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SAM II Measurements of the Polar Stratospheric Aerosol

Volume IV - April 1980 to October 1980

M. Patrick McCormick
and David Brandl

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SAM II Measurements of the Polar Stratospheric Aerosol

Volume IV - April 1980 to October 1980

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PREFACE

This is the fourth 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 6 months of data, covering October 1979 to April 1980, were published in NASA Reference Publication 1106. 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 1980 through October 1980. 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, SRI International; and M. P. McCormick, NASA Langley Research Center.

CONTENTS

SUMMARY

The Stratospheric Aerosol Measurement (SAM) II sensor is flying aboard the Earth-orbiting Nimbus 7 spacecraft providing extinction measurements of the Antarctic and Arctic stratospheric aerosol with a vertical resolution of 1 km. This report presents representative examples and weekly averages of these aerosol data as well as corresponding temperature profiles provided by the National Meteorological Center of the National Oceanic and Atmospheric Administration (NOAA) for the time and place of each SAM II measurement during the fourth 6 months of satellite flight, April 1980 through October 1980. 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 for this time period are 2 to 4 times 10^{-4} km^{-1} for the Southern Hemisphere throughout the time period and 2 to 4 times 10^{-4} 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 0.002 to 0.003 at the beginning to 0.005 to 0.006 at the end of the time period for the Northern Hemisphere. These values are somewhat larger than normal background levels due to the injection of aerosols into the stratosphere by the eruptions of Mount St. Helens (May 1980) and Sierra Negra (Nov. 1979). Polar stratospheric clouds (PSC's) at altitudes between the tropopause and 20 km were observed during the Antarctic winter at various times and locations. No attempt has been made in this report to give any detailed explanations or interpretations of these data. The intent of this report is to provide, in a ready-to-use format, a representative sample of the fourth 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. The archived products also include 18 different types of output products produced on 16-mm film and consisting of profiles, cross sections, maps, and histories.

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

EXTINCTION PROFILES

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

EXTINCTION ISOPLETHS

Figures 12 to 63 present isopleths of aerosol extinction and temperature contours for a 1-day sample taken from each week of the 6-month period. The extinction isopleths are plotted as extinction as a function of altitude and longitude and were generated from the 14 individual extinction profiles for the particular day by using a cubic-spline contouring program. The tension of the cubic-spline fit was set at 2.5. Once again, because of the large amount of data, all 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 28.23 means 5:31 a.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 ($\oplus$). 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 values are marked with an "L" and maximum values with an "H."

Figures 12 to 37 show the Arctic measurements and figures 38 to 63 show the Antarctic measurements. The plots show rather interesting variations in the aerosol as a function of longitude. These variations have not been observed in measurements obtained with other methods because this satellite system is the first to obtain a high density of measurements in a short time interval, thus allowing such plots to be made. This set of plots also enables one to observe the correlations which exist between the aerosol extinction and the temperature. For example, some of the plots reveal the presence of polar stratospheric clouds (PSC's), which occur in the Antarctic in the winter. (See figs. 44 to 60.) 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 6. 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. 7).

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 fourth 6 months (Apr. 27, 1980, to Oct. 25, 1980) 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 4 1/2 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.

Langley Research Center
National Aeronautics and Space Administration
Hampton, VA 23665
April 29, 1983

REFERENCES

1. Chu, W. P.; and McCormick, M. P.: Inversion of Stratospheric Aerosol and Gaseous Constituents From Spacecraft Solar Extinction Data in the 0.38-1.0-μm Wavelength Region. Appl. Opt., vol. 18, no. 9, May 1, 1979, pp. 1404-1413.

2. McCormick, M. P.; Hamill, Patrick; Pepin, T. J.; Chu, W. P.; Swissler, T. J.; and McMaster, L. R.: Satellite Studies of the Stratospheric Aerosol. Bull. American Meteorol. Soc., vol. 60, no. 9, Sept. 1979, pp. 1038-1046.

3. Russell, P. B.; McCormick, M. P.; McMaster, L. R.; Pepin, T. J.; Chu, W. P.; and Swissler, T. J.: SAM II Ground-Truth Plan - Correlative Measurements for the Stratospheric Aerosol Measurement-II (SAM II) Sensor on the NIMBUS G Satellite. NASA TM-78747, 1978.

4. Madrid, Charles R., ed.: The Nimbus 7 User's Guide. NASA TM-79969, 1978.

5. Russell, P. B., ed.: SAGE Ground Truth Plan - Correlative Measurements for the Stratospheric Aerosol and Gas Experiment (SAGE) on the AEM-B Satellite. NASA TM-80076, 1979.

6. McCormick, M. P.; Steele, H. M.; Hamill, Patrick; Chu, W. P.; and Swissler, T. J.: Polar Stratospheric Cloud Sightings by SAM II. J. Atmos. Sci., vol. 39, no. 6, June 1982, pp. 1387-1397.

7. McCormick, M. P.; Chu, W. P.; Grams, G. W.; Hamill, Patrick; Herman, B. M.; McMaster L. R.; Pepin, T. J.; Russell, P. B.; Steele, H. M.; and Swissler, T. J.: High-Latitude Aerosols Measured by the SAM II Satellite System in 1978 and 1979. Science, vol. 214, no. 4518, Oct. 16, 1981, pp. 328-331.

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. 27, 1980	73.6	8.66	211.6×10^{-5}
May 4, 1980	71.8	7.61	275.0
May 11, 1980	70.2	7.63	270.3
May 18, 1980	68.8	8.87	199.7
May 25, 1980	67.7	9.28	196.3
June 1, 1980	66.8	8.86	337.8
June 8, 1980	66.3	8.96	482.4
June 15, 1980	66.1	8.96	555.3
June 22, 1980	66.2	8.79	561.2
June 29, 1980	66.6	9.14	610.3
July 6, 1980	67.3	9.43	607.2
July 13, 1980	68.3	9.33	666.5
July 20, 1980	69.5	9.25	700.0
July 27, 1980	71.0	9.42	627.9
Aug. 3, 1980	72.6	9.49	667.9
Aug. 10, 1980	74.7	8.96	611.7
Aug. 17, 1980	76.2	8.89	667.7
Aug. 24, 1980	77.9	8.38	616.2
Aug. 31, 1980	79.5	8.30	715.7
Sept. 7, 1980	80.6	7.95	733.4
Sept. 14, 1980	81.1	7.80	755.3
Sept. 21, 1980	80.8	8.25	697.3
Sept. 28, 1980	79.8	7.87	660.9
Oct. 5, 1980	78.4	8.13	627.6
Oct. 12, 1980	76.7	8.07	634.2
Oct. 19, 1980	74.9	8.46	568.6

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. 27, 1980	72.1	8.91	164.7×10^{-5}
May 4, 1980	70.5	7.42	218.2
May 11, 1980	68.9	8.56	187.0
May 18, 1980	67.6	8.87	172.3
May 25, 1980	66.5	9.24	164.1
June 1, 1980	65.6	8.92	225.7
June 8, 1980	65.0	8.44	218.7
June 15, 1980	64.8	8.74	216.3
June 22, 1980	64.8	8.84	265.5
June 29, 1980	65.1	9.30	335.5
July 6, 1980	65.7	9.60	485.5
July 13, 1980	66.5	10.48	431.8
July 20, 1980	67.7	10.57	636.0
July 27, 1980	69.0	11.13	831.2
Aug. 3, 1980	70.5	10.87	701.0
Aug. 10, 1980	72.4	10.37	1064.6
Aug. 17, 1980	73.9	11.44	827.5
Aug. 24, 1980	75.7	11.09	884.3
Aug. 31, 1980	77.3	11.24	611.9
Sept. 7, 1980	78.9	11.83	589.8
Sept. 14, 1980	80.0	11.65	440.2
Sept. 21, 1980	80.7	10.95	313.6
Sept. 28, 1980	80.6	10.38	172.1
Oct. 5, 1980	79.8	9.53	161.6
Oct. 12, 1980	78.4	9.73	138.1
Oct. 19, 1980	76.7	9.58	130.2

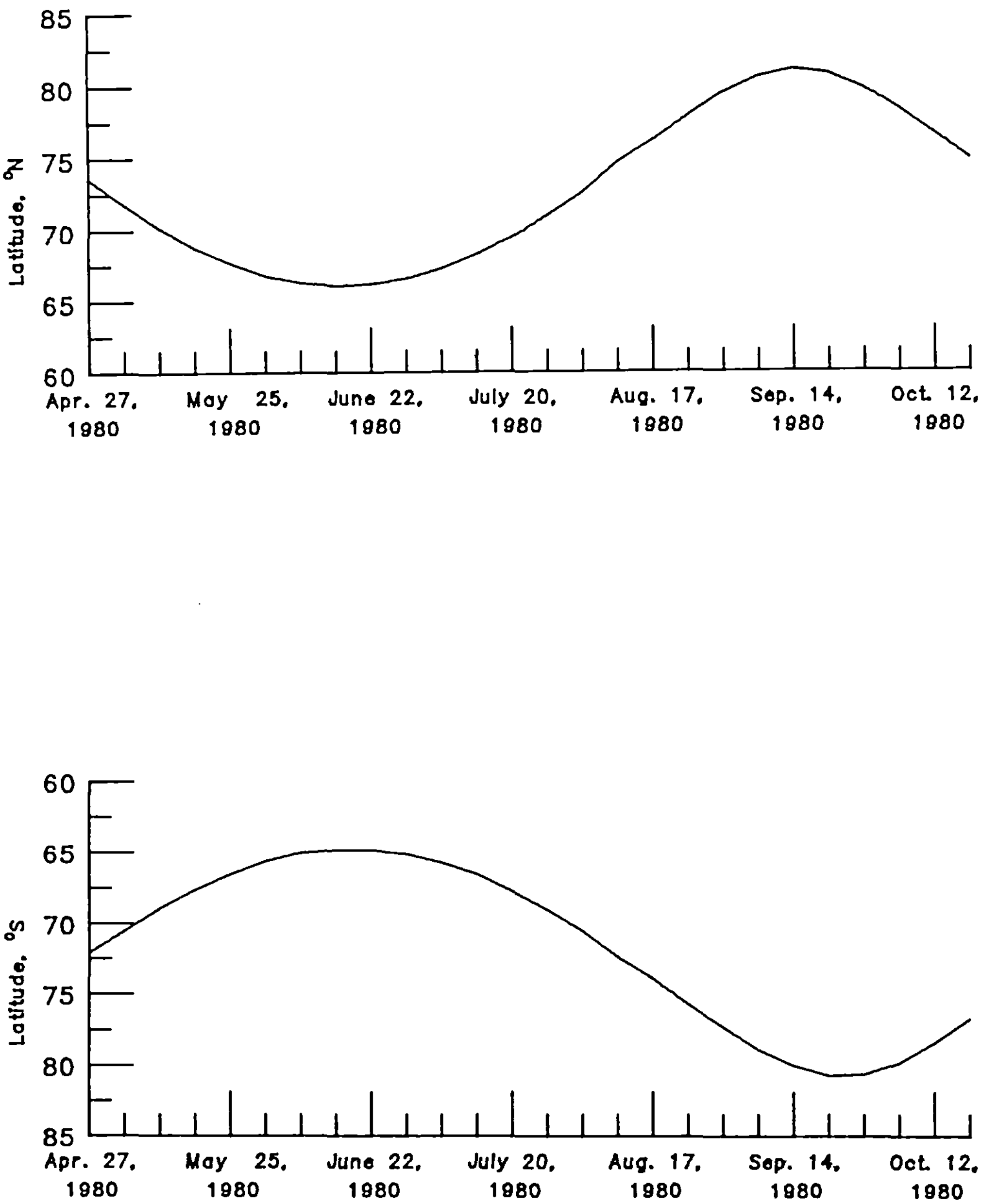


Figure 1.- Latitudinal coverage of SAM II measurements for April 1980 to October 1980.

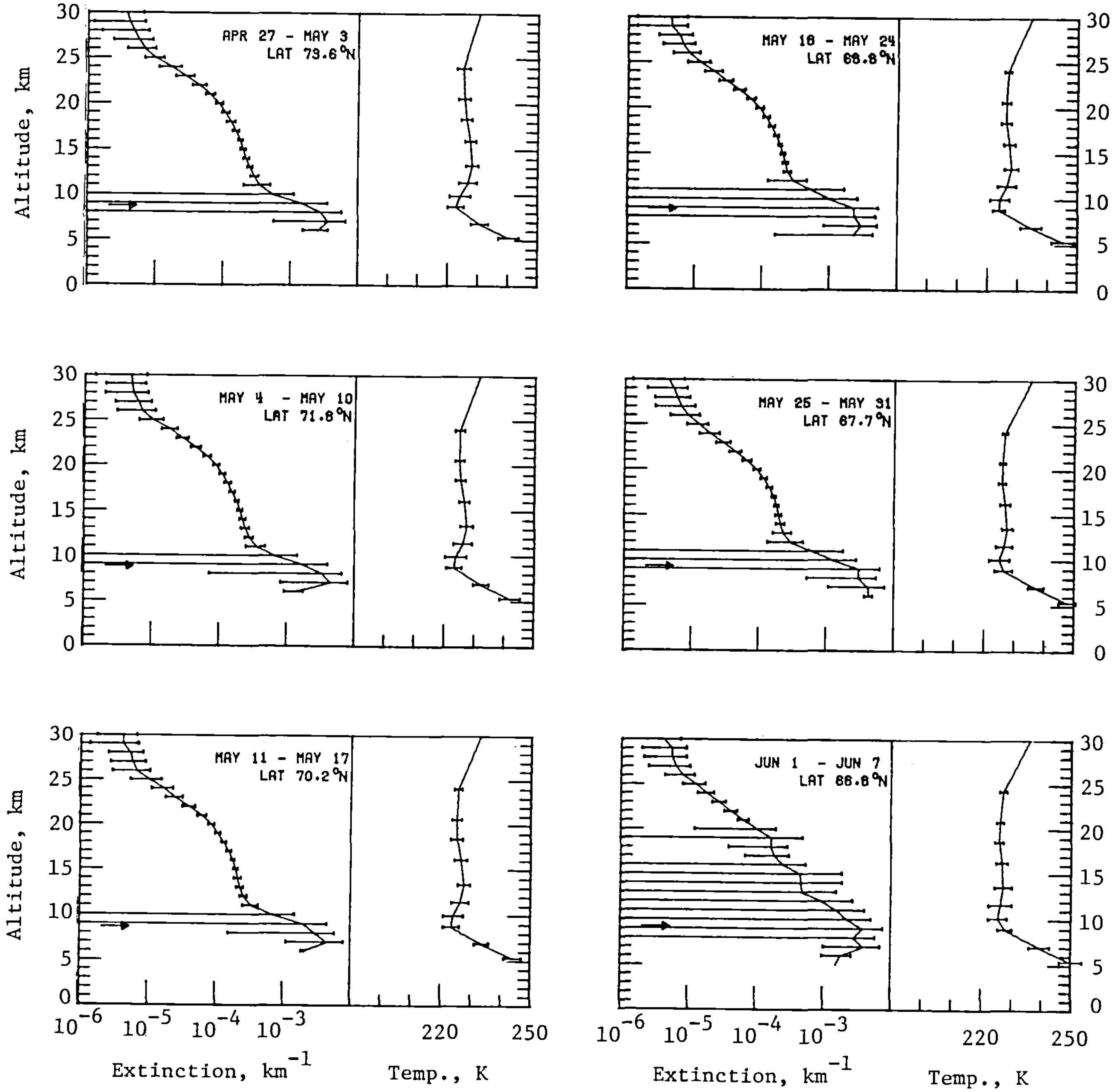


Figure 2.- Arctic extinction and temperature profiles for April 27 to June 7, 1980.

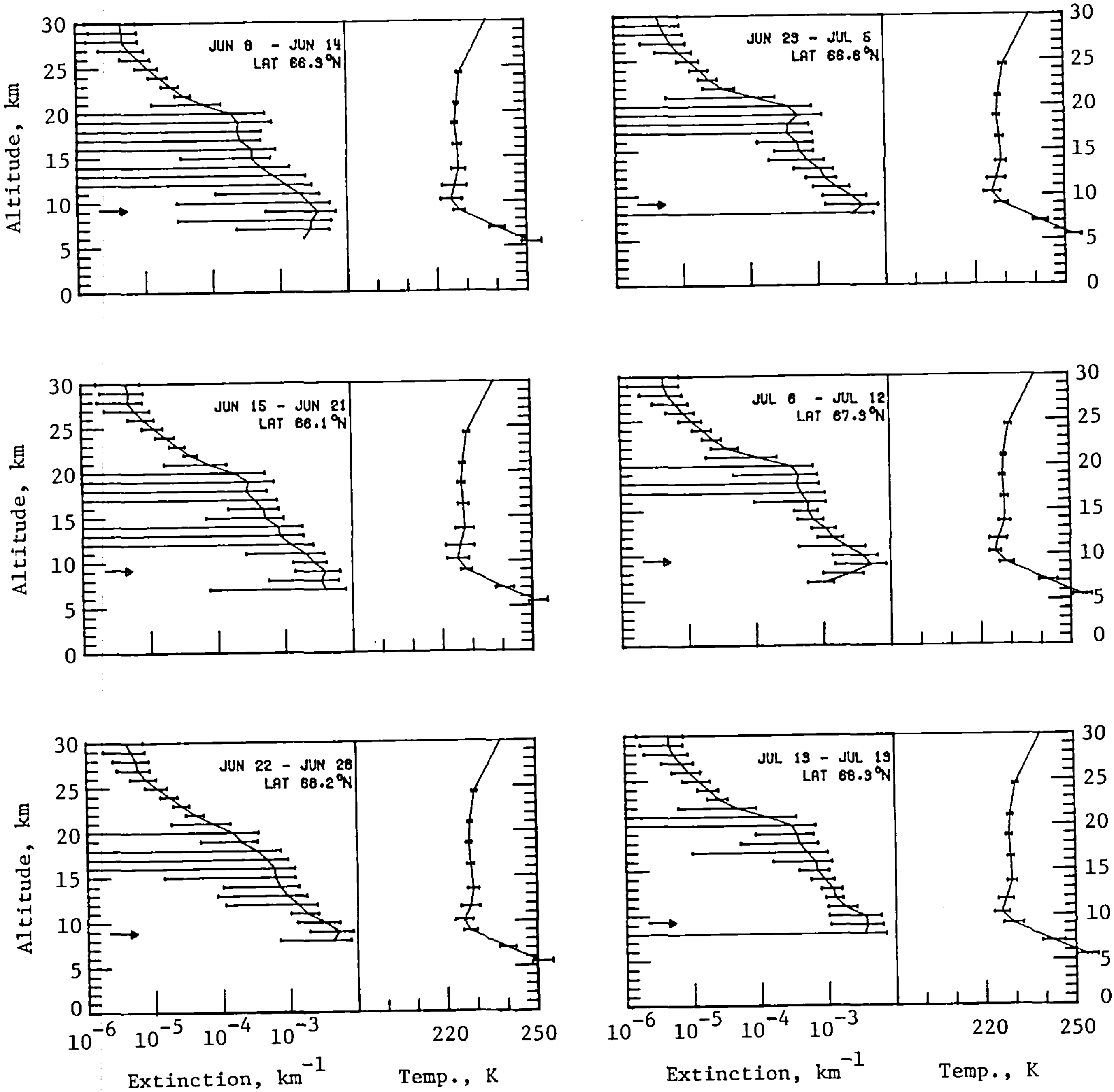


Figure 3.- Arctic extinction and temperature profiles for June 8 to July 19, 1980.

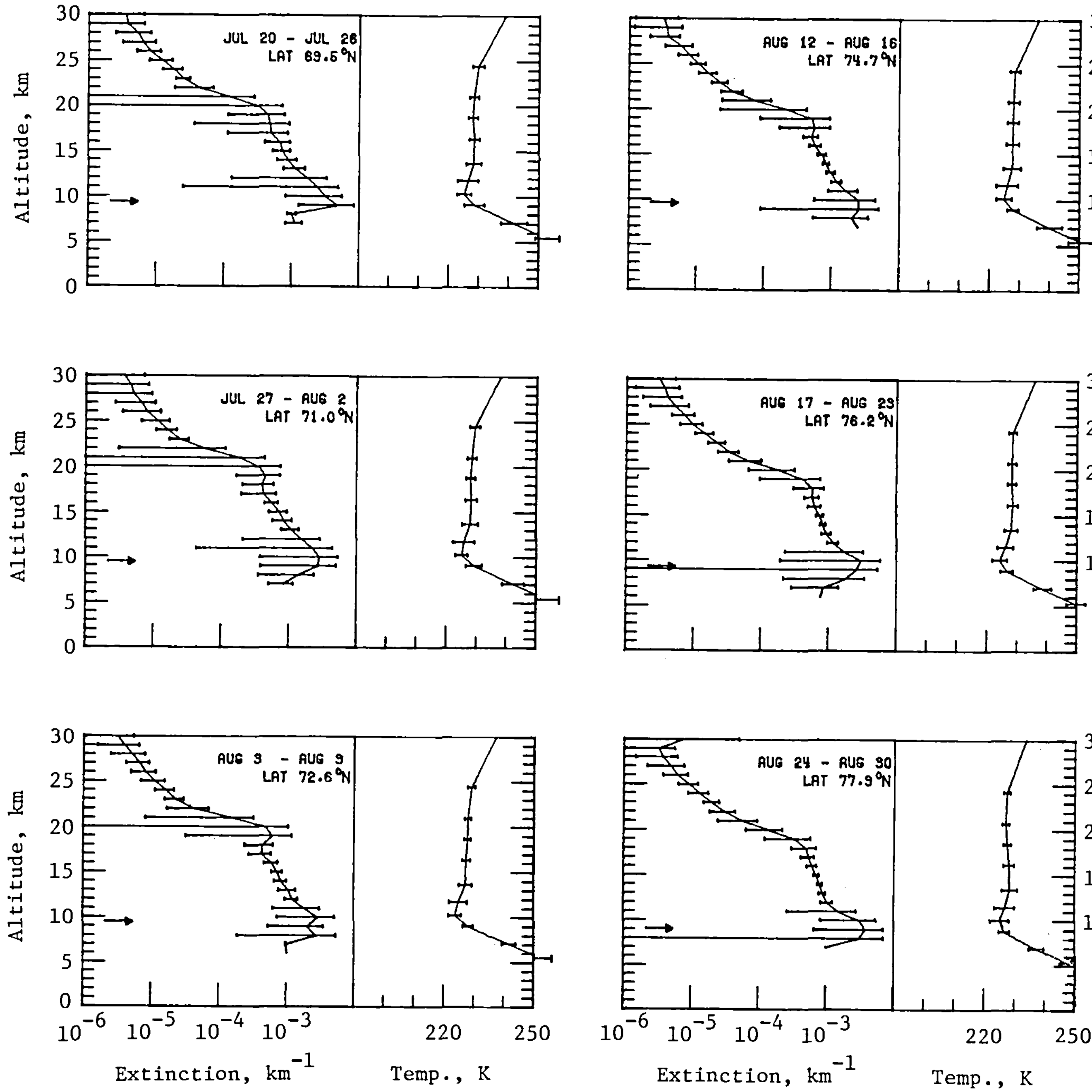


Figure 4.- Arctic extinction and temperature profiles for July 20 to August 30, 1980.

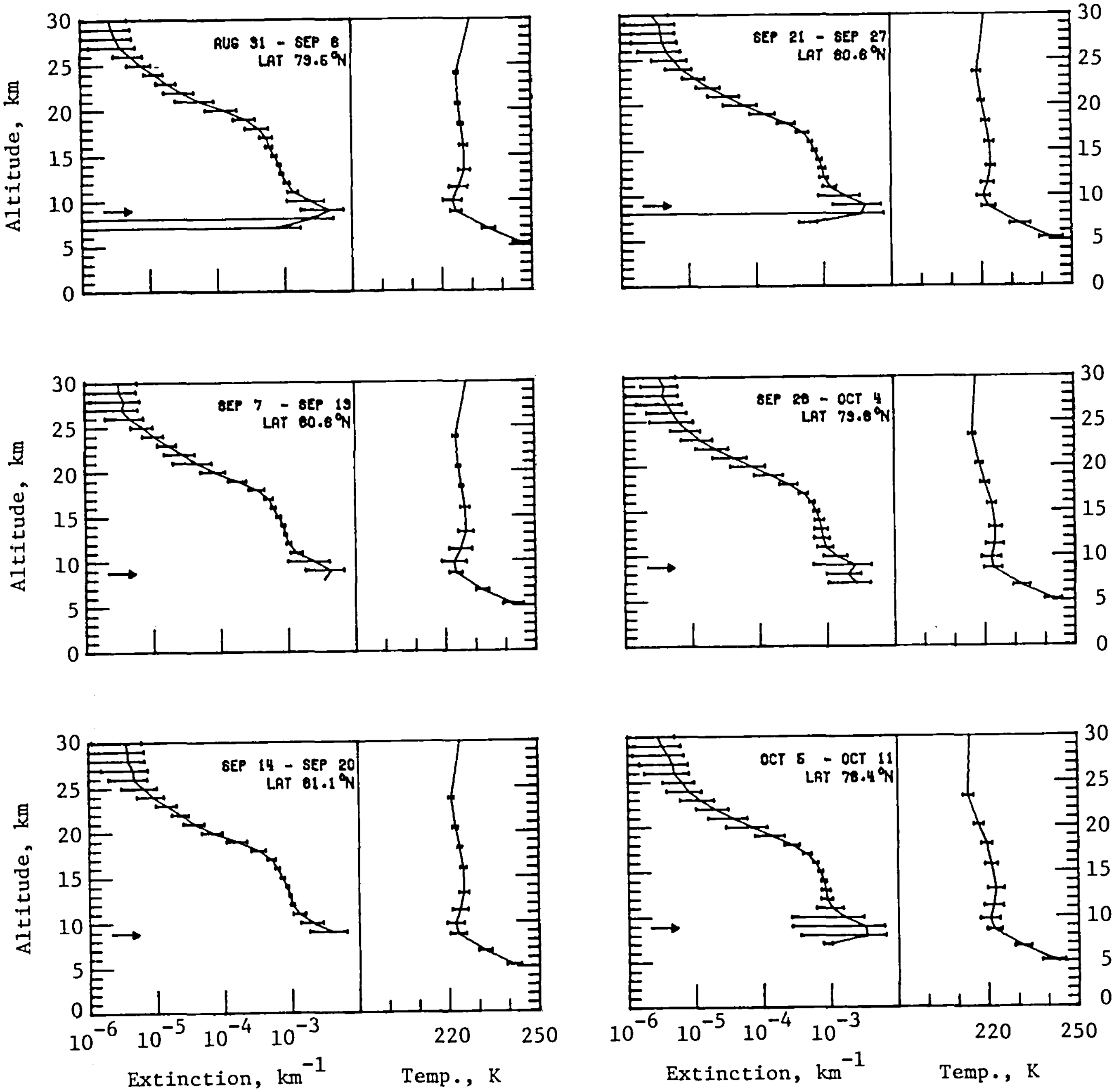


Figure 5.- Arctic extinction and temperature profiles for August 31 to October 11, 1980.

