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SAM II Measurements of the Polar Stratospheric Aerosol

Volume VI—April 1981 to October 1981

M. Patrick McCormick
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National Aeronautics
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PREFACE

This is the sixth 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 second 6 months of data, covering April 1979 to October 1979, were published in NASA Reference Publication 1088, and the third, fourth, and fifth 6 months of data were reported in NASA Reference Publications 1106, 1107, and 1140, respectively. 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. This report includes data from April 1981 through October 1981. It is intended for future reports to cover subsequent consecutive 6-month time periods.

All 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 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, NASA Ames Research Center; and M. P. McCormick, NASA Langley Research Center.

CONTENTS

PREFACE iii

SUMMARY 1

INTRODUCTION 1

SAM II INSTRUMENT 1

THE NIMBUS 7 SATELLITE ORBIT AND SAM II MEASUREMENTS 2

DATA PRODUCTS 3

EXTINCTION PROFILES 3

EXTINCTION ISOPLETHS 3

SIX-MONTH AVERAGE OF AEROSOL EXTINCTION 4

OPTICAL DEPTH 5

CONCLUDING REMARKS 5

REFERENCES 6

TABLES:
I.- Average Optical Depth for Arctic Region 7
II.- Average Optical Depth for Antarctic Region 8

FIGURES:
1.- Latitudinal coverage of SAM II measurements 9
2-6.- Arctic extinction and temperature profiles 10
7-11.- Antarctic extinction and temperature profiles 15
12-37.- Arctic extinction isopleths and temperature contours 20
38-63.- Antarctic extinction isopleths and temperature contours 46
64-65.- Weekly averaged extinction and temperature data 72

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 sixth 6 months of satellite flight, April 1981 through October 1981. 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 in the main stratospheric aerosol layer are 2 to 4 times 10^{-4} km^{-1} for the Southern Hemisphere throughout the time period and 8 to 9 times 10^{-3} km^{-1} at the beginning to 1 to 2 times 10^{-3} km^{-1} at the end of the time period for the Northern Hemisphere. Optical depths for the stratosphere are about 0.002 to 0.003 for the Southern Hemisphere throughout the time period and 0.006 to 0.007 at the beginning to 0.003 to 0.004 at the end of the time period for the Northern Hemisphere. These Northern Hemisphere values are much larger than normal background levels due to the injection of aerosols into the stratosphere by the eruptions of Mount St. Helens (May 1980) and Alaid (Apr. 1981). Polar stratospheric clouds (PSC's) at altitudes between the tropopause and 20 km were observed during the Antarctic winter at various times and locations, as expected. 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 sixth 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 microphysics, 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 degree 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 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-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 of 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 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° each 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 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.

This report presents a portion of these data. Specifically, it contains the sixth 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. The profiles in figures 2 to 6 for the Northern Hemisphere show high values below about 15 km. This is due to the April 27, 1981, eruption of Alaid (50.8° N, 155.5° E). Figures 8 to 10 show the influence of polar stratospheric clouds (PSC's) on the profiles for the Southern Hemisphere during winter.

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 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, April 28.89 means 9:22 p.m. on April 28.) 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 1.20×10^{-4} km^{-1}. The plotting routine used truncates decimal points, so that the lines marked "1" correspond to 1.32×10^{-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 labeled in kelvins 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. Figures 12 and 13 continue to show the enhancement over the background values of 1978 to 1979 due to the Mount St. Helens eruption of May 1980, although by now the effects are lessening. Figure 14 and subsequent figures, however, show the very strong perturbation at 15 km and below due to the eruption of Alaid (ref. 6). 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 PSC's, which occur in the Antarctic region in the winter. (See figs. 43 to 59.) The corresponding temperature fields show very low temperatures at the location of the PSC's. The stratospheric-cloud sightings are described in detail by McCormick et al. in reference 7. 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. 8).

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 2 km above the tropopause up to 30 km. The optical depths obtained from all 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 100×10^{-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.

CONCLUDING REMARKS

This report has presented a representative sample and summaries of the sixth 6 months (Apr. 26, 1981, to Oct. 26, 1981) 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 6 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 continue to be published.

NASA Langley Research Center
Hampton, VA 23665
February 26, 1985

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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 plus 2 km
Apr. 26, 1981	73.9	8.25	338.3×10^{-5}
May 3, 1981	72.1	8.70	300.7
May 10, 1981	70.5	8.98	459.8
May 17, 1981	69.0	9.23	675.6
May 24, 1981	67.9	9.47	580.8
May 31, 1981	67.0	9.73	668.7
June 7, 1981	66.4	9.92	685.2
June 14, 1981	66.1	10.04	642.7
June 21, 1981	66.1	10.29	529.8
June 28, 1981	66.5	10.03	533.5
July 5, 1981	67.1	10.29	524.9
July 12, 1981	68.1	10.13	530.5
July 19, 1981	69.3	10.07	531.1
July 26, 1981	70.8	9.84	489.7
Aug. 2, 1981	72.4	9.91	447.4
Aug. 9, 1981	74.1	9.65	455.7
Aug. 16, 1981	76.0	9.47	461.2
Aug. 23, 1981	77.7	9.39	430.6
Aug. 30, 1981	79.3	9.48	424.1
Sep. 6, 1981	80.5	9.84	358.8
Sep. 13, 1981	81.1	9.12	426.0
Sep. 20, 1981	80.9	8.71	428.7
Sep. 27, 1981	80.1	9.00	388.9
Oct. 4, 1981	78.7	9.44	354.6
Oct. 11, 1981	77.1	9.31	351.3
Oct. 18, 1981	75.3	9.35	339.1

TABLE II.- AVERAGE OPTICAL DEPTH FOR ANTARCTIC REGION

Week beginning -	Latitude, °S	Average tropopause height, km	Average optical depth measured from tropopause plus 2 km
Apr. 26, 1981	72.4	8.92	196.2×10^{-5}
May 3, 1981	70.7	8.96	205.8
May 10, 1981	69.2	9.23	197.7
May 17, 1981	67.8	9.02	205.4
May 24, 1981	66.7	9.02	209.6
May 31, 1981	65.8	9.74	199.2
June 7, 1981	65.1	9.83	198.9
June 14, 1981	64.8	9.89	202.6
June 21, 1981	64.8	10.20	196.1
June 28, 1981	65.0	10.45	258.8
July 5, 1981	65.6	10.74	325.7
July 12, 1981	66.4	11.29	298.3
July 19, 1981	67.4	10.92	323.6
July 26, 1981	68.7	11.47	619.6
Aug. 2, 1981	70.2	11.43	580.8
Aug. 9, 1981	71.8	12.21	640.9
Aug. 16, 1981	73.5	12.42	402.4
Aug. 23, 1981	75.2	12.53	309.0
Aug. 30, 1981	77.0	11.94	420.2
Sep. 6, 1981	78.6	11.83	295.2
Sep. 13, 1981	79.8	12.01	150.9
Sep. 20, 1981	80.6	11.64	94.9
Sep. 27, 1981	80.6	11.45	108.0
Oct. 4, 1981	79.9	11.65	98.2
Oct. 11, 1981	78.6	11.04	101.4
Oct. 18, 1981	76.9	10.24	125.1

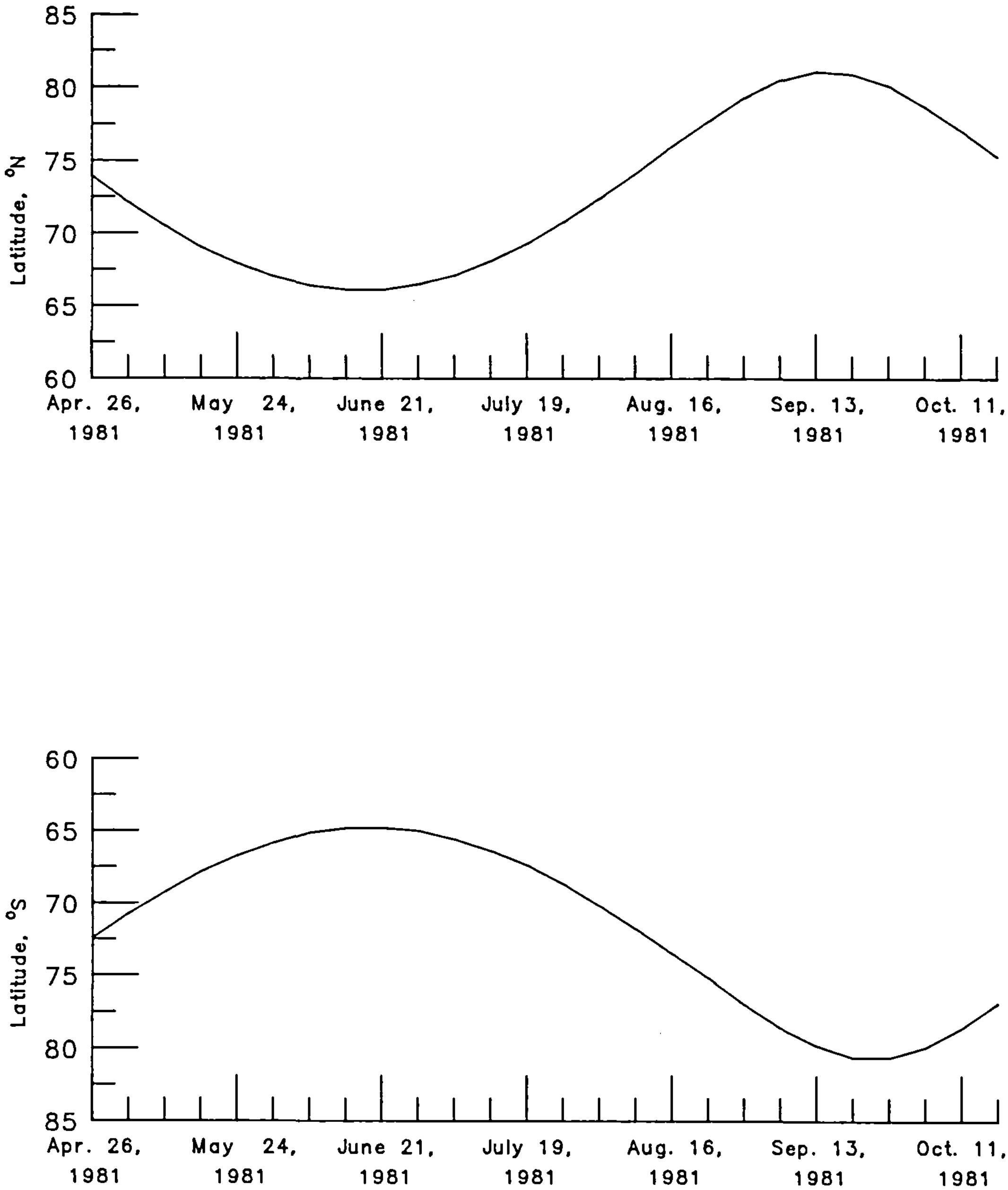


Figure 1.- Latitudinal coverage of SAM II measurements for April 1981 to October 1981.

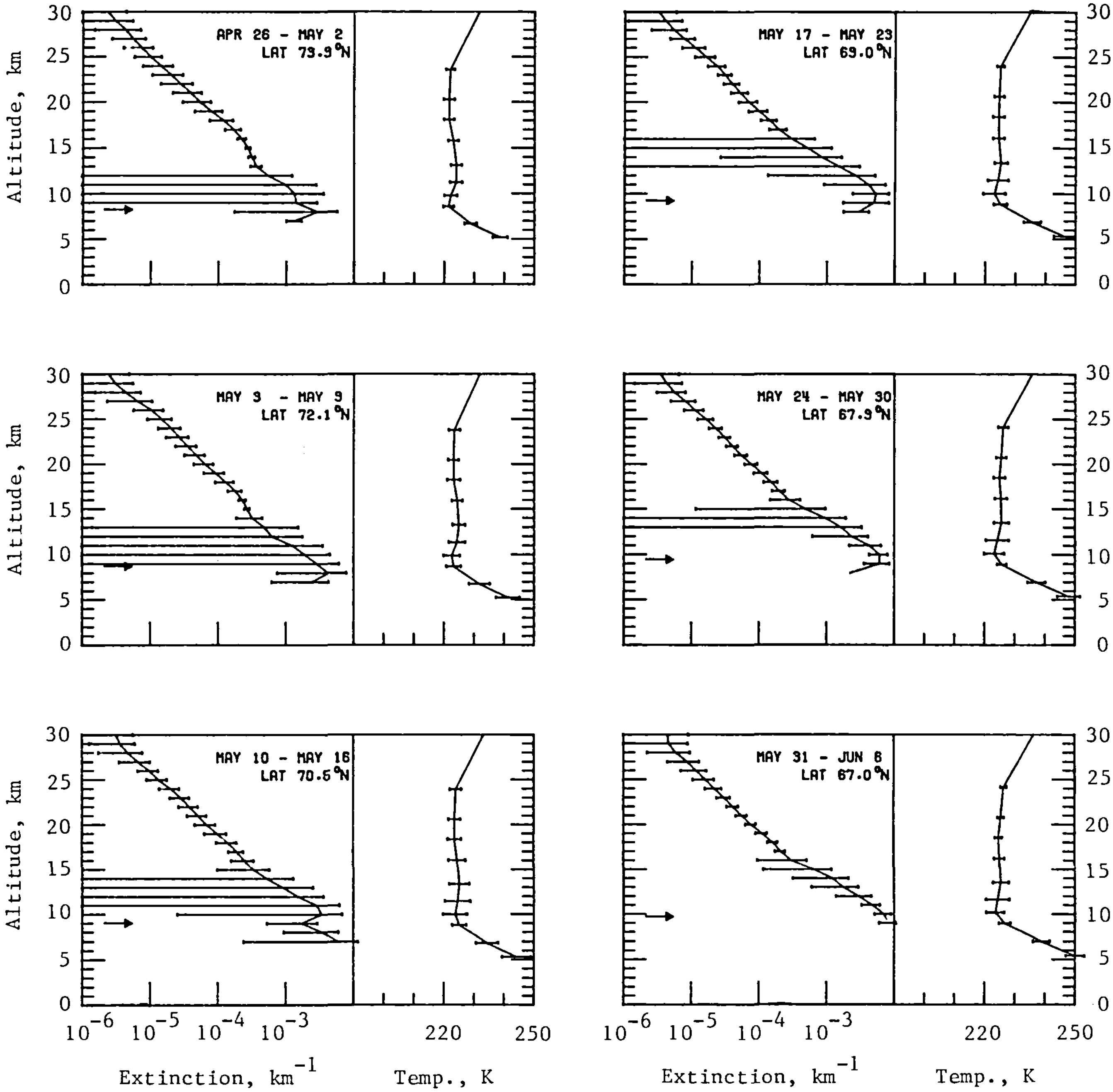


Figure 2.- Arctic extinction and temperature profiles for April 26 to June 6, 1981.

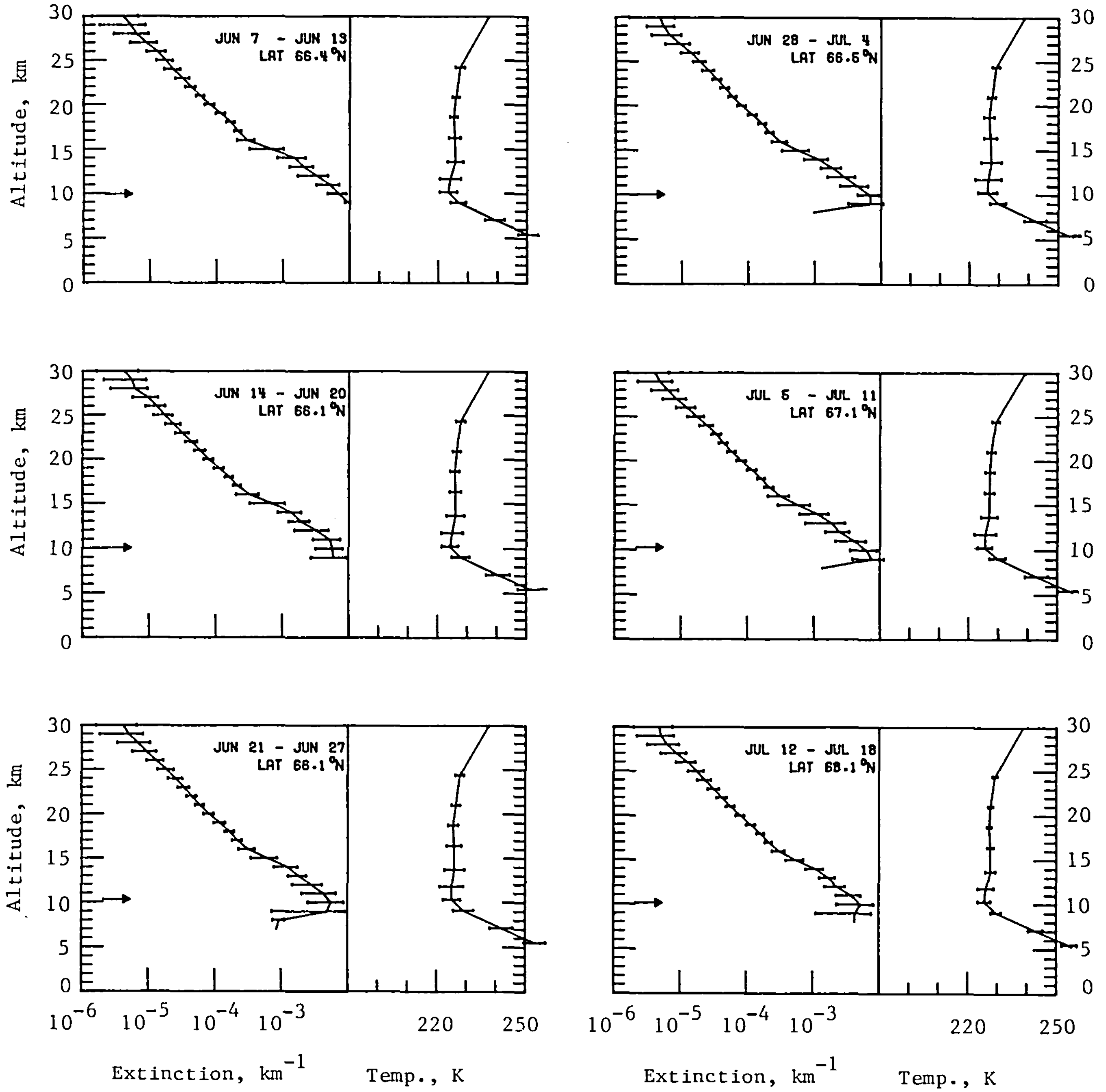


Figure 3.- Arctic extinction and temperature profiles for June 7 to July 18, 1981.

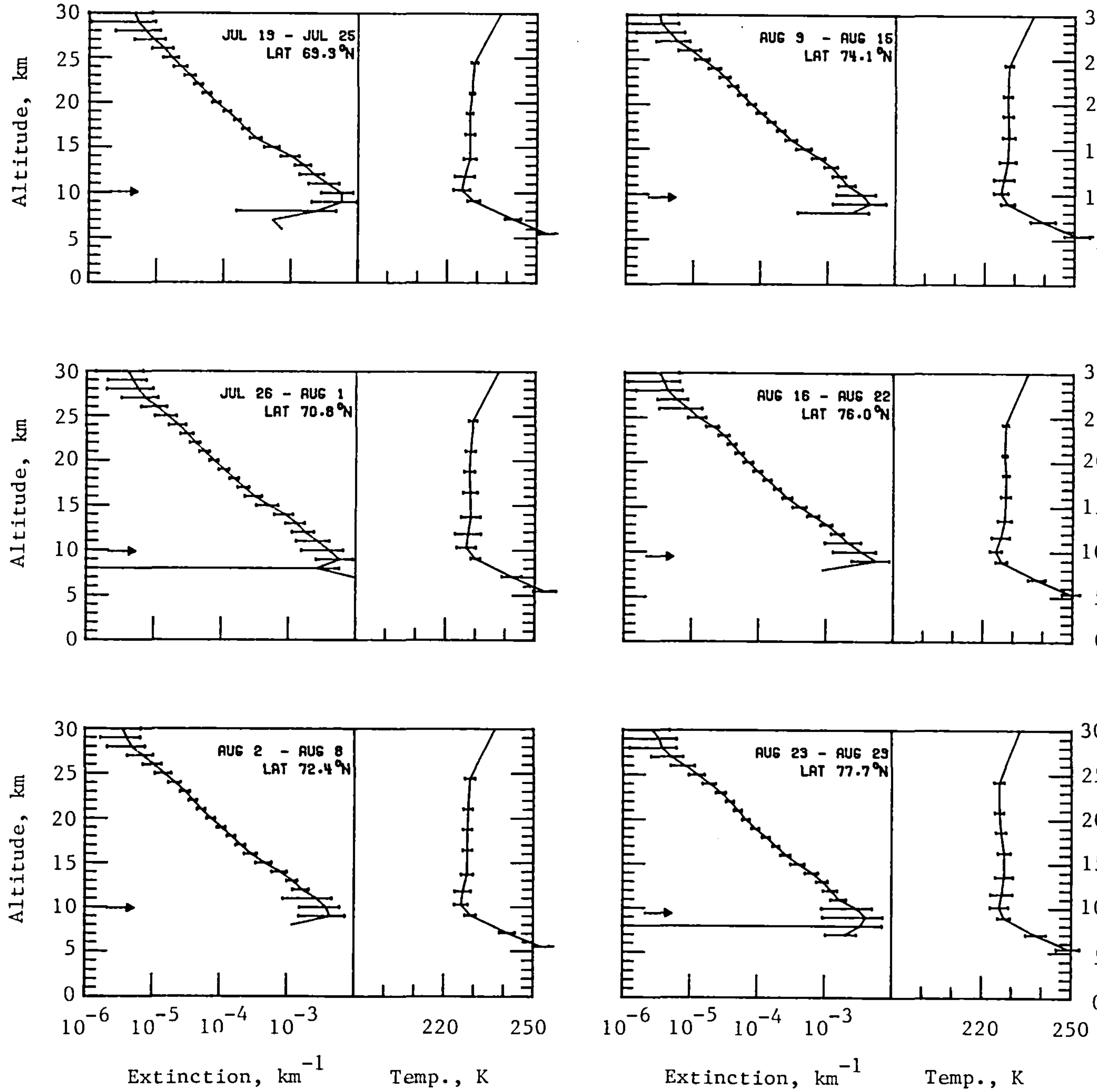


Figure 4.- Arctic extinction and temperature profiles for July 19 to August 29, 1981.

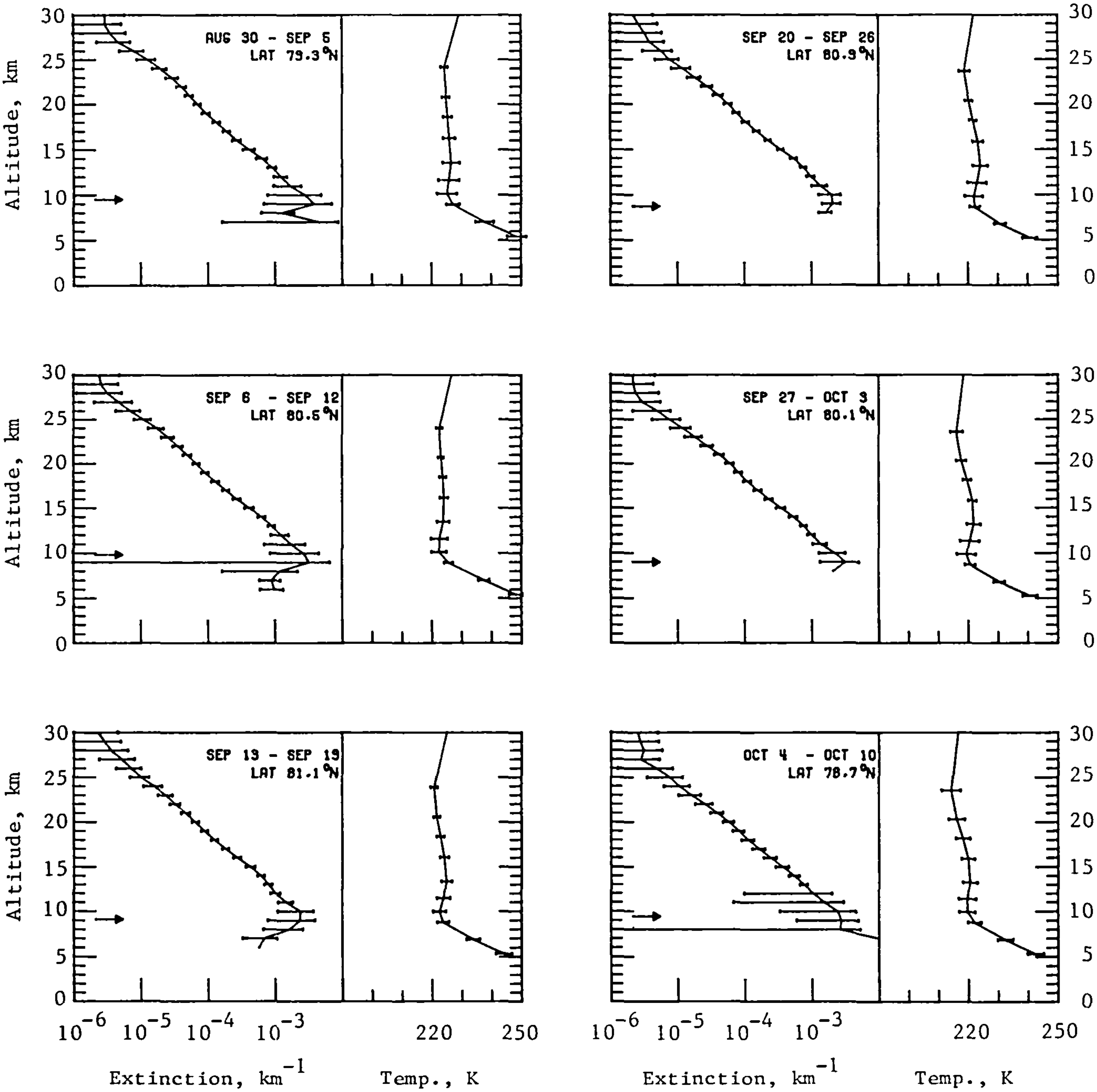


Figure 5.- Arctic extinction and temperature profiles for August 30 to October 10, 1981.

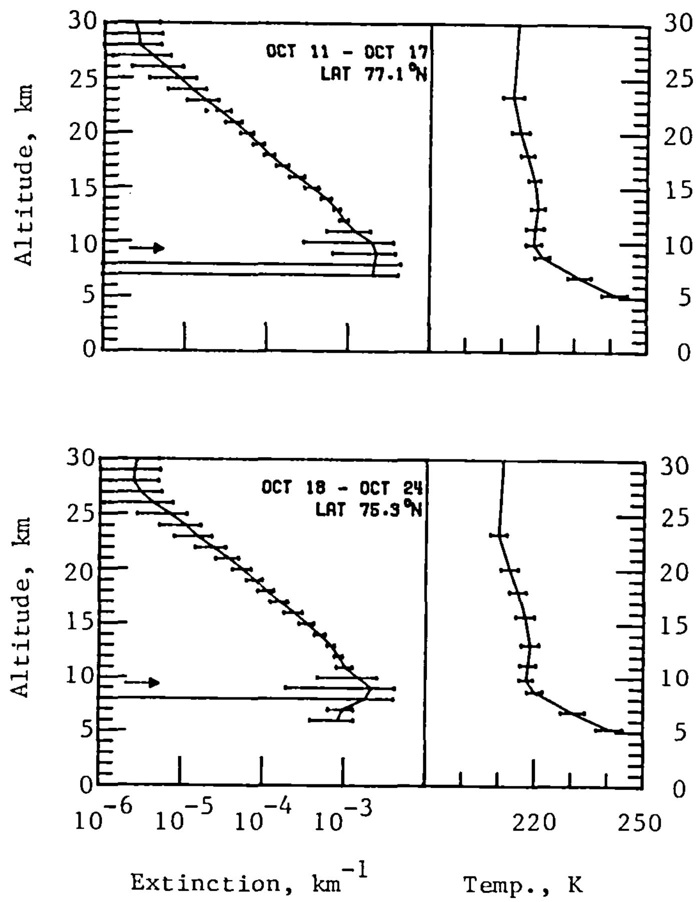


Figure 6.- Arctic extinction and temperature profiles for October 11 to October 24, 1981.

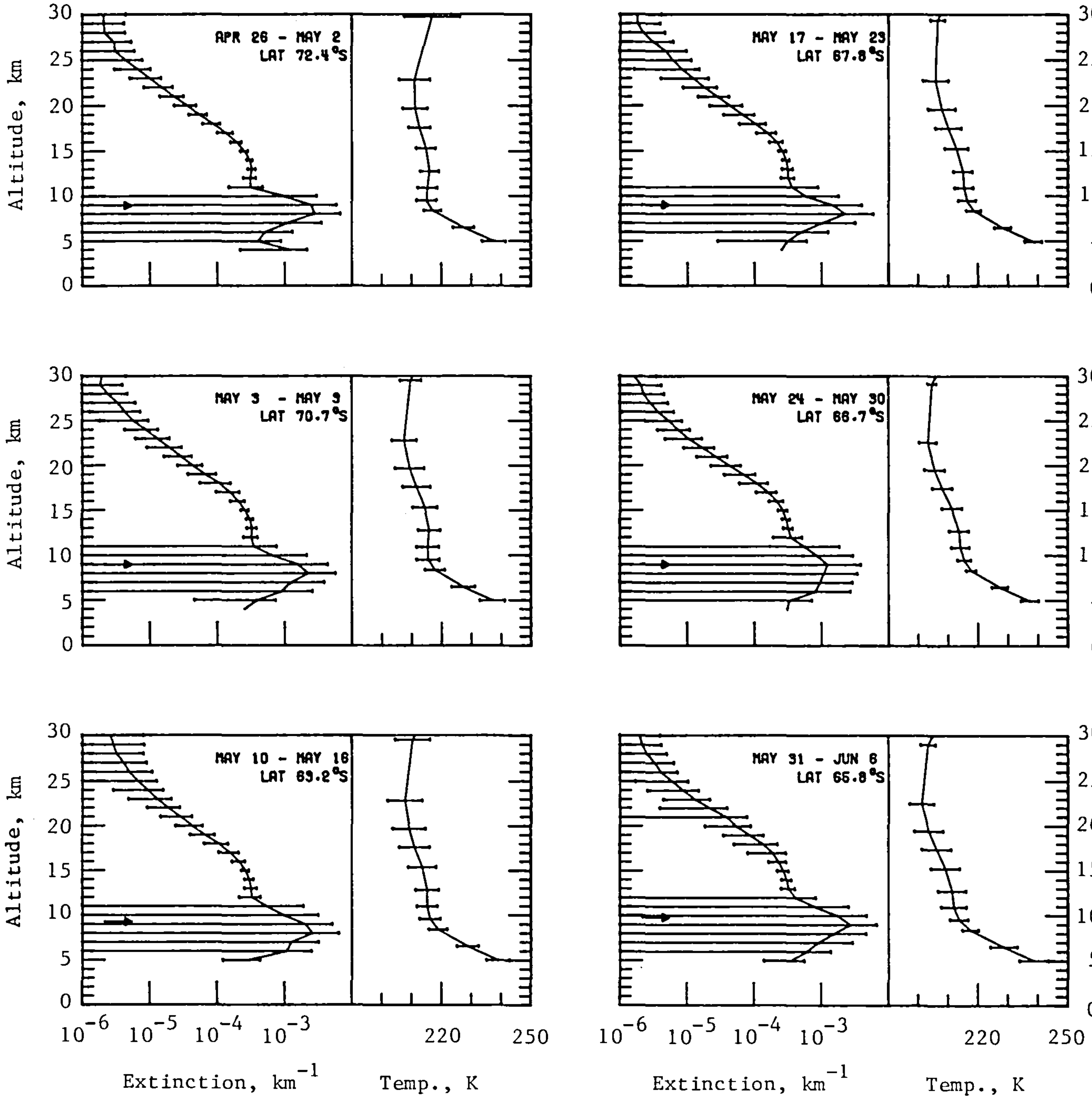


Figure 7.- Antarctic extinction and temperature profiles for April 26 to June 6, 1981.

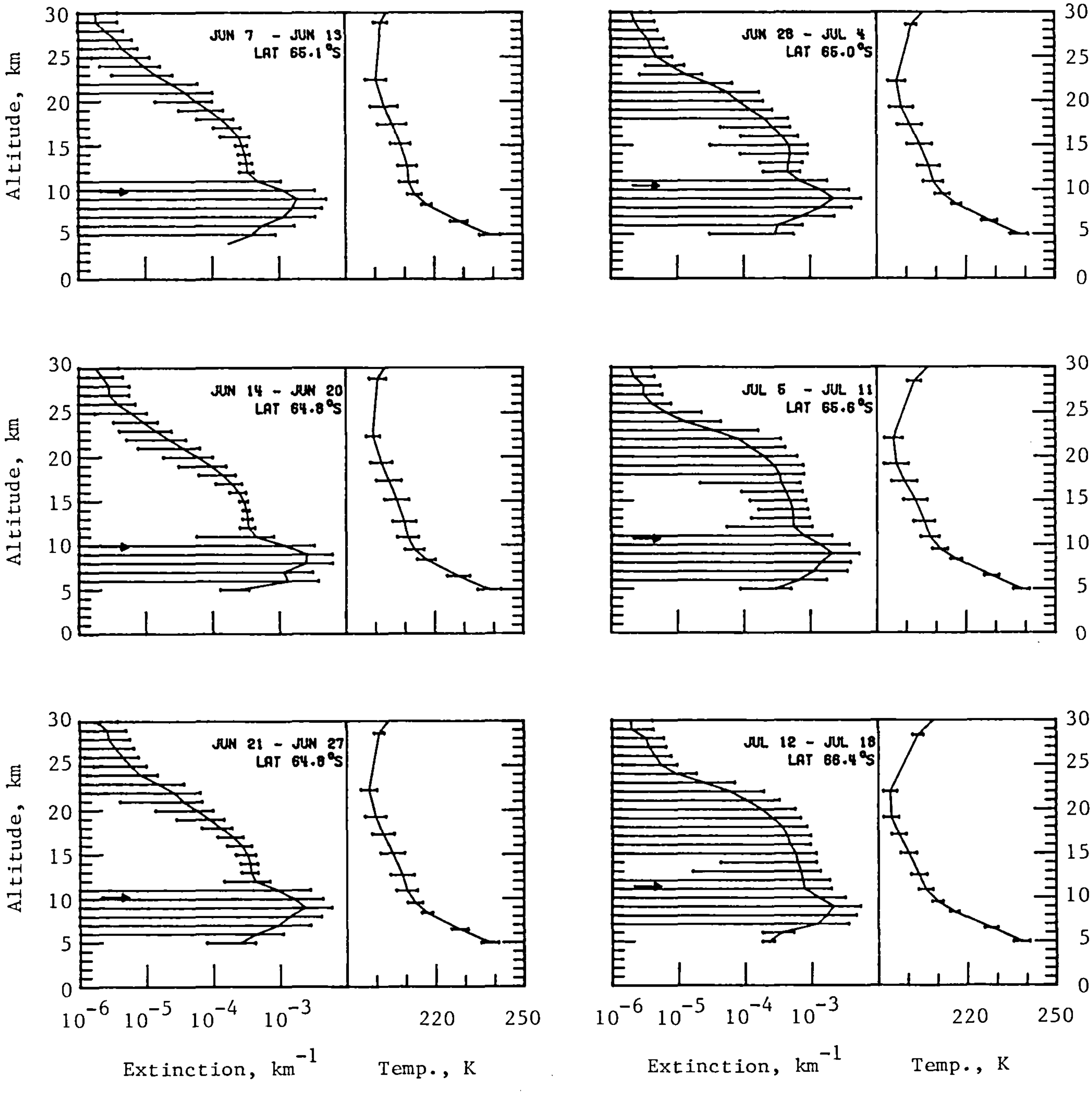


Figure 8.- Antarctic extinction and temperature profiles for June 7 to July 18, 1981.

