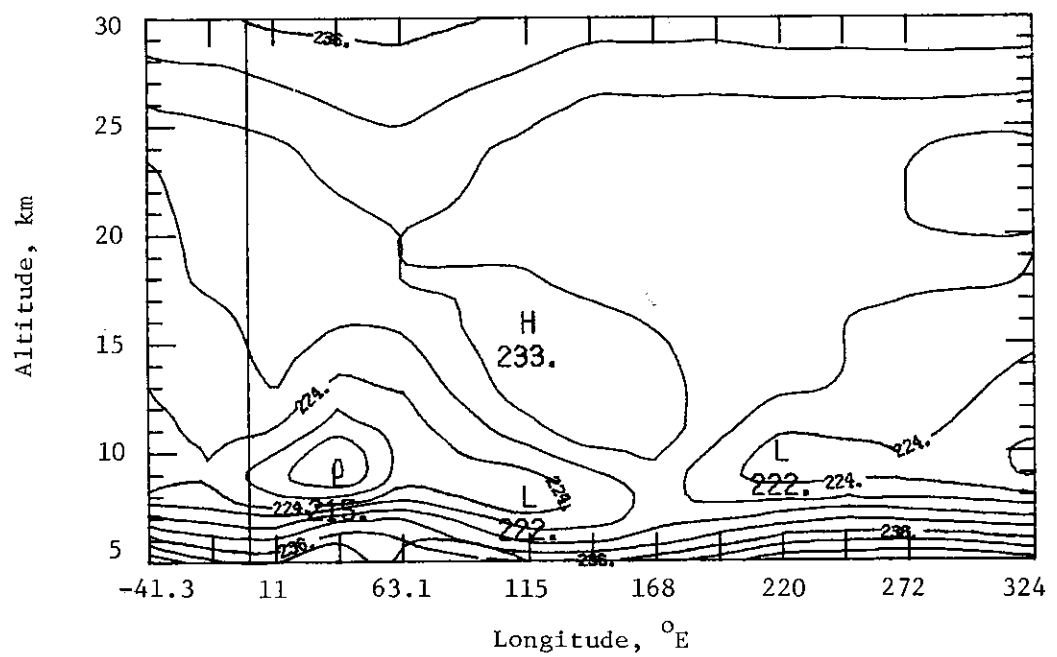



(b) Temperature contours.

Figure 53.- Antarctic extinction isopleth and temperature contours for February 11.92 to 13.00, 1979, at latitudes from 71.3° to 71.6° S corresponding to orbits 1530 to 1545.

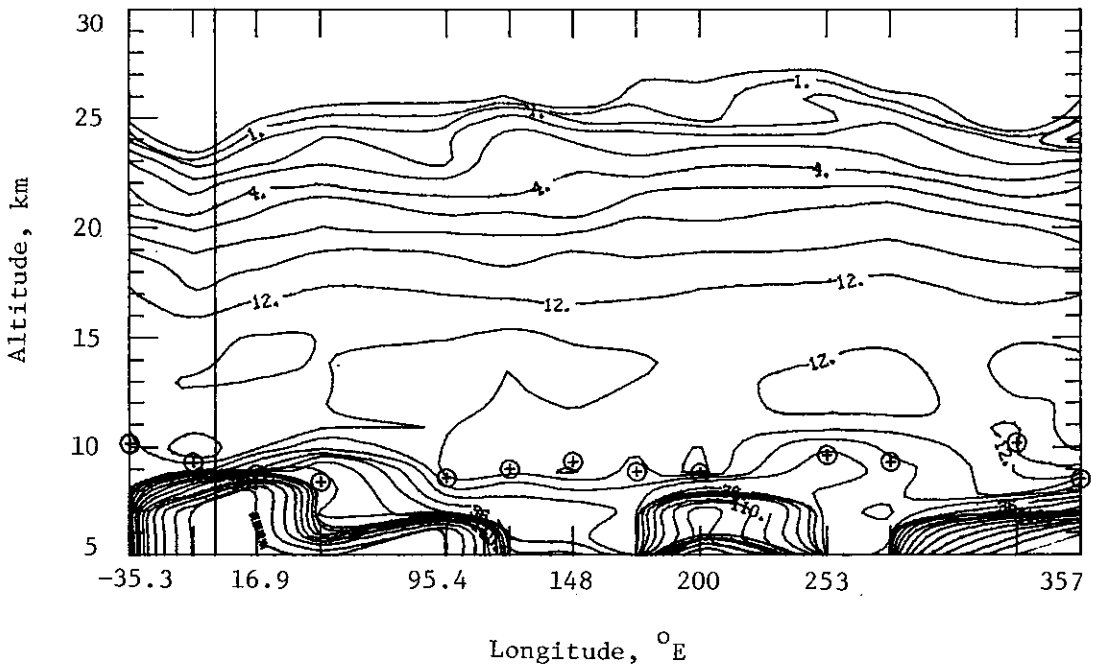



(a) Extinction isopleth.

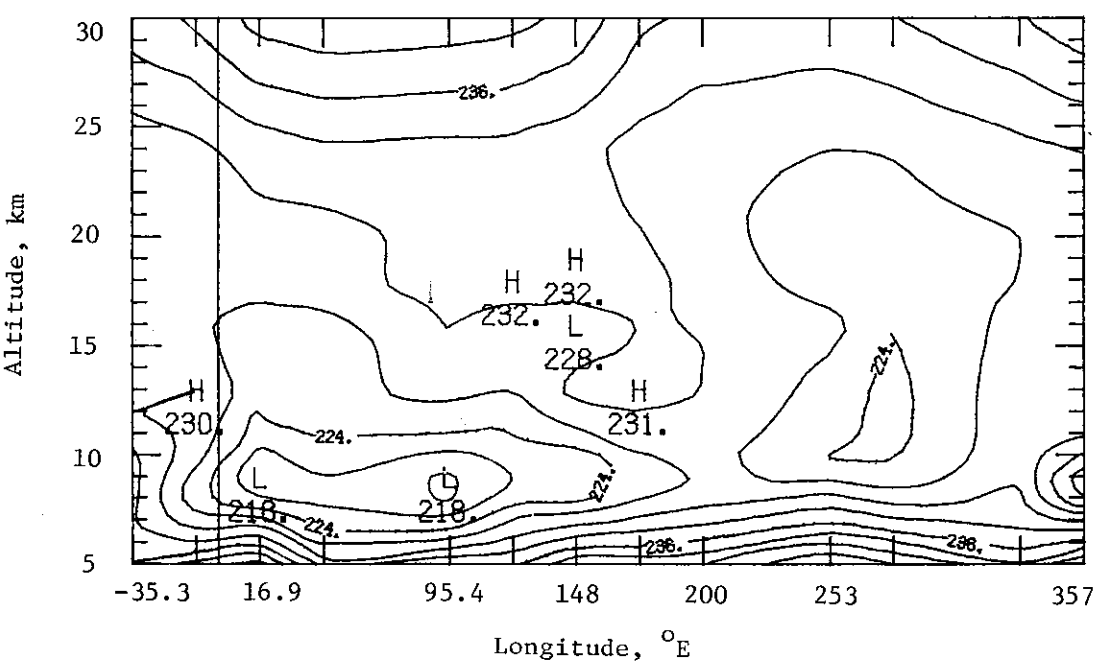



(b) Temperature contours.