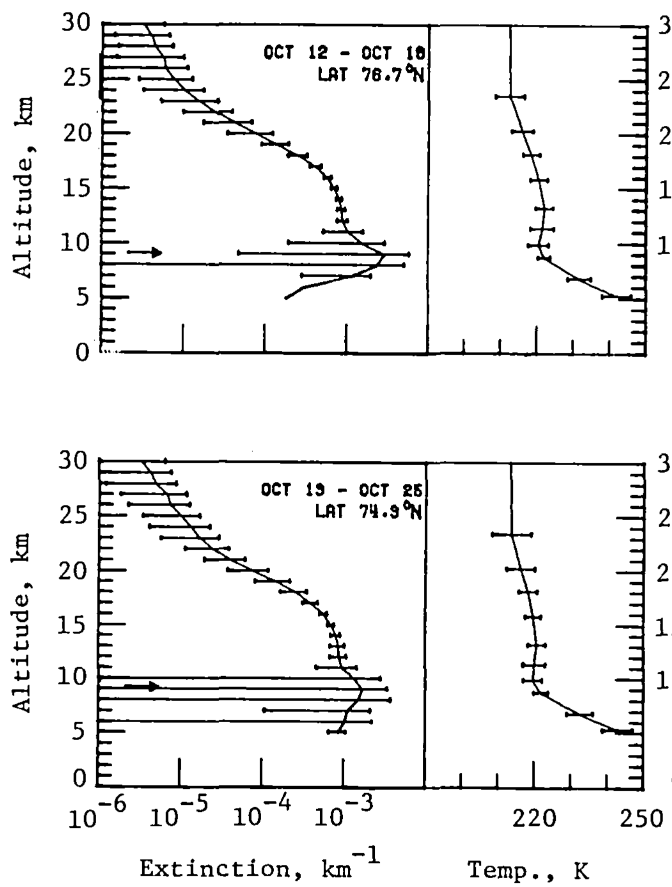


Figure 6.- Arctic extinction and temperature profiles for October 12 to October 25, 1980.

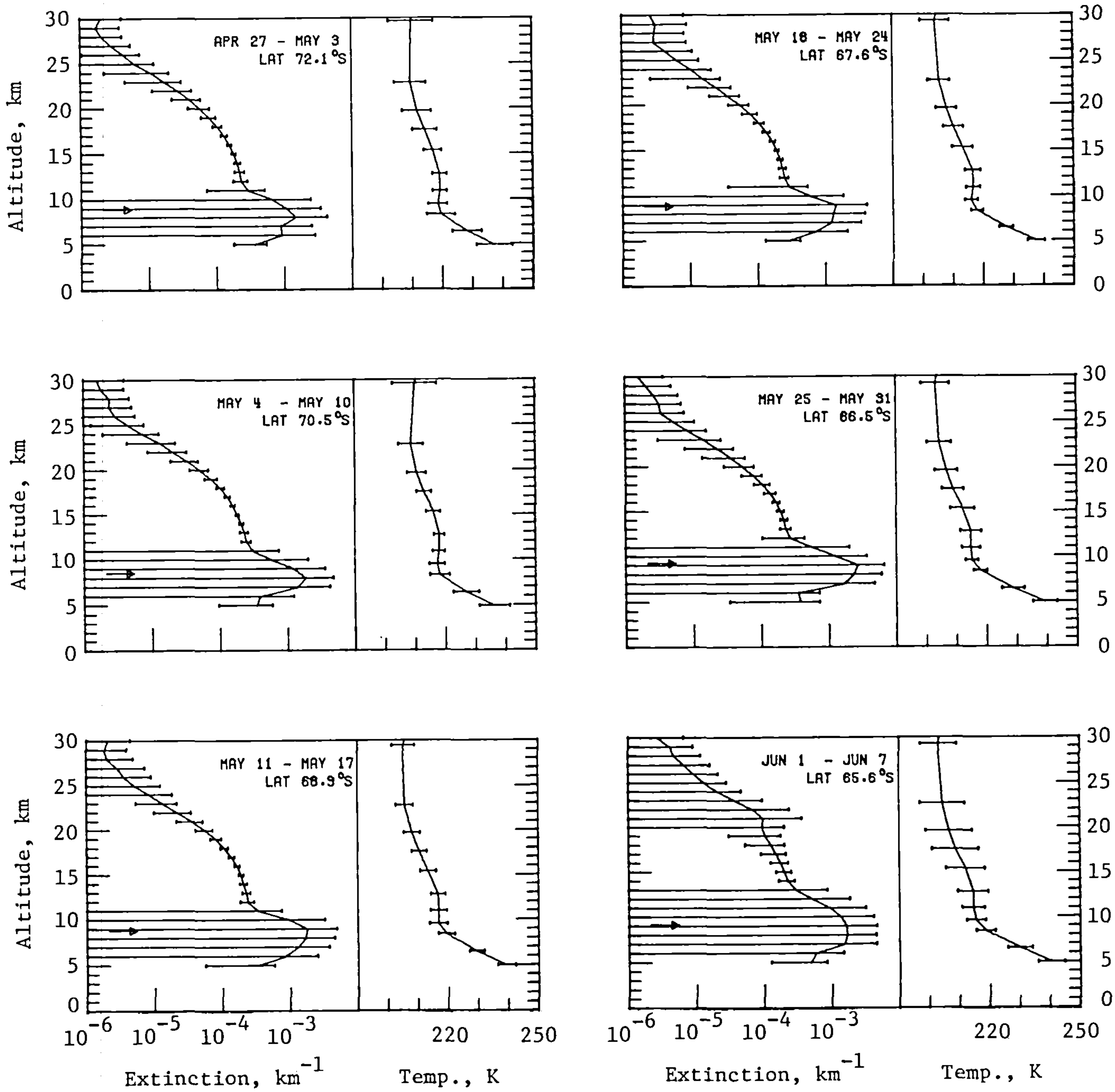


Figure 7.- Antarctic extinction and temperature profiles for April 27 to June 7, 1980.

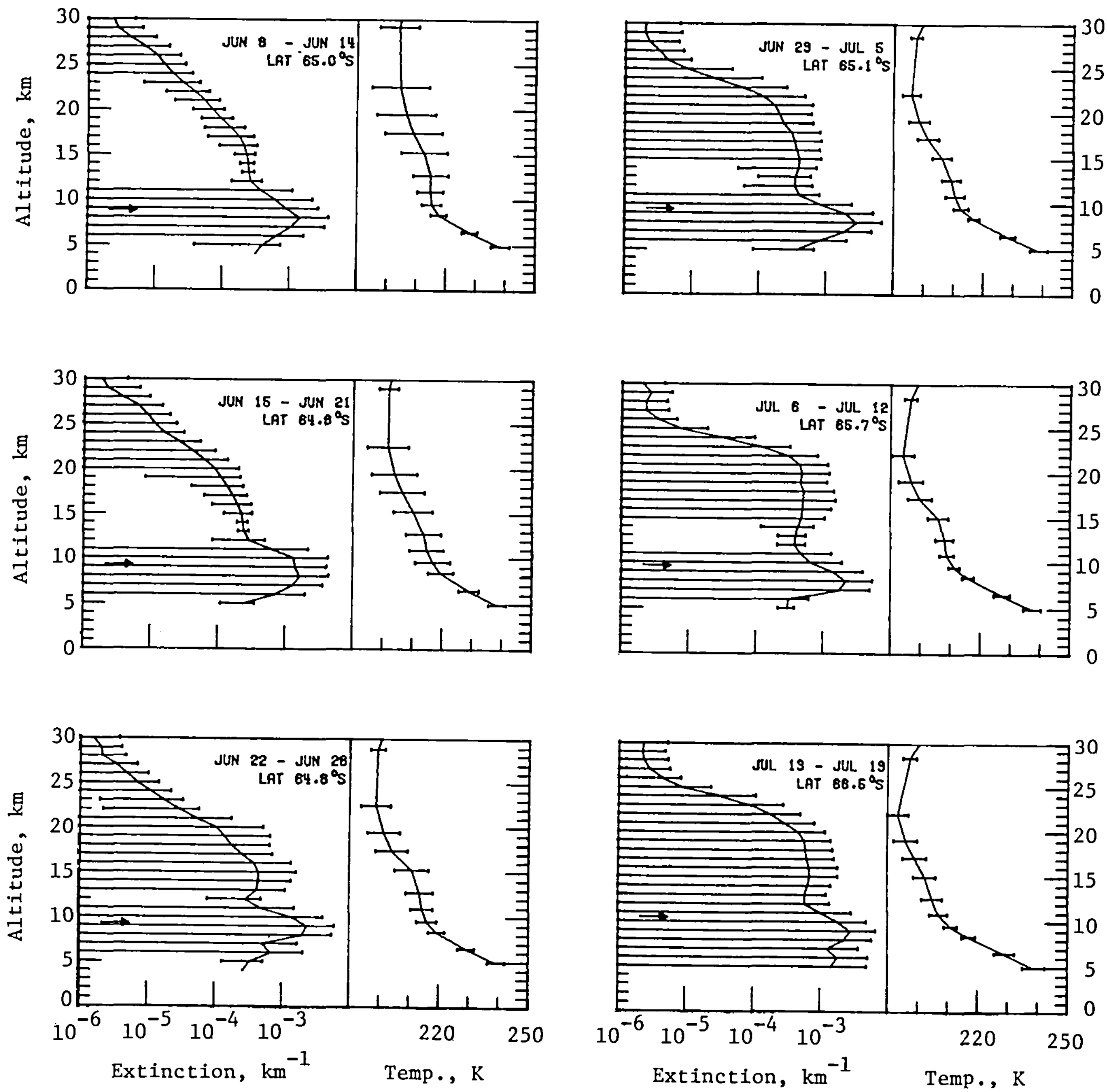


Figure 8.- Antarctic extinction and temperature profiles for June 8 to July 19, 1980.

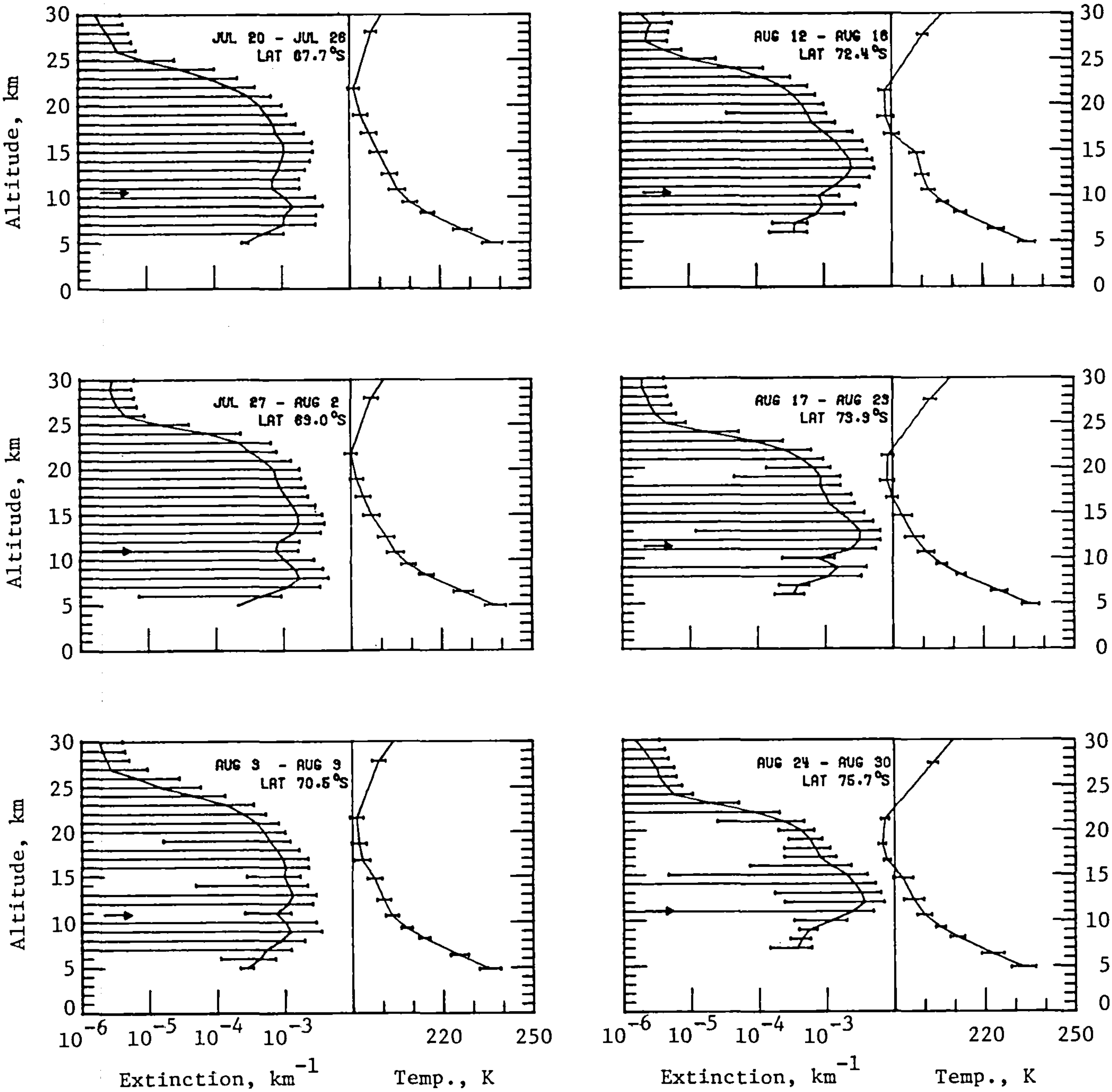


Figure 9.- Antarctic extinction and temperature profiles for July 20 to August 30, 1980.

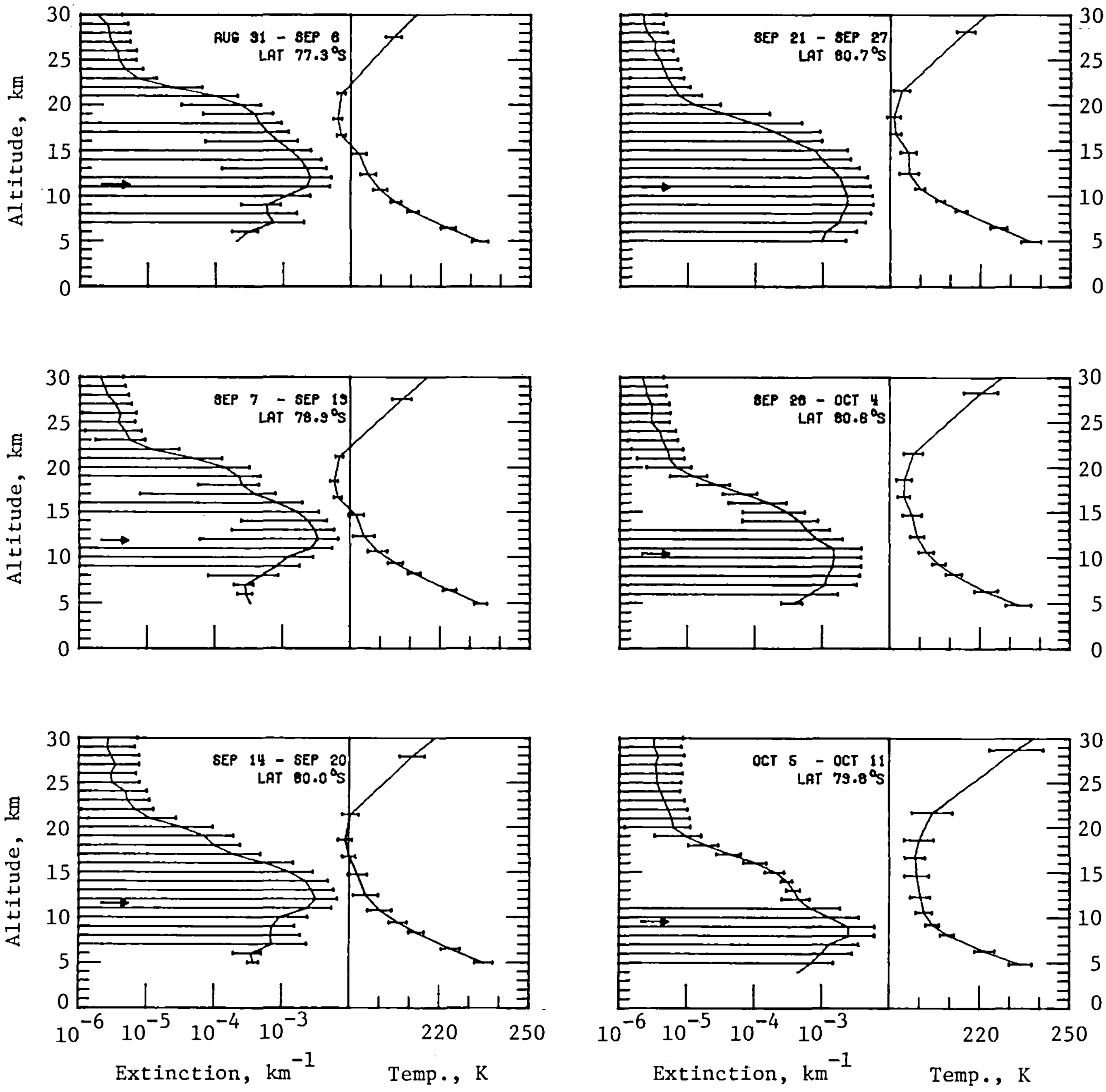


Figure 10.- Antarctic extinction and temperature profiles for August 31 to October 11, 1980.

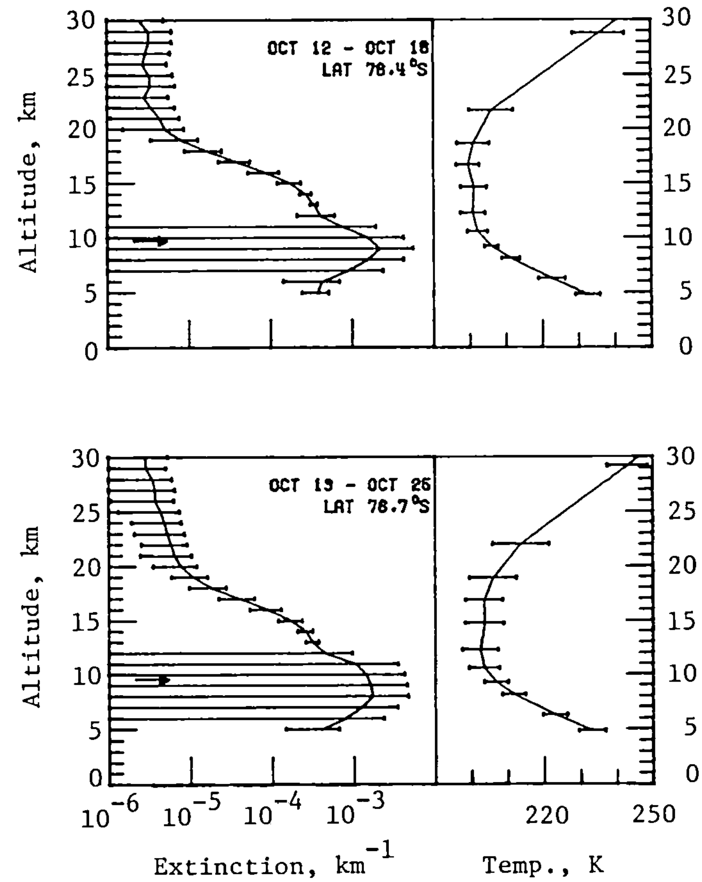
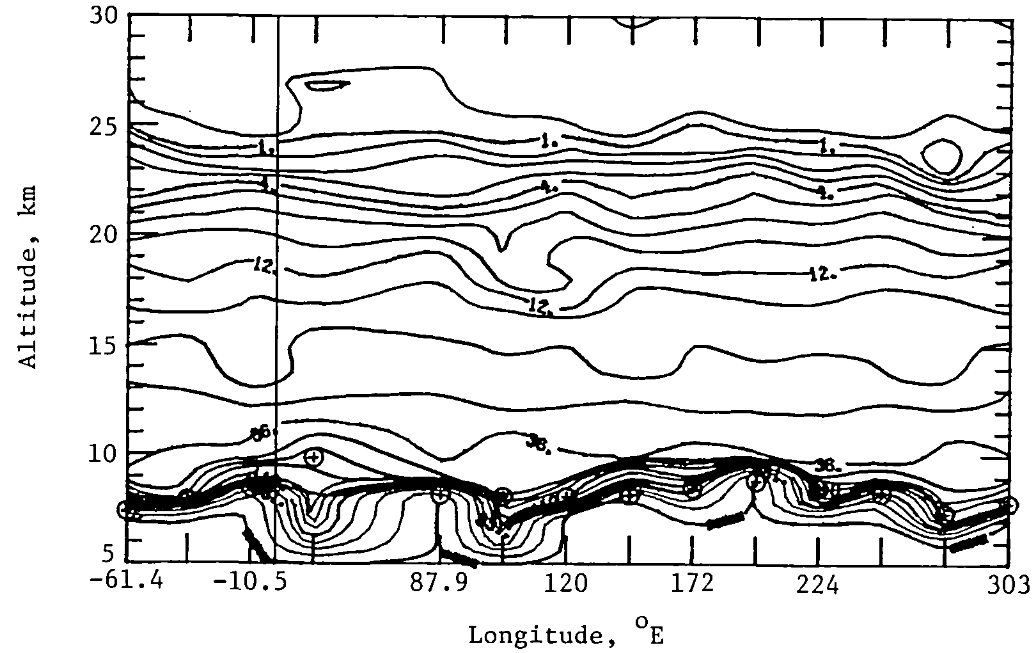
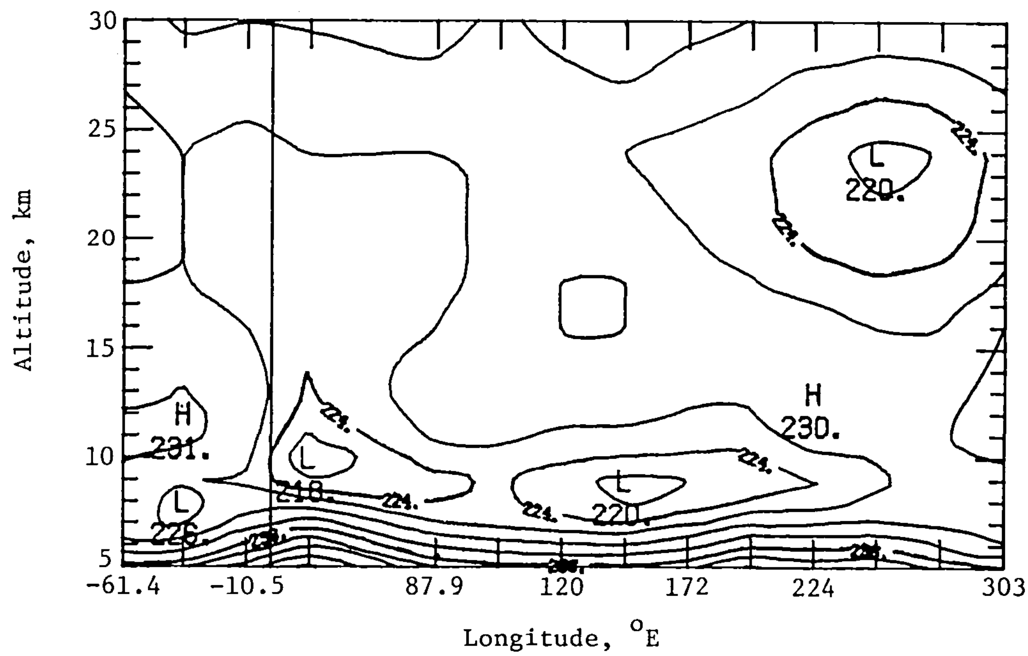


Figure 11.- Antarctic extinction and temperature profiles for October 12 to October 25, 1980.