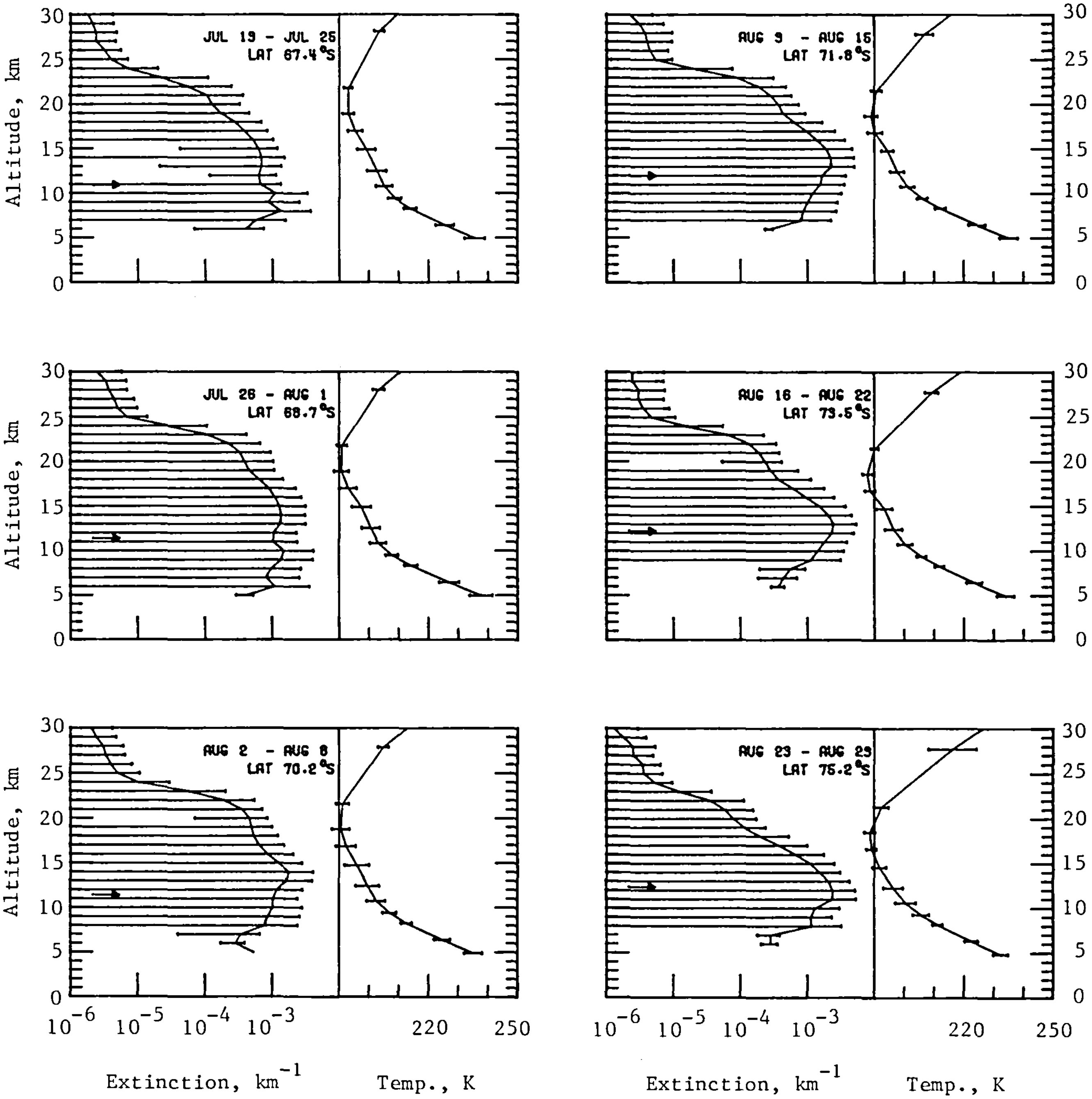


Figure 9.- Antarctic extinction and temperature profiles for July 19 to August 29, 1981.

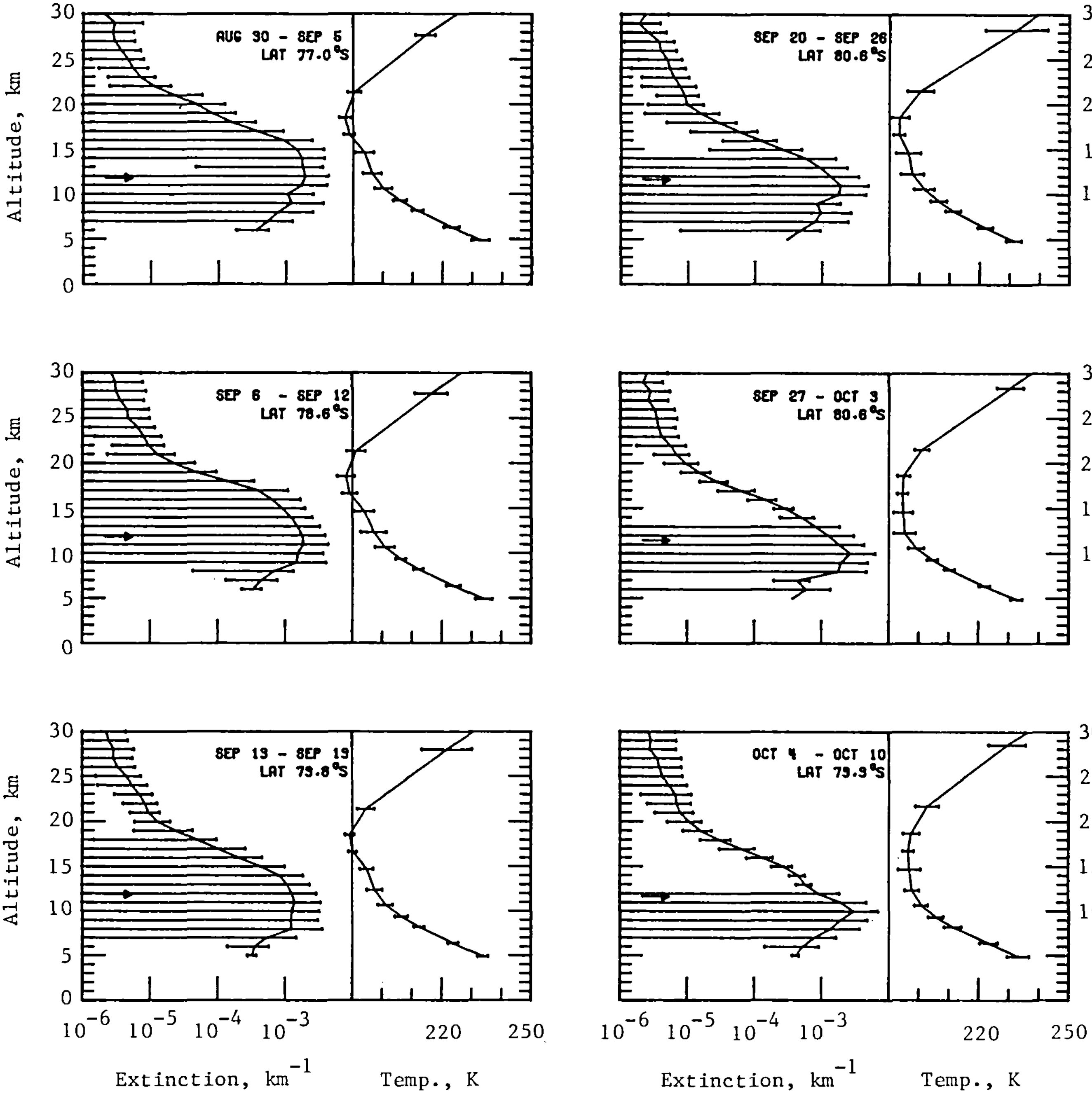


Figure 10.- Antarctic extinction and temperature profiles for August 30 to October 10, 1981.

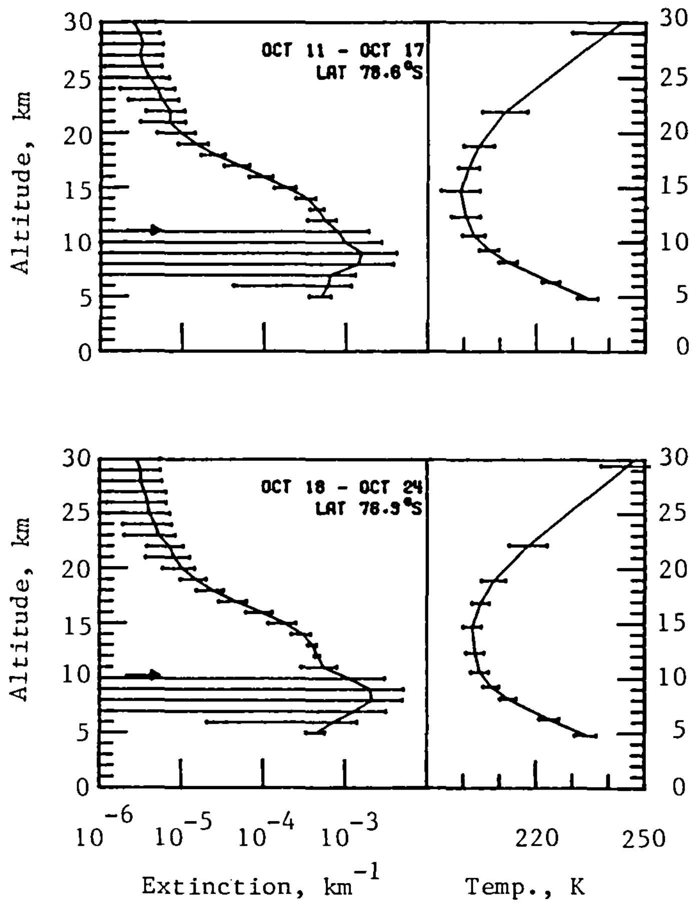
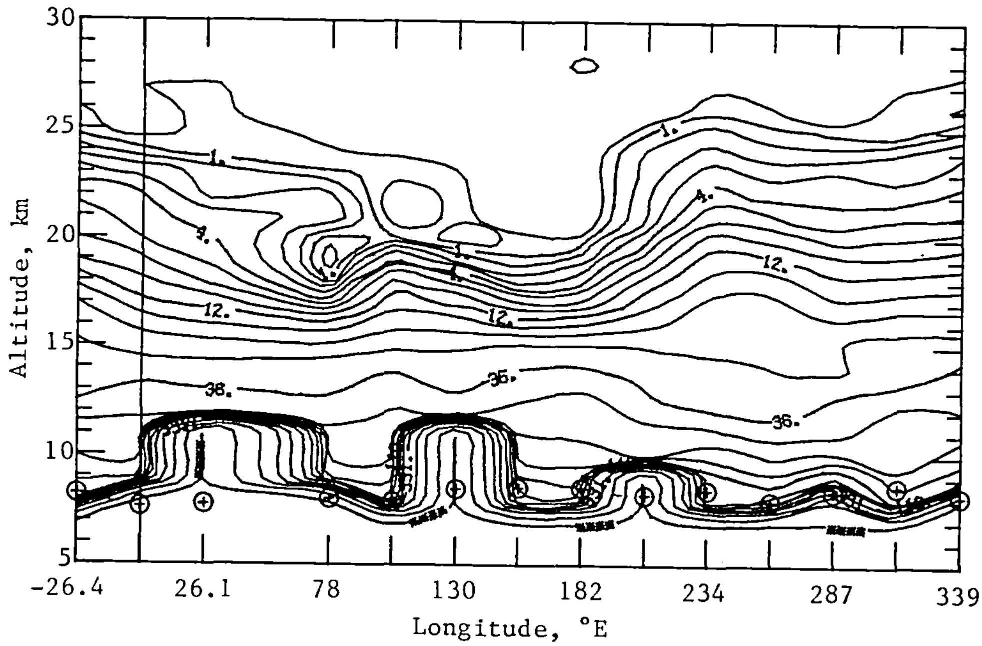
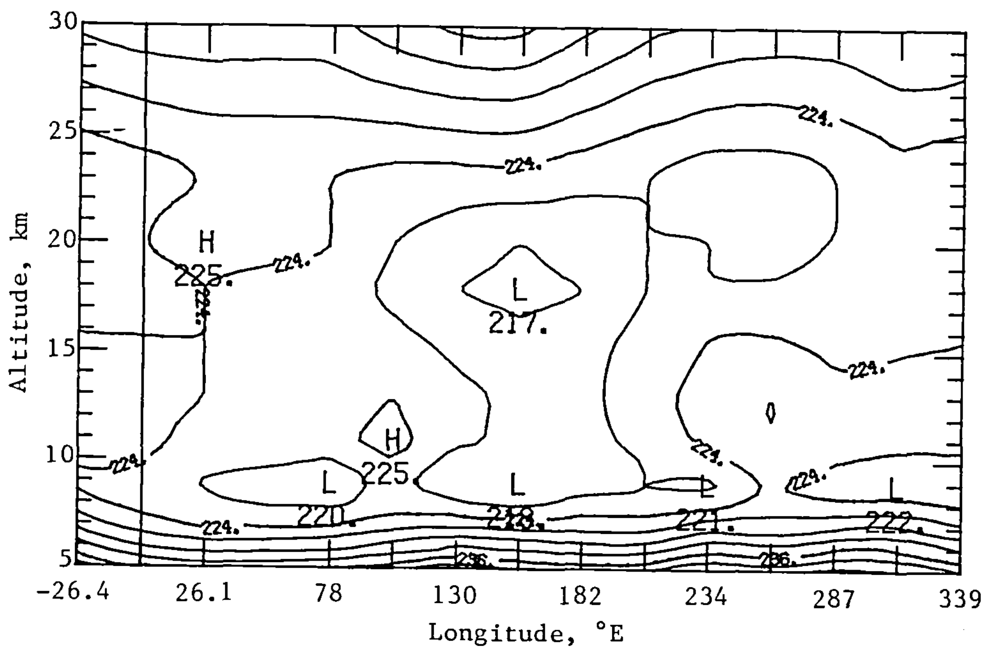


Figure 11.- Antarctic extinction and temperature profiles for October 11 to October 24, 1981.

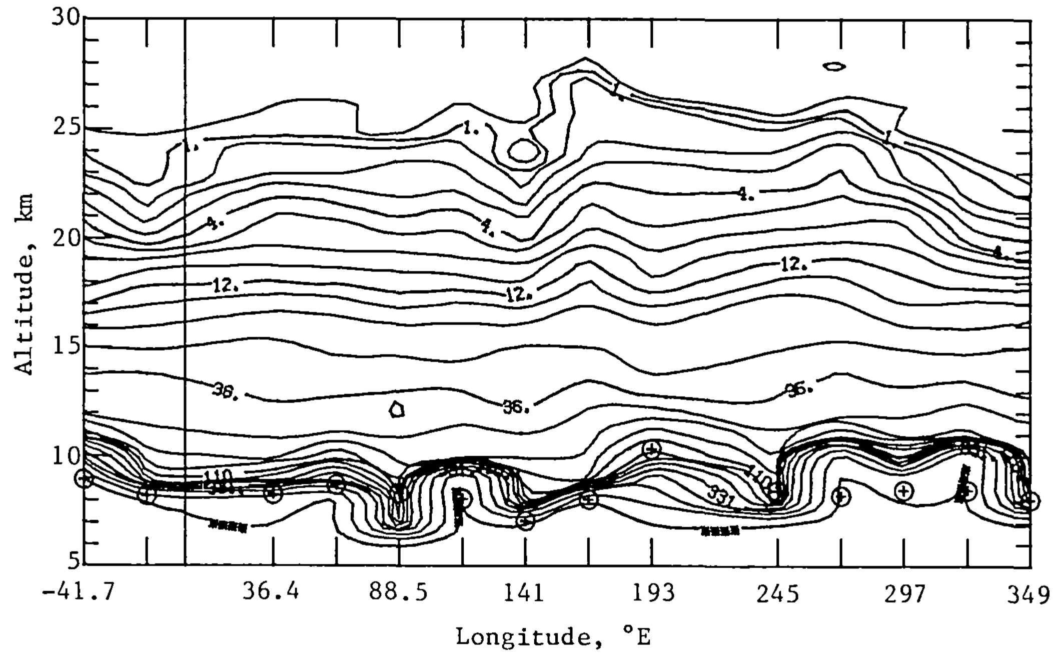


(a) Extinction isopleth.

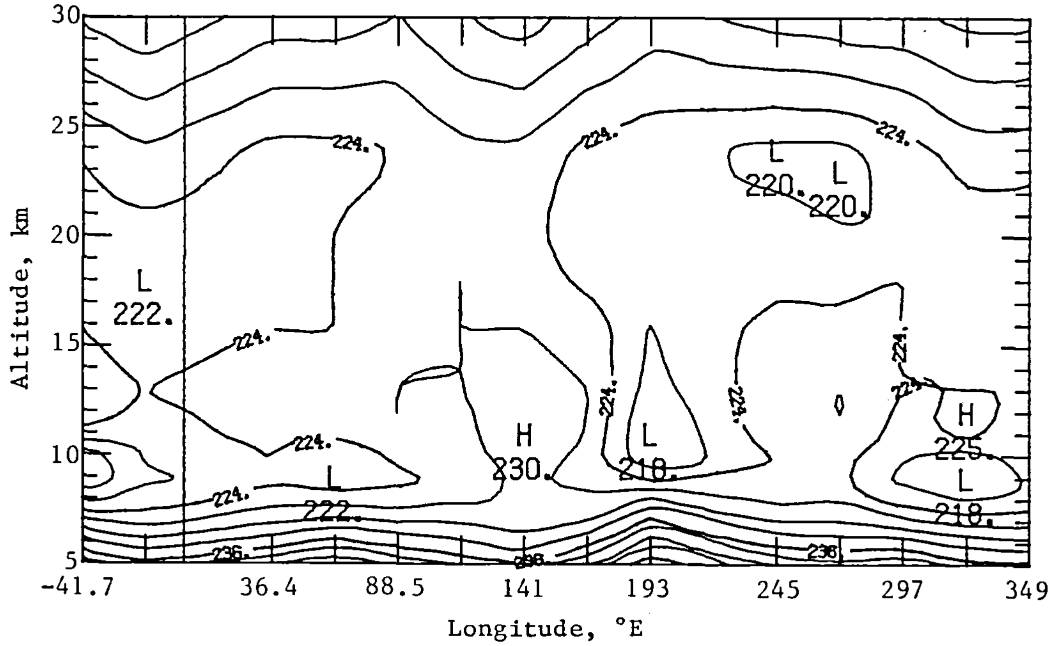


(b) Temperature contours.

Figure 12.- Arctic extinction isopleth and temperature contours for April 27.13 to 28.14, 1981, at latitudes from 74.6° to 74.3° N corresponding to orbits 12 657 to 12 671.

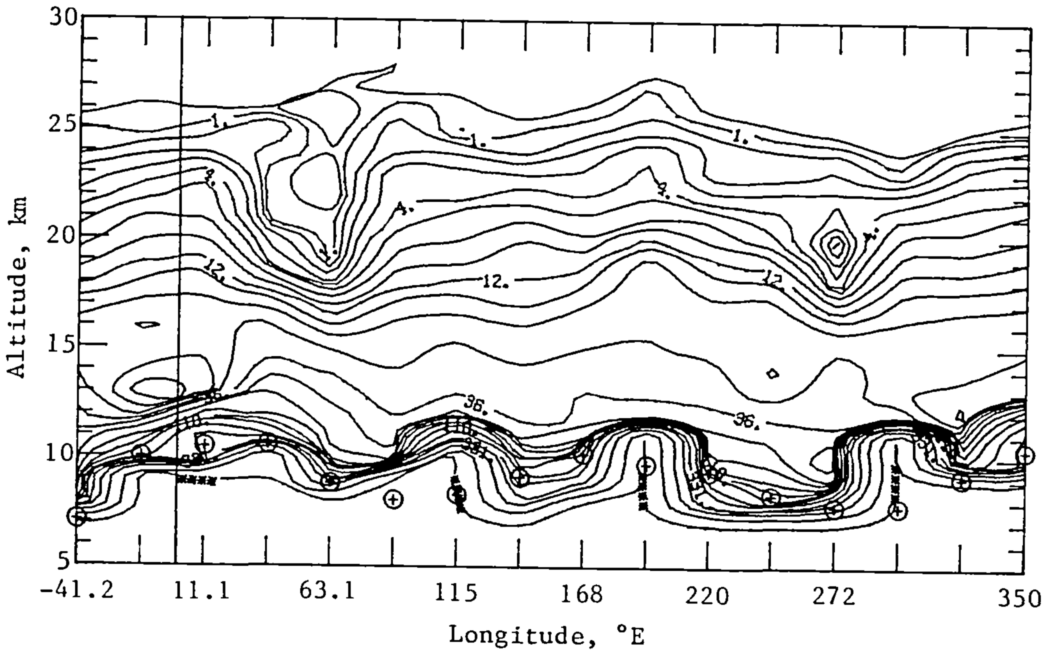


(a) Extinction isopleth.

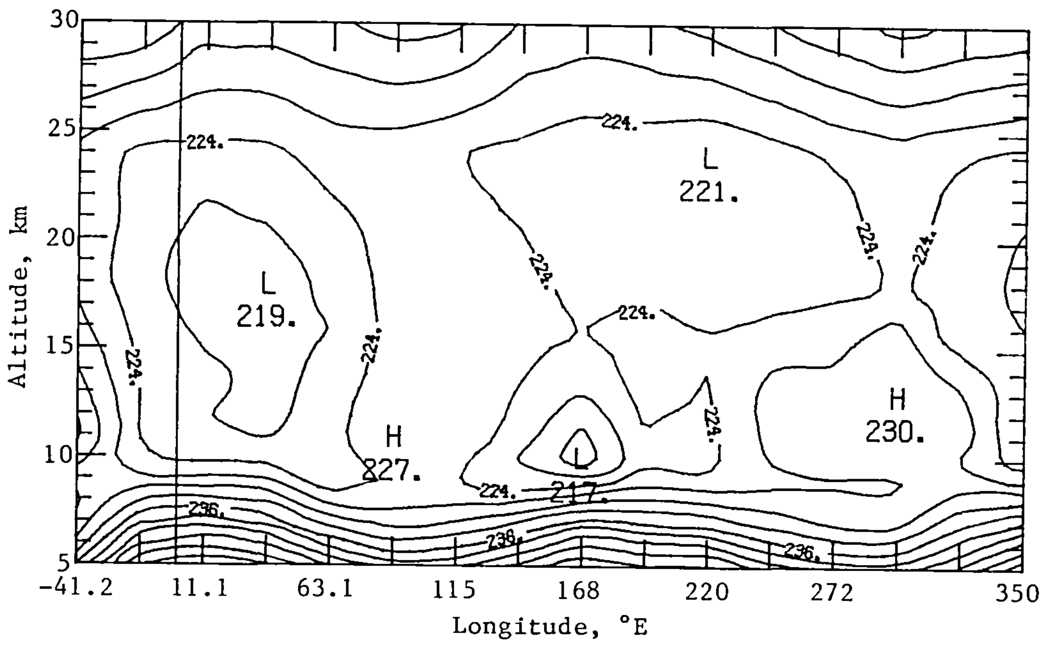


(b) Temperature contours.

Figure 13.- Arctic extinction isopleth and temperature contours for May 5.09 to 6.17, 1981, at latitudes from 72.5° to 72.2° N corresponding to orbits 12 767 to 12 782.

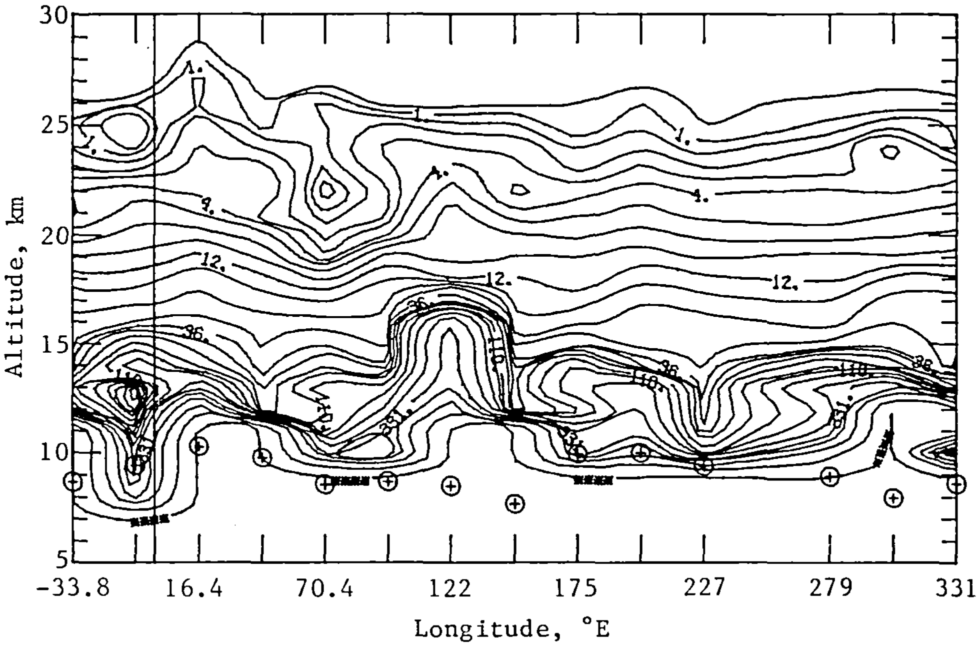


(a) Extinction isopleth.

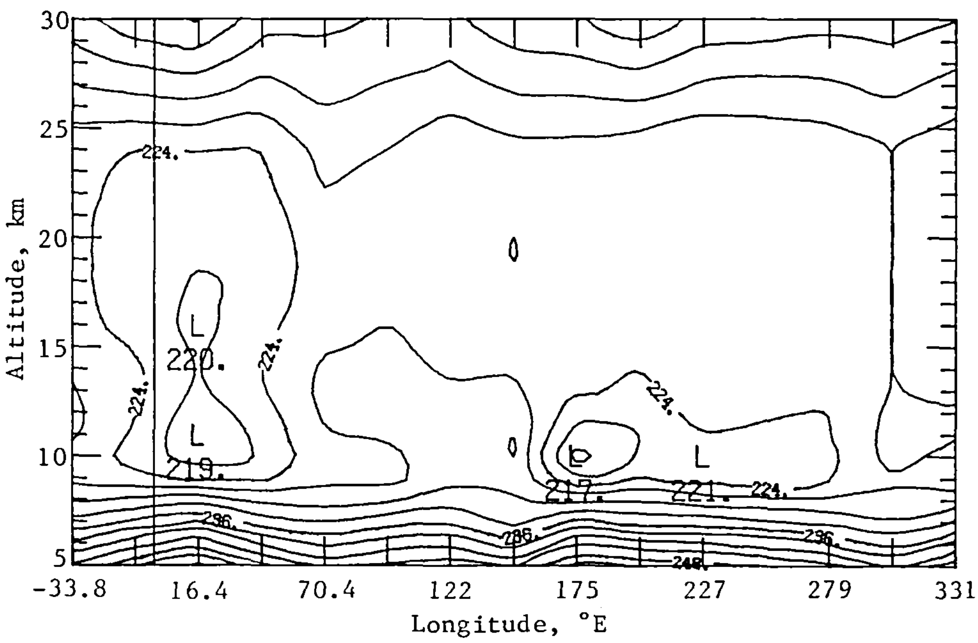


(b) Temperature contours.

Figure 14.- Arctic extinction isopleth and temperature contours for May 10.08 to 11.17, 1981, at latitudes from 71.2° to 71.0° N corresponding to orbits 12 836 to 12 851.

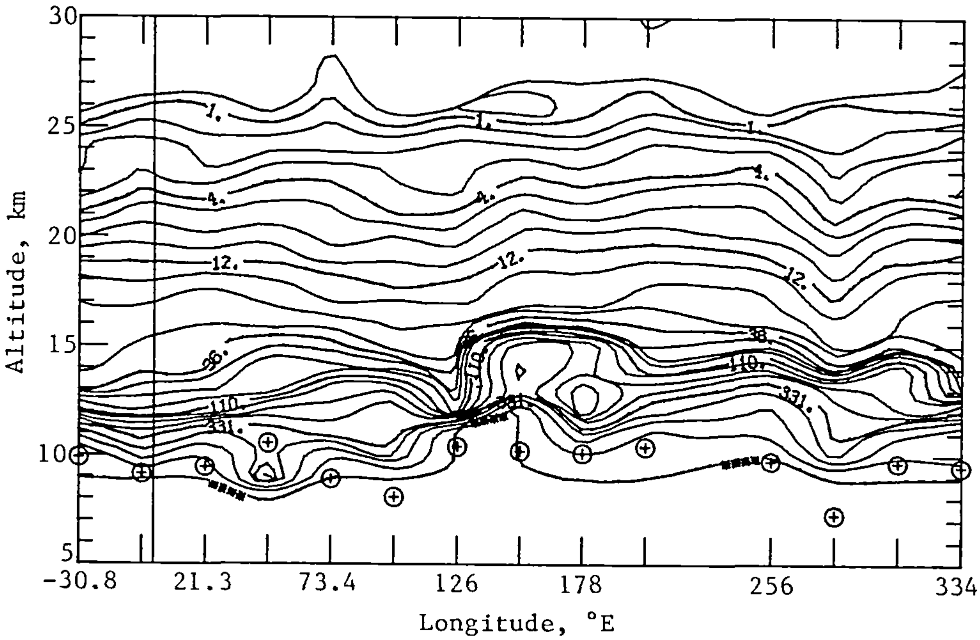


(a) Extinction isopleth.

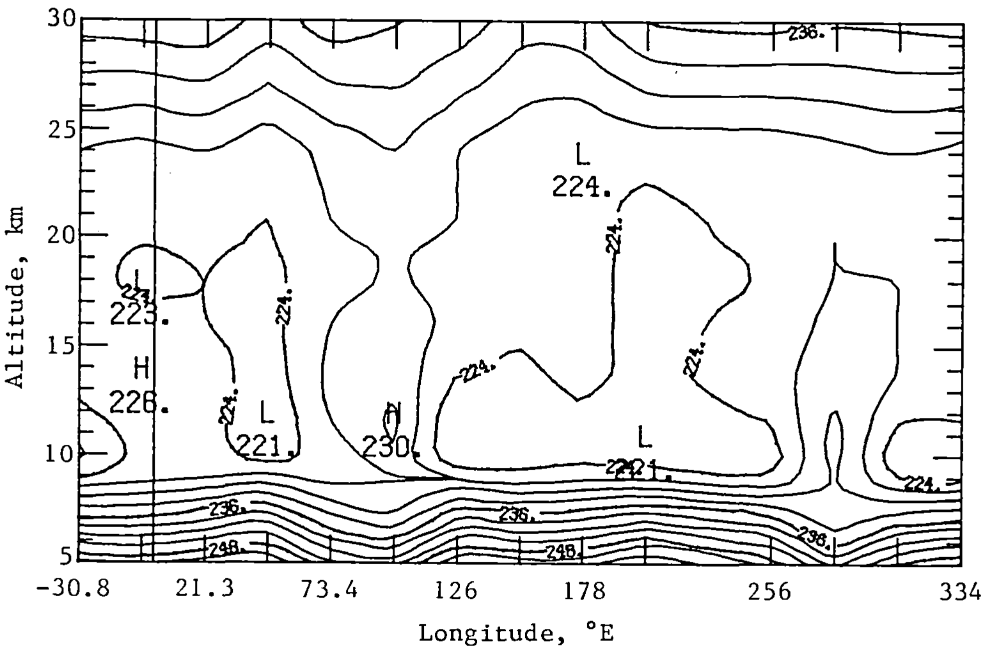


(b) Temperature contours.

Figure 15.- Arctic extinction isopleth and temperature contours for May 19.13 to 20.14, 1981, at latitudes from 69.3° to 69.1° N corresponding to orbits 12 961 to 12 975.

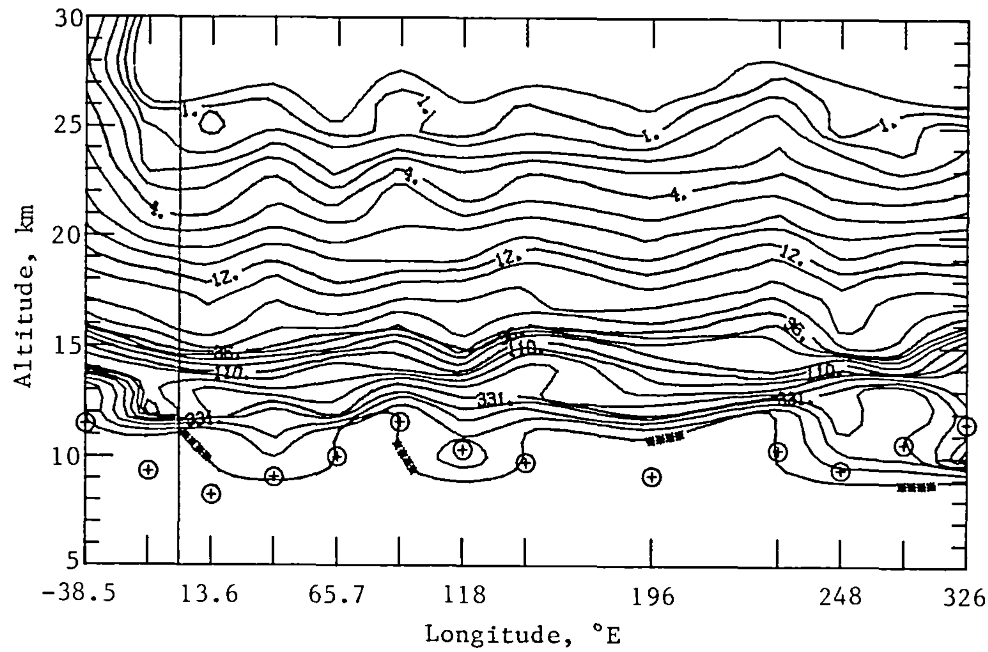


(a) Extinction isopleth.

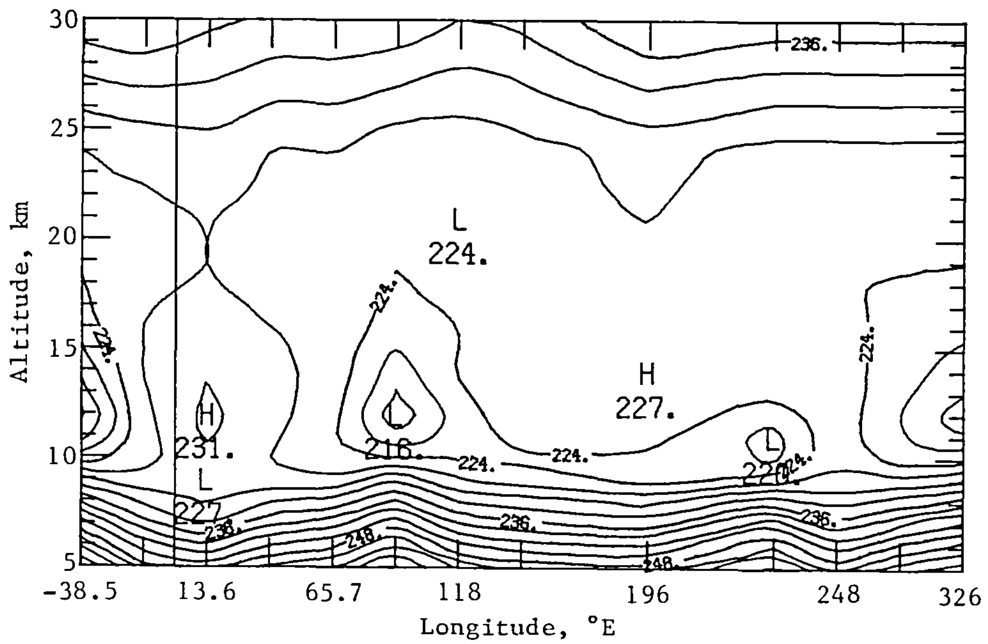


(b) Temperature contours.

Figure 16.- Arctic extinction isopleth and temperature contours for May 29.11 to 30.12, 1981, at latitudes from 67.6° to 67.5° N corresponding to orbits 13 099 to 13 113.