Figure 54.- Antarctic extinction isopleth and temperature contours for February 21.97 to 22.98, 1979, at latitudes from 73.9° to 74.1° S corresponding to orbits 1669 to 1683.

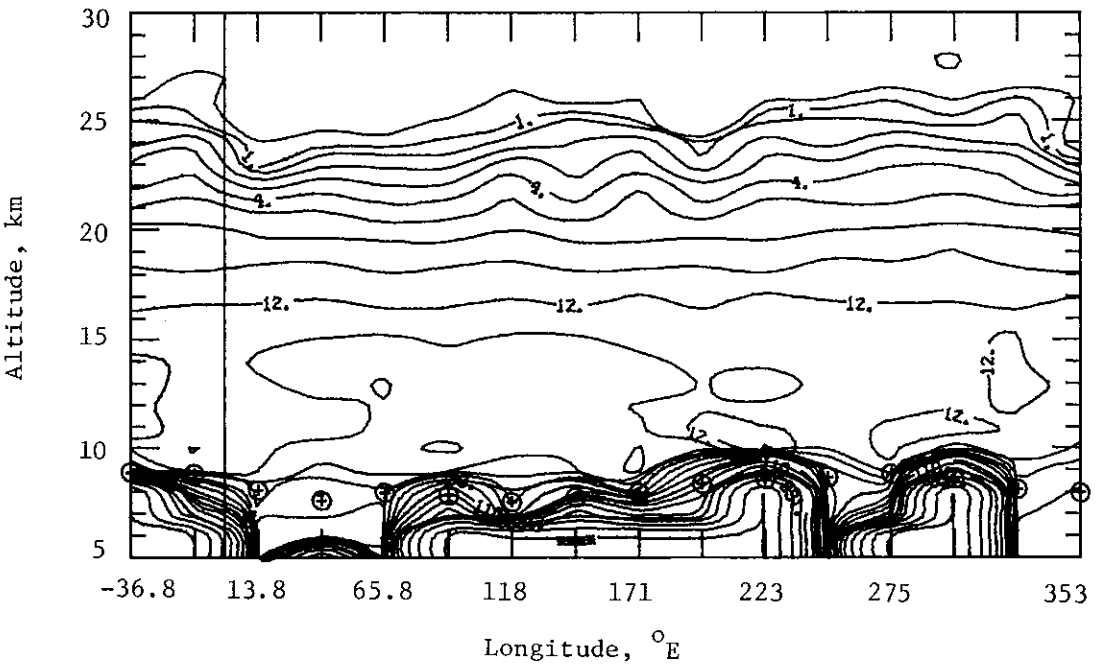



(a) Extinction isopleth.

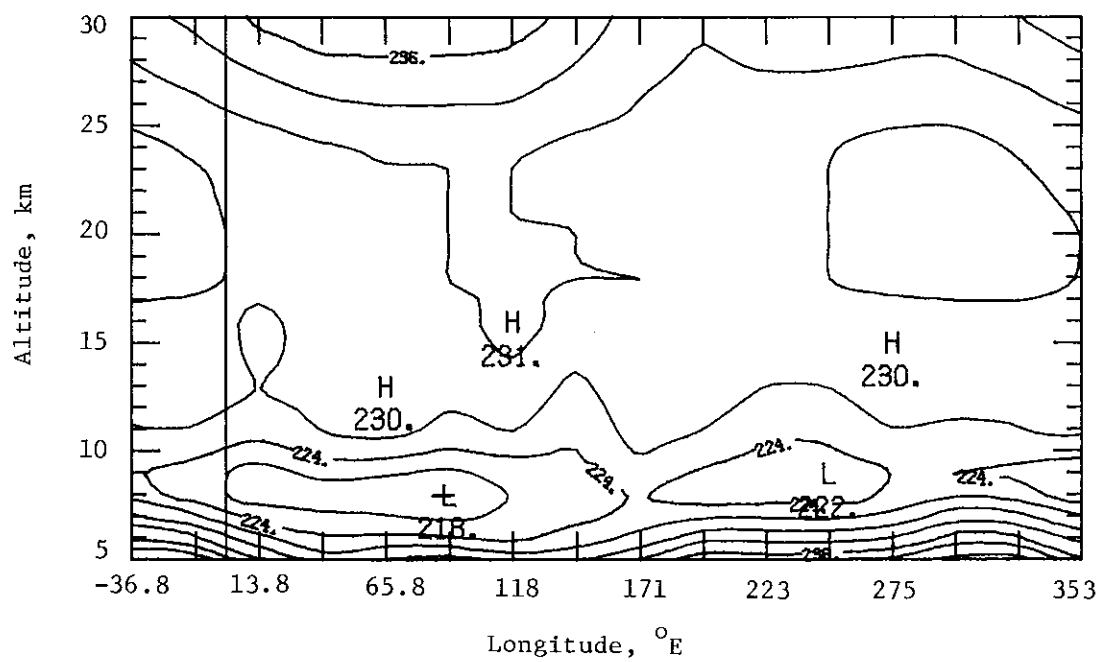



(b) Temperature contours.

Figure 55.- Antarctic extinction isopleth and temperature contours for March 1.86 to 2.94, 1979, at latitudes from 75.7° to 75.9° S corresponding to orbits 1778 to 1793.

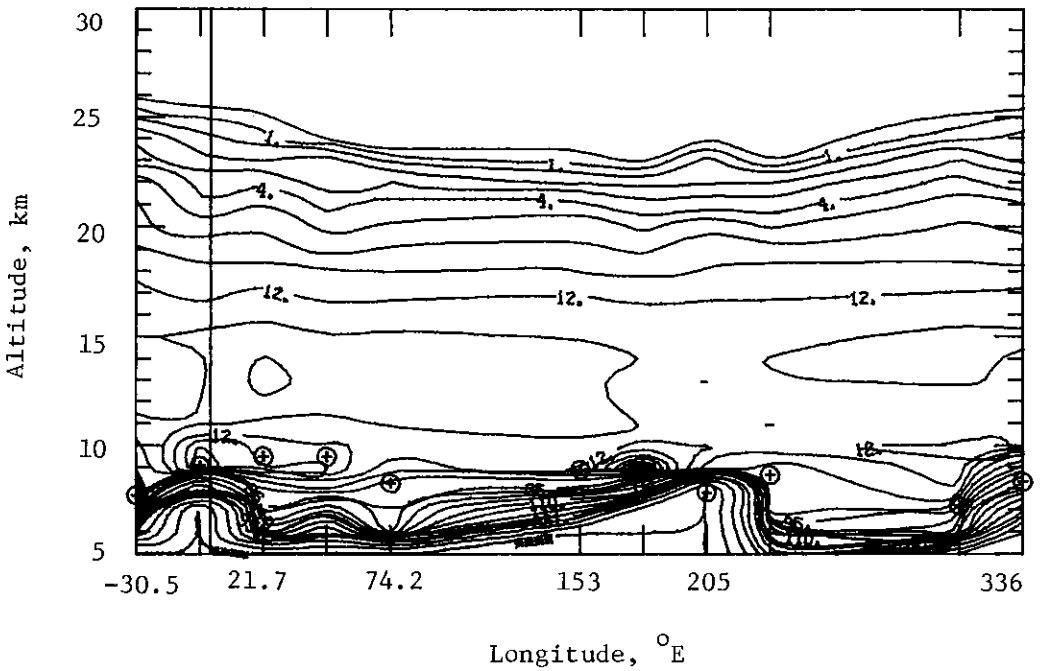



(a) Extinction isopleth.