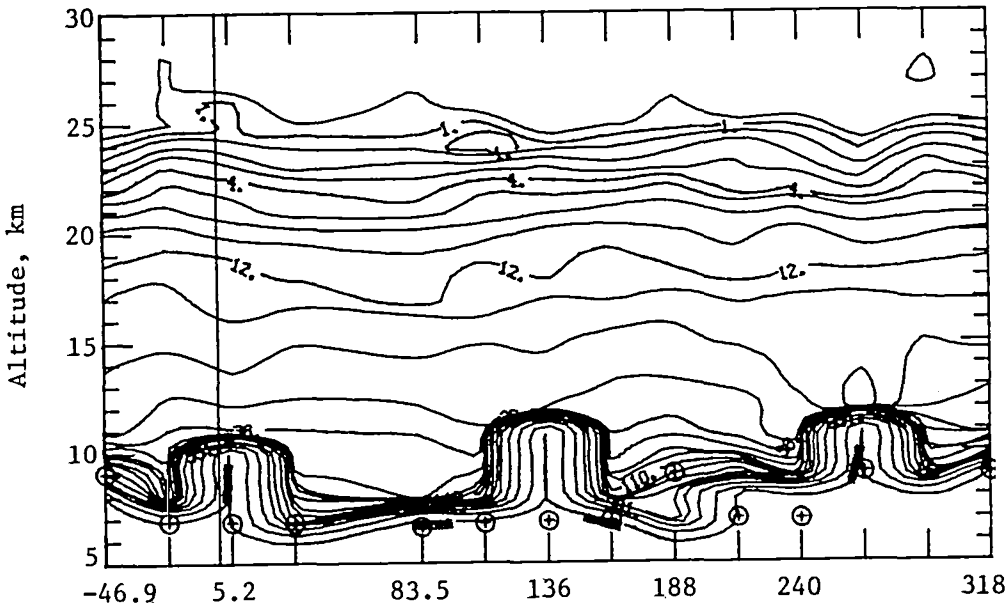


(a) Extinction isopleth.

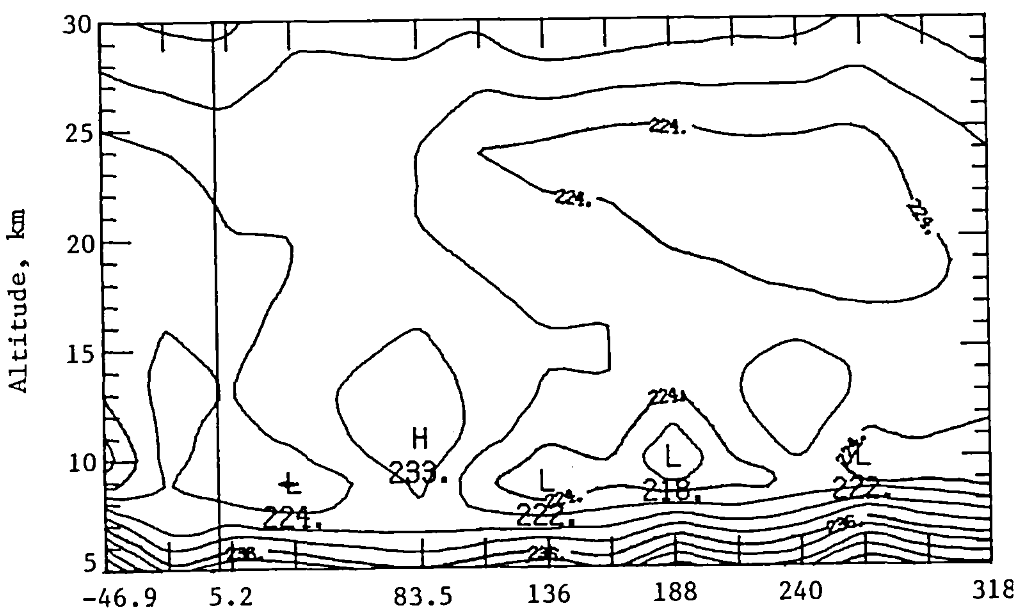


(b) Temperature contours.

Figure 12.- Arctic extinction isopleth and temperature contours for April 28.23 to 29.24, 1980, at latitudes from 74.2° to 73.8° N corresponding to orbits 7628 to 7642.

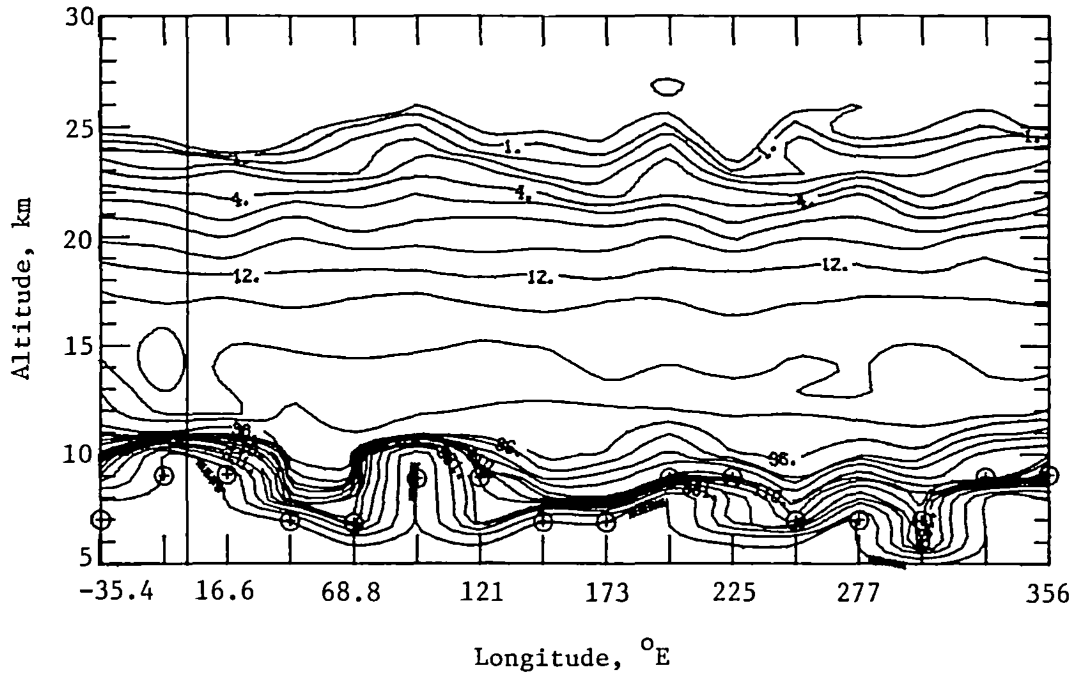


(a) Extinction isopleth.

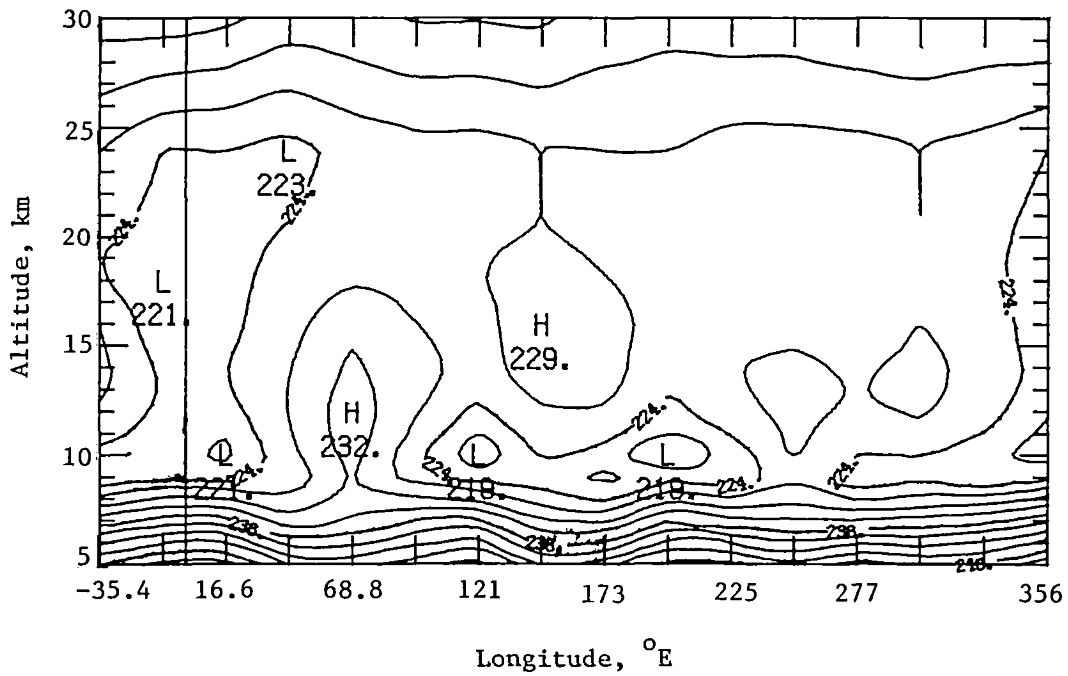


(b) Temperature contours.

Figure 13.- Arctic extinction isopleth and temperature contours for May 5.17 to 6.19, 1980, at latitudes from 72.4° to 72.1° N corresponding to orbits 7724 to 7738.

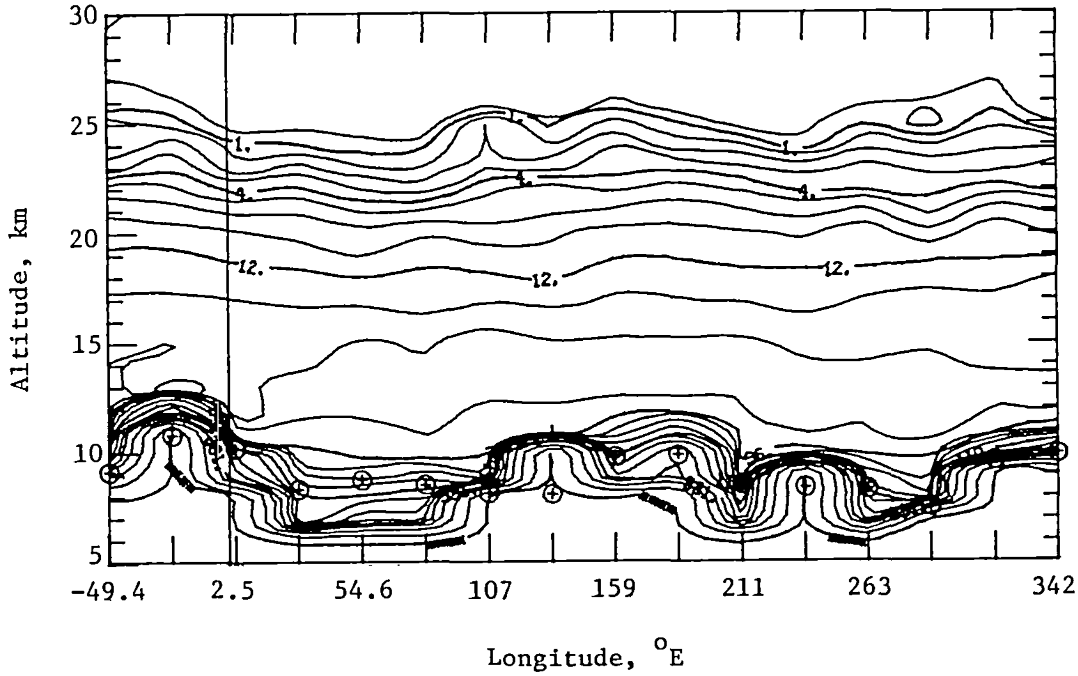


(a) Extinction isopleth.

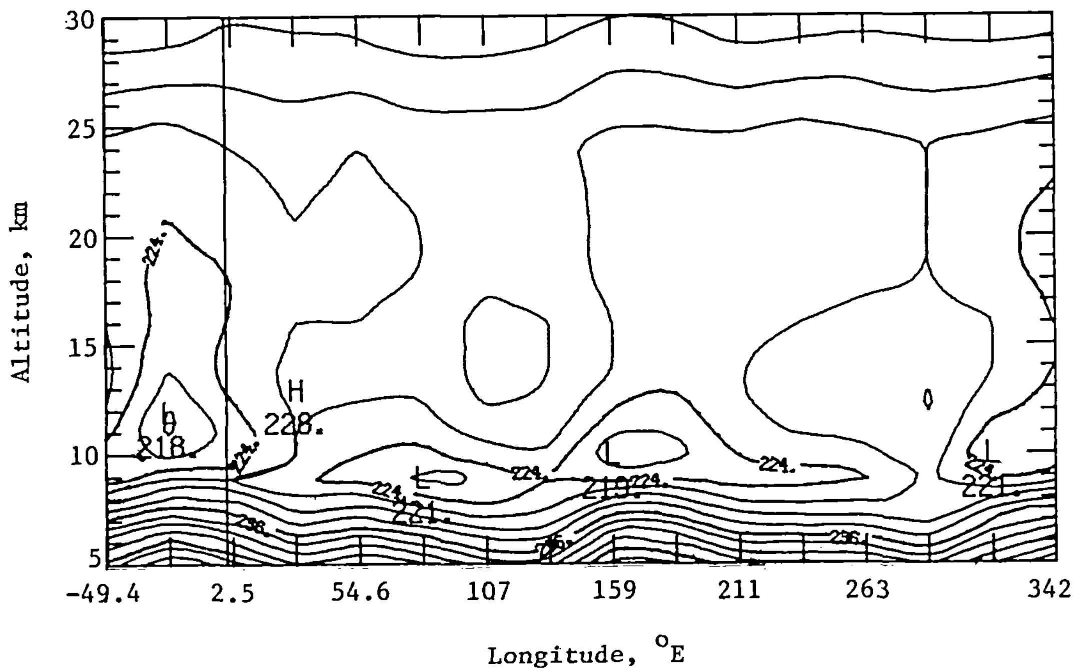


(b) Temperature contours.

Figure 14.- Arctic extinction isopleth and temperature contours for May 13.06 to 14.15, 1980, at latitudes from 70.5° to 70.2° N corresponding to orbits 7833 to 7848.

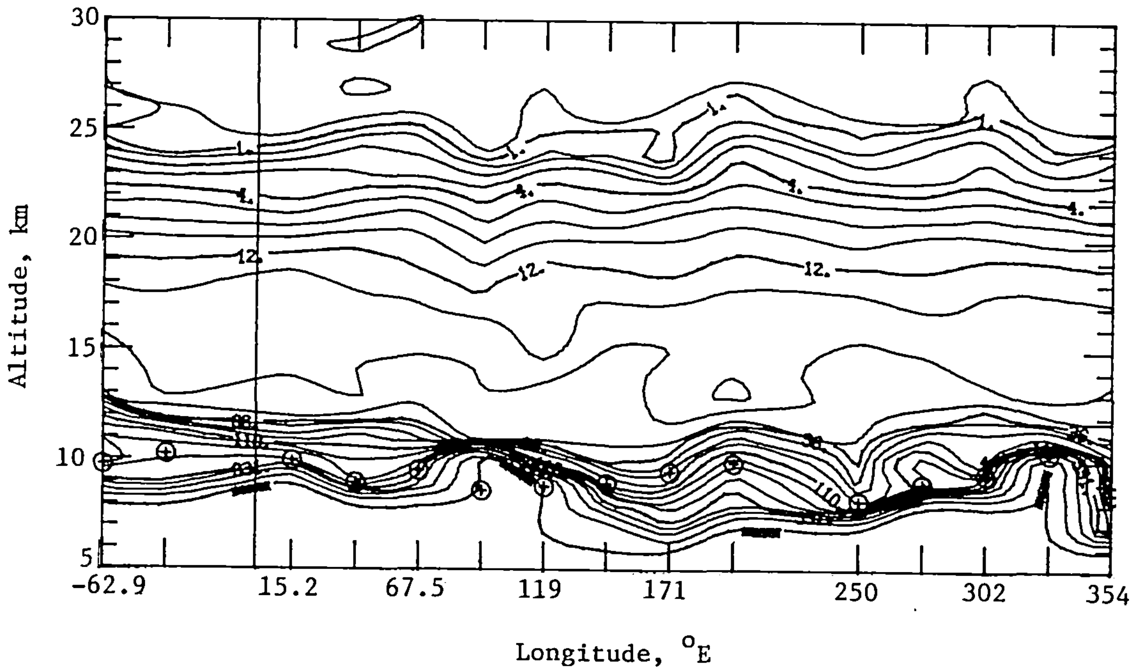


(a) Extinction isopleth.

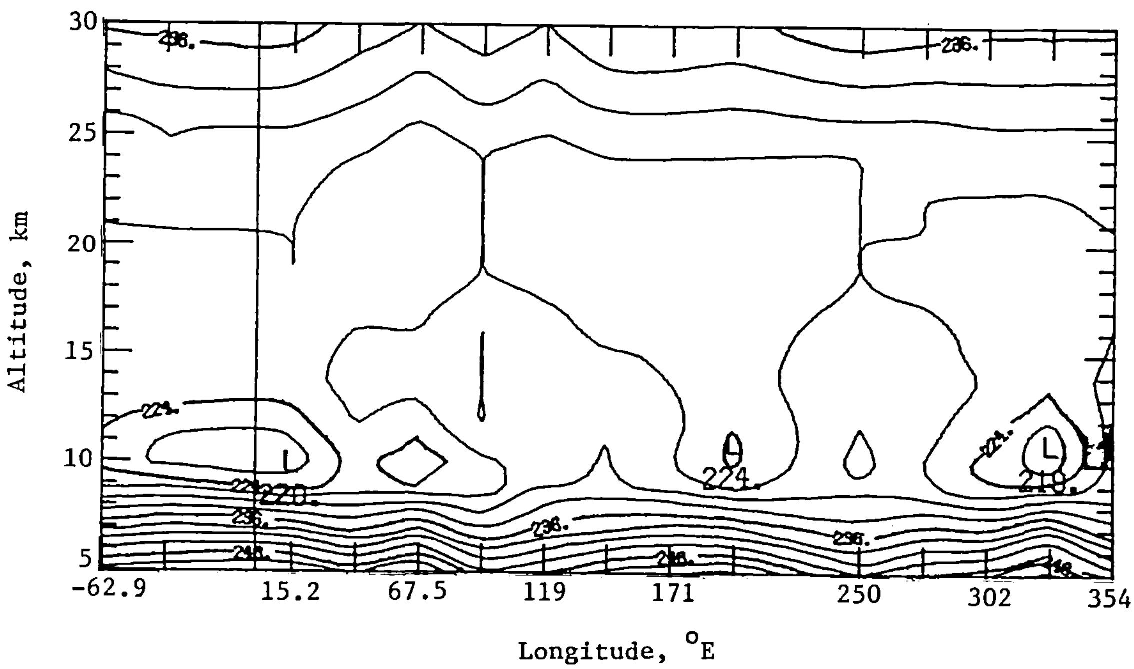


(b) Temperature contours.

Figure 15.- Arctic extinction isopleth and temperature contours for May 21.10 to 22.18, 1980, at latitudes from 68.9° to 68.7° N corresponding to orbits 7944 to 7959.

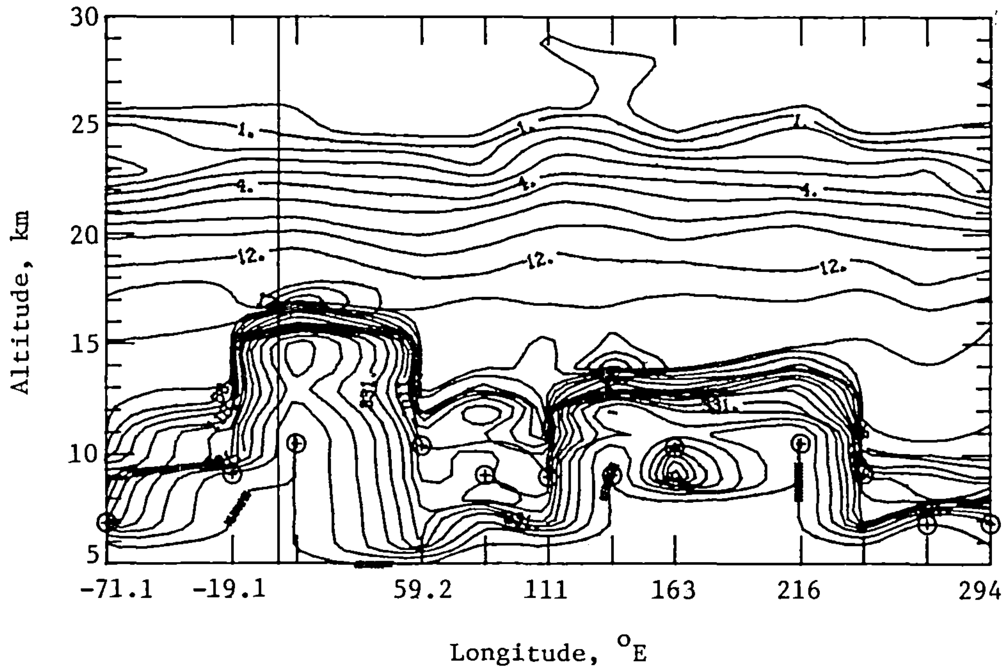


(a) Extinction isopleth.

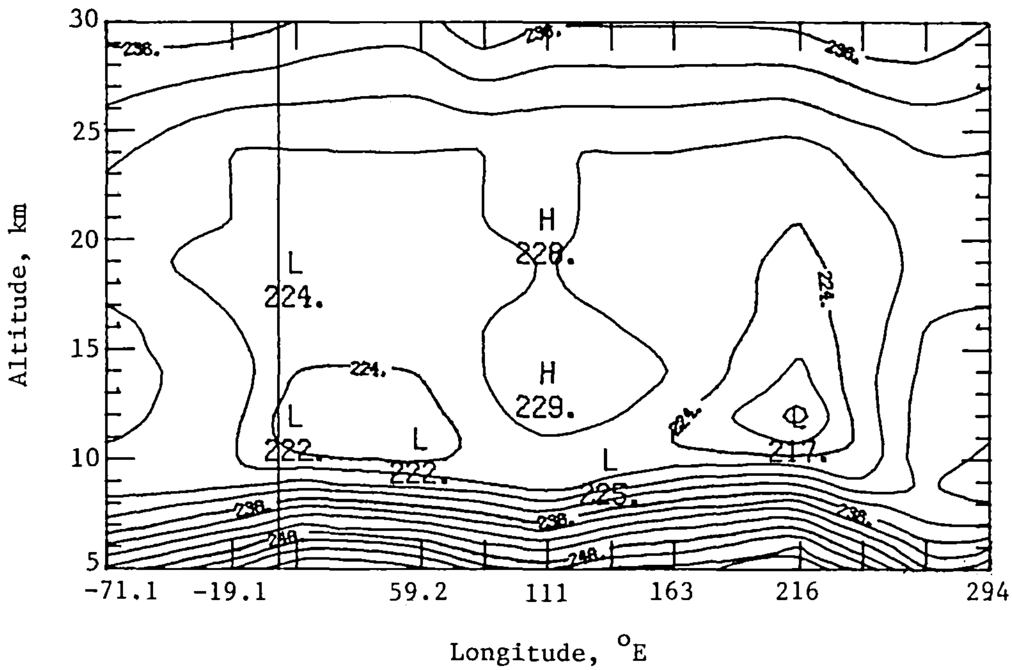


(b) Temperature contours.

Figure 16.- Arctic extinction isopleth and temperature contours for May 29.06 to 30.21, 1980, at latitudes from 67.6° to 67.4° N corresponding to orbits 8054 to 8070.

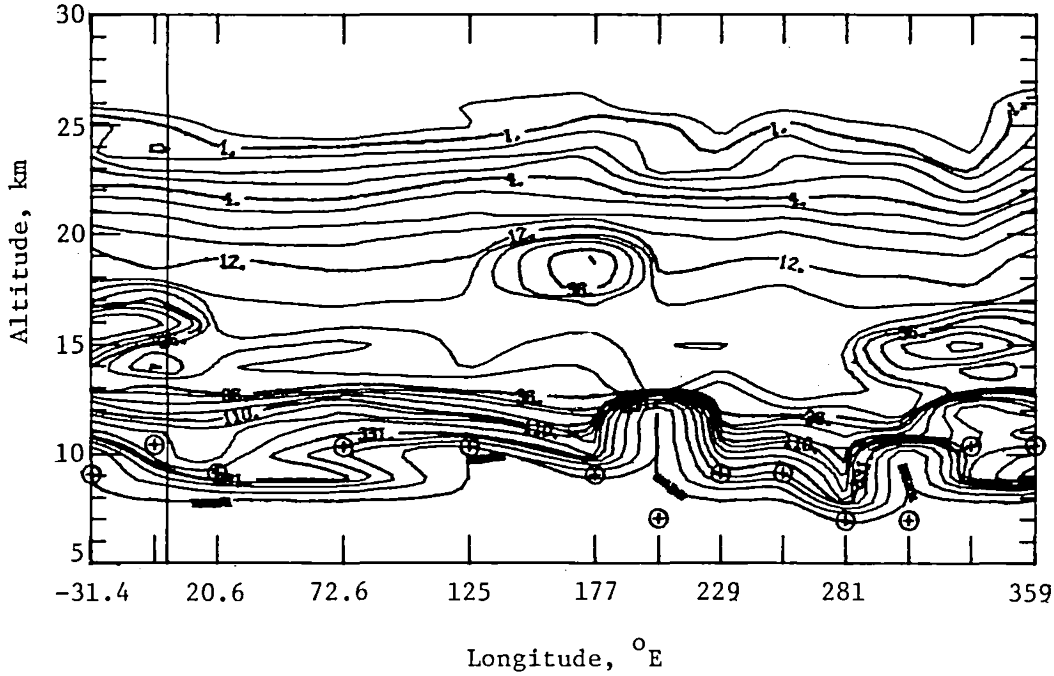


(a) Extinction isopleth.