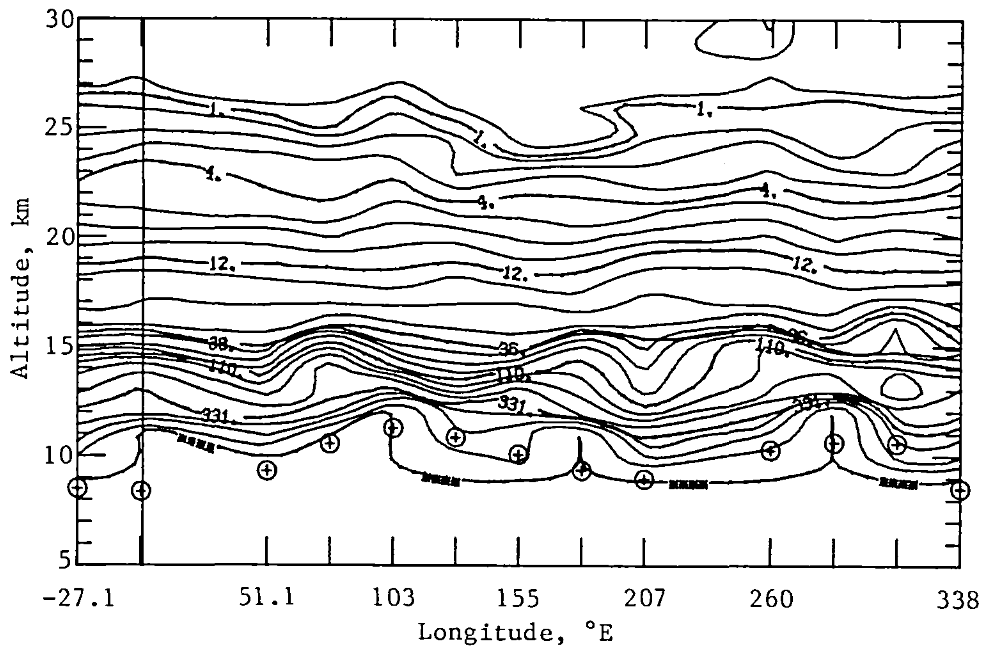


(a) Extinction isopleth.

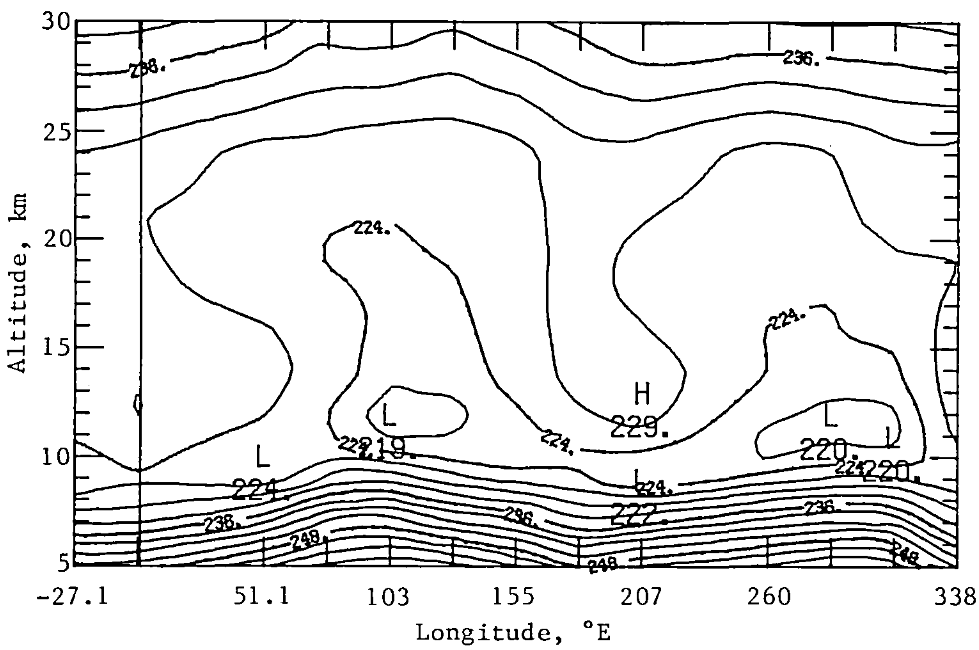


(b) Temperature contours.

Figure 17.- Arctic extinction isopleth and temperature contours for June 5.13 to 6.14, 1981, at latitudes from 66.8° to 66.7° N corresponding to orbits 13 196 to 13 210.

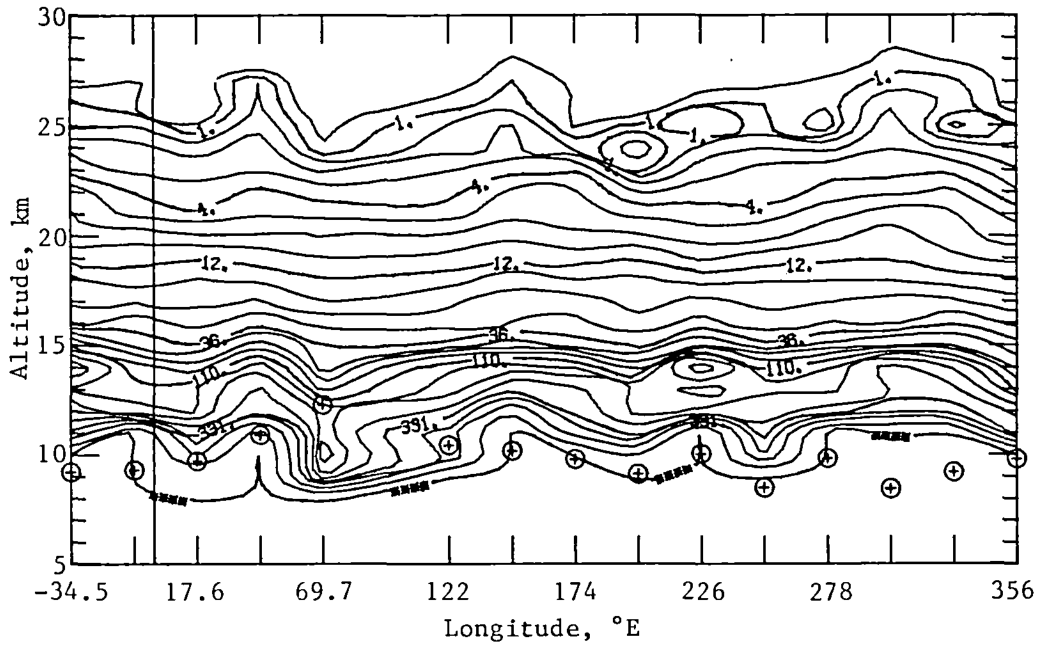


(a) Extinction isopleth.

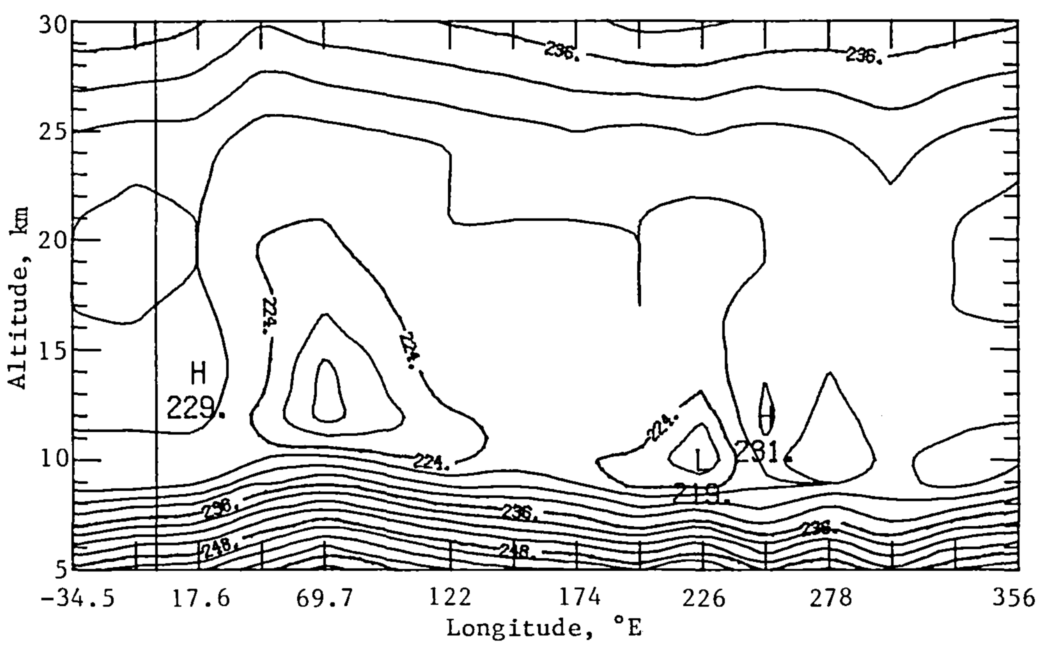


(b) Temperature contours.

Figure 18.- Arctic extinction isopleth and temperature contours for June 8.10 to 9.11, 1981, at a latitude of 66.5° N corresponding to orbits 13 237 to 13 251.

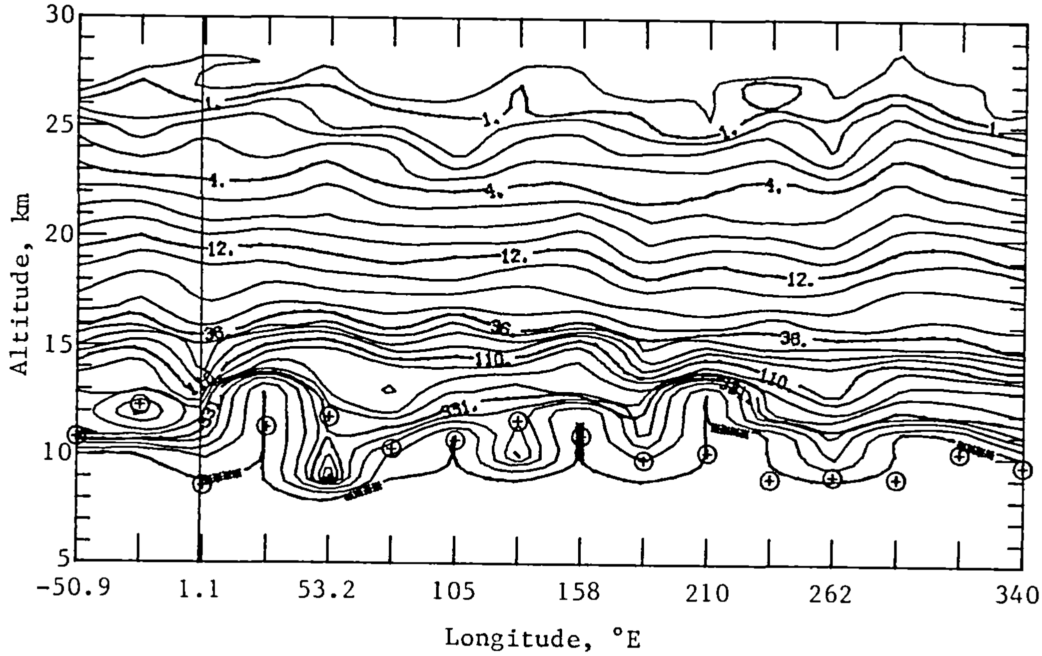


(a) Extinction isopleth.

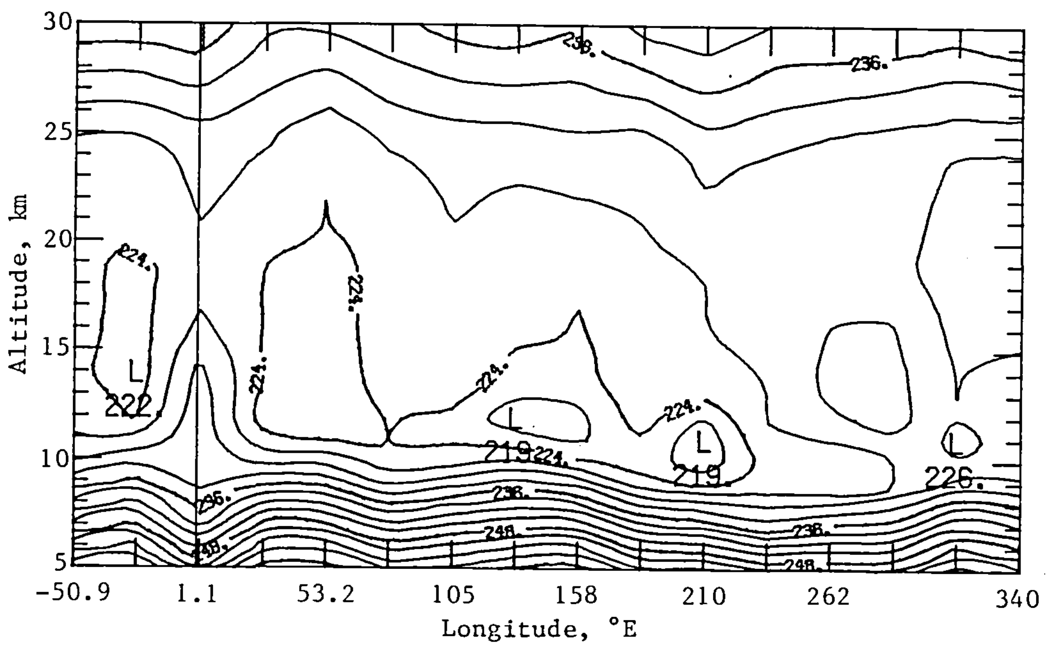


(b) Temperature contours.

Figure 19.- Arctic extinction isopleth and temperature contours for June 15.04 to 16.13, 1981, at a latitude of 66.1° N corresponding to orbits 13 333 to 13 348.

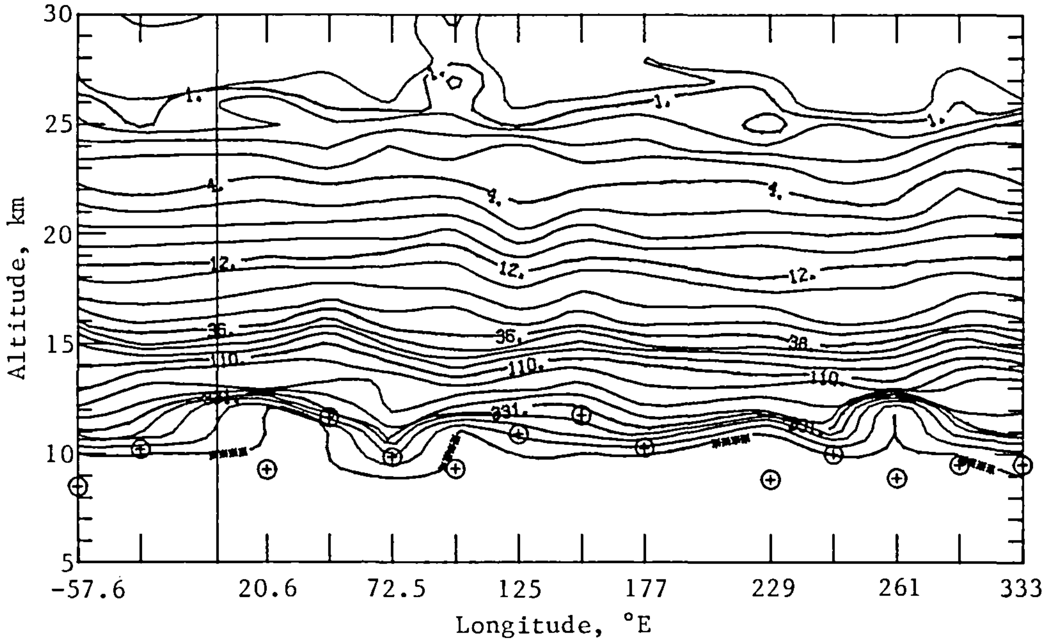


(a) Extinction isopleth.

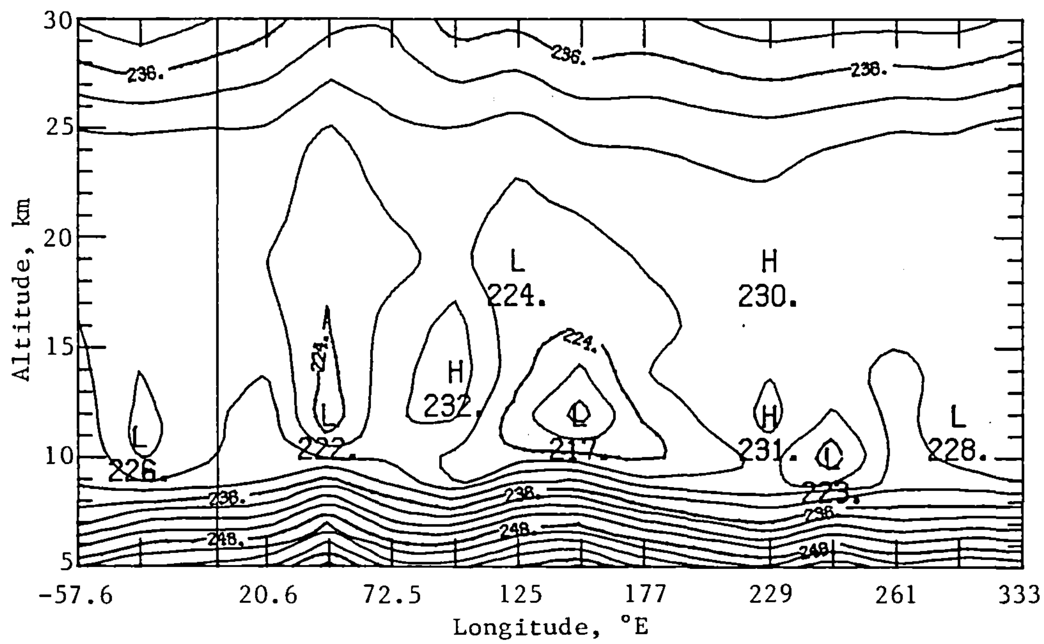


(b) Temperature contours.

Figure 20.- Arctic extinction isopleth and temperature contours for June 24.09 to 25.17, 1981, at a latitude of 66.1° N corresponding to orbits 13 458 to 13 473.

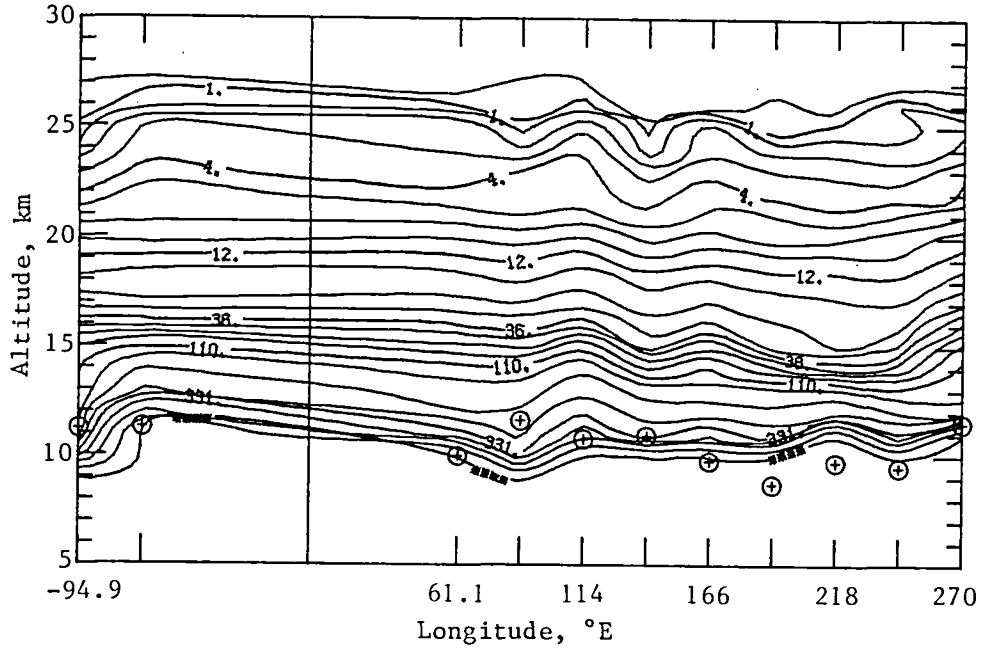


(a) Extinction isopleth.

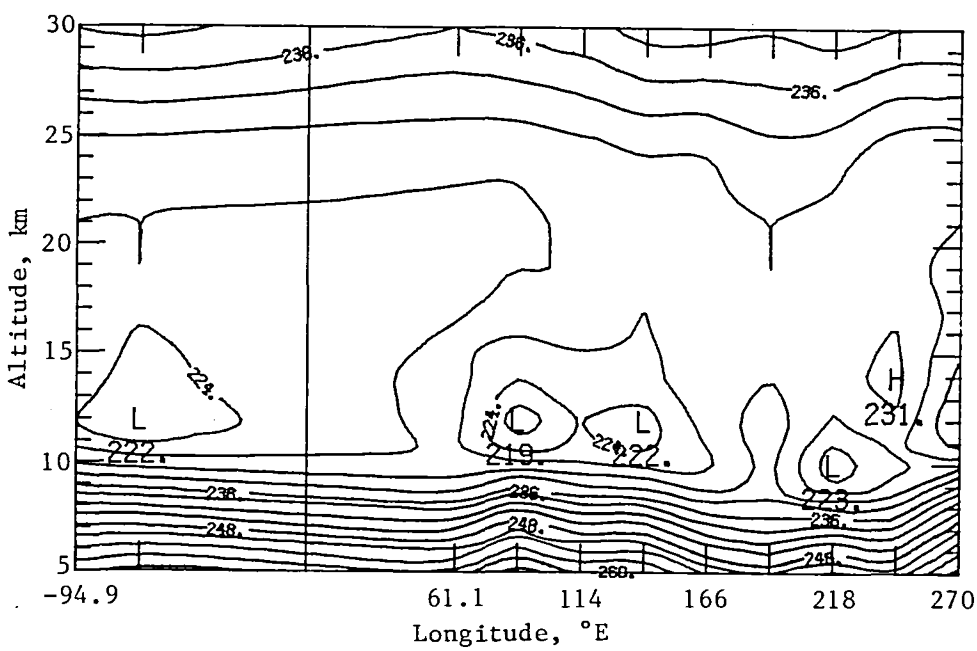


(b) Temperature contours.

Figure 21.- Arctic extinction isopleth and temperature contours for July 1.11 to 2.19, 1981, at latitudes from 66.4° to 66.5° N corresponding to orbits 13 555 to 13 570.

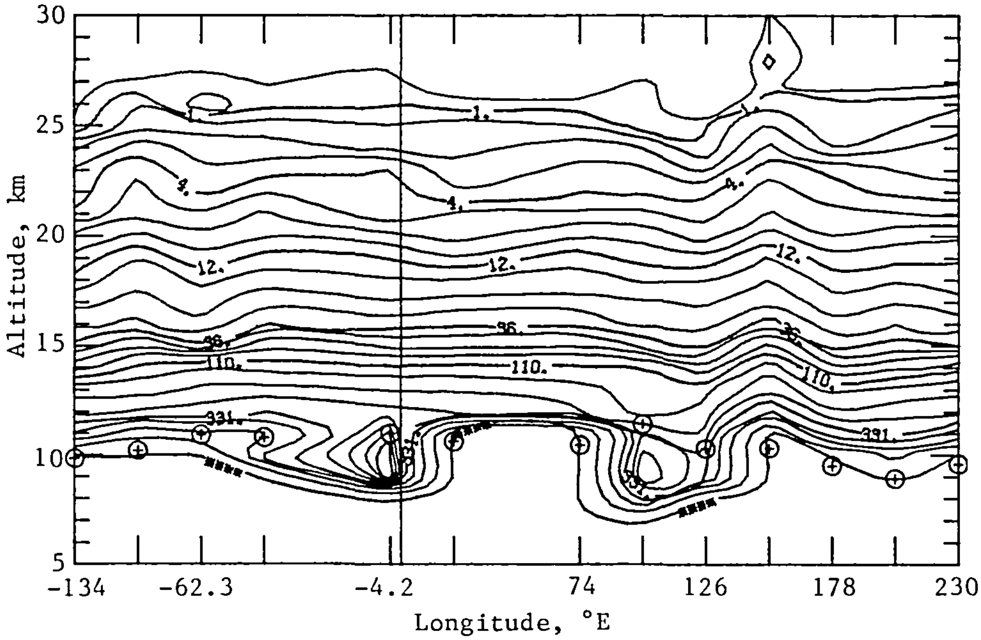


(a) Extinction isopleth.

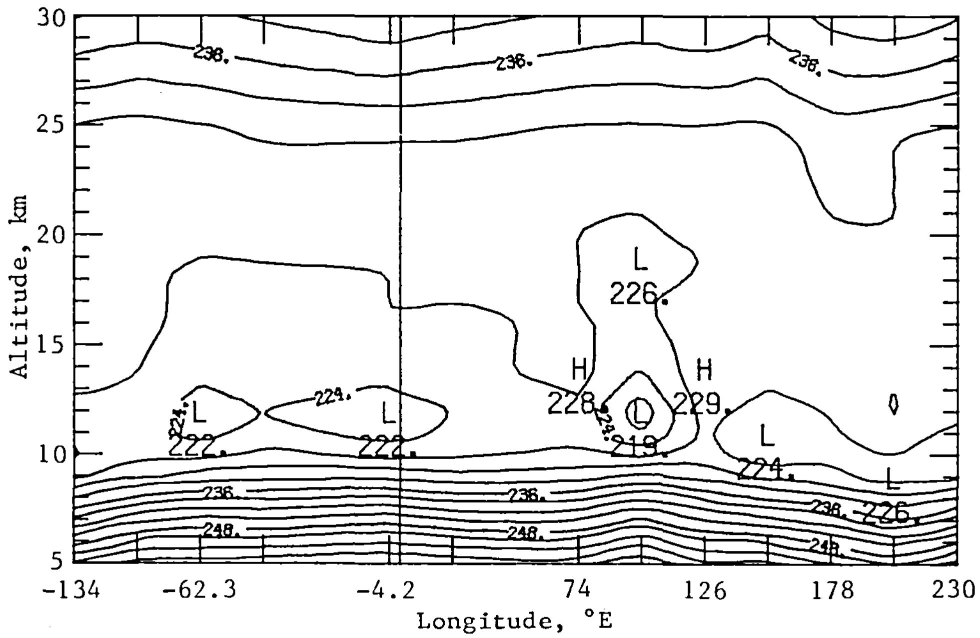


(b) Temperature contours.

Figure 22.- Arctic extinction isopleth and temperature contours for July 9.28 to 10.29, 1981, at latitudes from 67.2° to 67.3° N corresponding to orbits 13 668 to 13 682.

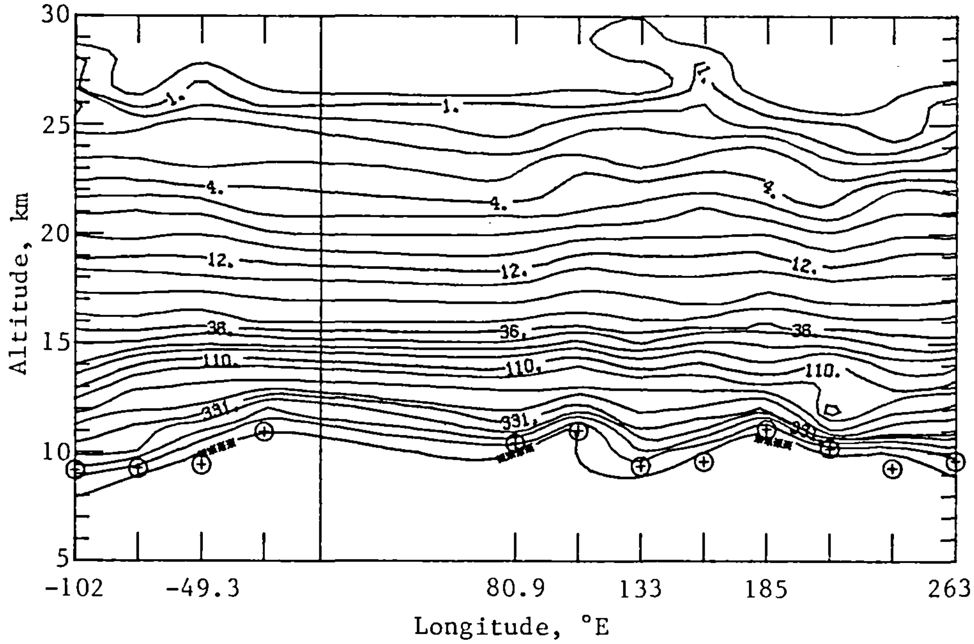


(a) Extinction isopleth.

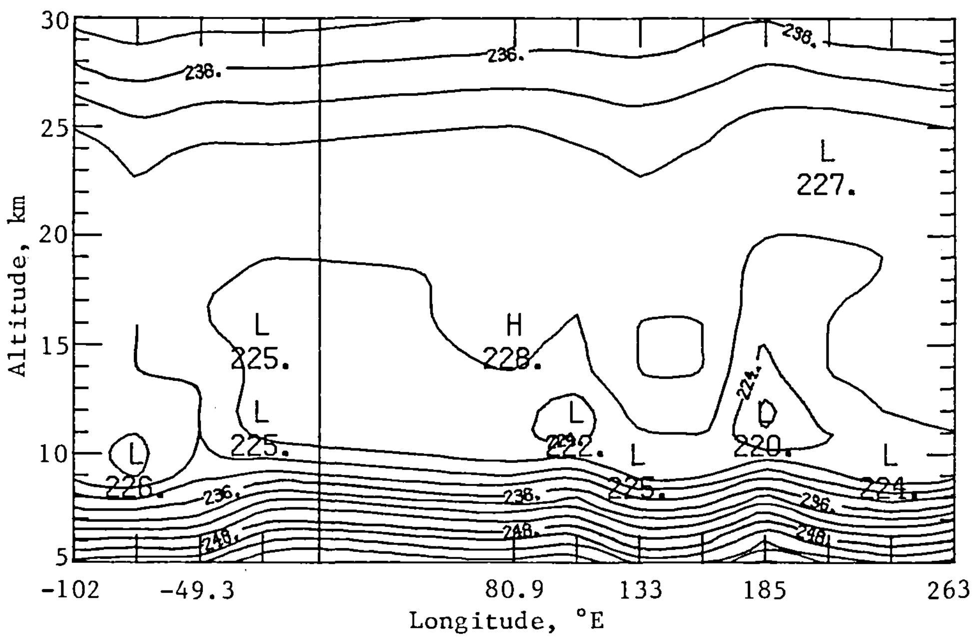


(b) Temperature contours.

Figure 23.- Arctic extinction isopleth and temperature contours for July 12.39 to 13.41, 1981, at latitudes from 67.6° to 67.8° N corresponding to orbits 13 711 to 13 725.

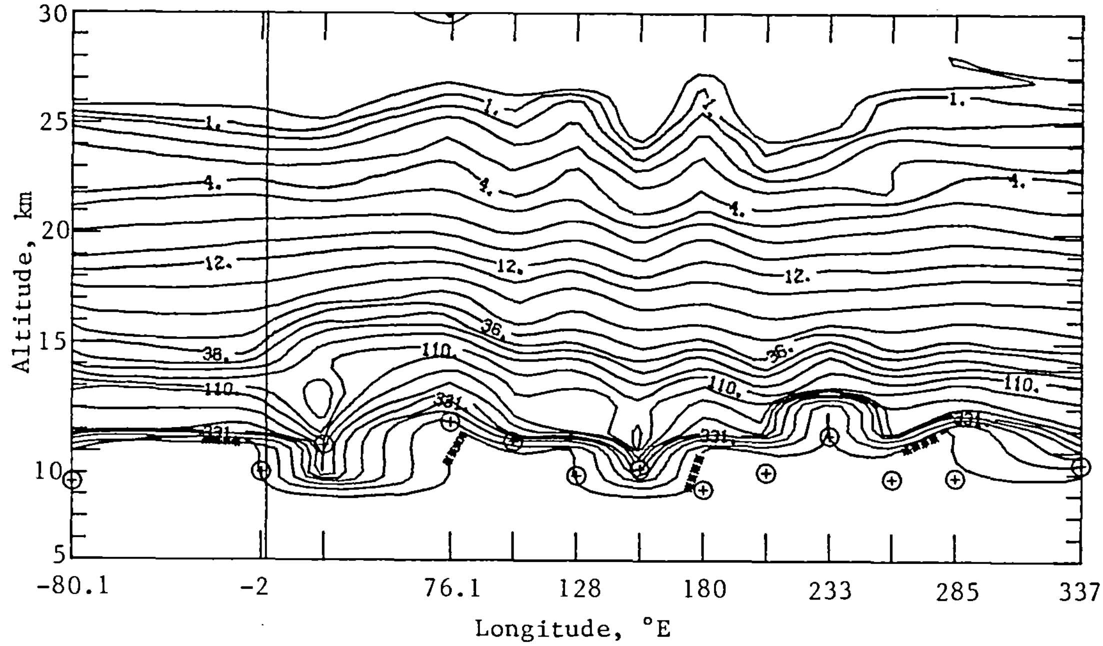


(a) Extinction isopleth.

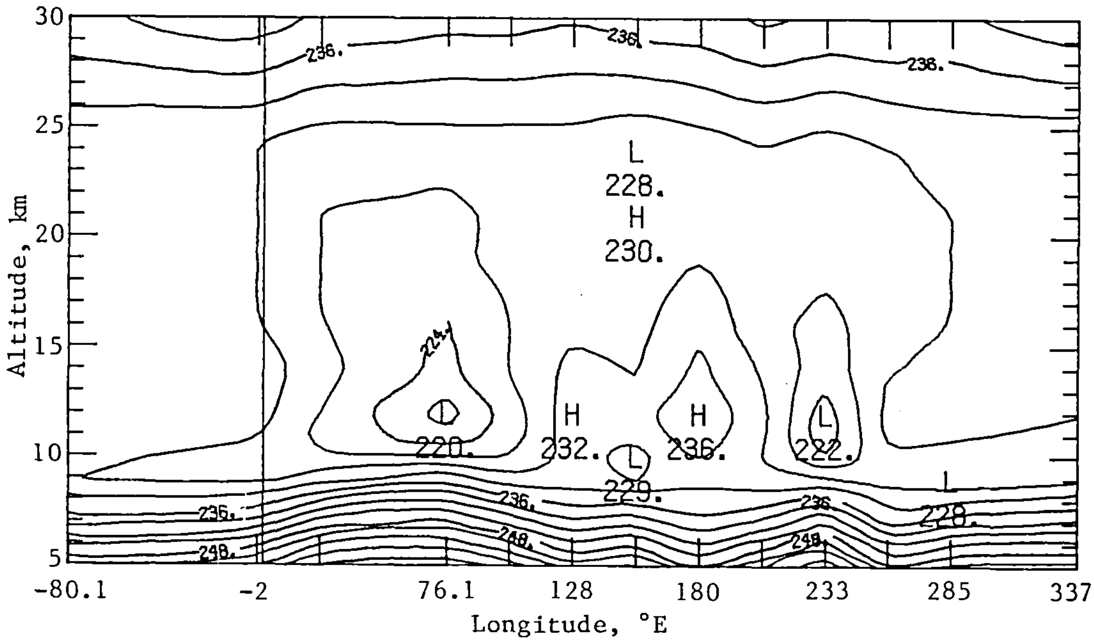


(b) Temperature contours.

Figure 24.- Arctic extinction isopleth and temperature contours for July 22.30 to 23.32, 1981, at latitudes from 69.2° to 69.4° N corresponding to orbits 13 848 to 13 862.

