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# SAM II Measurements of the Polar Stratospheric Aerosol

*Volume IX—October 1982 to April 1983*

L. R. McMaster
and K. A. Powell

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# SAM II Measurements of the Polar Stratospheric Aerosol

*Volume IX—October 1982 to April 1983*

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Space Administration
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## Preface

This is the ninth in a series of reports presenting results obtained from the Stratospheric Aerosol Measurement (SAM) II sensor aboard the Nimbus 7 spacecraft. The first 6 months of data were previously reported by McCormick in NASA Reference Publication 1081 entitled "SAM II Measurements of the Polar Stratospheric Aerosol, Volume I—October 1978 to April 1979." Similarly, the data processed through October 1982 have been published in NASA Reference Publications as listed below. Each report contains 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 after 11 years of operation. This report includes data from October 1982 to April 1983. It is intended for future reports to cover subsequent consecutive 6-month time periods.

| SAM II data reference publications | | | |
|---|---|---|---|
| Volume | Time period covered | NASA reference | Publication date |
| I | October 1978–April 1979 | RP-1081 | December 1981 |
| II | April 1979–October 1979 | RP-1088 | March 1982 |
| III | October 1979–April 1980 | RP-1106 | June 1983 |
| IV | April 1980–October 1980 | RP-1107 | June 1983 |
| V | October 1980–April 1981 | RP-1140 | May 1985 |
| VI | April 1981–October 1981 | RP-1141 | May 1985 |
| VII | October 1981–April 1982 | RP-1164 | August 1986 |
| VIII | April 1982–October 1982 | RP-1165 | August 1986 |

All the SAM II data and data products are being archived on magnetic tape at the National Space Sciences Data Center (NSSDC), NASA Goddard Space Flight Center, Greenbelt, Maryland 20771. These products are available to interested researchers and instructions for requesting them are provided. Because of the large volume of data retrieved by the SAM II system, however, it is impossible to present all 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. Many scientific investigations have been conducted using these data and a representative listing of references is provided; however, no attempt has been made in this report to provide any scientific analysis with the data set.

The authors wish to recognize the SAM II Science Team consisting of G. W. Grams, Georgia Institute of Technology; B. M. Herman, University of Arizona; T. J. Pepin, University of Wyoming; P. B. Russell, NASA Ames Research Center; M. P. McCormick, NASA Langley Research Center (LaRC); and the LaRC SAM II Data Processing Team whose dedicated efforts provided these high-quality data.

## Contents

## Summary

The Stratospheric Aerosol Measurement (SAM) II sensor is aboard the Earth-orbiting Nimbus 7 spacecraft and provides extinction measurements of the Arctic and Antarctic stratospheric aerosols with a vertical resolution of 1 km. The 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 ninth 6-month period of satellite operation, October 24, 1982, to April 23, 1983. 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 and spatial (altitude and longitude) variations are easily seen in both regions. The eruptions of El Chichon in Mexico in March to early April 1982 dramatically increased the stratospheric aerosol loading in both polar regions during this time period. Typical values of aerosol extinction at the SAM II wavelength of 1.0 $\mu$m in the main lower stratospheric aerosol layer increased from about 0.005 km$^{-1}$ to greater than 0.01 km$^{-1}$ for the Arctic region and from about 0.002 to 0.005 km$^{-1}$ for the Antarctic region. Stratospheric optical depths increased from about 0.019 to 0.068 for the Arctic region and from about 0.002 to 0.021 for the Antarctic region. Volcanic material from El Chichon, injected into the stratosphere at low latitudes, moved into the Arctic region during the fall of 1982. Maximum aerosol loading in the Arctic region was obtained in late March 1983 after the breakup of the northern polar vortex. In the Antarctic region, remnants of El Chichon were detected in November 1982 after the breakup of the southern polar vortex. Maximum aerosol loading in the Antarctic region was obtained in January 1983 but was not nearly as great as that detected in the northern hemisphere. Polar stratospheric clouds (PSC's) at altitudes of about 20 km would normally be observed during the Arctic winter but are obscured during this time period because of the volcanic debris of El Chichon. 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, representative samples of the ninth 6-month period of data to be used in atmospheric and climatic studies.

## Introduction

The SAM II instrument is aboard the Earth-orbiting Nimbus 7 spacecraft and is designed to measure solar irradiance 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 polar aerosol climatology. This data base will allow for studies of aerosol changes due to seasonal and short-term meteorological variations, atmospheric chemistry, cloud microphysics, and volcanic activity and other perturbations. The results obtained will be useful in a number of applications, particularly the evaluation of any potential climatic effect caused by stratospheric aerosols.

## SAM II Instrument

The SAM II instrument consists of a single-channel Sun photometer with a 0.04-$\mu$m passband centered at a wavelength of 1.0 $\mu$m. This is a region of the spectrum where absorption by atmospheric gases is negligible; consequently, any attenuation of sunlight 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 $\pm 0.03°$ in azimuth (left and right). A mirror begins a rapid vertical scan until the Sun's image is acquired by the SAM II telescope. The mirror then slowly scans vertically across the Sun at a rate of 0.25 degree per second reversing itself each time a Sun-limb crossing occurs. The entrance window to the SAM II telescope only passes sunlight of wavelengths greater than 0.9 $\mu$m. A circular aperture placed at the image plane serves to define the instantaneous field of view of the instrument to be 0.5 minute 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-$\mu$m-wavelength ($\pm 0.02$ $\mu$m) passband, to a photodiode detector. The solar intensity as a function of time is digitized, recorded, and periodically telemetered back to Earth. A description of the SAM II instrument, and of the experiment in general, is given by McCormick et al. in reference 1.

## 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 frequency 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. There is a measurement opportunity for the SAM II each time that the satellite enters into or emerges from the Earth's shadow. Consequently, the instrument takes data during approximately 14 sunrises and 14 sunsets each Earth day. Nimbus 7 is in a high-noon, Sun-synchronous orbit; that is, the satellite crosses the Equator during each orbit at local noon. In general terms, this means that the orbital plane of the satellite is fixed with respect to the Sun, and thus all sunsets occur in the Arctic region and 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 Arctic region and similarly for the Antarctic region. All the points obtained during 1 day in a given region 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° each week, gradually sweeping out the area from 64° to 80°. Figure 1 shows this latitude coverage for the period covered by this report. The 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 spatially 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 on the order of 5000.

## Data Products

The SAM II satellite data are processed after being telemetered to the ground, with the data on solar intensity versus time being mathematically inverted to yield extinction coefficient versus altitude (extinction profile) for each sunrise or sunset event. The mathematical inversion used is described by Chu and McCormick in reference 2.

The basic data product, therefore, is the extinction profile obtained during each measurement opportunity, which can be analyzed to determine the spatial and temporal variations in the upper tropospheric and stratospheric aerosol. These extinction data are archived at the National Space Sciences Data Center (NSSDC) on magnetic tapes after being subjected to an extensive validation program including comparisons with correlative aerosol observations (refs. 3–6). A detailed description of the archived data products is given in the SAM II user's guide (ref. 7).

This report presents a portion of these data. Specifically, it contains the following data for the ninth 6-month period of operation: weekly averages of SAM II extinction profiles; a 1-day sample for each week of aerosol extinction and temperature contours as a function of altitude and longitude (referred to as "isopleths"); 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. Therefore, it was decided instead to present 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. 8). 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 2–11. The temperatures at given pressure levels of 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, and 10 millibars (where 1 millibar = 100 Pa) are provided by NOAA for each SAM II measurement. These temperatures are averaged to give a temperature at each pressure level and are 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. During this time period, the extinction profiles for both polar regions show very high values. This is primarily due to the March to early April 1982 eruptions of El Chichon (17.3°N, 93.2°W). Aerosol extinction values in the Arctic region ranging from $0.5 \times 10^{-2}$ to $0.8 \times 10^{-2}$ km$^{-1}$ are shown in figures 2 and 3; and aerosol extinction values greater than $1.0 \times 10^{-2}$ km$^{-1}$, when maximum aerosol loading was obtained, are shown in figures 4–6. Aerosol extinction values in the Antarctic region ranging from

$2 \times 10^{-3}$ to $3 \times 10^{-3}$ km$^{-1}$ are shown in figure 7; values ranging from $0.3 \times 10^{-2}$ km$^{-1}$ to greater than $1.0 \times 10^{-2}$ km$^{-1}$, when maximum values were obtained, are shown in figure 8; and values ranging from $4 \times 10^{-3}$ to $5 \times 10^{-3}$ km$^{-1}$ are shown in figures 9–11. Polar stratospheric clouds (PSC's) which exist in both polar regions during the winter months, often form at altitudes between 15 and 25 km with the occurrence of low temperatures. During the specific time period covered in this paper, the detection of PSC's was obscured because of the high background (ambient) aerosol loading produced by El Chichon. PSC's are described in detail by McCormick et al. in references 9–11.

## Extinction Isopleths

Figures 12–63 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 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 the isopleths obtained are not presented. Instead, a representative day from each week has been selected for presentation. Dates and time are indicated in the legends as a decimal fraction of the day. (For example, April 28.09 means 2:10 a.m. on April 28.) The values labeled on the extinction isopleths are scaled by $10^5$, and the value of the $k$th 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$^{-1}$. The plotting routine 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 longitudes of the individual profile measurements that were used to form the isopleth. The vertical line indicates the prime meridian (0° E). The dashed line extends through the lowest altitude location point of each profile measurement. The tropopause height, when available, is indicated with a circle containing a plus sign ($\oplus$). 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 labeled in kelvins and are separated by 3 K. Local minimum (low) values are marked with an "L" and maximum (high) values with an "H." Figures 12–37 show the Arctic measurements and figures 38–63 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 spatial density of measurements in a short time interval, thus allowing such plots to be made. For example, plots generated during the period when the north polar vortex is intact show aerosol extinction values above 18 km to be lower inside the vortex than extinction values outside the vortex. (See fig. 26.) This phenomenon is discussed in greater detail in references 12 and 13. The figures can also be used to observe the correlations that exist between the aerosol extinction and temperature. During this time period, and under normal conditions, the presence of PSC's in the Arctic region would be indicated in the plots by high aerosol extinction values corresponding to very low temperatures at approximately 20 km. However, PSC's existing during this time period were obscured by the volcanic remnants of El Chichon and were not easily identified (ref. 14).

## 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 extinction value can be regarded as a zonal mean since the latitude variation is only about 1 degree per week, and measurements made during each week span 360° longitude. 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 shows the Arctic region and figure 65 shows the Antarctic region. Further descriptions and analyses of these plots are found in reference 15 by McCormick et al.

## Optical Depth

Tables I and II contain weekly averaged values of the stratospheric optical depth for the Arctic and Antarctic measurements. The values are obtained by first integrating the extinction profile from 2 km above the tropopause to 30 km. If the lowest altitude at which extinction data are available is higher than 2 km above the tropopause, then the extinction profile is integrated from that minimum altitude to 30 km. All optical-depth values so obtained during a given week are then averaged, and the average values are presented in the tables for each week of the period covered by this report. During this time period of high stratospheric loading from El Chichon, there were many instances when the dynamic range of the SAM II instrument was exceeded at altitudes above the tropopause plus 2 km. Thus, these weekly average optical-depth values should be viewed as minimum values. Also included in the tables are the average latitude of the SAM II measurements and the average tropopause height for each week.

## Data Availability and Use

This series of reports is intended to provide an easy-to-use visual format for use in atmospheric and climatic studies as well as to provide an introduction to the full data set. The archived aerosol extinction data can be requested on magnetic tape directly from the National Space Sciences Data Center, NASA Goddard Space Flight Center, Mail Code 633, Greenbelt, Maryland 20771. (Foreign requests should be sent to Mail Code 630.2.) Each request should specify the experimental data desired and the time period of interest. The SAM II aerosol extinction data are on Beta and Aerosol Number Density Archive Tape (BANAT), I.D. No. 78-098A-06B, each containing a month's data. Examples of the use of these data to study the polar atmosphere include the use of aerosols as tracers of atmospheric dynamics (refs. 12 and 13), the effect of stratospheric warmings on aerosol behavior (refs. 16 and 17), the effect of volcanic eruptions on aerosol loading (ref. 18), the variability of aerosols in the free troposphere (ref. 19), the discovery and quantification of PSC's (ref. 9), and the correlation of PSC's with Antarctic springtime ozone depletion (refs. 20–22). It is also intended that future SAM II data will be summarized and published in reports using this same format.

## Concluding Remarks

This report has presented a representative sample and summaries of data from the ninth 6-month period of operation (October 24, 1982, to April 23, 1983) of the Stratospheric Aerosol Measurement (SAM) II instrument. 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 and temperature 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, isotherms, or tropopause height.

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Table I. Average Optical Depth for Arctic Region

| Week beginning— | Average latitude, °N | Average tropopause height, km | Average optical depth measured from tropopause plus 2 km |
|---|---|---|---|
| Oct. 24, 1982 | 73.9 | 9.03 | $2140.8 \times 10^{-5}$ |
| Oct. 31, 1982 | 71.9 | 9.61 | 1909.3 |
| Nov. 07, 1982 | 70.1 | 8.97 | 2409.6 |
| Nov. 14, 1982 | 68.5 | 8.82 | 3546.6 |
| Nov. 21, 1982 | 67.2 | 9.21 | 2675.4 |
| Nov. 28, 1982 | 66.1 | 9.07 | 3464.7 |
| Dec. 05, 1982 | 65.3 | 9.34 | 4000.0 |
| Dec. 12, 1982 | 64.8 | 9.07 | 3871.8 |
| Dec. 19, 1982 | 64.7 | 9.24 | 4367.3 |
| Dec. 26, 1982 | 64.9 | 9.05 | 4684.2 |
| Jan. 02, 1983 | 65.5 | 9.13 | 4457.3 |
| Jan. 09, 1983 | 66.4 | 9.36 | 4070.1 |
| Jan. 16, 1983 | 67.6 | 9.71 | 4768.0 |
| Jan. 23, 1983 | 69.2 | 9.69 | 4761.0 |
| Jan. 30, 1983 | 71.0 | 9.45 | 3904.1 |
| Feb. 06, 1983 | 73.1 | 9.69 | 3962.6 |
| Feb. 13, 1983 | 75.2 | 9.12 | 5432.9 |
| Feb. 20, 1983 | 77.4 | 8.73 | 3536.5 |
| Feb. 27, 1983 | 79.5 | 9.30 | 4541.4 |
| Mar. 06, 1983 | 81.4 | 9.30 | 4188.3 |
| Mar. 13, 1983 | 82.6 | 8.66 | 4648.4 |
| Mar. 20, 1983 | 82.8 | 7.99 | 6232.7 |
| Mar. 27, 1983 | 82.0 | 7.34 | 6756.3 |
| Apr. 03, 1983 | 80.5 | 7.25 | 5889.1 |
| Apr. 10, 1983 | 78.6 | 7.96 | 5570.3 |
| Apr. 17, 1983 | 76.5 | 8.02 | 5435.0 |

Table II. Average Optical Depth for Antarctic Region

| Week beginning— | Average latitude, °S | Average tropopause height, km | Average optical depth measured from tropopause plus 2 km |
|---|---|---|---|
| Oct. 24, 1982 | 75.4 | 10.16 | $190.9 \times 10^{-5}$ |
| Oct. 31, 1982 | 73.3 | 9.64 | 411.0 |
| Nov. 07, 1982 | 71.4 | 9.79 | 494.3 |
| Nov. 14, 1982 | 69.7 | 9.38 | 979.8 |
| Nov. 21, 1982 | 68.2 | 9.42 | 1278.2 |
| Nov. 28, 1982 | 66.9 | 9.17 | 1482.8 |
| Dec. 05, 1982 | 65.9 | 8.76 | 1570.6 |
| Dec. 12, 1982 | 65.2 | 8.84 | 2082.0 |
| Dec. 19, 1982 | 64.8 | 8.76 | 2027.8 |
| Dec. 26, 1982 | 64.7 | 8.86 | 2064.6 |
| Jan. 02, 1983 | 65.0 | 8.74 | 2188.0 |
| Jan. 09, 1983 | 65.6 | 8.89 | 2064.5 |
| Jan. 16, 1983 | 66.5 | 8.77 | 2096.7 |
| Jan. 23, 1983 | 67.6 | 8.74 | 2081.9 |
| Jan. 30, 1983 | 69.0 | 8.78 | 2115.4 |
| Feb. 06, 1983 | 70.6 | 8.73 | 2101.0 |
| Feb. 13, 1983 | 72.3 | 8.26 | 2080.7 |
| Feb. 20, 1983 | 74.0 | 7.86 | 1967.4 |
| Feb. 27, 1983 | 75.7 | 7.90 | 1947.6 |
| Mar. 06, 1983 | 77.1 | 8.14 | 1848.0 |
| Mar. 13, 1983 | 78.1 | 8.12 | 1869.4 |
| Mar. 20, 1983 | 78.5 | 8.10 | 1854.0 |
| Mar. 27, 1983 | 78.3 | 8.49 | 1943.8 |
| Apr. 03, 1983 | 77.4 | 8.09 | 1962.5 |
| Apr. 10, 1983 | 76.1 | 8.61 | 1818.8 |
| Apr. 17, 1983 | 74.5 | 8.69 | 1726.3 |

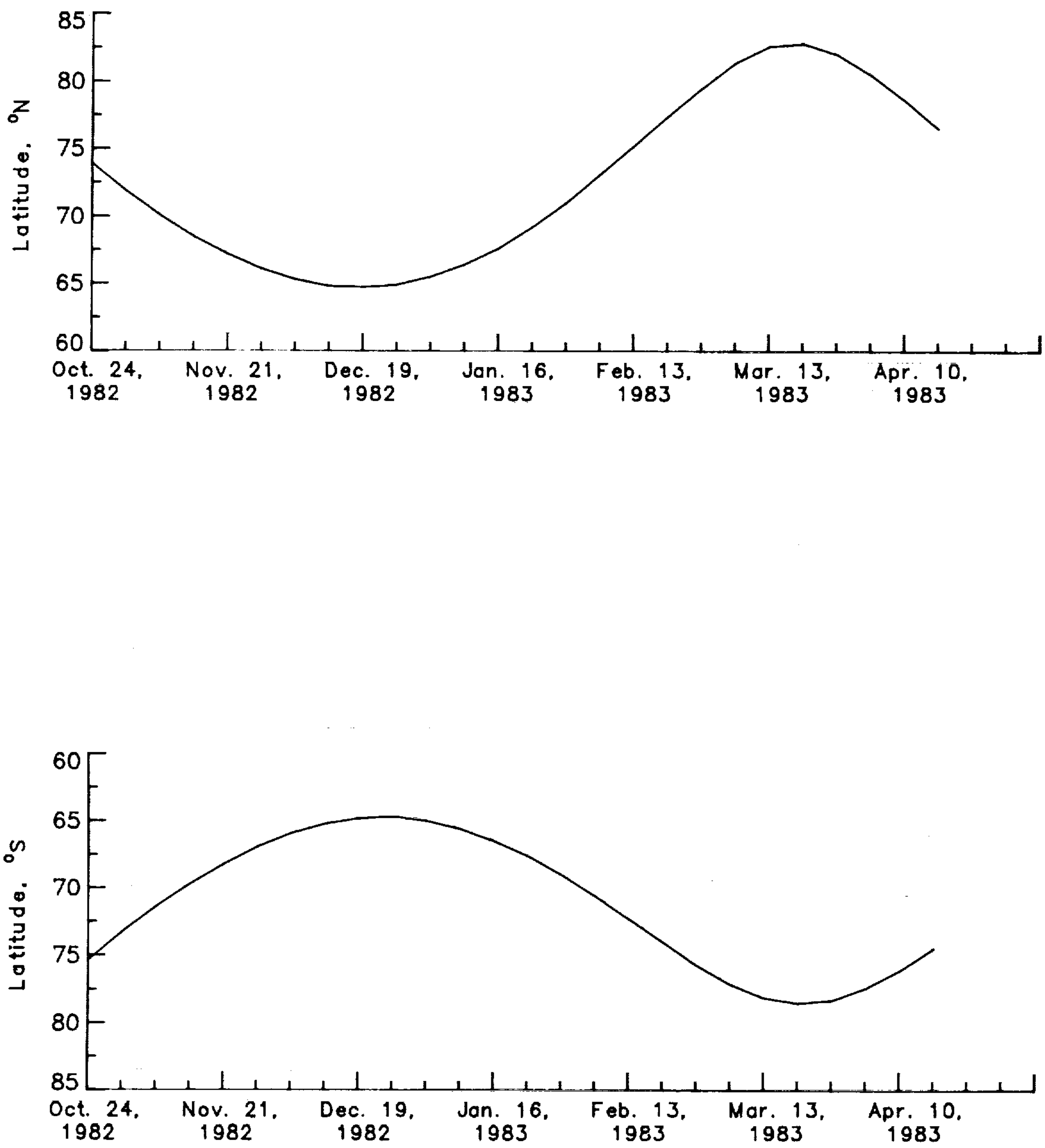



Figure 1. Latitude coverage of SAM II measurements for October 1982 to April 1983.

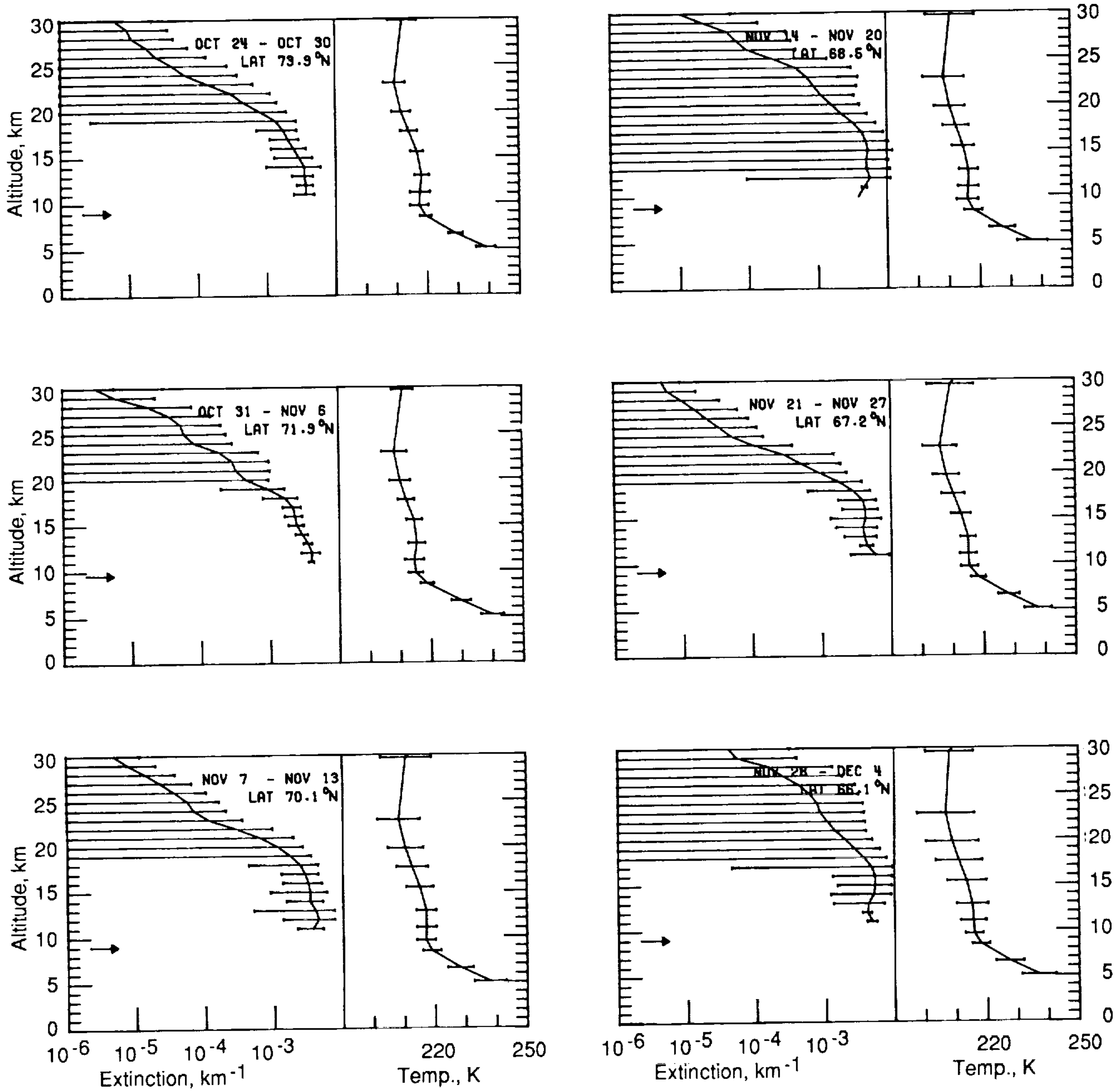



Figure 2. Arctic extinction and temperature profiles for October 24 to December 4, 1982.

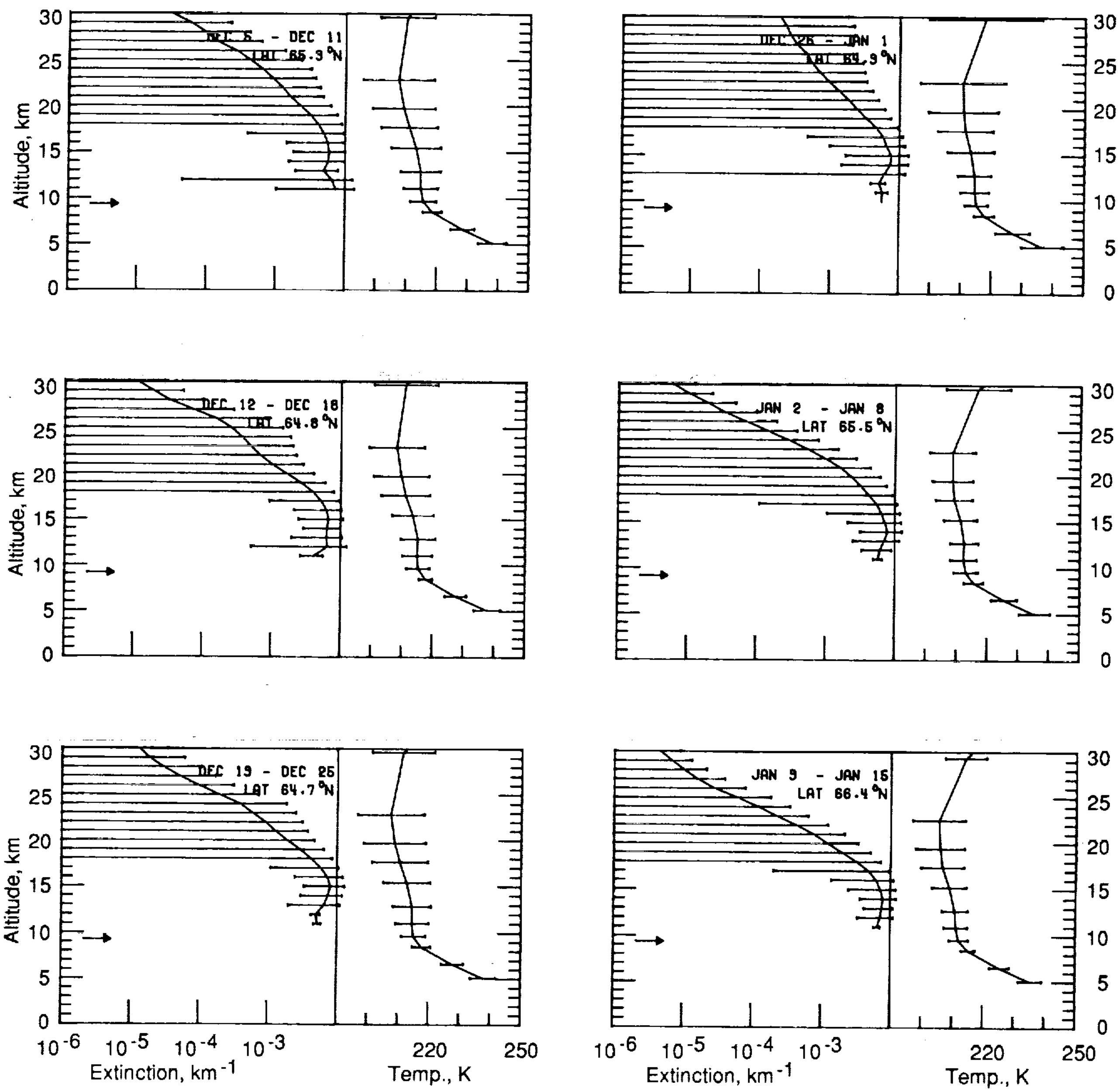



Figure 3. Arctic extinction and temperature profiles for December 5, 1982, to January 15, 1983.

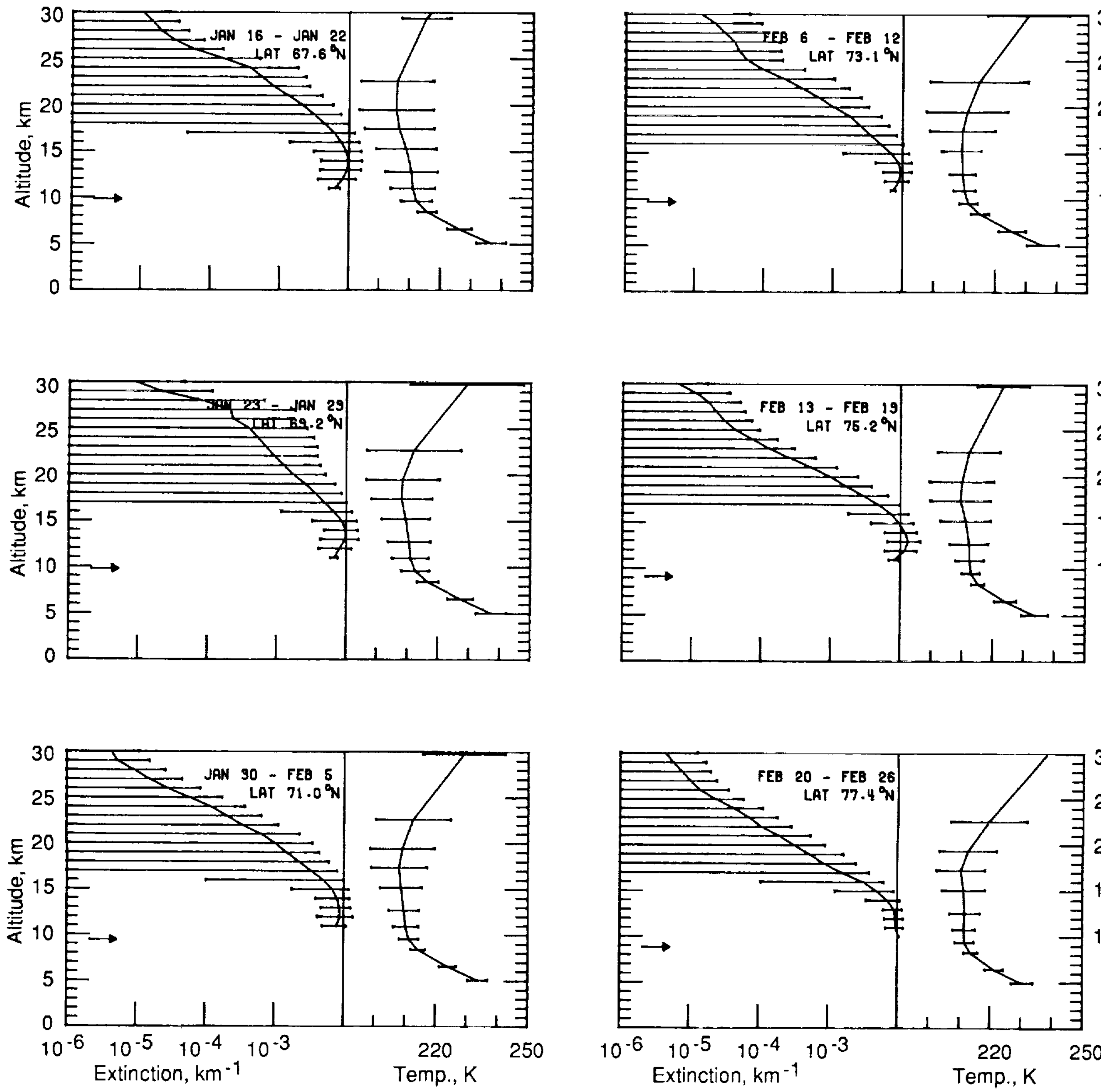



Figure 4. Arctic extinction and temperature profiles for January 16 to February 26, 1983.

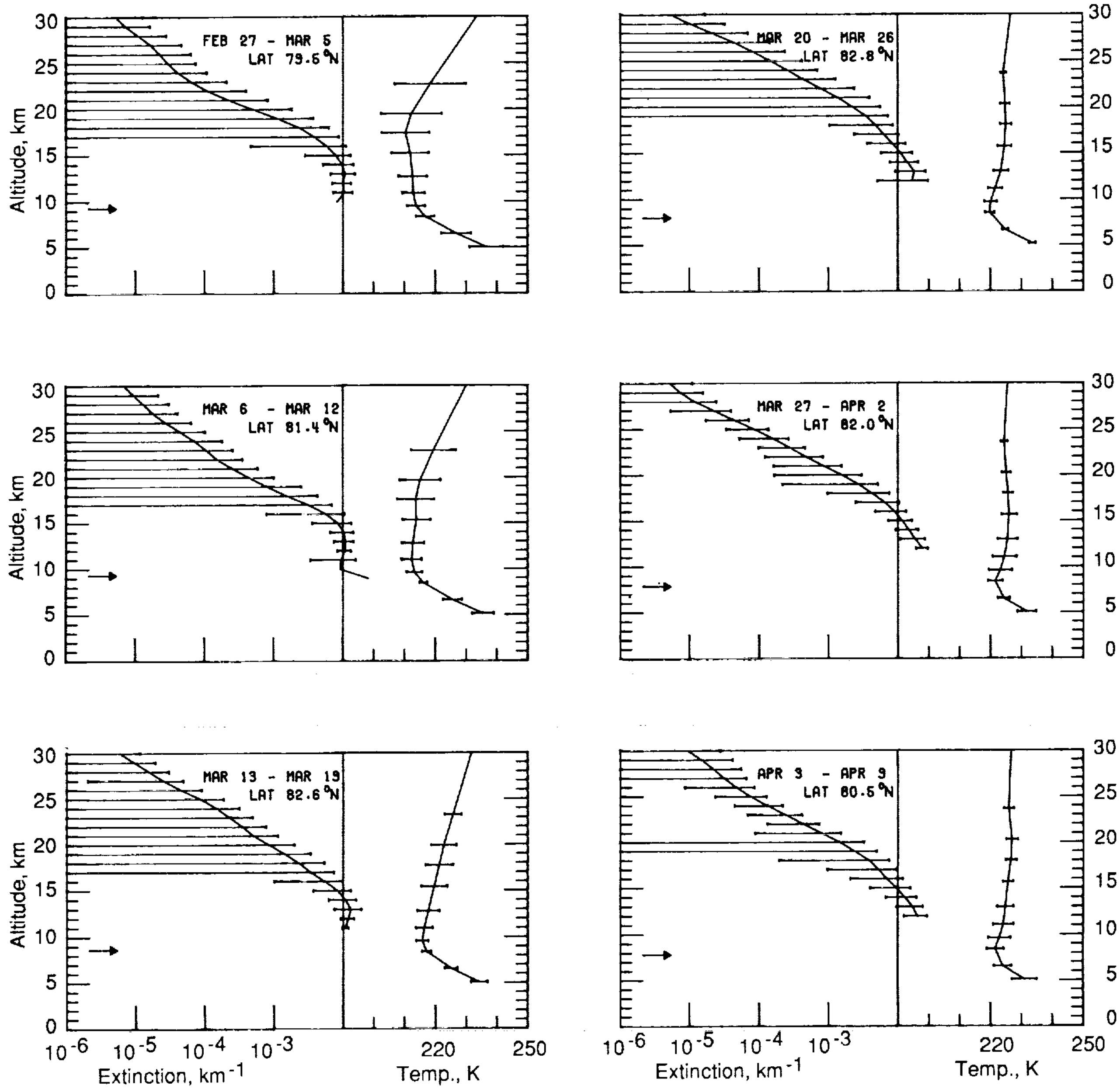



Figure 5. Arctic extinction and temperature profiles for February 27 to April 9, 1983.

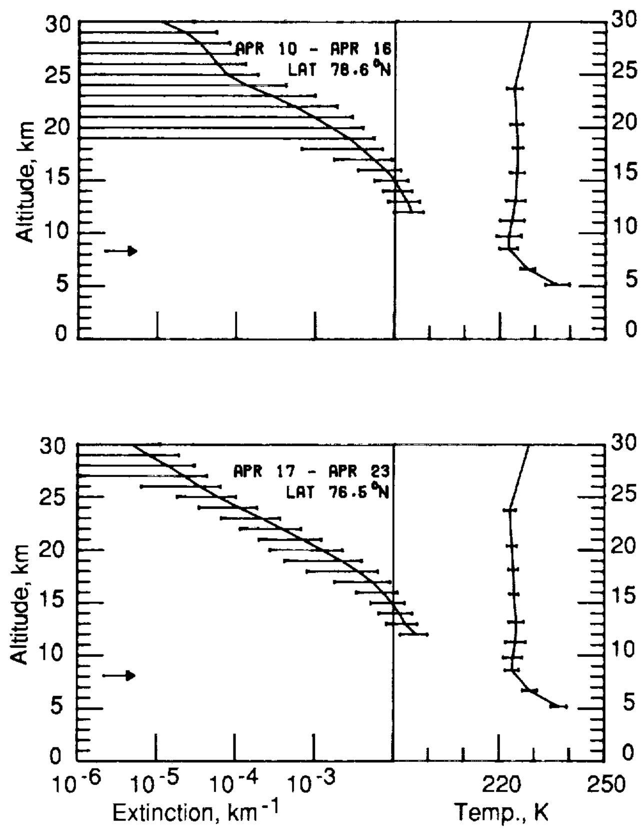



Figure 6. Arctic extinction and temperature profiles for April 10 to 23, 1983.