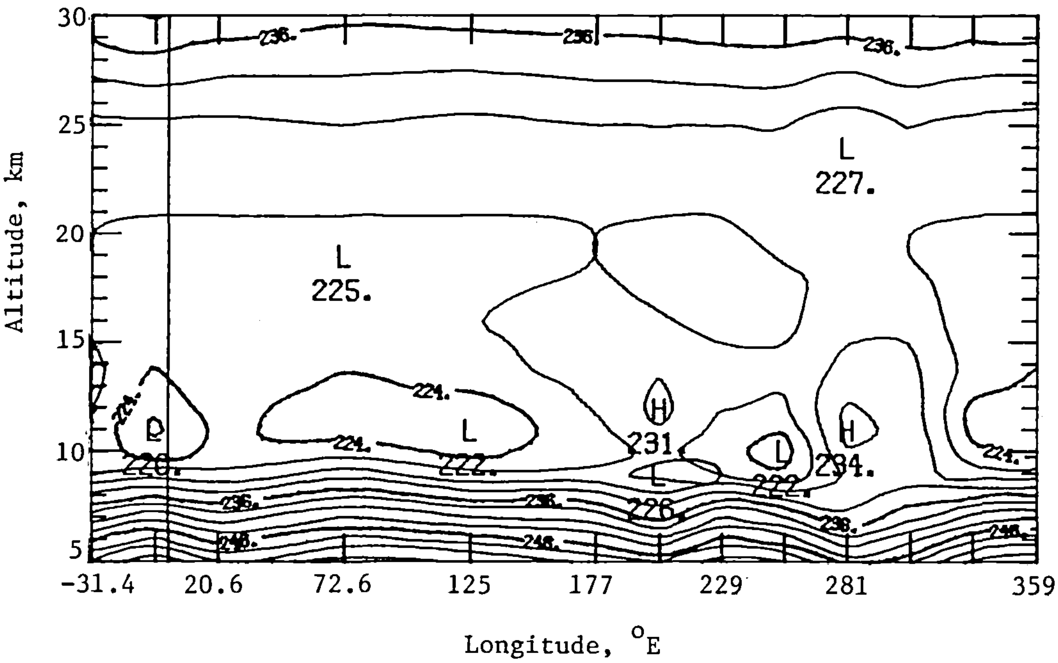


(b) Temperature contours.

Figure 17.- Arctic extinction isopleth and temperature contours for June 5.22 to 6.23, 1980, at latitudes from 66.8° to 66.7° N corresponding to orbits 8153 to 8167.

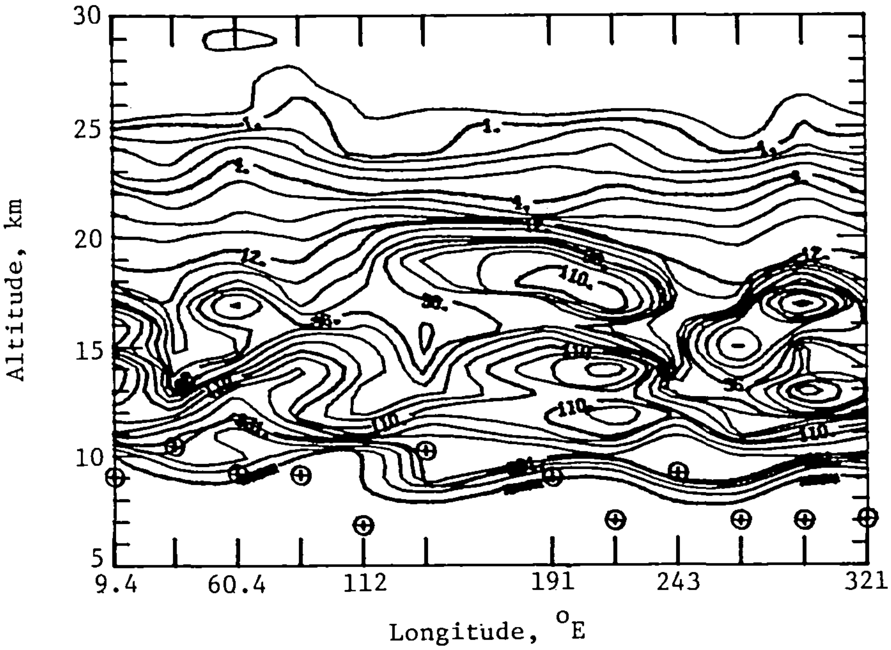


(a) Extinction isopleth.

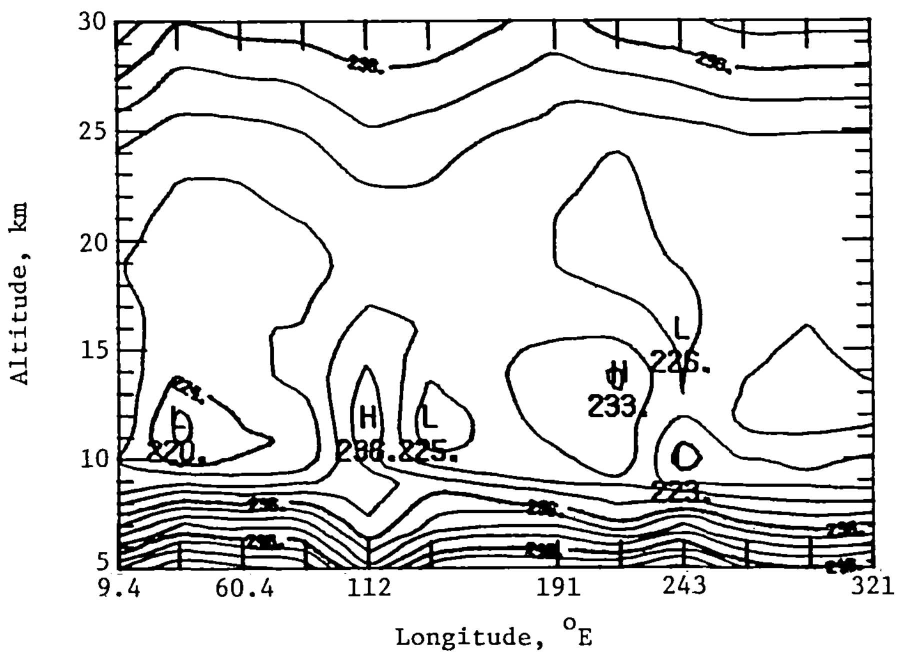


(b) Temperature contours.

Figure 18.- Arctic extinction isopleth and temperature contours for June 13.04 to 14.12, 1980, at a latitude of 66.2° N corresponding to orbits 8261 to 8276.

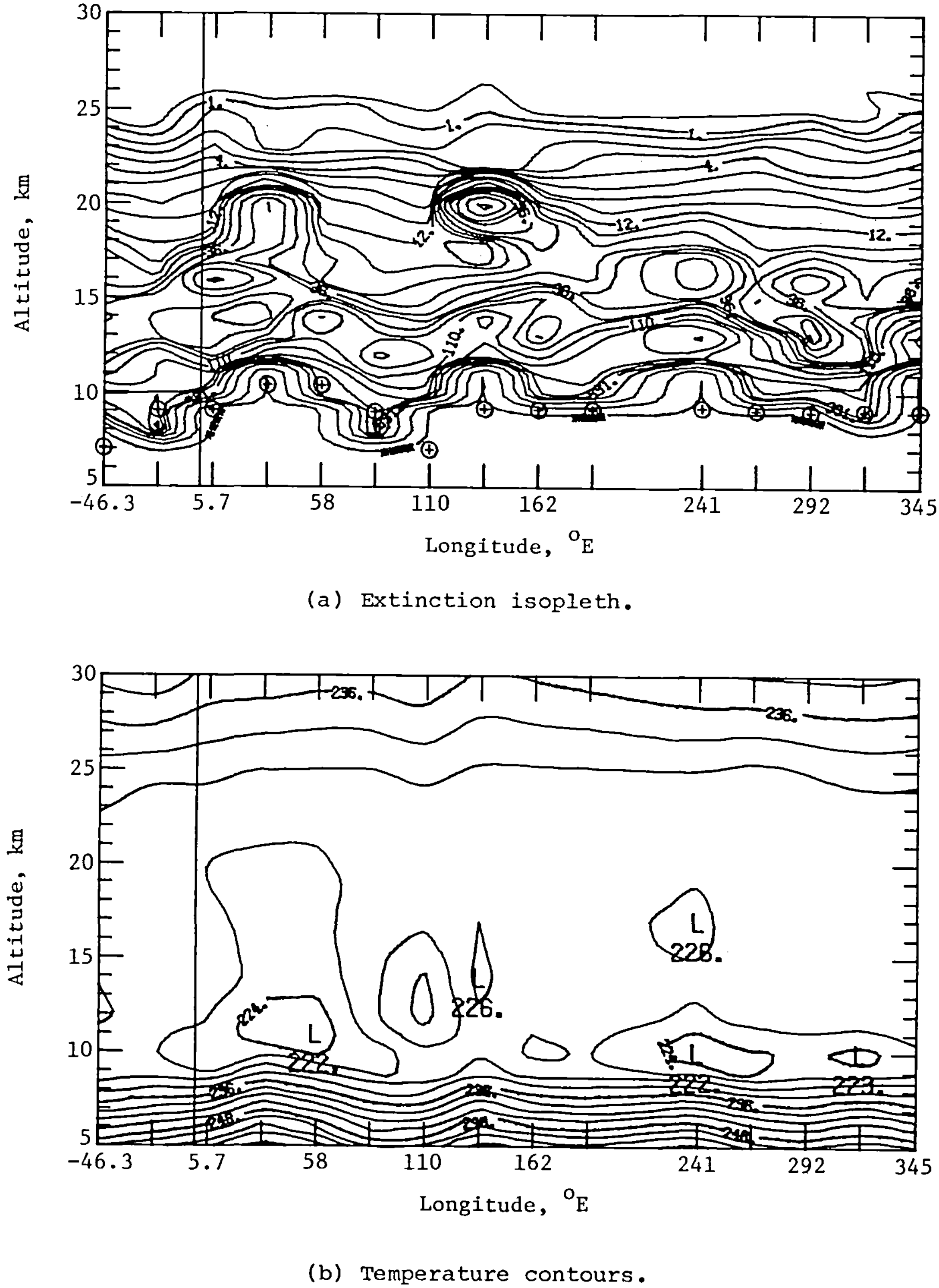


(a) Extinction isopleth.



(b) Temperature contours.

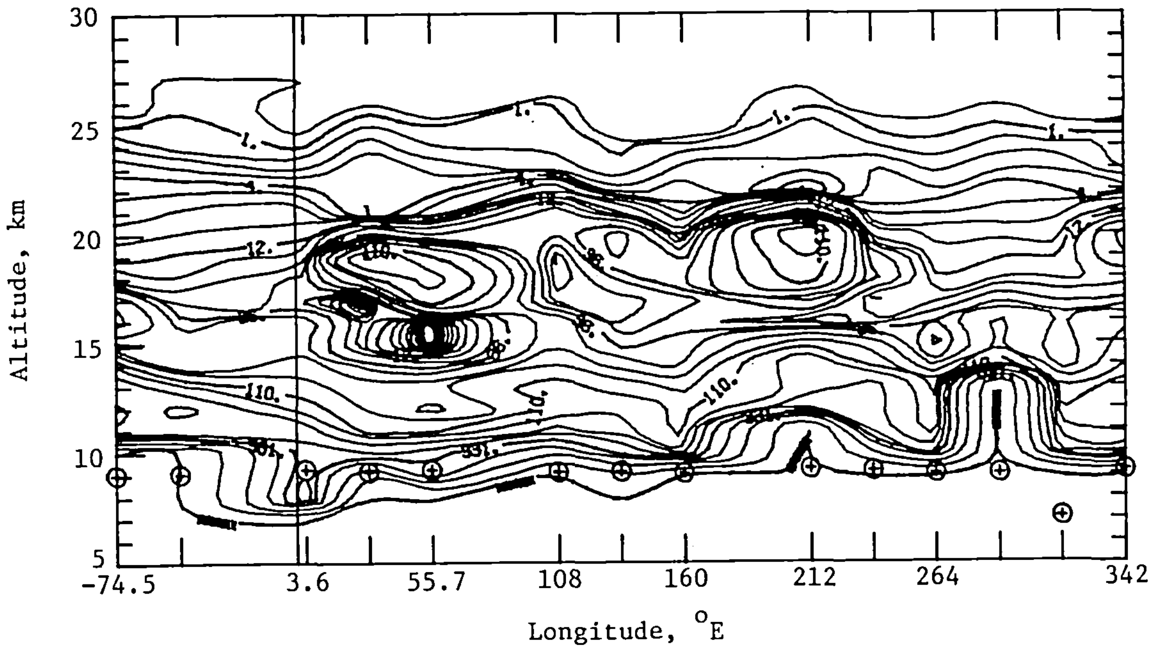
Figure 19.- Arctic extinction isopleth and temperature contours for June 21.14 to 22.01, 1980, at latitudes from 66.1° to 66.0° N corresponding to orbits 8373 to 8385.



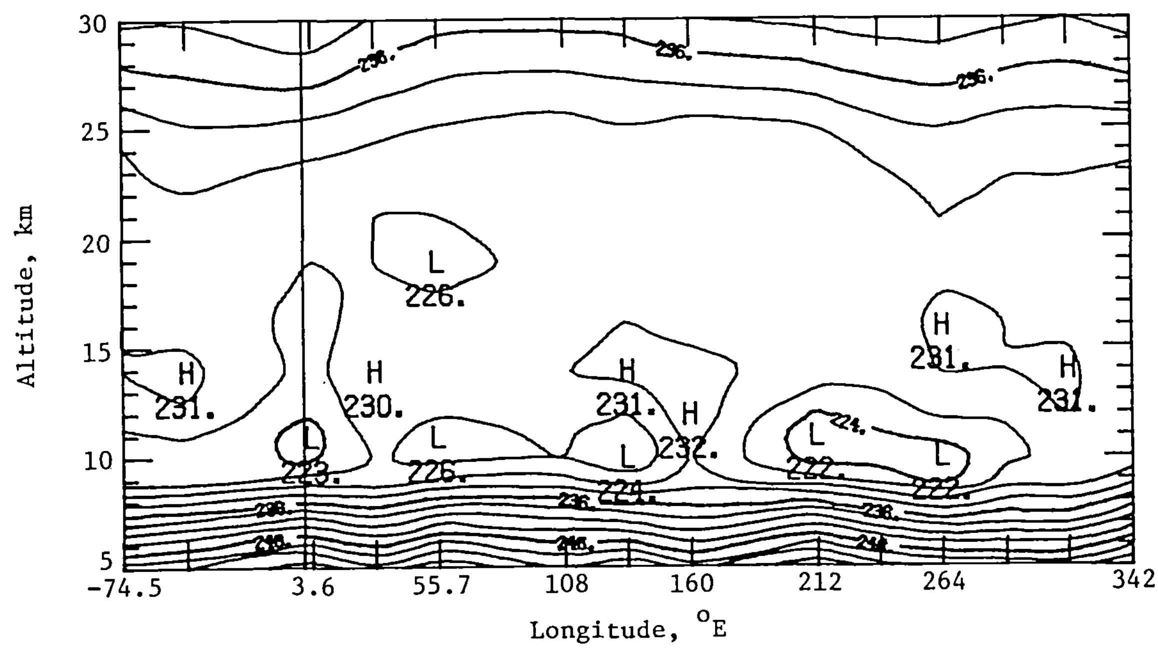
(a) Extinction isopleth.

(b) Temperature contours.

Figure 20.- Arctic extinction isopleth and temperature contours for June 27.07 to 28.16, 1980, at latitudes from 66.2° to 66.3° N corresponding to orbits 8455 to 8470.

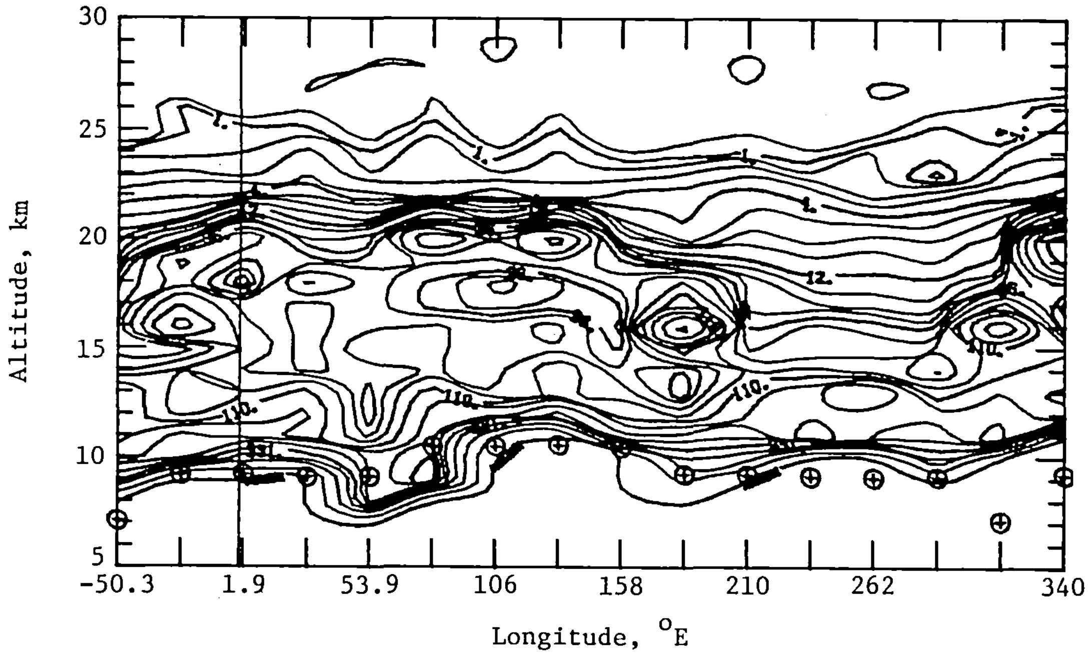


(a) Extinction isopleth.

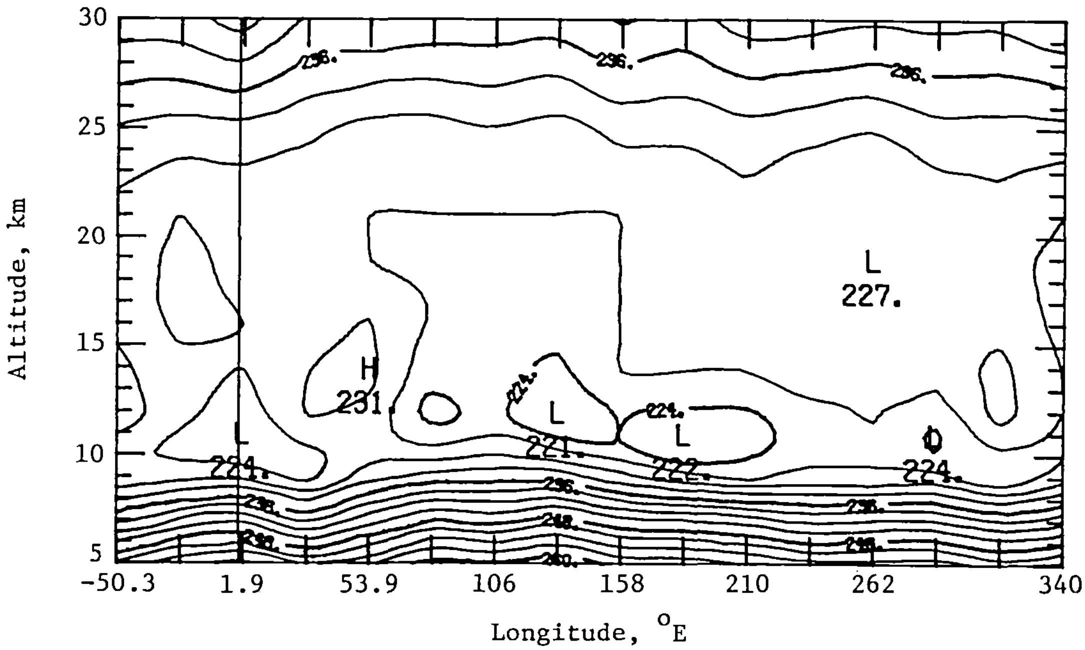


(b) Temperature contours.

Figure 21.- Arctic extinction isopleth and temperature contours for July 3.08 to 4.24, 1980, at latitudes from 66.6° to 66.7° N corresponding to orbits 8538 to 8554.

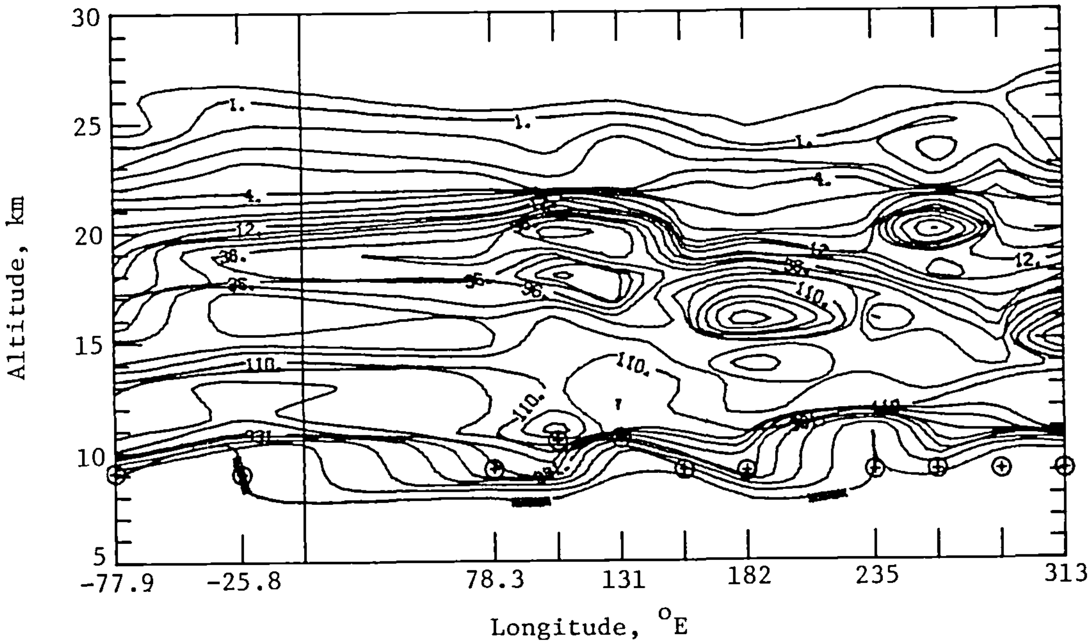


(a) Extinction isopleth.

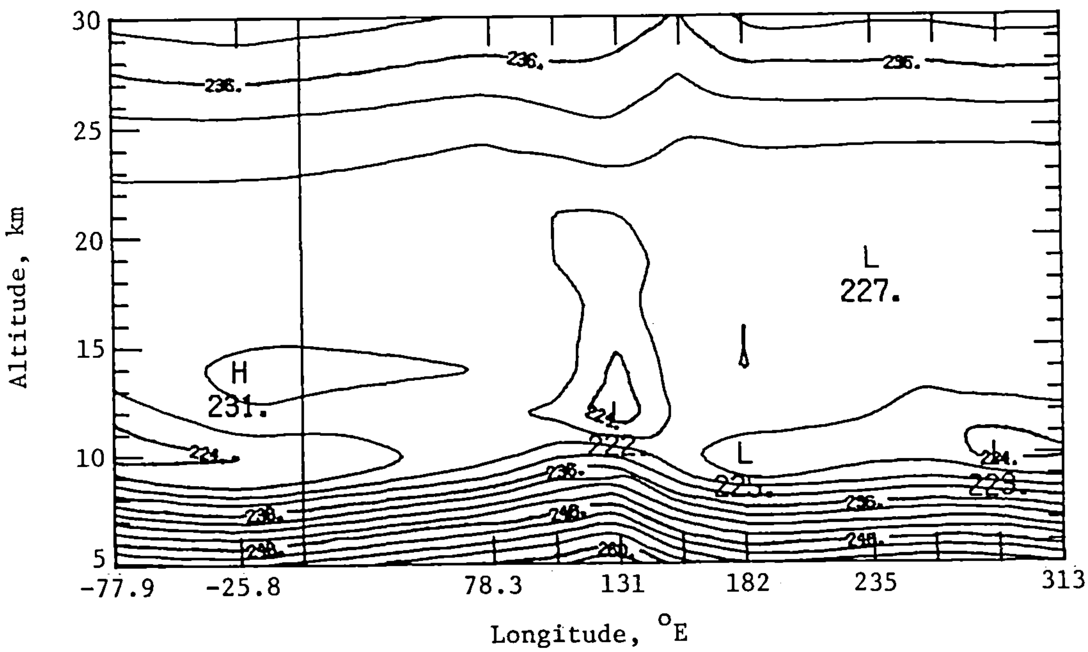


(b) Temperature contours.

Figure 22.- Arctic extinction isopleth and temperature contours for July 9.09 to 10.17, 1980, at latitudes from 67.2° to 67.3° N corresponding to orbits 8621 to 8636.

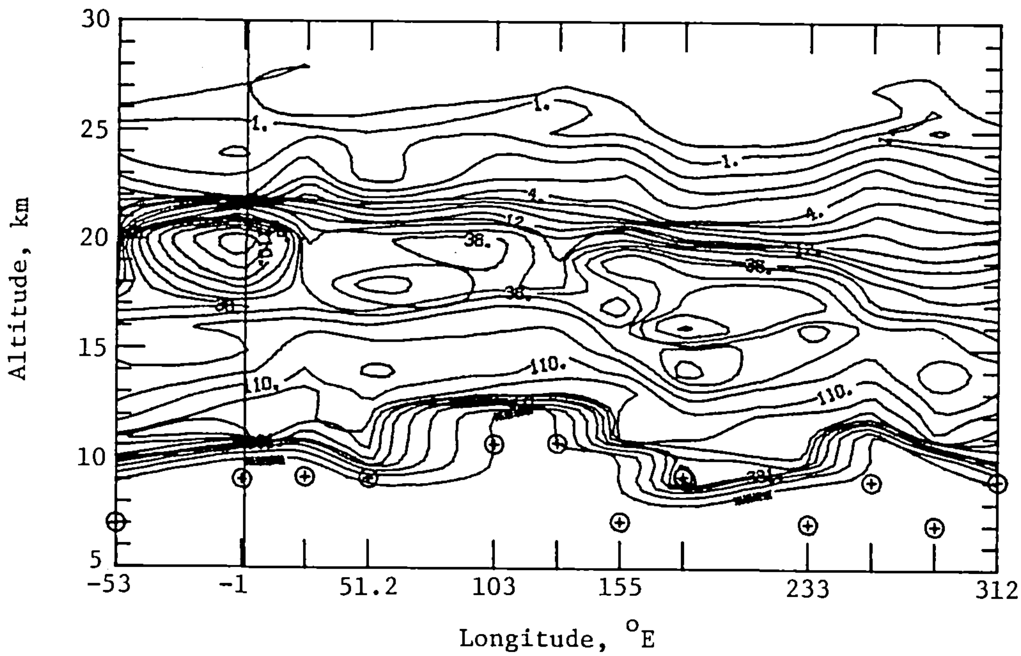


(a) Extinction isopleth.