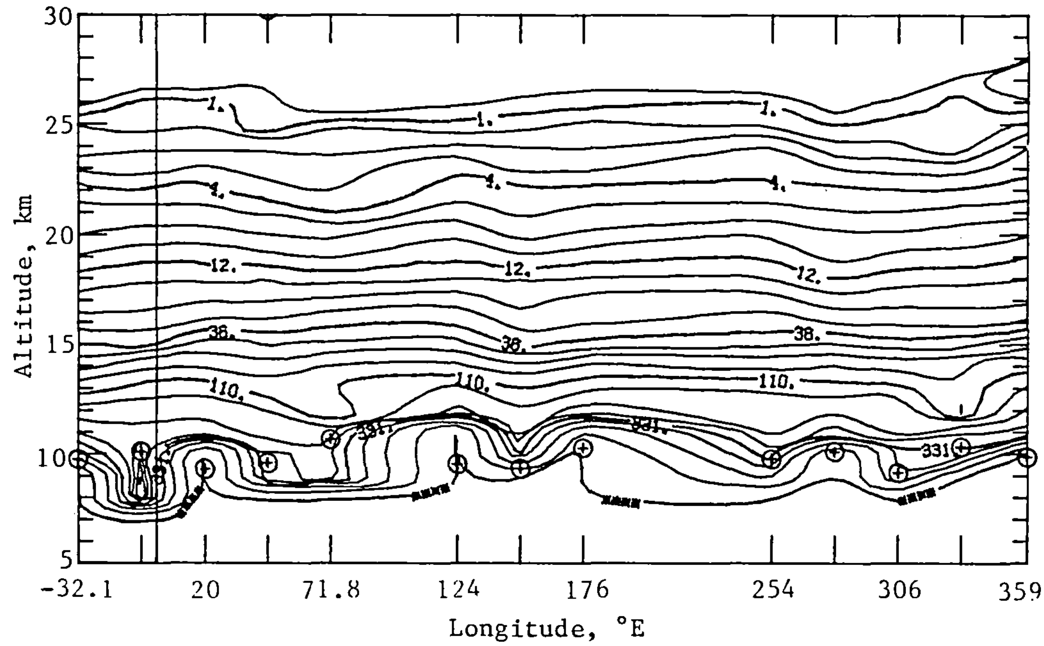


(a) Extinction isopleth.

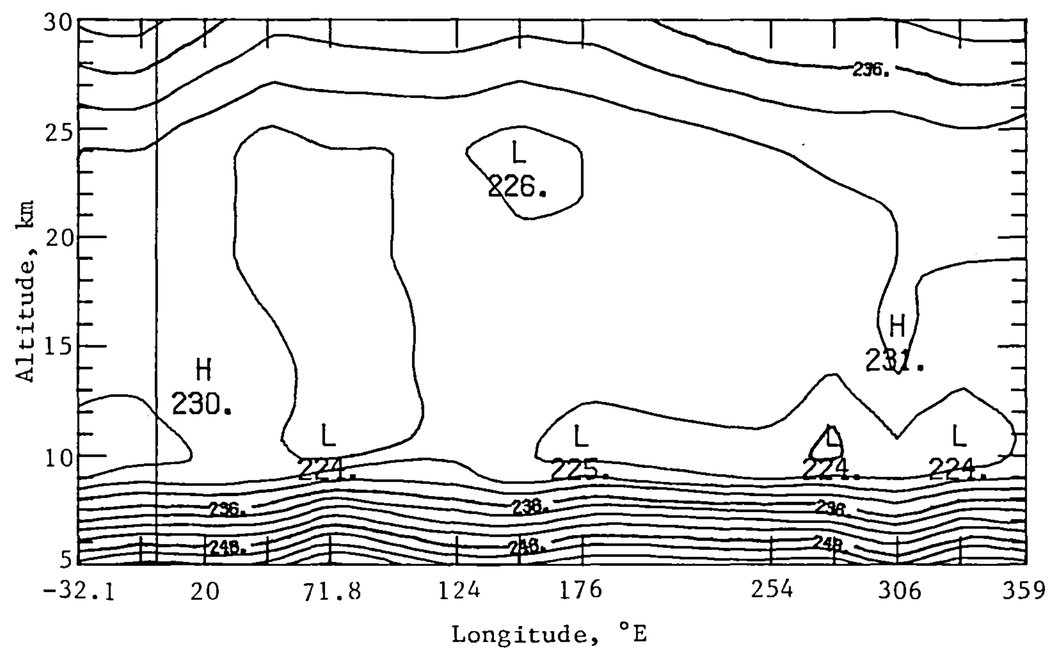


(b) Temperature contours.

Figure 25.- Arctic extinction isopleth and temperature contours for July 29.11 to 30.26, 1981, at latitudes from 70.6° to 70.9° N corresponding to orbits 13 942 to 13 958.

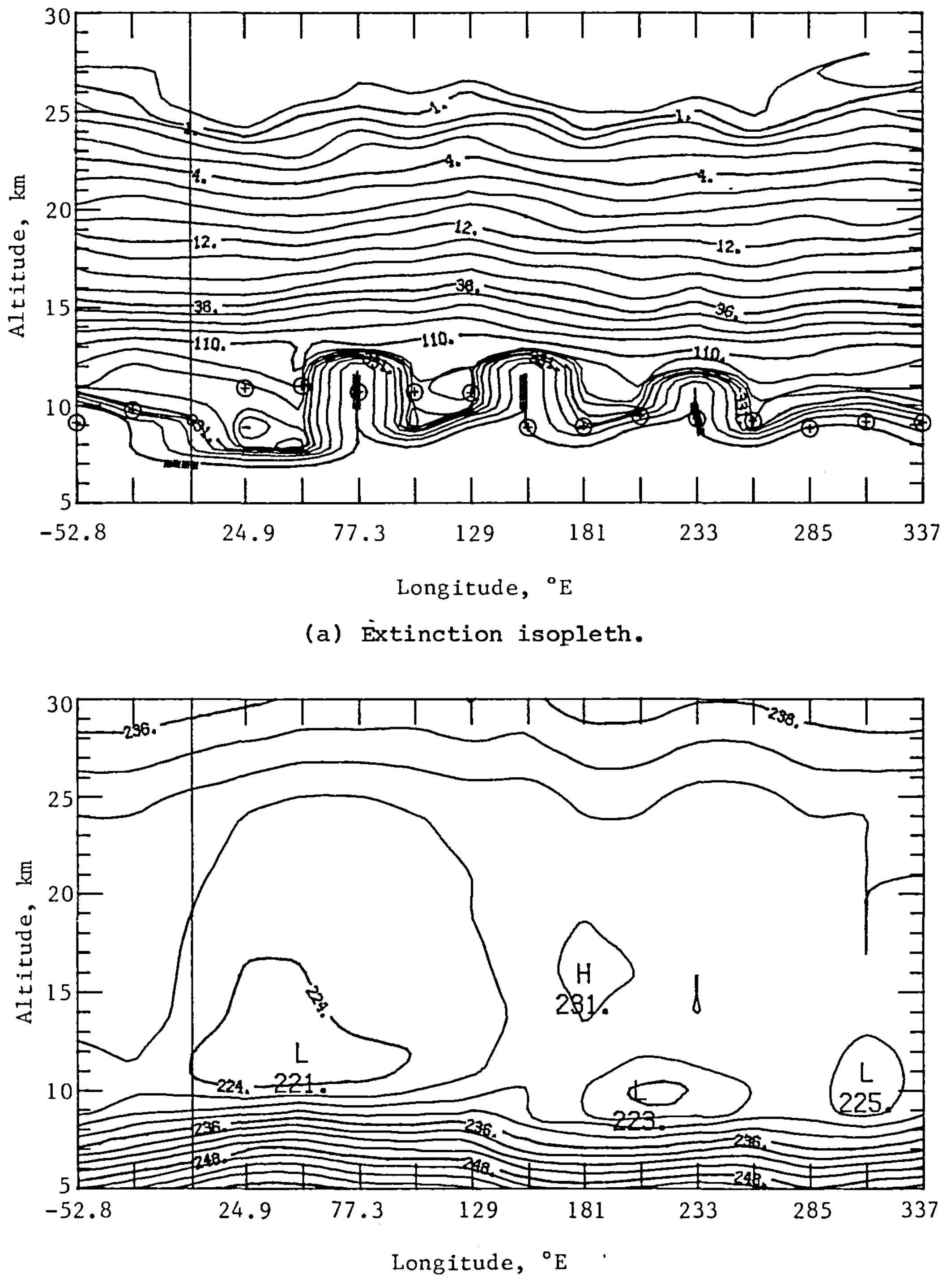


(a) Extinction isopleth.



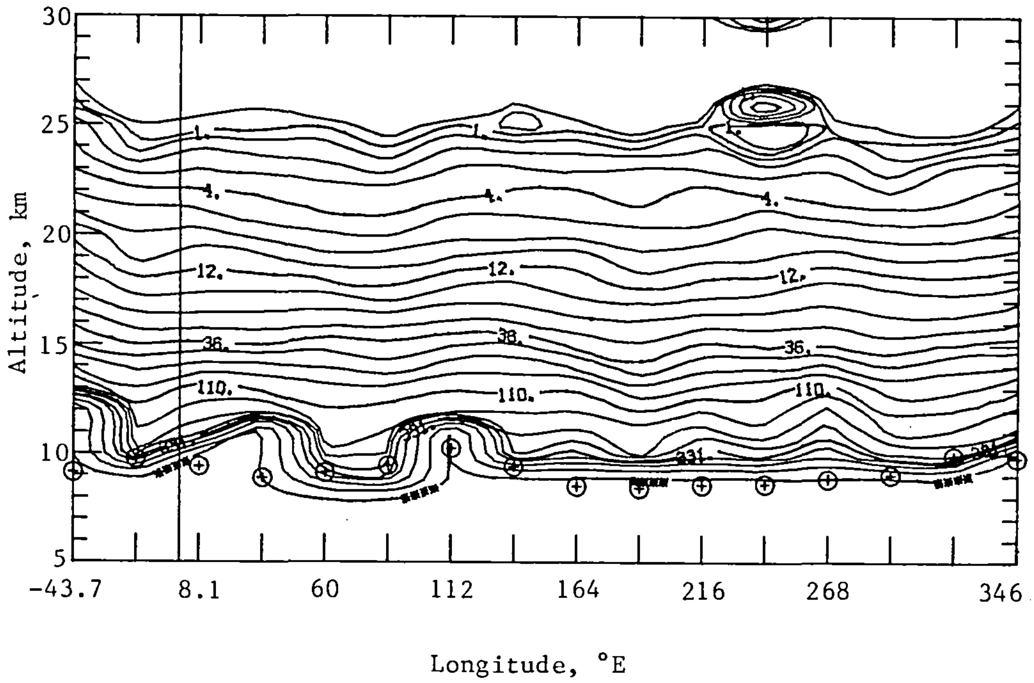
(b) Temperature contours.

Figure 26.- Arctic extinction isopleth and temperature contours for August 5.05 to 6.14, 1981, at latitudes from 72.2° to 72.5° N corresponding to orbits 14 038 to 14 053.

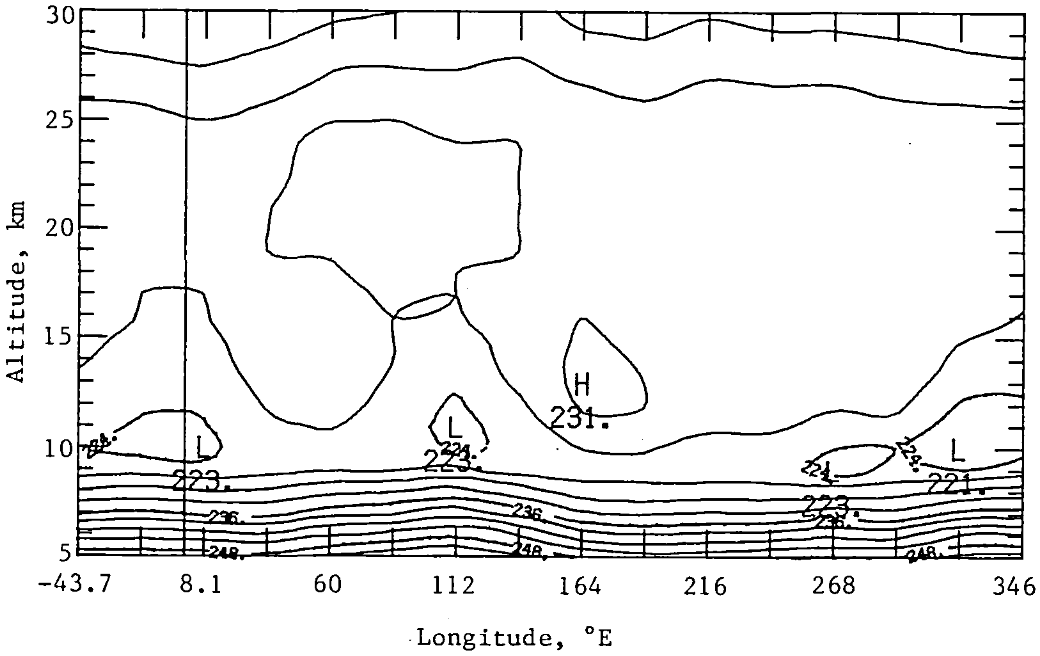


(b) Temperature contours.

Figure 27.- Arctic extinction isopleth and temperature contours for August 10.12 to 11.20, 1981, at latitudes from 73.5° to 73.8° N corresponding to orbits 14 108 to 14 123.

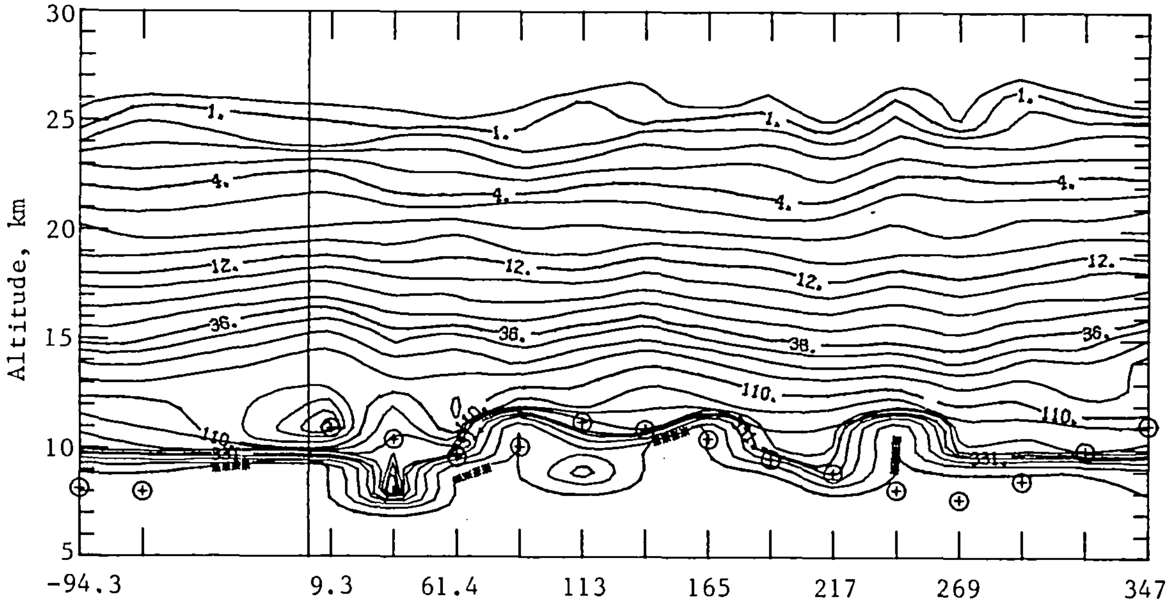


(a) Extinction isopleth.

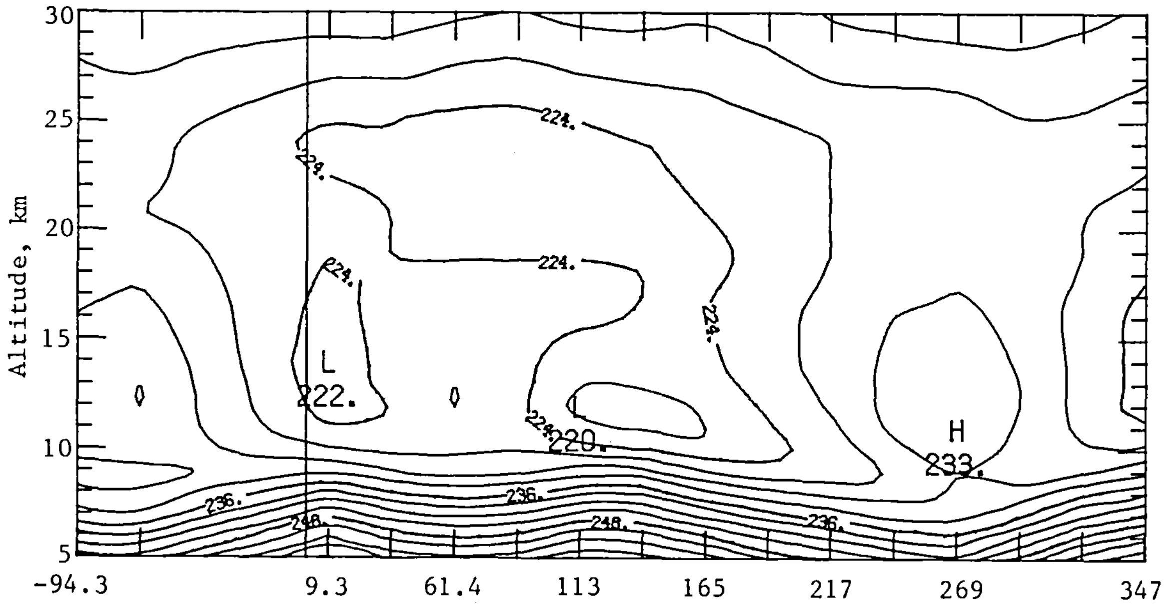


(b) Temperature contours.

Figure 28.- Arctic extinction isopleth and temperature contours for August 21.11 to 22.20, 1981, at latitudes from 76.3° to 76.6° N corresponding to orbits 14 260 to 14 275.

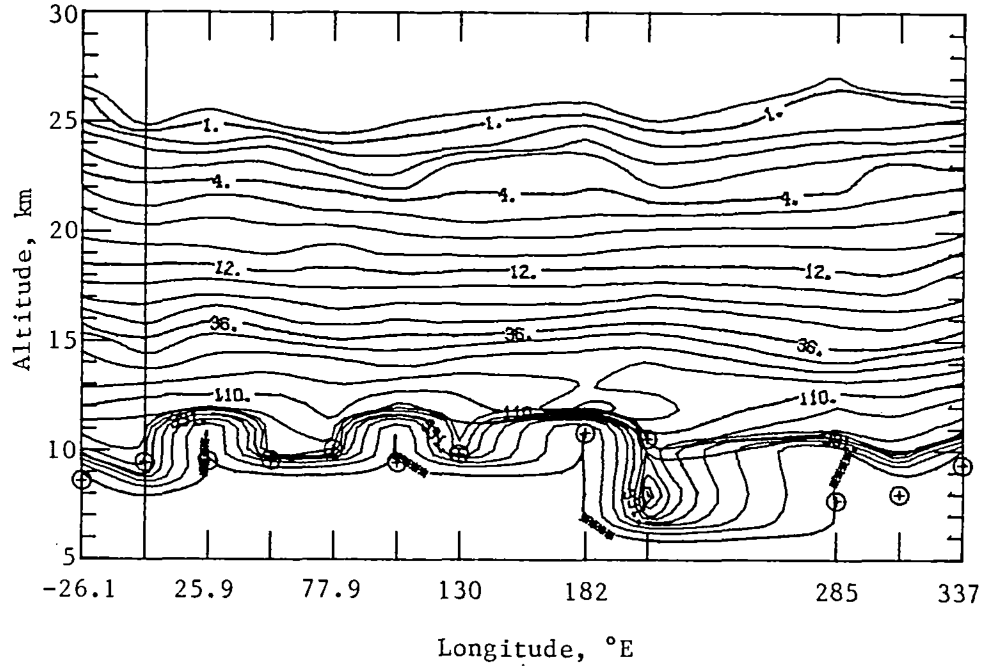


(a) Extinction isopleth.

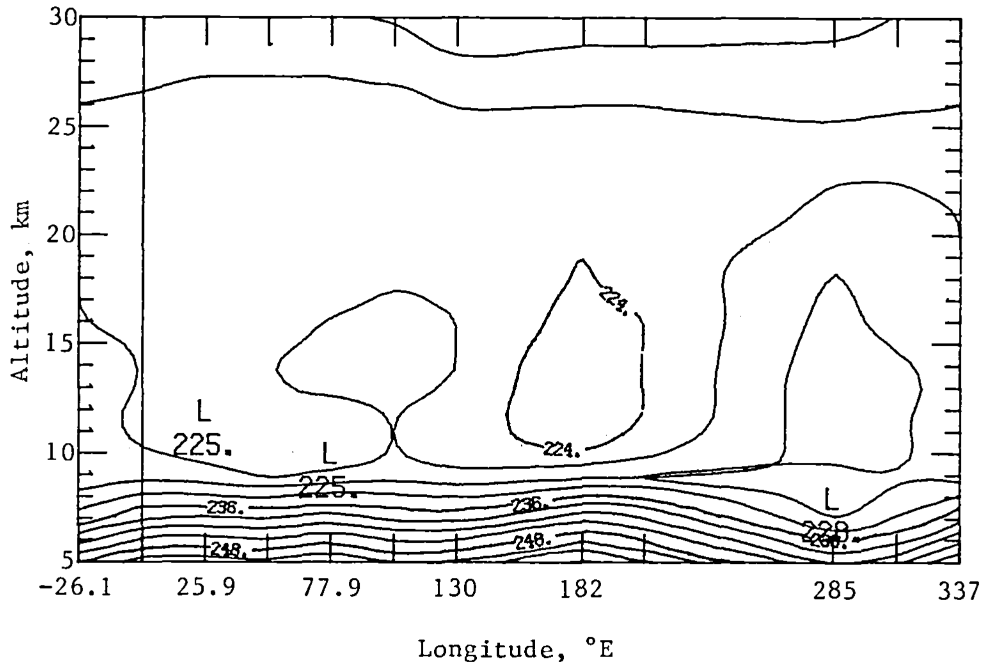


(b) Temperature contours.

Figure 29.- Arctic extinction isopleth and temperature contours for August 28.13 to 29.36, 1981, at latitudes from 78.1° to 78.4° N corresponding to orbits 14 357 to 14 374.

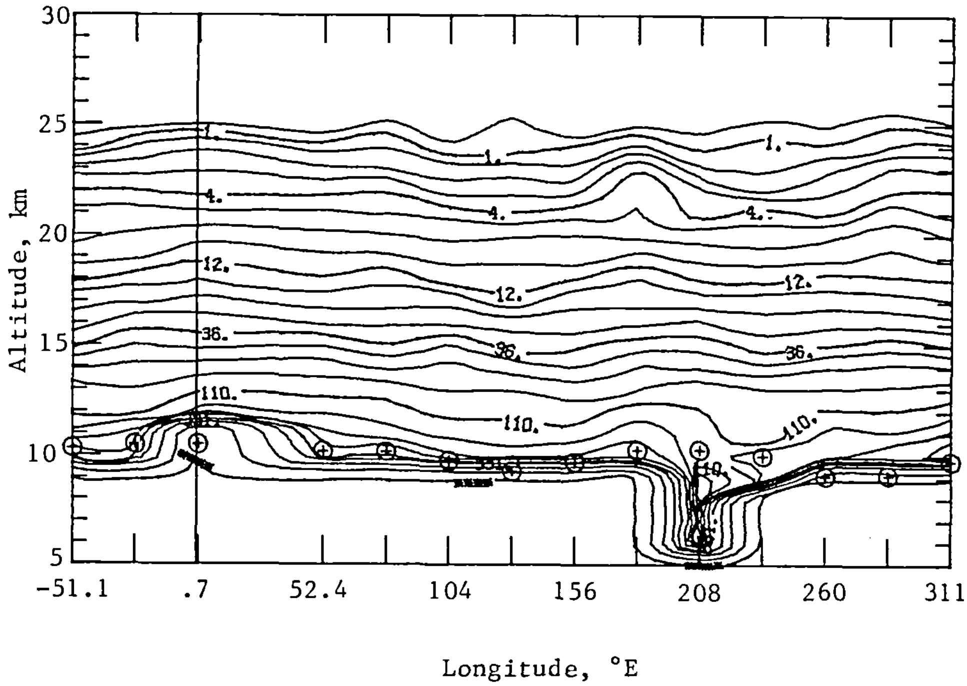


(a) Extinction isopleth.

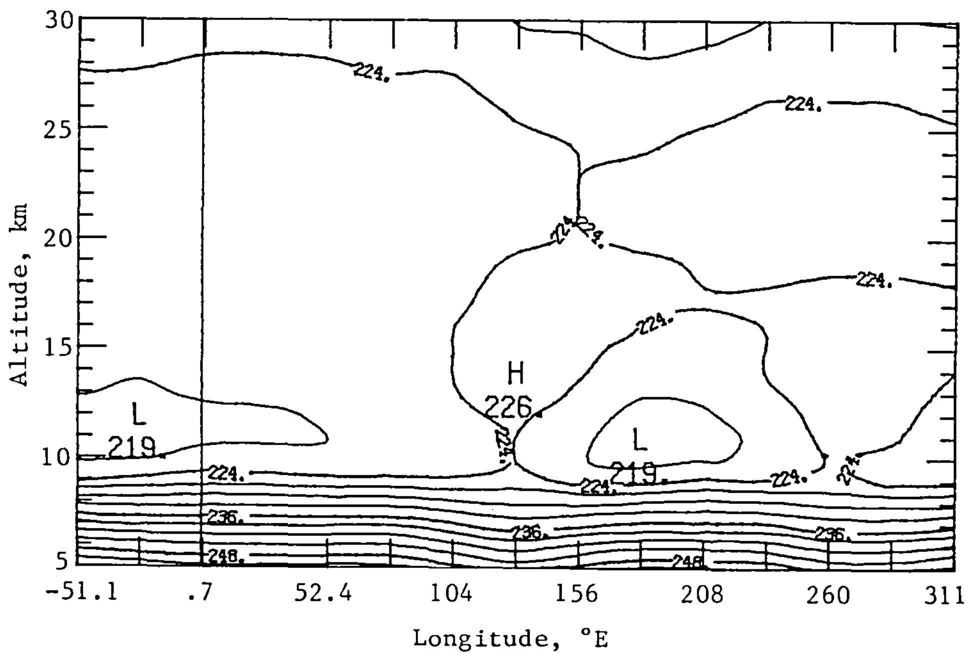


(b) Temperature contours.

Figure 30.- Arctic extinction isopleth and temperature contours for August 31.17 to September 1.18, 1981, at latitudes from 78.8° to 79.0° N corresponding to orbits 14 399 to 14 413.

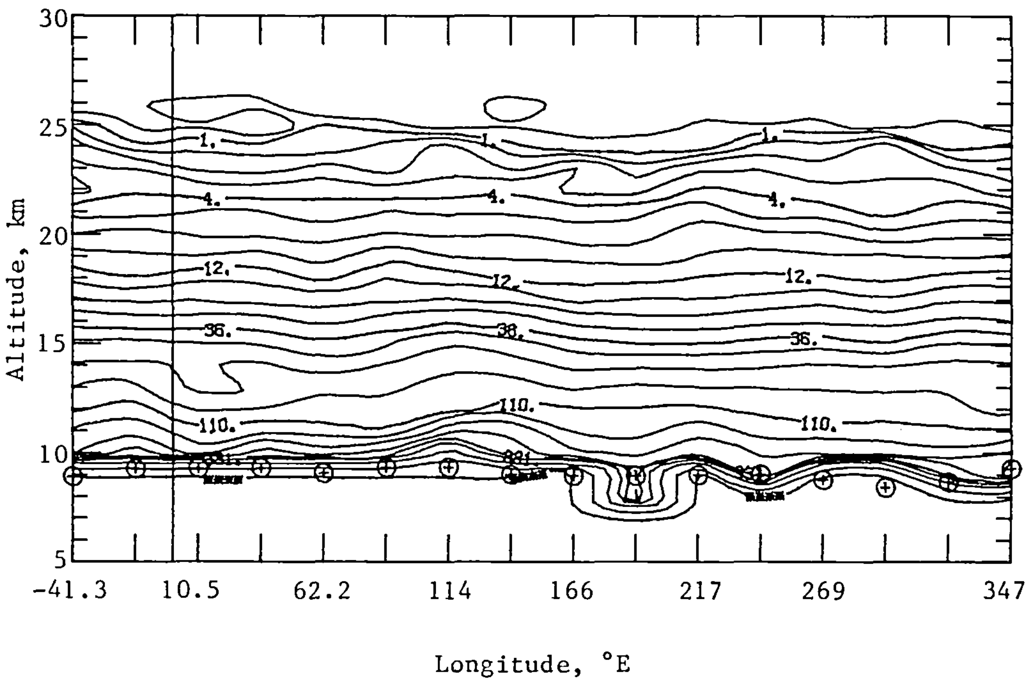


(a) Extinction isopleth.

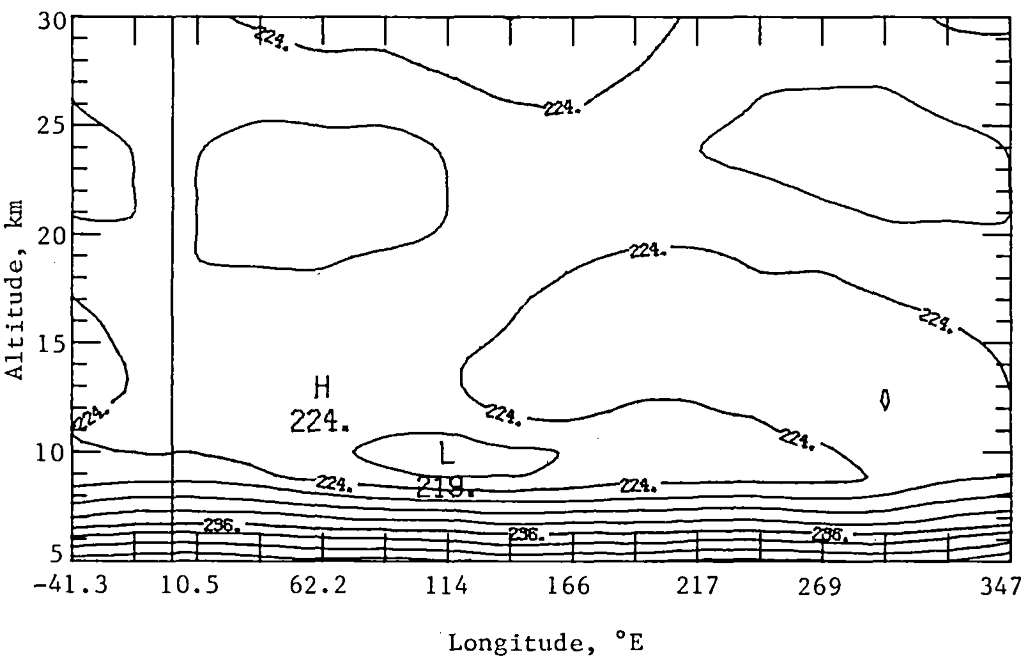


(b) Temperature contours.

Figure 31.- Arctic extinction isopleth and temperature contours for September 9.29 to 10.30, 1981, at latitudes from 80.5° to 80.6° N corresponding to orbits 14 525 to 14 539.

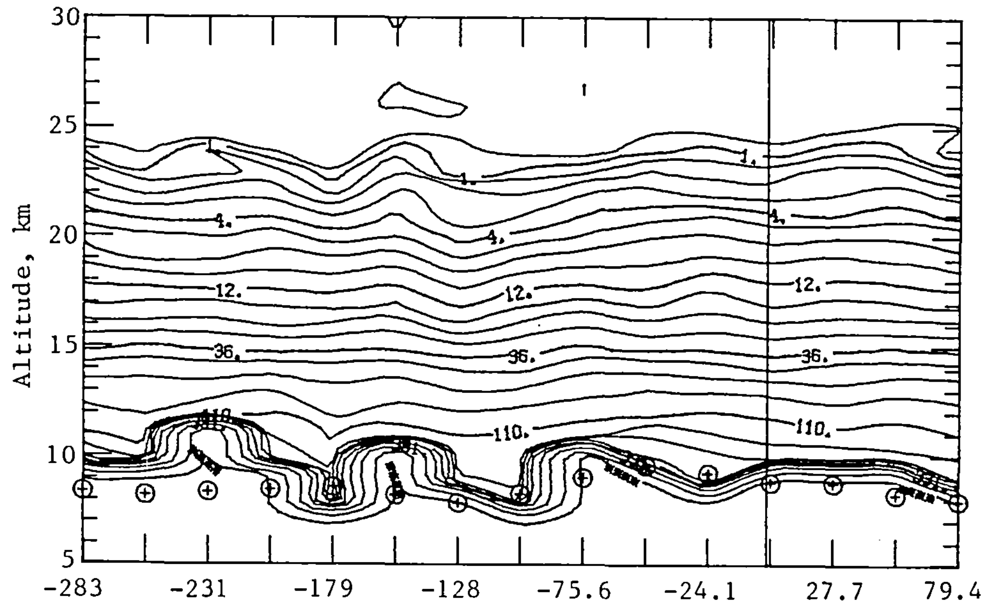


(a) Extinction isopleth.

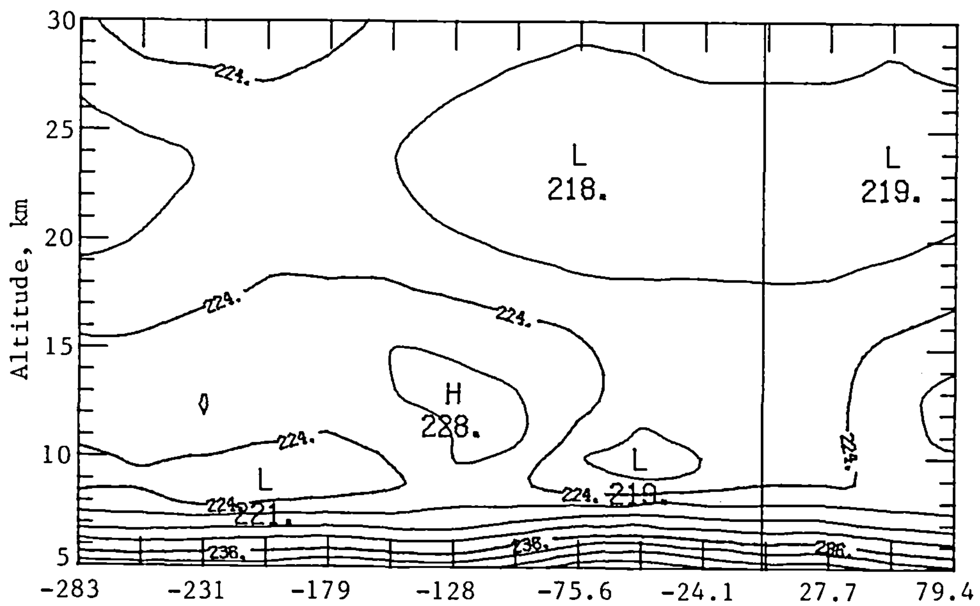


(b) Temperature contours.

Figure 32.- Arctic extinction isopleth and temperature contours for September 16.23 to 17.32, 1981, at a latitude of 81.1° N corresponding to orbits 14 621 to 14 636.