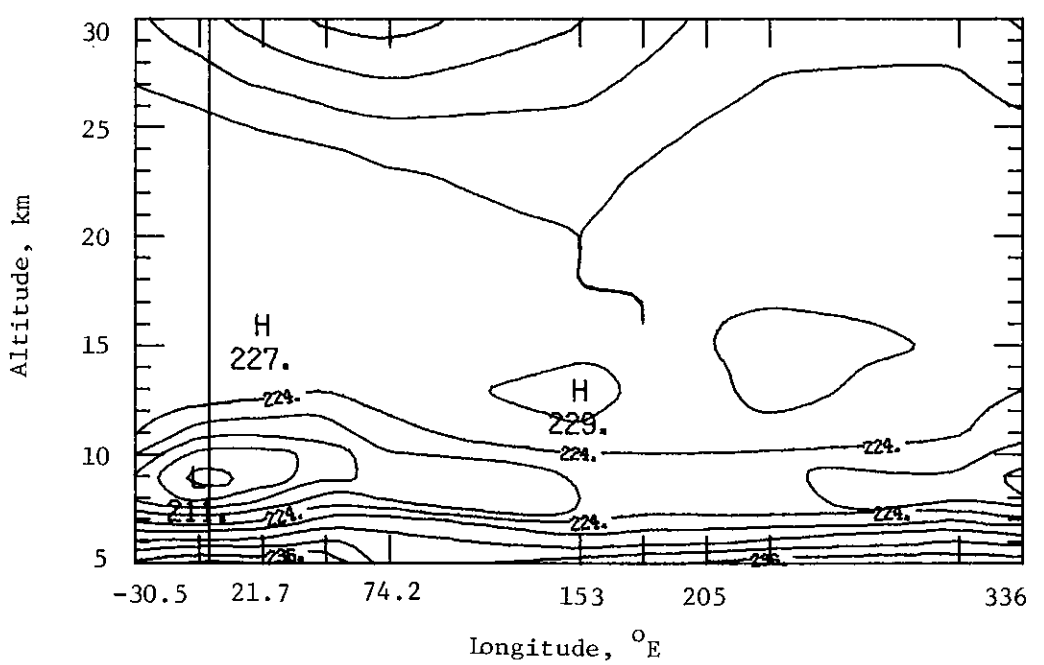



(b) Temperature contours.

Figure 56.- Antarctic extinction isopleth and temperature contours for March 6.85 to 7.93, 1979, at latitudes from 76.7° to 77.0° S corresponding to orbits 1847 to 1862.

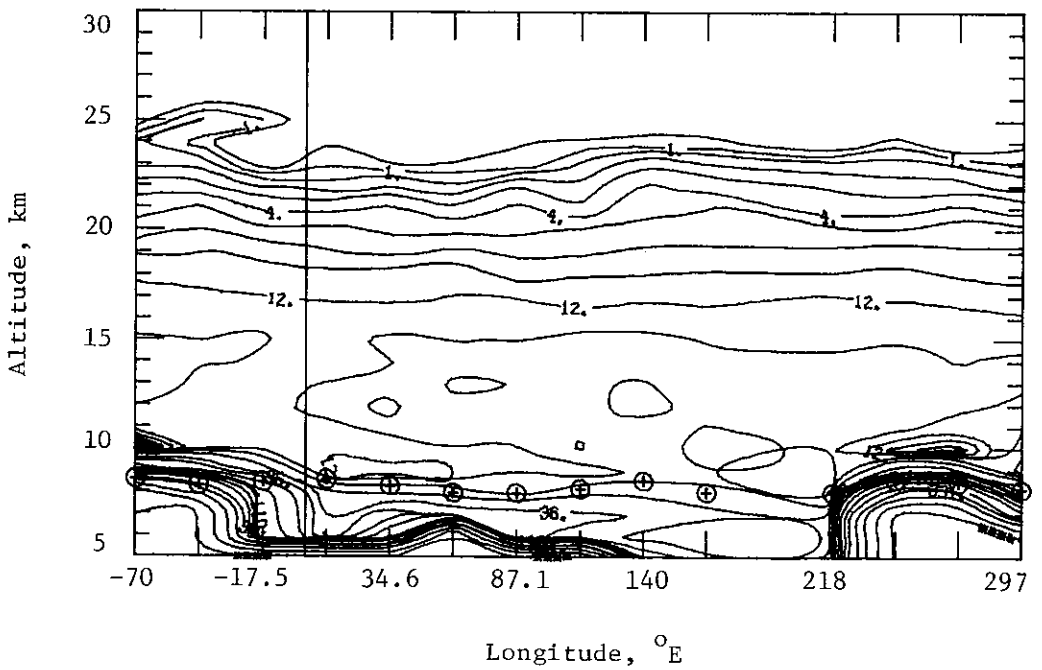



(a) Extinction isopleth.

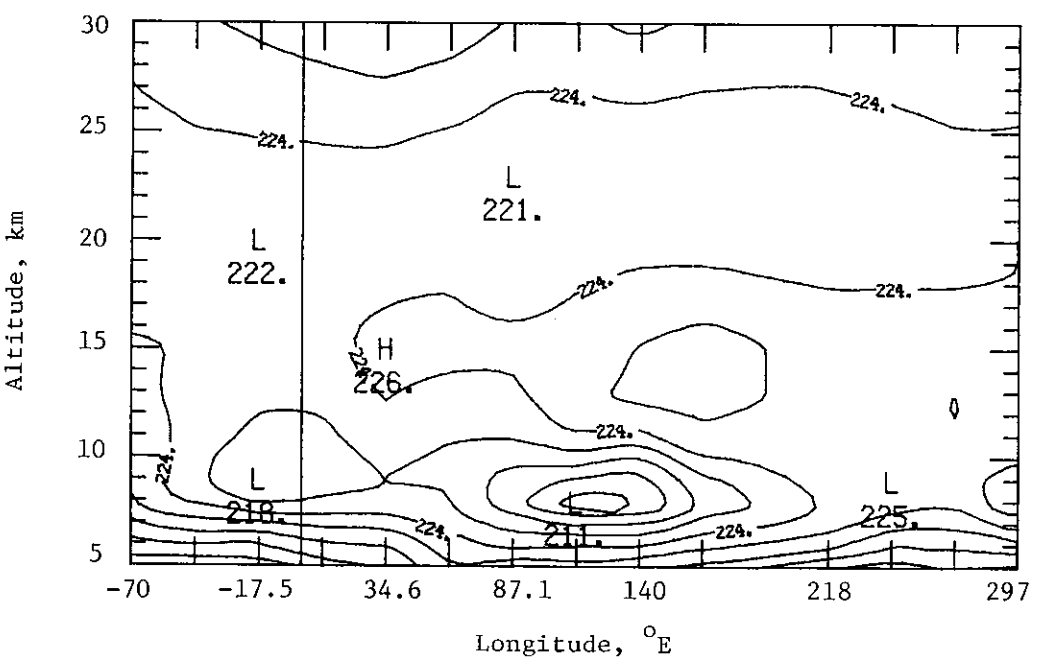



(b) Temperature contours.