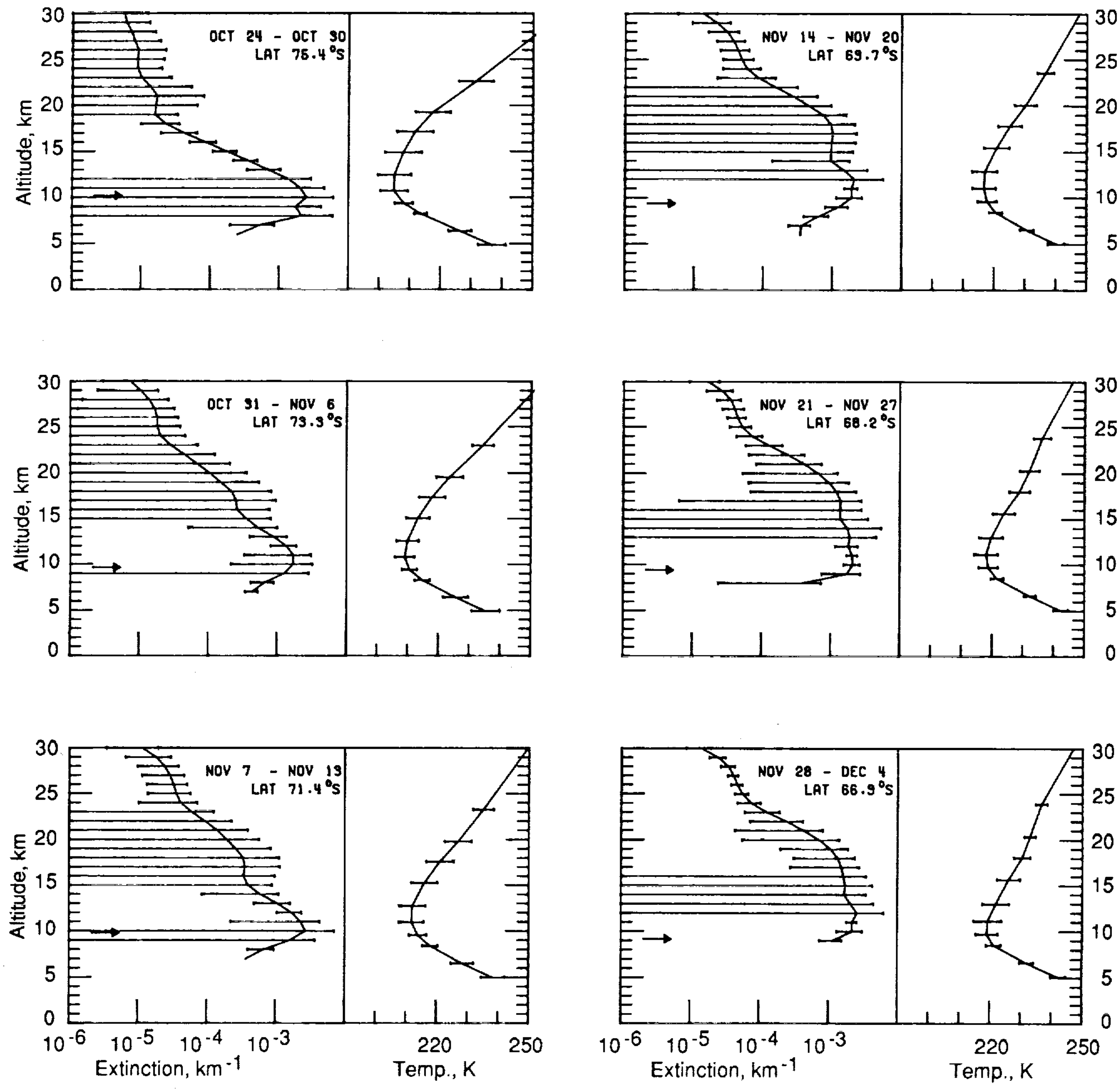



Figure 7. Antarctic extinction and temperature profiles for October 24 to December 4, 1982.

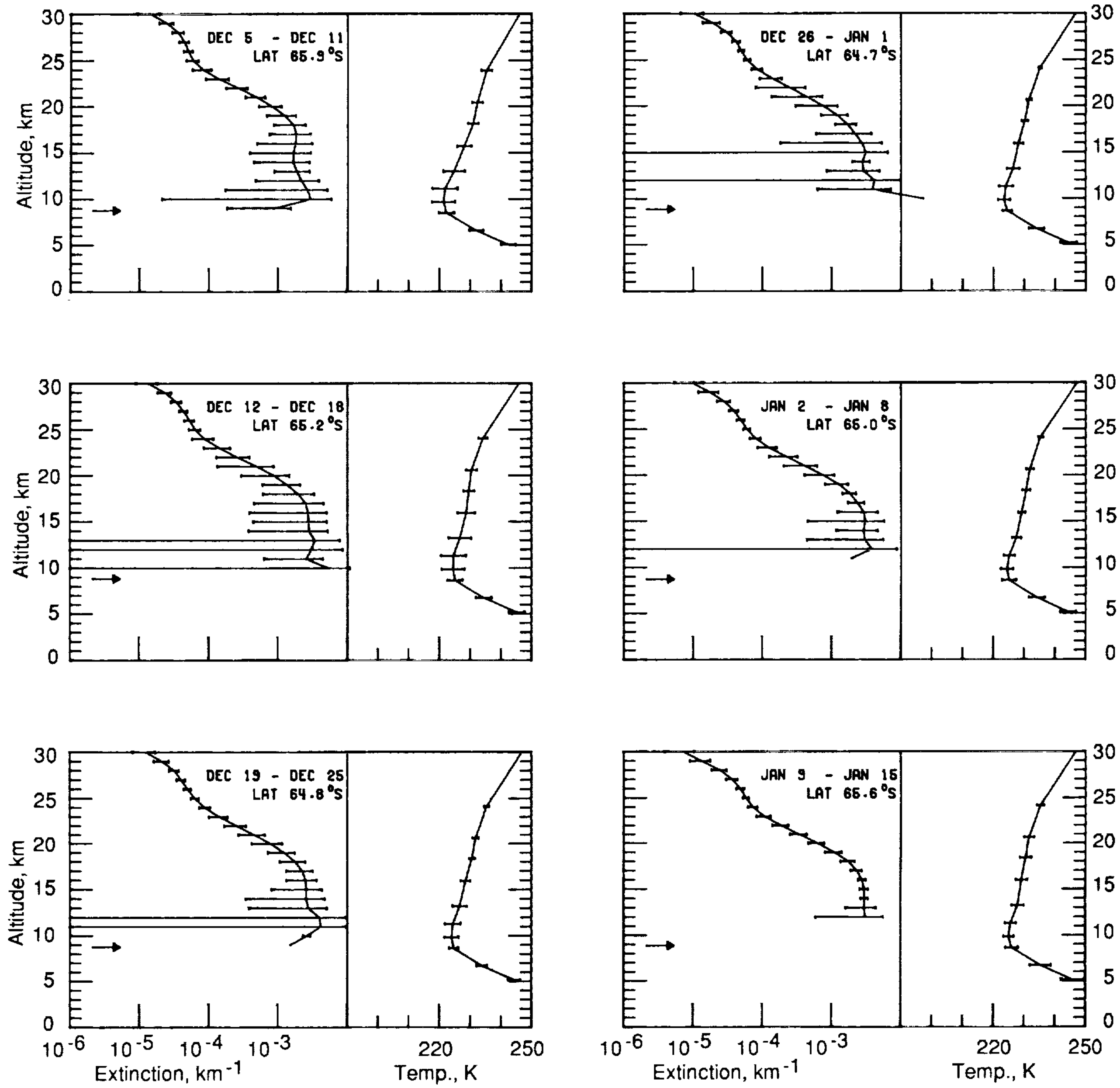



Figure 8. Antarctic extinction and temperature profiles for December 5, 1982, to January 15, 1983.

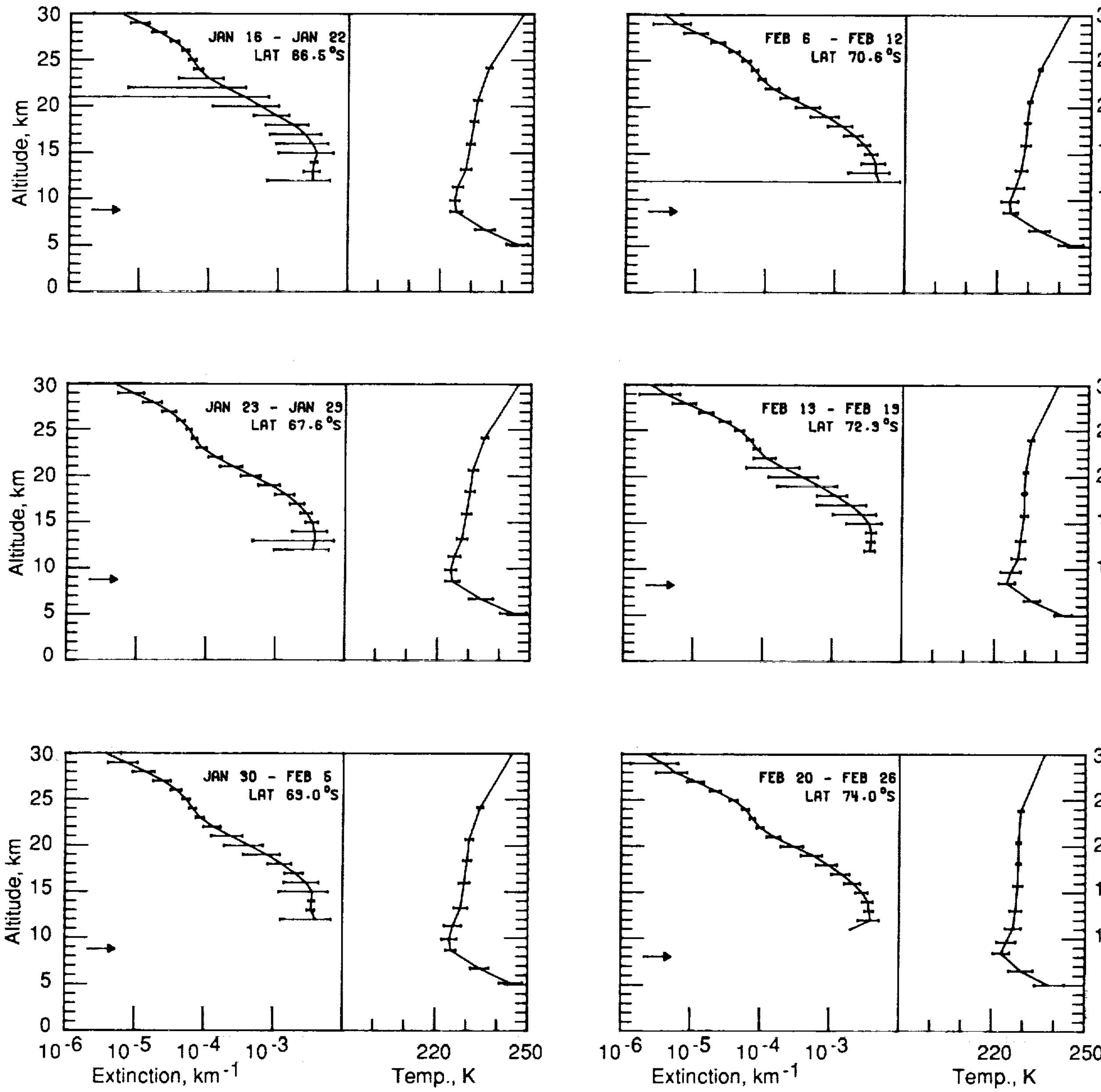



Figure 9. Antarctic extinction and temperature profiles for January 16 to February 26, 1983.

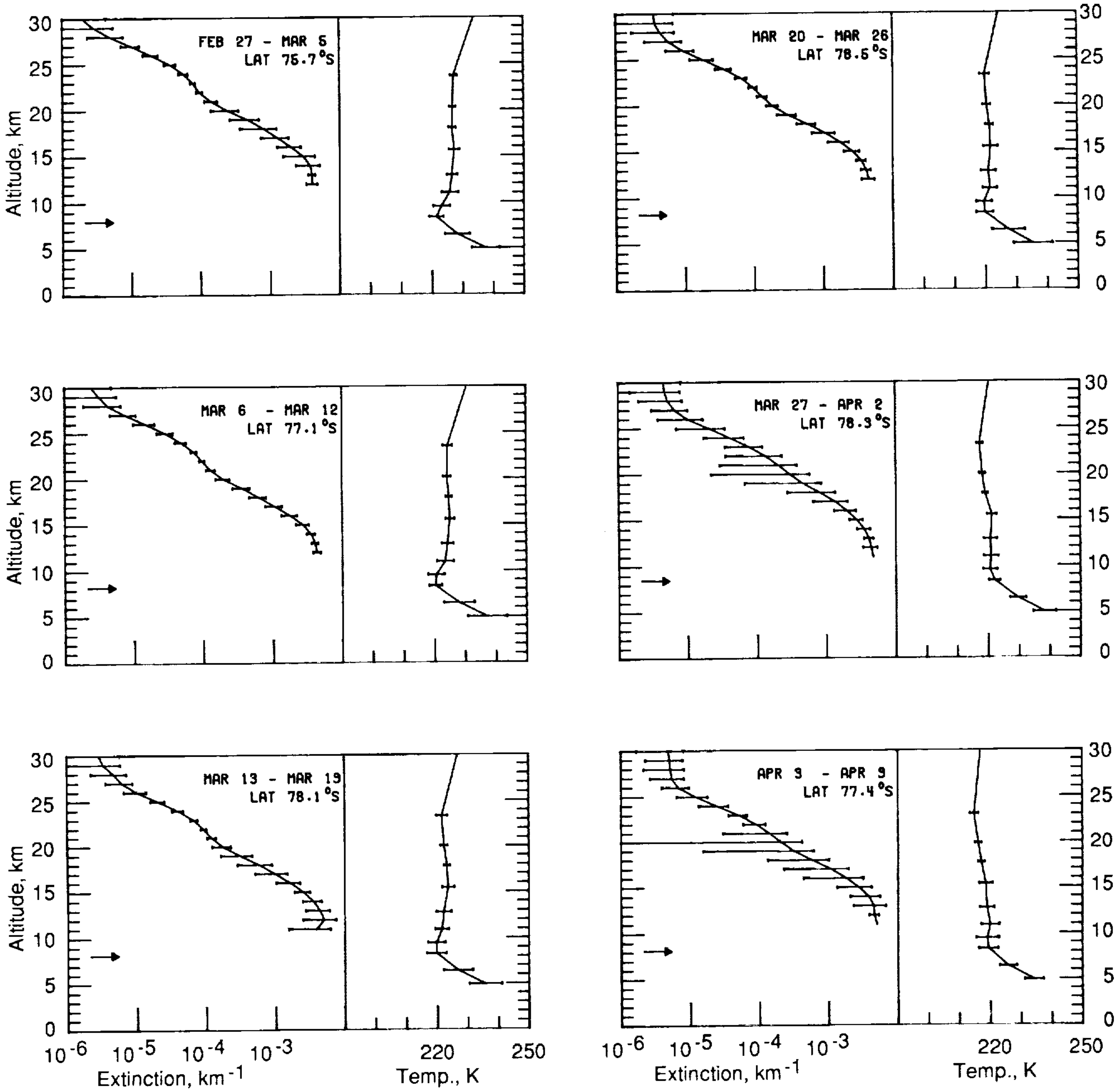



Figure 10. Antarctic extinction and temperature profiles for February 27 to April 9, 1983.

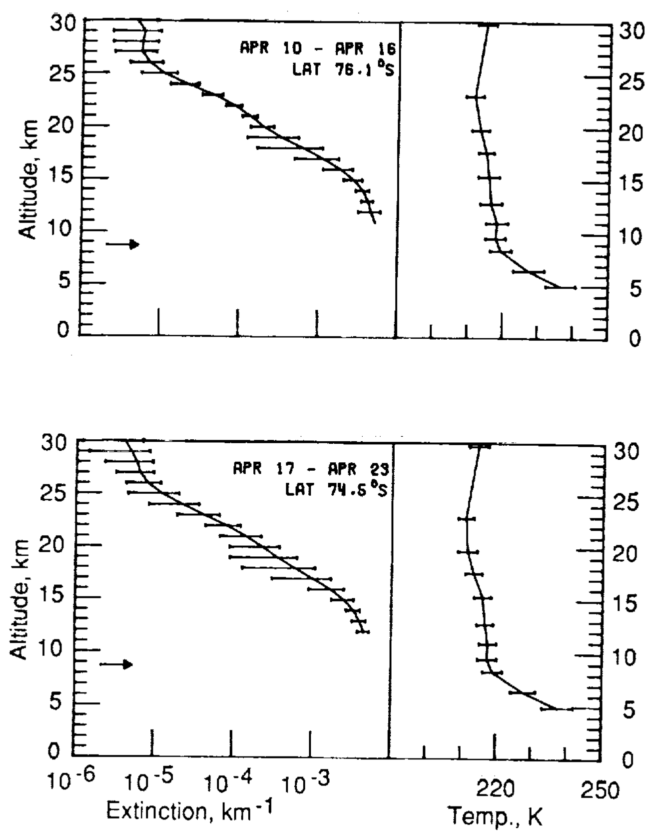
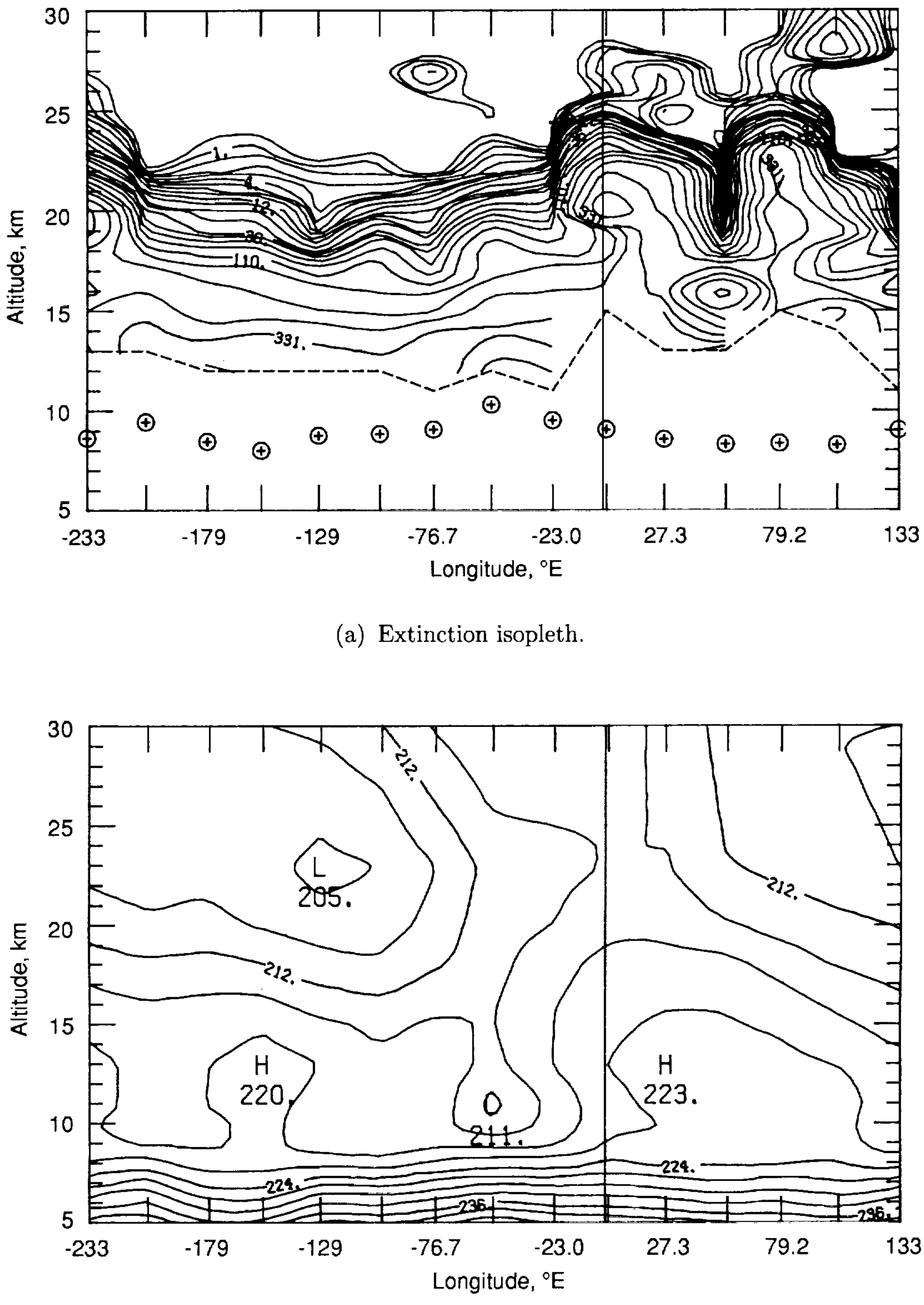


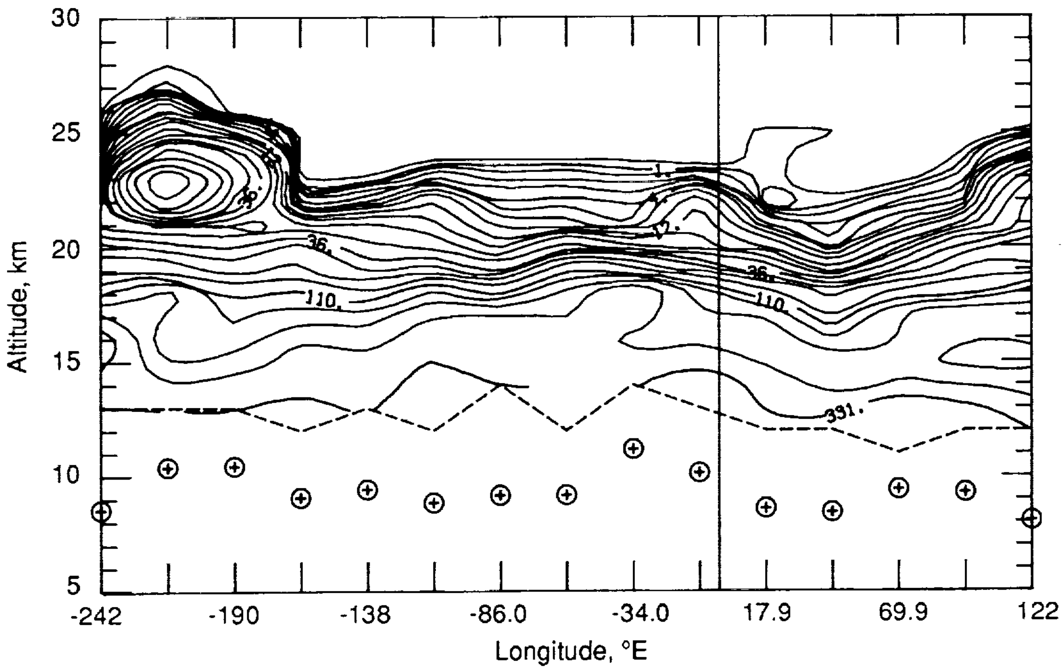

Figure 11. Antarctic extinction and temperature profiles for April 10 to 23, 1983.



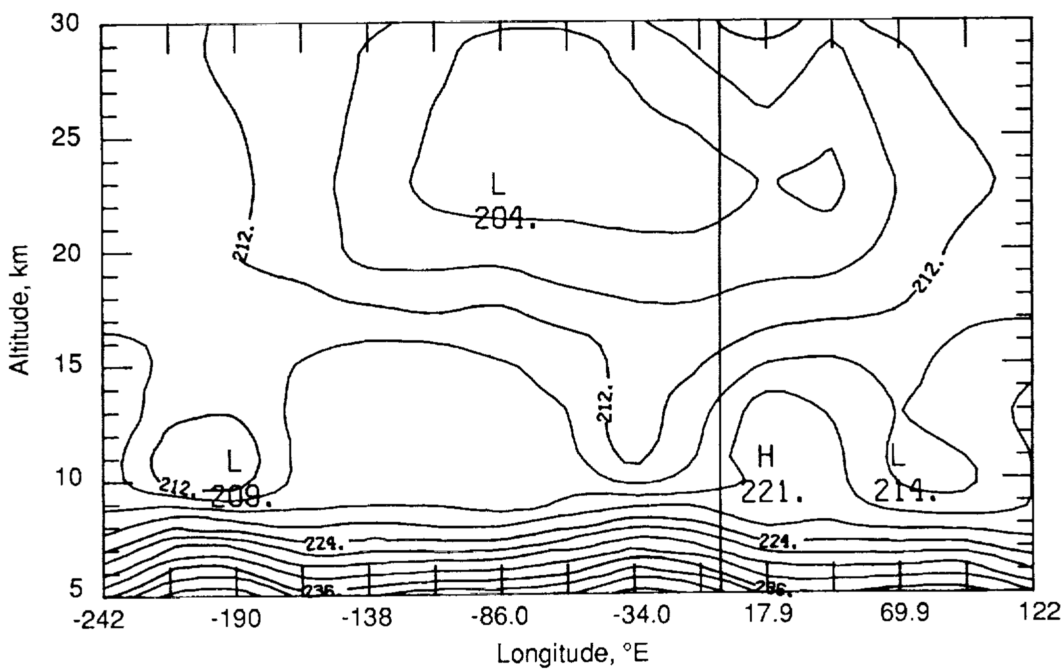

(a) Extinction isopleth.

(b) Temperature contours.

Figure 12. Arctic extinction isopleth and temperature contours for October 25.01 to 26.02, 1982, at latitudes from 74.8° to 74.2°N corresponding to orbits 20 202 to 20 216.

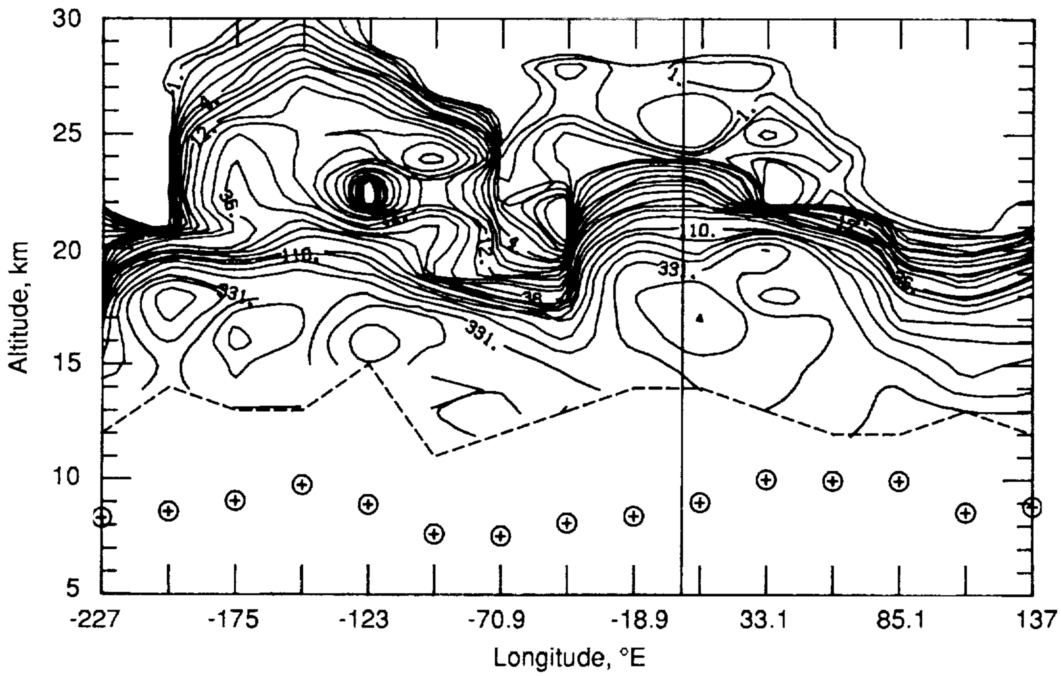



(a) Extinction isopleth.

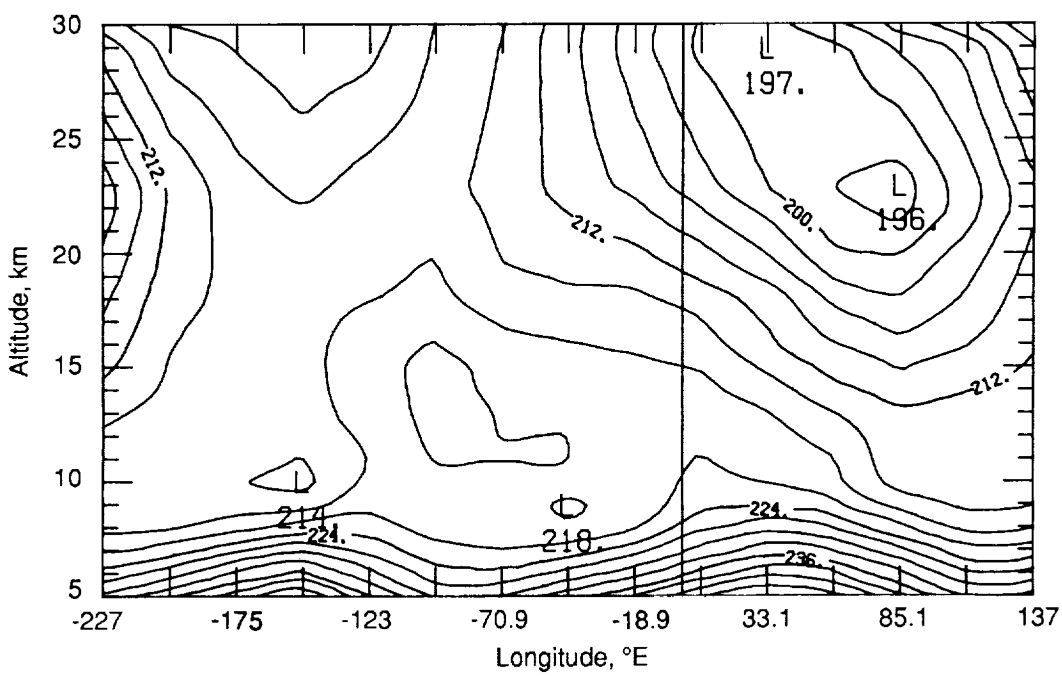



(b) Temperature contours.

Figure 13. Arctic extinction isopleth and temperature contours for November 3.05 to 4.06, 1982, at latitudes from 71.9° to 71.7°N corresponding to orbits 20 327 to 20 341.

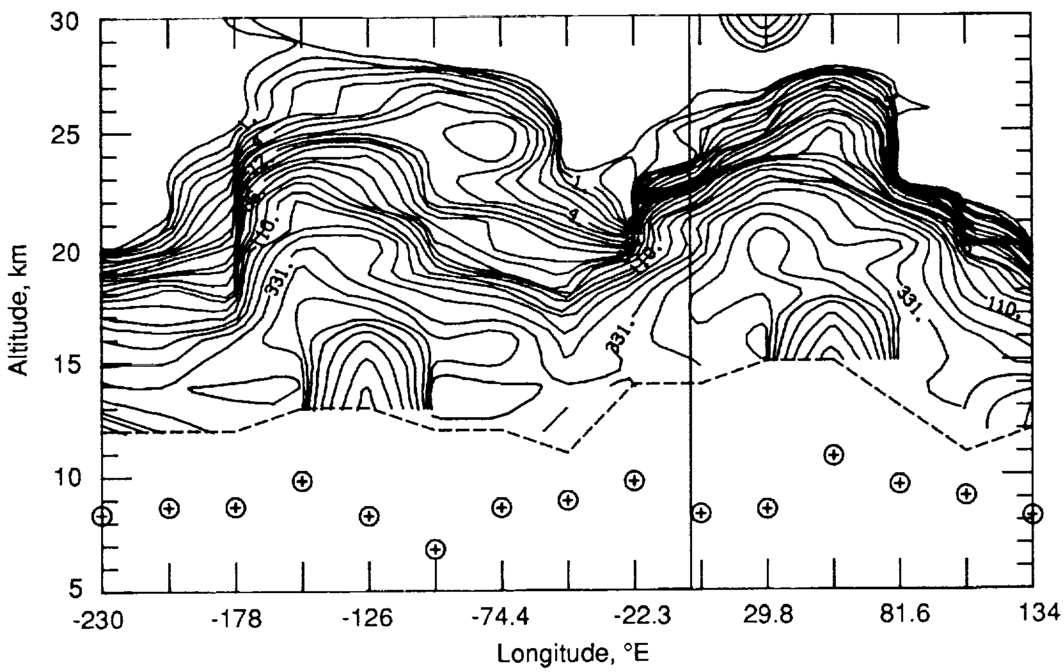



(a) Extinction isopleth.

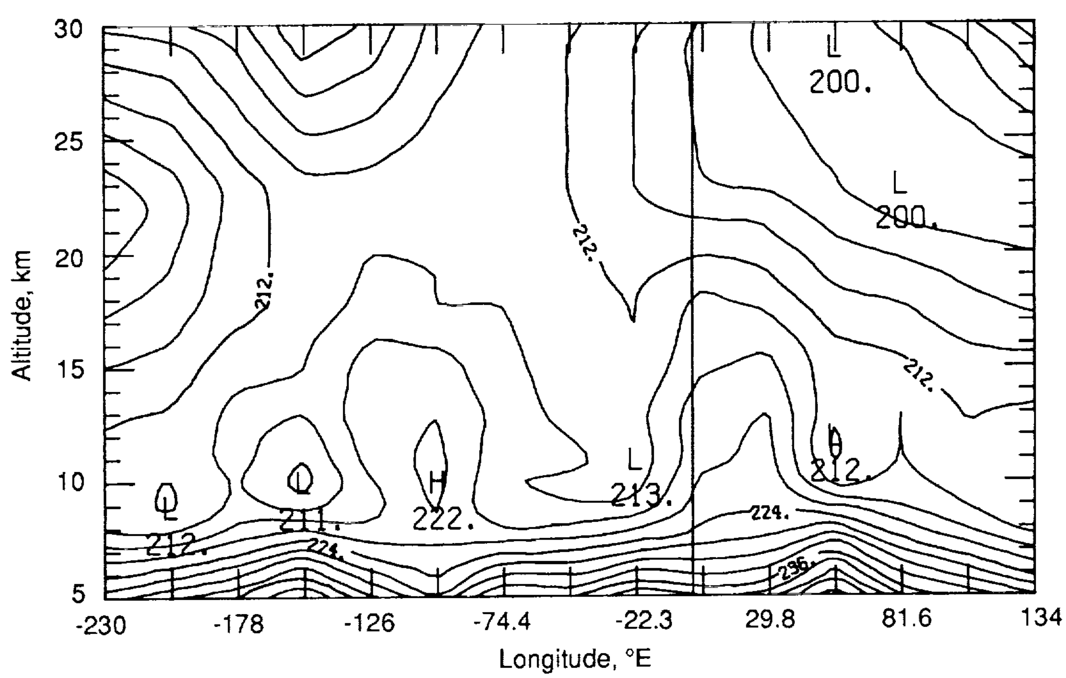



(b) Temperature contours.

Figure 14. Arctic extinction isopleth and temperature contours for November 12.02 to 13.03, 1982, at latitudes from 69.7° to 69.5°N corresponding to orbits 20 451 to 20 465.

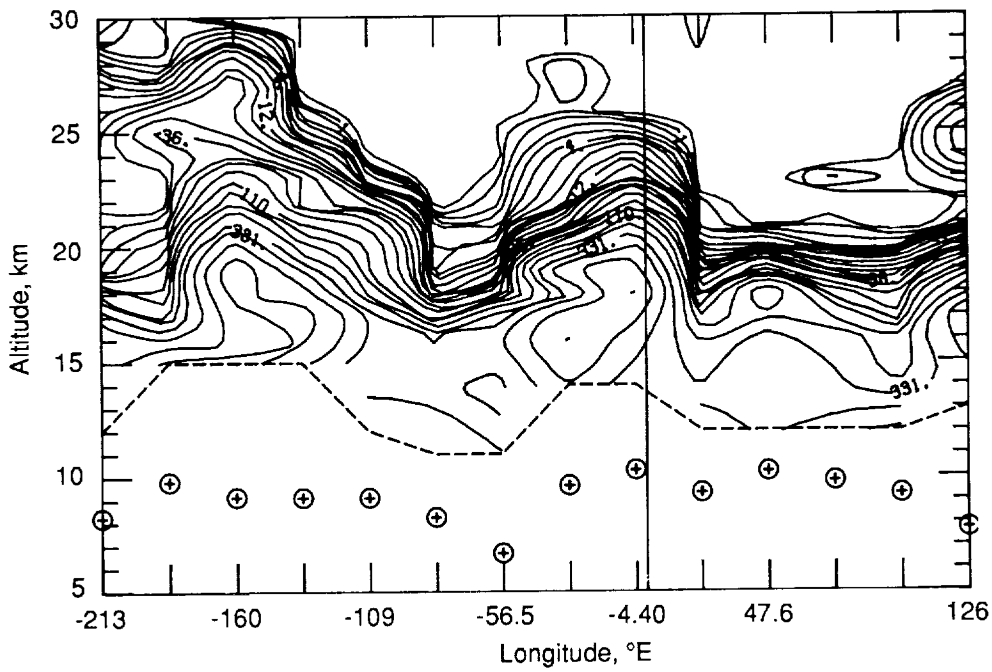



(a) Extinction isopleth.

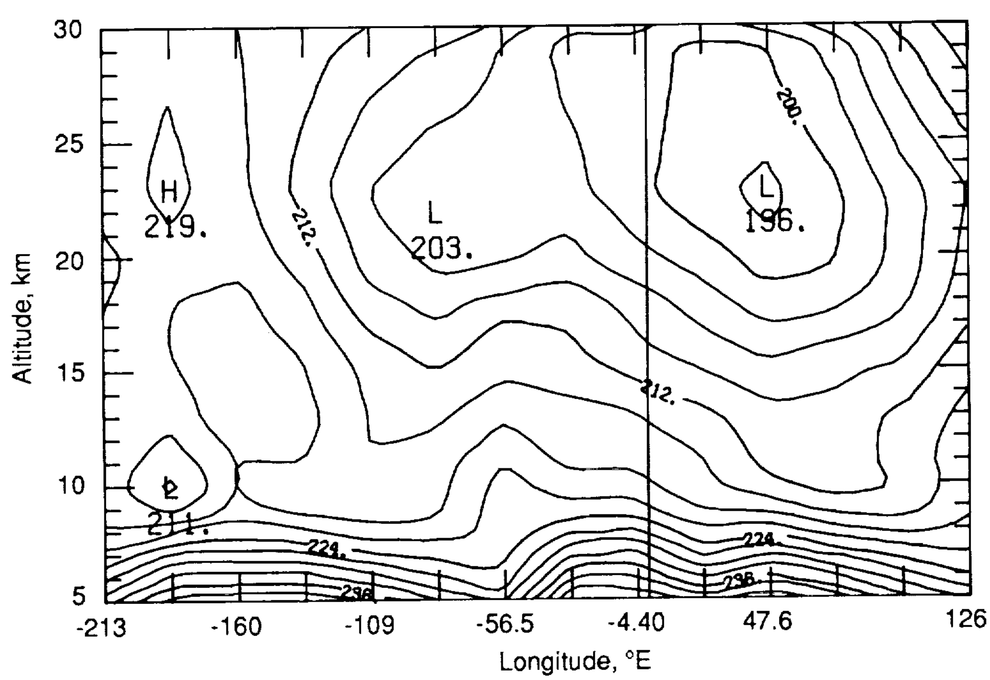



(b) Temperature contours.

Figure 15. Arctic extinction isopleth and temperature contours for November 19.04 to 20.05, 1982, at latitudes from 68.2° to 68.0°N corresponding to orbits 20 548 to 20 562.