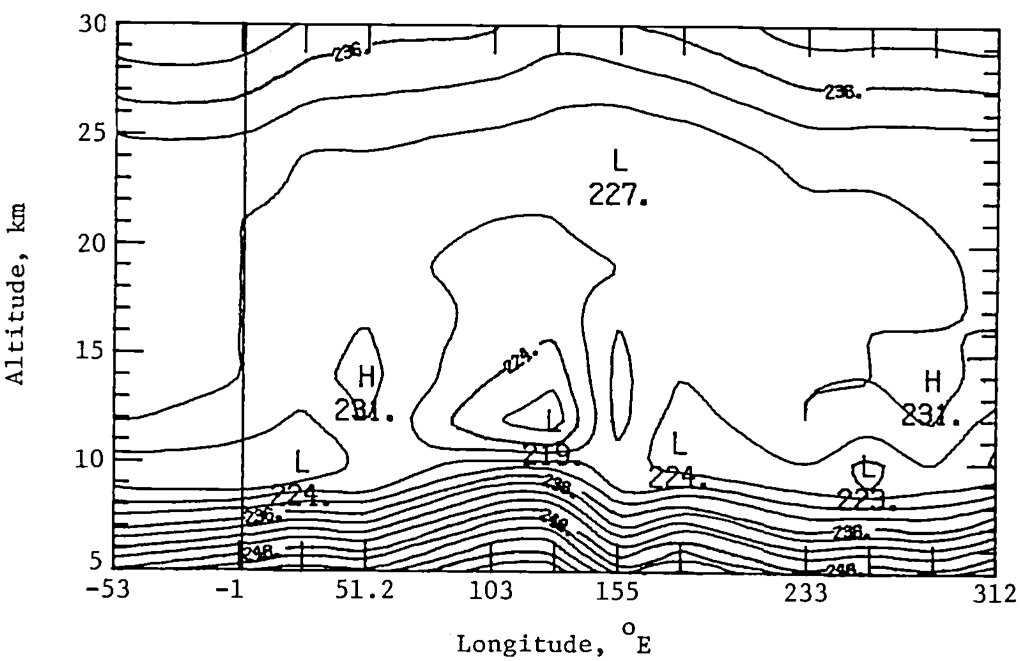


(b) Temperature contours.

Figure 23.- Arctic extinction isopleth and temperature contours for July 15.16 to 16.25, 1980, at latitudes from 68.0° to 68.2° N corresponding to orbits 8705 to 8720.

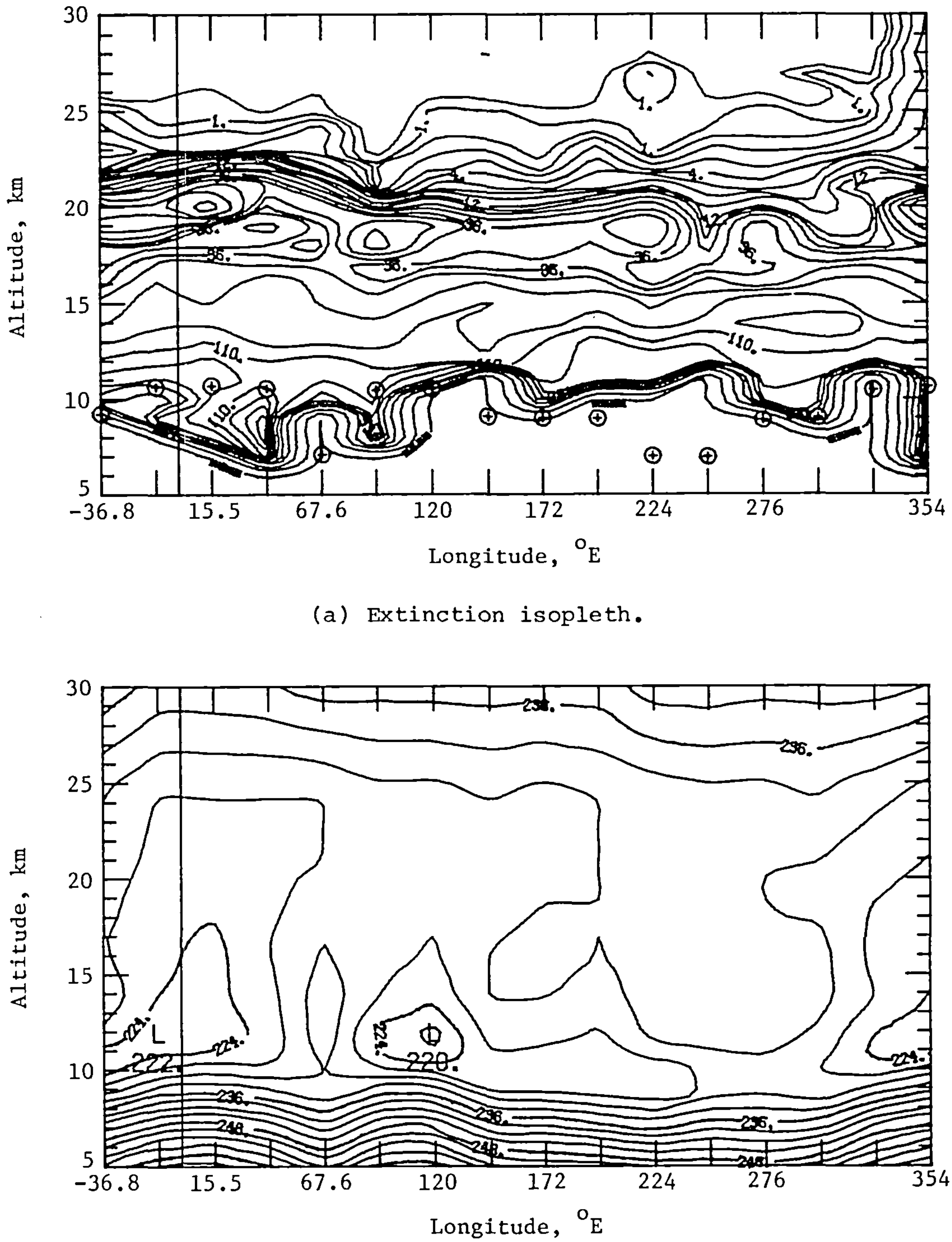


(a) Extinction isopleth.



(b) Temperature contours.

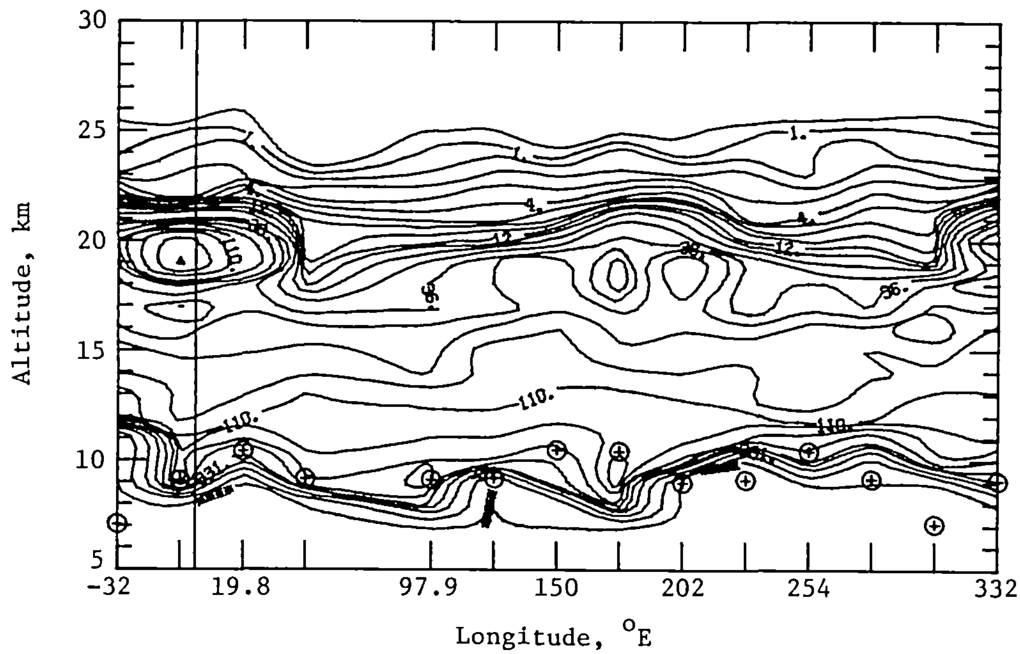
Figure 24.- Arctic extinction isopleth and temperature contours for July 21.17 to 22.18, 1980, at latitudes from 69.1° to 69.3° N corresponding to orbits 8788 to 8802.



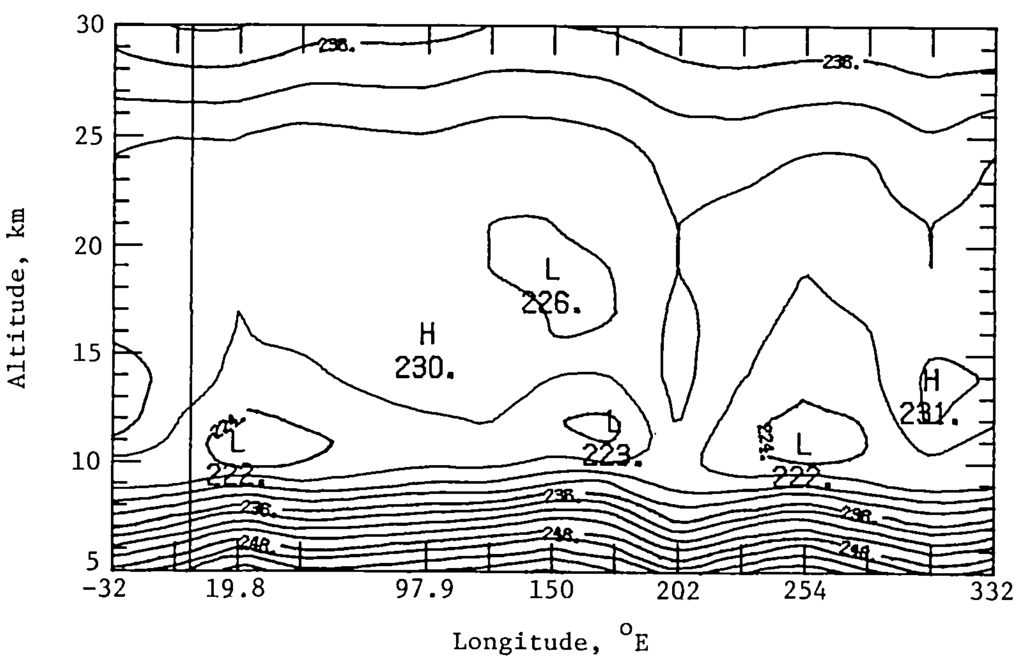
(a) Extinction isopleth.

(b) Temperature contours.

Figure 25.- Arctic extinction isopleth and temperature contours for July 29.06 to 30.14, 1980, at latitudes from 70.7° to 70.9° N corresponding to orbits 8897 to 8912.

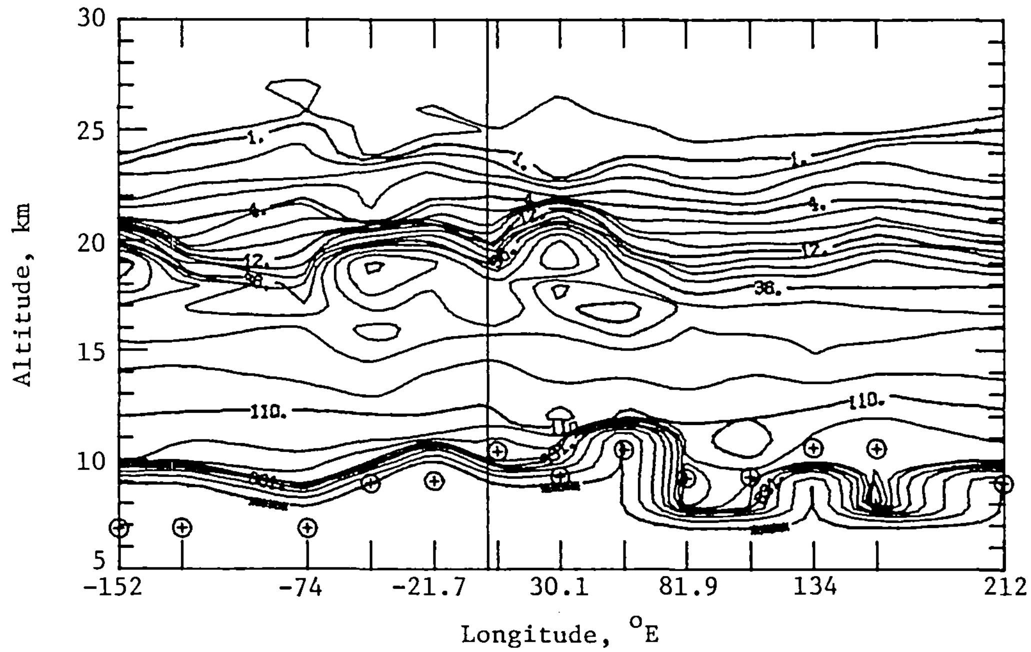


(a) Extinction isopleth.

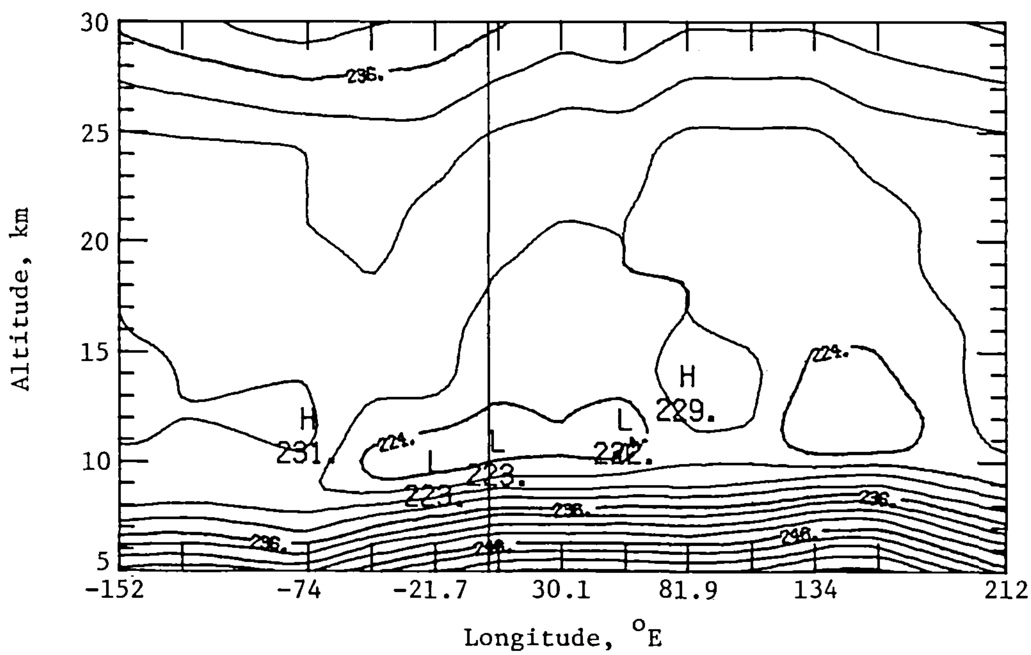


(b) Temperature contours.

Figure 26.- Arctic extinction isopleth and temperature contours for August 3.12 to 4.14, 1980, at latitudes from 71.8° to 72.0° N corresponding to orbits 8967 to 8981.

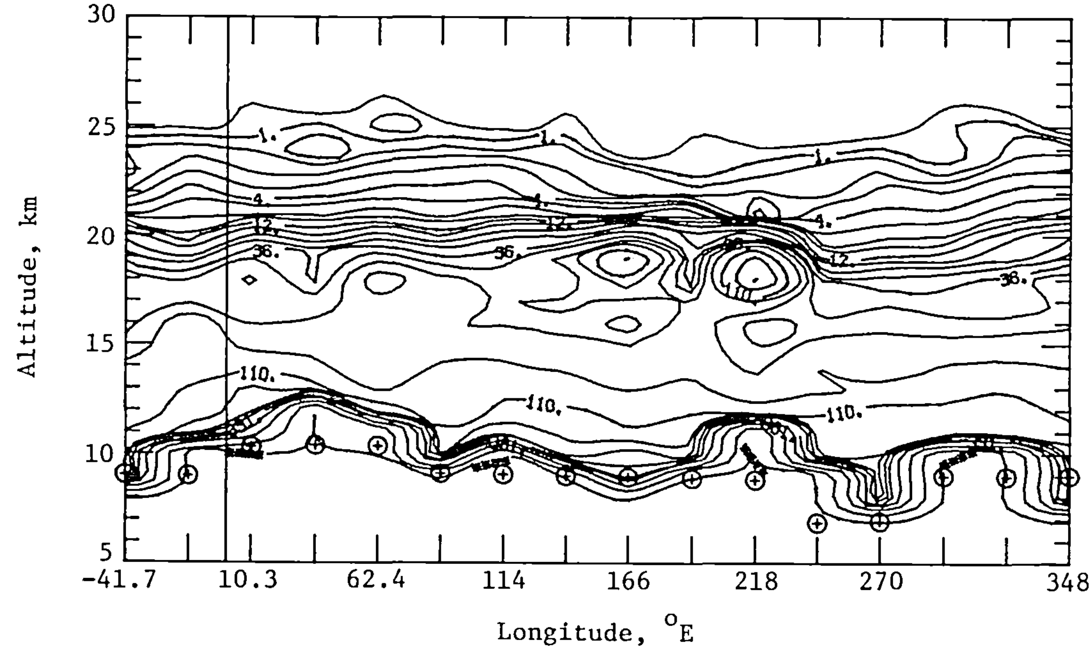


(a) Extinction isopleth.

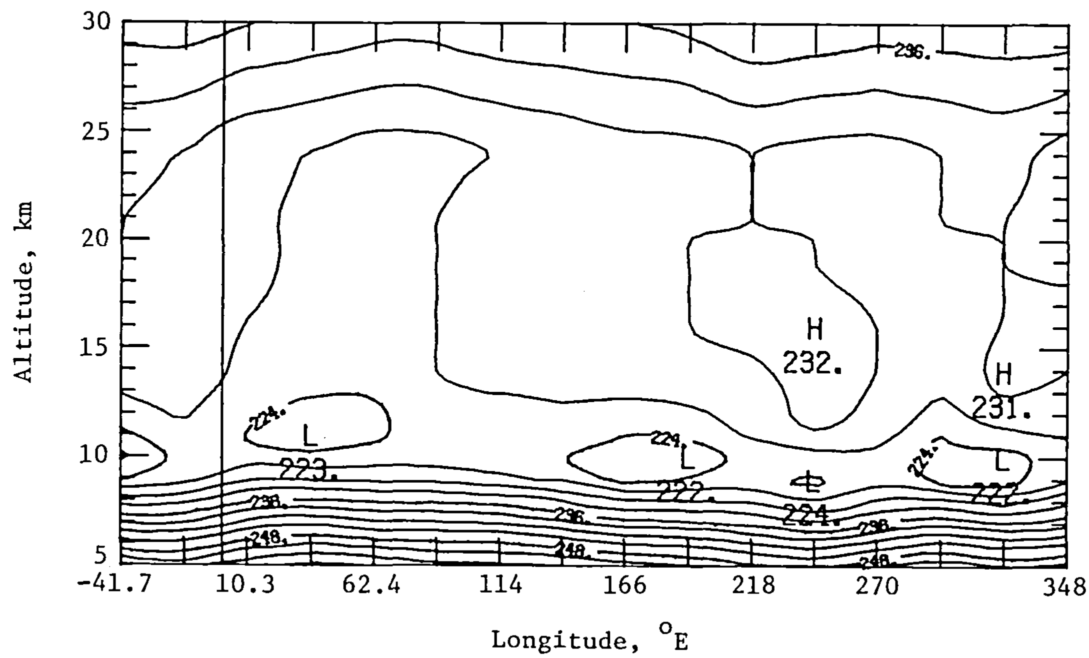


(b) Temperature contours.

Figure 27.- Arctic extinction isopleth and temperature contours for August 13.47 to 14.48, 1980, at latitudes from 74.4° to 74.7° N corresponding to orbits 9110 to 9124.

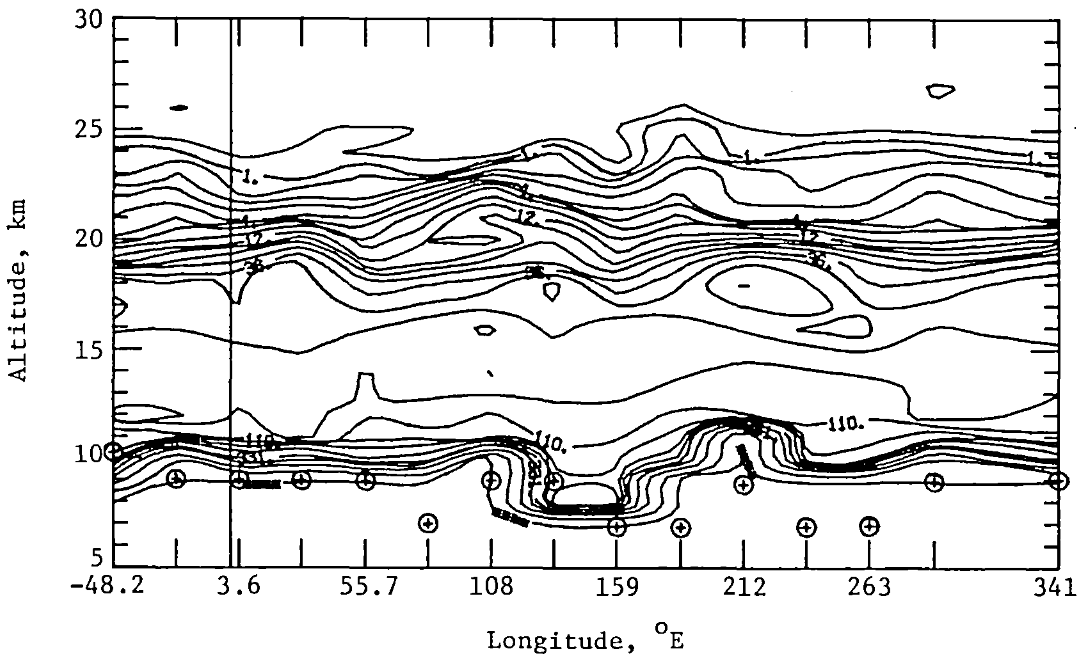


(a) Extinction isopleth.

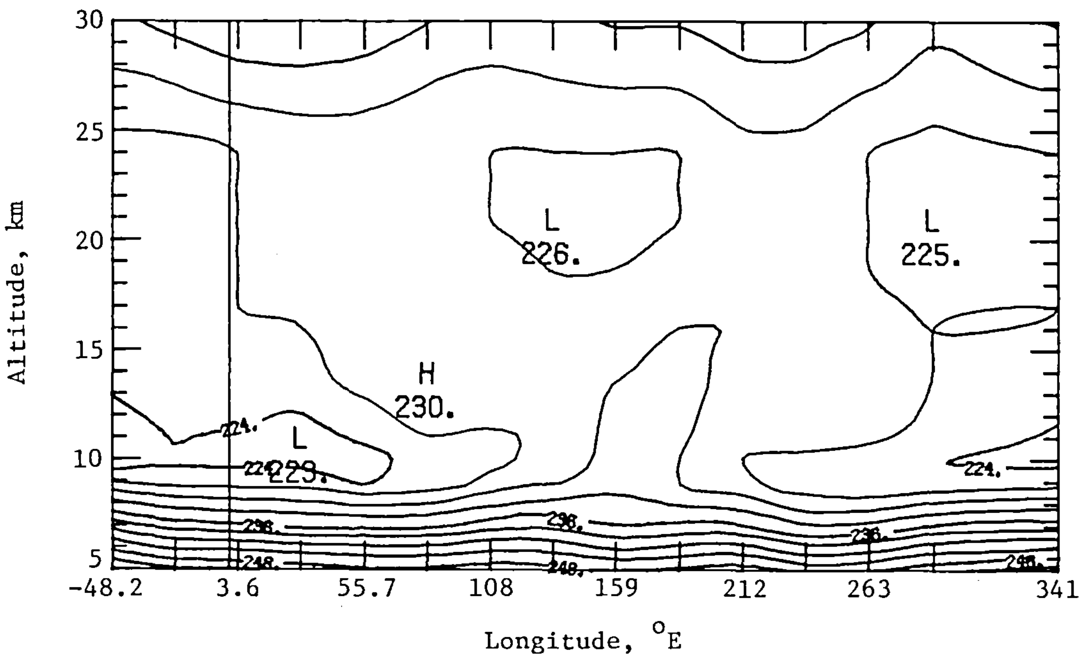


(b) Temperature contours.

Figure 28.- Arctic extinction isopleth and temperature contours for August 18.10 to 19.19, 1980, at latitudes from 75.6° to 75.9° N corresponding to orbits 9174 to 9189.