Figure 57.- Antarctic extinction isopleth and temperature contours for March 13.87 to 14.88, 1979, at latitudes from 78.0° to 78.1° S corresponding to orbits 1944 to 1958.

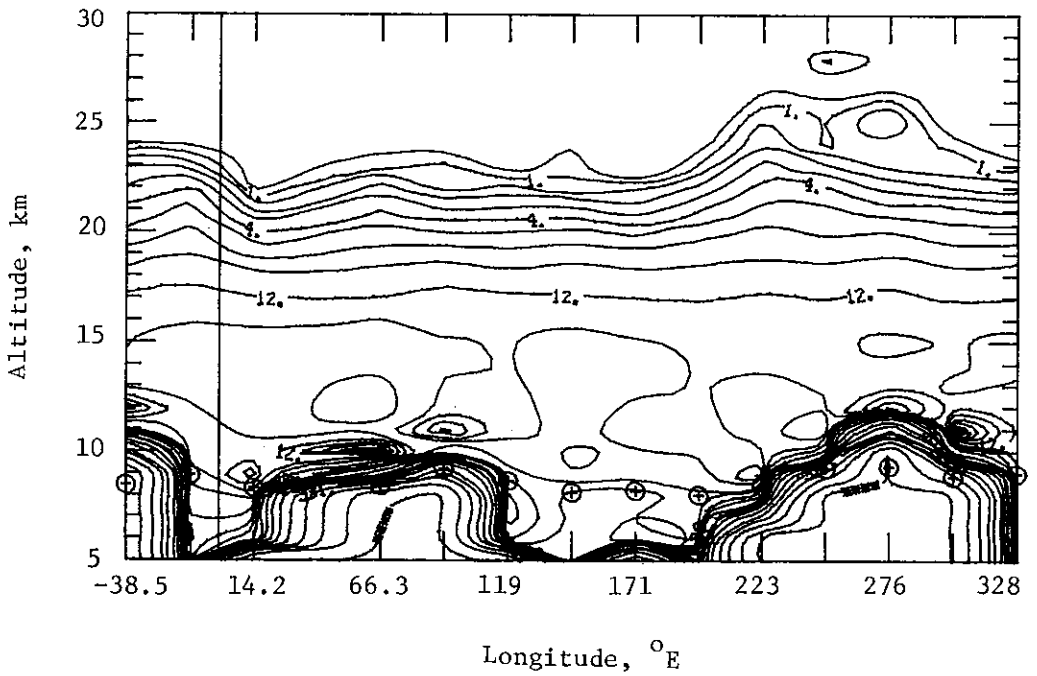



(a) Extinction isopleth.

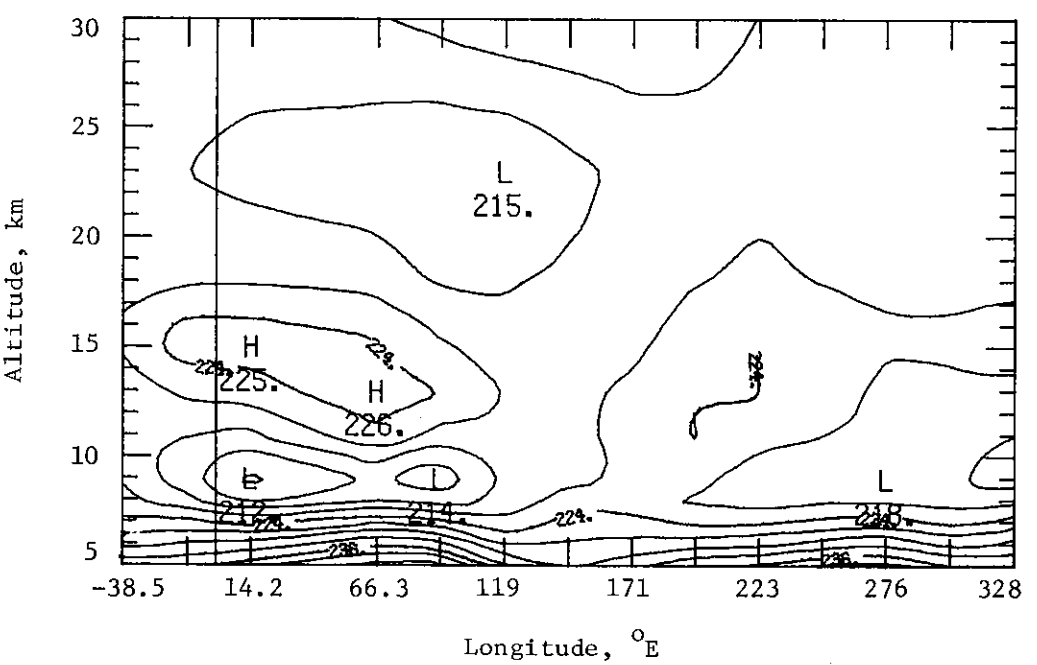



(b) Temperature contours.

Figure 58.- Antarctic extinction isopleth and temperature contours for March 19.94 to 20.96, 1979, at latitudes from 78.5° to 78.6° S corresponding to orbits 2028 to 2042.

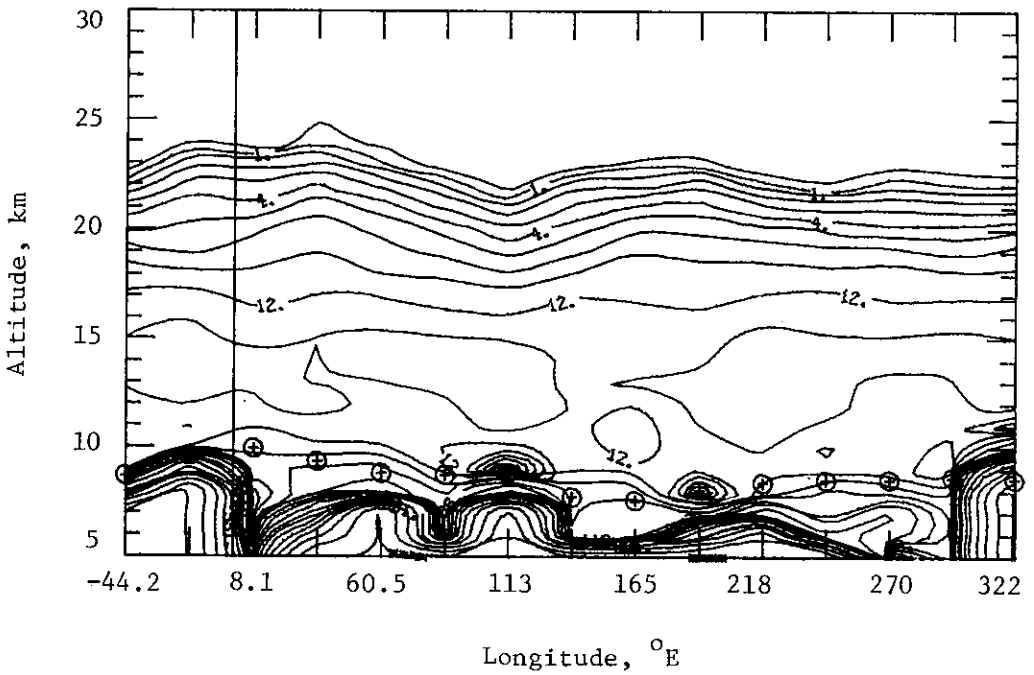



(a) Extinction isopleth.