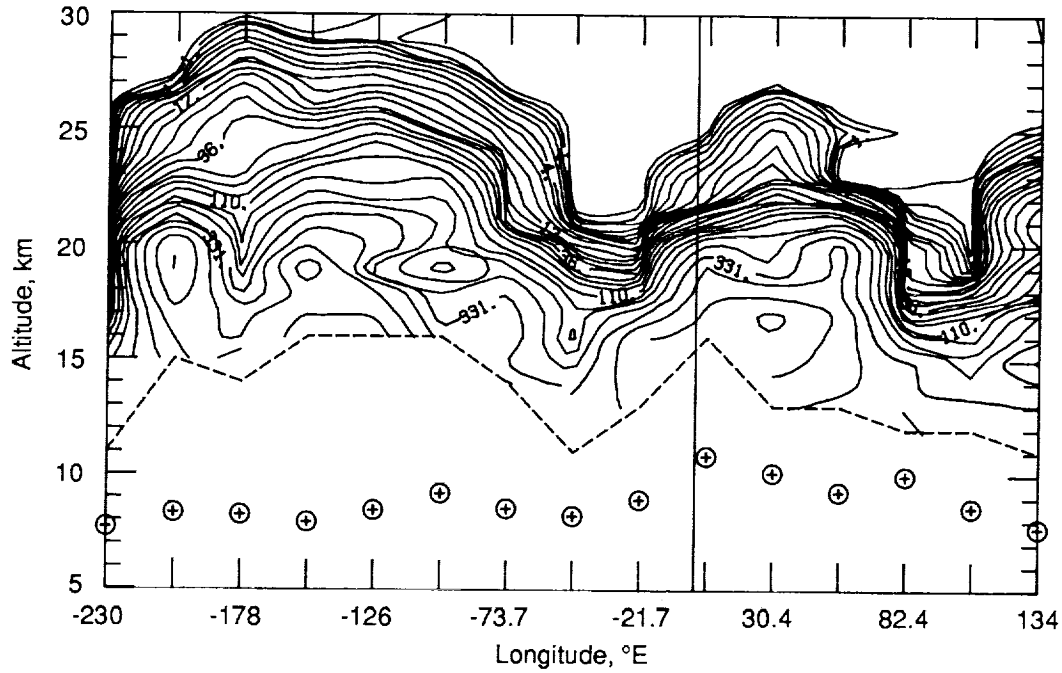



(a) Extinction isopleth.

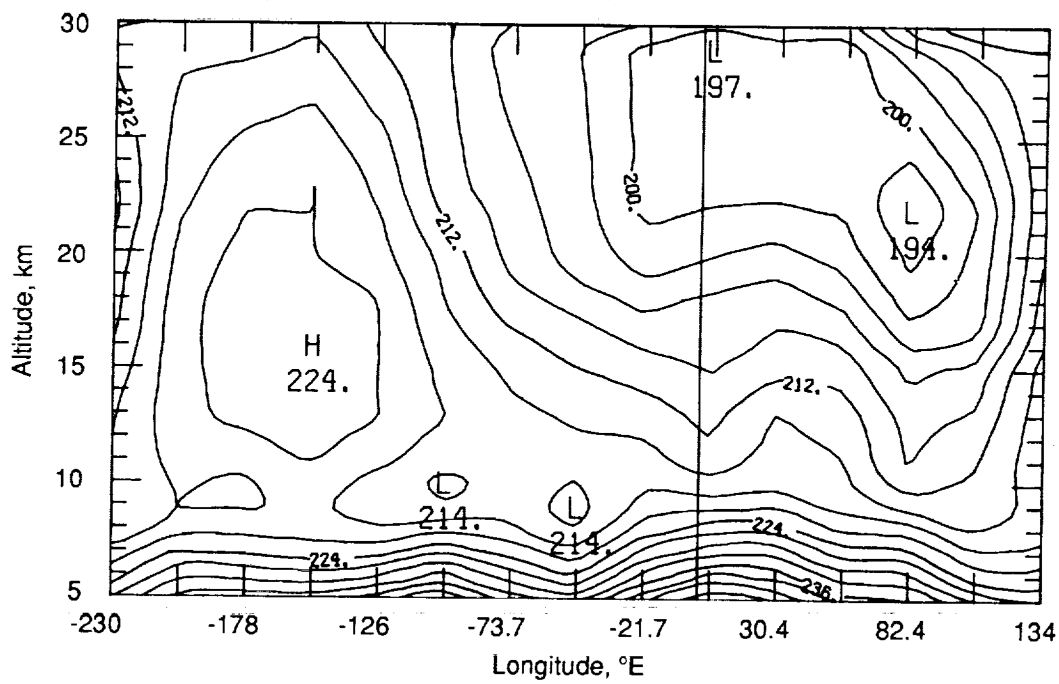



(b) Temperature contours.

Figure 16. Arctic extinction isopleth and temperature contours for November 27.07 to 28.01, 1982, at latitudes from 66.8° to 66.6°N corresponding to orbits 20 659 to 20 672.

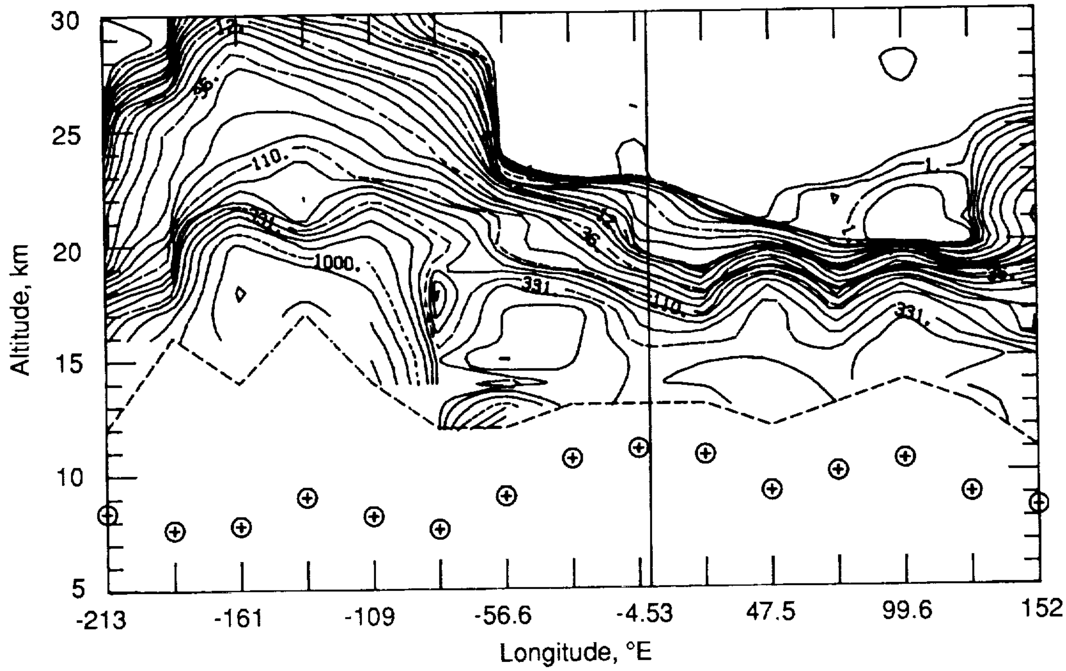



(a) Extinction isopleth.

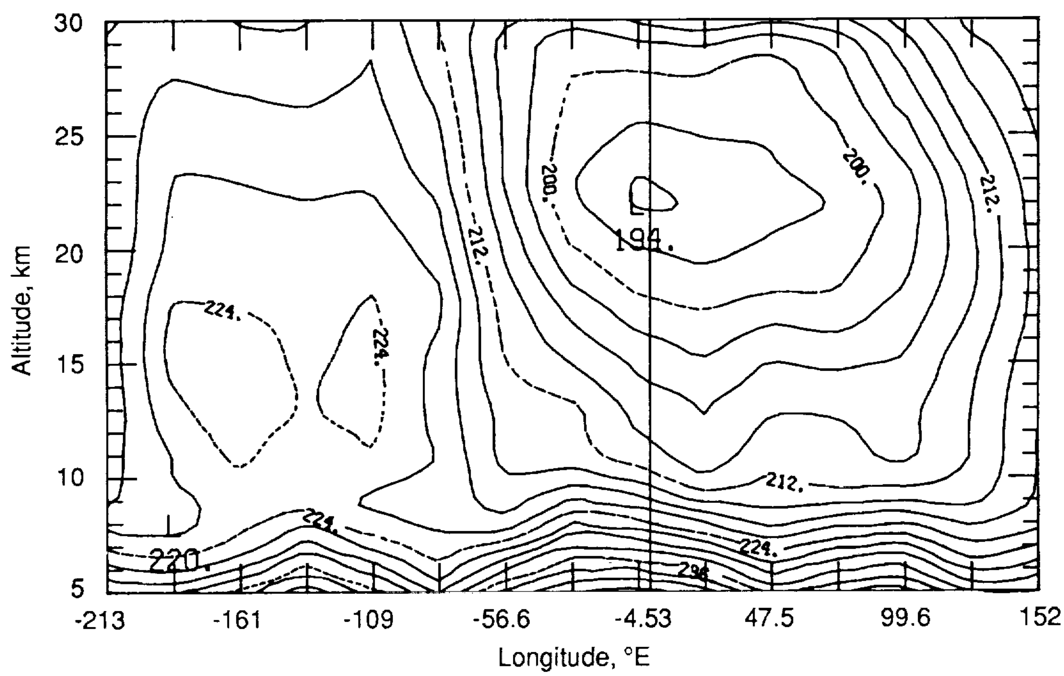



(b) Temperature contours.

Figure 17. Arctic extinction isopleth and temperature contours for December 1.05 to 2.06, 1982, at latitudes from 66.1° to 66.0°N corresponding to orbits 20 714 to 20 728.

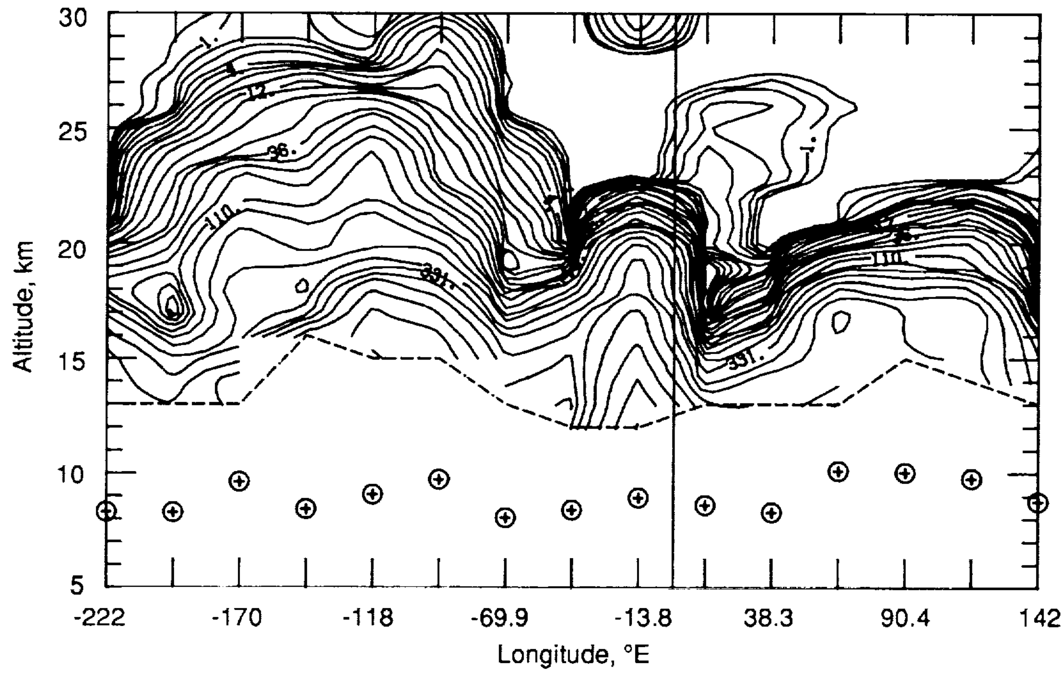



(a) Extinction isopleth.

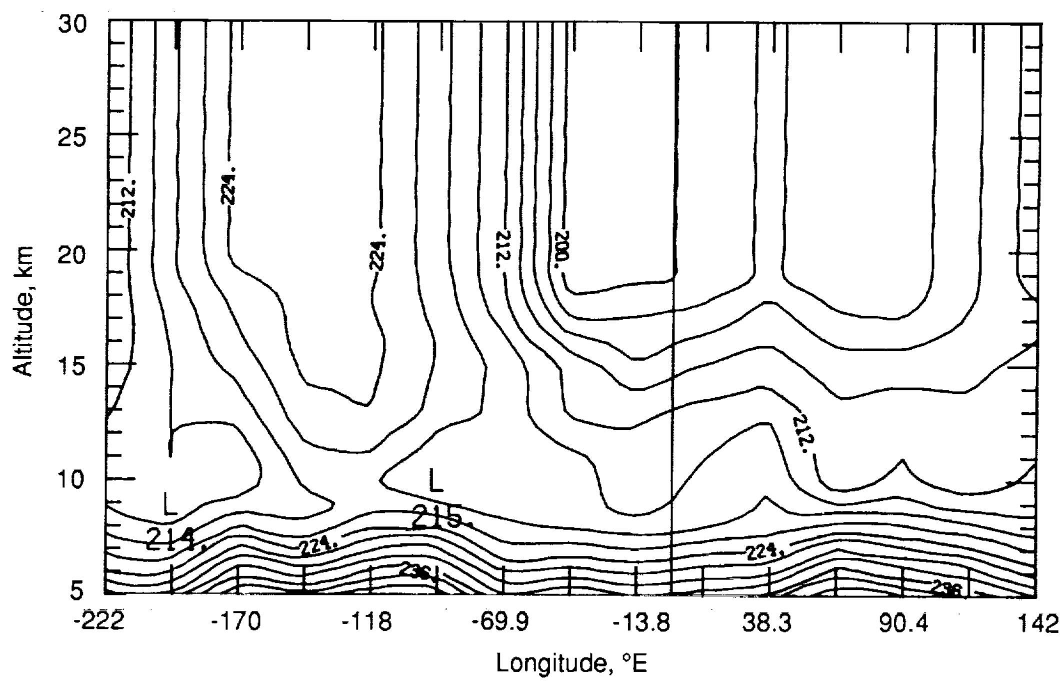



(b) Temperature contours.

Figure 18. Arctic extinction isopleth and temperature contours for December 9.00 to 10.02, 1982, at latitudes from 65.2° to 65.1°N corresponding to orbits 20 824 to 20 838.

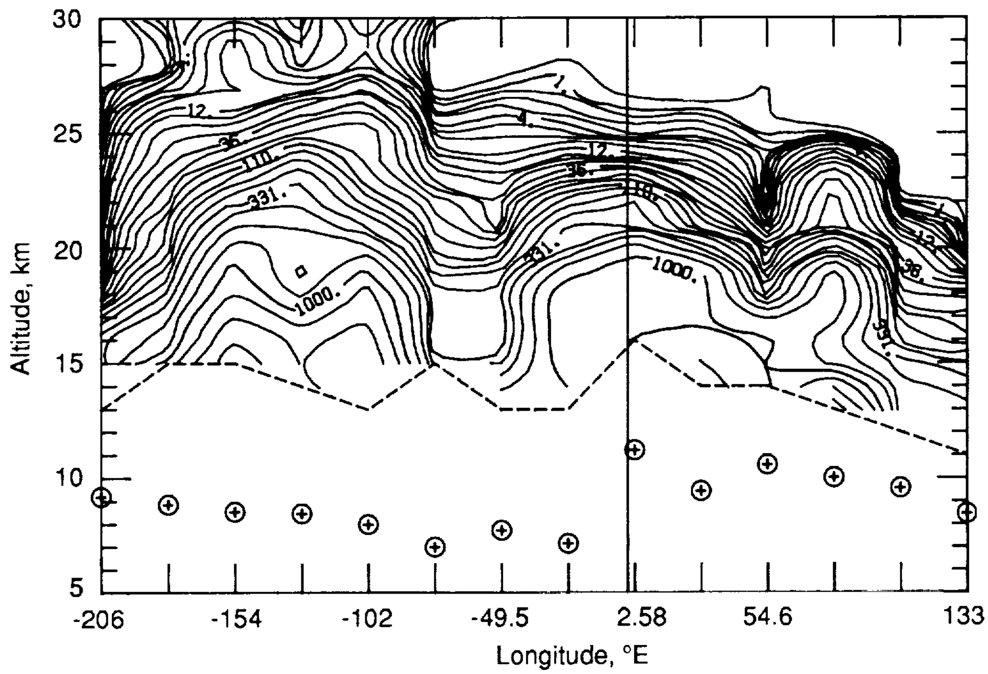



(a) Extinction isopleth.

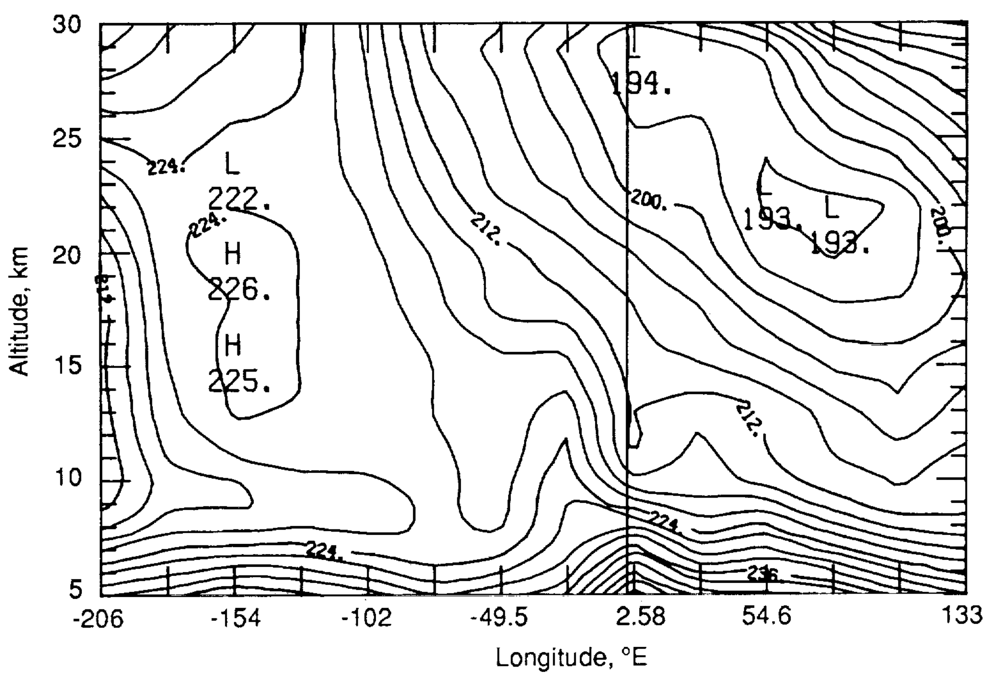



(b) Temperature contours.

Figure 19. Arctic extinction isopleth and temperature contours for December 17.03 to 18.05, 1982, at a latitude of 64.7°N corresponding to orbits 20 935 to 20 949.

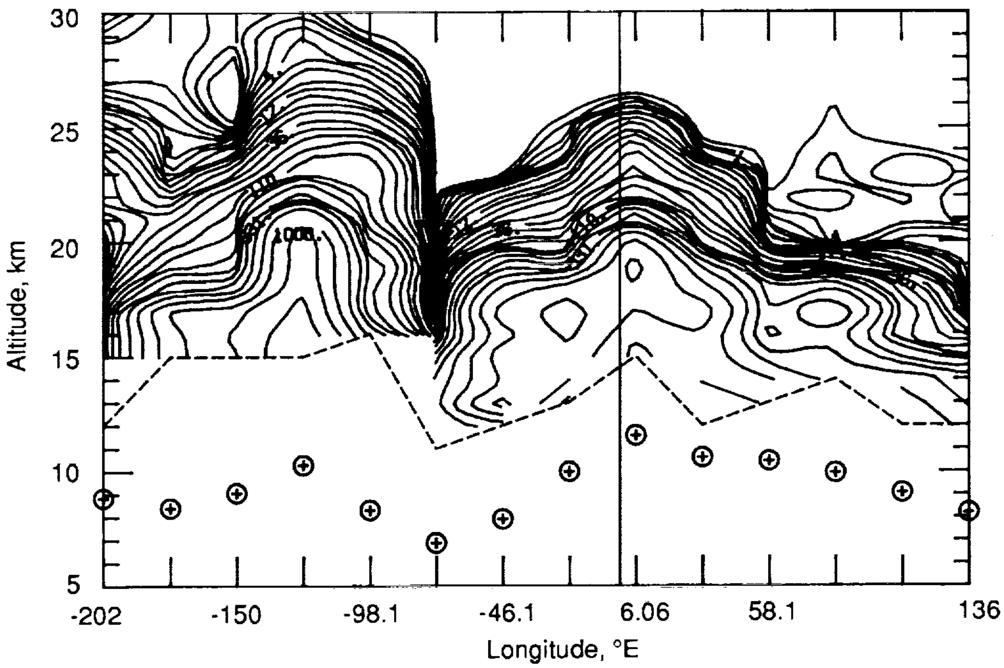



(a) Extinction isopleth.

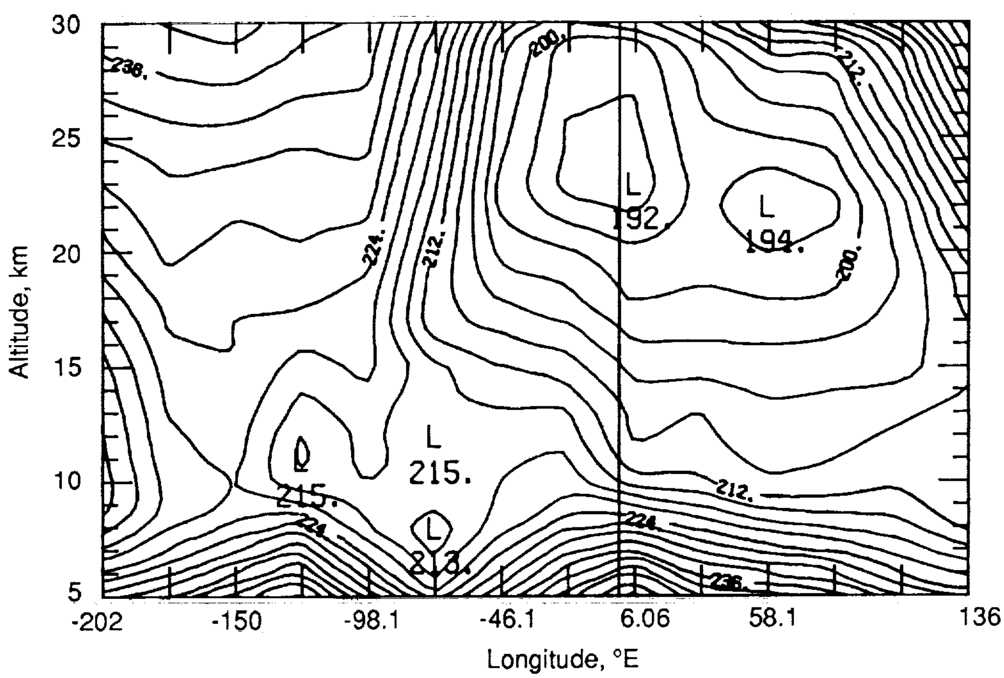



(b) Temperature contours.

Figure 20. Arctic extinction isopleth and temperature contours for December 25.06 to 26.00, 1982, at a latitude of 64.7°N corresponding to orbits 21 046 to 21 059.

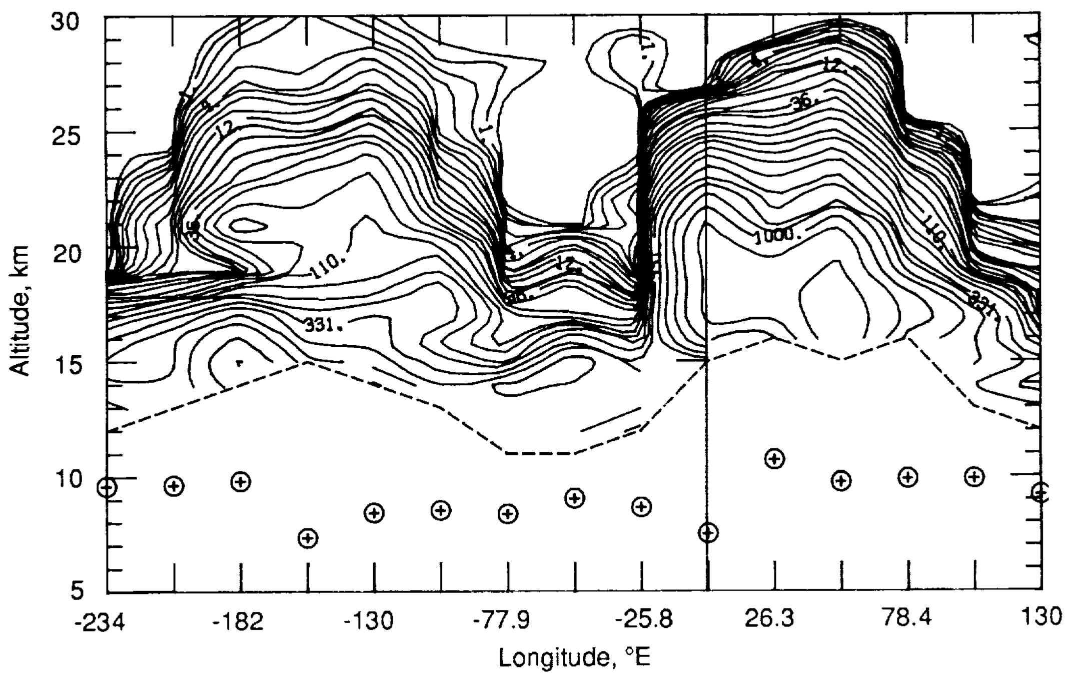



(a) Extinction isopleth.

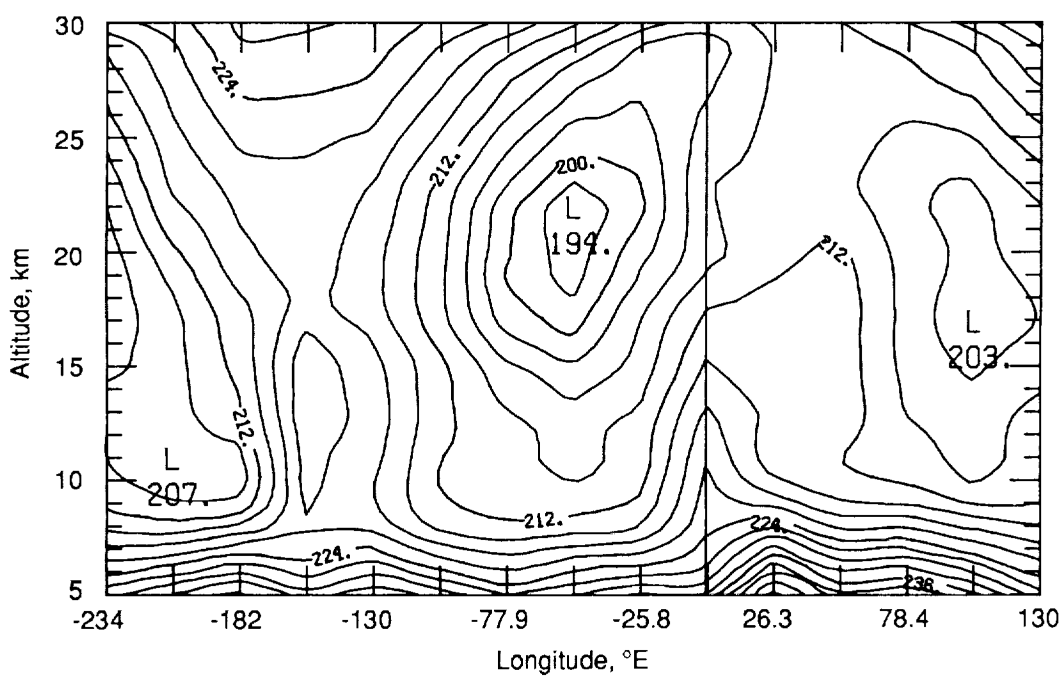



(b) Temperature contours.

Figure 21. Arctic extinction isopleth and temperature contours for December 30.05 to 31.00, 1982, at a latitude of 64.9° to 65.0°N corresponding to orbits 21 115 to 21 128.

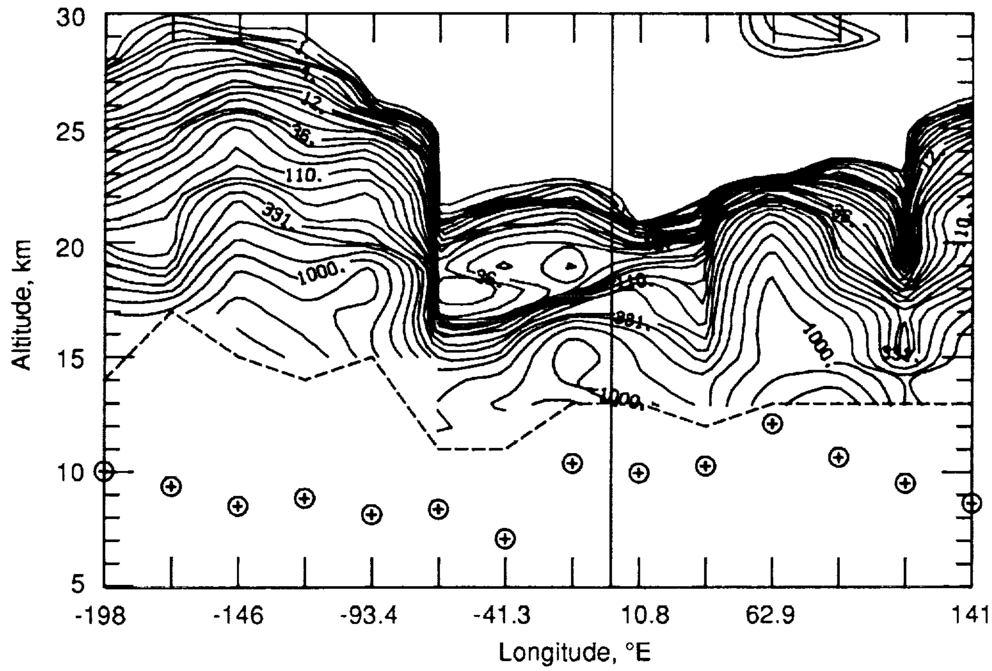



(a) Extinction isopleth.

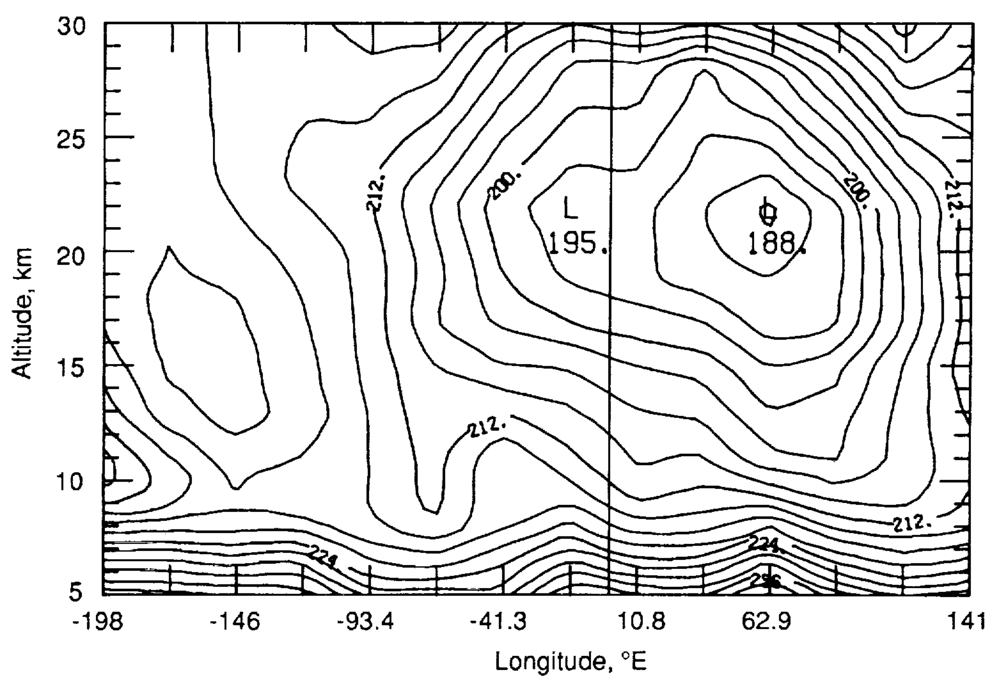



(b) Temperature contours.

Figure 22. Arctic extinction isopleth and temperature contours for January 6.07 to 7.09, 1983, at a latitude of 65.5° to 65.6°N corresponding to orbits 21 212 to 21 226.

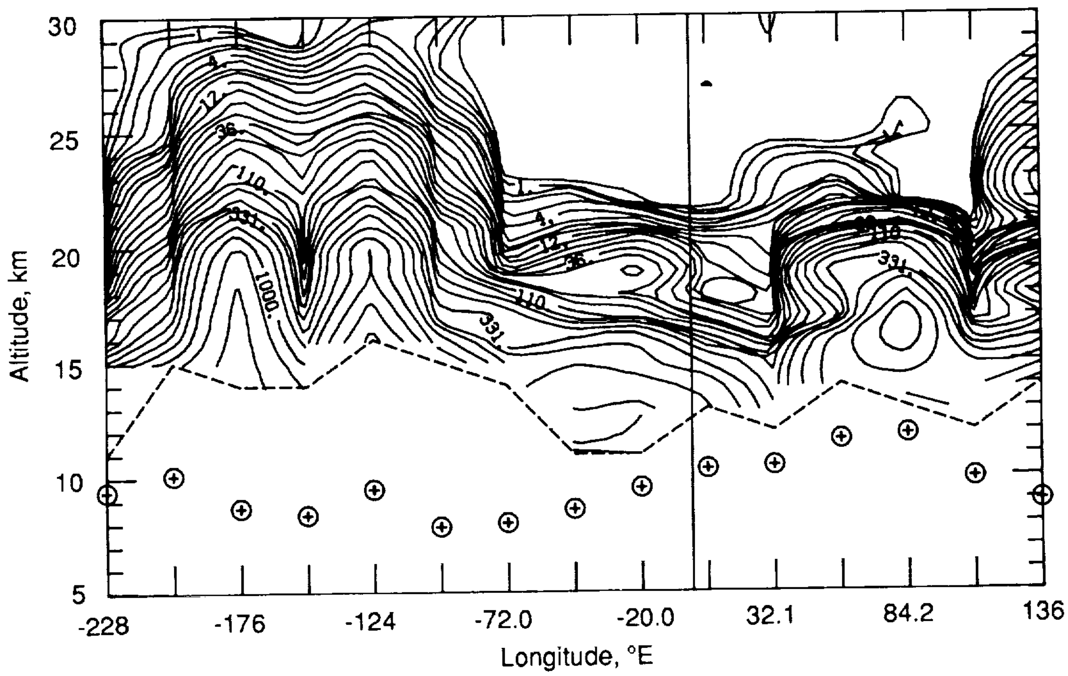



(a) Extinction isopleth.

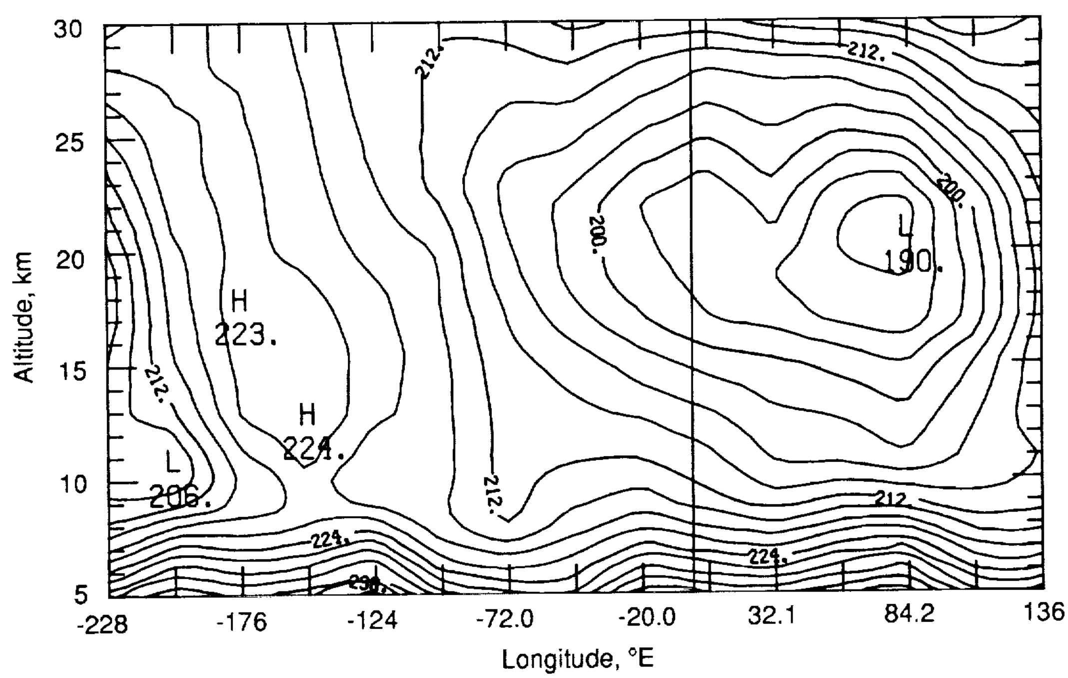



(b) Temperature contours.

Figure 23. Arctic extinction isopleth and temperature contours for January 15.04 to 15.98, 1983, at a latitude of 66.8° to 67.0°N corresponding to orbits 21 336 to 21 349.