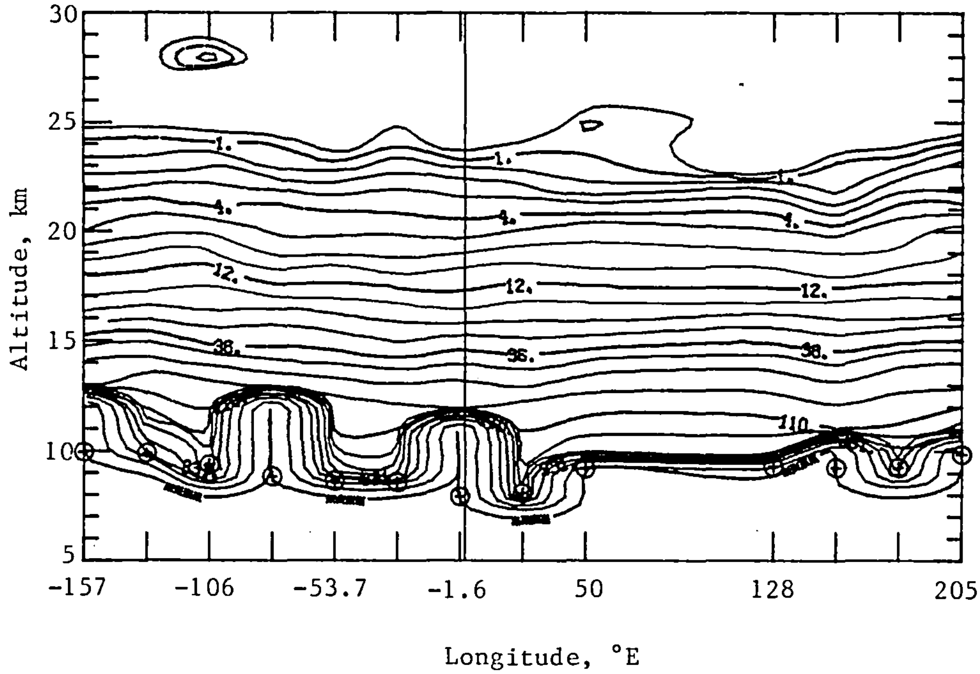


(a) Extinction isopleth.

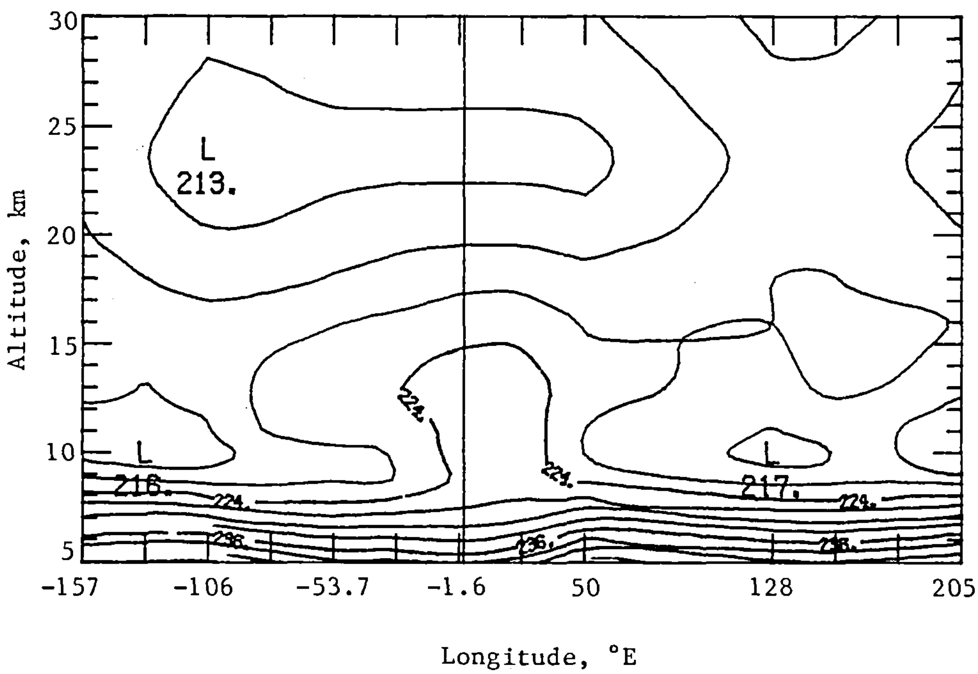


(b) Temperature contours.

Figure 33.- Arctic extinction isopleth and temperature contours for September 21.01 to 22.02, 1981, at a latitude of 81.1° N corresponding to orbits 14 687 to 14 701.

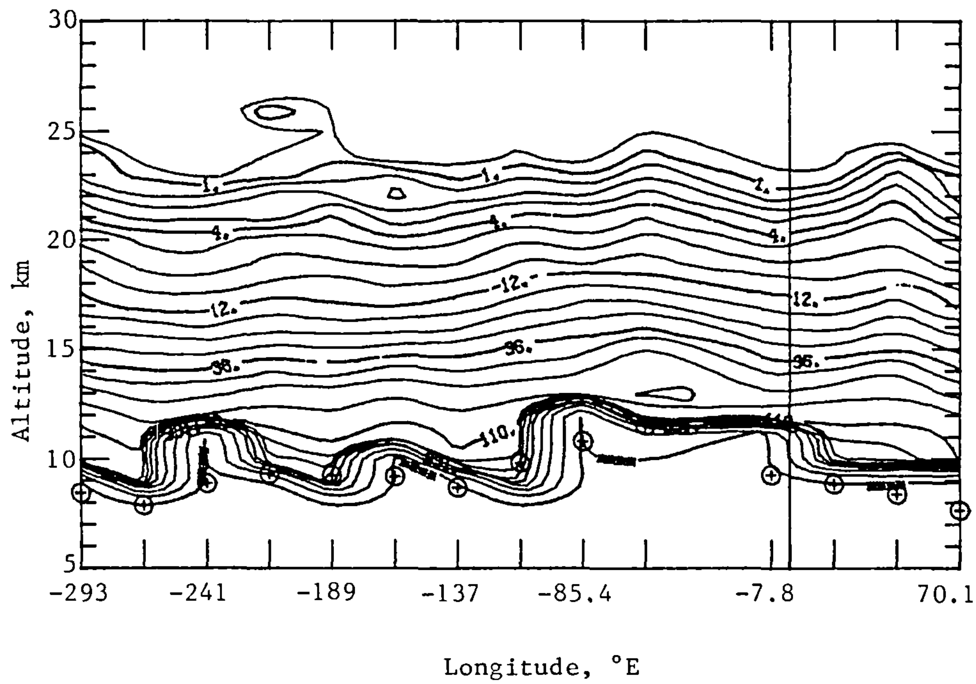


(a) Extinction isopleth.

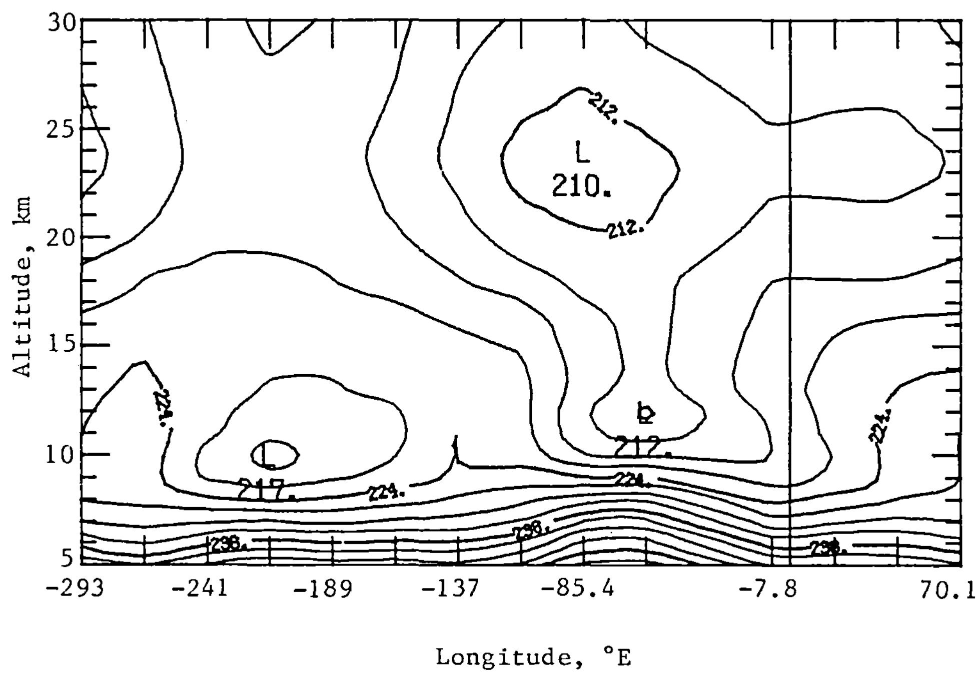


(b) Temperature contours.

Figure 34.- Arctic extinction isopleth and temperature contours for October 2.73 to 3.74, 1981, at latitudes from 79.7° to 79.5° N corresponding to orbits 14 849 to 14 863.

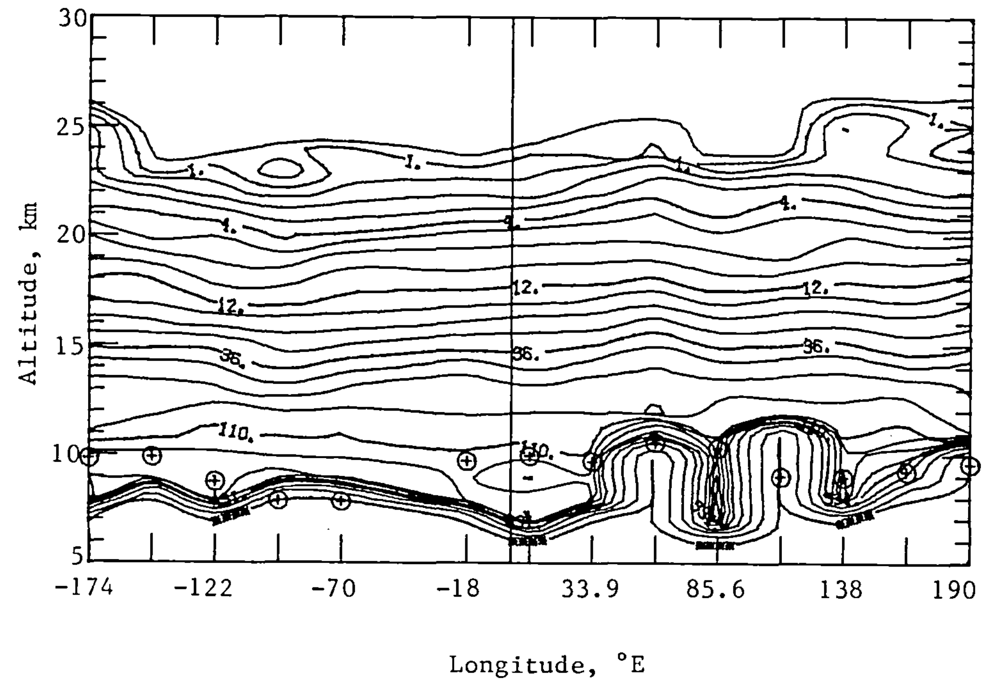


(a) Extinction isopleth.

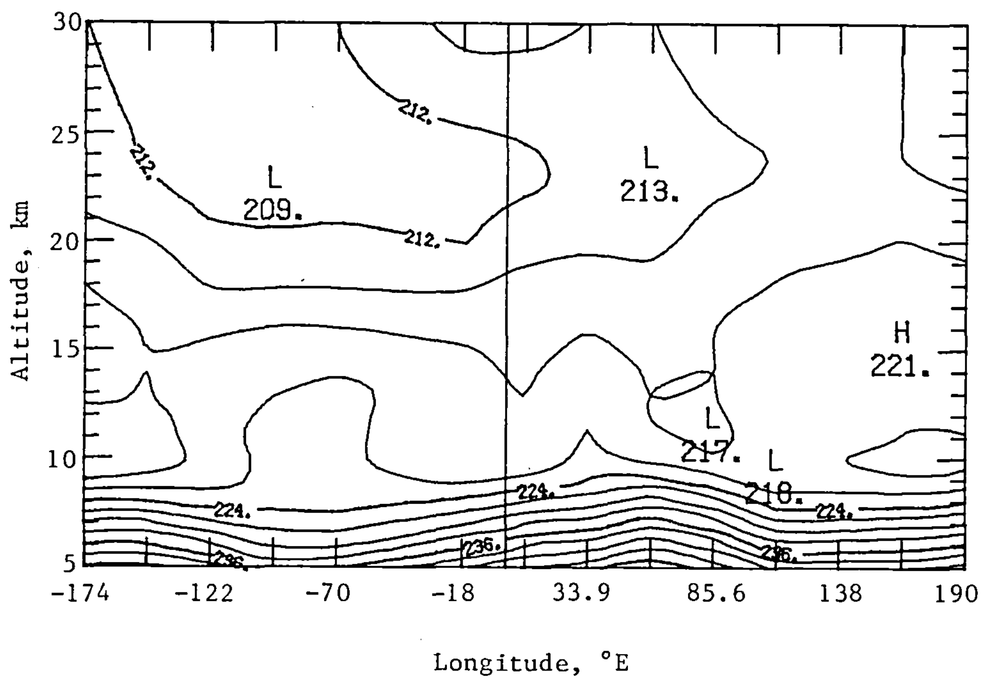


(b) Temperature contours.

Figure 35.- Arctic extinction isopleth and temperature contours for October 5.11 to 6.13, 1981, at latitudes from 79.3° to 79.1° N corresponding to orbits 14 882 to 14 896.

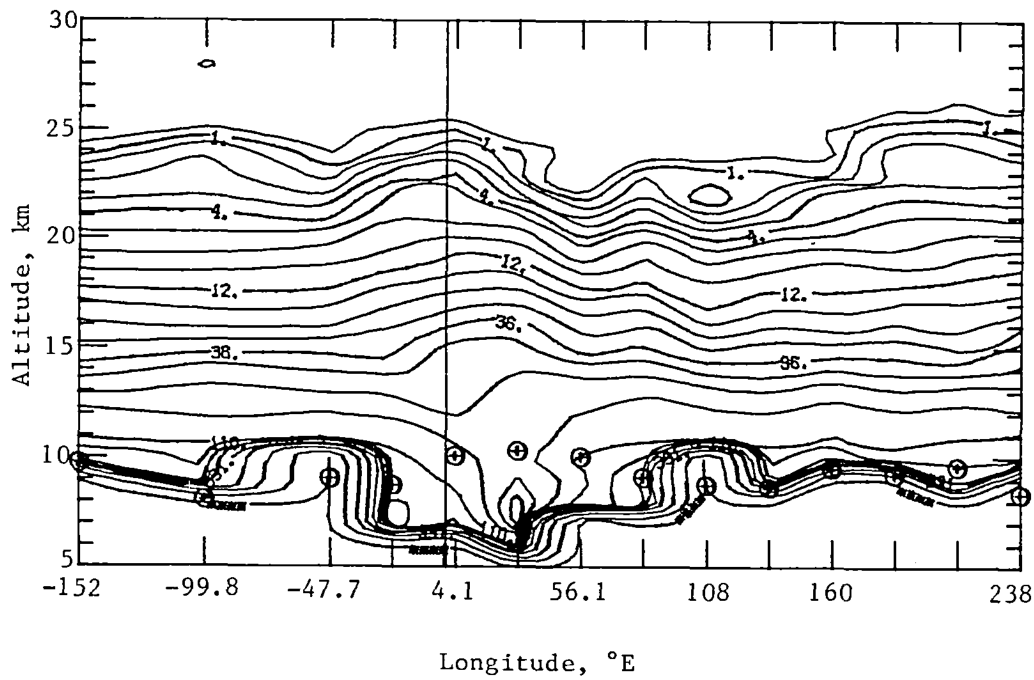


(a) Extinction isopleth.

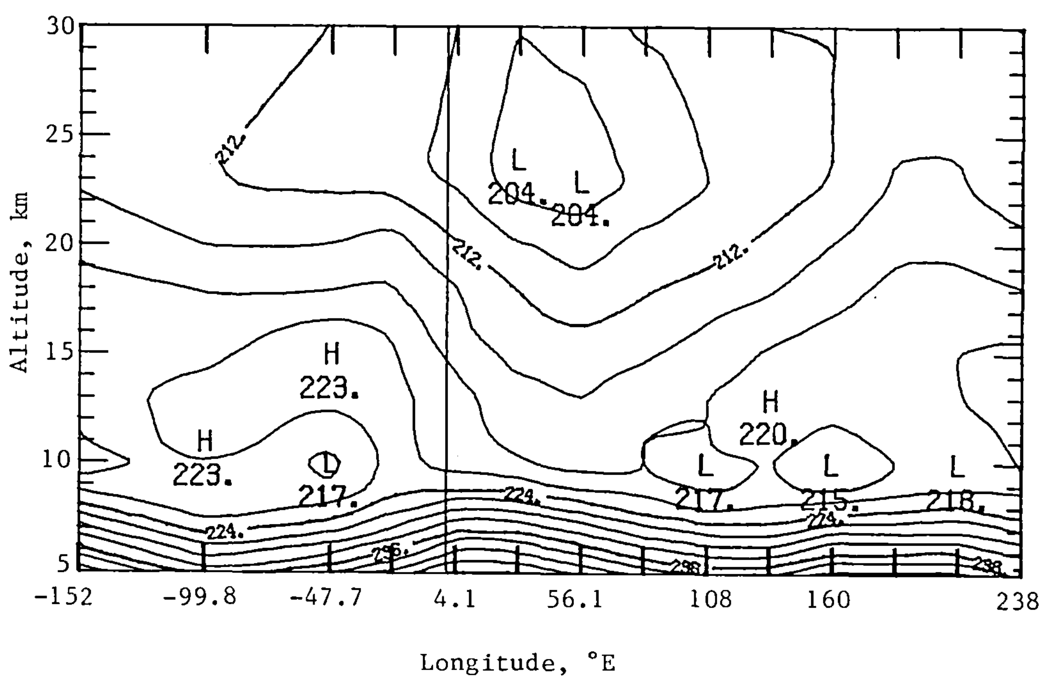


(b) Temperature contours.

Figure 36.- Arctic extinction isopleth and temperature contours for October 15.82 to 16.83, 1981, at latitudes from 76.8° to 76.5° N corresponding to orbits 15 030 to 15 044.

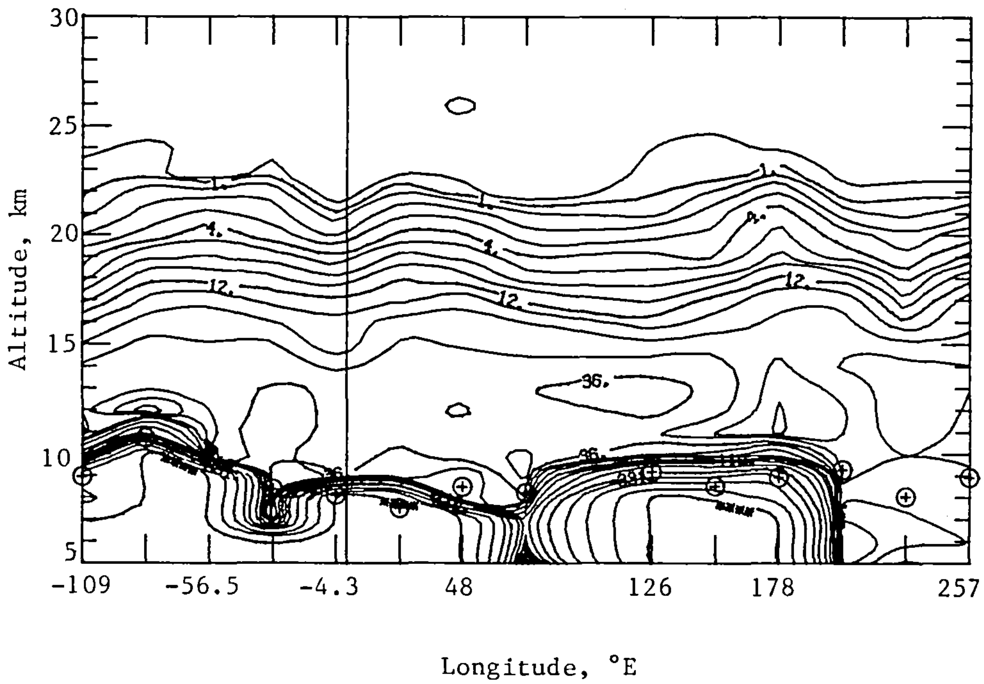


(a) Extinction isopleth.

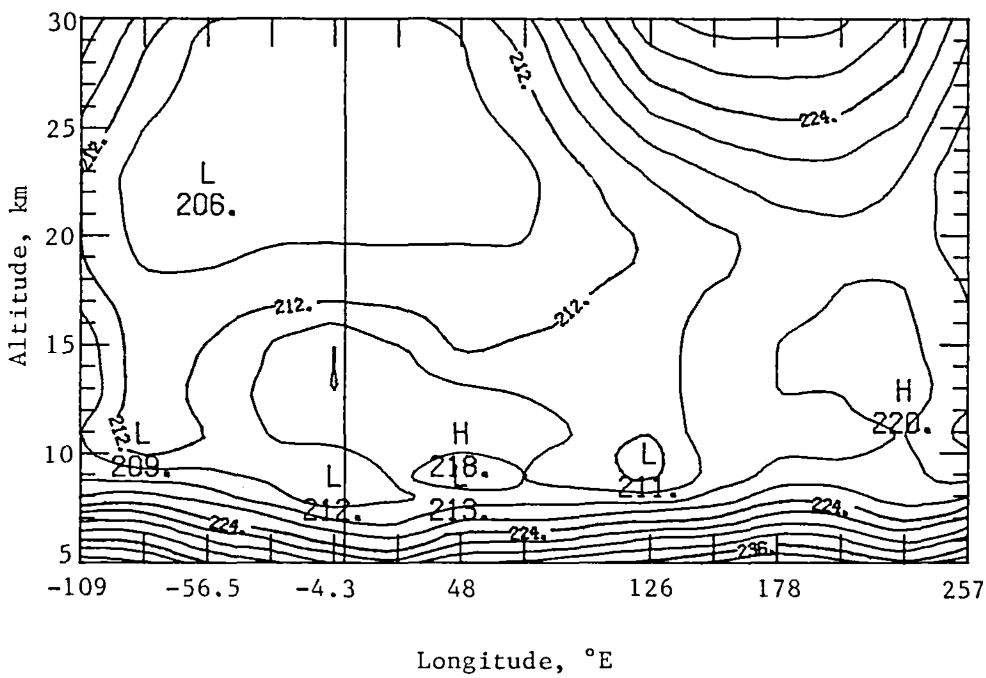


(b) Temperature contours.

Figure 37.- Arctic extinction isopleth and temperature contours for October 23.71 to 24.79, 1981, at latitudes from 74.7° to 74.4° N corresponding to orbits 15 139 to 15 154.

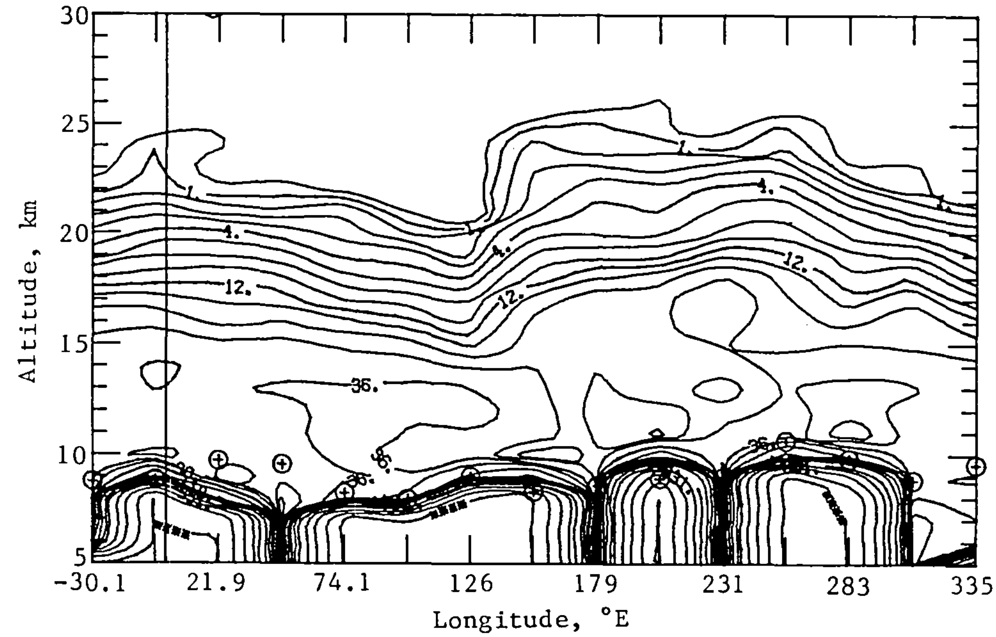


(a) Extinction isopleth.

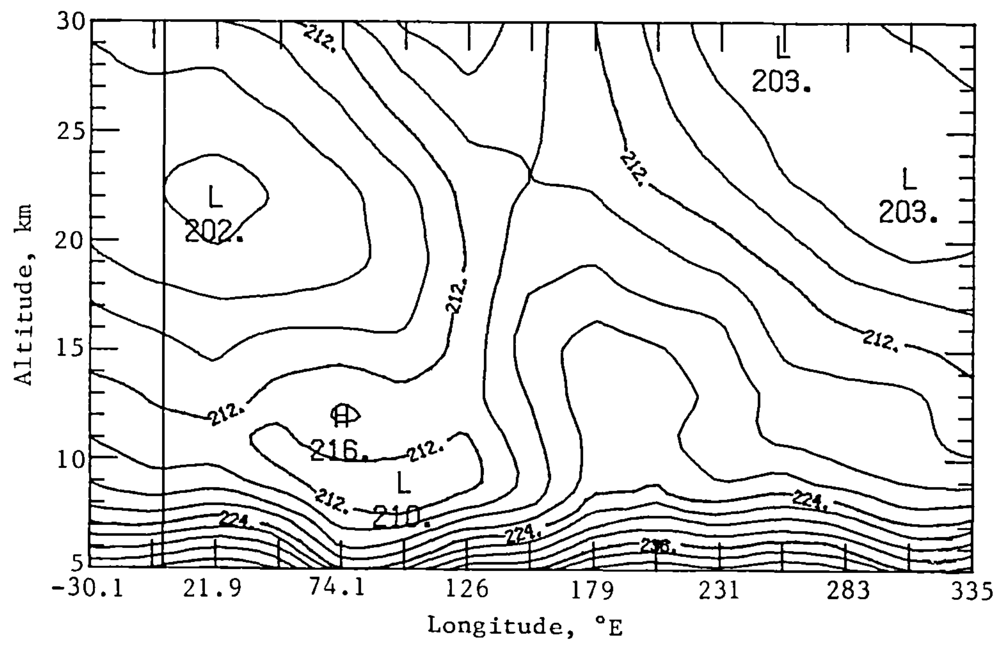


(b) Temperature contours.

Figure 38.- Antarctic extinction isopleth and temperature contours for April 28.89 to 29.90, 1981, at latitudes from 72.5° to 72.3° S corresponding to orbits 12 682 to 12 696.

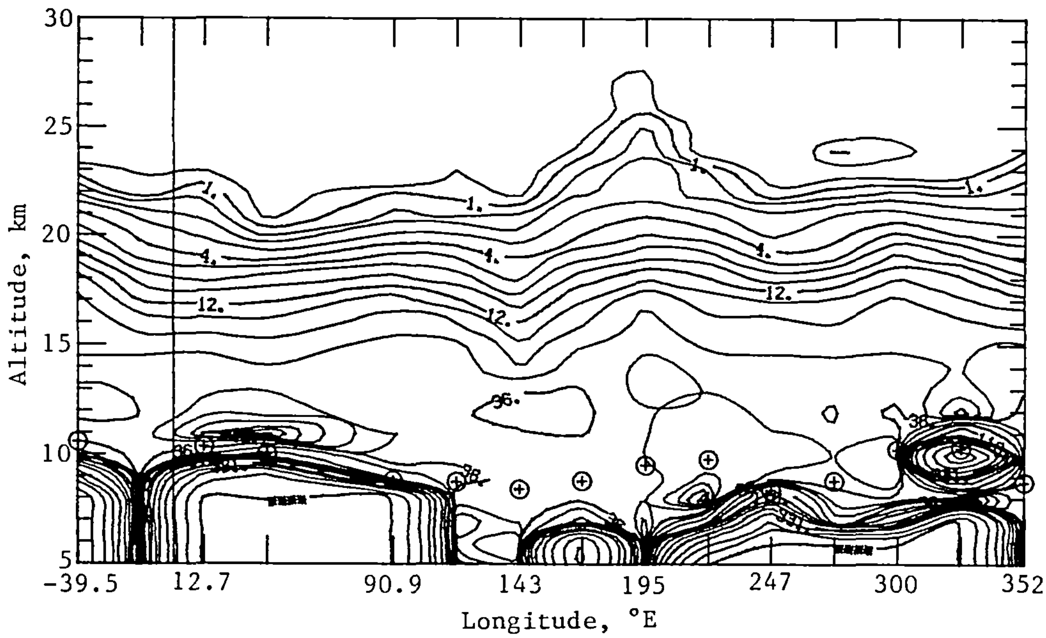


(a) Extinction isopleth.

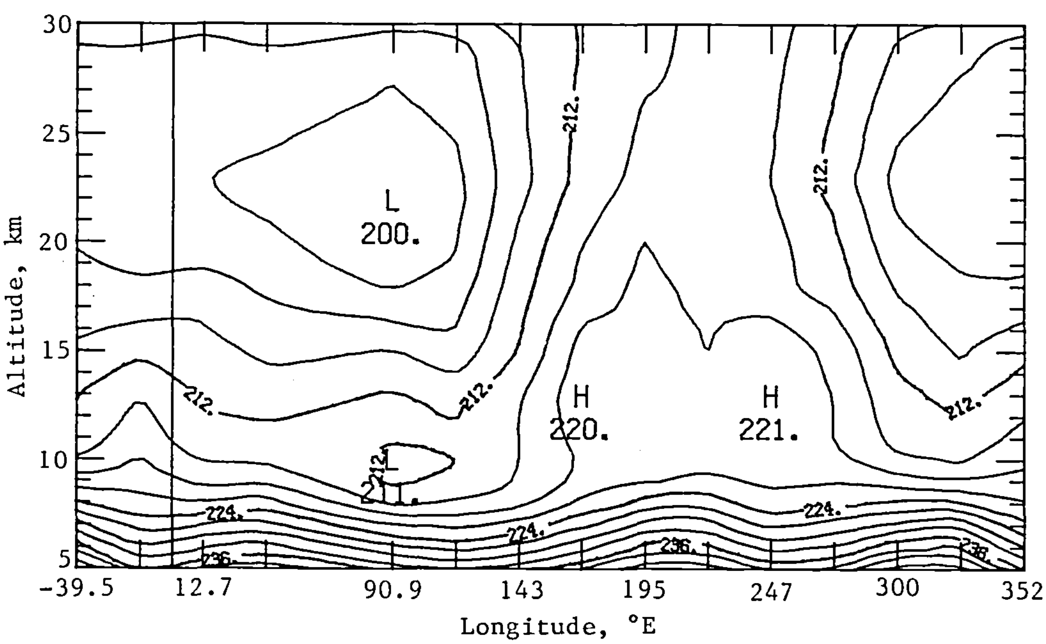


(b) Temperature contours.

Figure 39.- Antarctic extinction isopleth and temperature contours for May 8.66 to 9.67, 1981, at latitudes from 70.2° to 70.0° S corresponding to orbits 12 817 to 12 831.

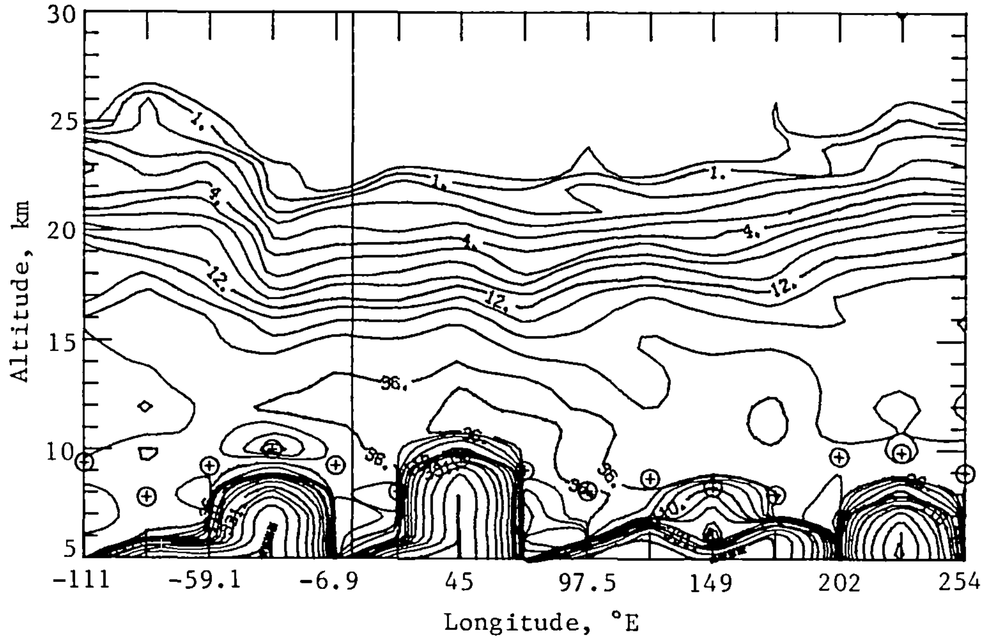


(a) Extinction isopleth.

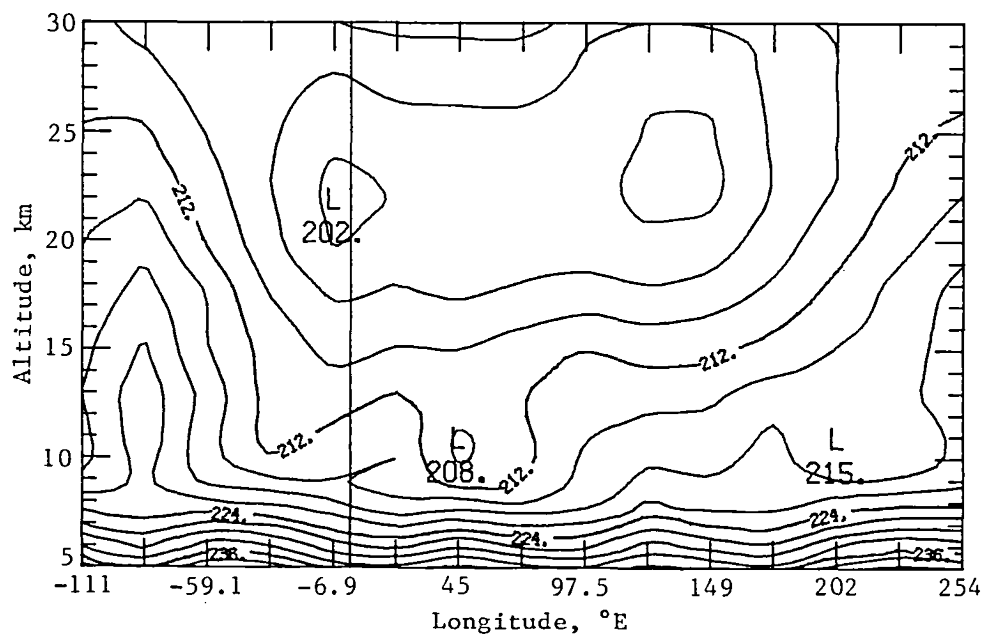


(b) Temperature contours.

Figure 40.- Antarctic extinction isopleth and temperature contours for May 15.60 to 16.69, 1981, at latitudes from 68.7° to 68.5° S corresponding to orbits 12 913 to 12 928.

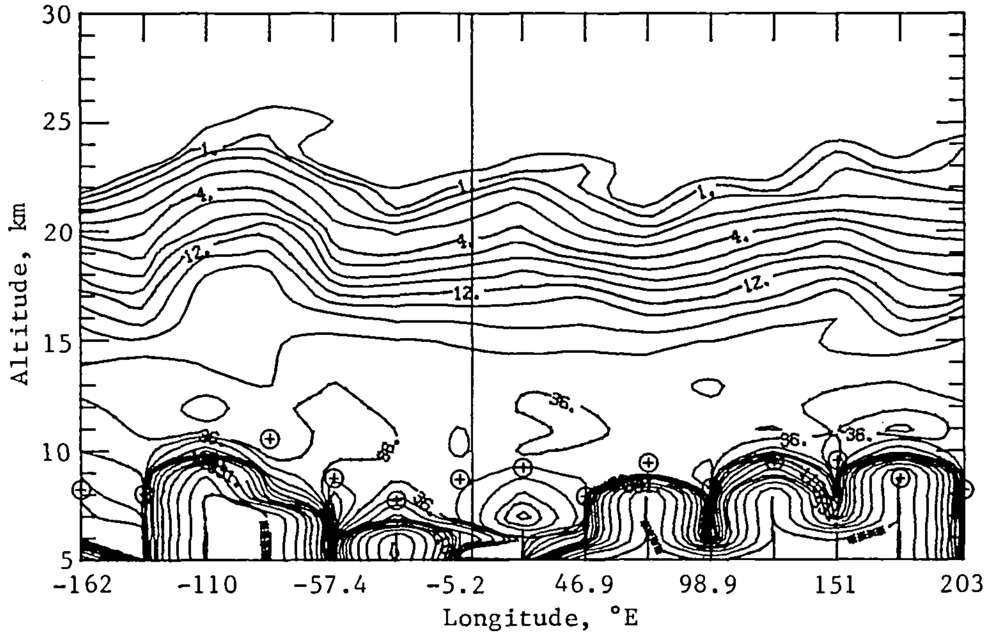


(a) Extinction isopleth.