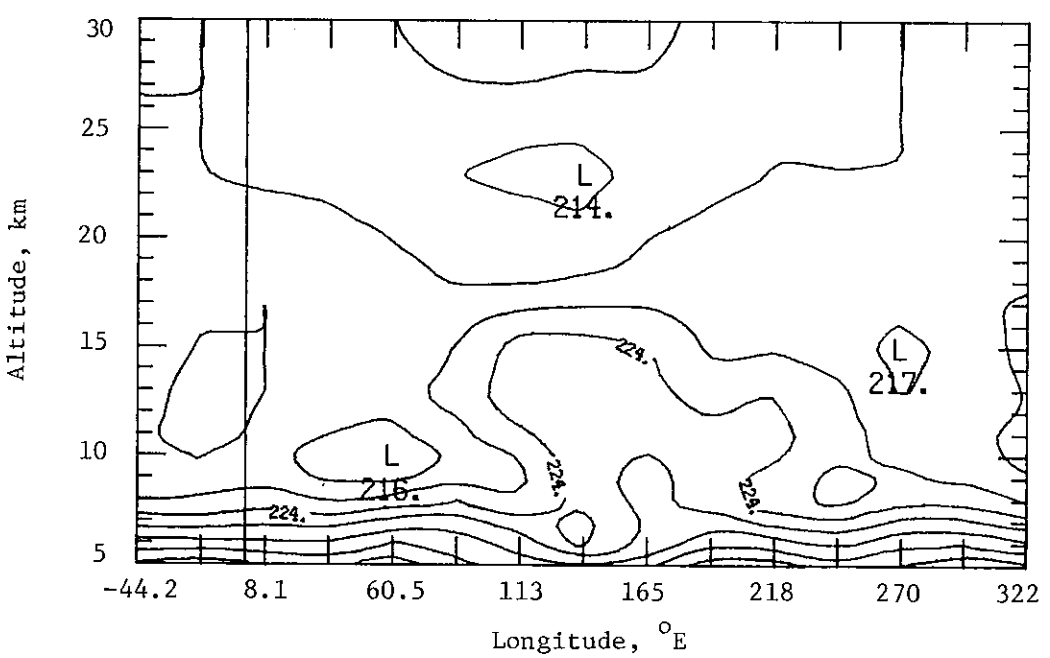



(b) Temperature contours.

Figure 59.- Antarctic extinction isopleth and temperature contours for March 30.79 to 31.81, 1979, at a latitude of 78.3° S corresponding to orbits 2178 to 2192.

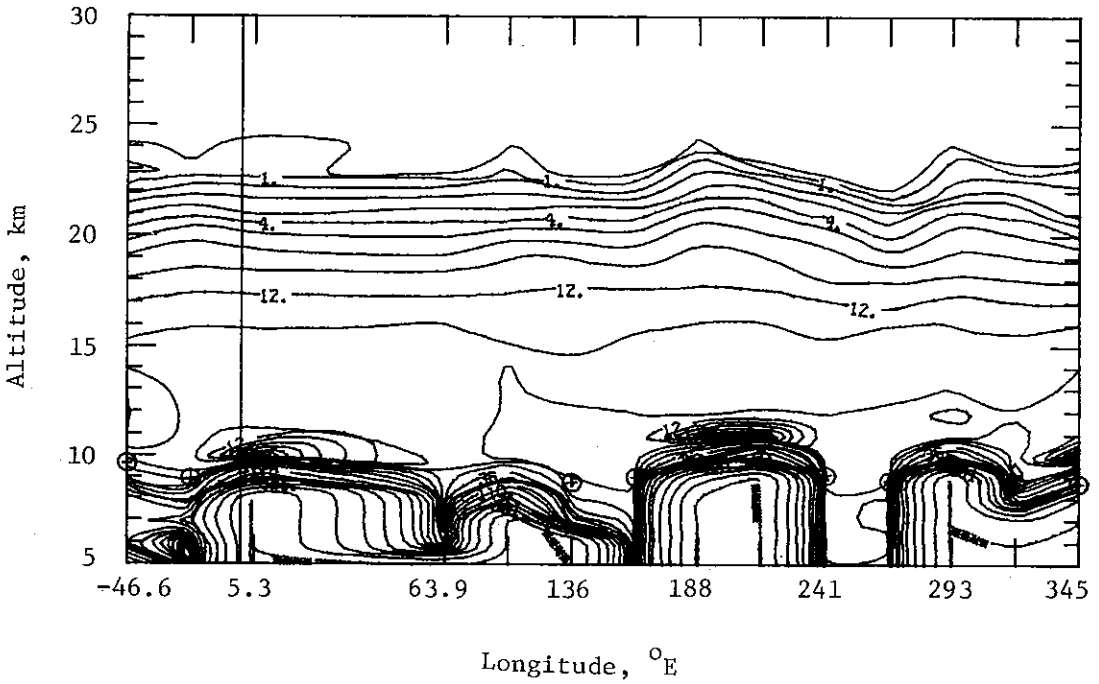



(a) Extinction isopleth.

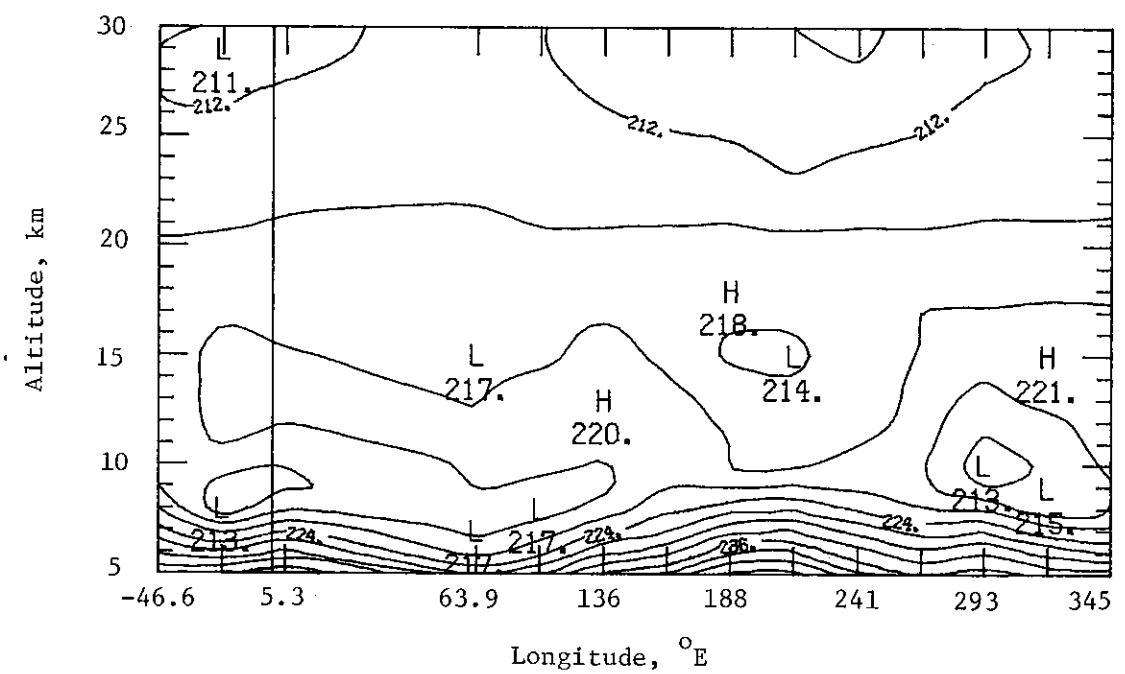



(b) Temperature contours.