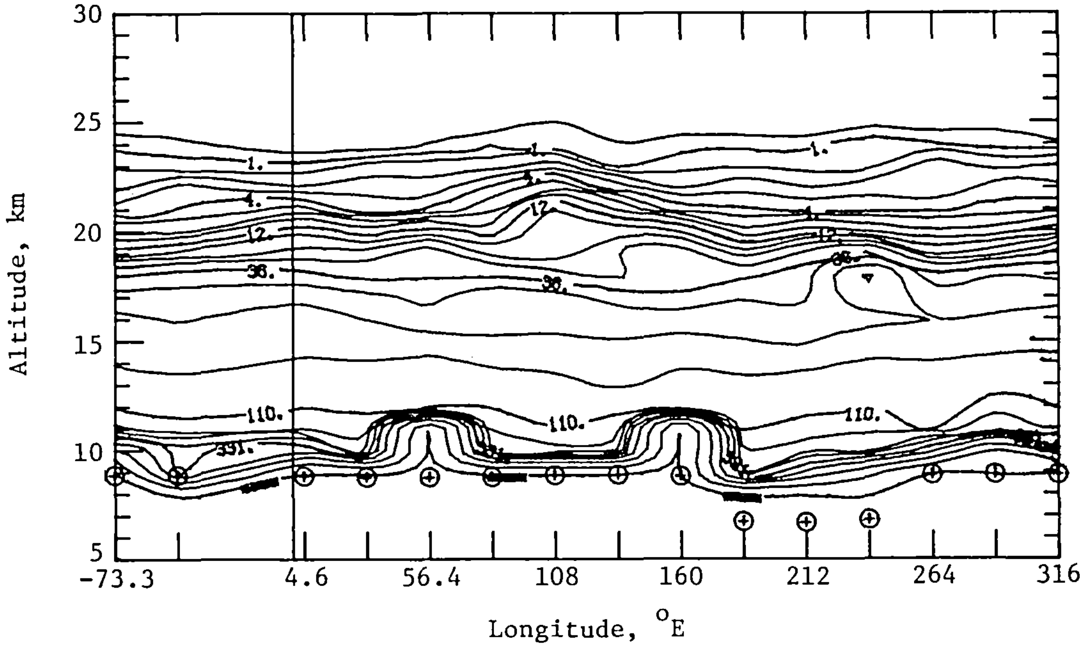


(a) Extinction isopleth.

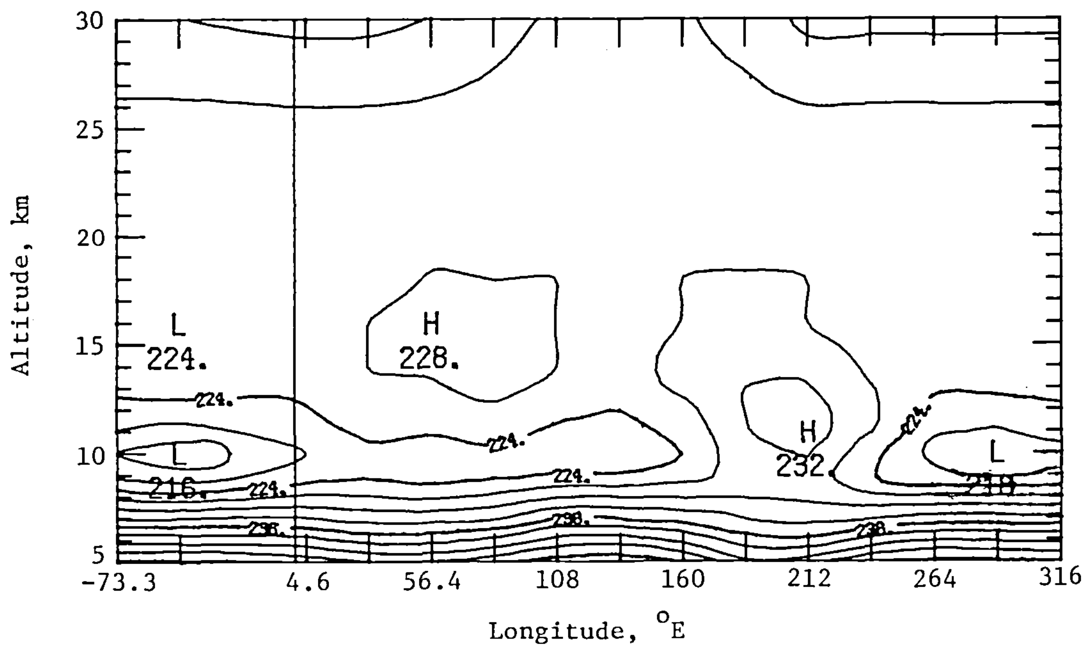


(b) Temperature contours.

Figure 29.- Arctic extinction isopleth and temperature contours for August 27.15 to 28.23, 1980, at latitudes from 77.9° to 78.1° N corresponding to orbits 9299 to 9314.

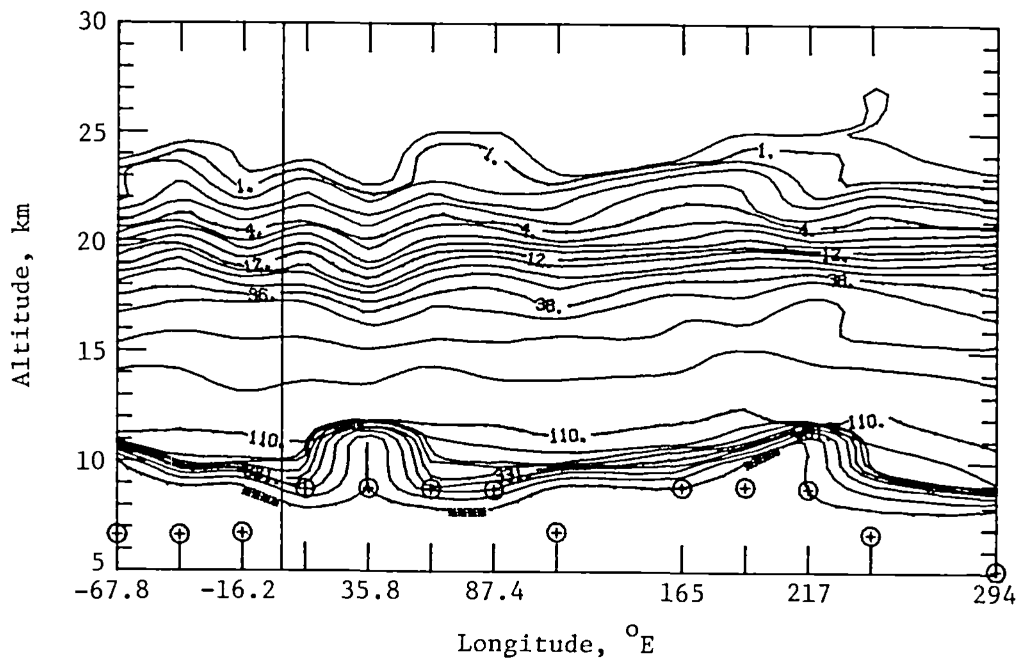


(a) Extinction isopleth.

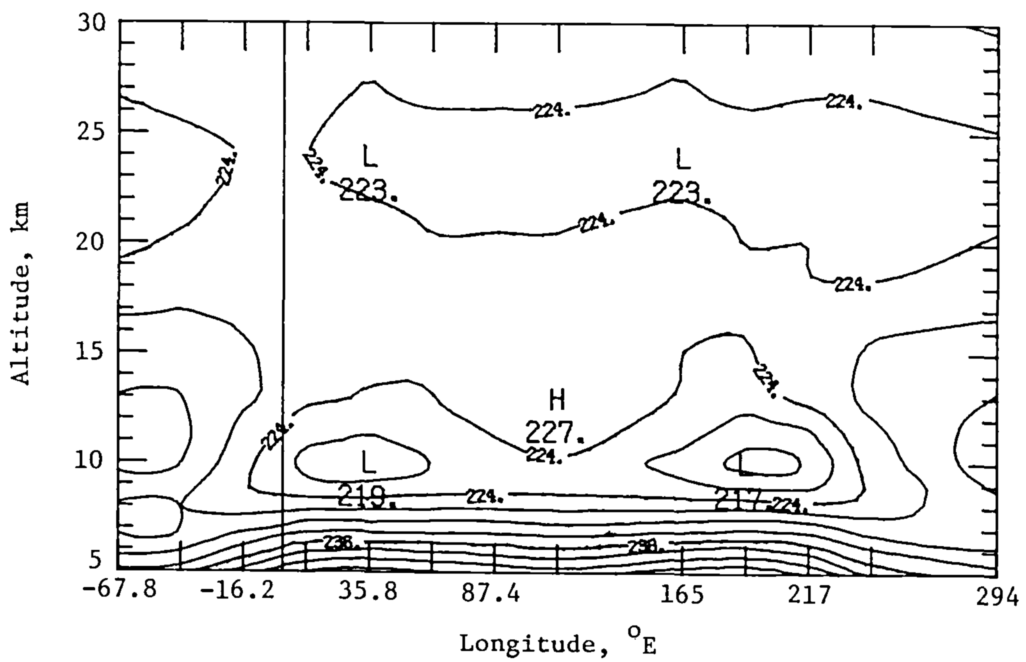


(b) Temperature contours.

Figure 30.- Arctic extinction isopleth and temperature contours for September 4.25 to 5.33, 1980, at latitudes from 79.6° to 79.8° N corresponding to orbits 9411 to 9426.

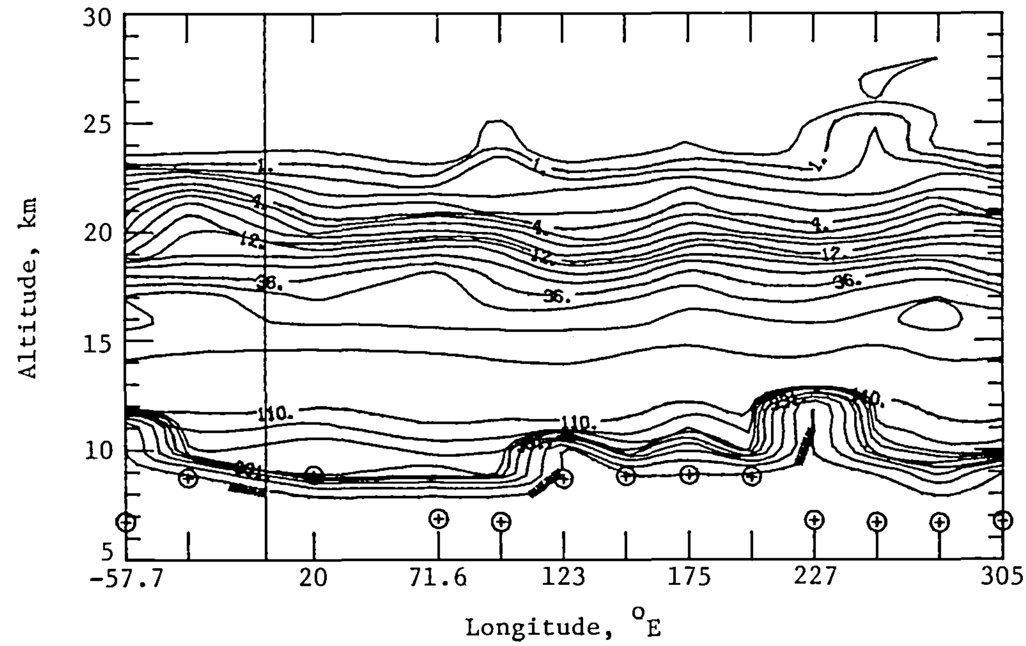


(a) Extinction isopleth.

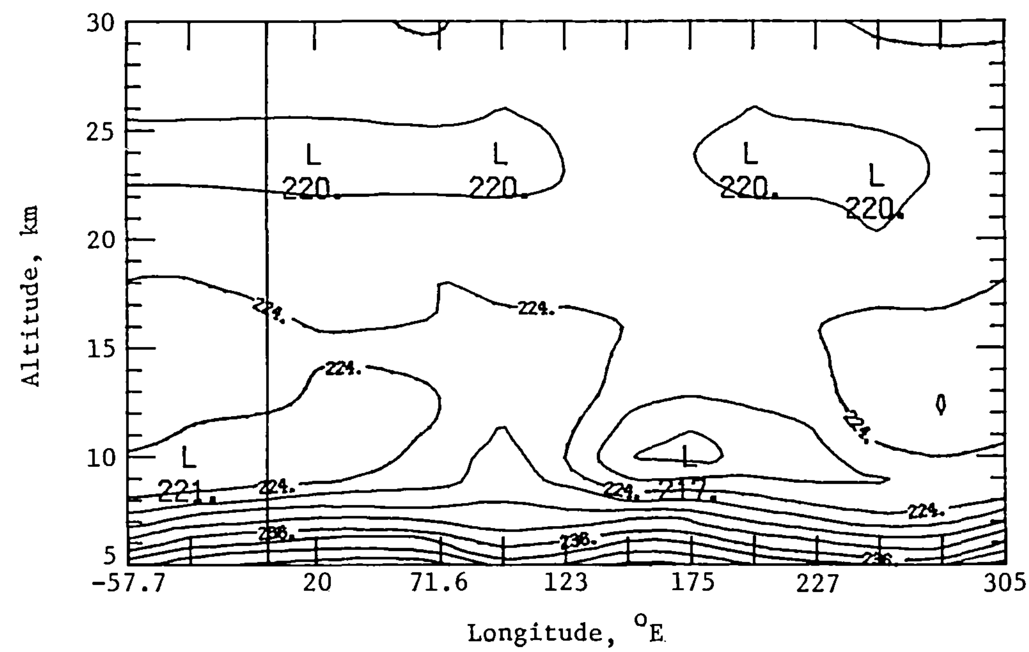


(b) Temperature contours.

Figure 31.- Arctic extinction isopleth and temperature contours for September 12.35 to 13.37, 1980, at latitudes from 80.8° to 80.9° N corresponding to orbits 9523 to 9537.

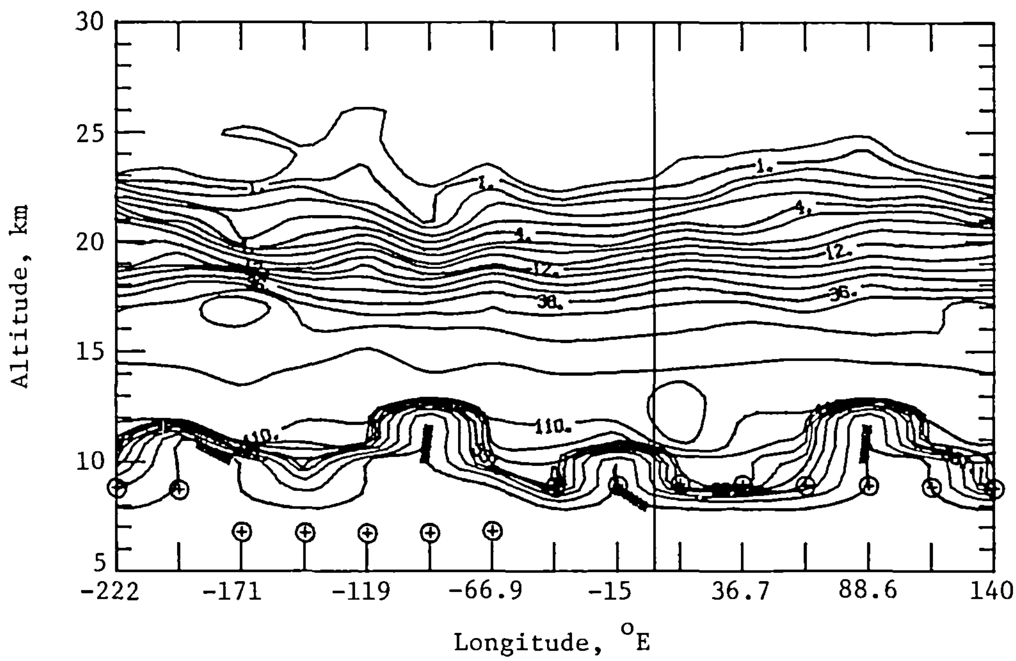


(a) Extinction isopleth.

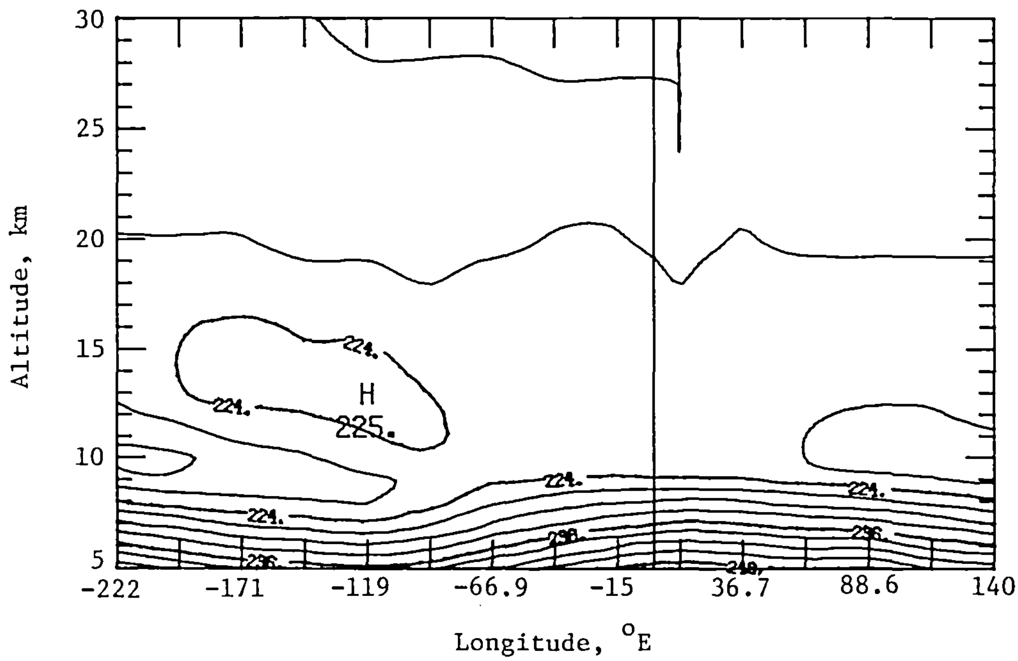


(b) Temperature contours.

Figure 32.- Arctic extinction isopleth and temperature contours for September 19.37 to 20.38, 1980, at a latitude of 81.1° N corresponding to orbits 9620 to 9634.

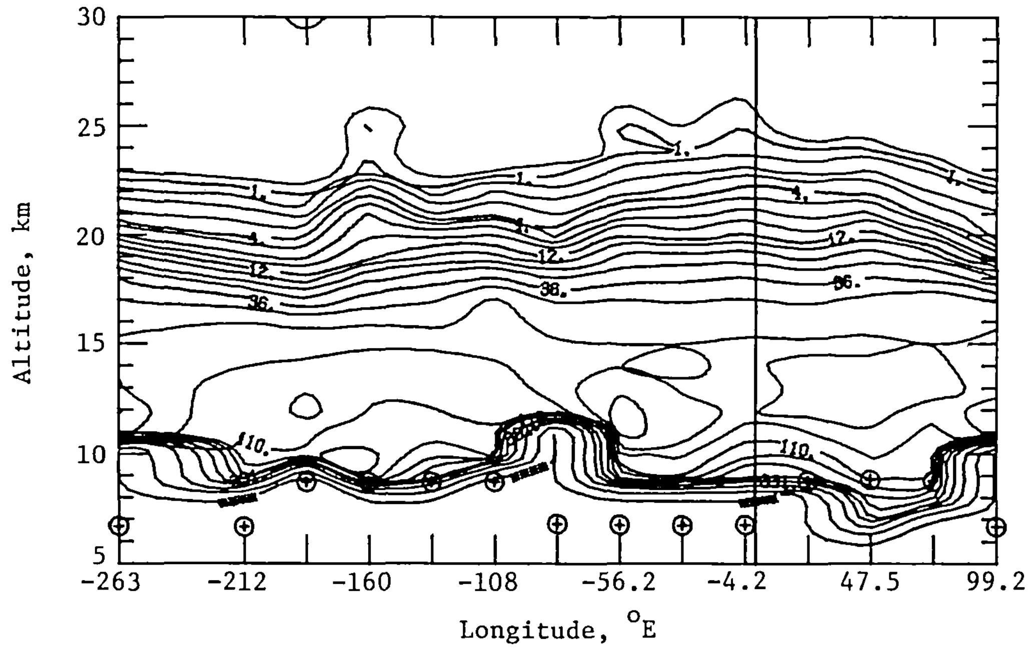


(a) Extinction isopleth.

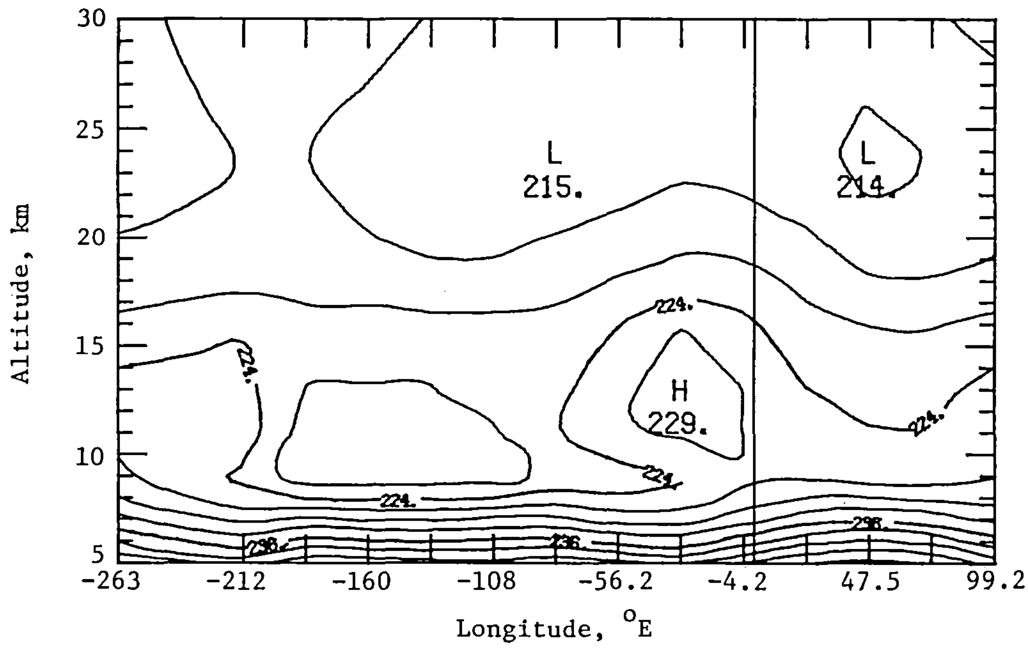


(b) Temperature contours.

Figure 33.- Arctic extinction isopleth and temperature contours for September 23.86 to 24.87, 1980, at latitudes from 80.9° to 80.8° N corresponding to orbits 9682 to 9696.

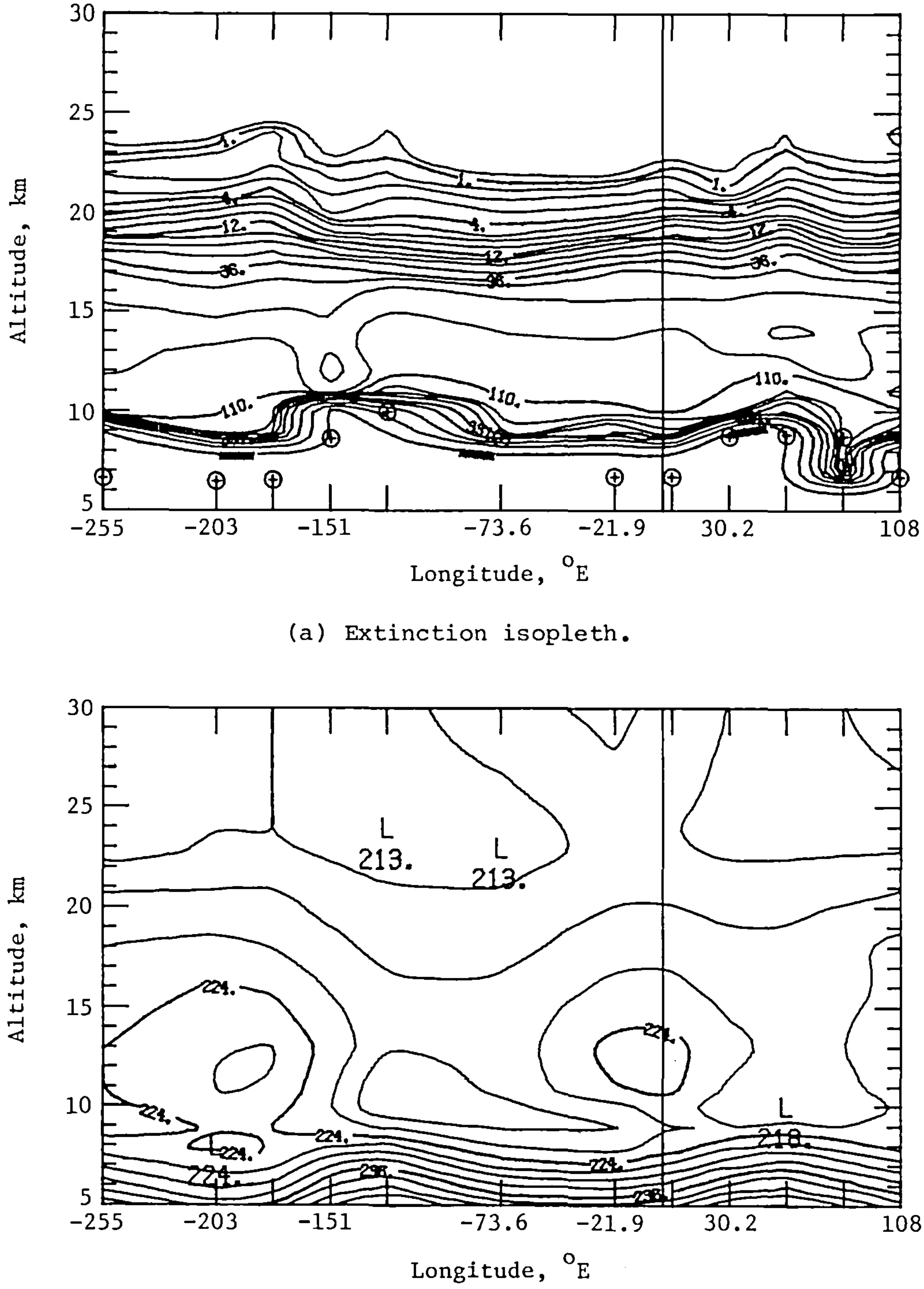


(a) Extinction isopleth.