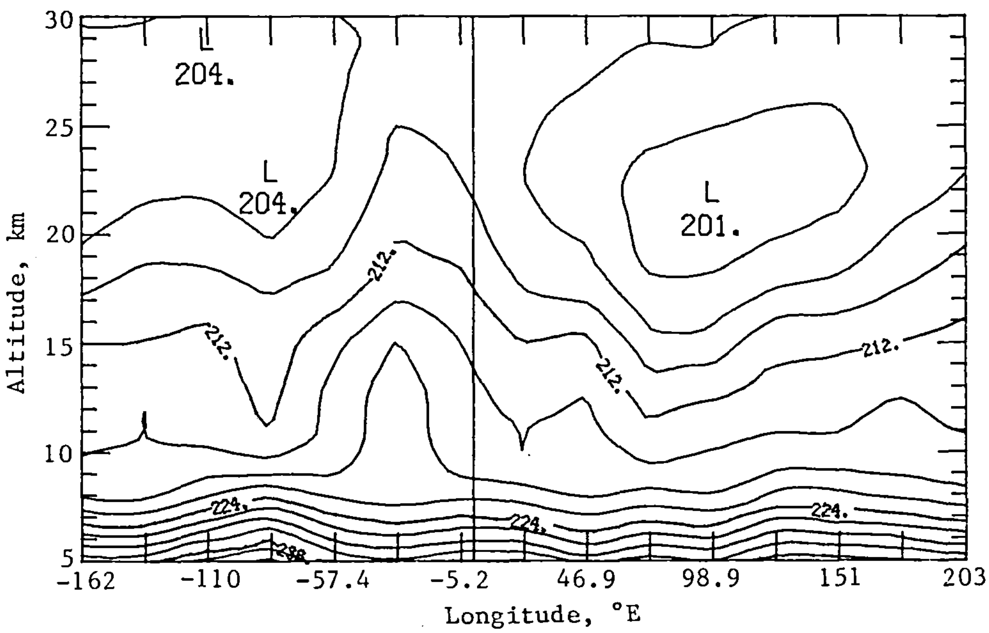


(b) Temperature contours.

Figure 41.- Antarctic extinction isopleth and temperature contours for May 19.87 to 20.89, 1981, at latitudes from 67.9° to 67.7° S corresponding to orbits 12 972 to 12 986.

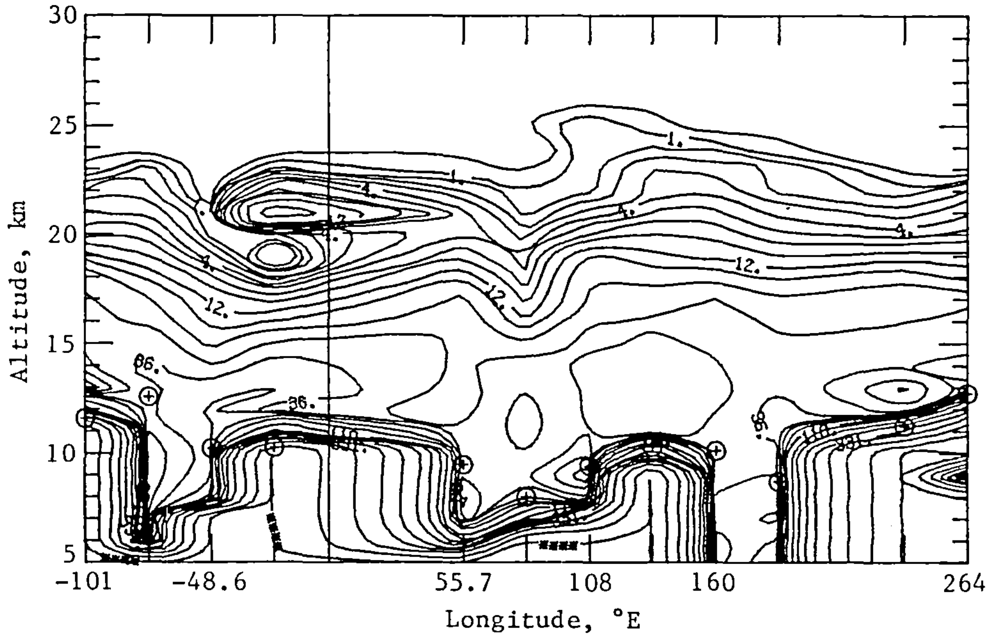


(a) Extinction isopleth.

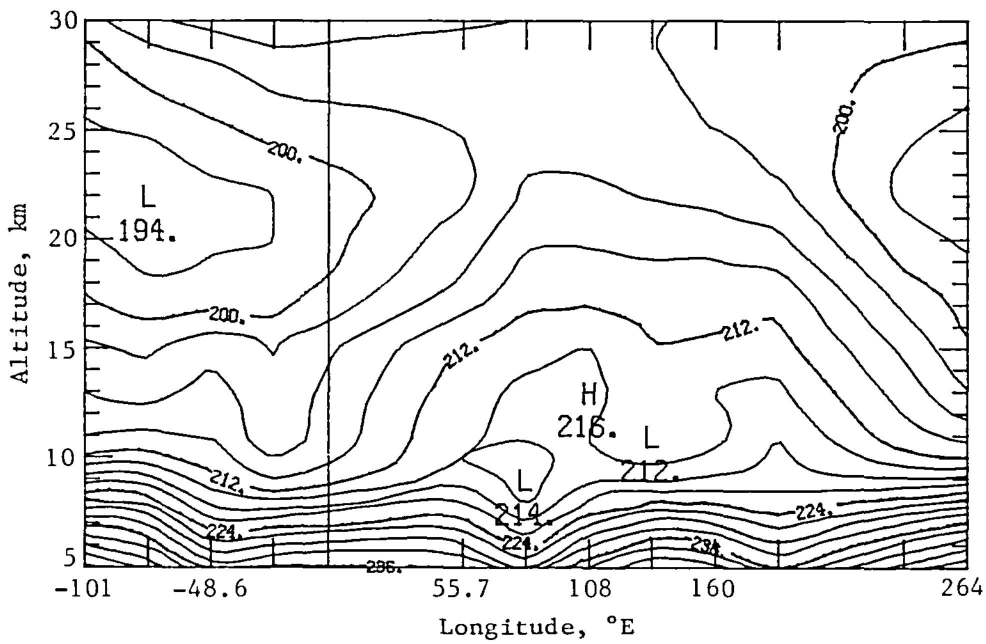


(b) Temperature contours.

Figure 42.- Antarctic extinction isopleth and temperature contours for May 25.01 to 26.02, 1981, at latitudes from 67.0° to 66.9° S corresponding to orbits 13 043 to 13 057.

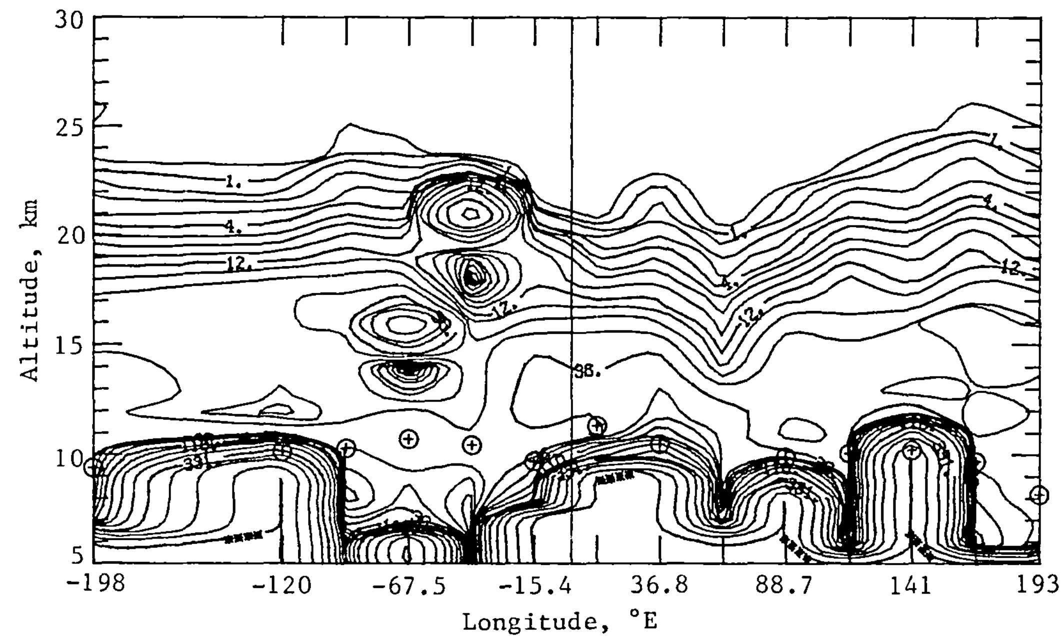


(a) Extinction isopleth.

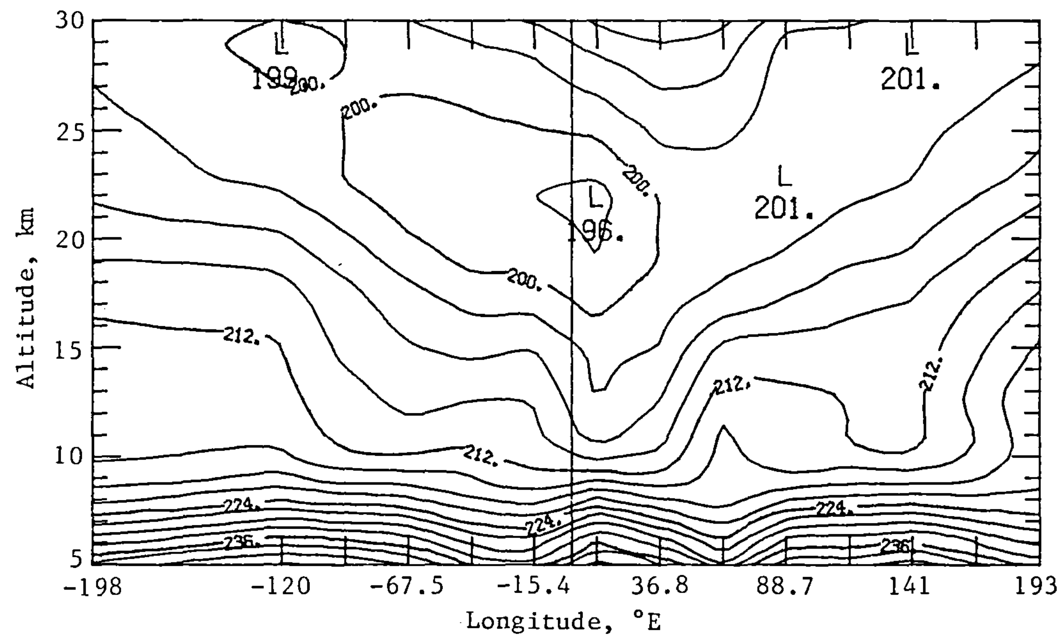


(b) Temperature contours.

Figure 43.- Antarctic extinction isopleth and temperature contours for June 2.84 to 3.85, 1981, at latitudes from 65.9° to 65.7° S corresponding to orbits 13 165 to 13 179.

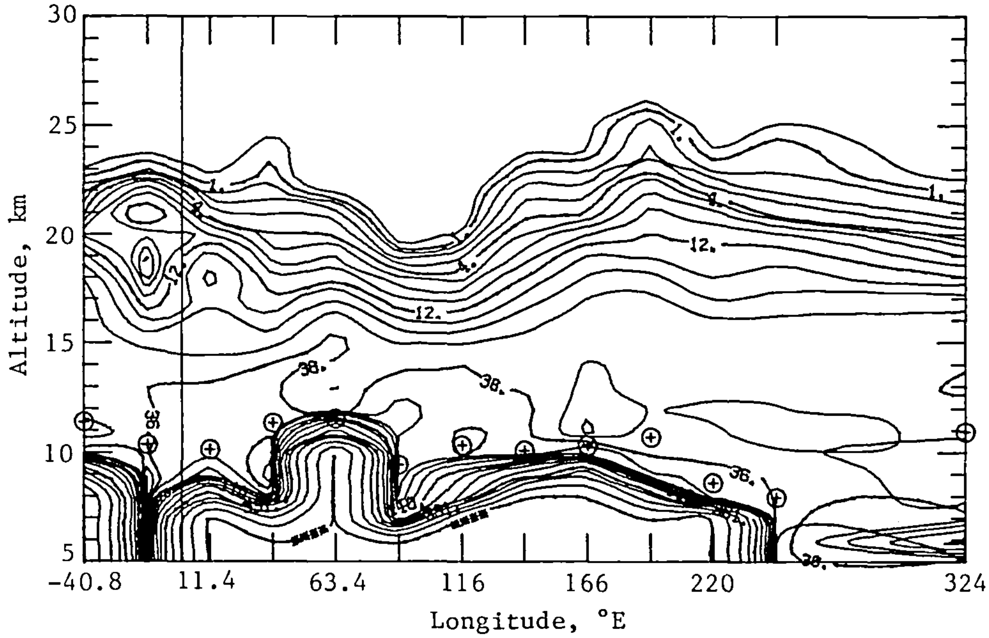


(a) Extinction isopleth.

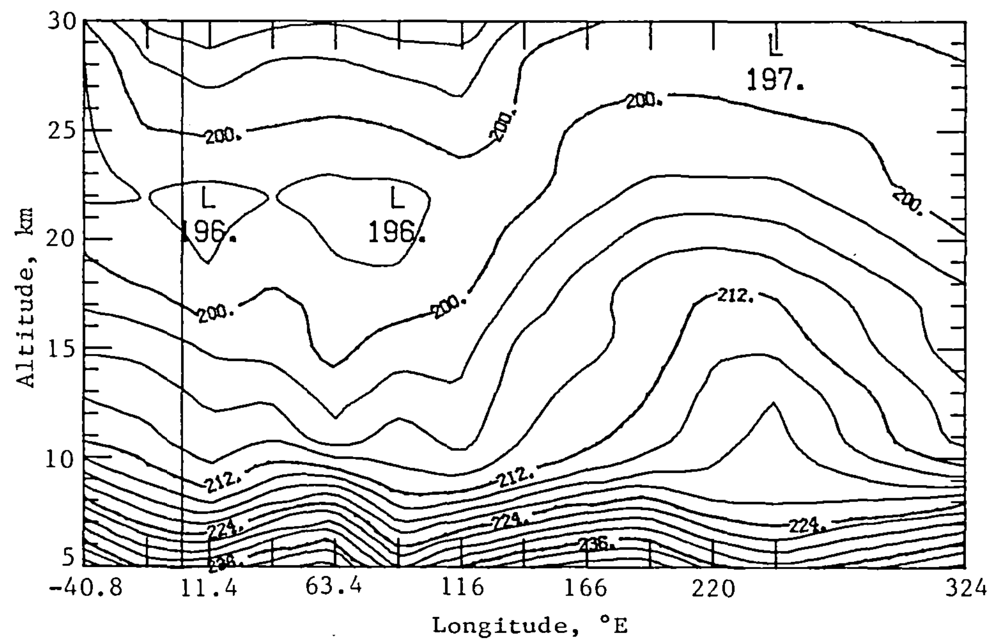


(b) Temperature contours.

Figure 44.- Antarctic extinction isopleth and temperature contours for June 7.04 to 8.12, 1981, at latitudes from 65.4° to 65.3° S corresponding to orbits 13 223 to 13 238.

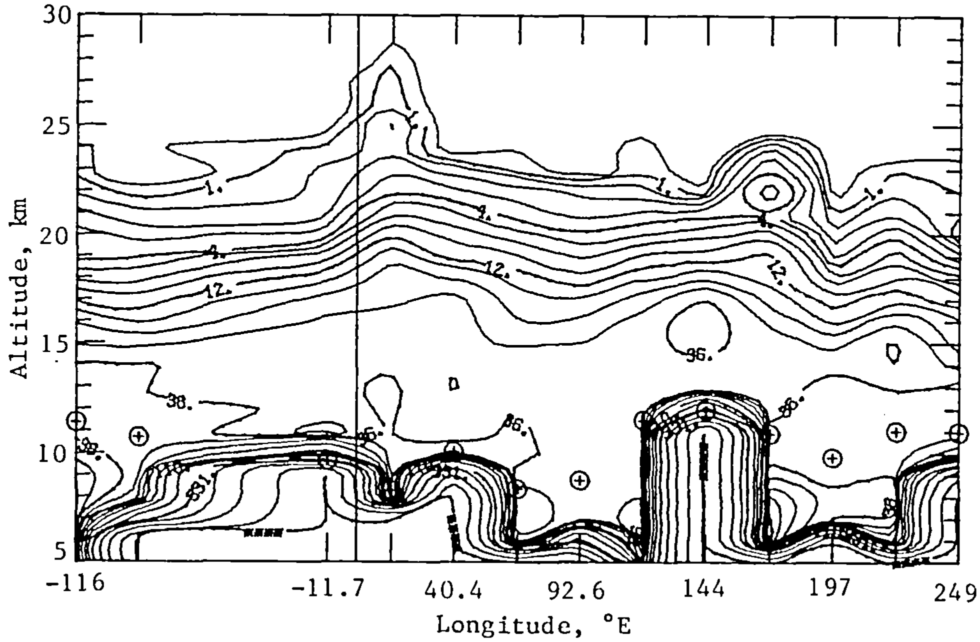


(a) Extinction isopleth.

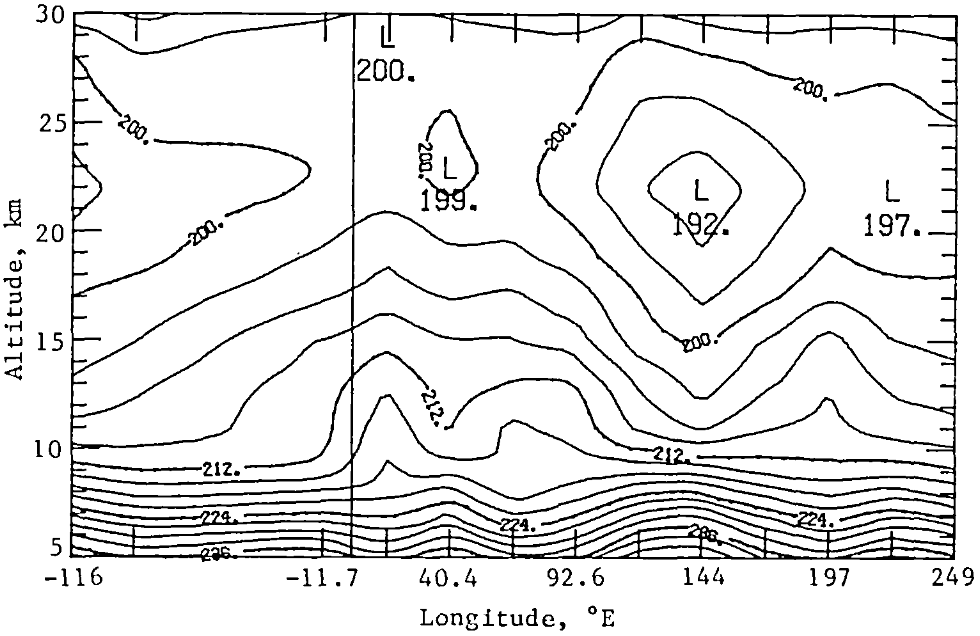


(b) Temperature contours.

Figure 45.- Antarctic extinction isopleth and temperature contours for June 17.67 to 18.69, 1981, at a latitude of 64.8° S corresponding to orbits 13 370 to 13 384.

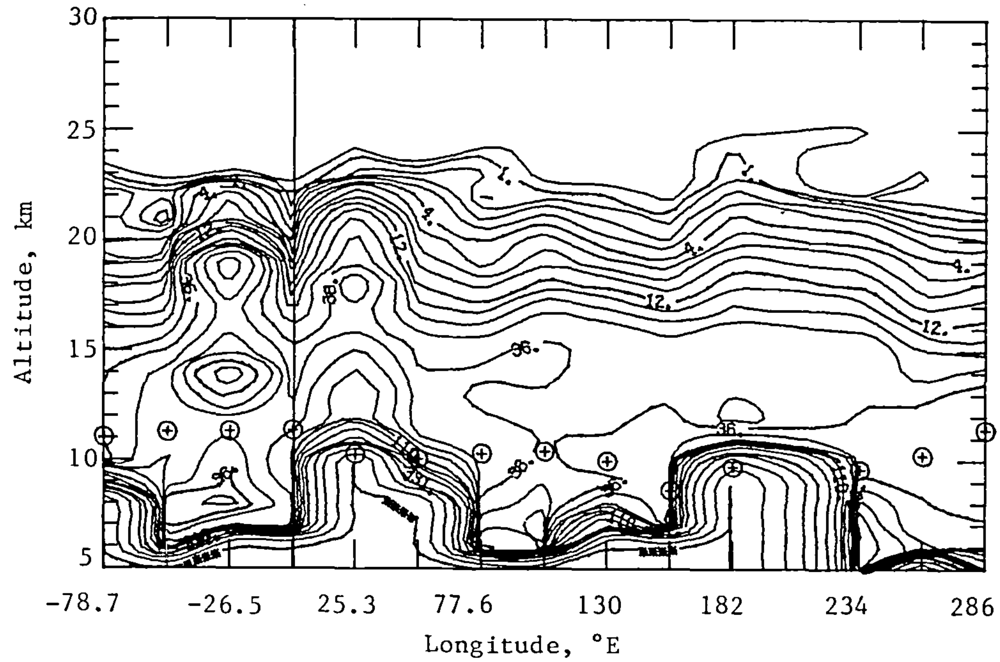


(a) Extinction isopleth.

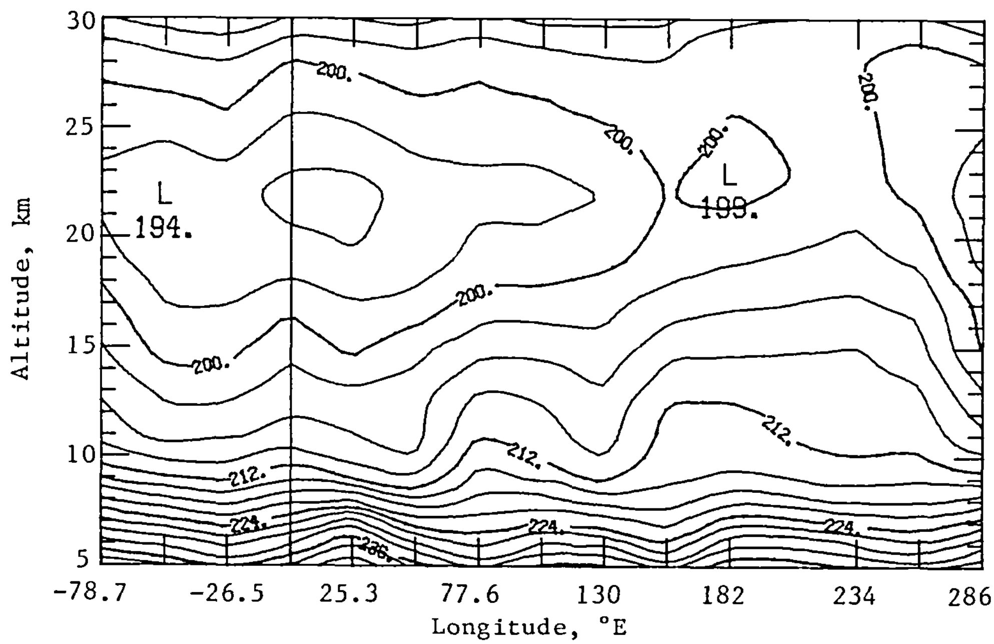


(b) Temperature contours.

Figure 46.- Antarctic extinction isopleth and temperature contours for June 22.88 to 23.89, 1981, at latitudes from 64.8° to 64.7° S corresponding to orbits 13 442 to 13 456.

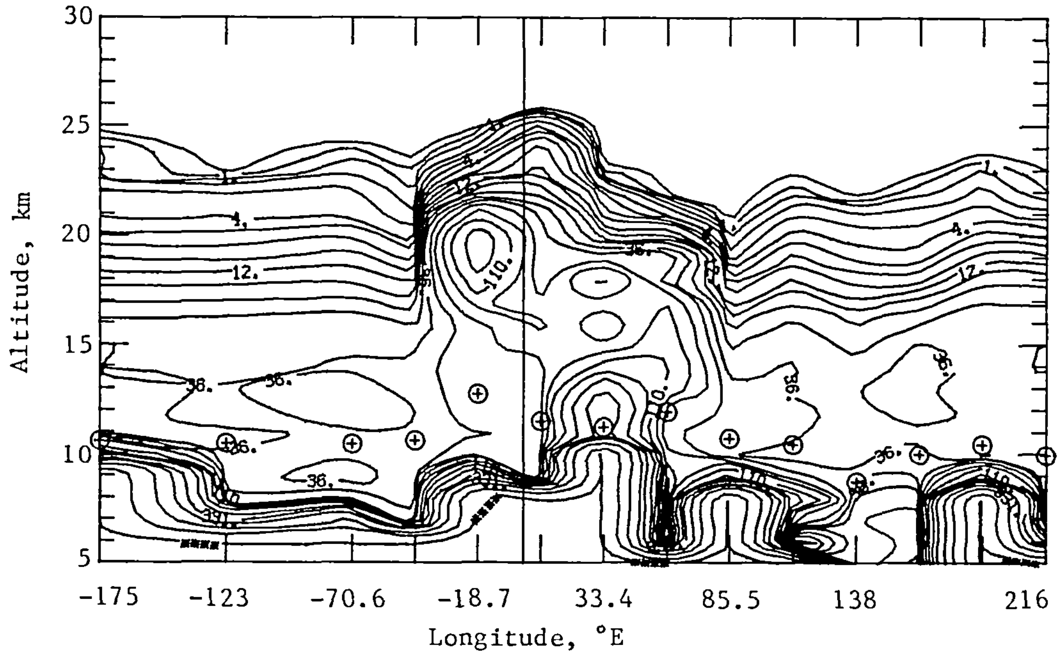


(a) Extinction isopleth.

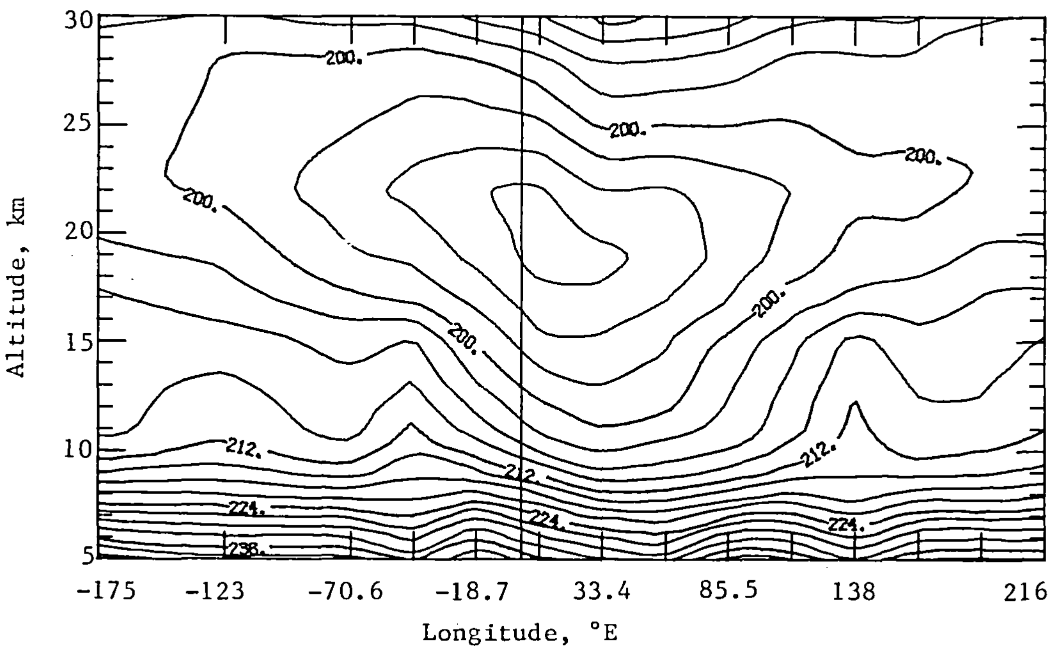


(b) Temperature contours.

Figure 47.- Antarctic extinction isopleth and temperature contours for July 1.78 to 2.79, 1981, at latitudes from 65.0° to 65.1° S corresponding to orbits 13 565 to 13 579.

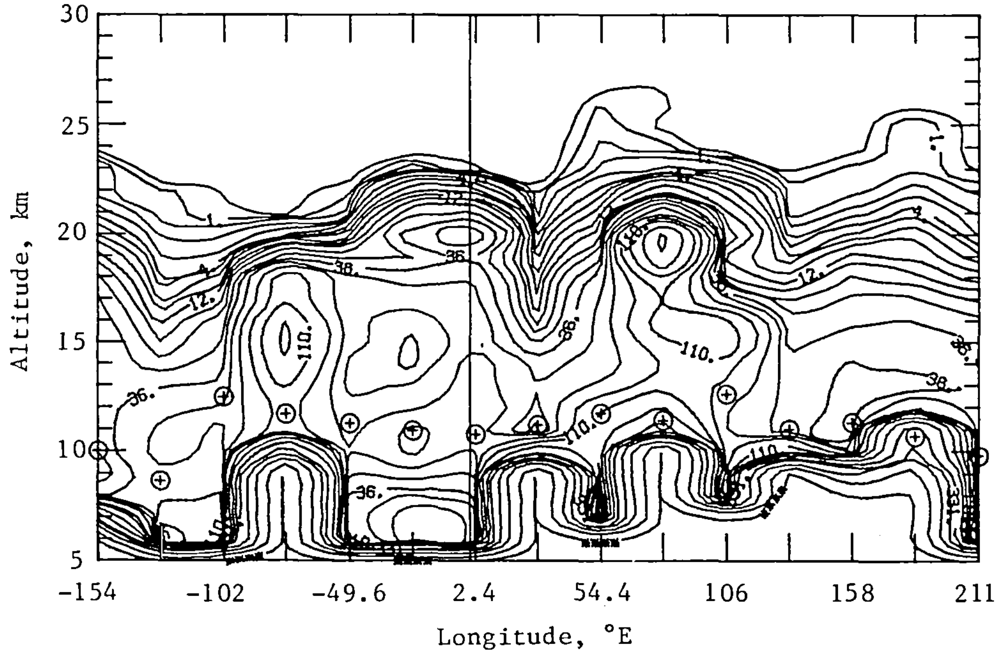


(a) Extinction isopleth.

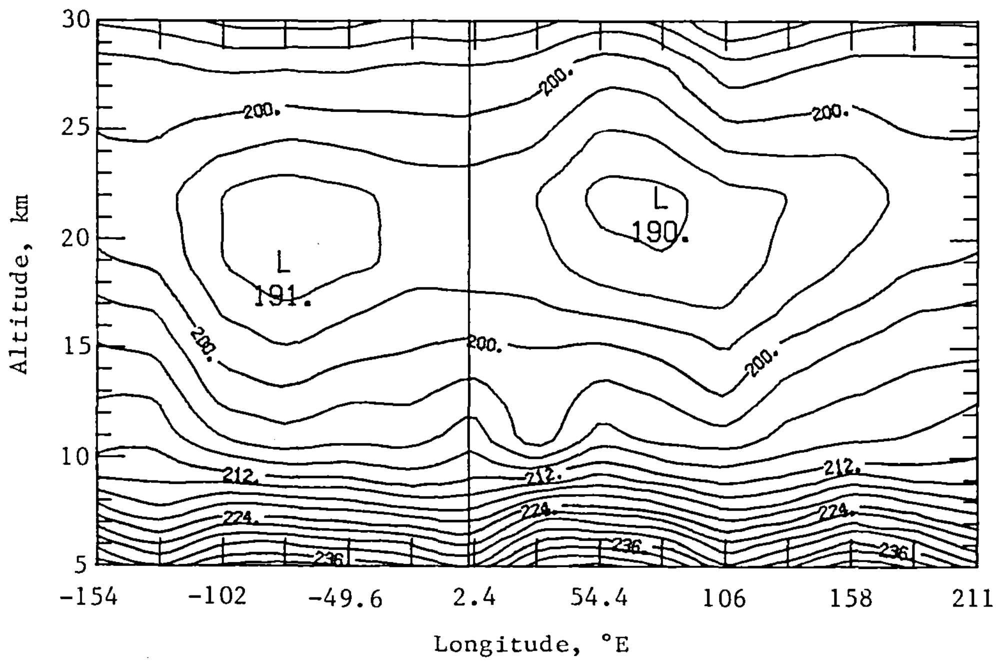


(b) Temperature contours.

Figure 48.- Antarctic extinction isopleth and temperature contours for July 5.98 to 7.06, 1981, at latitudes from 65.3° to 65.4° S corresponding to orbits 13 623 to 13 638.

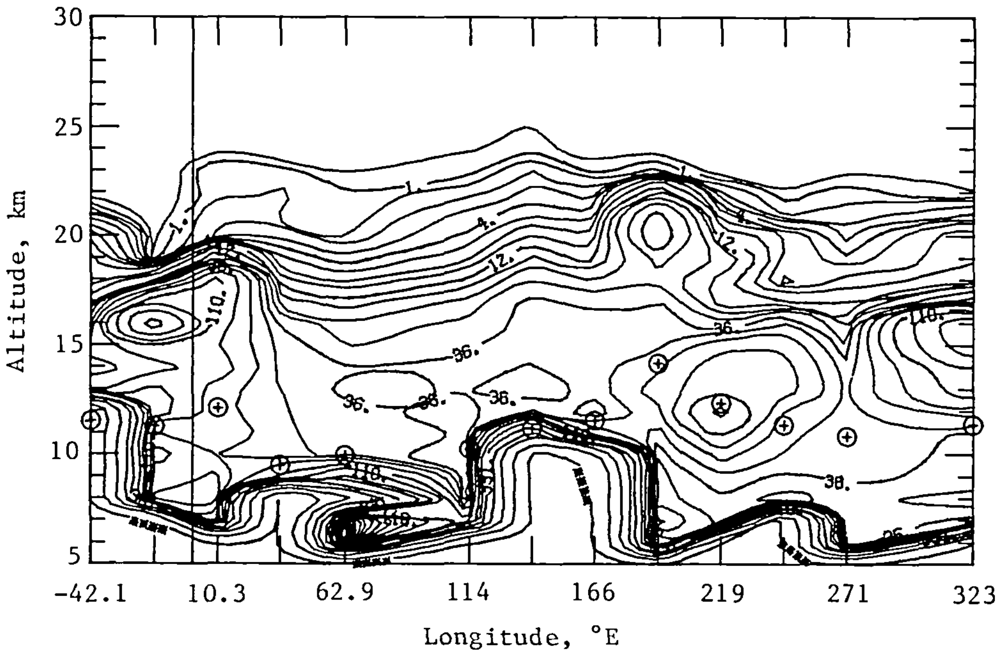


(a) Extinction isopleth.