Figure 60.- Antarctic extinction isopleth and temperature contours for April 4.79 to 5.80, 1979, at latitudes from 77.8° to 77.7° S corresponding to orbits 2247 to 2261.

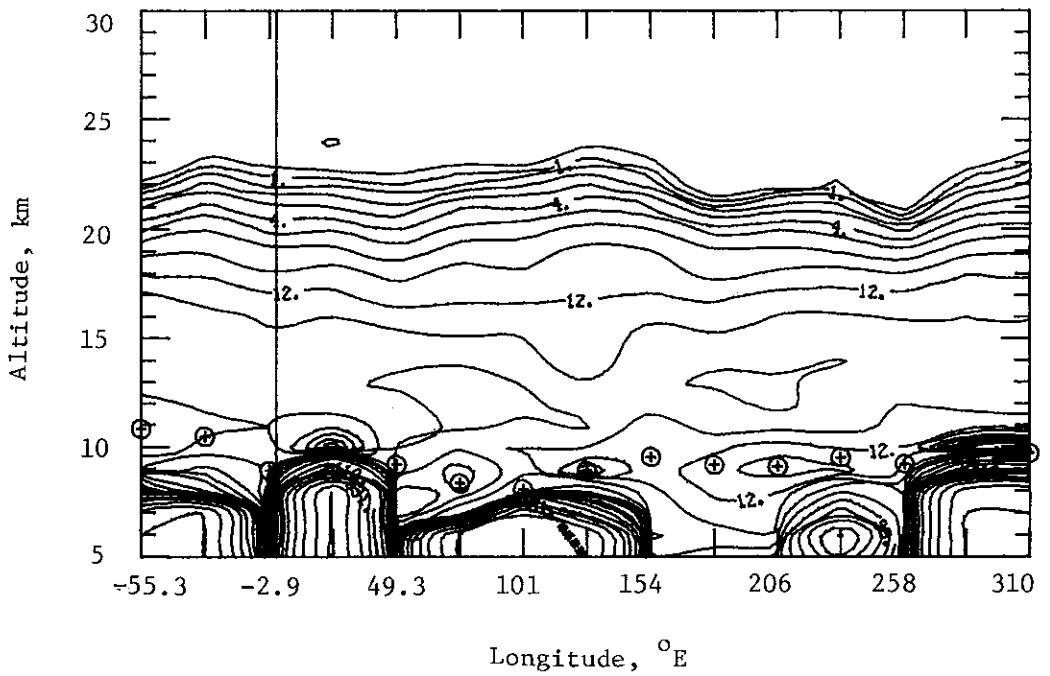



(a) Extinction isopleth.

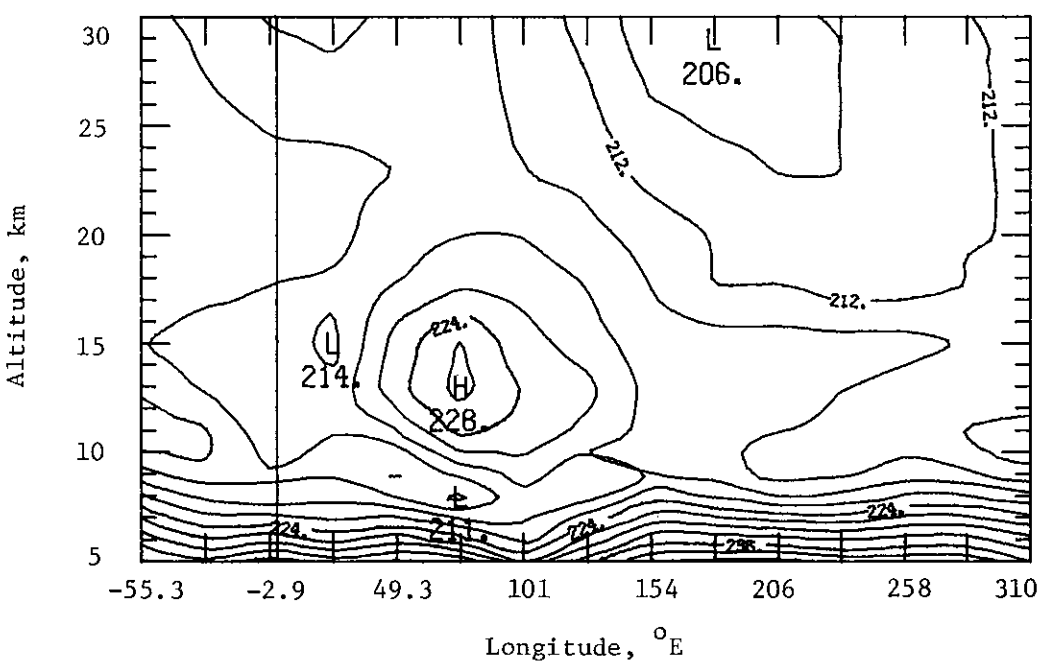



(b) Temperature contours.

Figure 61.- Antarctic extinction isopleth and temperature contours for April 13.69 to 14.77, 1979, at latitudes from 76.2° to 76.0° S corresponding to orbits 2370 to 2385.

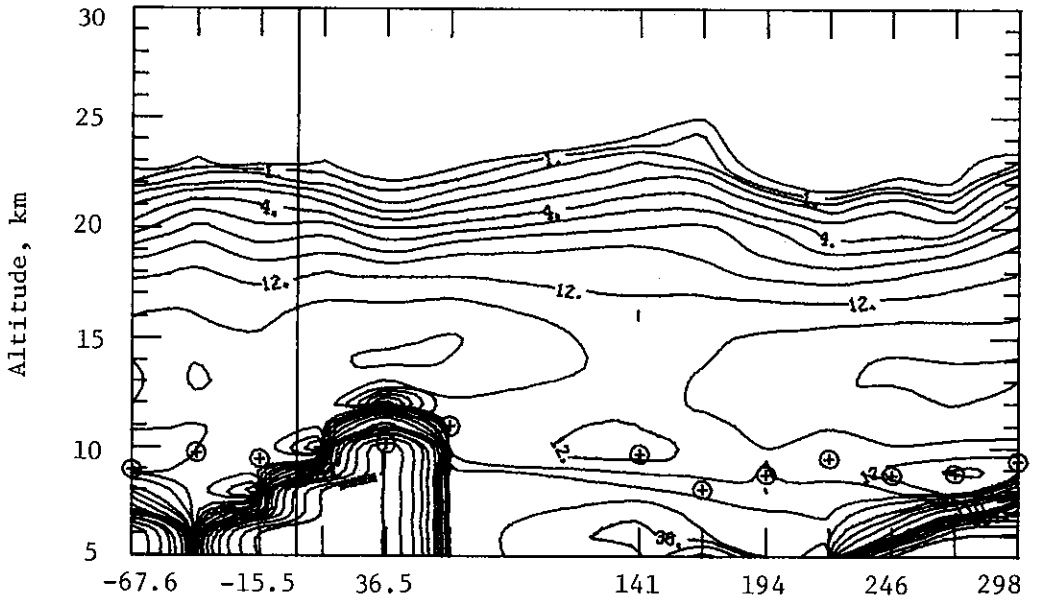



(a) Extinction isopleth.