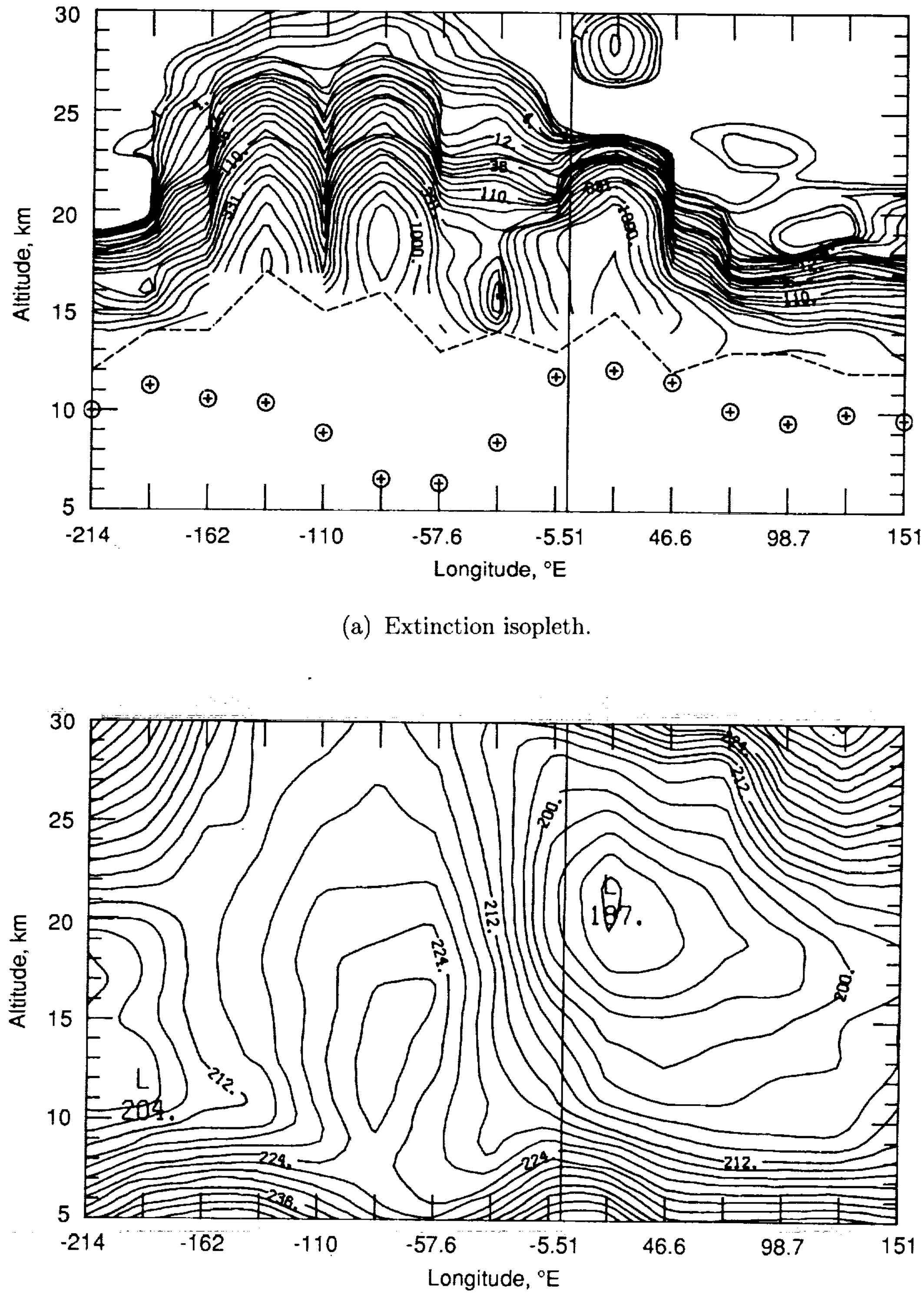



(a) Extinction isopleth.




(b) Temperature contours.

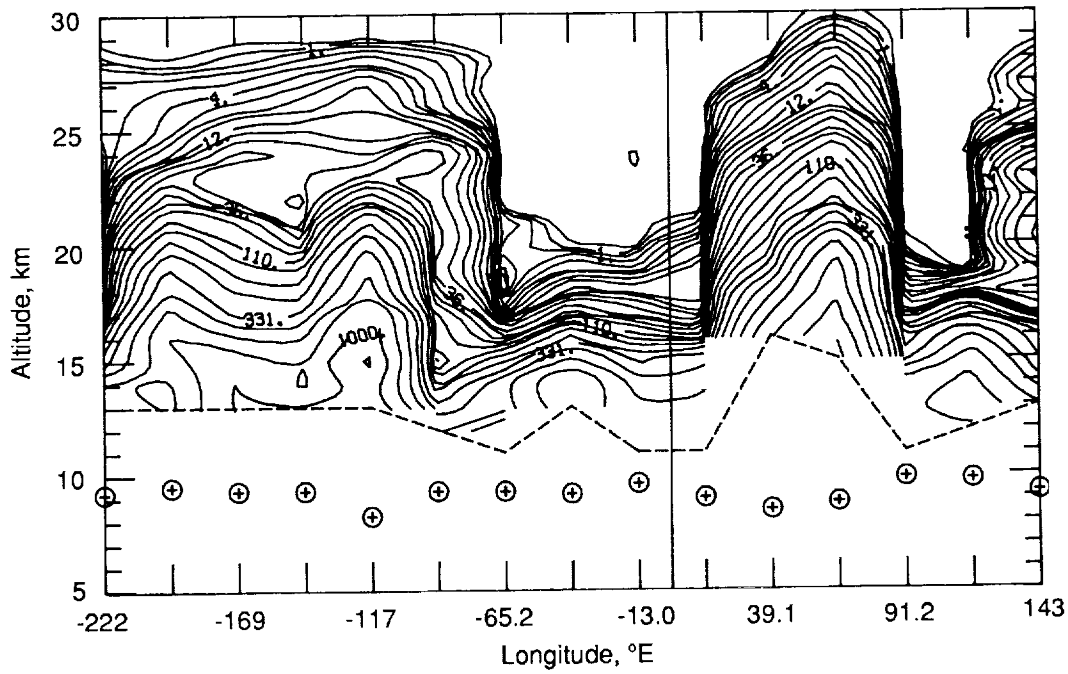
Figure 24. Arctic extinction isopleth and temperature contours for January 16.06 to 17.07, 1983, at a latitude of 67.0° to 67.2°N corresponding to orbits 21 350 to 21 364.



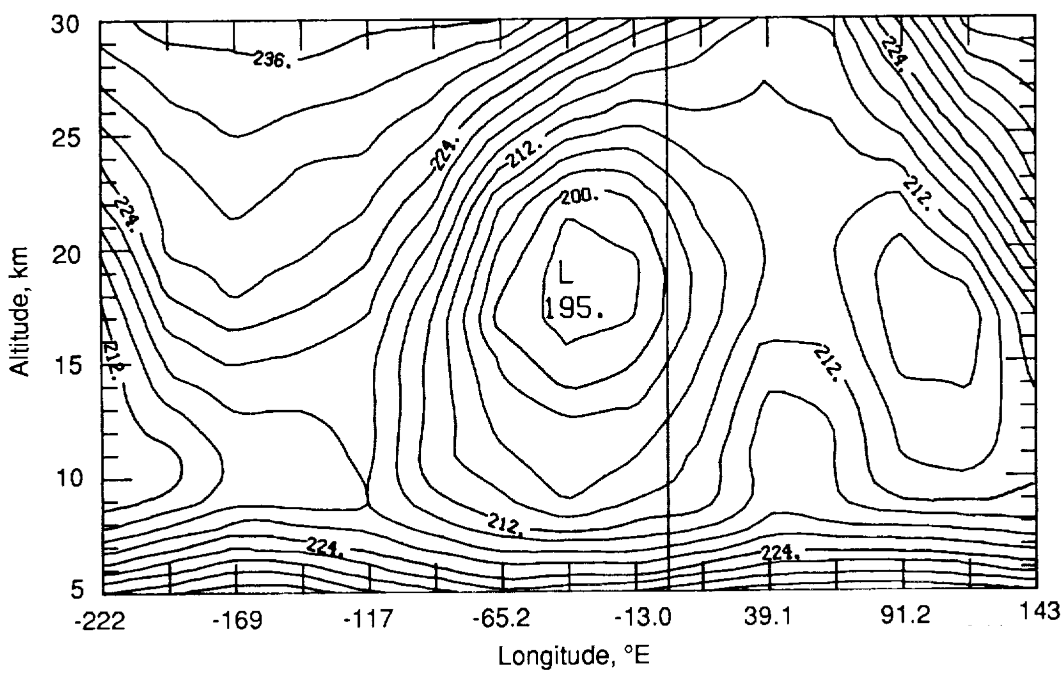

(a) Extinction isopleth.

(b) Temperature contours.

Figure 25. Arctic extinction isopleth and temperature contours for January 24.01 to 25.03, 1983, at a latitude of 68.6° to 68.8°N corresponding to orbits 21 460 to 21 474.

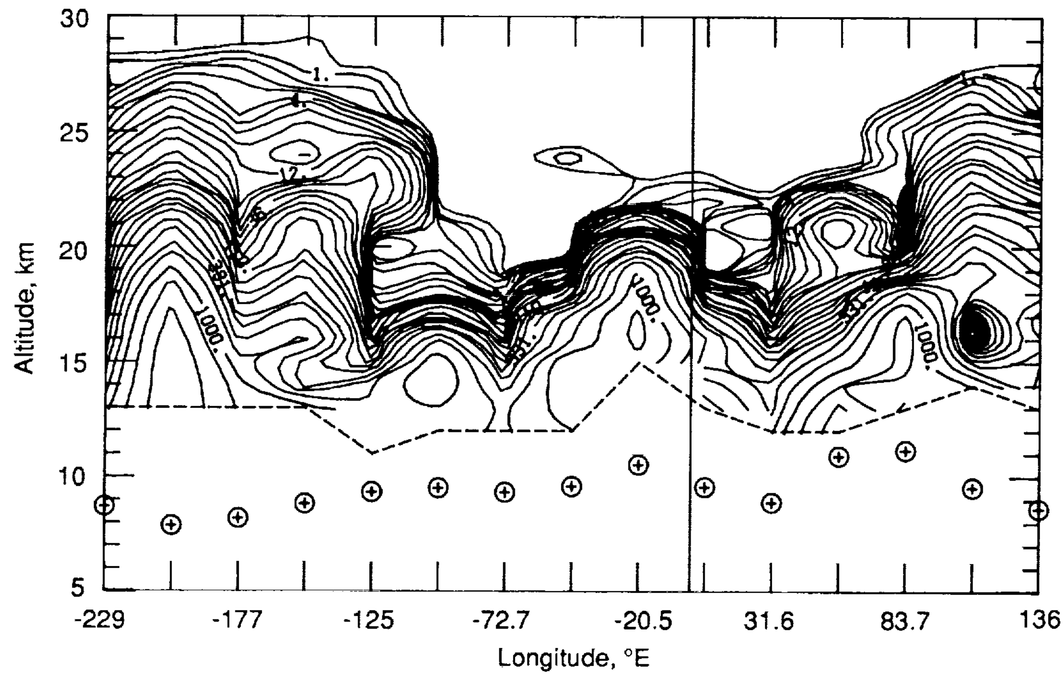



(a) Extinction isopleth.

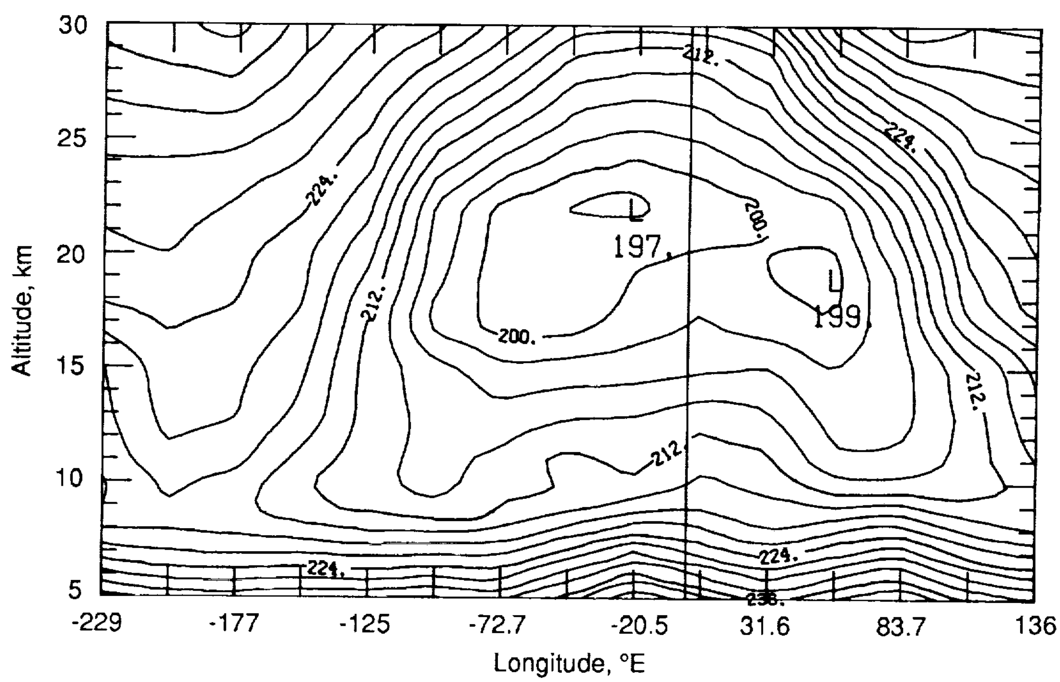



(b) Temperature contours.

Figure 26. Arctic extinction isopleth and temperature contours for January 31.03 to February 1.04, 1983, at a latitude of 70.3° to 70.6°N corresponding to orbits 21 557 to 21 571.

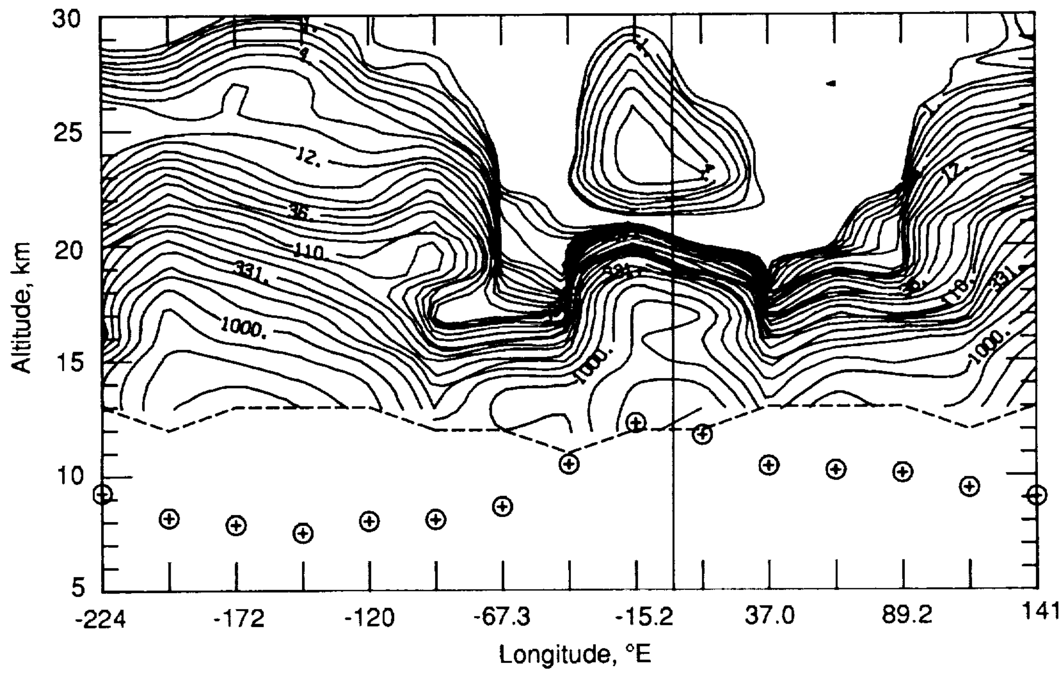



(a) Extinction isopleth.

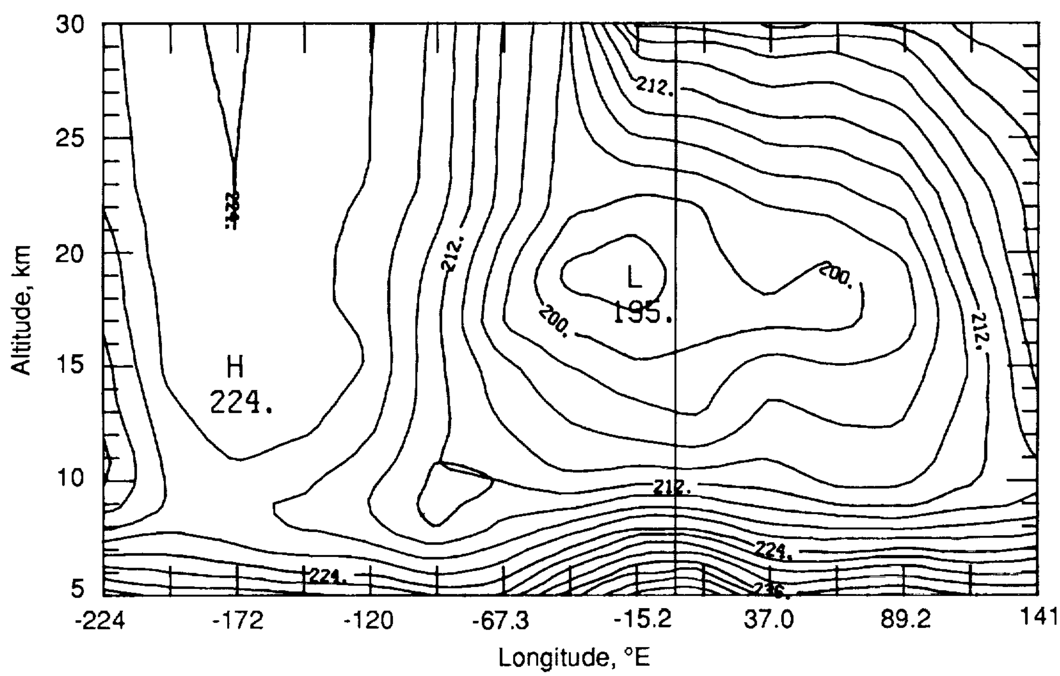



(b) Temperature contours.

Figure 27. Arctic extinction isopleth and temperature contours for February 12.04 to 13.05, 1983, at a latitude of 73.8° to 74.1°N corresponding to orbits 21 723 to 21 737.

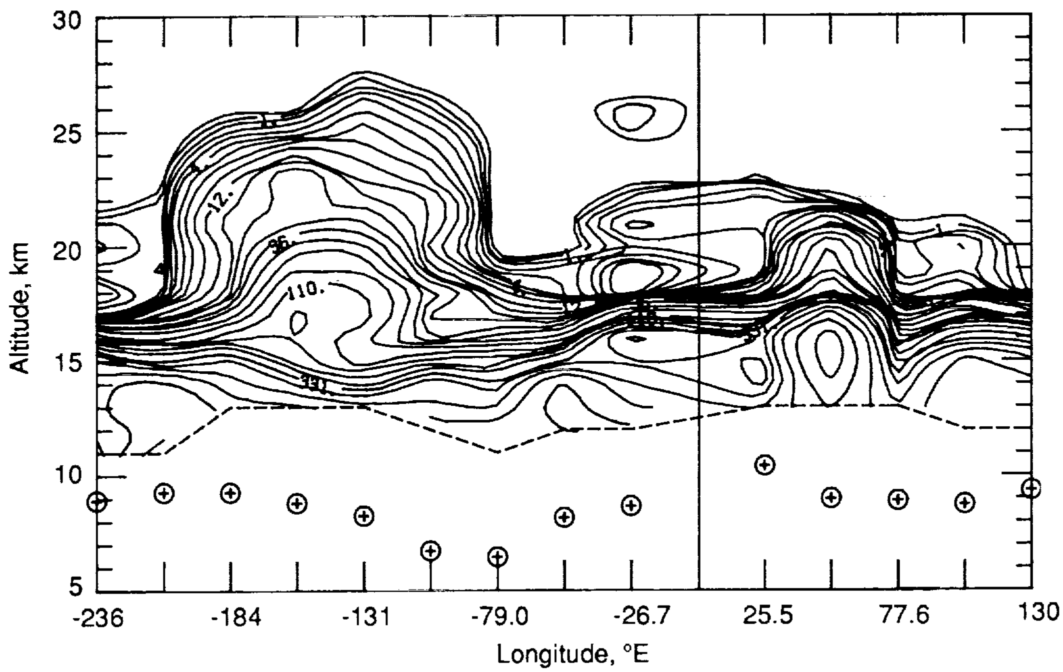



(a) Extinction isopleth.

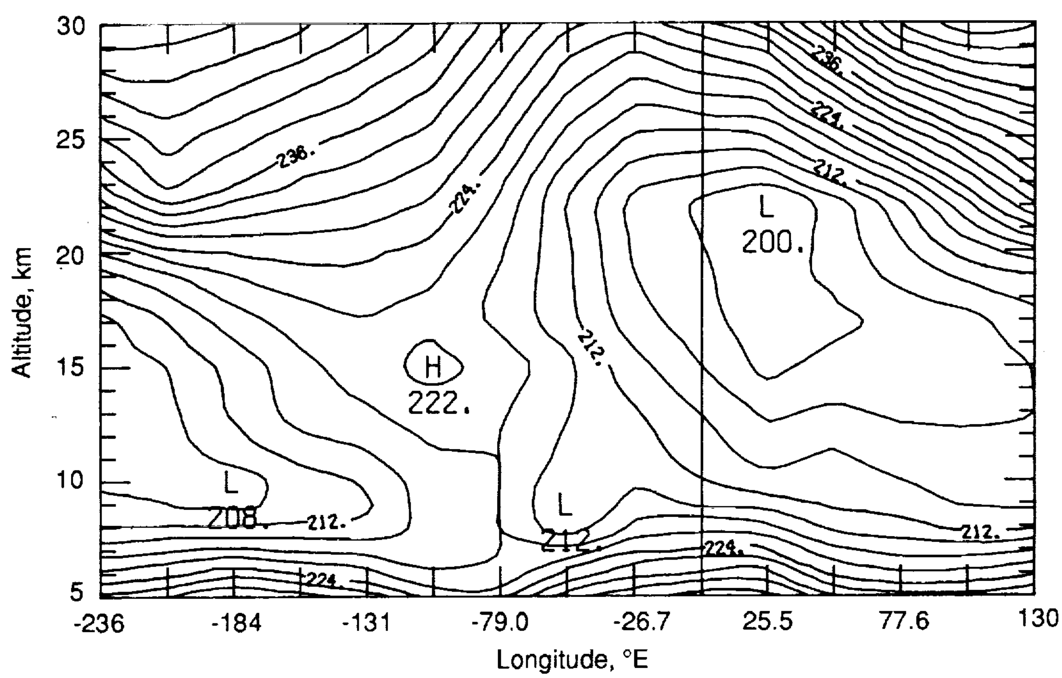



(b) Temperature contours.

Figure 28. Arctic extinction isopleth and temperature contours for February 16.02 to 17.03, 1983, at a latitude of 75.0° to 75.3°N corresponding to orbits 21 778 to 21 792.

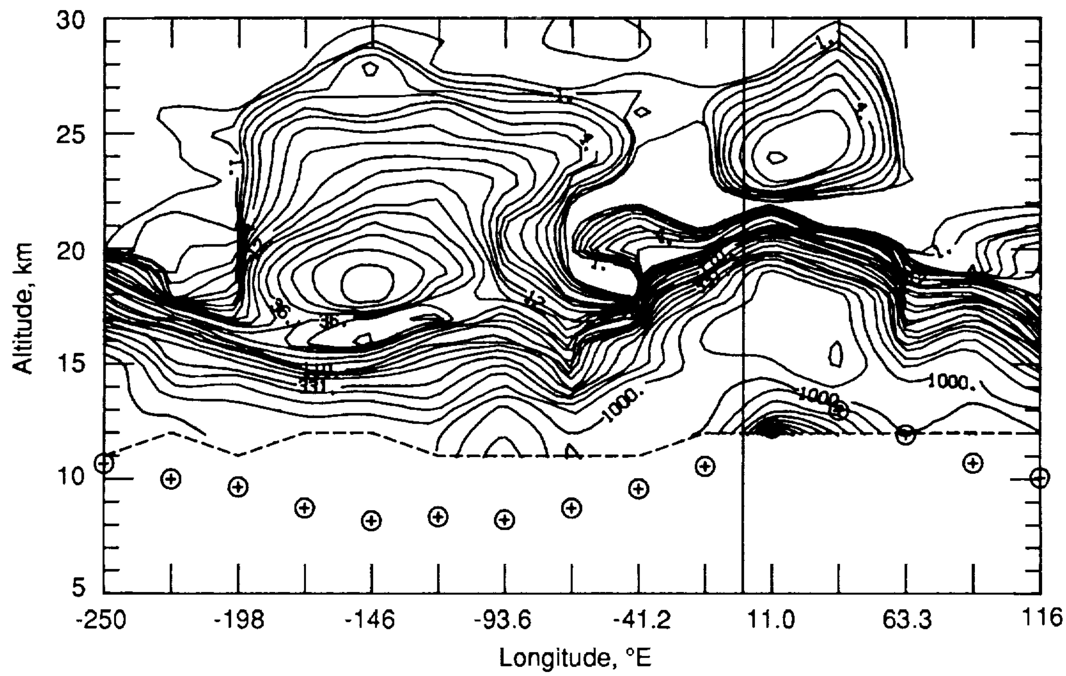



(a) Extinction isopleth.

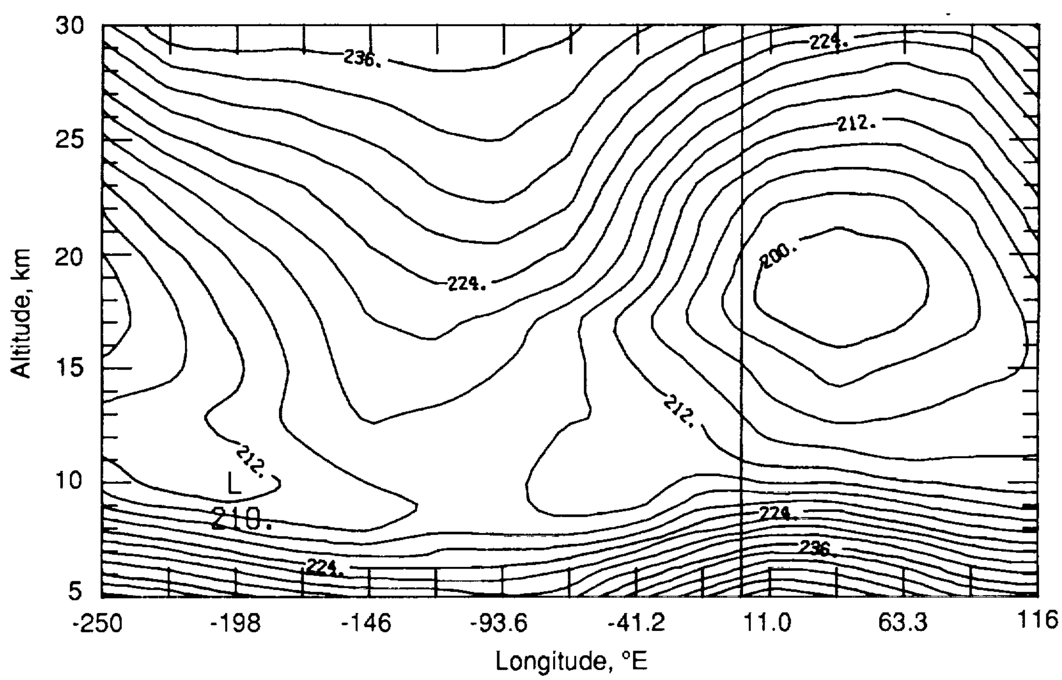



(b) Temperature contours.

Figure 29. Arctic extinction isopleth and temperature contours for February 23.04 to 24.05, 1983, at a latitude of 77.2° to 77.6°N corresponding to orbits 21 875 to 21 889.

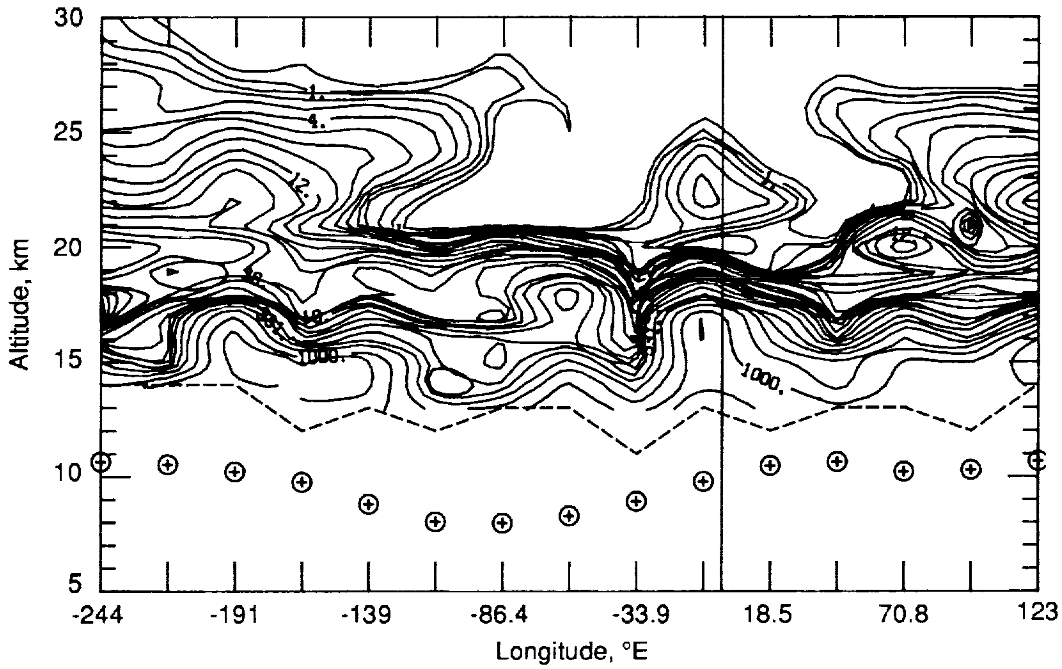



(a) Extinction isopleth.

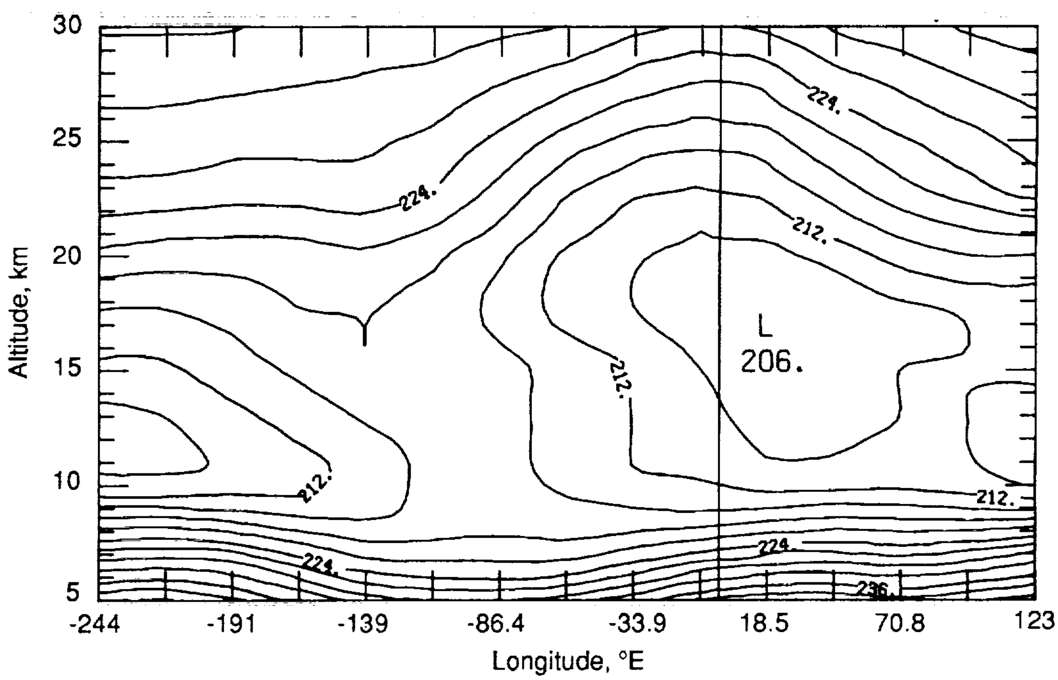



(b) Temperature contours.

Figure 30. Arctic extinction isopleth and temperature contours for March 2.06 to 3.07, 1983, at a latitude of 79.4° to 79.7°N corresponding to orbits 21 972 to 21 986.

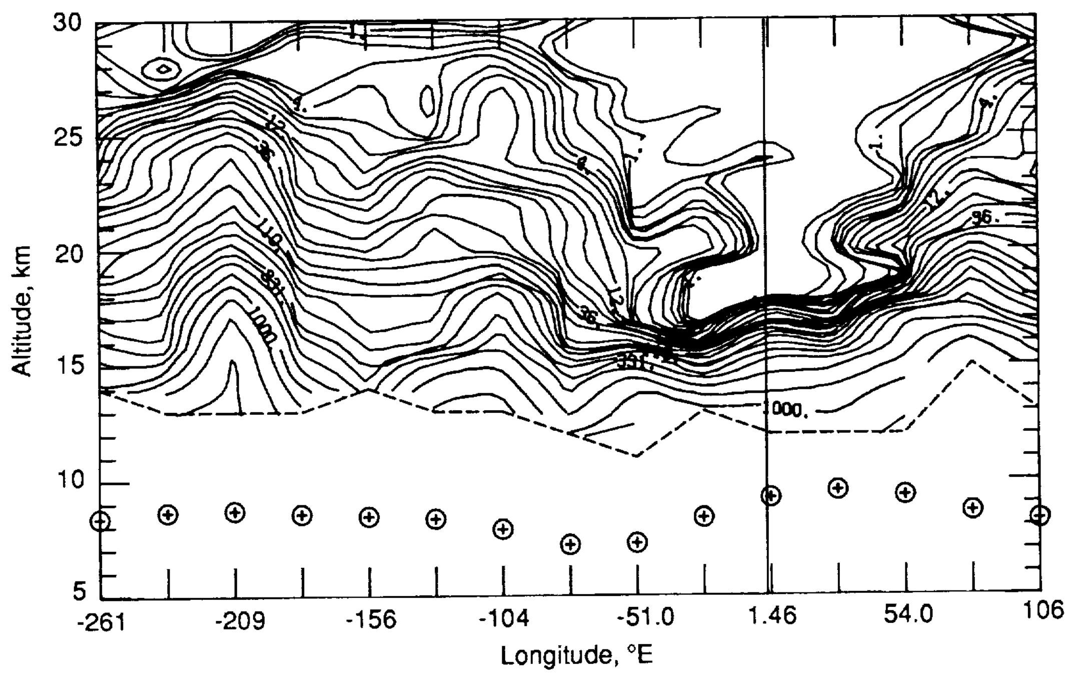



(a) Extinction isopleth.

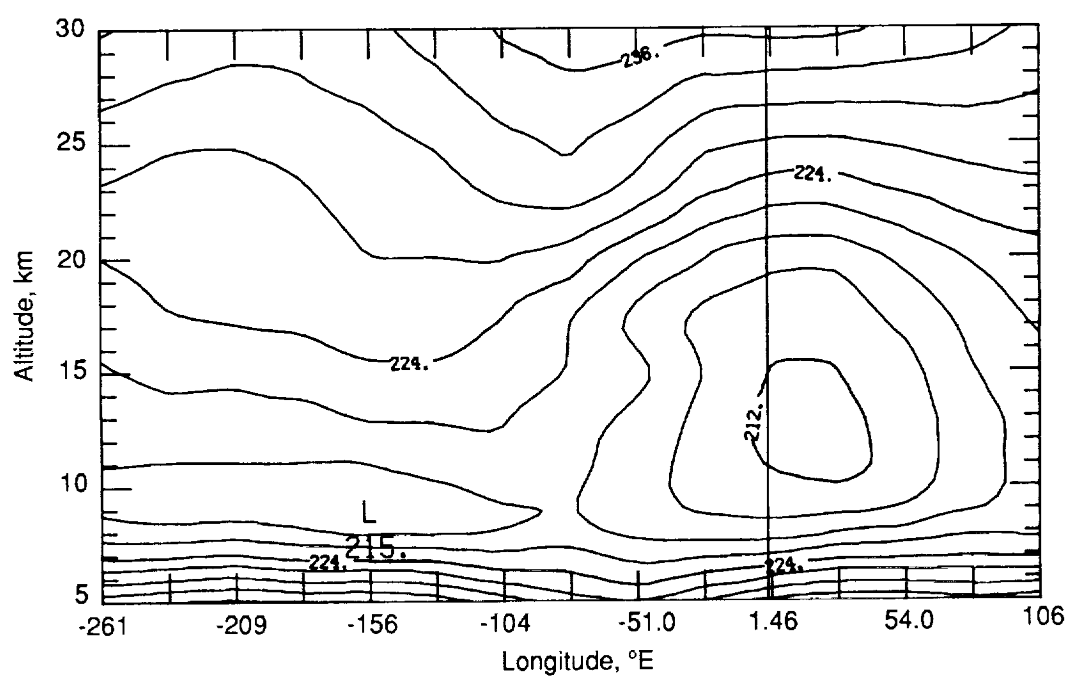



(b) Temperature contours.

Figure 31. Arctic extinction isopleth and temperature contours for March 9.00 to 10.01, 1983, at a latitude of 81.3° to 81.5°N corresponding to orbits 22 068 to 22 082.

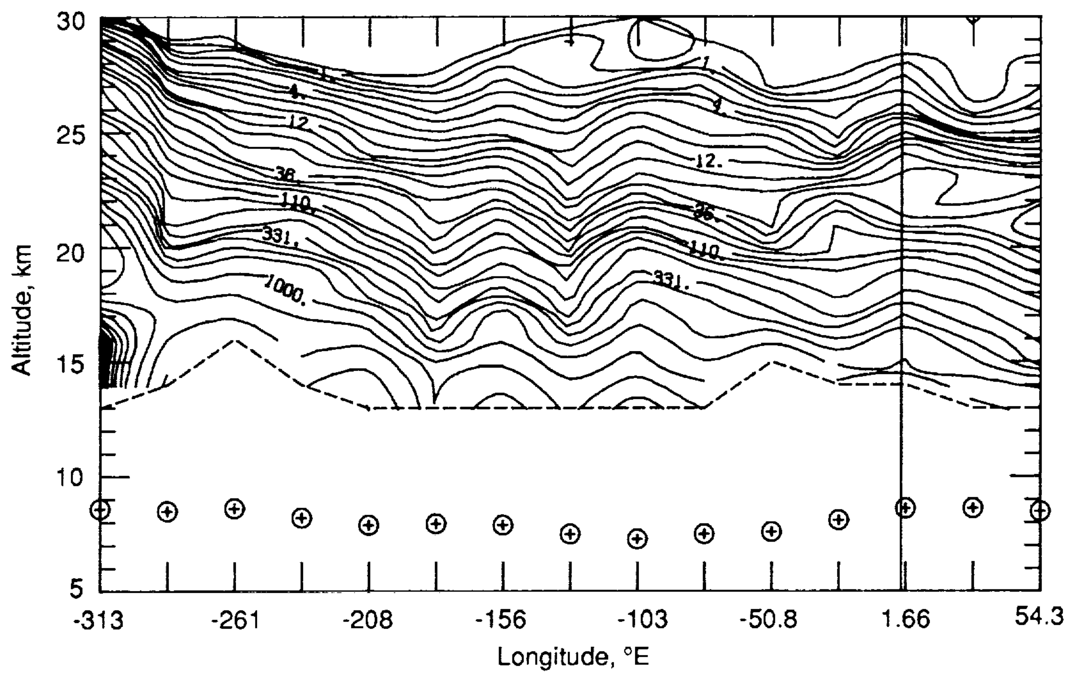



(a) Extinction isopleth.