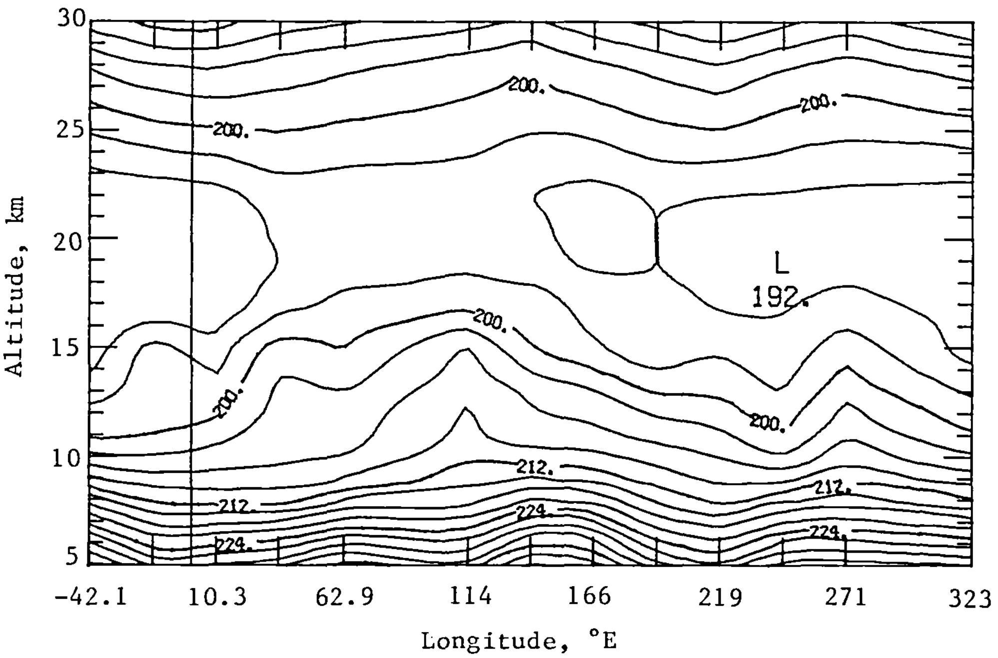


(b) Temperature contours.

Figure 49.- Antarctic extinction isopleth and temperature contours for July 13.00 to 14.01, 1981, at latitudes from 66.0° to 66.2° S corresponding to orbits 13 720 to 13 734.

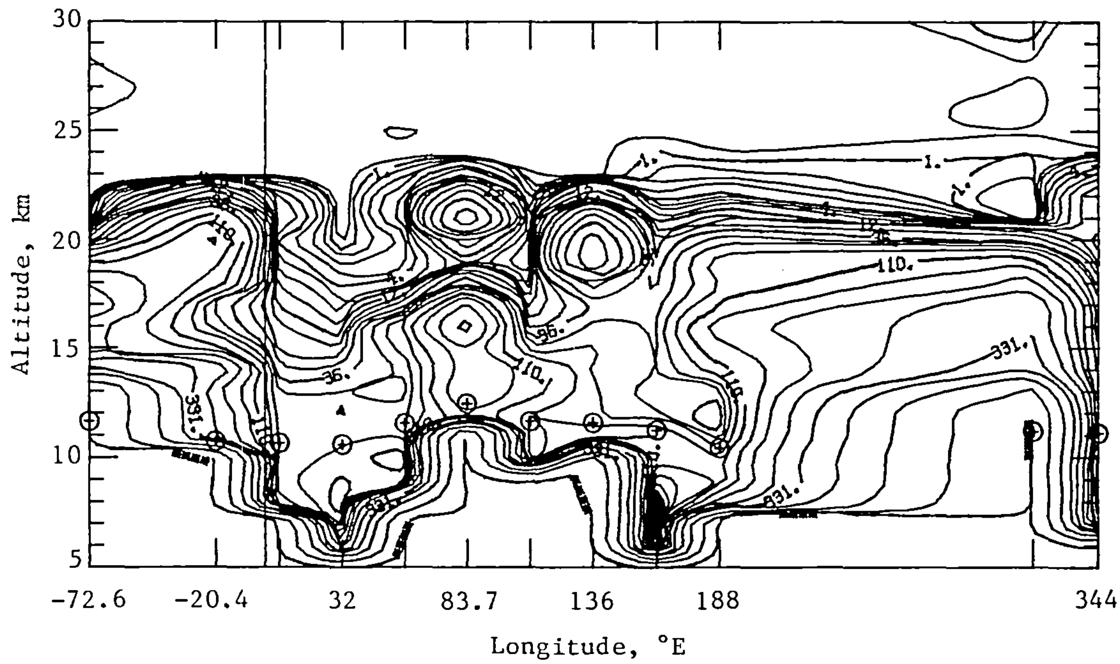


(a) Extinction isopleth.

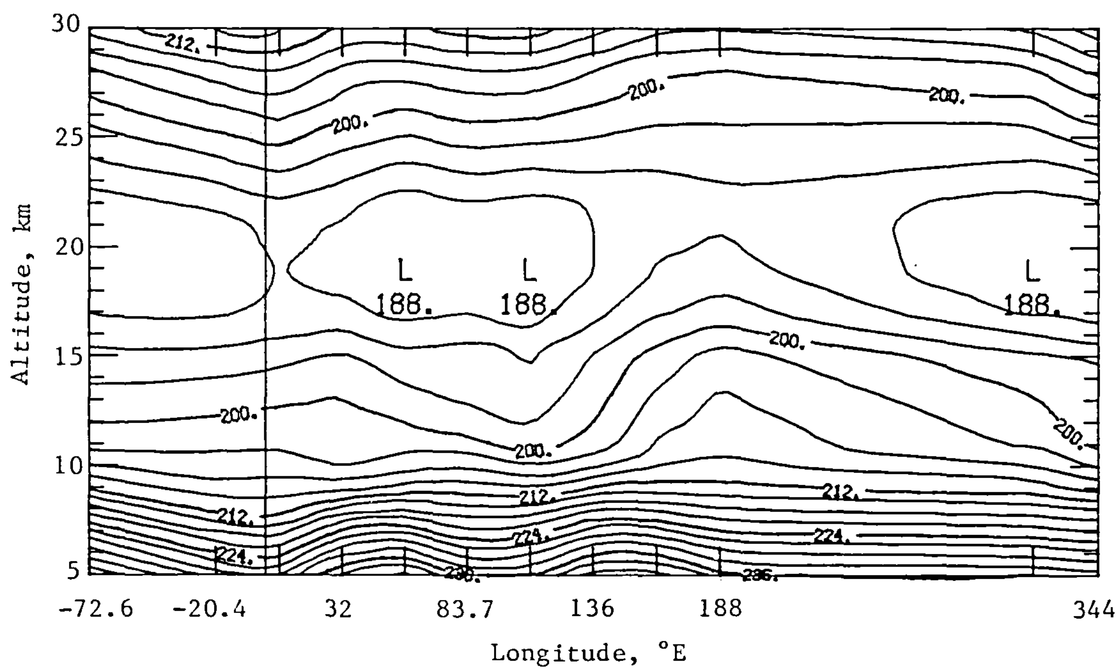


(b) Temperature contours.

Figure 50.- Antarctic extinction isopleth and temperature contours for July 22.69 to 23.70, 1981, at latitudes from 67.5° to 67.7° S corresponding to orbits 13 854 to 13 868.

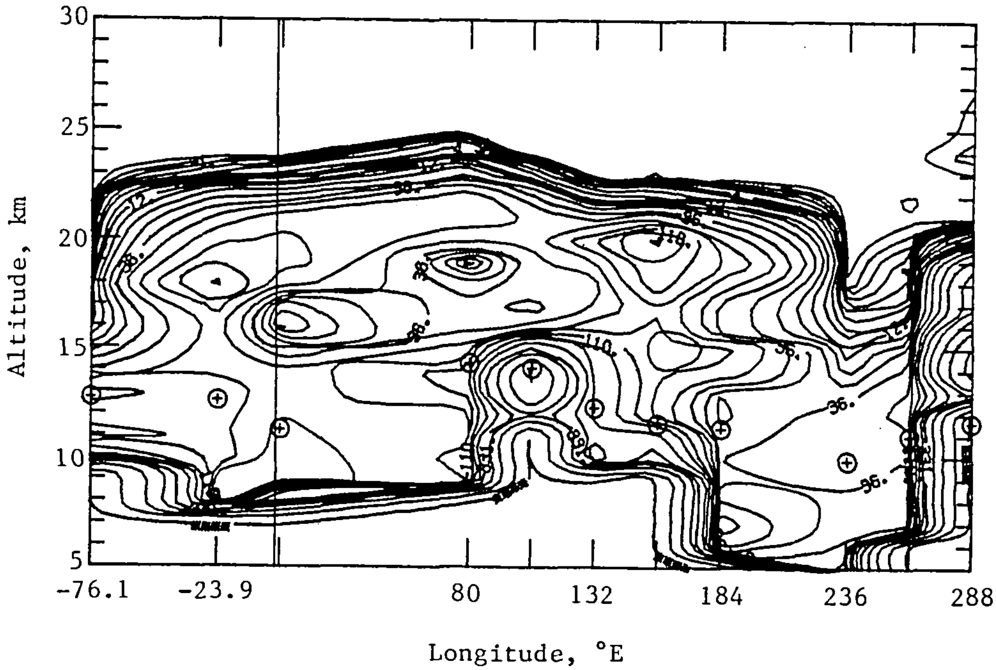


(a) Extinction isopleth.

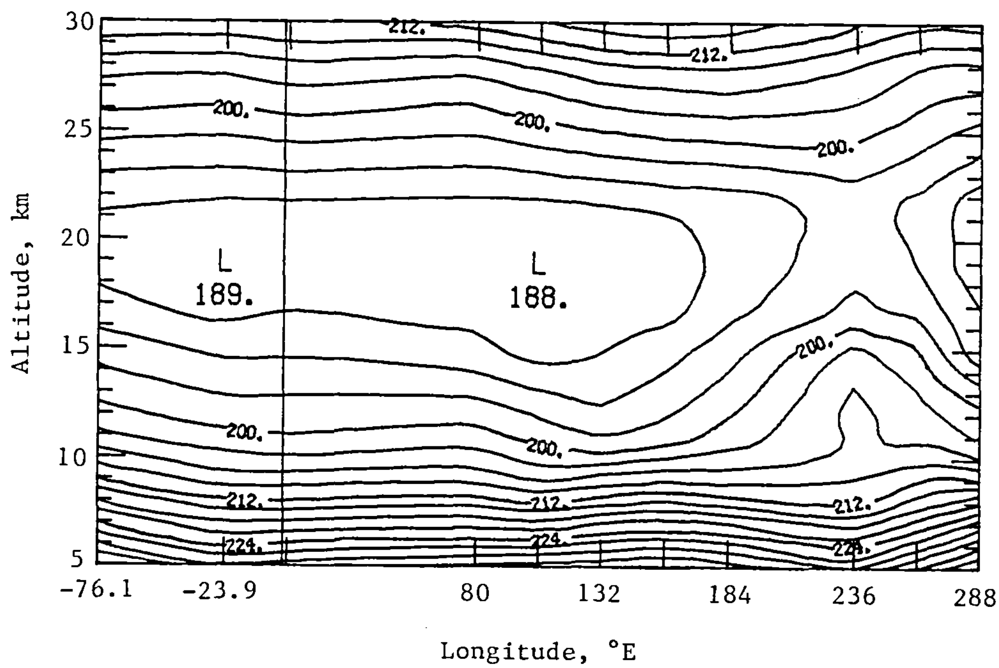


(b) Temperature contours.

Figure 51.- Antarctic extinction isopleth and temperature contours for July 29.64 to 30.79, 1981, at latitudes from 68.7° to 69.0° S corresponding to orbits 13 950 to 13 966.

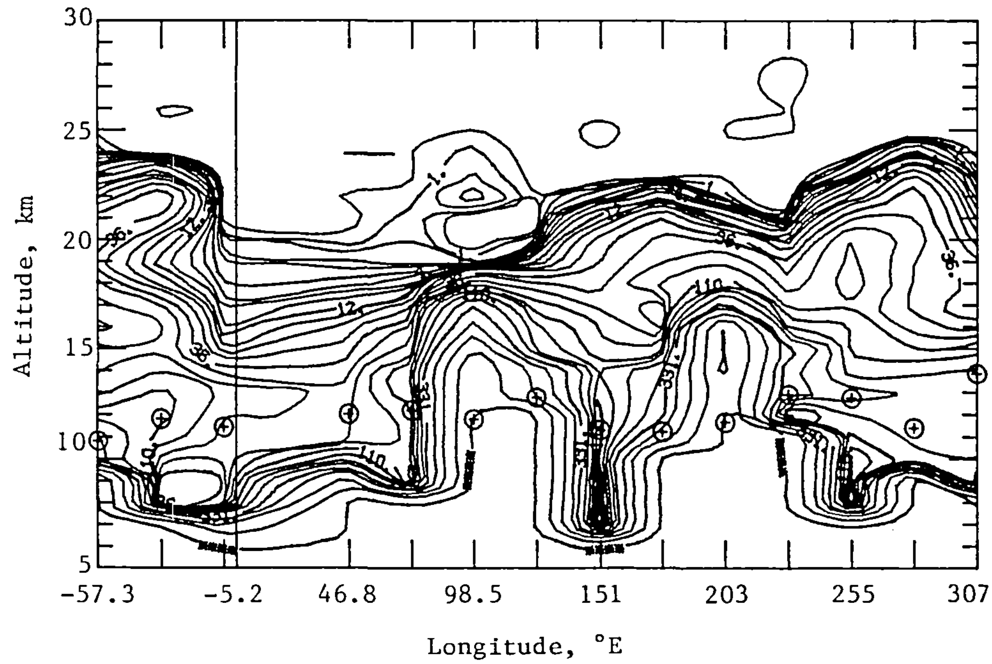


(a) Extinction isopleth.

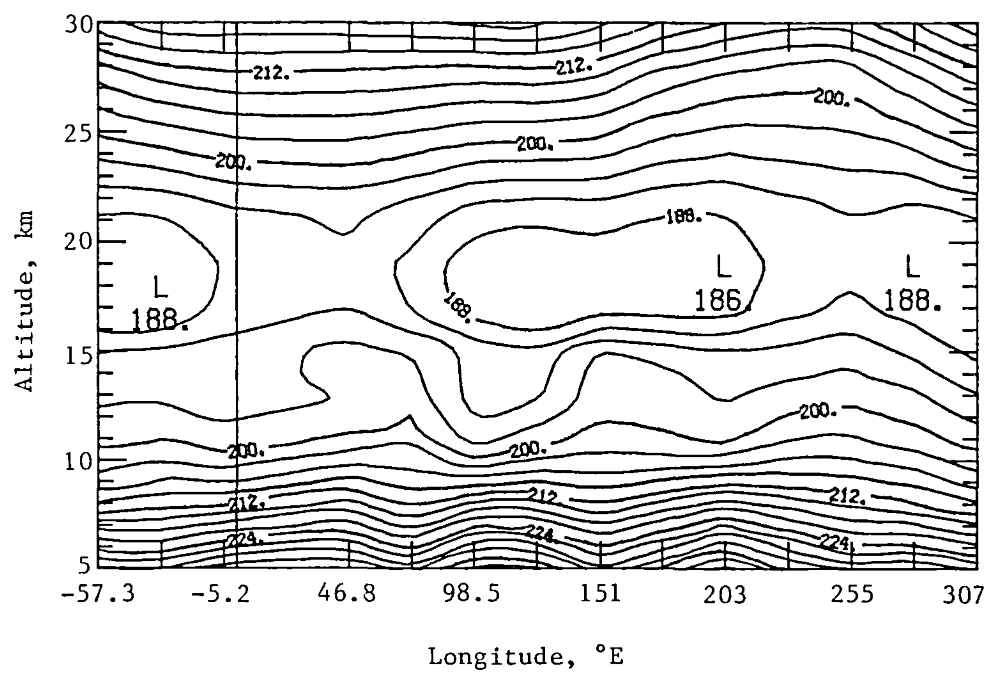


(b) Temperature contours.

Figure 52.- Antarctic extinction isopleth and temperature contours for August 5.80 to 6.81, 1981, at latitudes from 70.3° to 70.5° S corresponding to orbits 14 049 to 14 063.

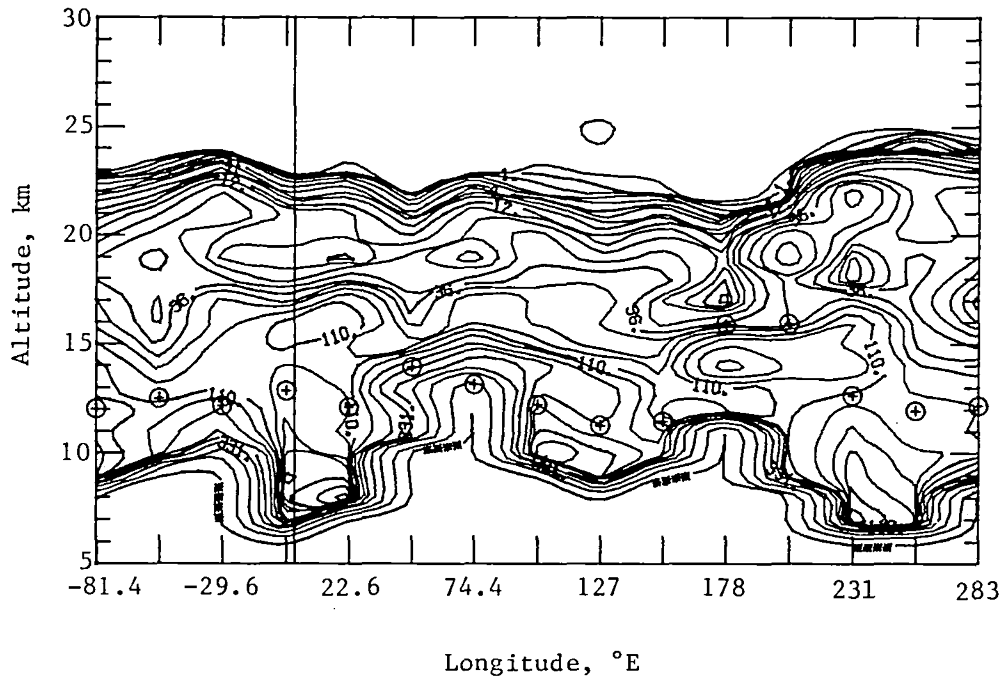


(a) Extinction isopleth.

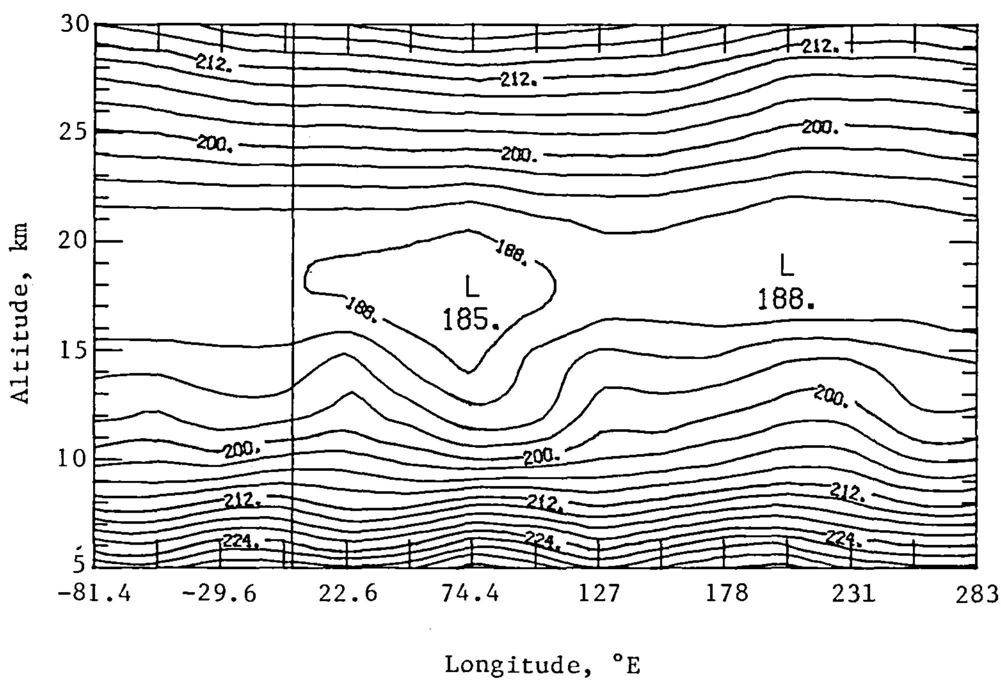


(b) Temperature contours.

Figure 53.- Antarctic extinction isopleth and temperature contours for August 13.76 to 14.77, 1981, at latitudes from 72.1° to 72.4° S corresponding to orbits 14 159 to 14 173.

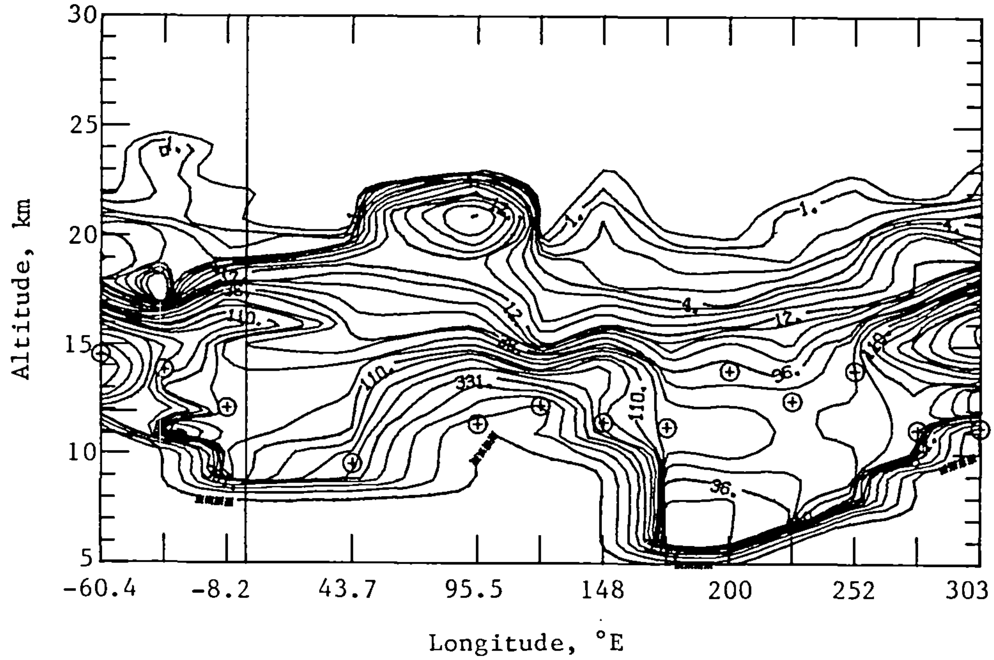


(a) Extinction isopleth.

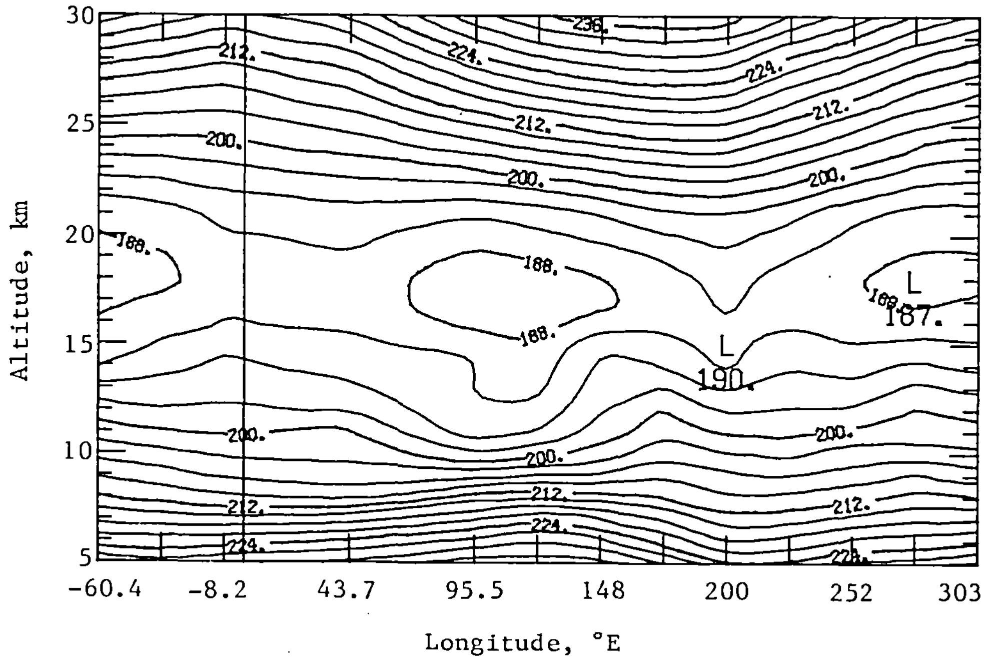


(b) Temperature contours.

Figure 54.- Antarctic extinction isopleth and temperature contours for August 19.84 to 20.85, 1981, at latitudes from 73.6° to 73.9° S corresponding to orbits 14 243 to 14 257.

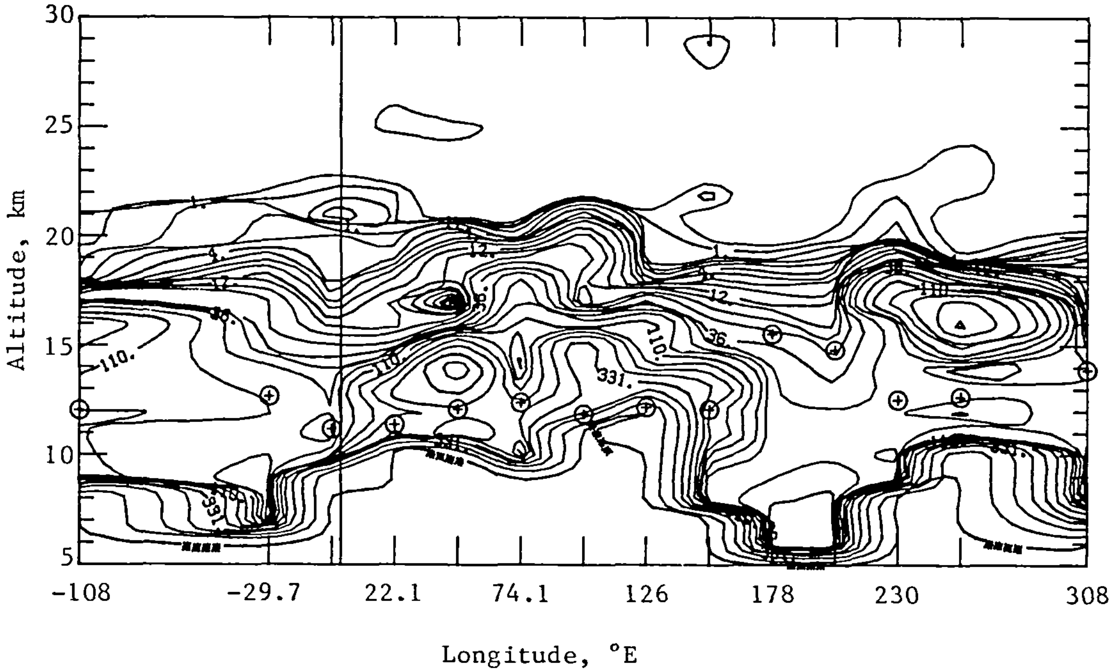


(a) Extinction isopleth.

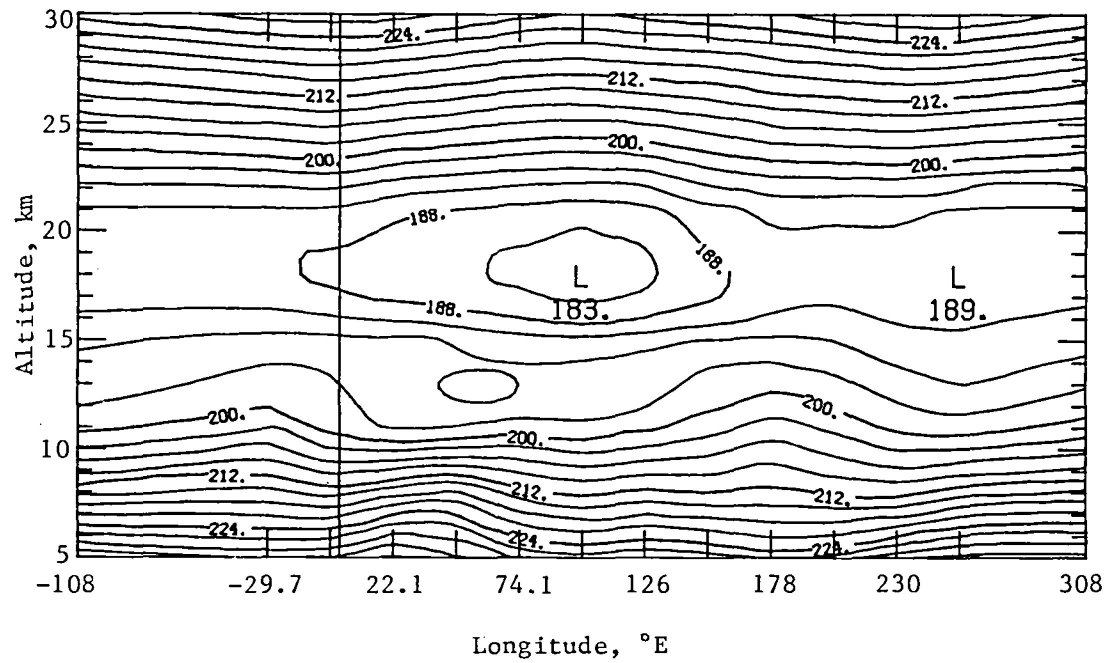


(b) Temperature contours.

Figure 55.- Antarctic extinction isopleth and temperature contours for August 27.79 to 28.81, 1981, at latitudes from 75.6° to 75.9° S corresponding to orbits 14 353 to 14 367.

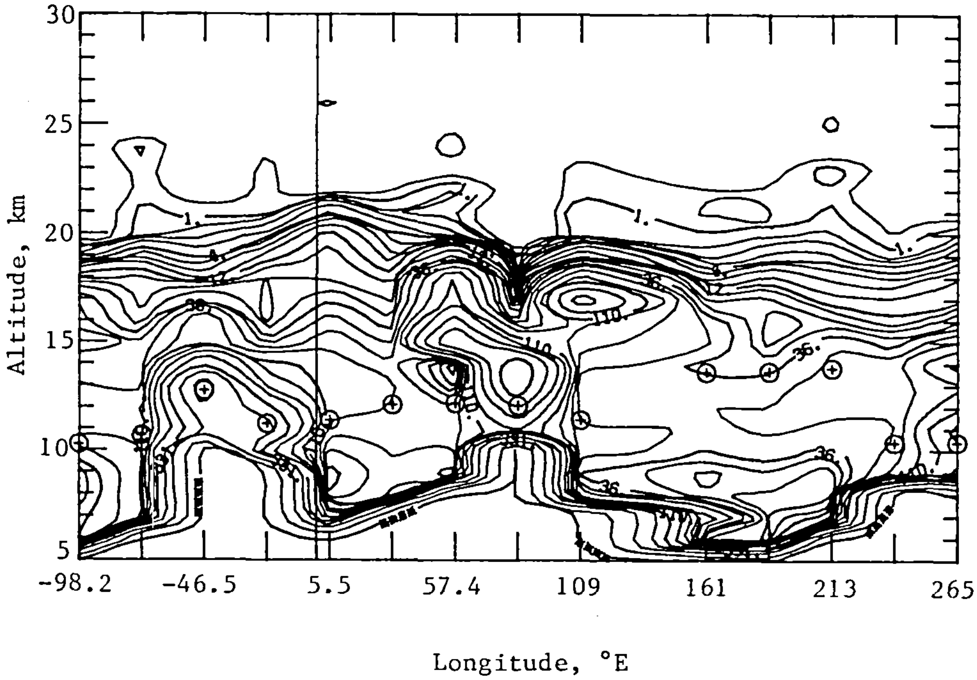


(a) Extinction isopleth.

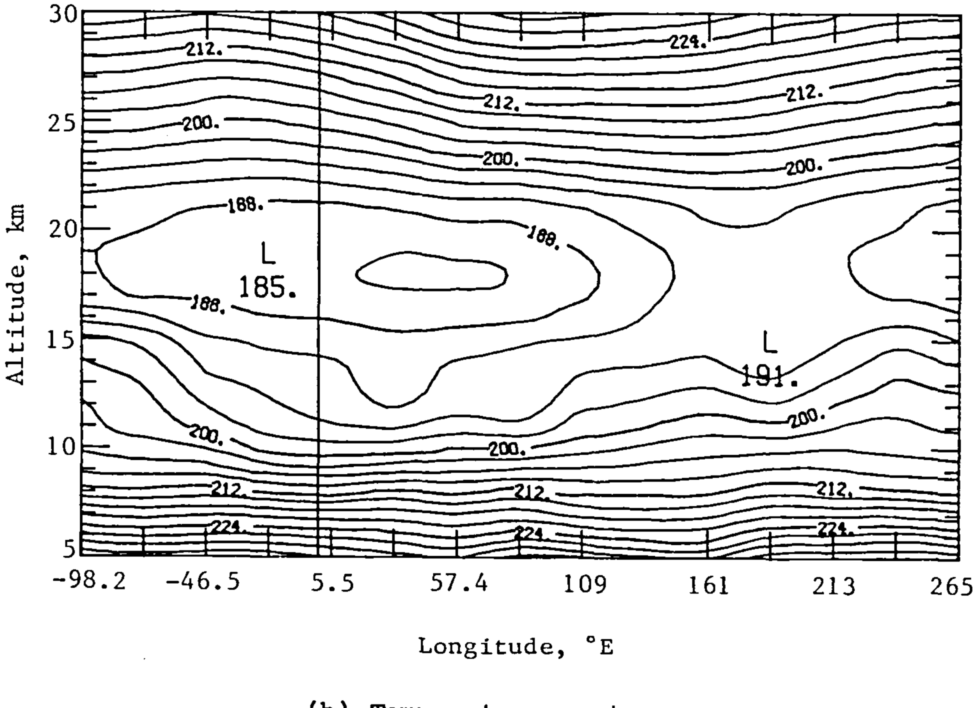


(b) Temperature contours.

Figure 56.- Antarctic extinction isopleth and temperature contours for September 2.80 to 3.96, 1981, at latitudes from 77.0° to 77.4° S corresponding to orbits 14 436 to 14 452.

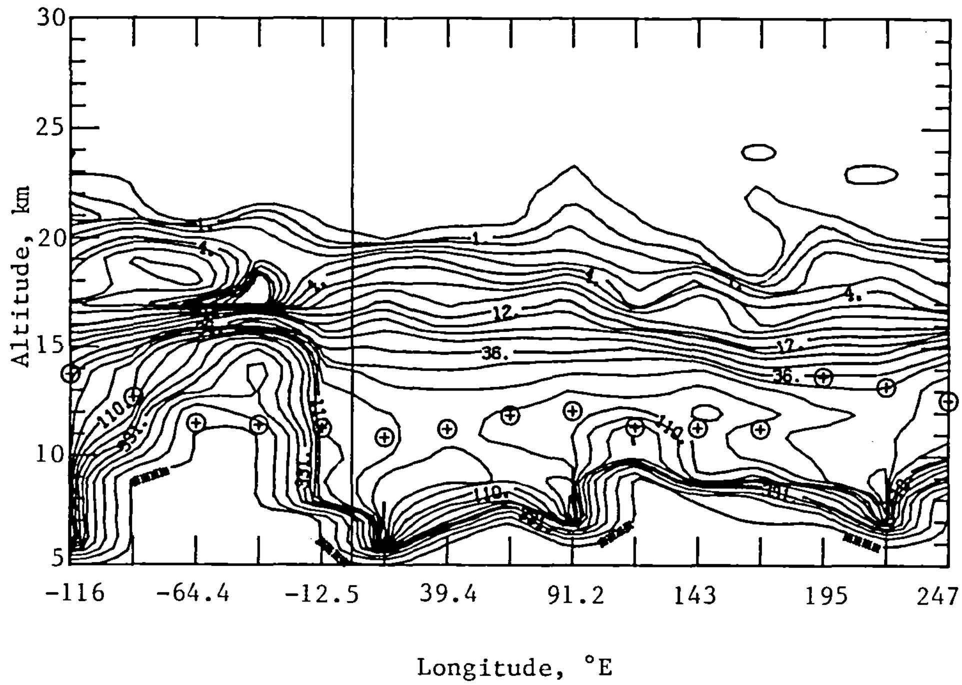


(a) Extinction isopleth.