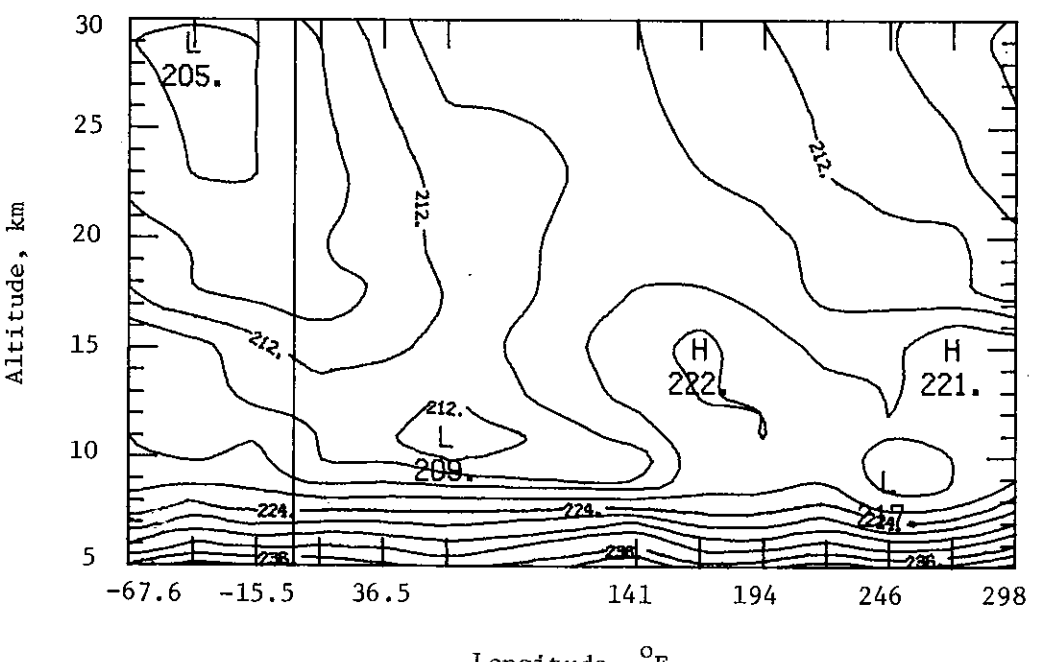



(b) Temperature contours.

Figure 62.- Antarctic extinction isopleth and temperature contours for April 19.76 to 20.78, 1979, at latitudes from 74.9° to 74.6° S corresponding to orbits 2454 to 2468.

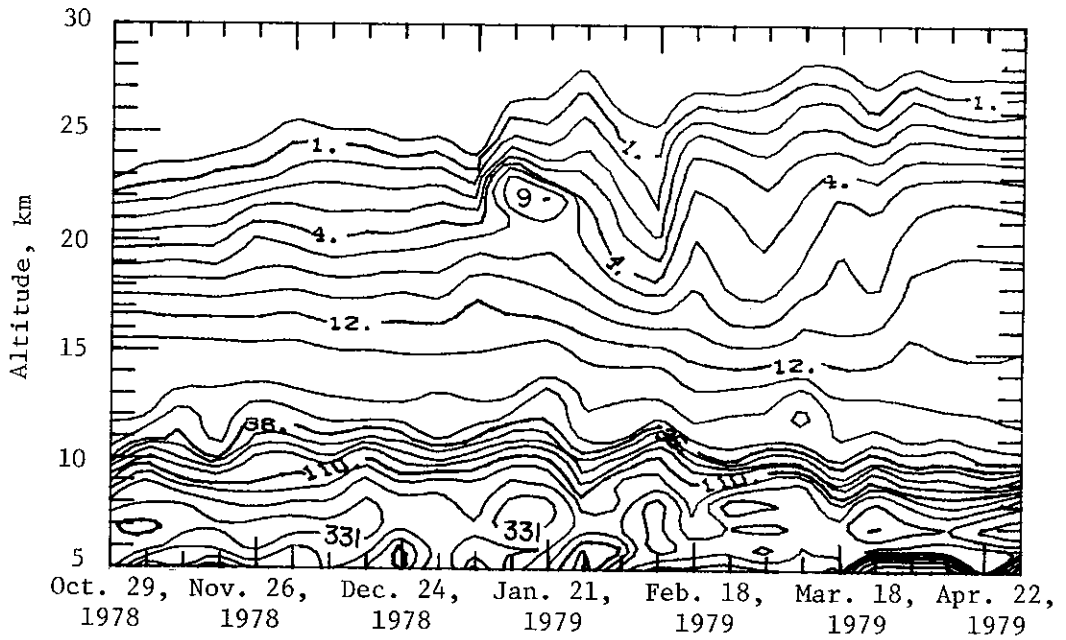



(a) Extinction isopleth.

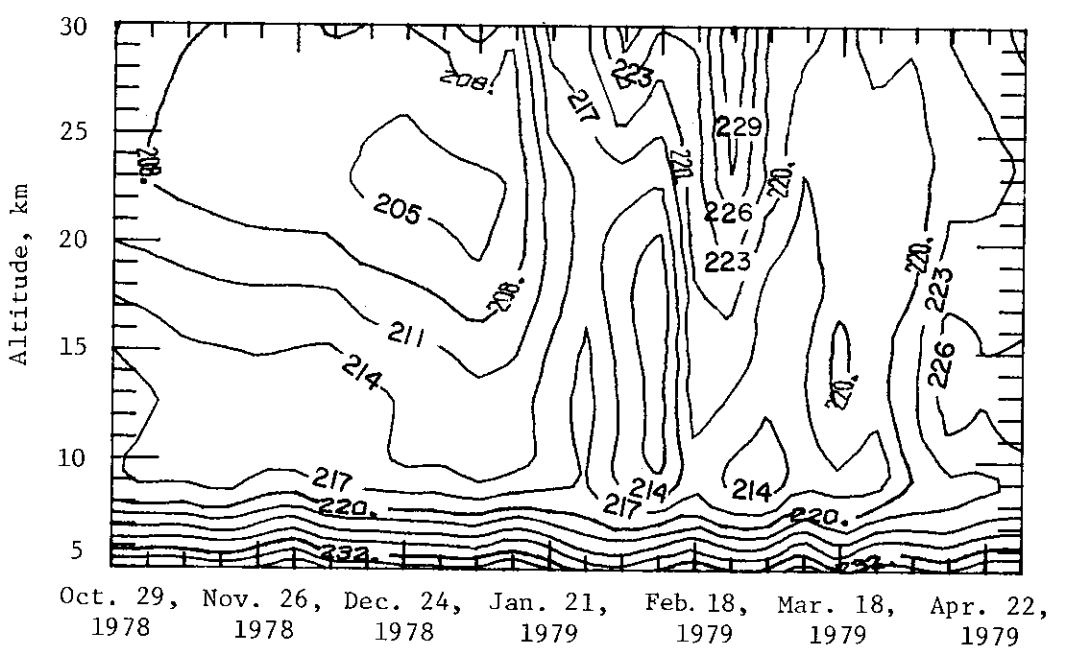



(b) Temperature contours.