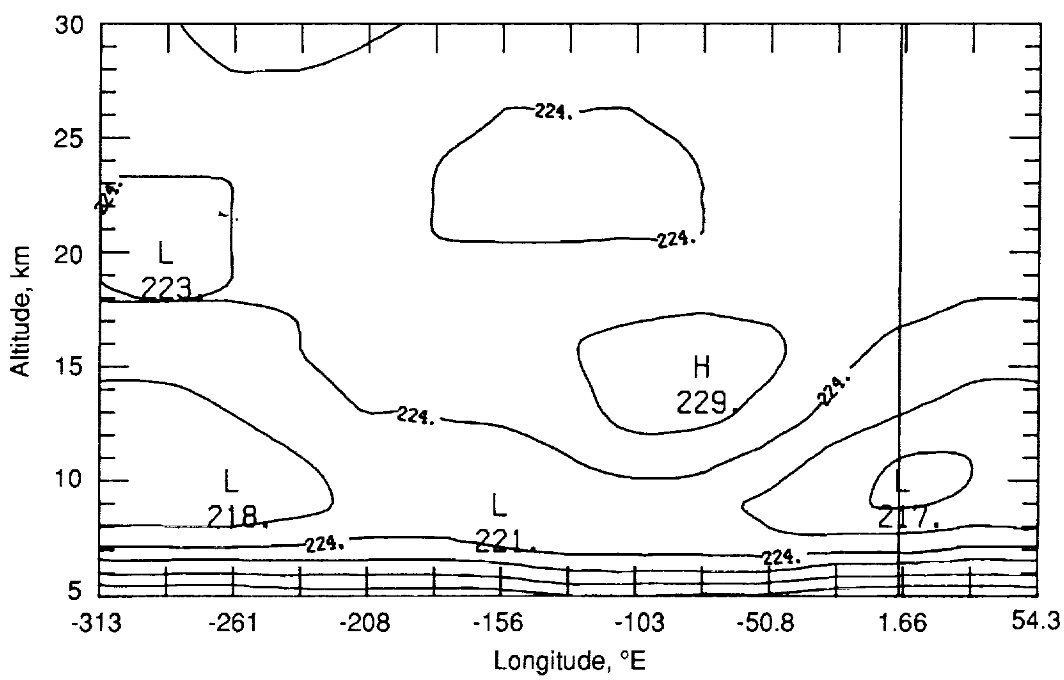



(b) Temperature contours.

Figure 32. Arctic extinction isopleth and temperature contours for March 15.01 to 16.02, 1983, at a latitude of 82.4° to 82.5°N corresponding to orbits 22 151 to 22 165.

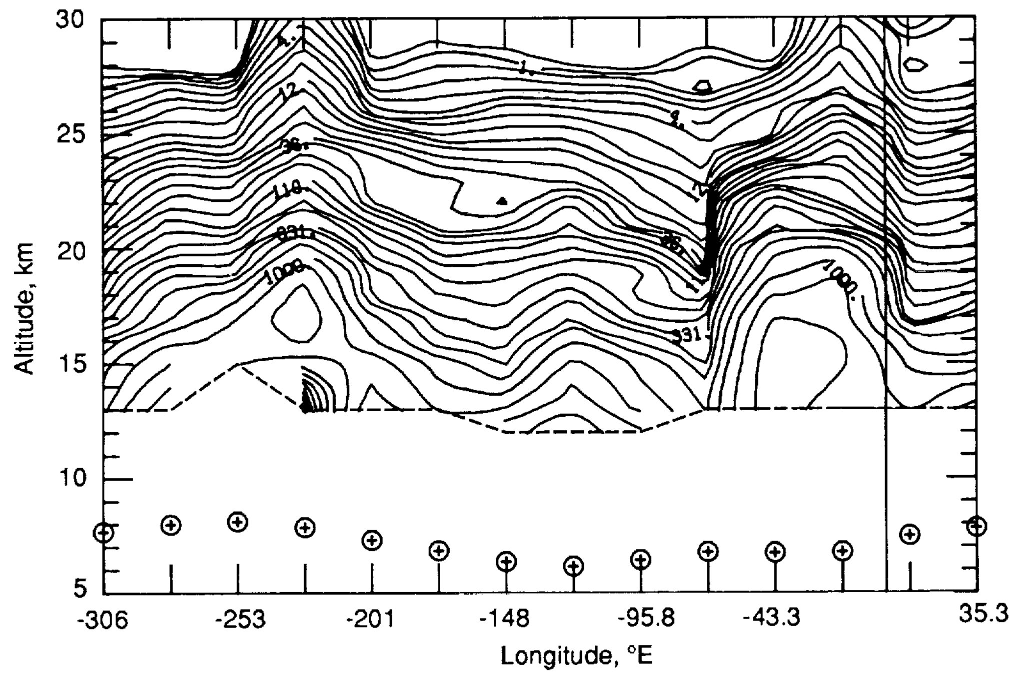



(a) Extinction isopleth.

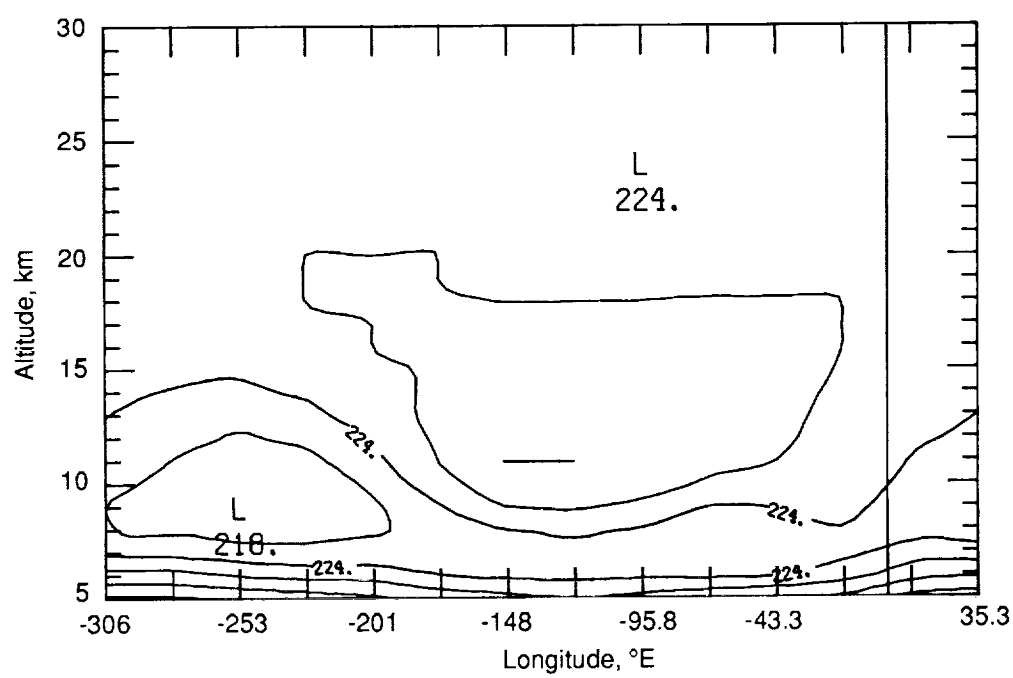



(b) Temperature contours.

Figure 33. Arctic extinction isopleth and temperature contours for March 25.06 to 26.08, 1983, at a latitude of 82.8° to 82.7°N corresponding to orbits 22 290 to 22 304.

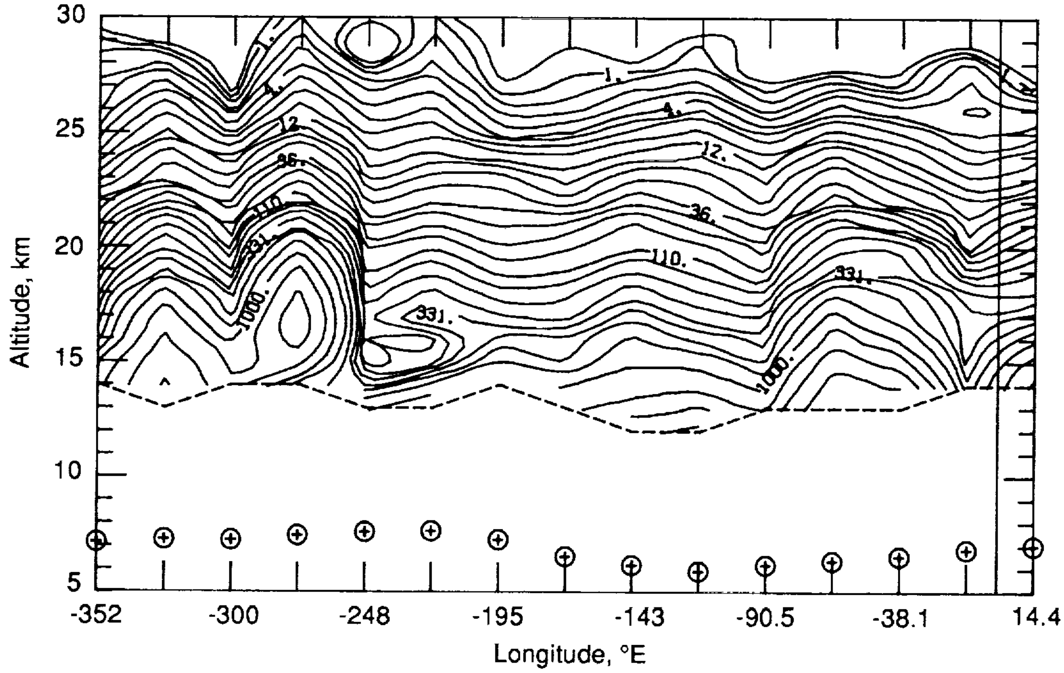



(a) Extinction isopleth.

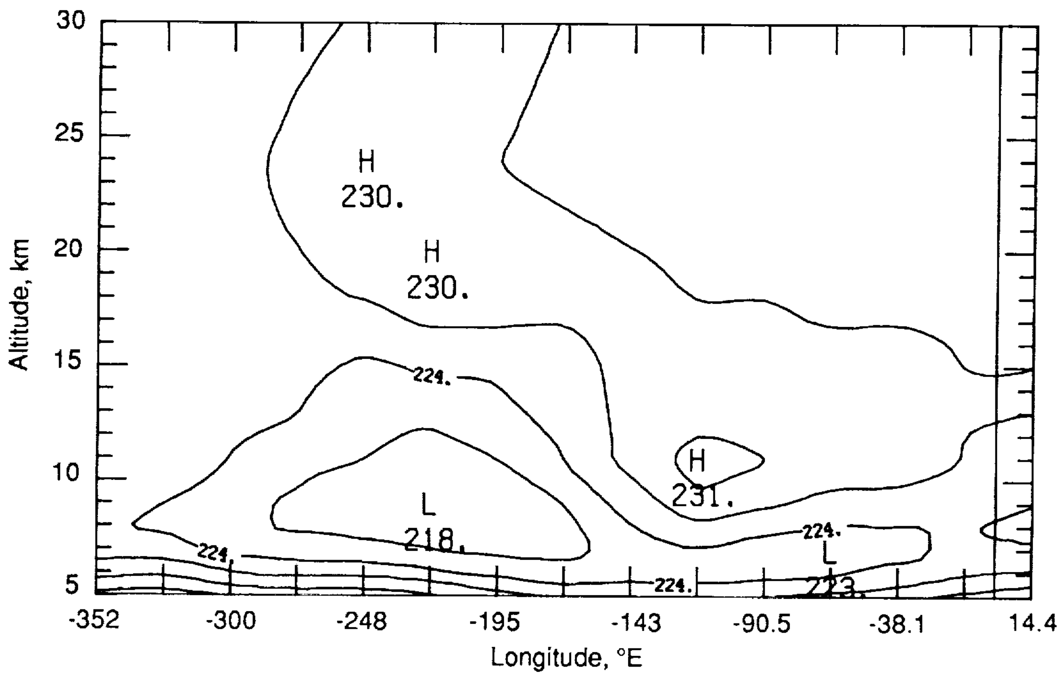



(b) Temperature contours.

Figure 34. Arctic extinction isopleth and temperature contours for March 31.07 to April 1.01, 1983, at a latitude of 82.0° to 81.8°N corresponding to orbits 22 373 to 22 386.

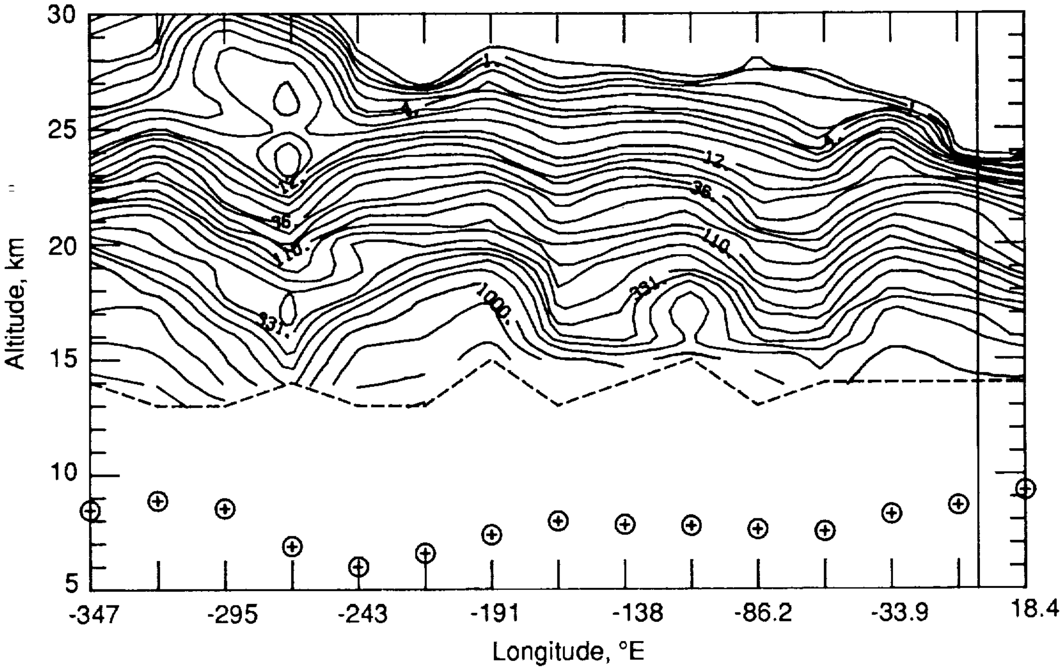



(a) Extinction isopleth.

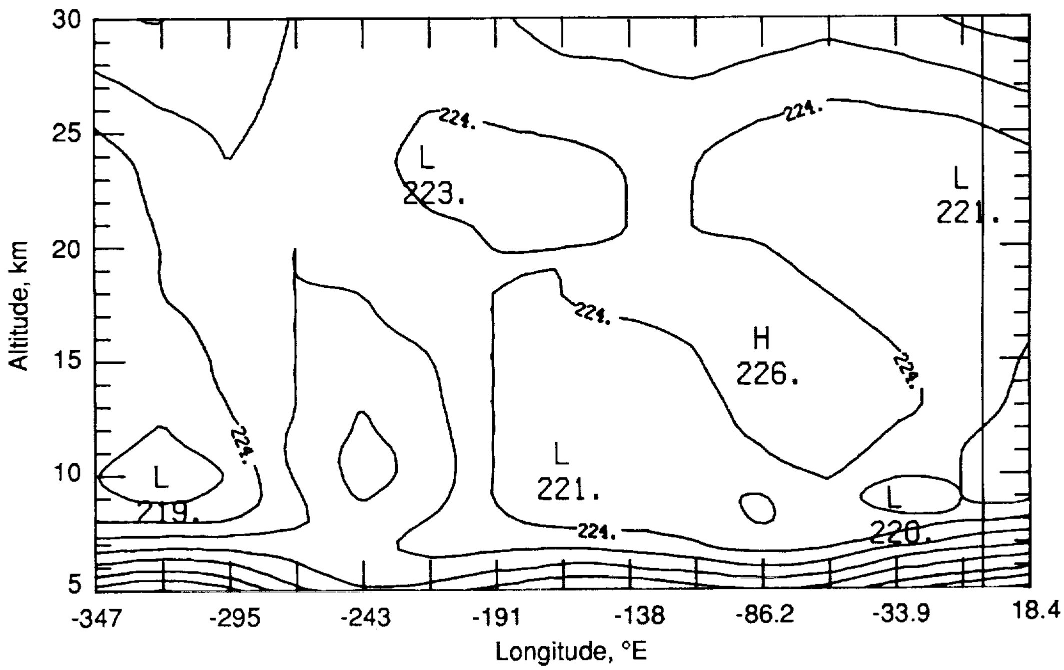



(b) Temperature contours.

Figure 35. Arctic extinction isopleth and temperature contours for April 3.11 to 4.12, 1983, at a latitude of 81.3° to 81.1°N corresponding to orbits 22 415 to 22 429.

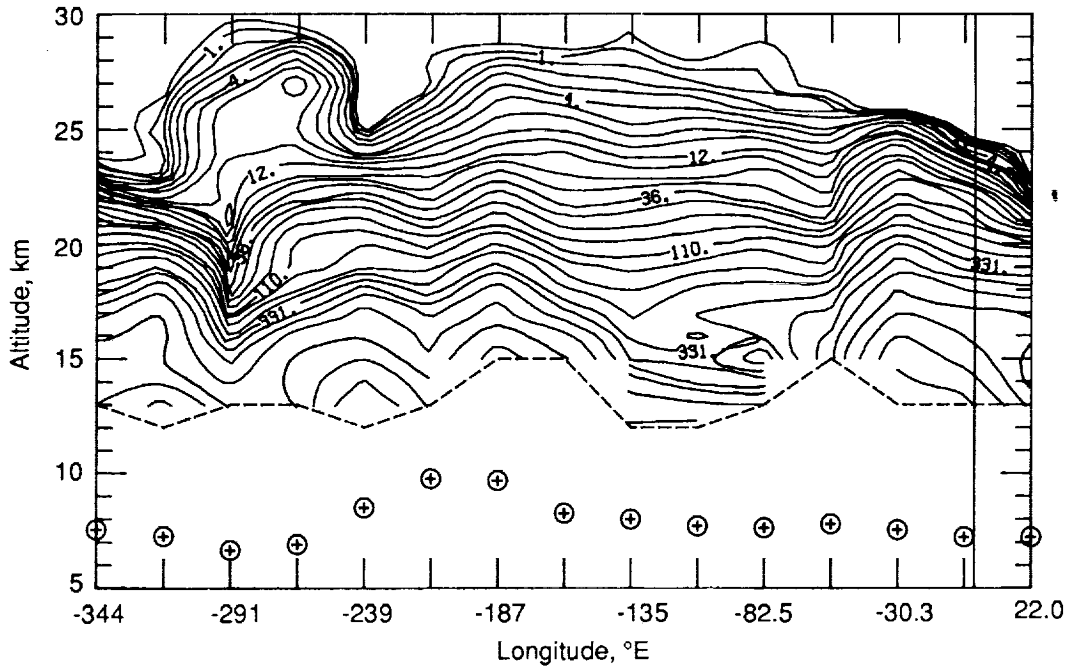



(a) Extinction isopleth.

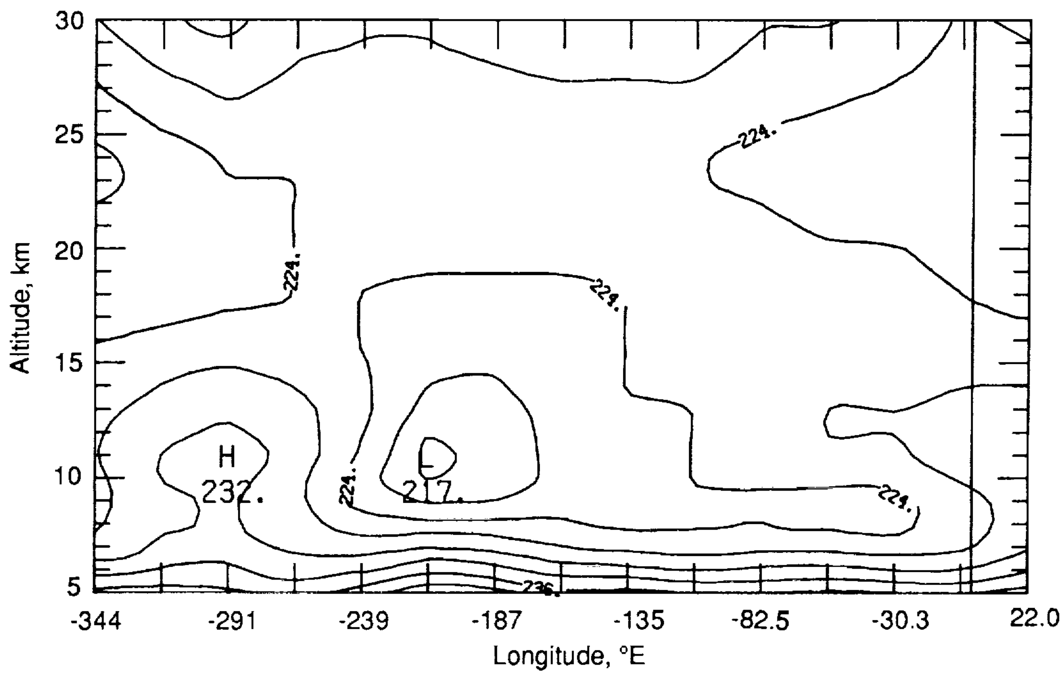



(b) Temperature contours.

Figure 36. Arctic extinction isopleth and temperature contours for April 15.04 to 16.06, 1983, at a latitude of 78.1° to 77.9°N corresponding to orbits 22 580 to 22 594.

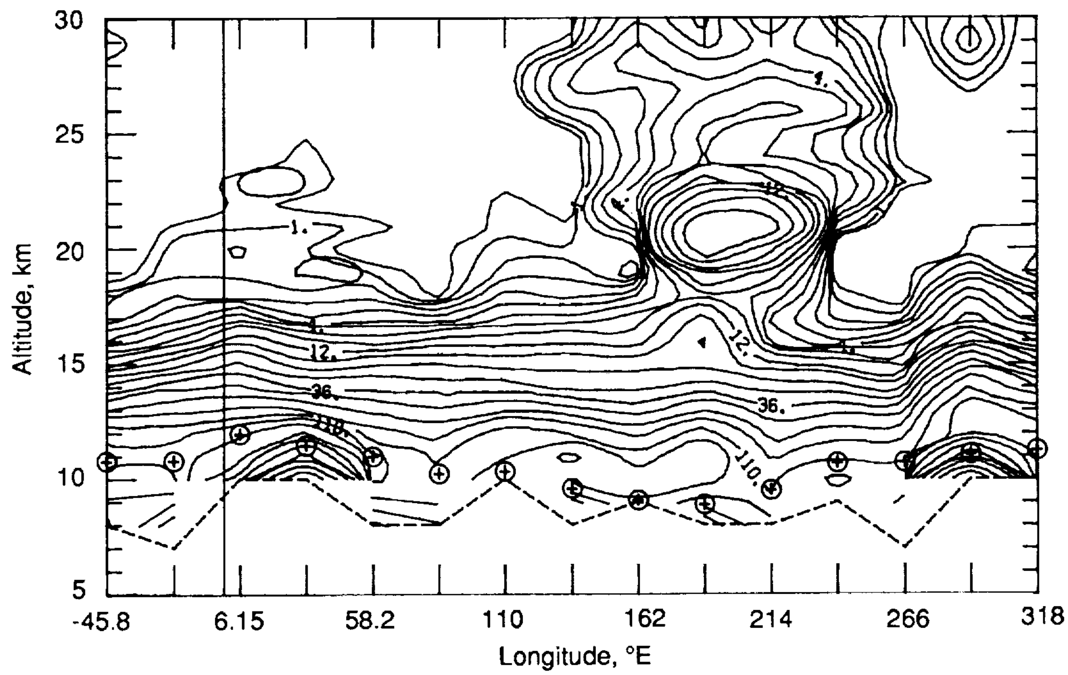



(a) Extinction isopleth.

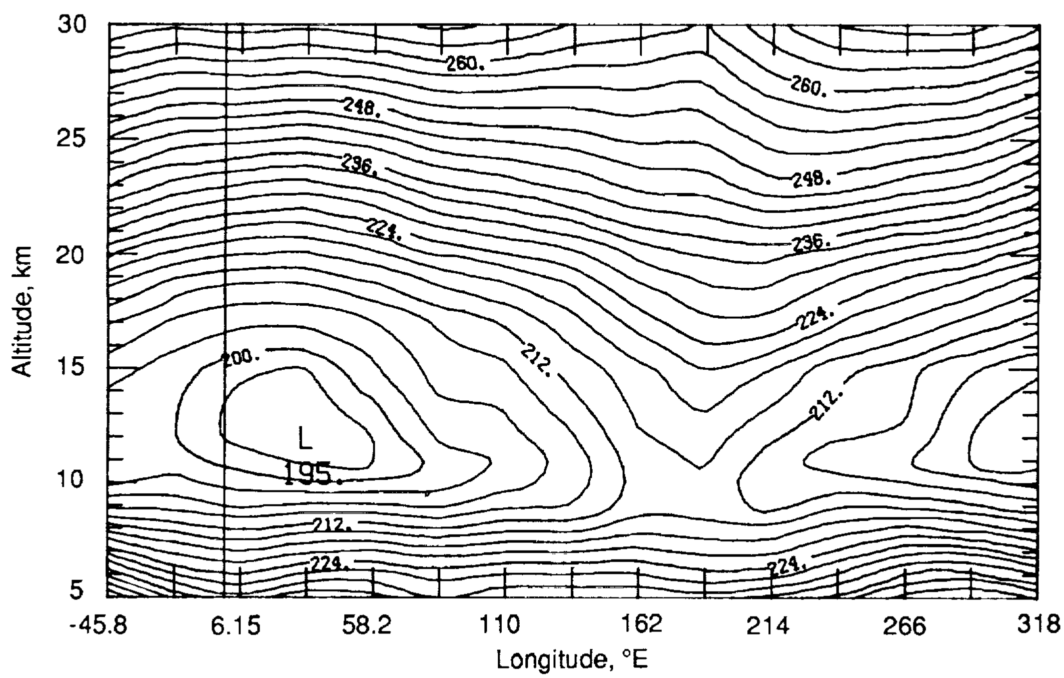



(b) Temperature contours.

Figure 37. Arctic extinction isopleth and temperature contours for April 19.02 to 20.04, 1983, at a latitude of 77.0° to 76.7°N corresponding to orbits 22 635 to 22 649.

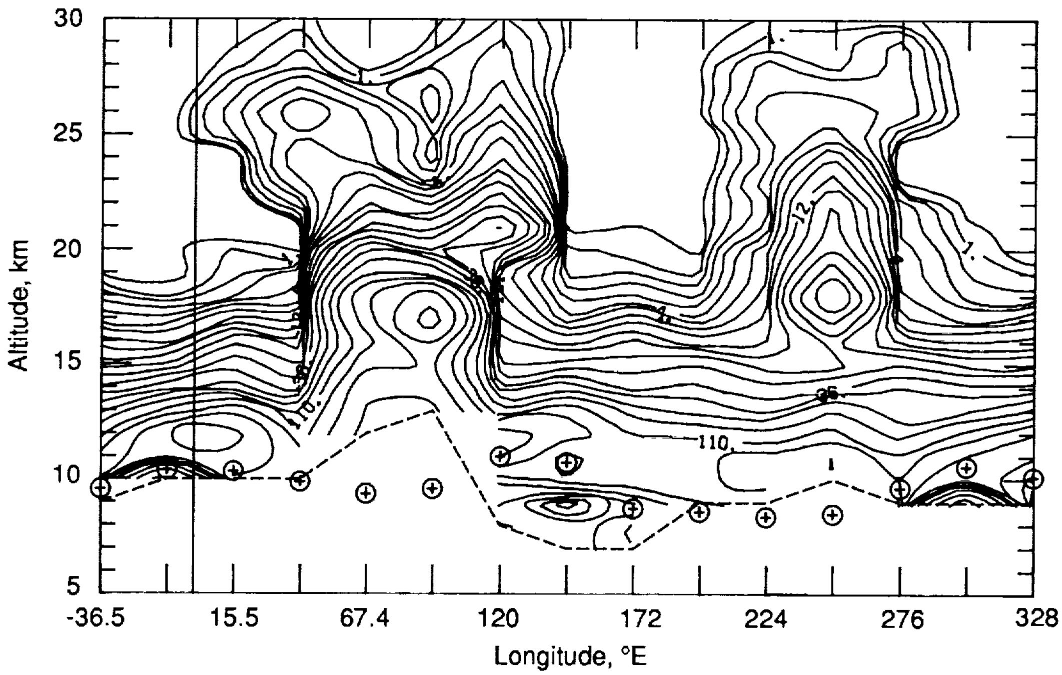



(a) Extinction isopleth.

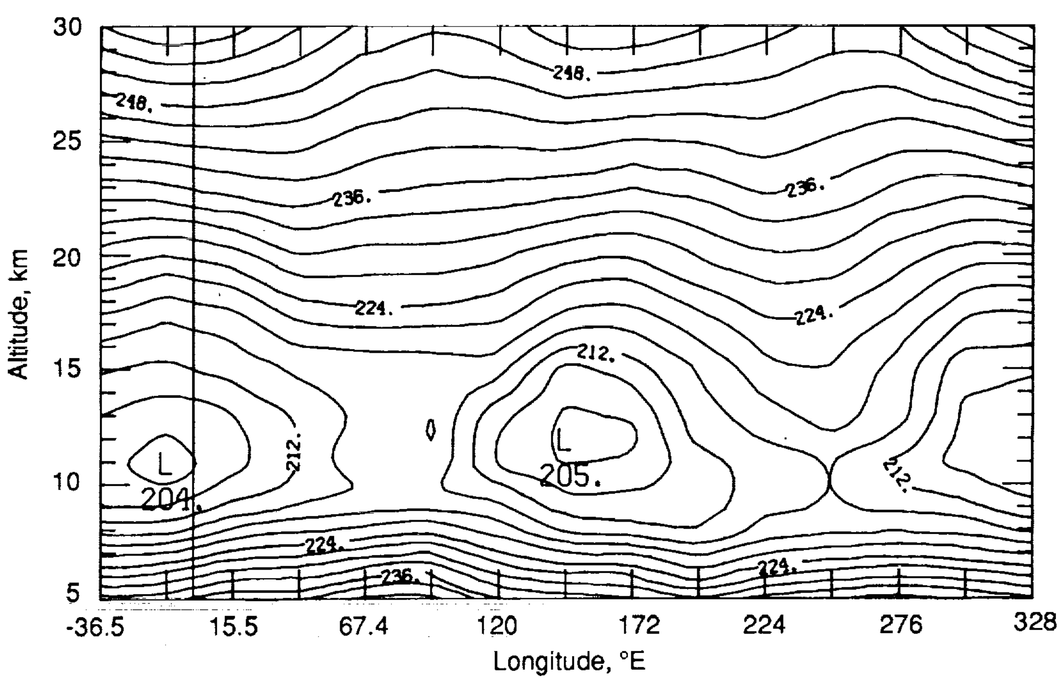



(b) Temperature contours.

Figure 38. Antarctic extinction isopleth and temperature contours for October 24.02 to 25.03, 1982, at latitudes from 76.3° to 76.0°S corresponding to orbits 20 189 to 20 203.

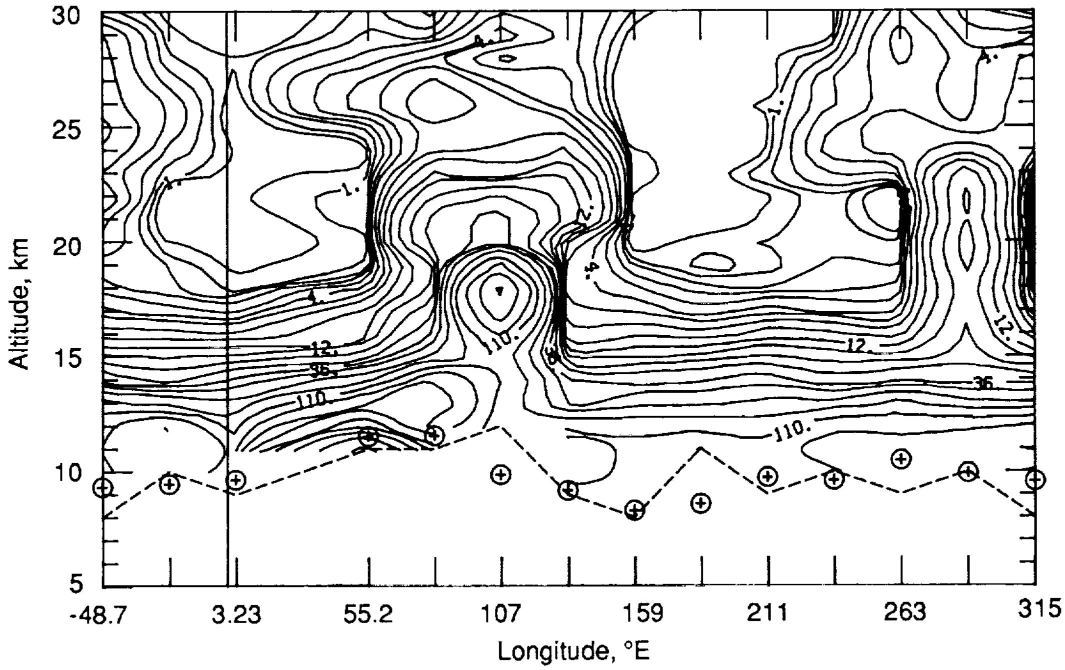



(a) Extinction isopleth.

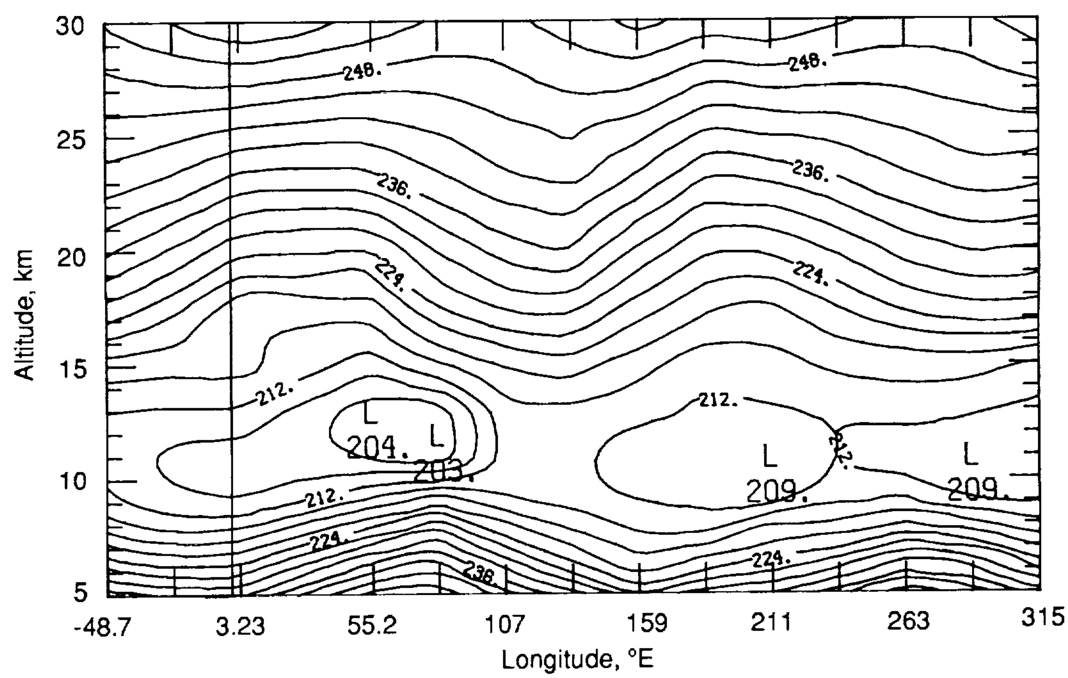



(b) Temperature contours.

Figure 39. Antarctic extinction isopleth and temperature contours for November 4.01 to 5.03, 1982, at latitudes from 73.2° to 72.9°S corresponding to orbits 20 341 to 20 355.

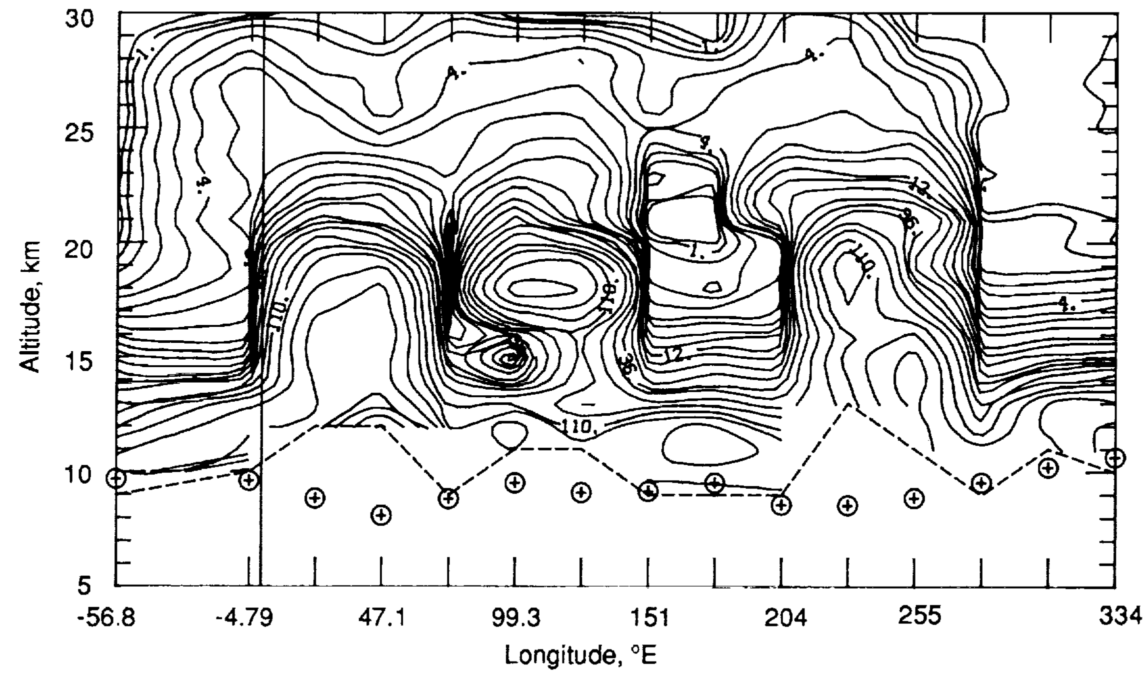



(a) Extinction isopleth.