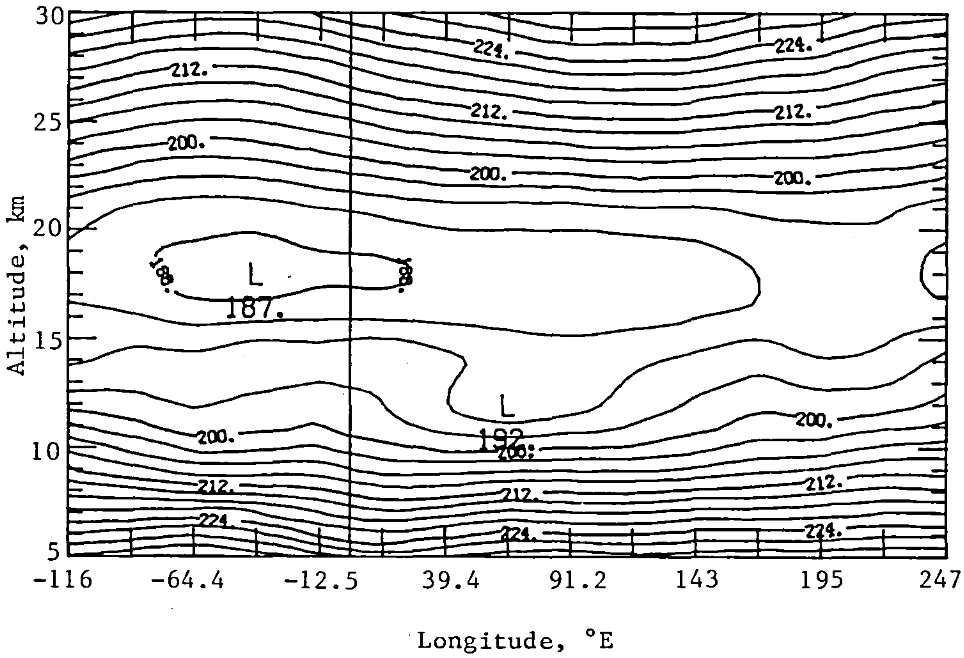


(b) Temperature contours.

Figure 57.- Antarctic extinction isopleth and temperature contours for September 7.94 to 8.95, 1981, at latitudes from 78.3° to 78.4° S corresponding to orbits 14 507 to 14 521.

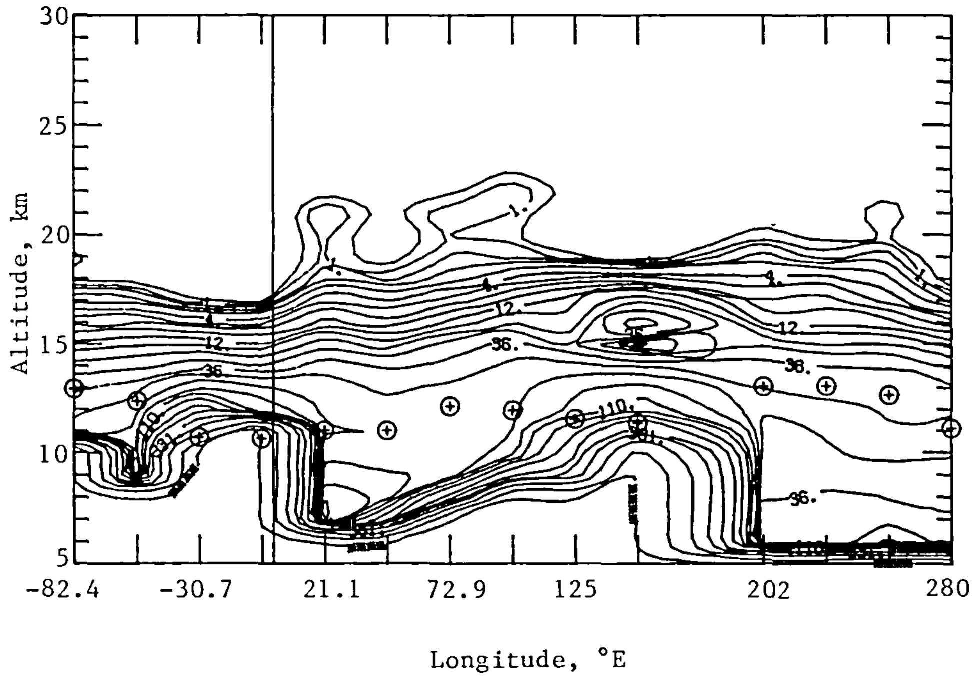


(a) Extinction isopleth.

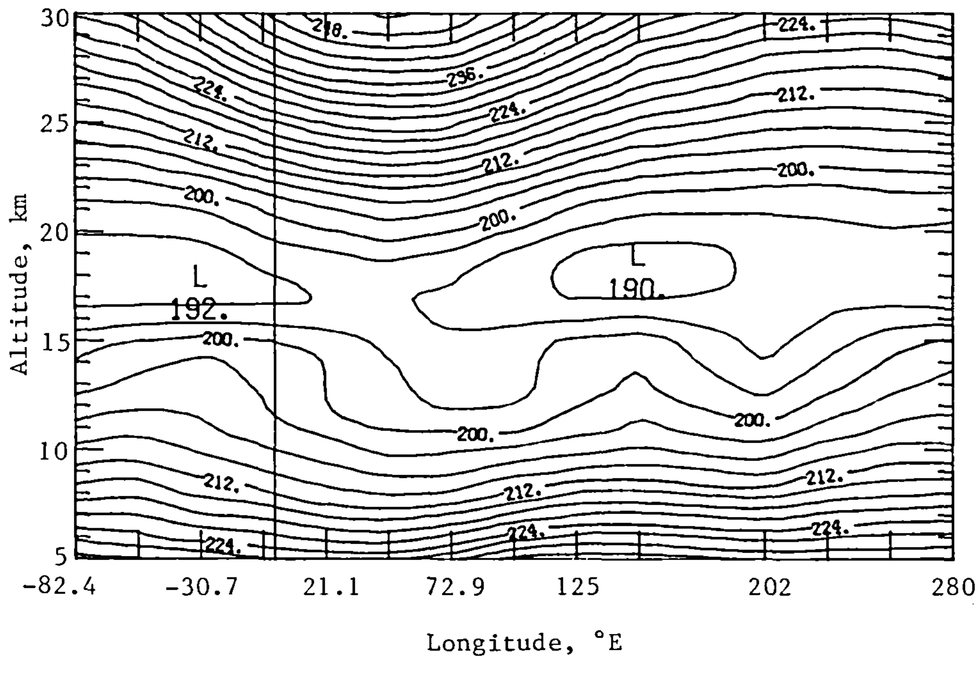


(b) Temperature contours.

Figure 58.- Antarctic extinction isopleth and temperature contours for September 14.01 to 15.03, 1981, at latitudes from 79.4° to 79.6° S corresponding to orbits 14 591 to 14 605.

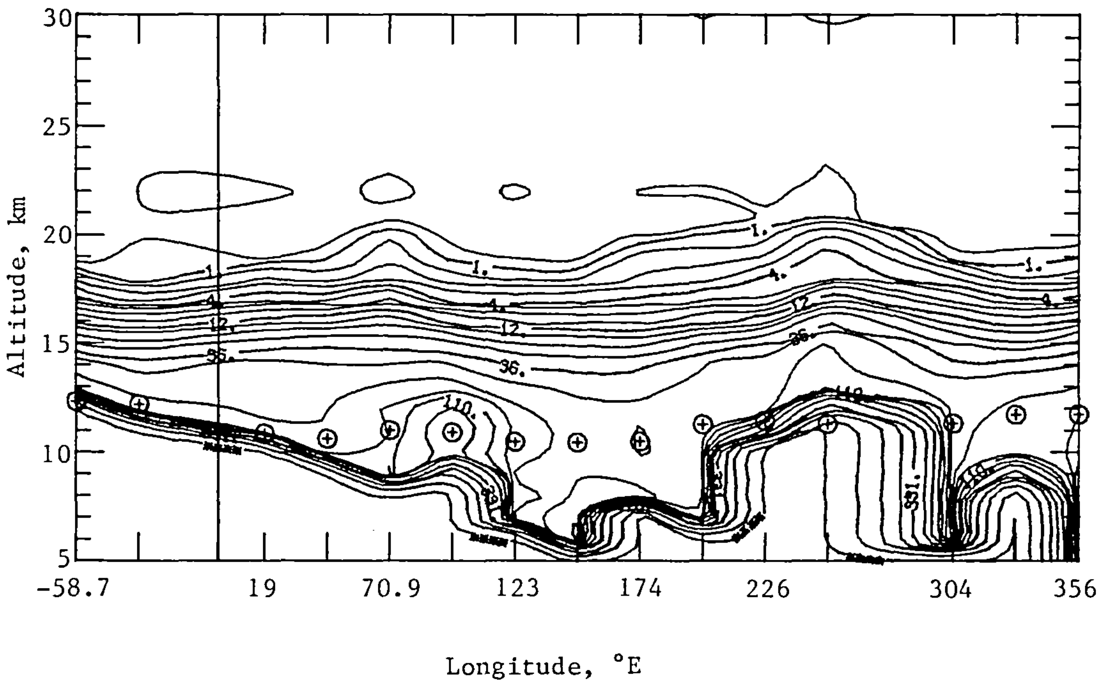


(a) Extinction isopleth.

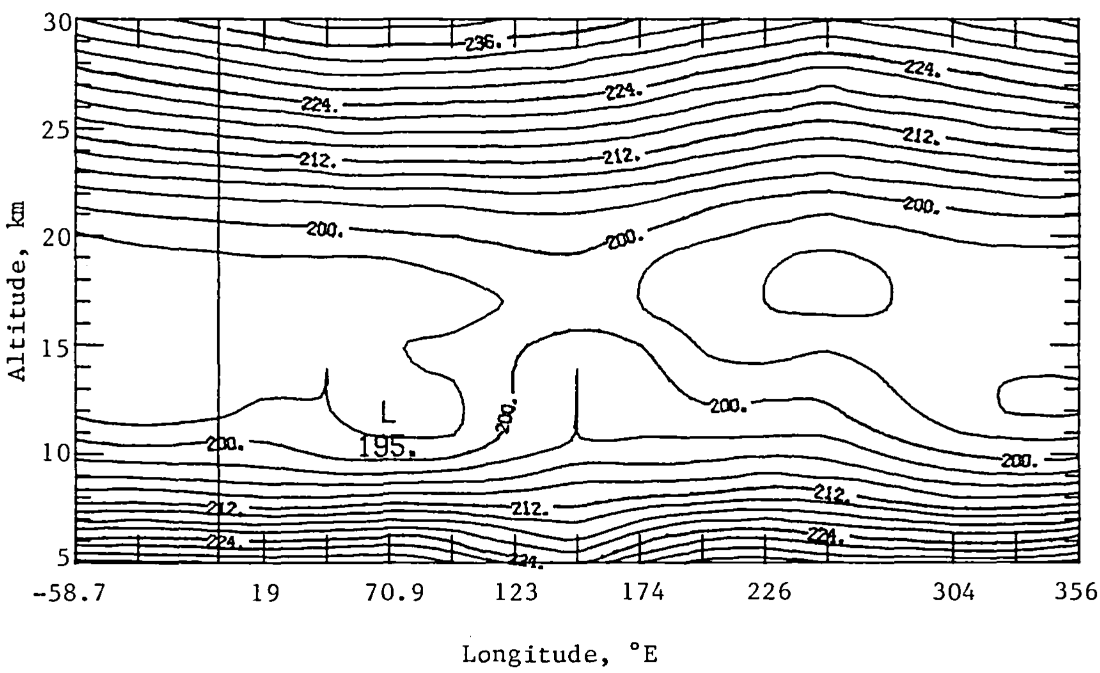


(b) Temperature contours.

Figure 59.- Antarctic extinction isopleth and temperature contours for September 20.96 to 21.97, 1981, at latitudes from 80.4° to 80.5° S corresponding to orbits 14 687 to 14 701.

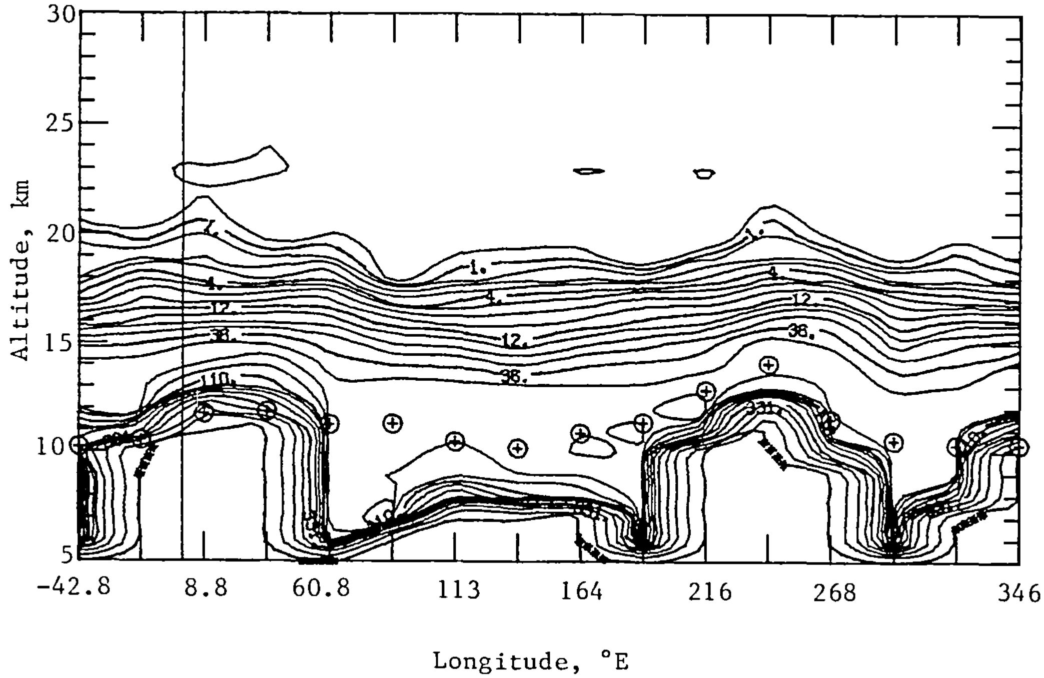


(a) Extinction isopleth.

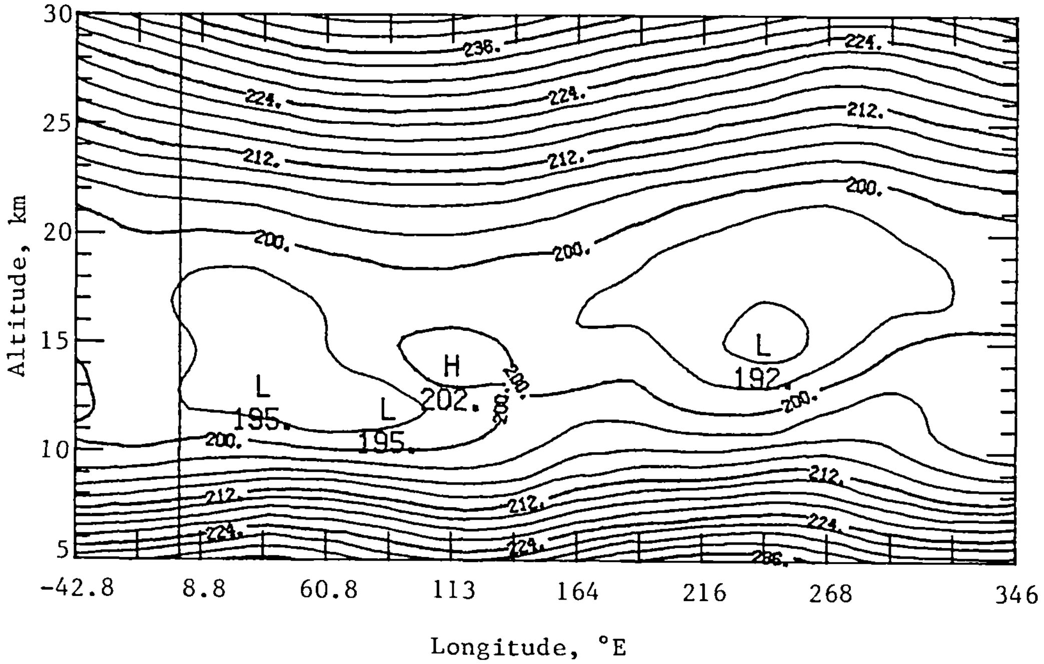


(b) Temperature contours.

Figure 60.- Antarctic extinction isopleth and temperature contours for October 2.82 to 3.98, 1981, at latitudes from 80.5° to 80.3° S corresponding to orbits 14 851 to 14 867.

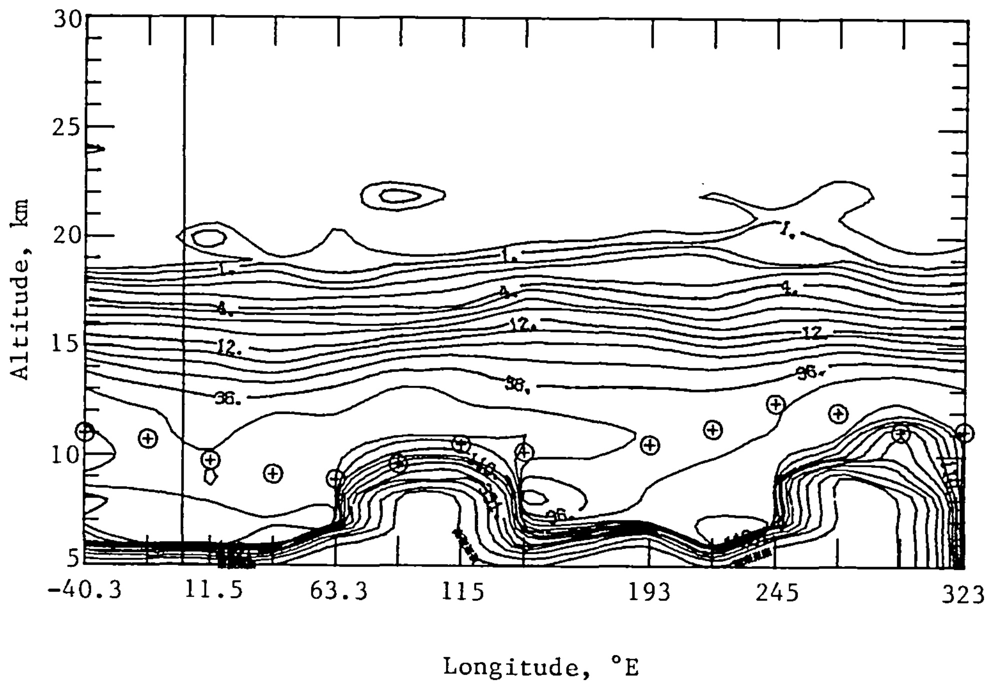


(a) Extinction isopleth.

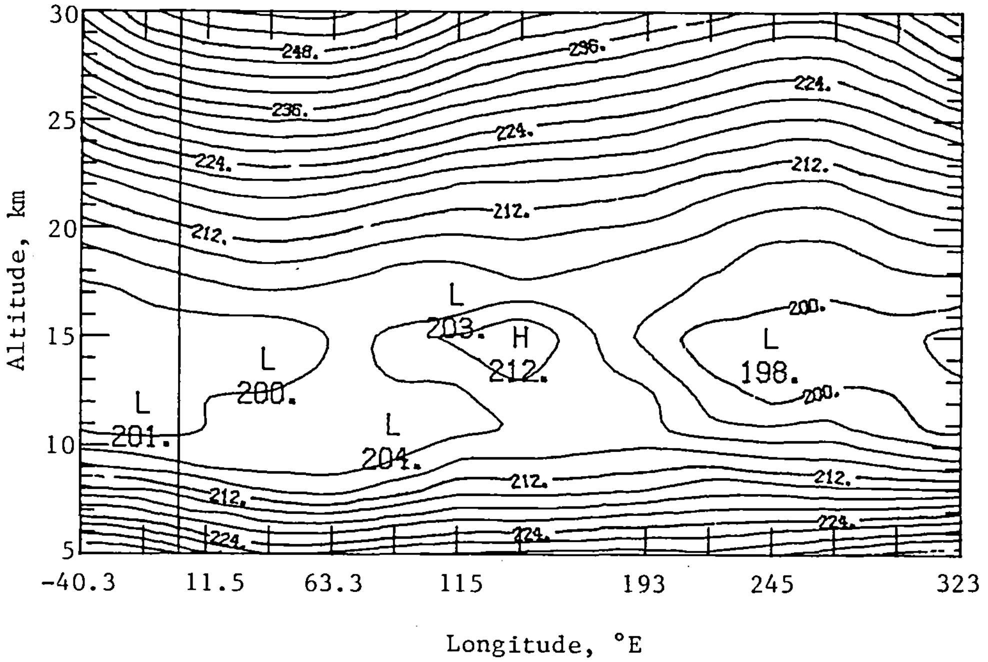


(b) Temperature contours.

Figure 61.- Antarctic extinction isopleth and temperature contours for October 6.87 to 7.96, 1981, at latitudes from 80.0° to 79.9° S corresponding to orbits 14 907 to 14 922.

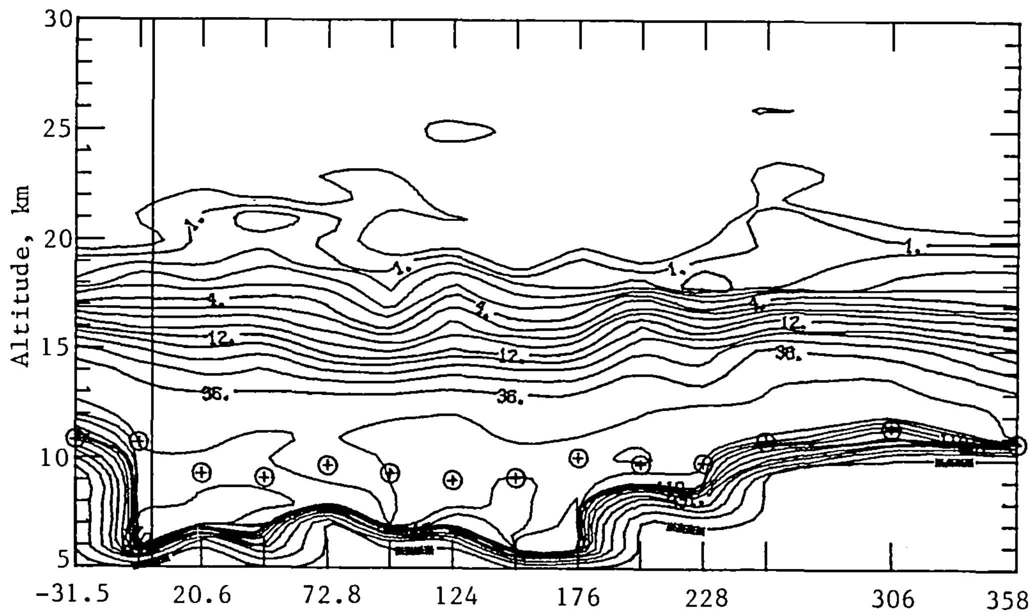


(a) Extinction isopleth.

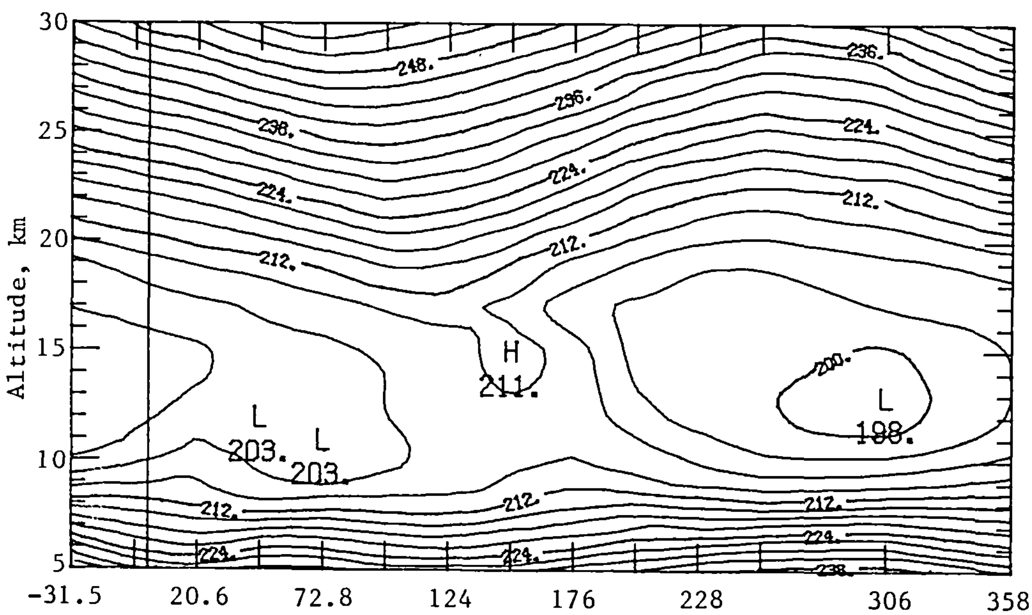


(b) Temperature contours.

Figure 62.- Antarctic extinction isopleth and temperature contours for October 14.98 to 15.99, 1981, at latitudes from 78.5° to 78.3° S corresponding to orbits 15 019 to 15 033.

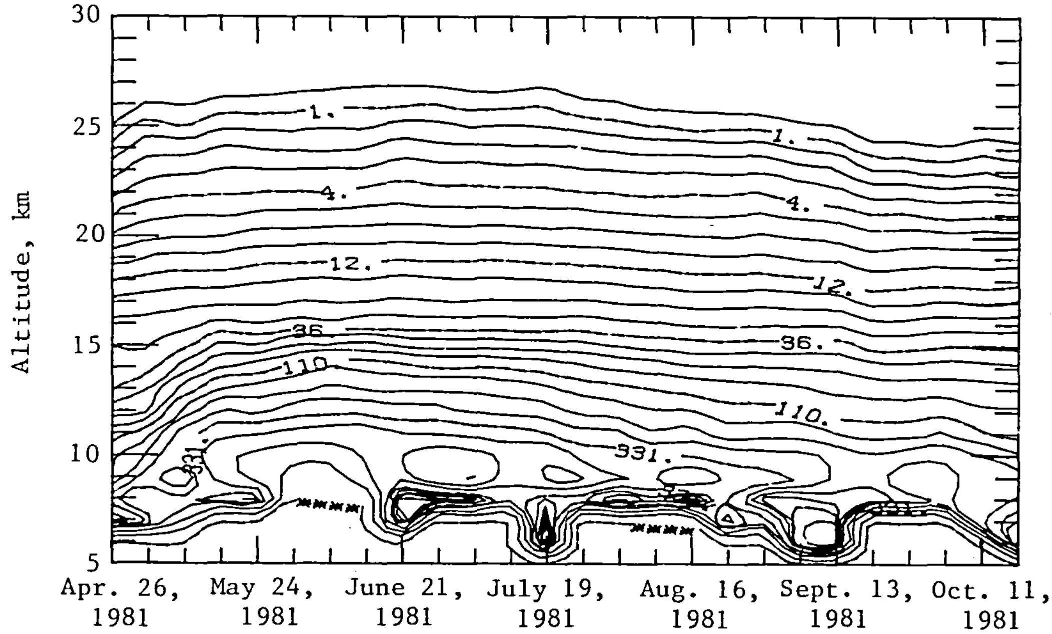


(a) Extinction isopleth.

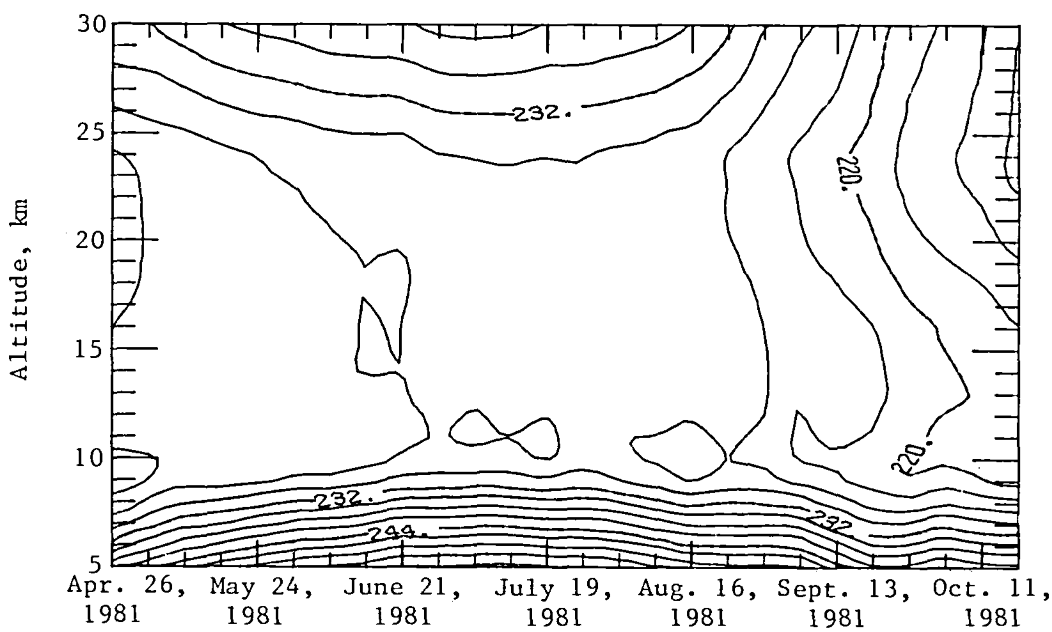


(b) Temperature contours.

Figure 63.- Antarctic extinction isopleth and temperature contours for October 19.90 to 20.98, 1981, at latitudes from 77.3° to 77.1° S corresponding to orbits 15 087 to 15 102.

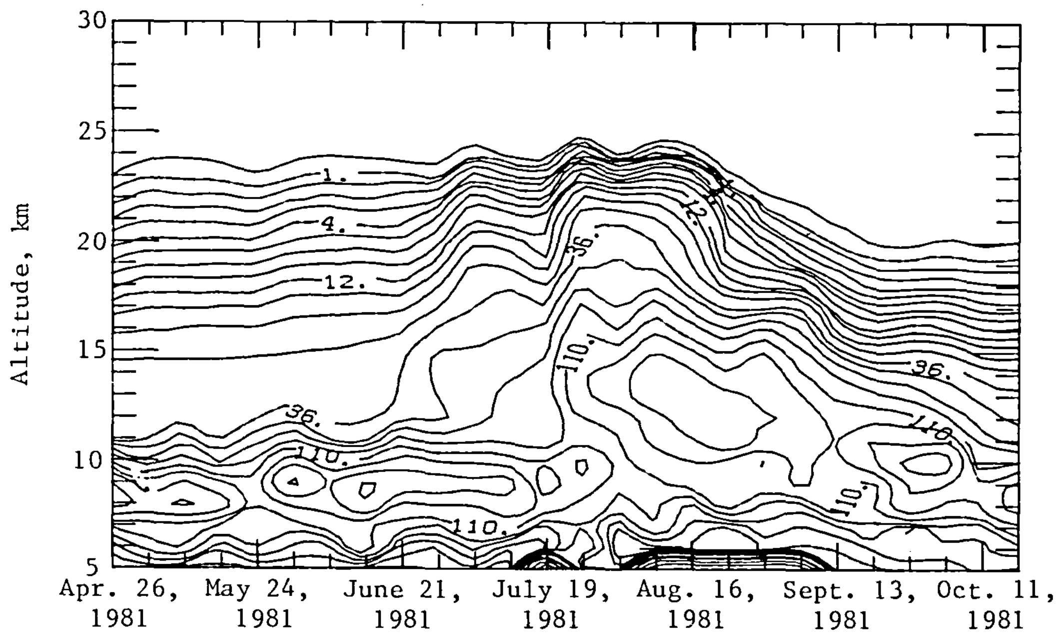


(a) Aerosol extinction at 1 μm in units of 10^{-5} km^{-1}.

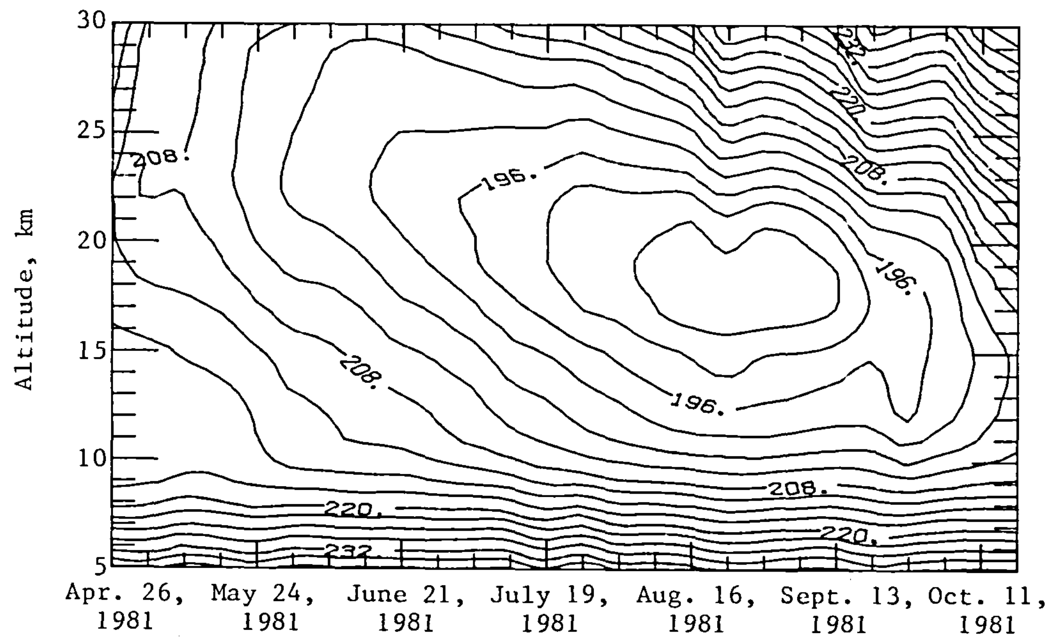


(b) Temperature field in kelvin at location of aerosol measurement.

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 the 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 the average value corresponds.

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15. Supplementary Notes

M. Patrick McCormick: Langley Research Center, Hampton, Virginia.
David Brandl: Systems and Applied Sciences Corporation, Hampton, Virginia.
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16. Abstract

The Stratospheric Aerosol Measurement (SAM) II sensor is aboard the Earth-orbiting Nimbus 7 spacecraft providing extinction measurements of the Antarctic and Arctic stratospheric aerosols with a vertical resolution of 1 km. Representative examples and weekly averages of these aerosol data and corresponding temperature profiles (Apr. 1981 to Oct. 1981) are presented. Contours of aerosol extinction as a function of altitude and longitude or time are plotted and weekly aerosol optical depths are calculated. Typical values of the main stratospheric aerosol extinction at the SAM II wavelength of 1.0 μm for this time period are 2 to 4 times 10^{-4} km^{-1} for the Antarctic region and 8 to 9 times 10^{-3} km^{-1} at the beginning to 1 to 2 times 10^{-3} km^{-1} at the end of the time period for the Arctic region. Stratospheric optical depths are 0.002 to 0.003 for the Antarctic region and 0.006 to 0.007 at the beginning to 0.003 to 0.004 at the end of the time period for the Arctic region. Polar stratospheric clouds at altitudes between the tropopause and 20 km were observed during the Antarctic winter. A ready-to-use format containing a representative sample of the sixth 6 months of data to be used in atmospheric and climatic studies is reported.

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