Figure 63.- Antarctic extinction isopleth and temperature contours for April 26.78 to 27.79, 1979, at latitudes from 73.2° to 72.9° S corresponding to orbits 2551 to 2565.

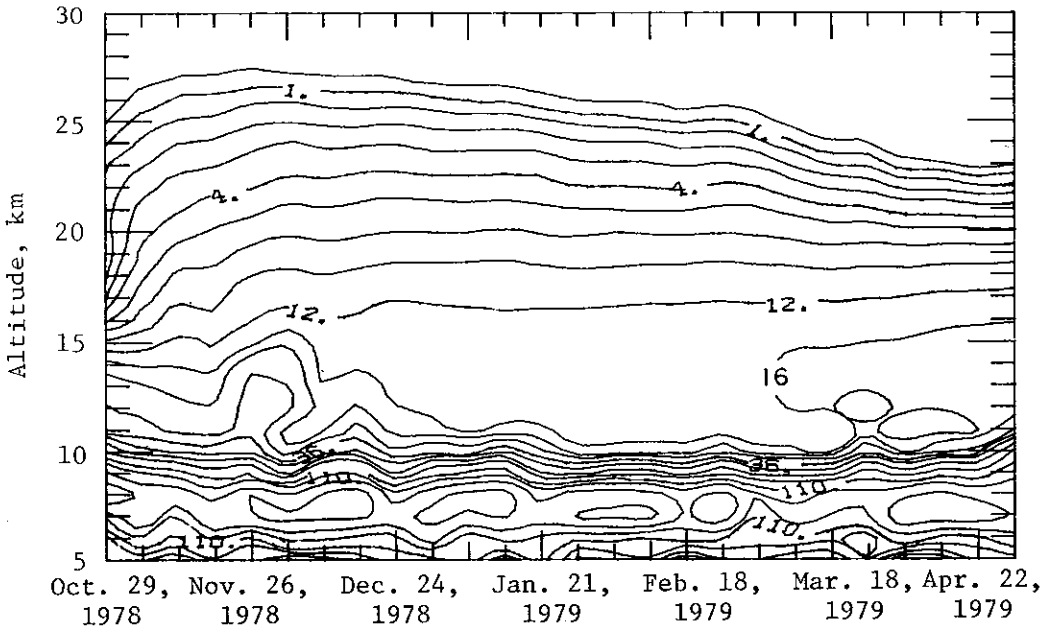



(a) Aerosol extinction at 1 μm in units of $10^{-5}$ $km^{-1}$.

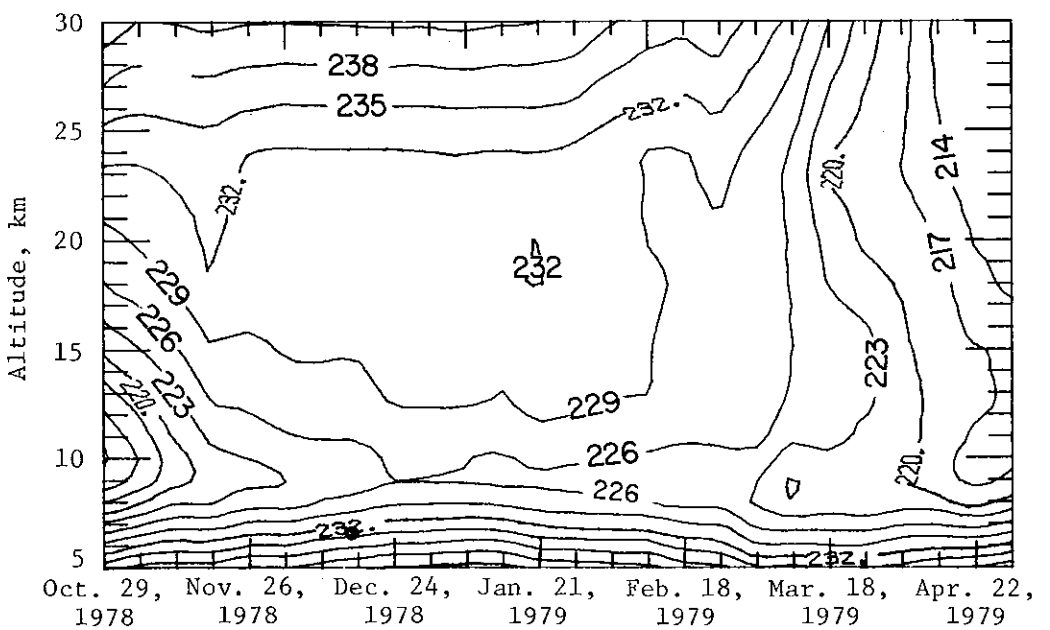



(b) Temperature field in kelvin at location of aerosol measurement.

Figure 64.- Arctic extinction and temperature data showing weekly averaged values. The date marked on the horizontal axis is the first day of the week to which average value corresponds.




(a) Aerosol extinction at 1 μm in units of $10^{-5}$ $km^{-1}$.




(b) Temperature field in kelvin at location of aerosol measurement.

Figure 65.- Antarctic extinction and temperature data showing weekly averaged values. The date marked on the horizontal axis is the first day of the week to which average value corresponds.

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15. Supplementary Notes

16. Abstract

The Stratospheric Aerosol Measurement (SAM) II sensor is flying aboard the Earth-orbiting Nimbus 7 spacecraft providing extinction measurements of the Antarctic and Arctic stratospheric aerosol with a vertical resolution of 1 km. This report presents representative examples and weekly averages of these aerosol data as well as corresponding temperature profiles provided by the National Meteorological Center of the National Oceanic and Atmospheric Administration (NOAA) for the time and place of each SAM II measurement during the first 6 months of satellite flight, October 29, 1978, to April 29, 1979. From the aerosol extinction-profile data, contours of aerosol extinction as a function of altitude and longitude or time are plotted. Also, aerosol optical depths are calculated for each week. Seasonal variations and variations in space (altitude and longitude) for both polar regions are easily seen. Typical values of aerosol extinction at the SAM II wavelength of 1.0 μm for this time period are 1 to 3 × $10^{-4}$ $km^{-1}$ in the main stratospheric aerosol layer. Optical depths for the stratosphere are about 0.002. Polar stratospheric clouds at altitudes of about 22 km were observed during the Arctic winter at various times and locations. No attempt has been made in this report to give any detailed explanations or interpretations of these data. The intent of this report is to provide, in a ready-to-use format, a representative sample of the first 6 months of data to be used in atmospheric and climatic studies.

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