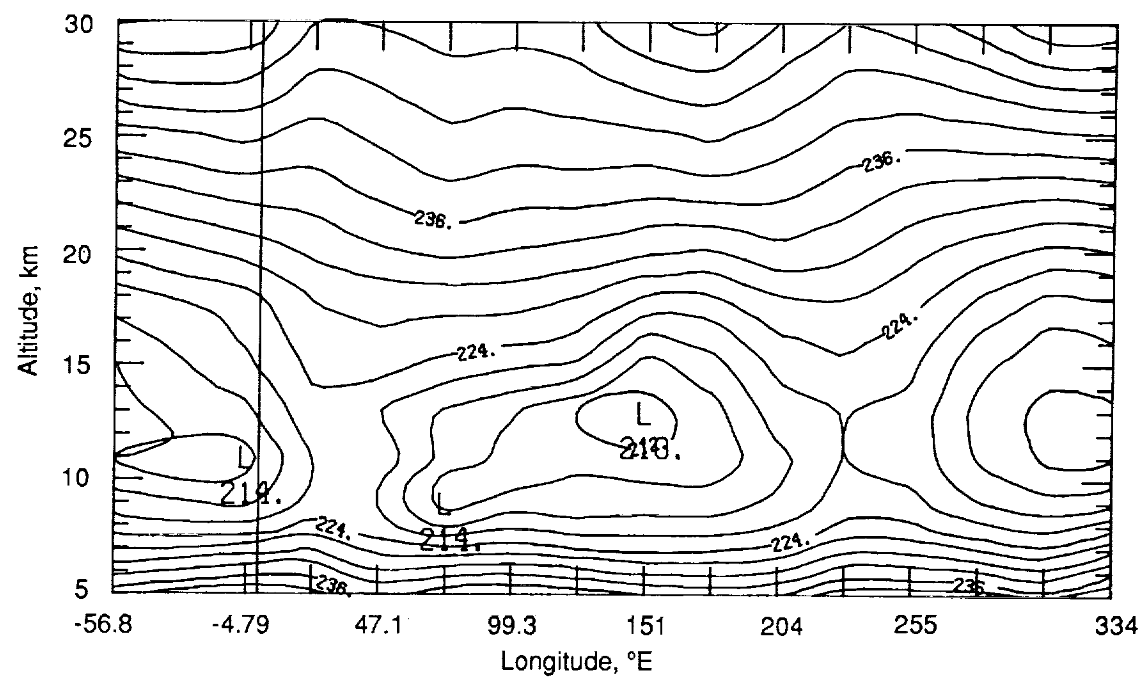



(b) Temperature contours.

Figure 40. Antarctic extinction isopleth and temperature contours for November 7.05 to 8.07, 1982, at latitudes from 72.3° to 72.1°S corresponding to orbits 20 383 to 20 397.

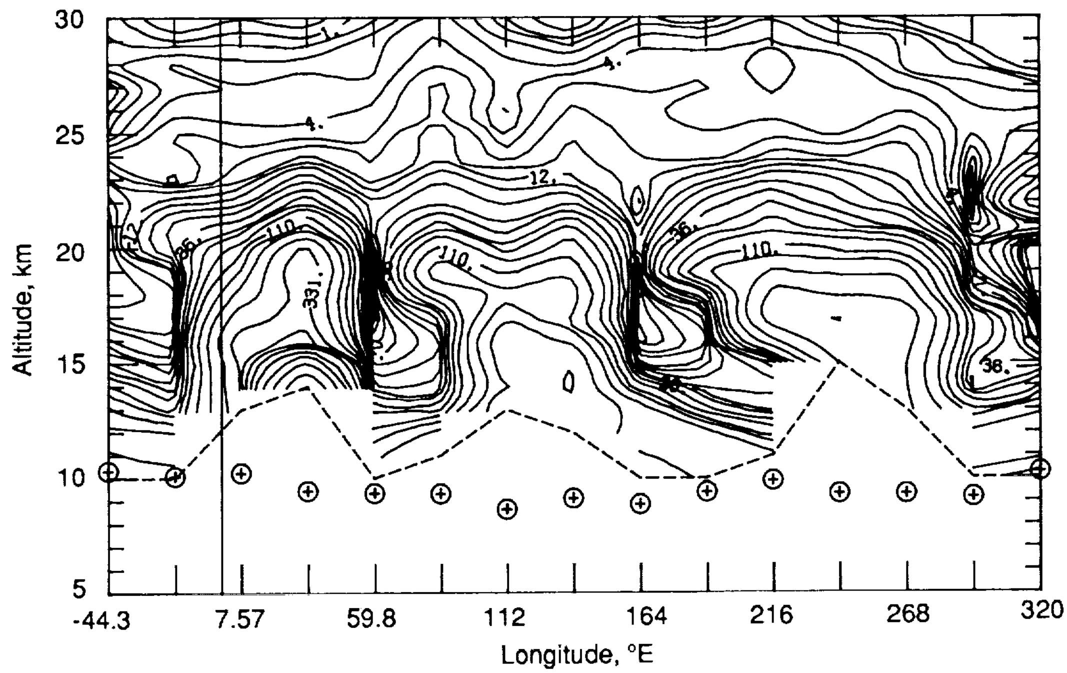



(a) Extinction isopleth.

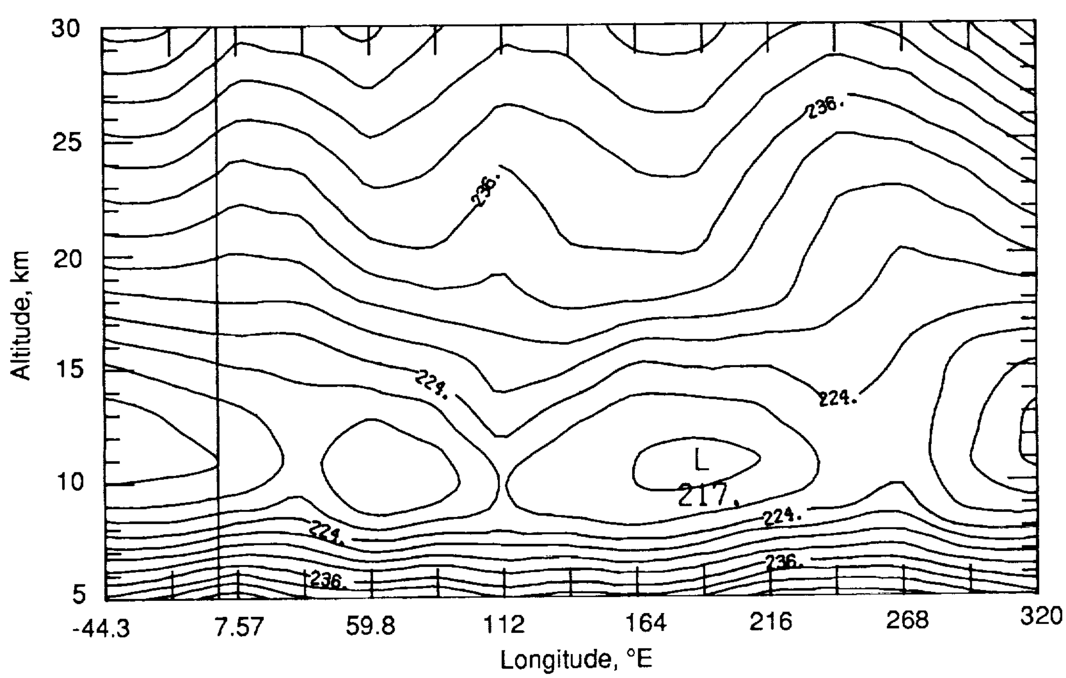



(b) Temperature contours.

Figure 41. Antarctic extinction isopleth and temperature contours for November 15.01 to 16.10, 1982, at latitudes from 70.3° to 70.0°S corresponding to orbits 20 493 to 20 508.

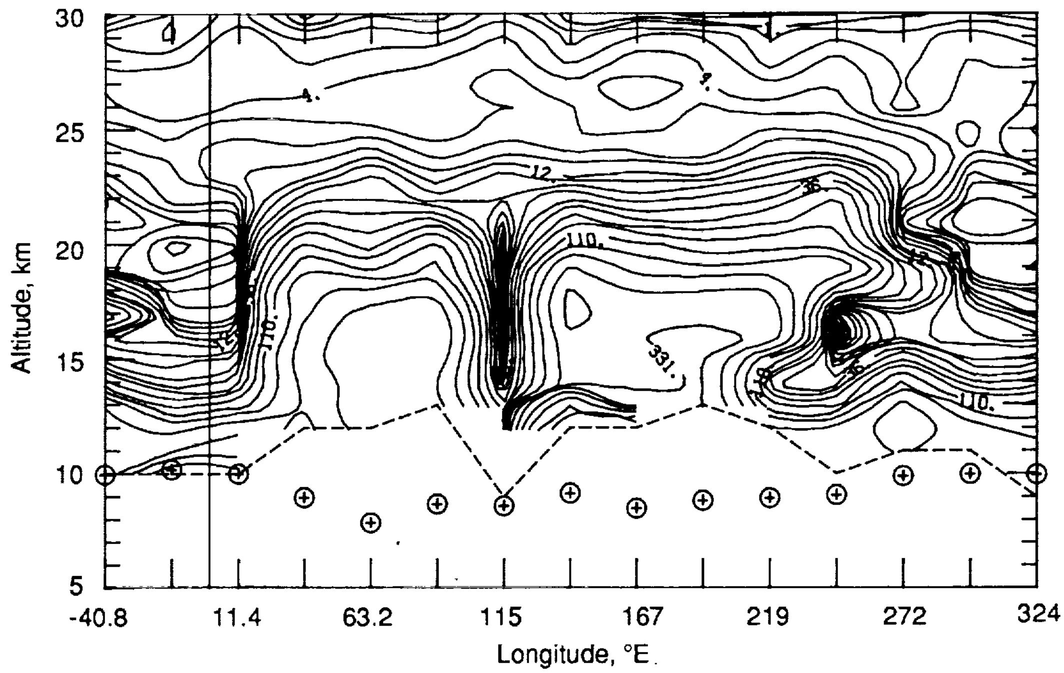



(a) Extinction isopleth.

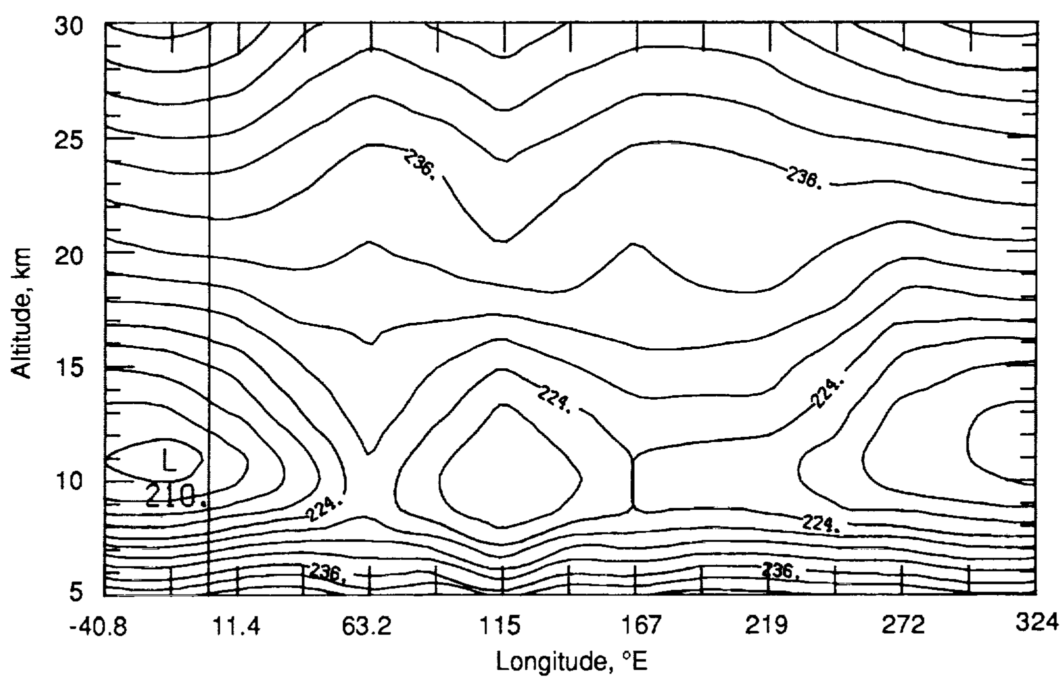



(b) Temperature contours.

Figure 42. Antarctic extinction isopleth and temperature contours for November 24.05 to 25.07, 1982, at latitudes from 68.3° to 68.0°S corresponding to orbits 20 618 to 20 632.

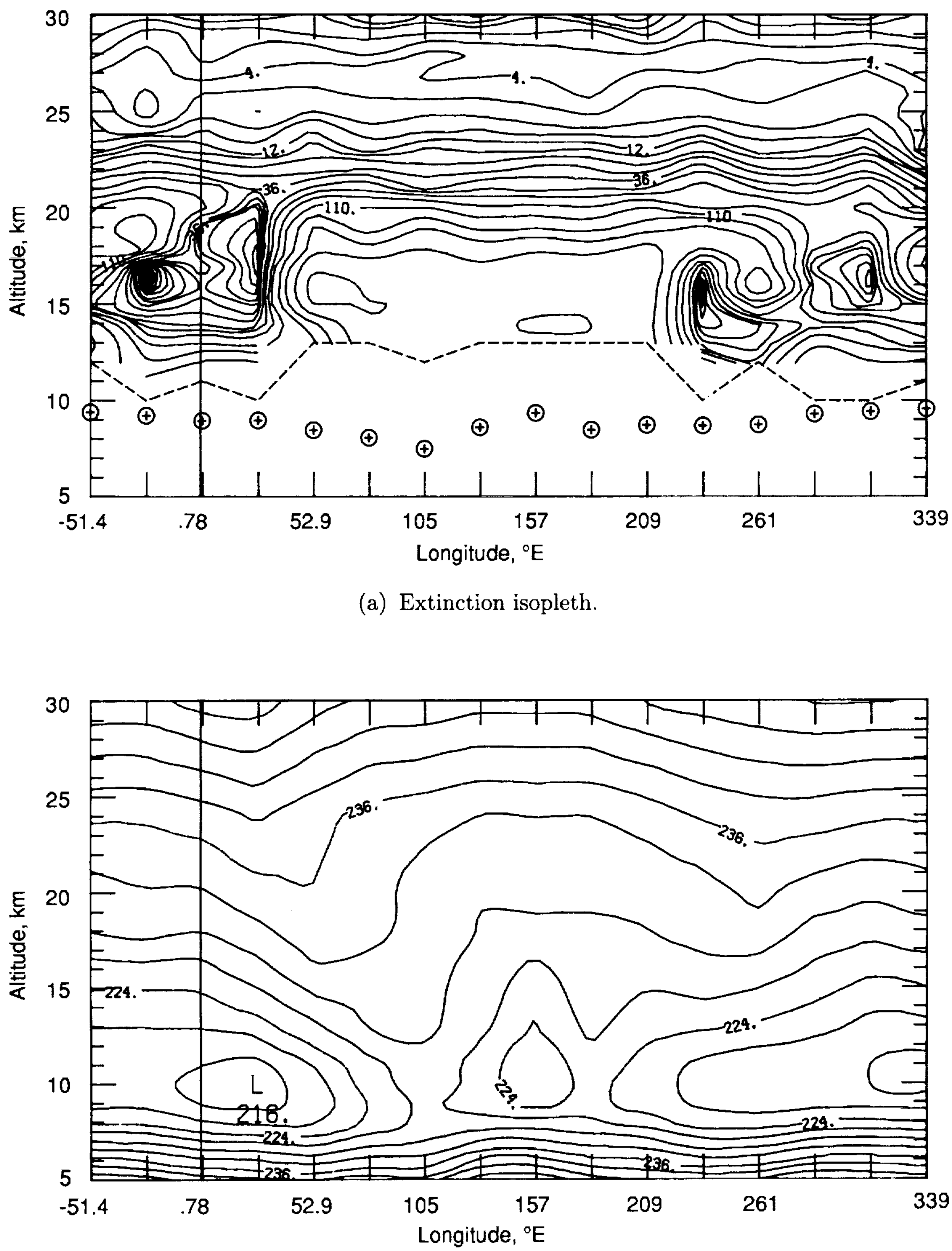



(a) Extinction isopleth.




(b) Temperature contours.

Figure 43. Antarctic extinction isopleth and temperature contours for November 29.04 to 30.06, 1982, at latitudes from 67.3° to 67.1°S corresponding to orbits 20 687 to 20 701.

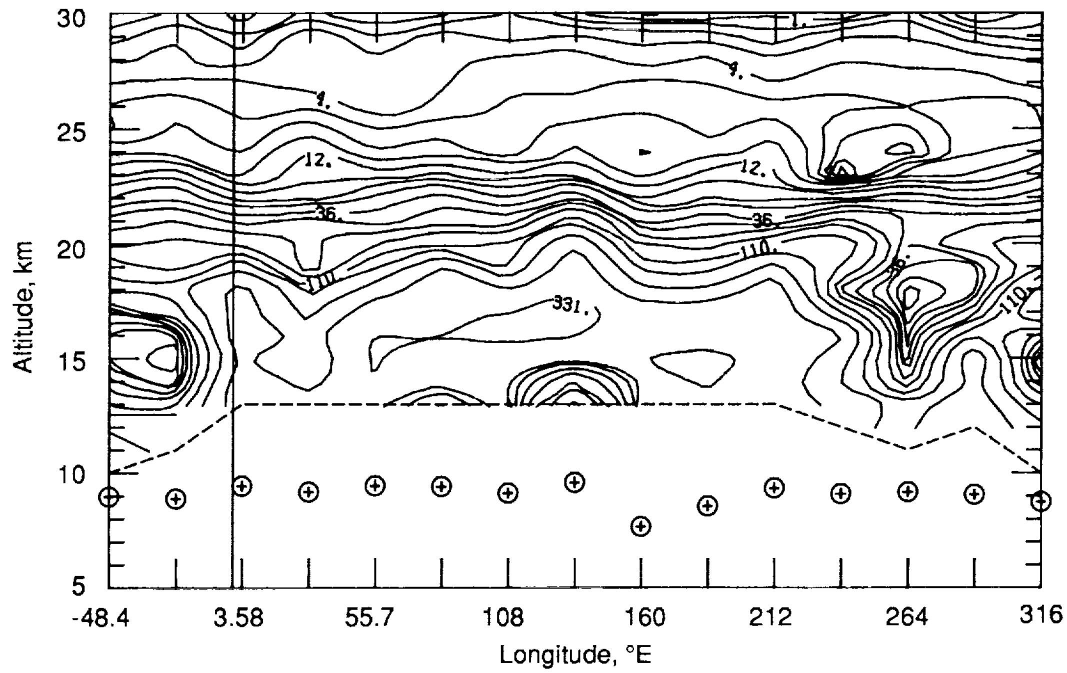



(a) Extinction isopleth.

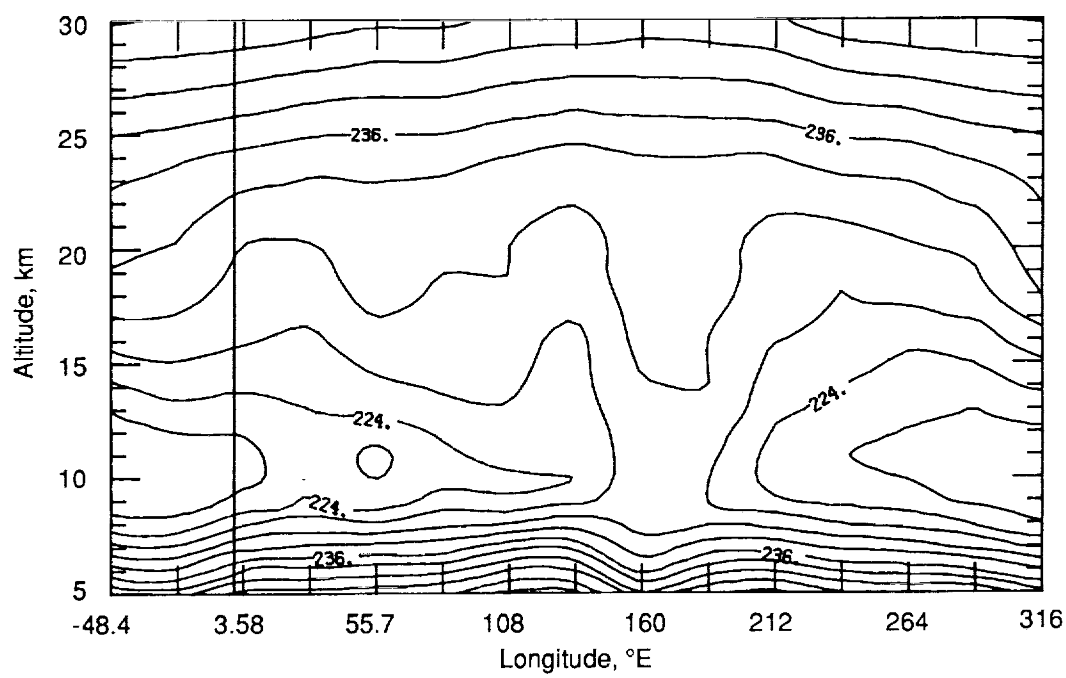


(b) Temperature contours.

Figure 44. Antarctic extinction isopleth and temperature contours for December 7.00 to 8.09, 1982, at latitudes from 66.0° to 65.9°S corresponding to orbits 20 797 to 20 812.

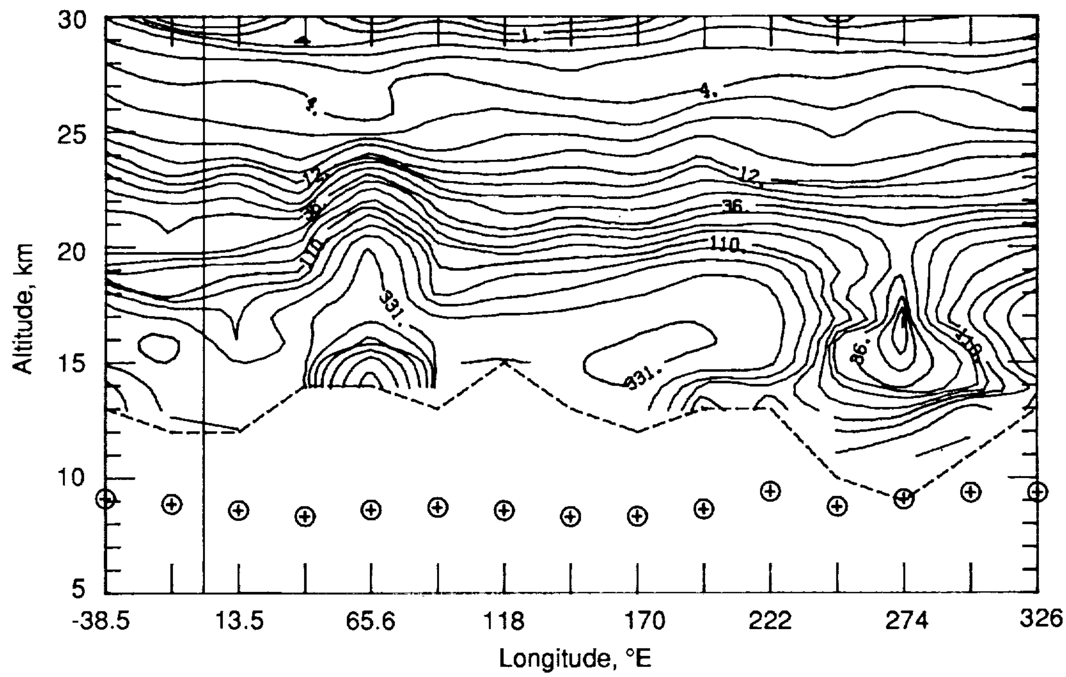



(a) Extinction isopleth.

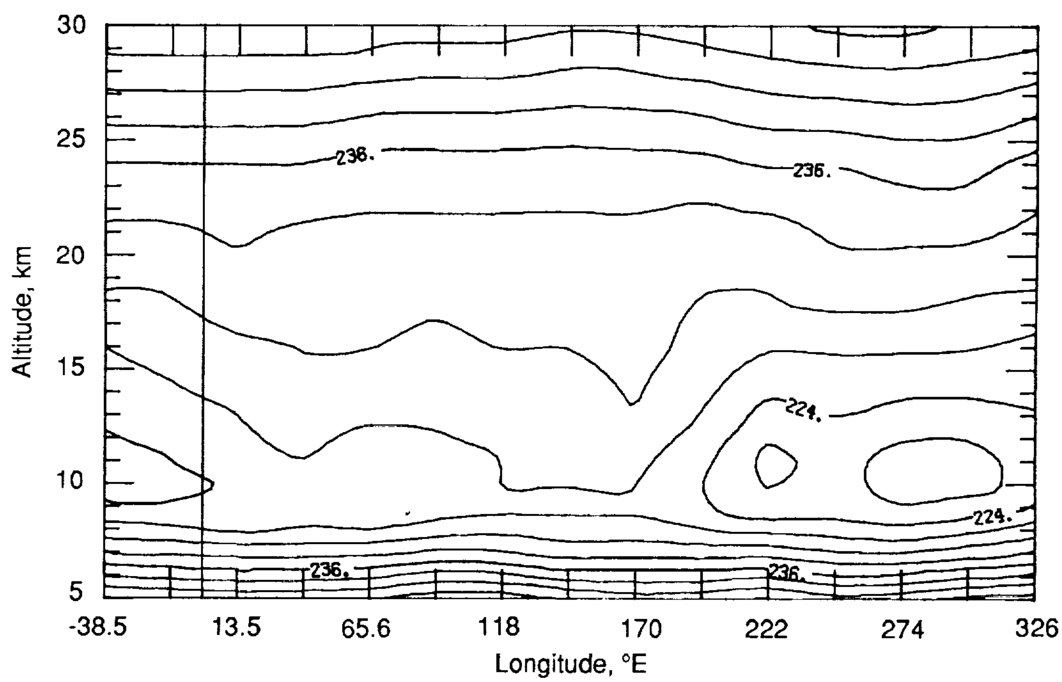



(b) Temperature contours.

Figure 45. Antarctic extinction isopleth and temperature contours for December 12.07 to 13.08, 1982, at latitudes from 65.5° to 65.4°S corresponding to orbits 20 867 to 20 881.

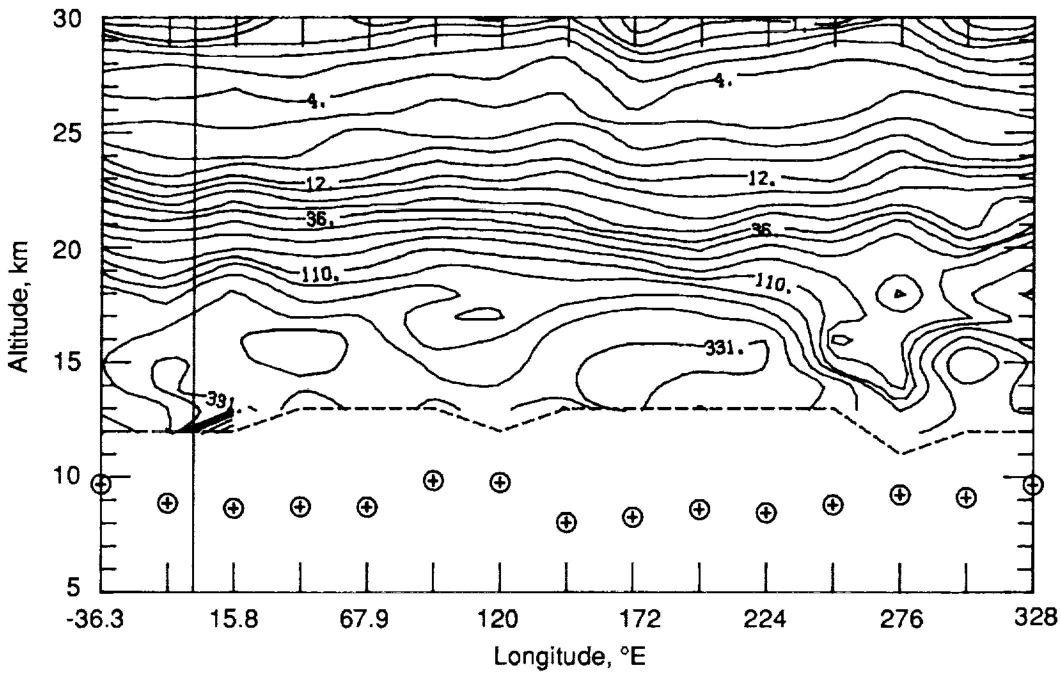



(a) Extinction isopleth.

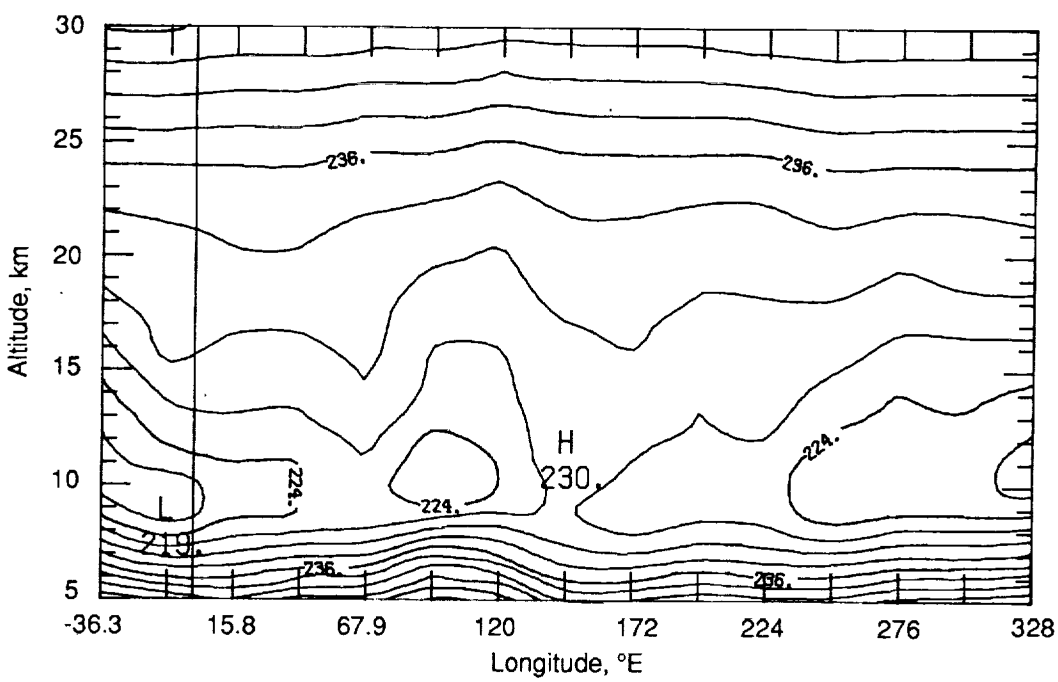



(b) Temperature contours.

Figure 46. Antarctic extinction isopleth and temperature contours for December 21.04 to 22.05, 1982, at a latitude of 64.8°S corresponding to orbits 20 991 to 21 005.

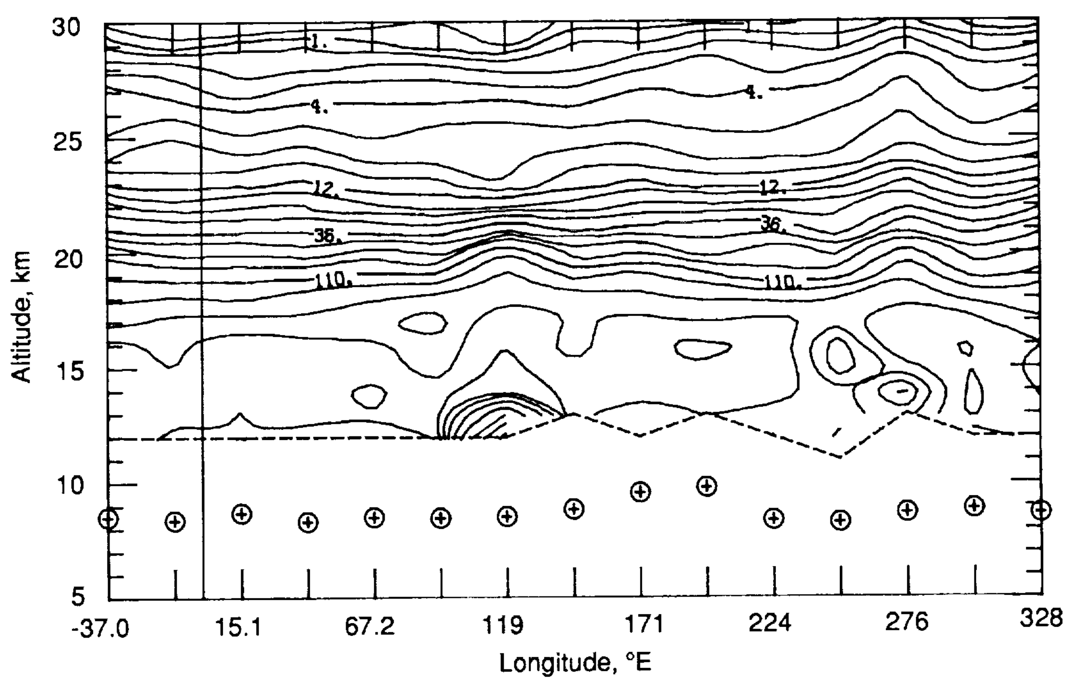



(a) Extinction isopleth.

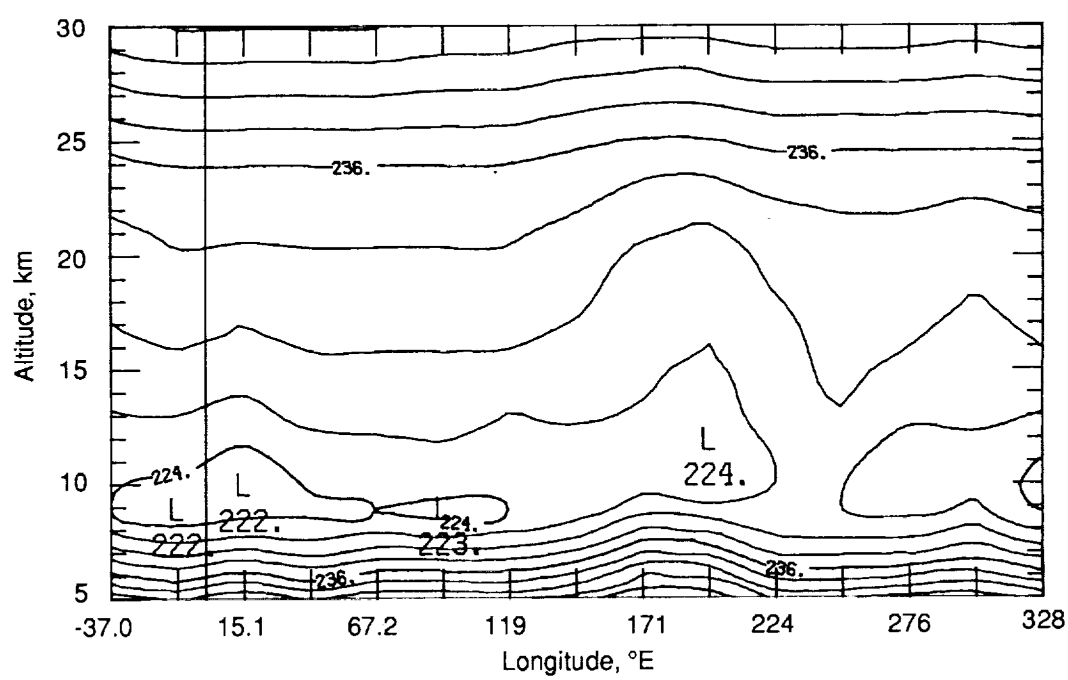



(b) Temperature contours.

Figure 47. Antarctic extinction isopleth and temperature contours for December 26.03 to 27.04, 1982, at a latitude of 64.7°S corresponding to orbits 21 060 to 21 074.

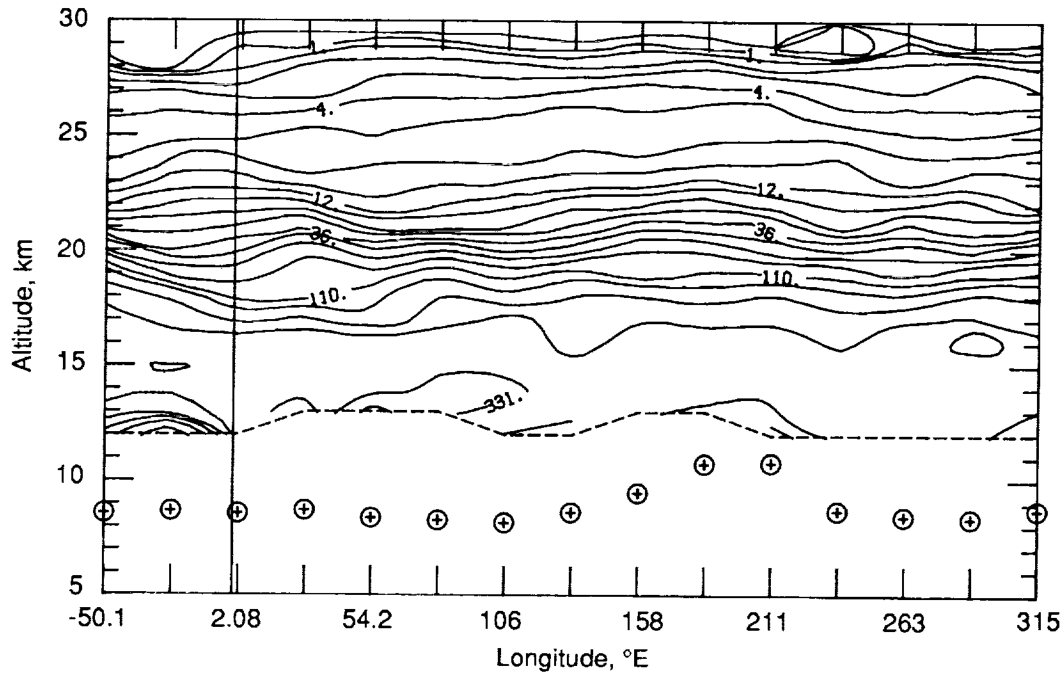



(a) Extinction isopleth.