(b) Temperature contours.

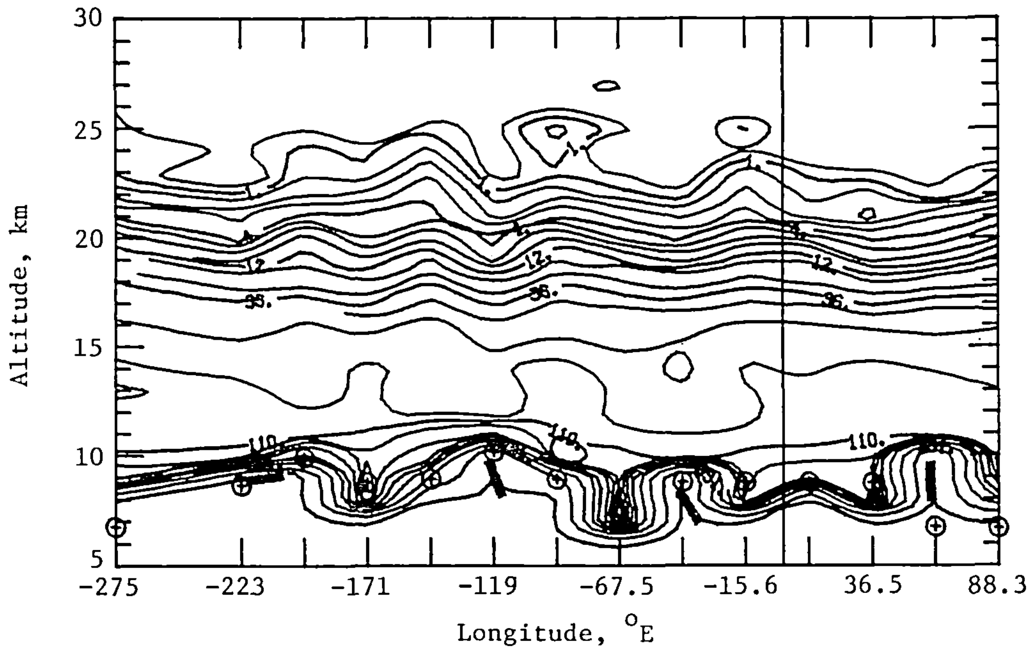
Figure 34.- Arctic extinction isopleth and temperature contours for September 30.01 to October 1.02, 1980, at latitudes from 80.1° to 80.0° N corresponding to orbits 9767 to 9781.



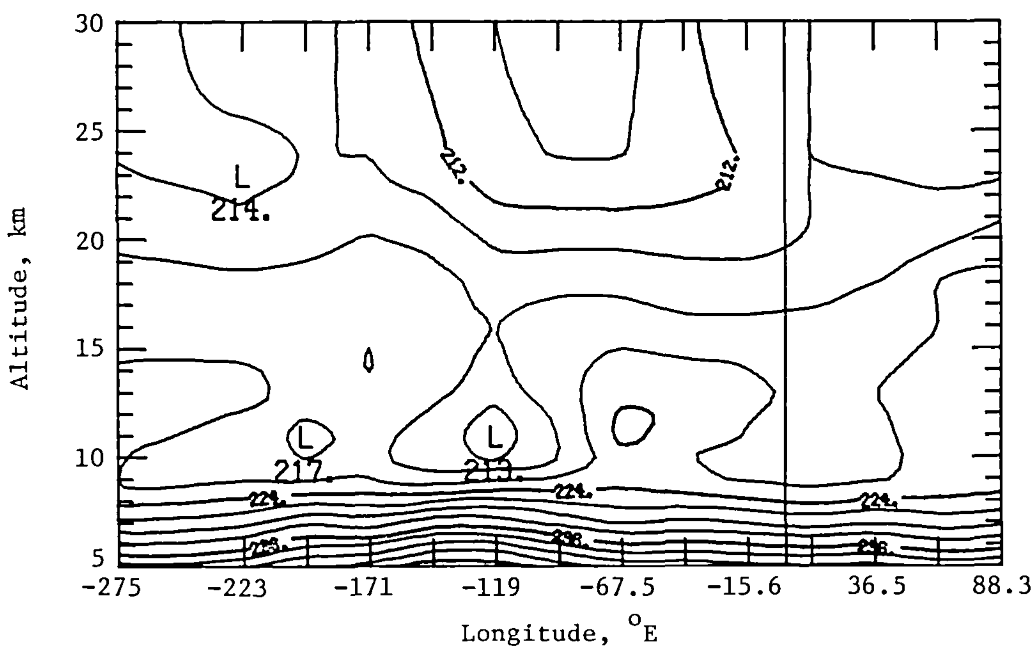
(a) Extinction isopleth.

(b) Temperature contours.

Figure 35.- Arctic extinction isopleth and temperature contours for October 6.01 to 7.03, 1980, at latitudes from 79.0° to 78.8° N corresponding to orbits 9850 to 9864.

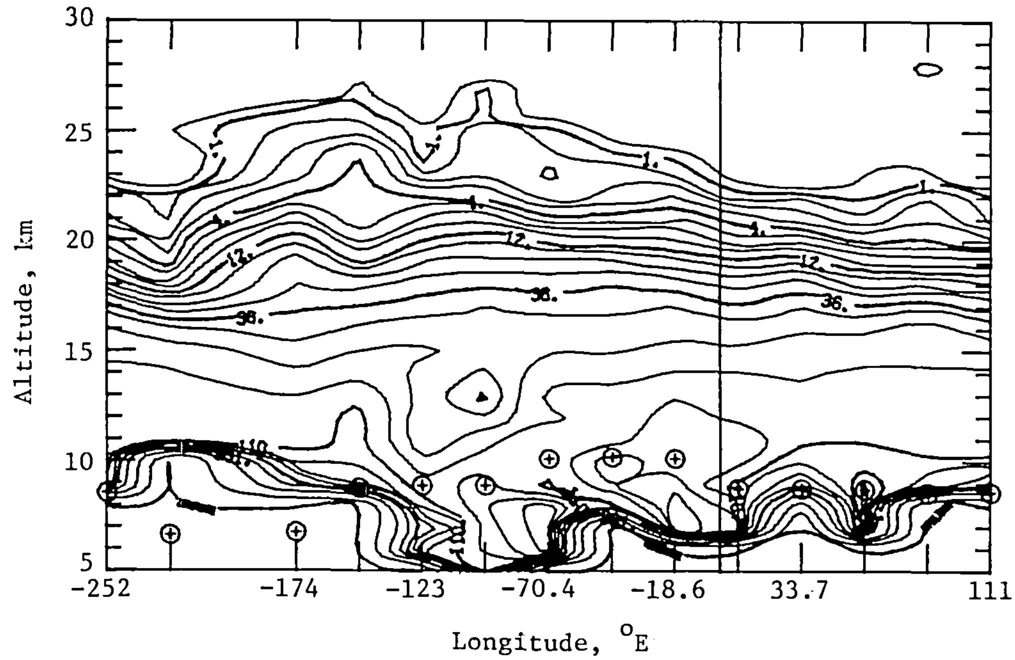


(a) Extinction isopleth.

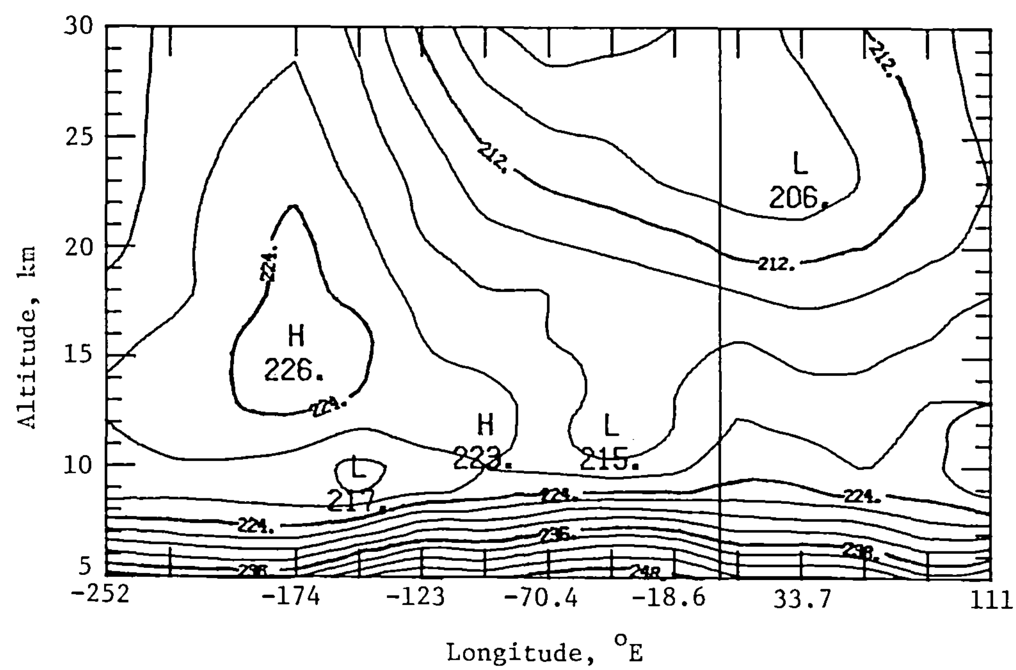


(b) Temperature contours.

Figure 36.- Arctic extinction isopleth and temperature contours for October 12.09 to 13.10, 1980, at latitudes from 77.6° to 77.3° N corresponding to orbits 9934 to 9948.

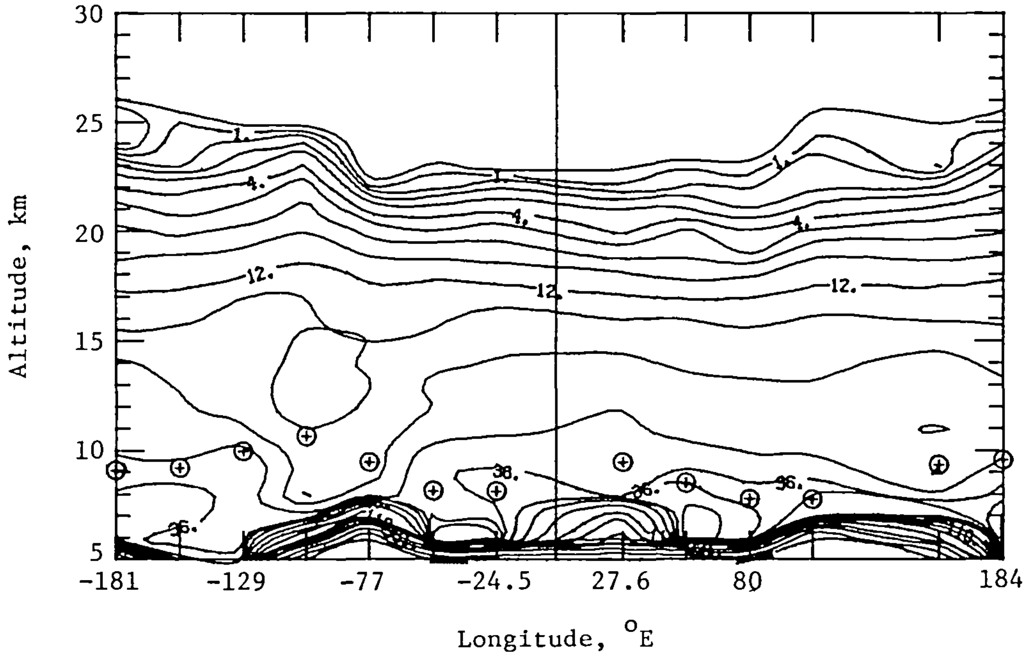


(a) Extinction isopleth.

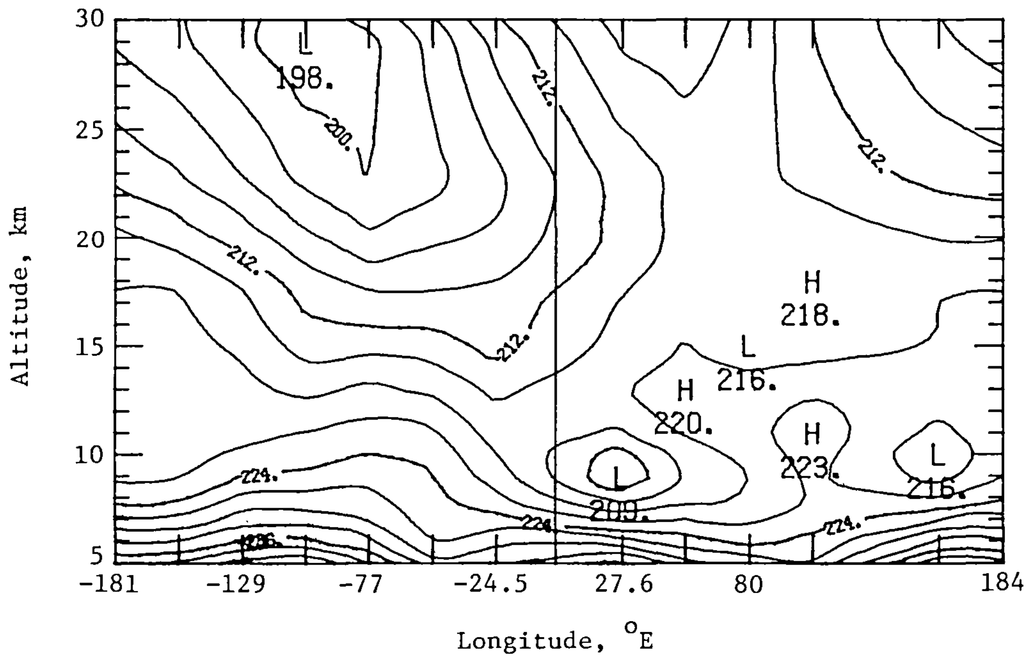


(b) Temperature contours.

Figure 37.- Arctic extinction isopleth and temperature contours for October 20.05 to 21.06, 1980, at latitudes from 75.6° to 75.3° N corresponding to orbits 10 044 to 10 058.

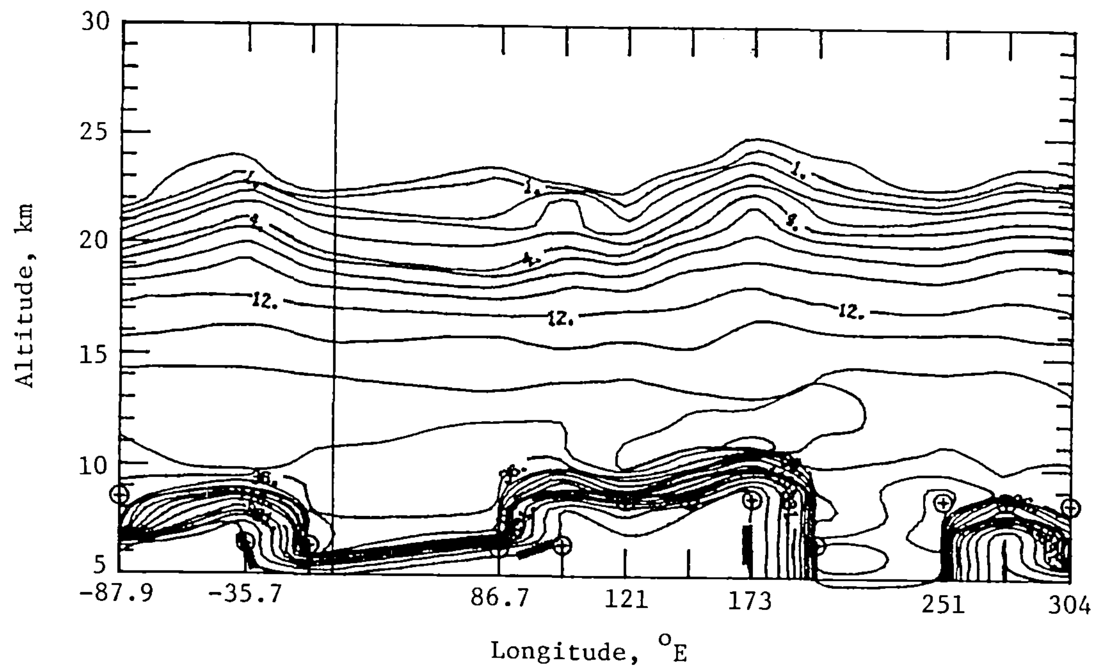


(a) Extinction isopleth.

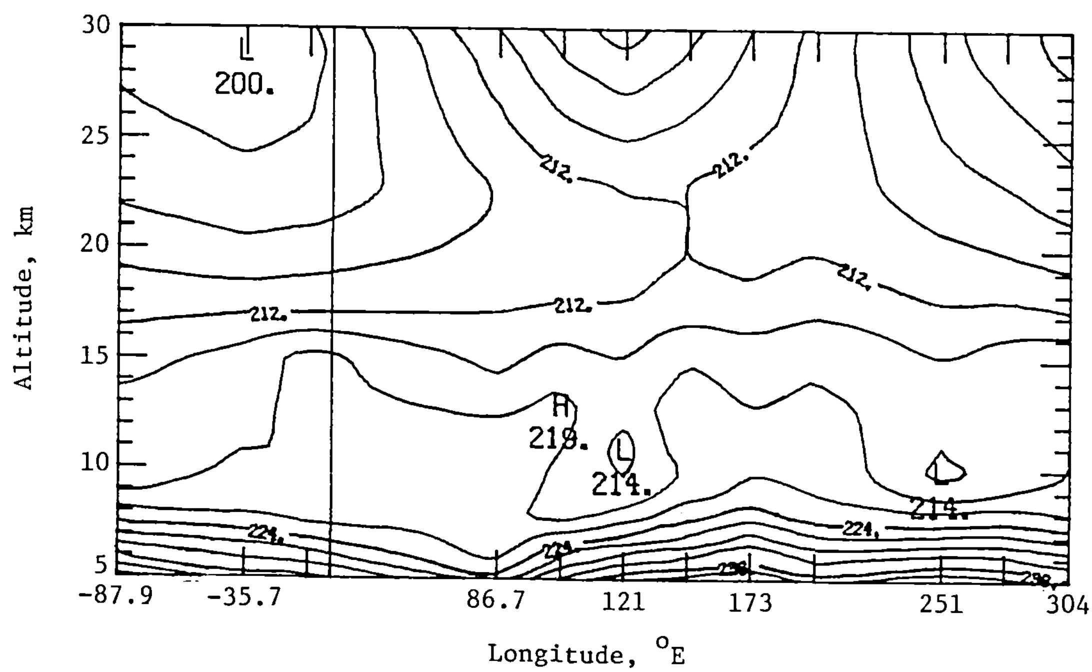


(b) Temperature contours.

Figure 38.- Antarctic extinction isopleth and temperature contours for April 27.09 to 28.11, 1980, at latitudes from 72.9° to 72.7° S corresponding to orbits 7613 to 7627.

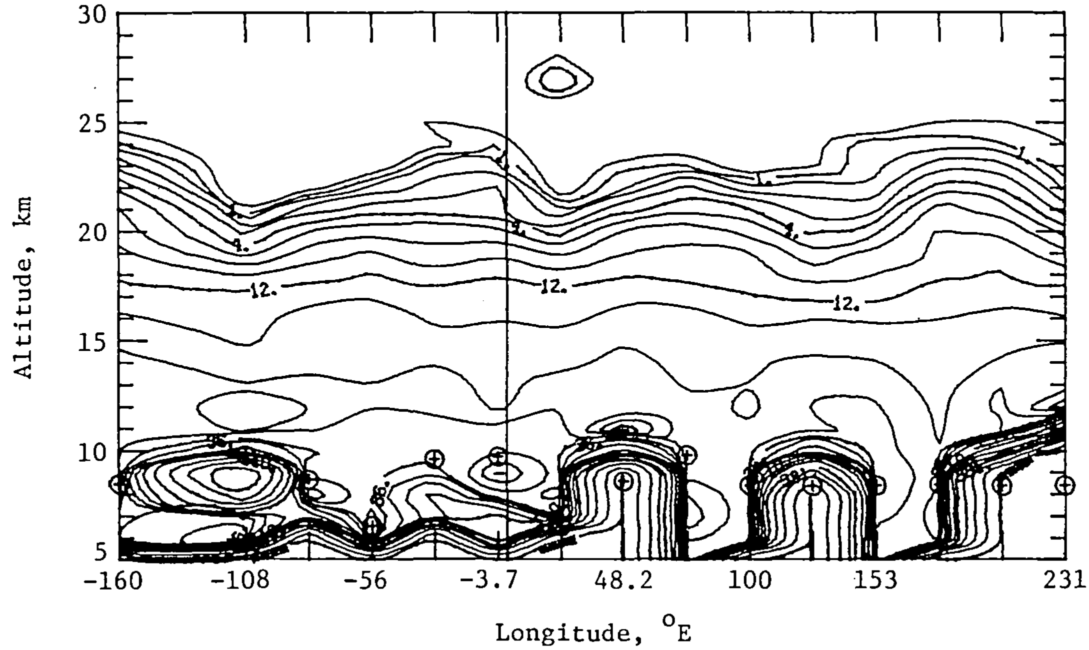


(a) Extinction isopleth.

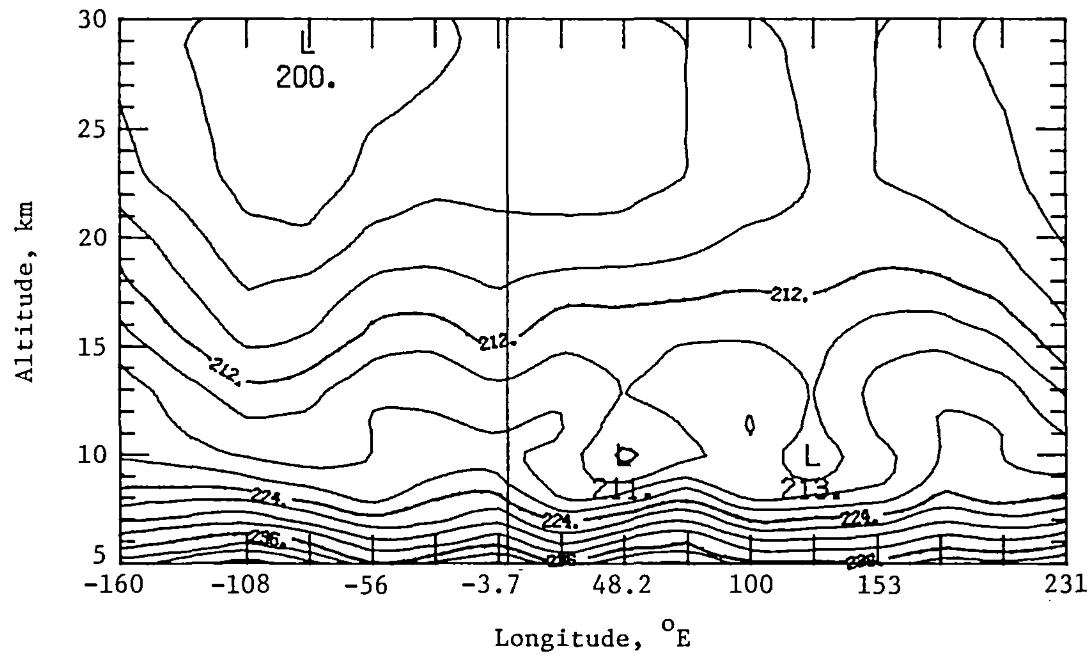


(b) Temperature contours.

Figure 39.- Antarctic extinction isopleth and temperature contours for May 8.75 to 9.83, 1980, at latitudes from 70.2° to 69.9° S corresponding to orbits 7774 to 7789.

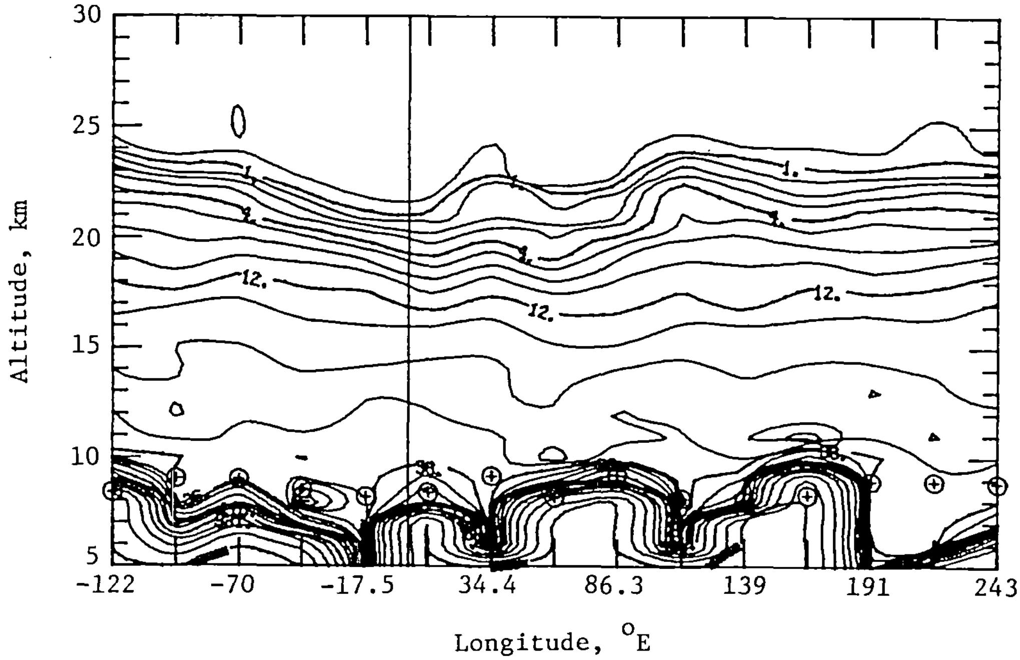


(a) Extinction isopleth.