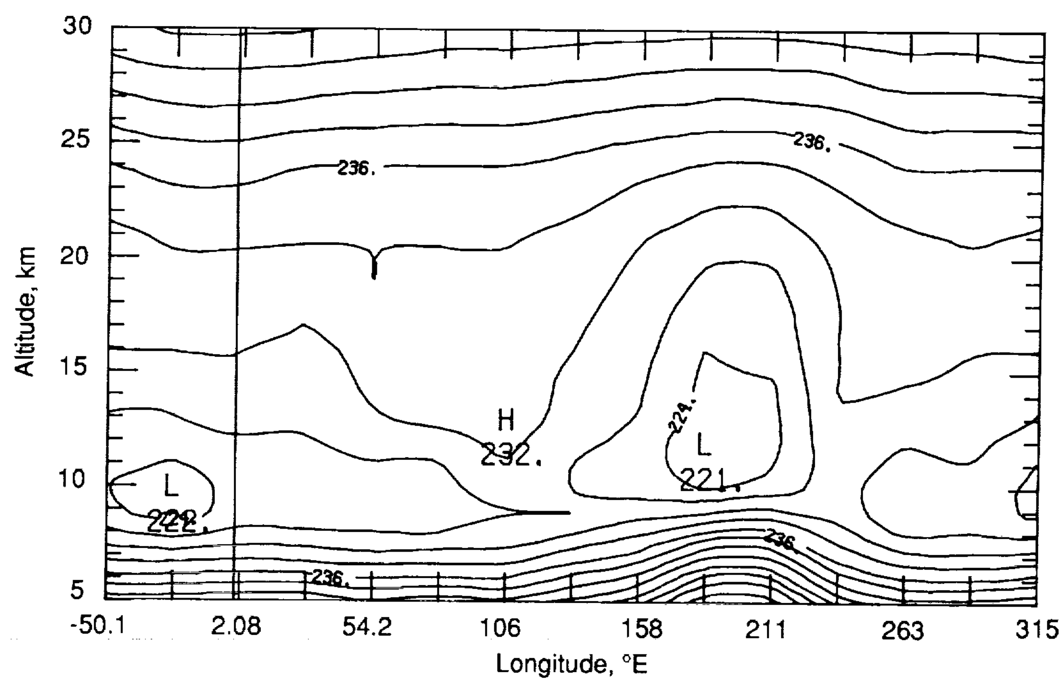



(b) Temperature contours.

Figure 48. Antarctic extinction isopleth and temperature contours for January 6.03 to 7.04, 1983, at a latitude of 65.0° to 65.1°S corresponding to orbits 21 212 to 21 226.

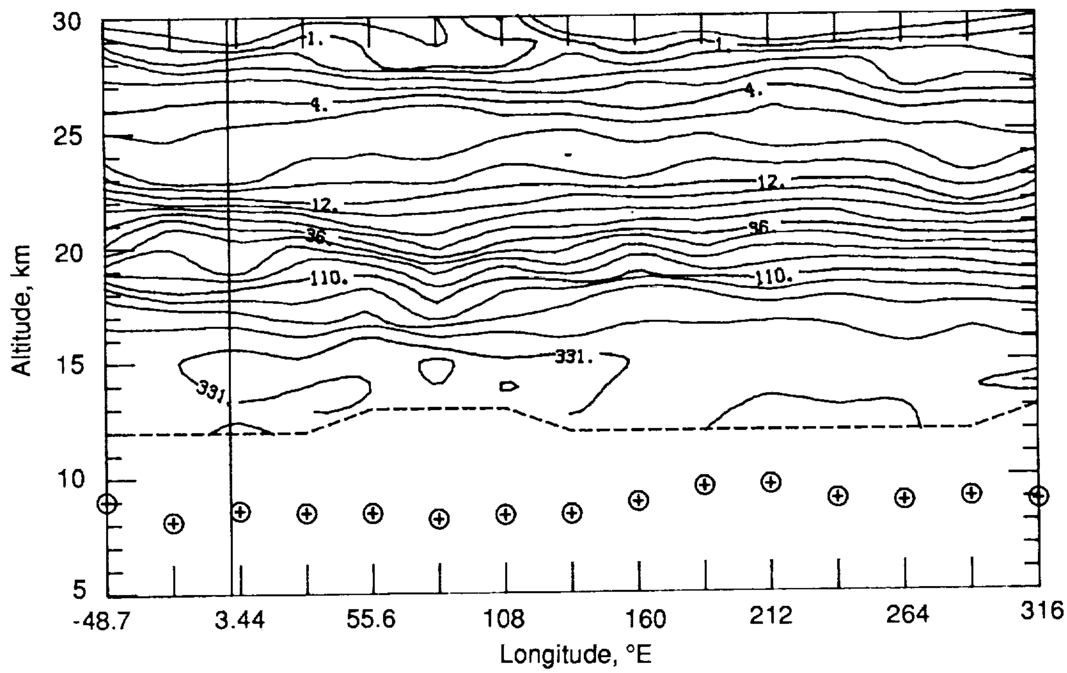



(a) Extinction isopleth.

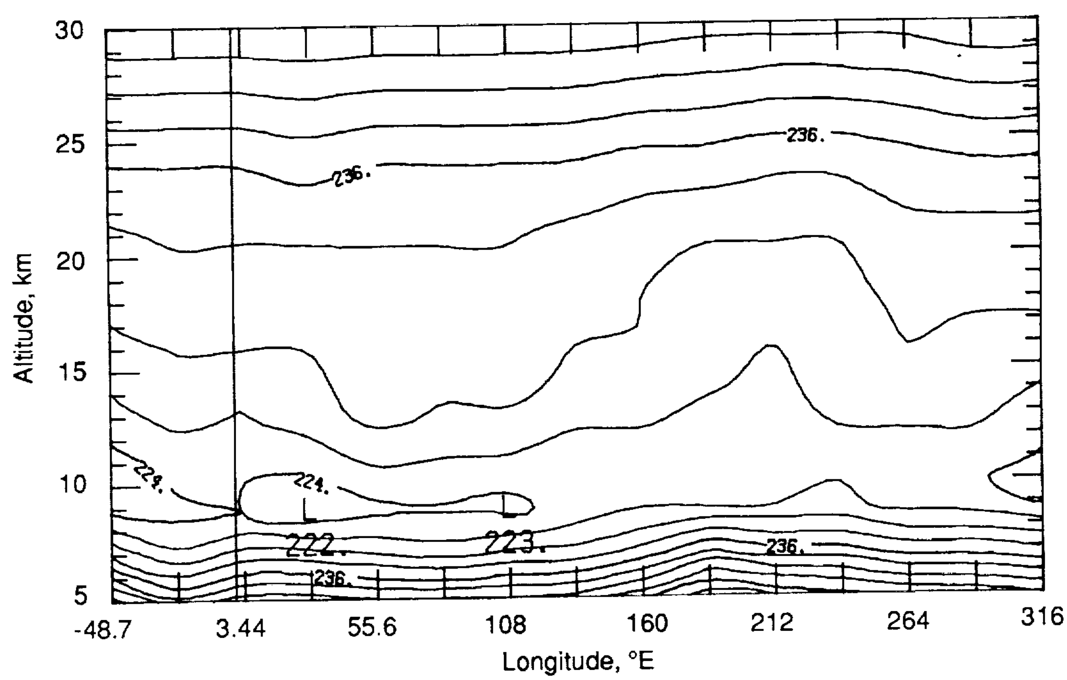



(b) Temperature contours.

Figure 49. Antarctic extinction isopleth and temperature contours for January 14.06 to 15.07, 1983, at a latitude of 65.7° to 65.9°S corresponding to orbits 21 323 to 21 337.

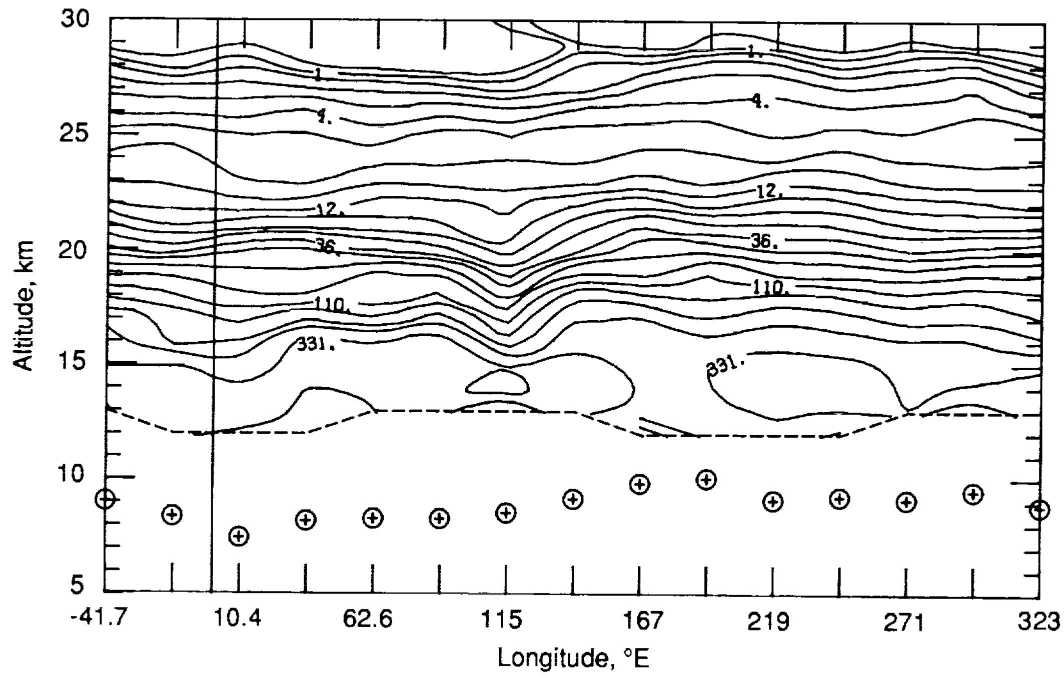



(a) Extinction isopleth.

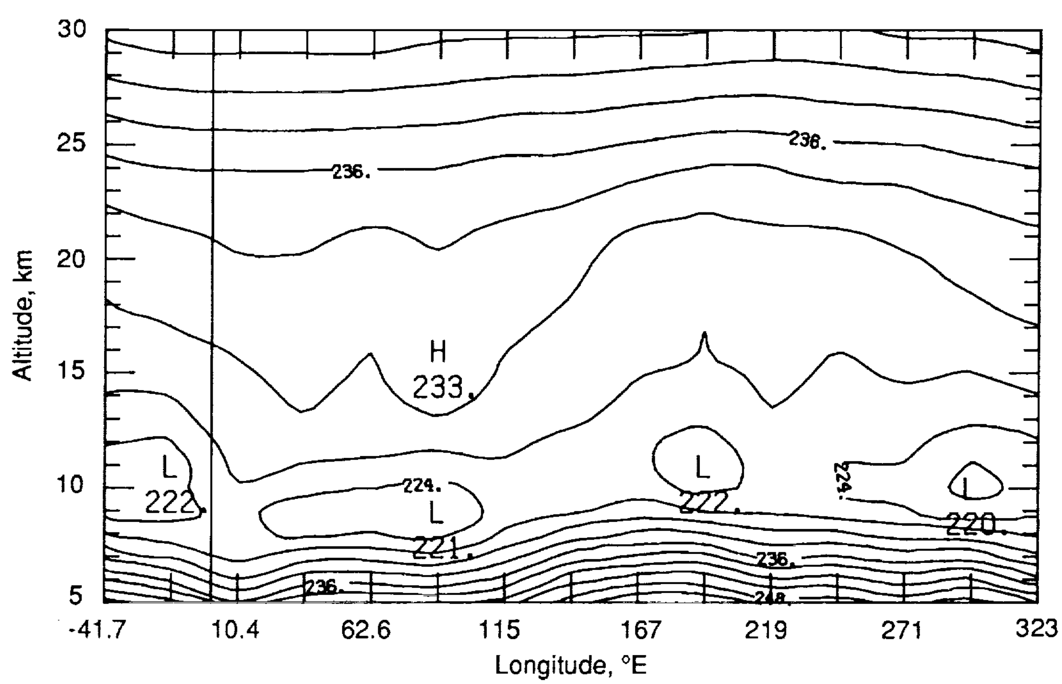



(b) Temperature contours.

Figure 50. Antarctic extinction isopleth and temperature contours for January 19.05 to 20.06, 1983, at a latitude of 66.4° to 66.5°S corresponding to orbits 21 392 to 21 406.

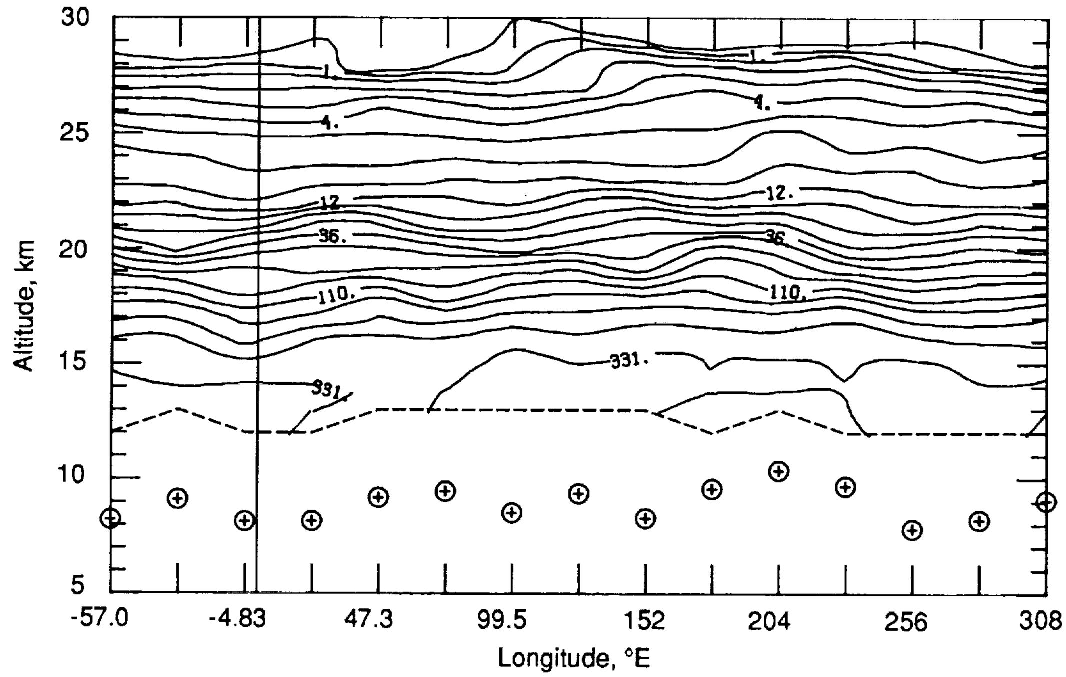



(a) Extinction isopleth.

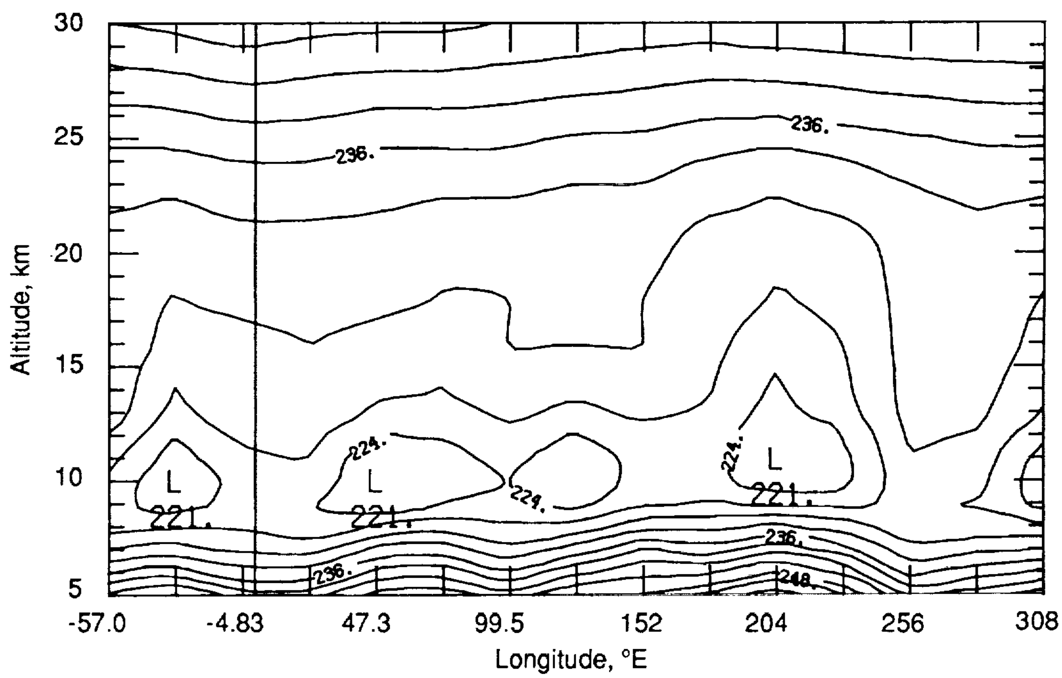



(b) Temperature contours.

Figure 51. Antarctic extinction isopleth and temperature contours for January 28.02 to 29.03, 1983, at a latitude of 67.9° to 68.1°S corresponding to orbits 21 516 to 21 530.

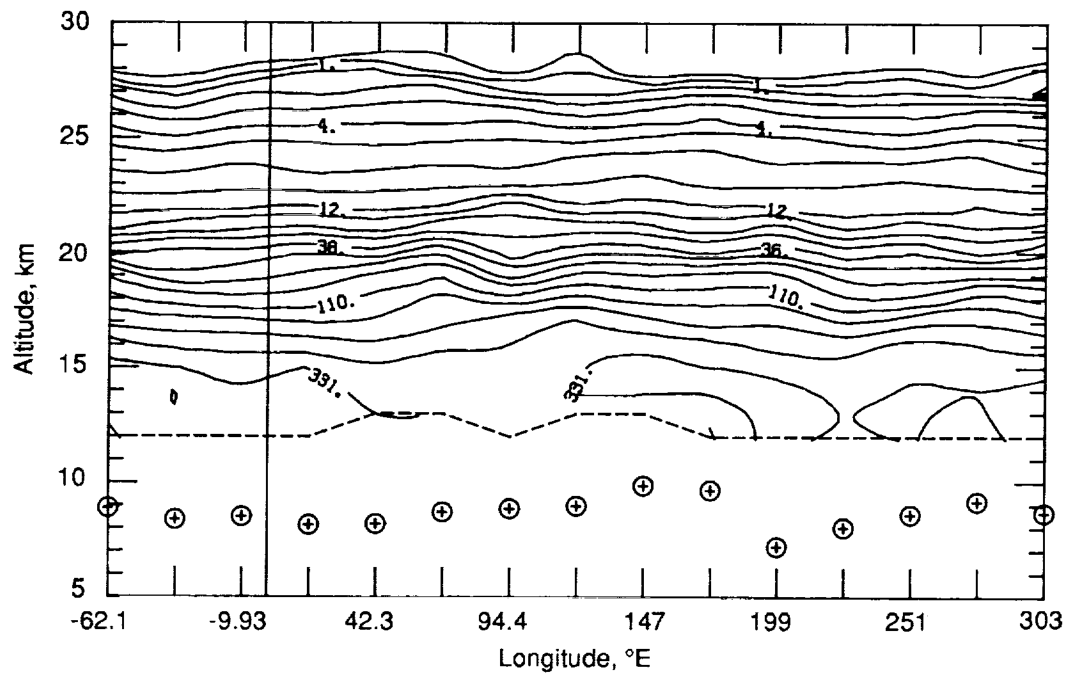



(a) Extinction isopleth.

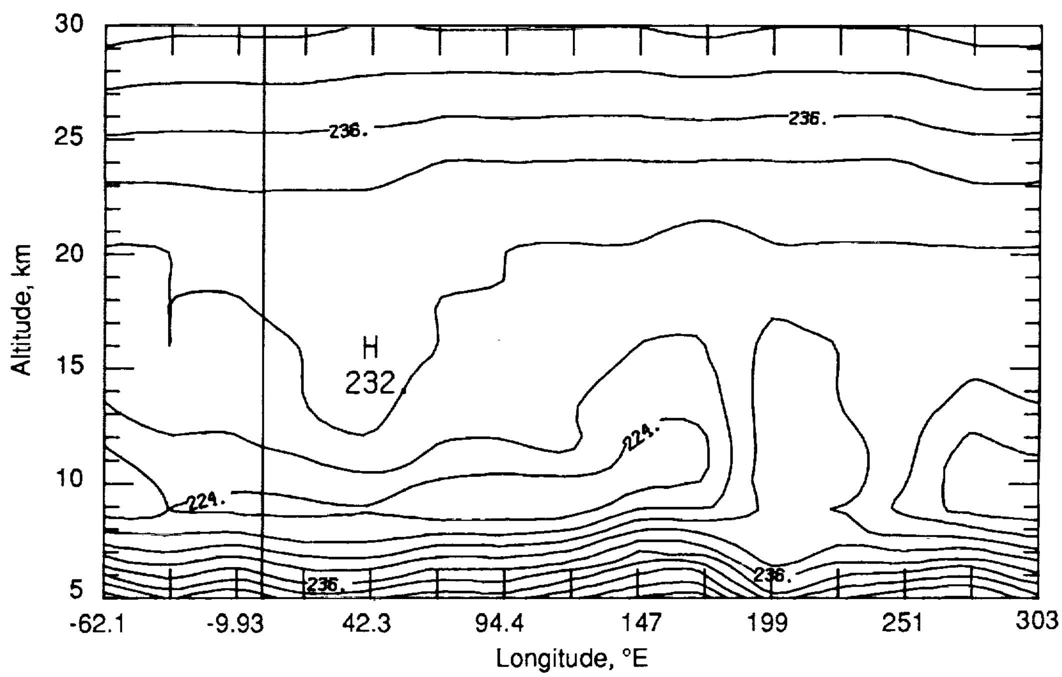



(b) Temperature contours.

Figure 52. Antarctic extinction isopleth and temperature contours for January 31.06 to February 1.07, 1983, at a latitude of 68.5° to 68.7°S corresponding to orbits 21 558 to 21 572.

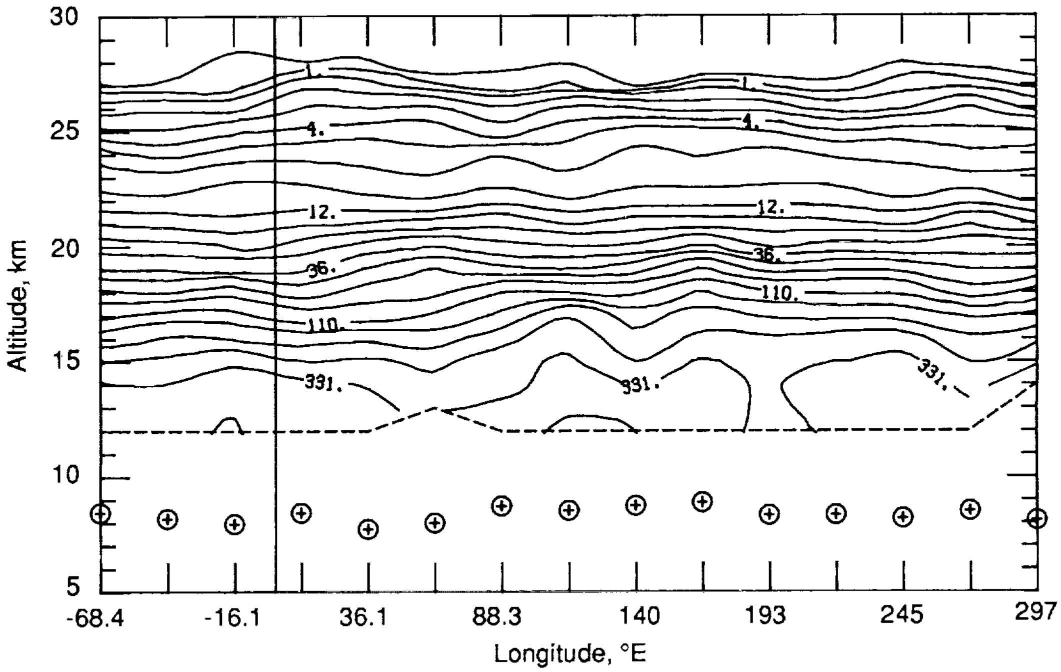



(a) Extinction isopleth.

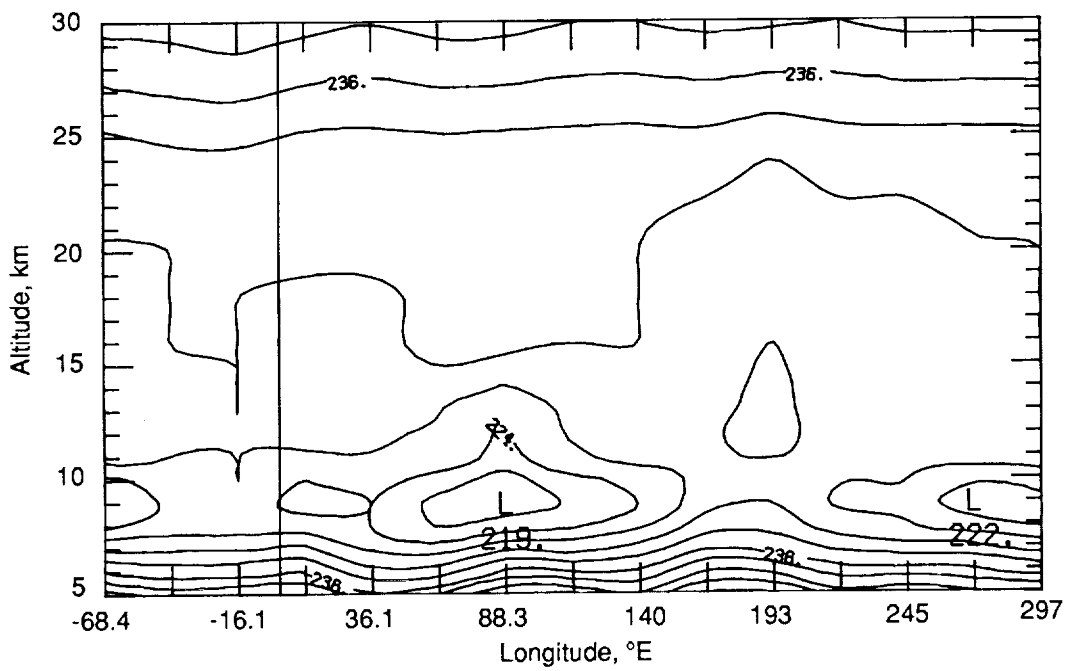



(b) Temperature contours.

Figure 53. Antarctic extinction isopleth and temperature contours for February 11.05 to 12.07, 1983, at a latitude of 71.0° to 71.2°S corresponding to orbits 21 710 to 21 724.

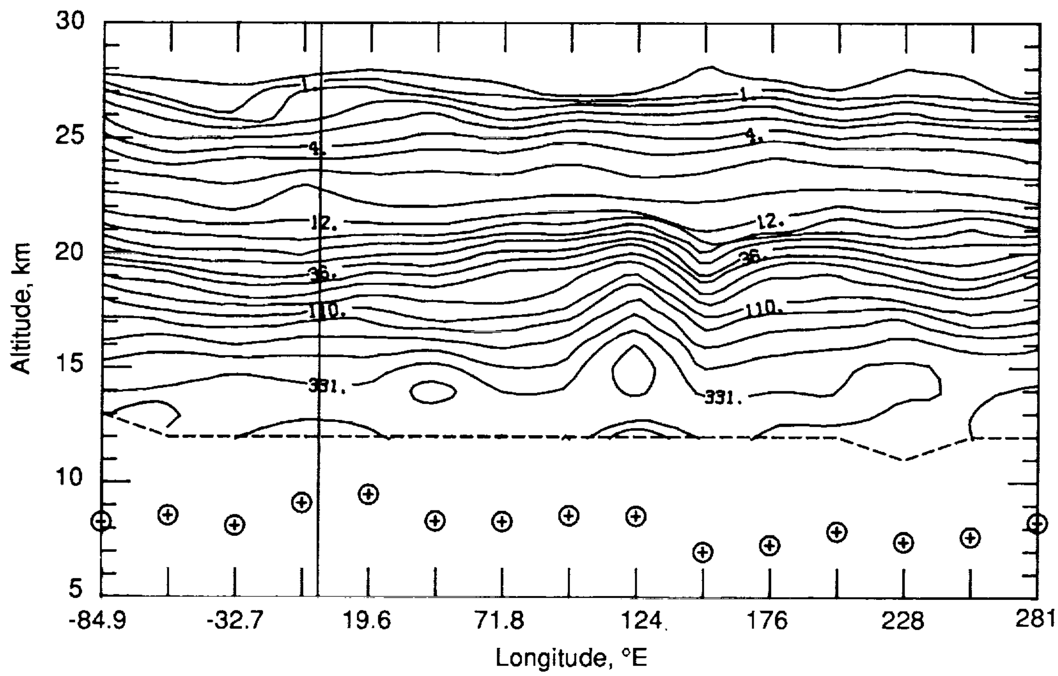



(a) Extinction isopleth.

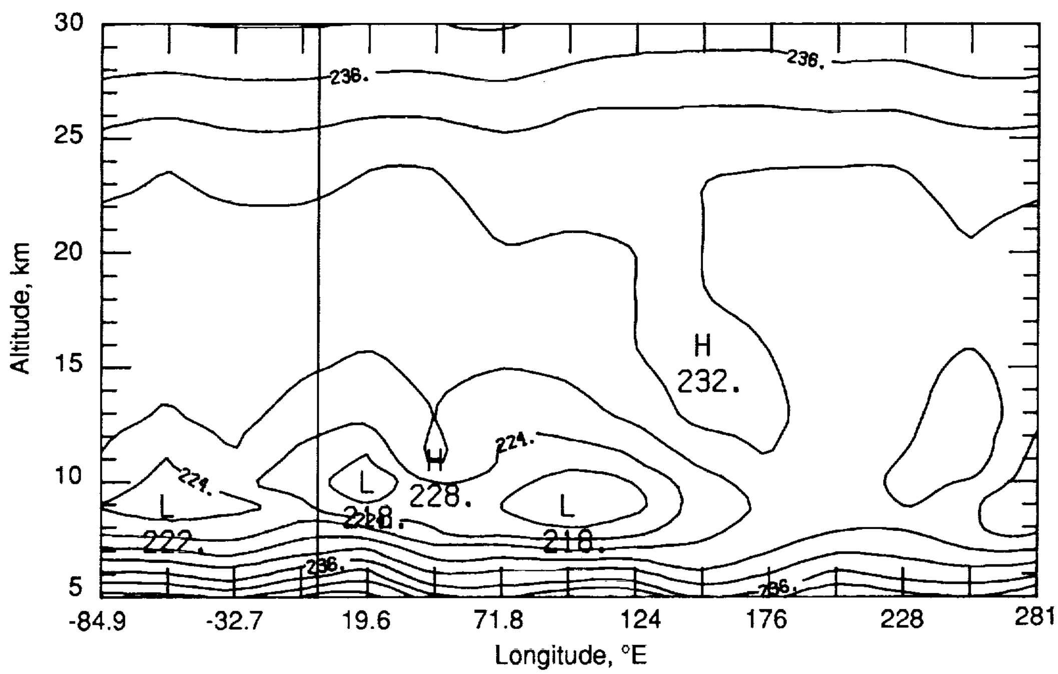



(b) Temperature contours.

Figure 54. Antarctic extinction isopleth and temperature contours for February 17.06 to 18.07, 1983, at a latitude of 72.4° to 72.7°S corresponding to orbits 21 793 to 21 807.

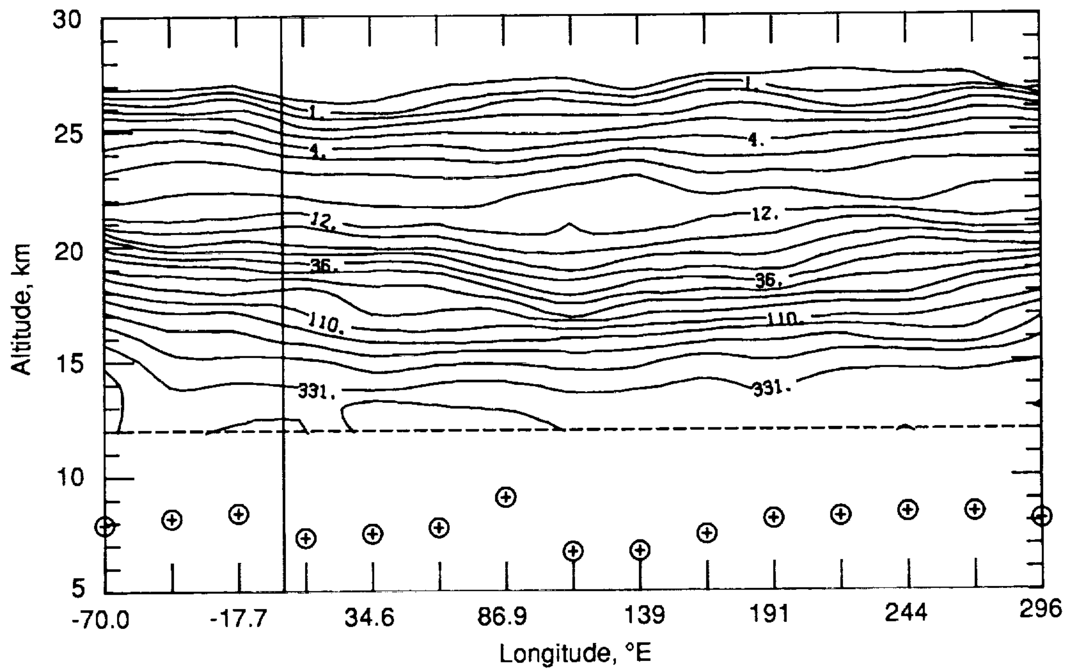



(a) Extinction isopleth.

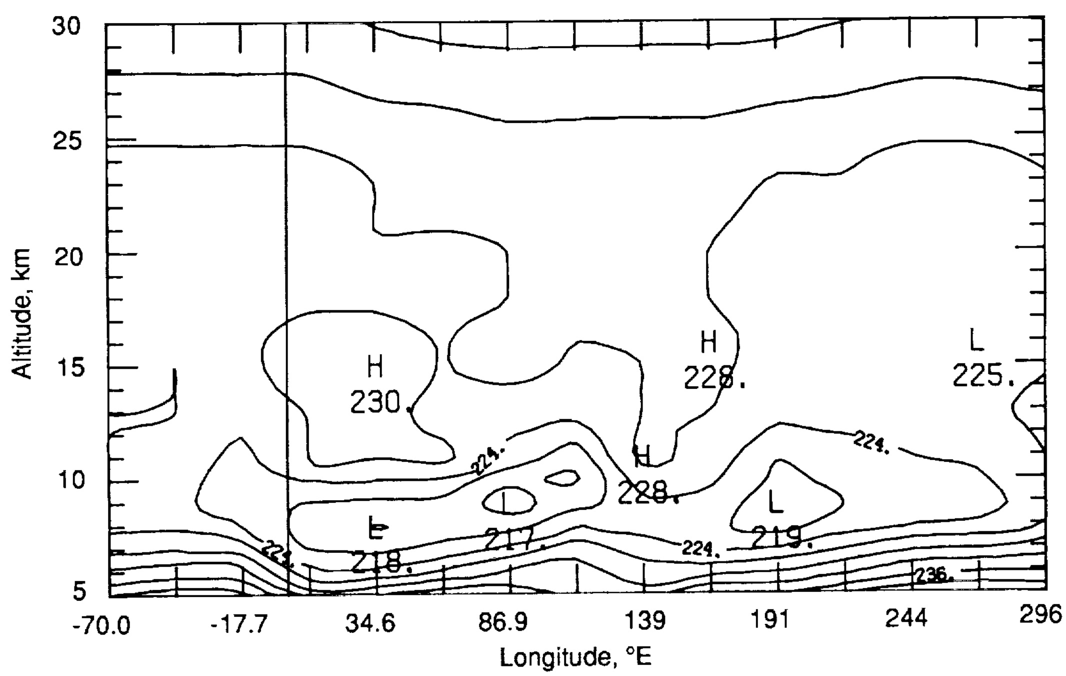



(b) Temperature contours.

Figure 55. Antarctic extinction isopleth and temperature contours for February 20.10 to 21.11, 1983, at a latitude of 73.2° to 73.4°S corresponding to orbits 21 835 to 21 849.

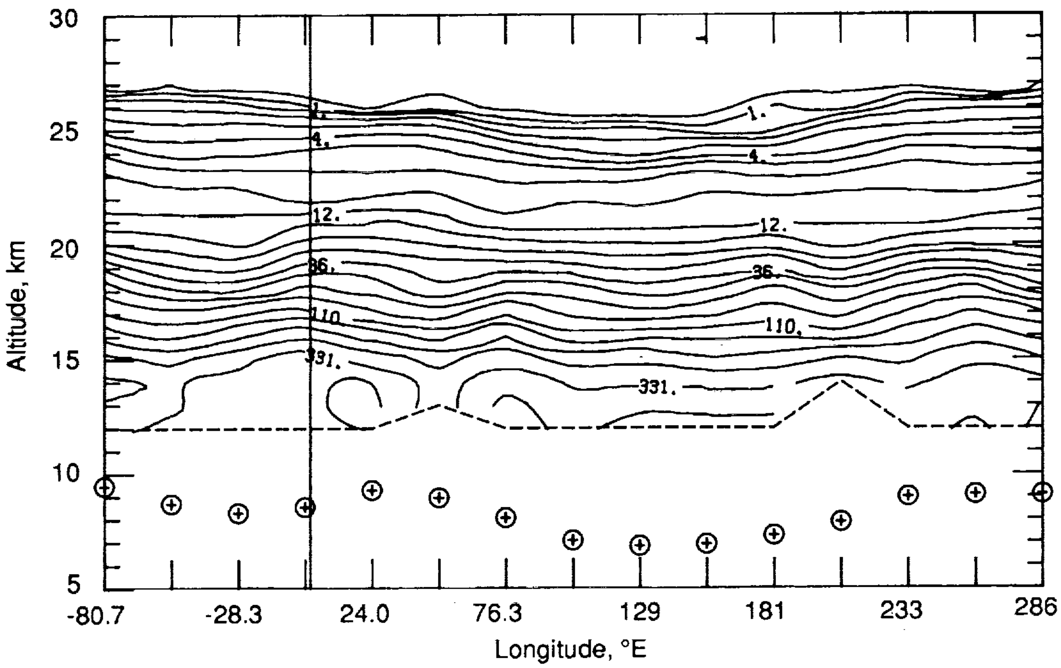



(a) Extinction isopleth.

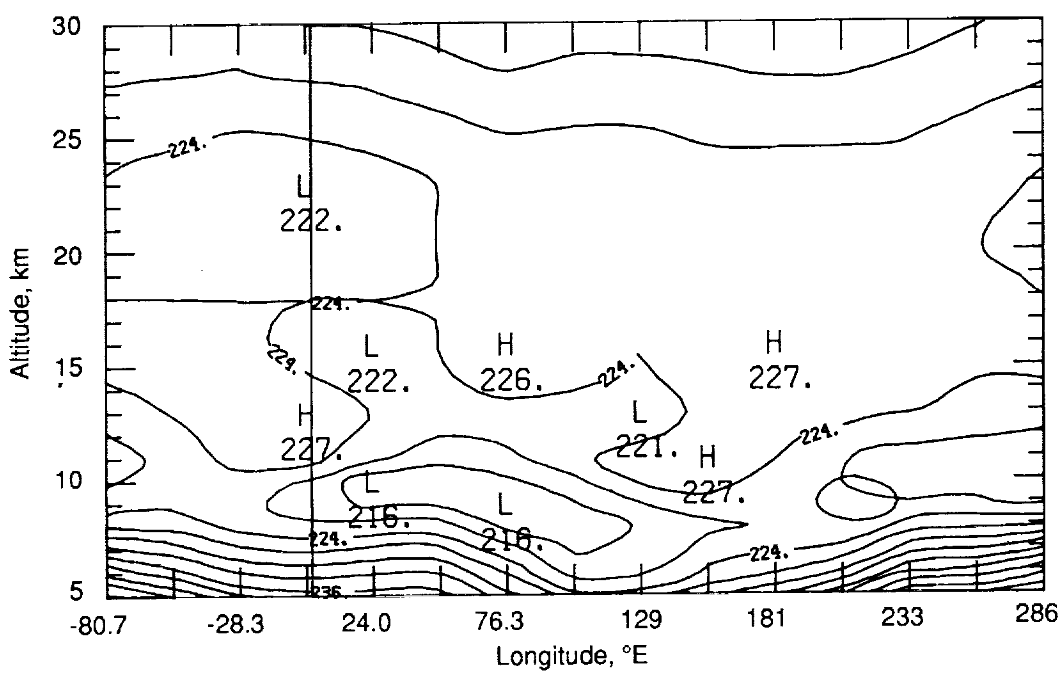



(b) Temperature contours.

Figure 56. Antarctic extinction isopleth and temperature contours for March 3.02 to 4.04, 1983, at a latitude of 75.8° to 76.0°S corresponding to orbits 21 986 to 22 000.

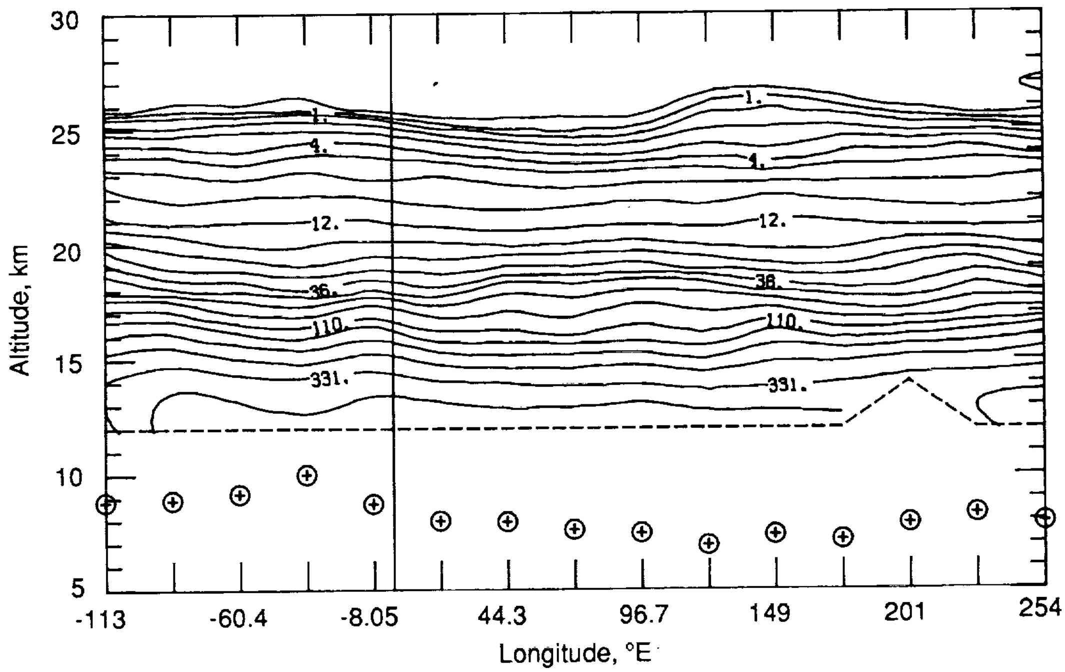



(a) Extinction isopleth.

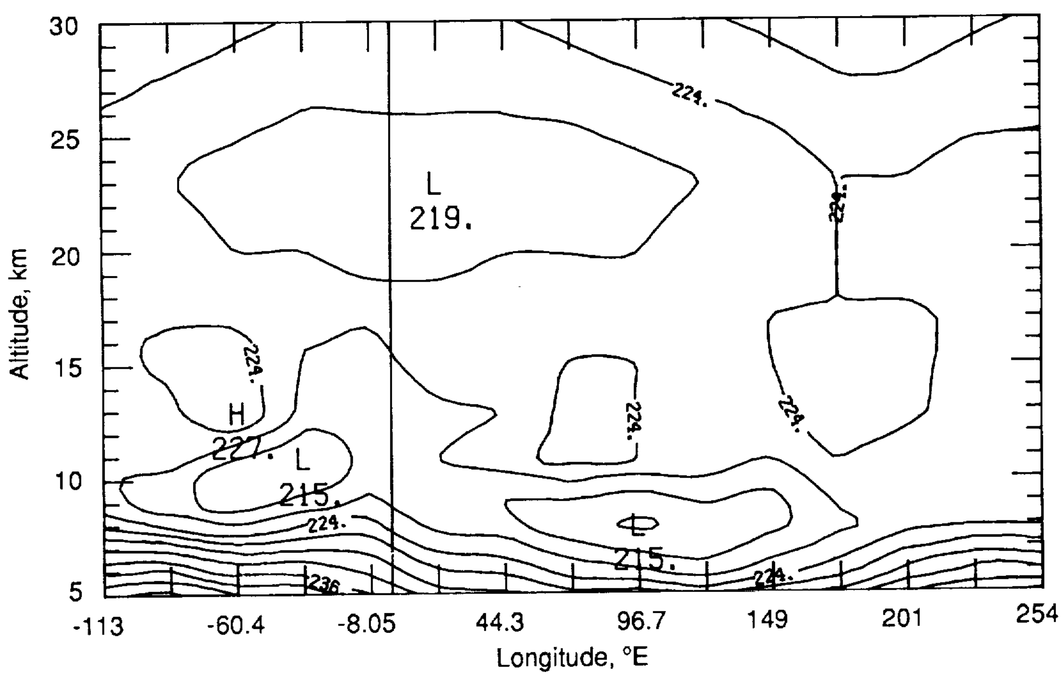



(b) Temperature contours.

Figure 57. Antarctic extinction isopleth and temperature contours for March 9.03 to 10.04, 1983, at a latitude of 77.0° to 77.2°S corresponding to orbits 22 069 to 22 083.

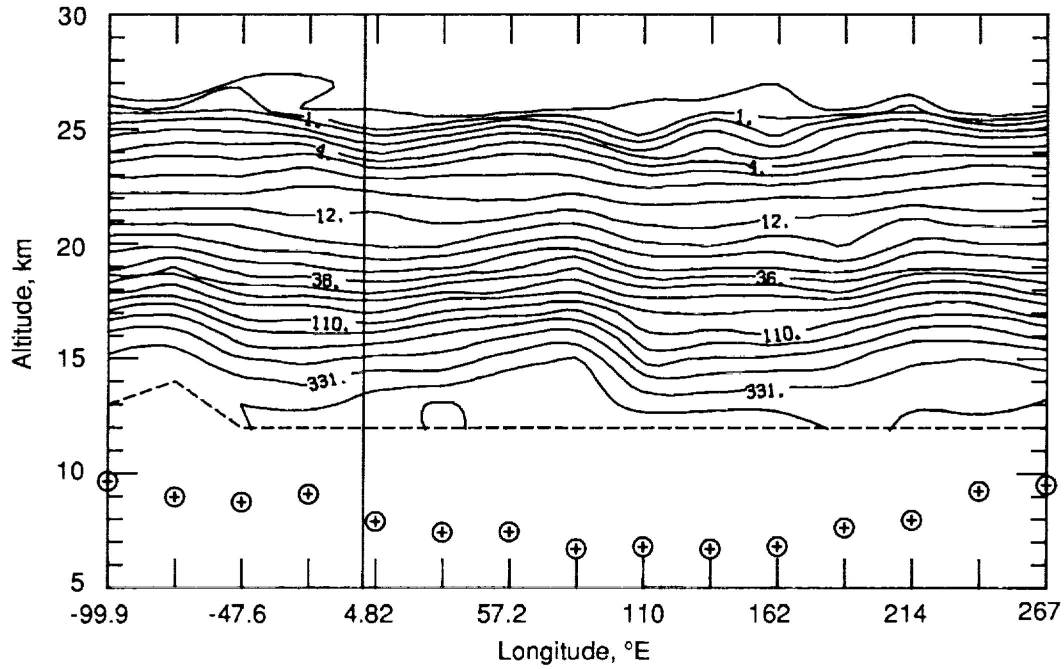



(a) Extinction isopleth.

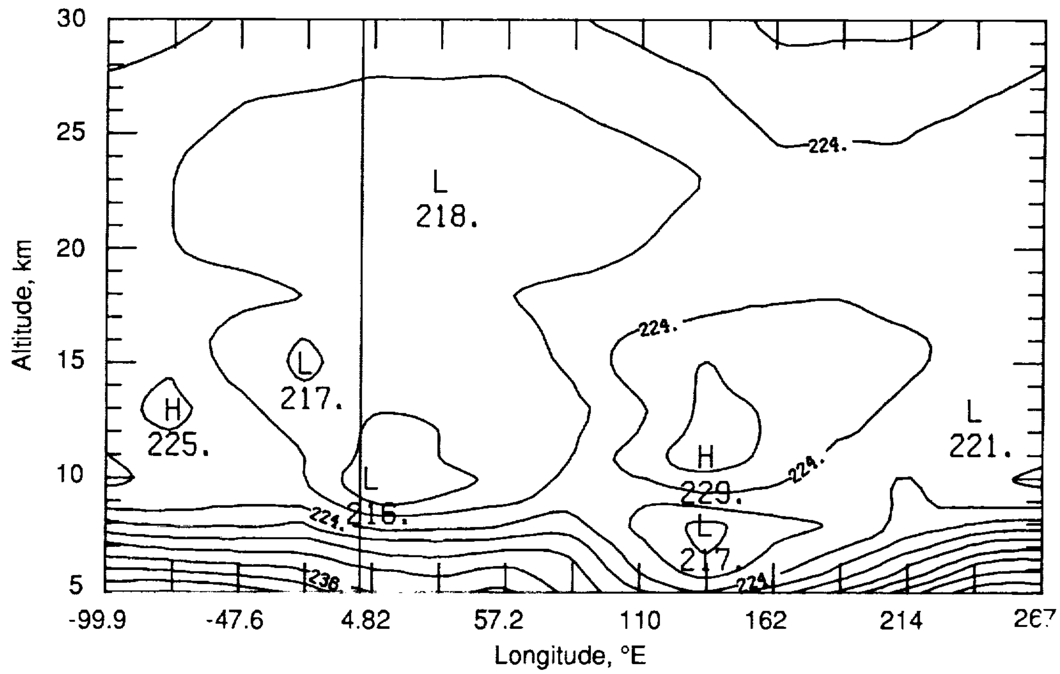



(b) Temperature contours.

Figure 58. Antarctic extinction isopleth and temperature contours for March 18.07 to 19.08, 1983, at a latitude of 78.3°S corresponding to orbits 22 194 to 22 208.

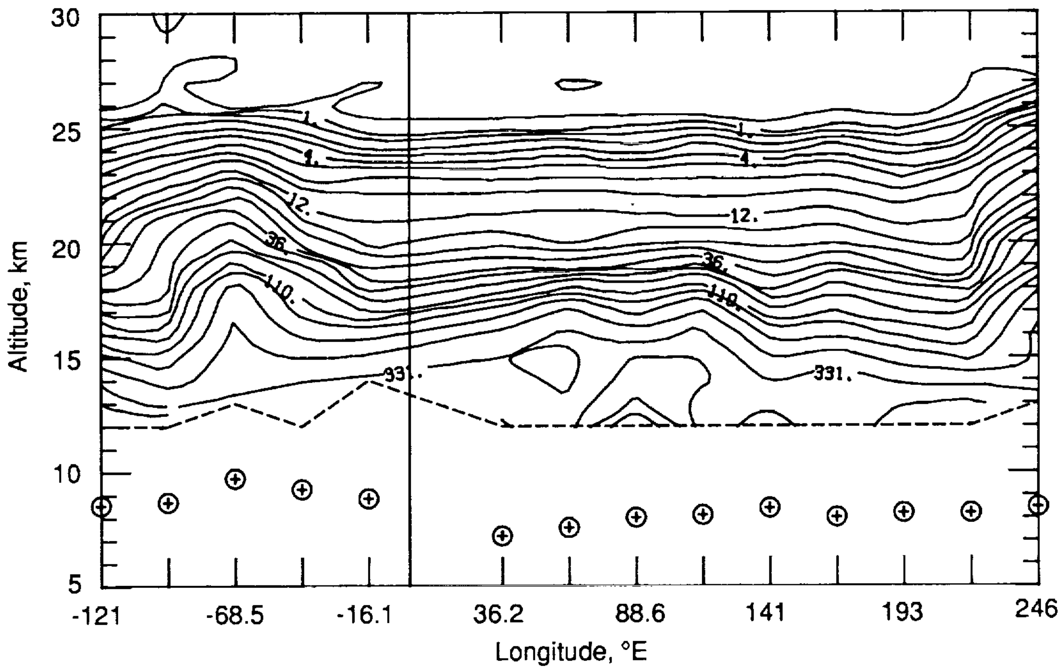



(a) Extinction isopleth.

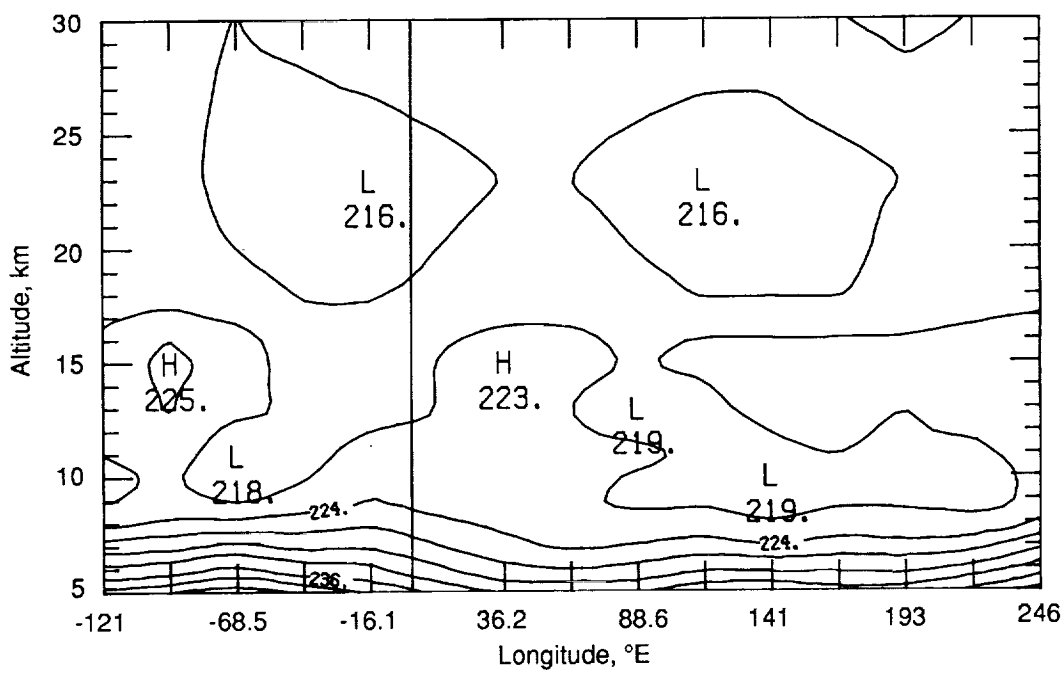



(b) Temperature contours.

Figure 59. Antarctic extinction isopleth and temperature contours for March 20.02 to 21.04, 1983, at a latitude of 78.4° to 78.5°S corresponding to orbits 22 221 to 22 235.

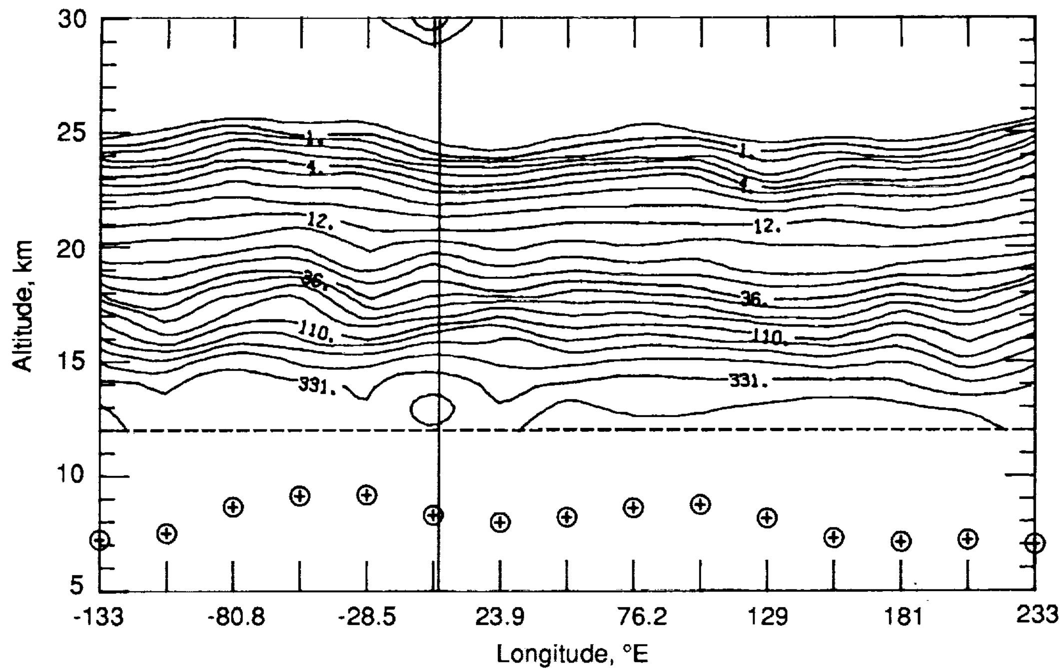



(a) Extinction isopleth.

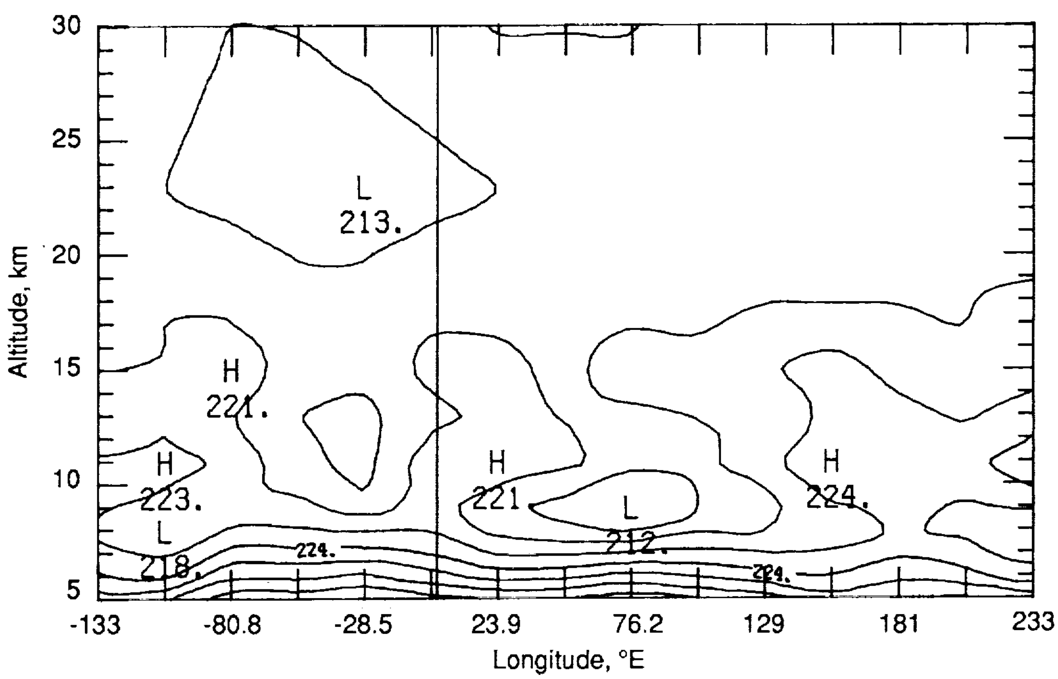



(b) Temperature contours.

Figure 60. Antarctic extinction isopleth and temperature contours for March 31.02 to April 1.03, 1983, at a latitude of 78.3° to 78.1°S corresponding to orbits 22 373 to 22 387.

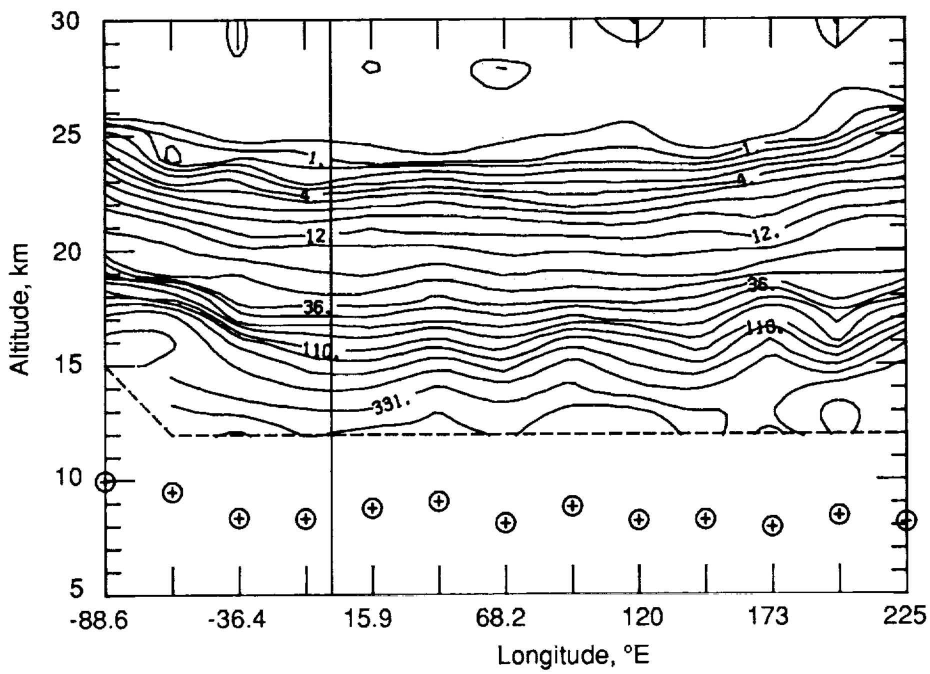



(a) Extinction isopleth.

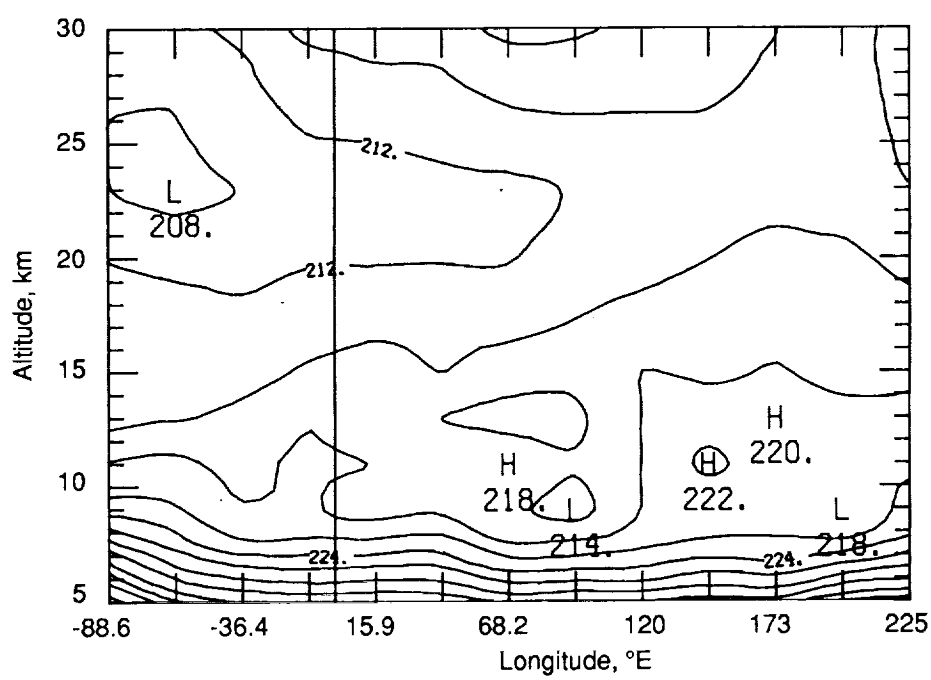



(b) Temperature contours.

Figure 61. Antarctic extinction isopleth and temperature contours for April 6.03 to 7.04, 1983, at a latitude of 77.5° to 77.3°S corresponding to orbits 22 456 to 22 470.

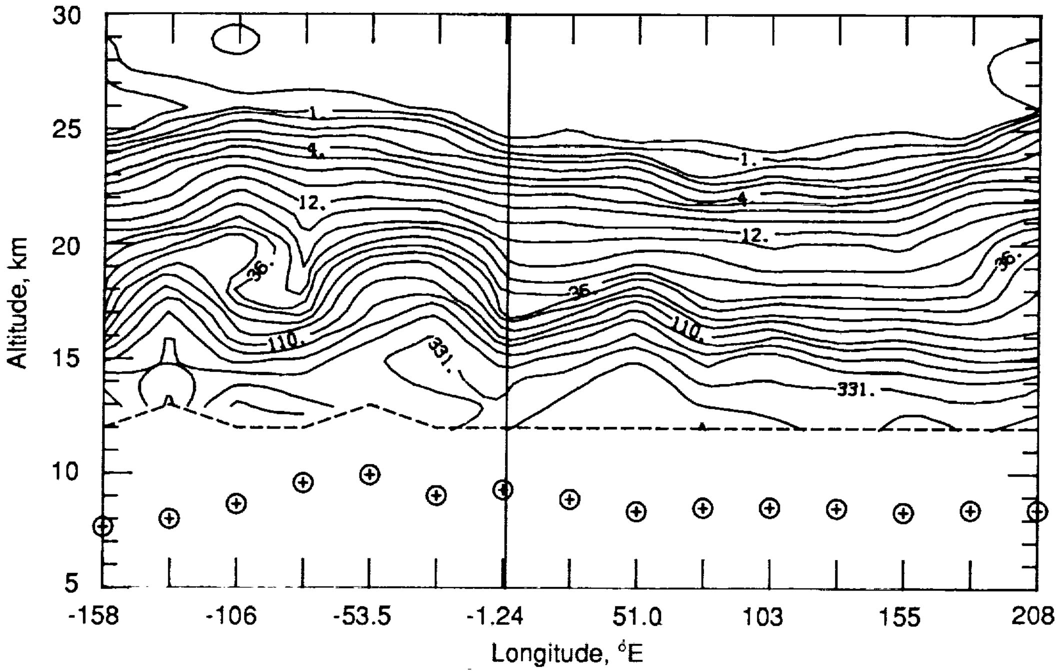



(a) Extinction isopleth.

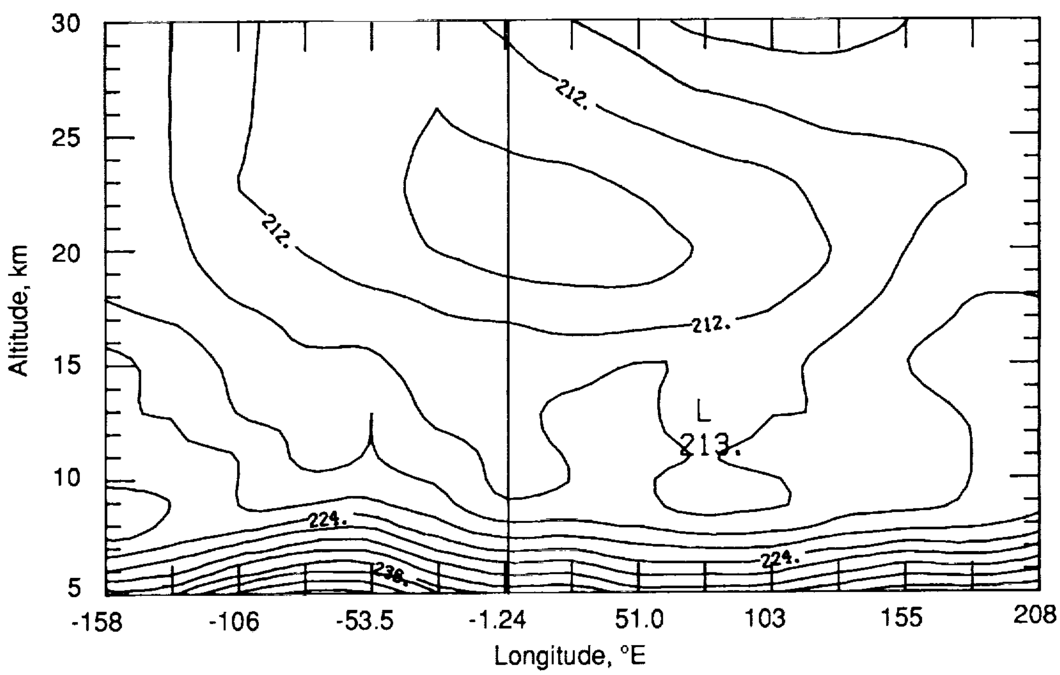



(b) Temperature contours.

Figure 62. Antarctic extinction isopleth and temperature contours for April 16.01 to 16.88, 1983, at a latitude of 75.6° to 75.4°S corresponding to orbits 22 594 to 22 606.

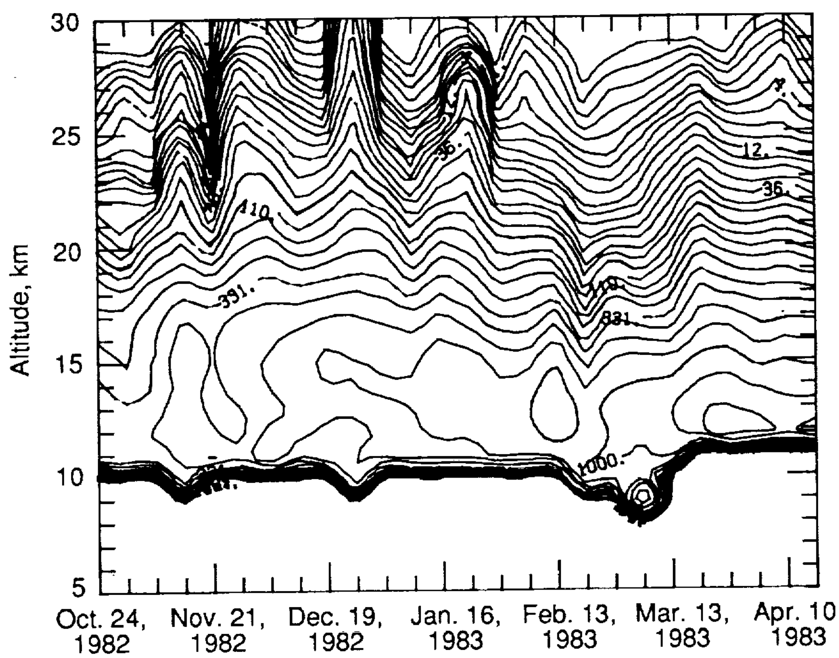



(a) Extinction isopleth.

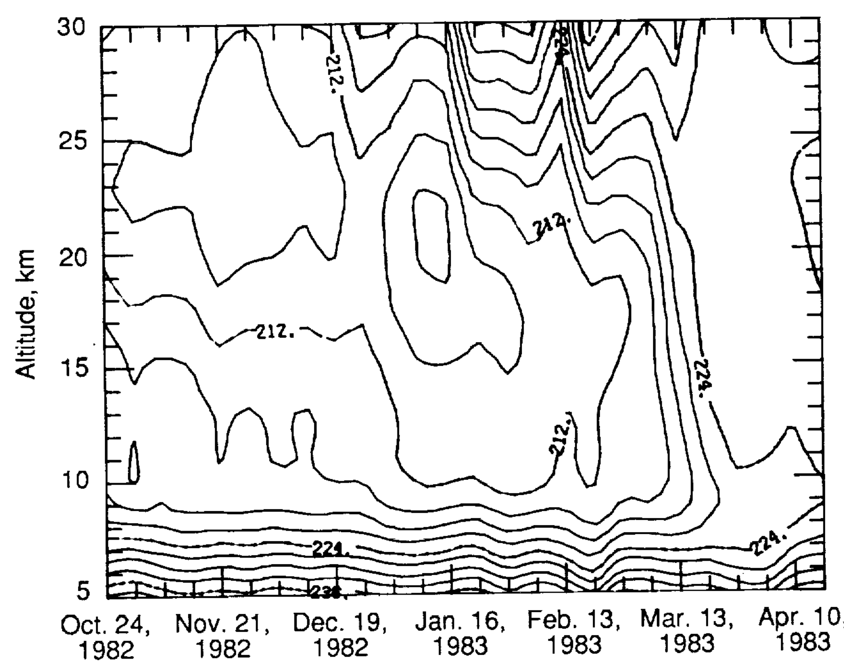



(b) Temperature contours.

Figure 63. Antarctic extinction isopleth and temperature contours for April 19.05 to 20.06, 1983, at a latitude of 74.9° to 74.6°S corresponding to orbits 22 636 to 22 650.

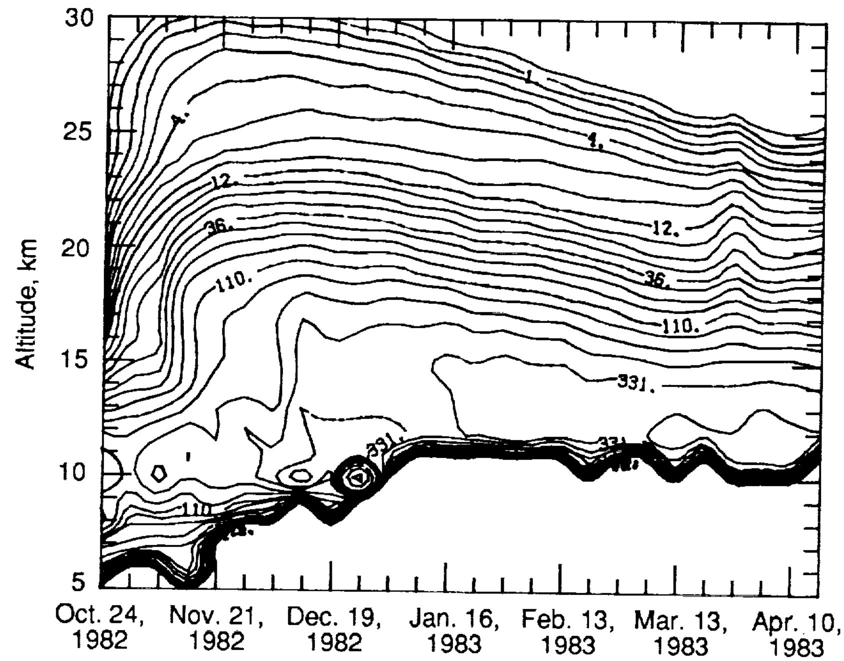



(a) Aerosol extinction at 1 $\mu$m in units of $10^{-5}$ km$^{-1}$.

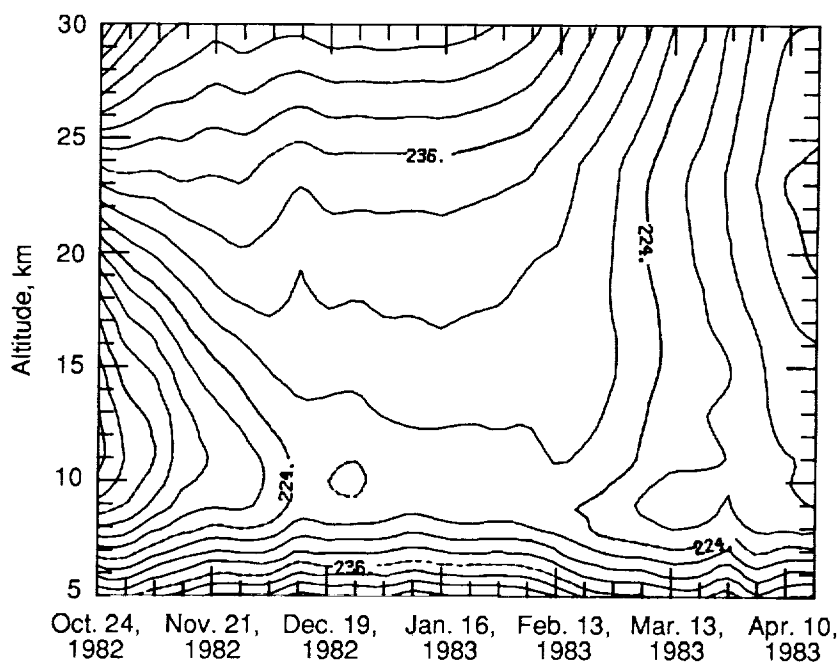



(b) Temperature field (in kelvins) at location of aerosol measurement.

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 the average value corresponds.




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




(b) Temperature field (in kelvins) 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 the average value corresponds.

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# Report Documentation Page

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16. Abstract

The Stratospheric Aerosol Measurement (SAM) II sensor aboard Nimbus 7 is providing 1.0-$\mu$m extinction measurements of Antarctic and Arctic stratospheric aerosols with a vertical resolution of 1 km. Representative examples and weekly averages including corresponding temperature profiles provided by NOAA for the time and place of each SAM II measurement (Oct. 1982 to Apr. 1983) are presented. Contours of aerosol extinction as a function of altitude and longitude or time are plotted, and aerosol optical depths are calculated for each week. Typical values of aerosol extinction and stratospheric optical depth in the Arctic are unusually large because of the presence of material from the El Chichon volcano eruption in the spring of 1982. For example, the optical depth peaked at 0.068, more than 50 times the background values. Typical values of aerosol extinction and stratospheric optical depth in the Antarctic varied considerably during this period because of the transport and arrival of the material from the El Chichon eruption. For example, the stratospheric optical depth varied from 0.002 in October 1982 to 0.021 in January 1983. Polar stratospheric clouds were observed during the Arctic winter, as expected. This report provides, in a ready-to-use format, a representative sample of the ninth 6-month period of data to be used in atmospheric and climatic studies.

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