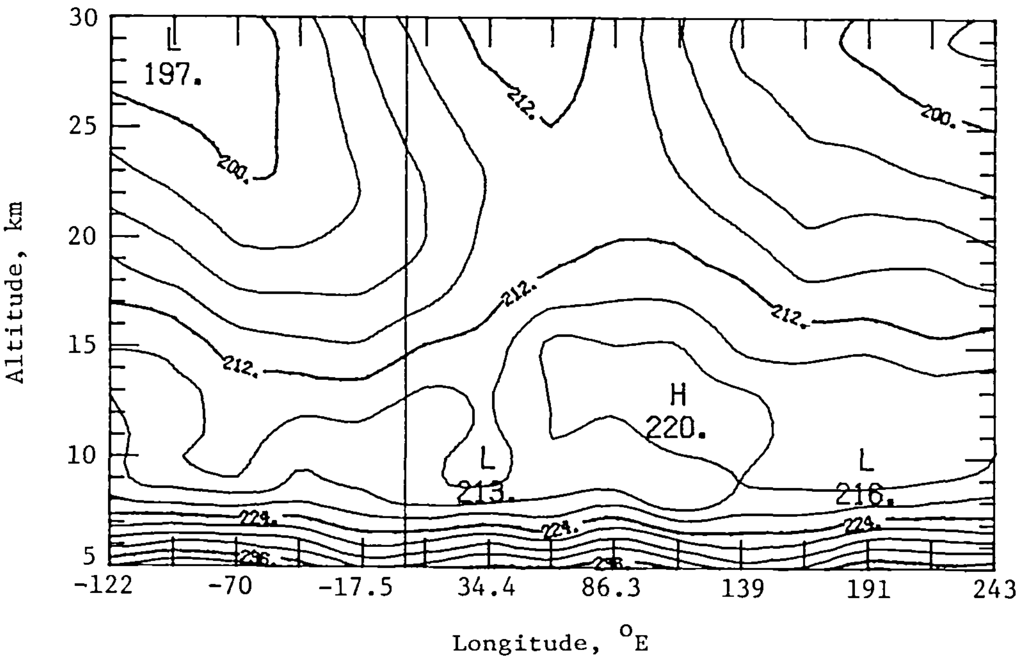


(b) Temperature contours.

Figure 40.- Antarctic extinction isopleth and temperature contours for May 12.94 to 14.03, 1980, at latitudes from 69.3° to 69.0° S corresponding to orbits 7832 to 7847.

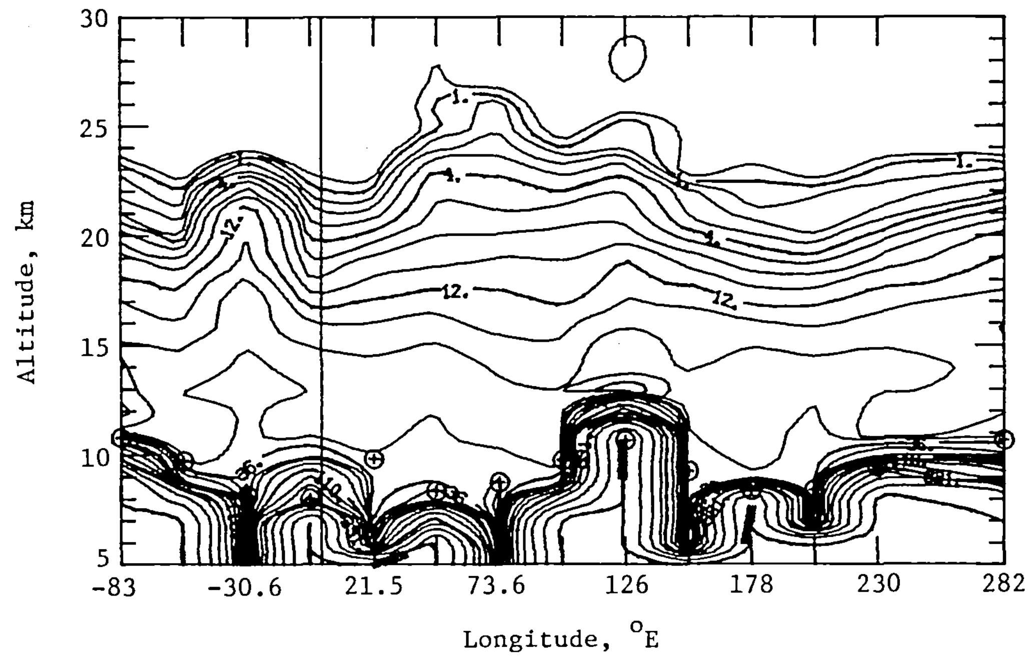


(a) Extinction isopleth.

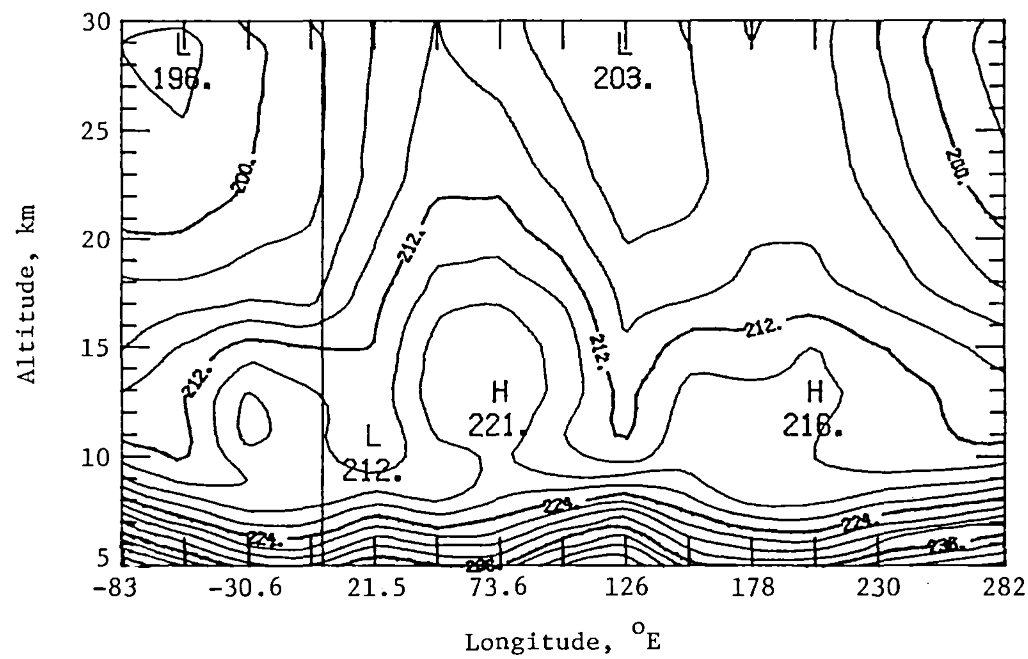


(b) Temperature contours.

Figure 41.- Antarctic extinction isopleth and temperature contours for May 20.90 to 21.92, 1980, at latitudes from 67.7° to 67.5° S corresponding to orbits 7942 to 7956.

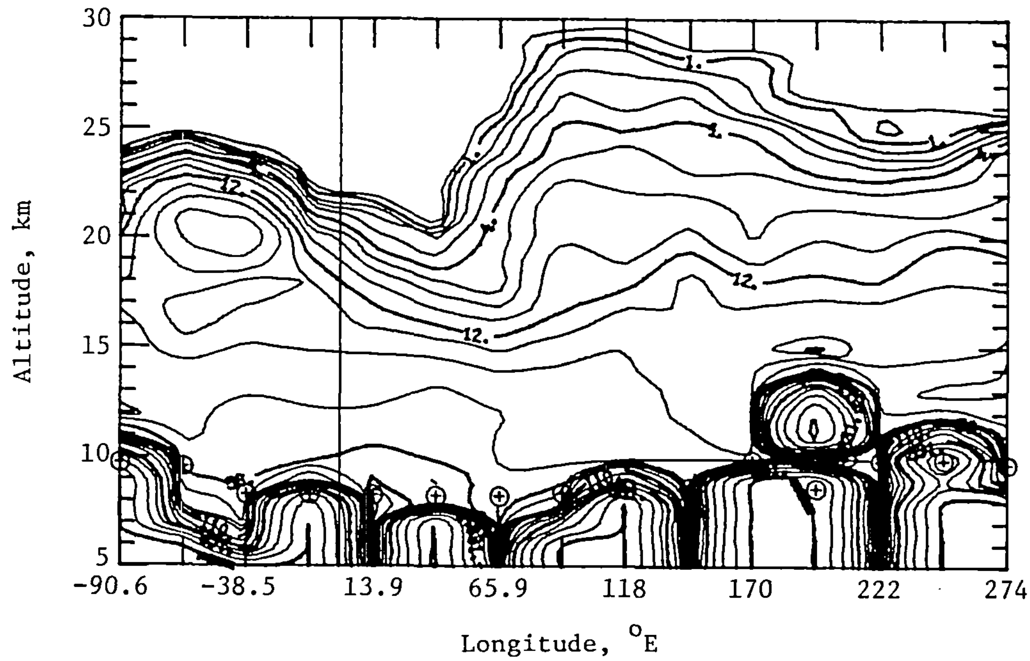


(a) Extinction isopleth.

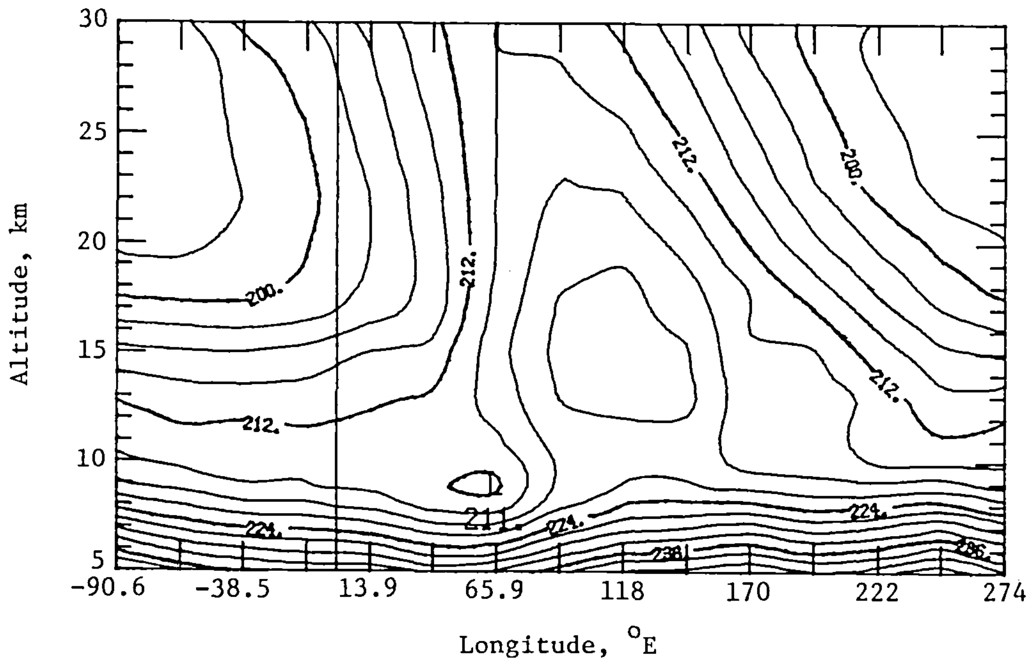


(b) Temperature contours.

Figure 42.- Antarctic extinction isopleth and temperature contours for May 28.79 to 29.80, 1980, at latitudes from 66.4° to 66.3° S corresponding to orbits 8051 to 8065.

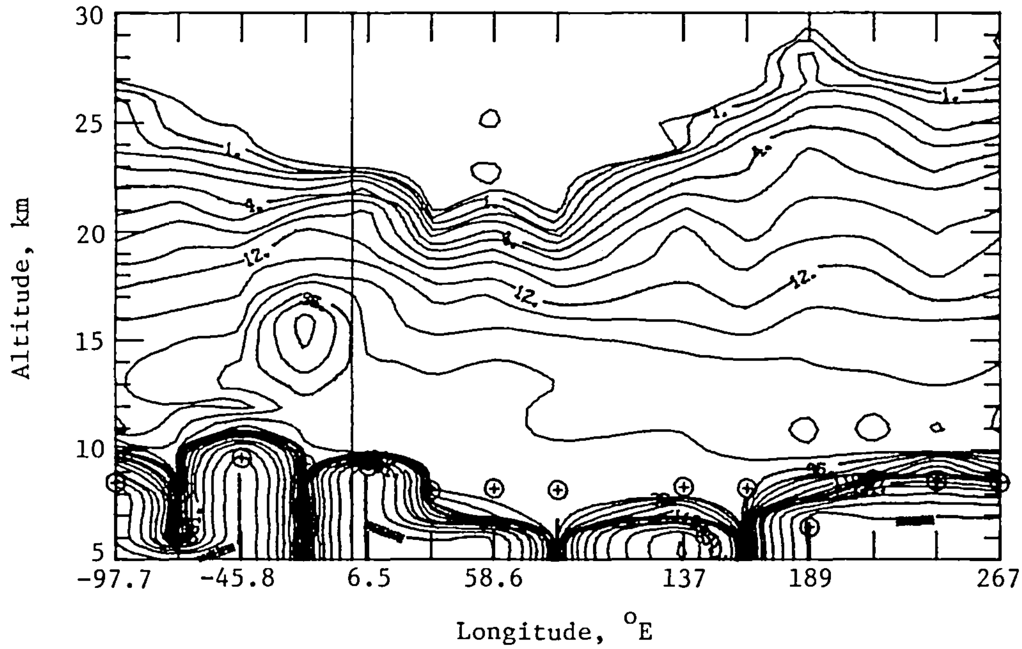


(a) Extinction isopleth.

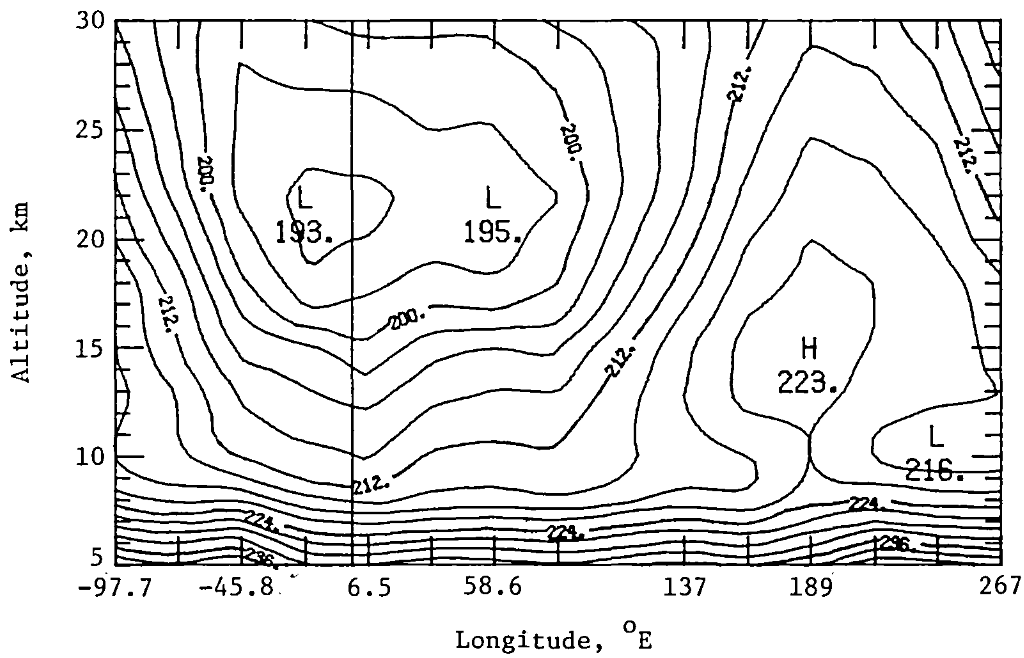


(b) Temperature contours.

Figure 43.- Antarctic extinction isopleth and temperature contours for June 4.81 to 5.82, 1980, at latitudes from 65.6° to 65.5° S corresponding to orbits 8148 to 8162.

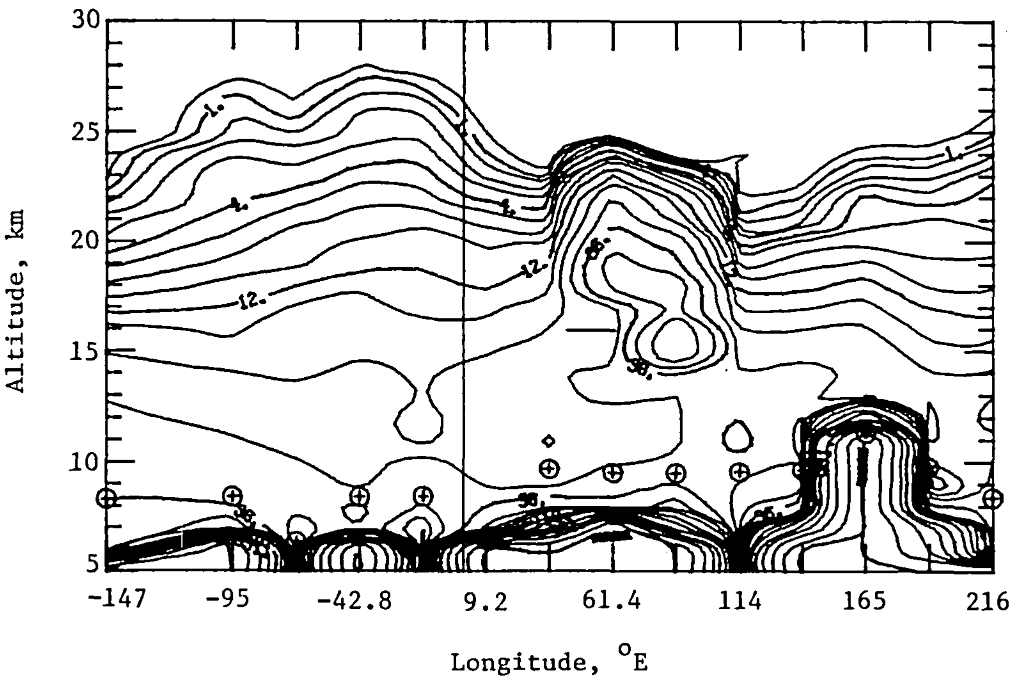


(a) Extinction isopleth.

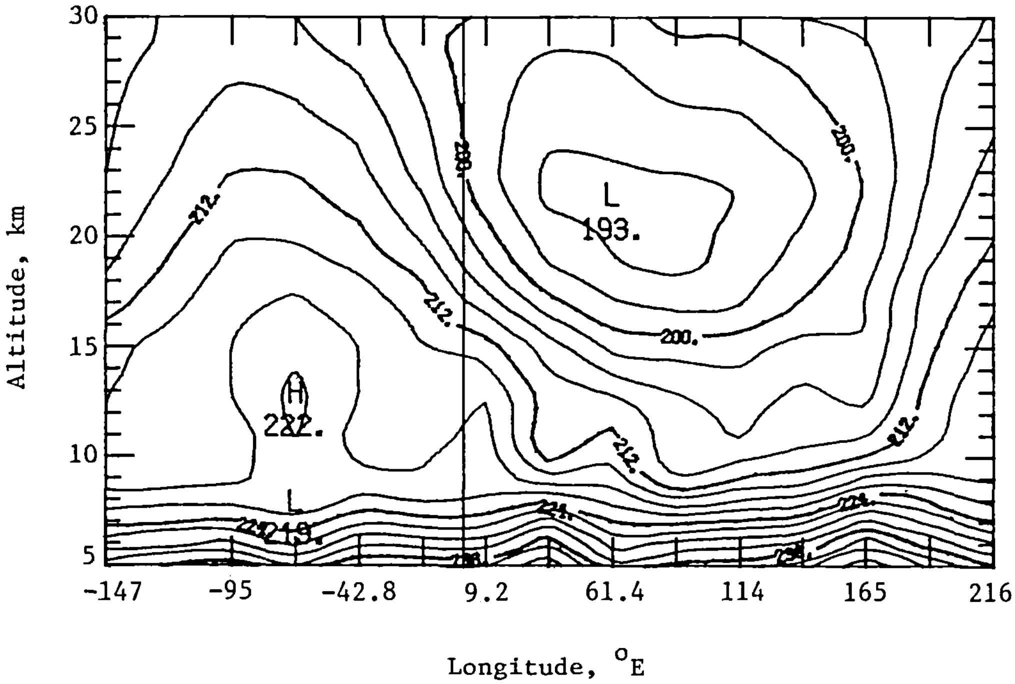


(b) Temperature contours.

Figure 44.- Antarctic extinction isopleth and temperature contours for June 11.83 to 12.84, 1980, at a latitude of 65.0° S corresponding to orbits 8245 to 8259.

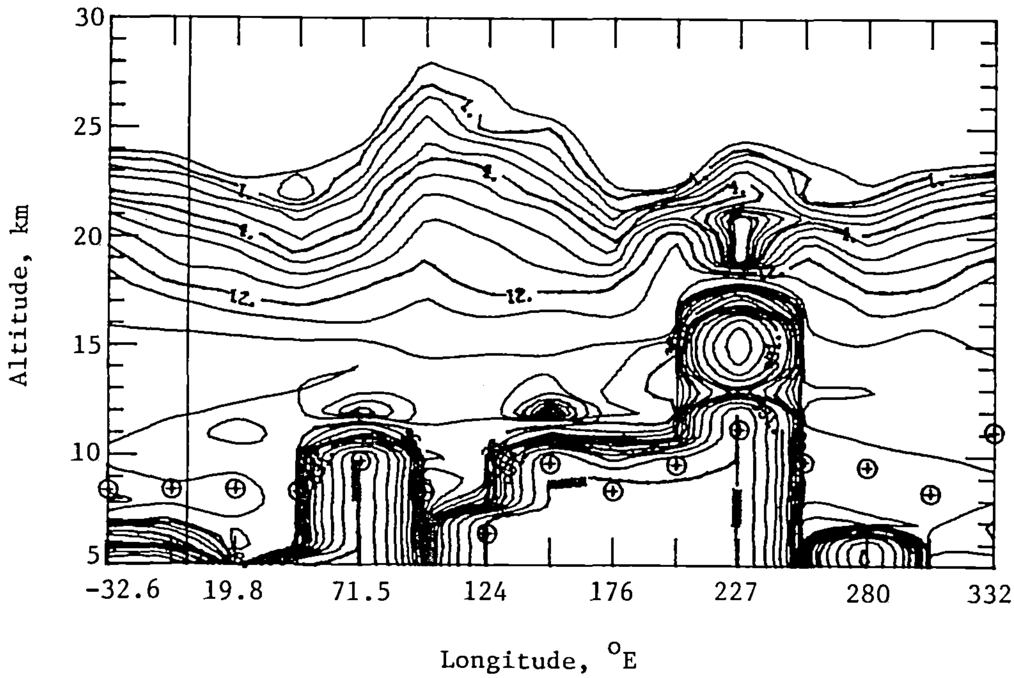


(a) Extinction isopleth.

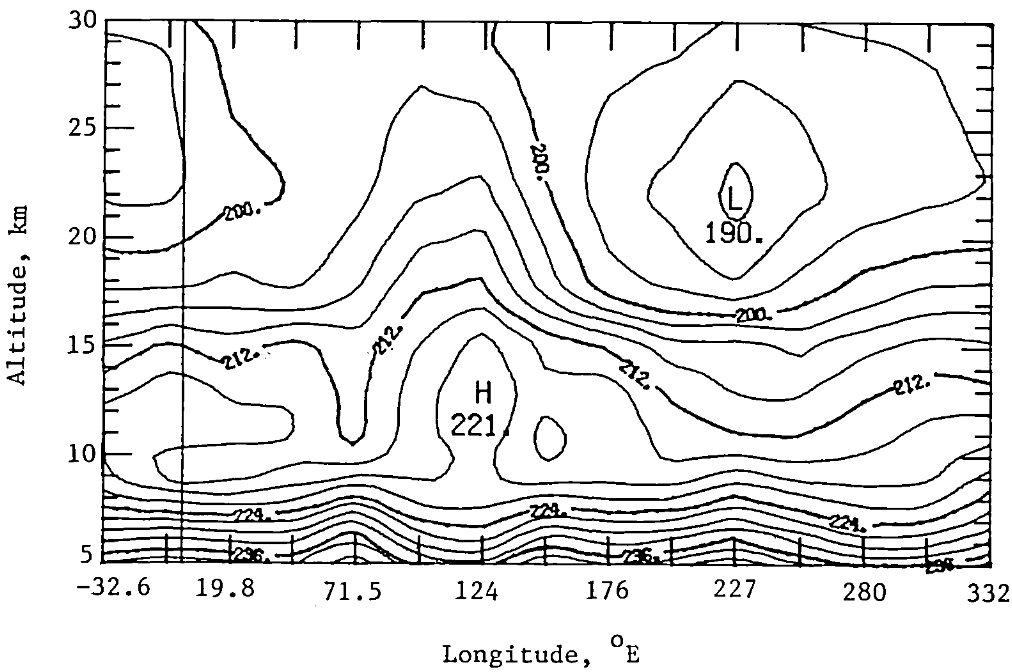


(b) Temperature contours.

Figure 45.- Antarctic extinction isopleth and temperature contours for June 16.97 to 17.98, 1980, at a latitude of 64.8° S corresponding to orbits 8316 to 8330.

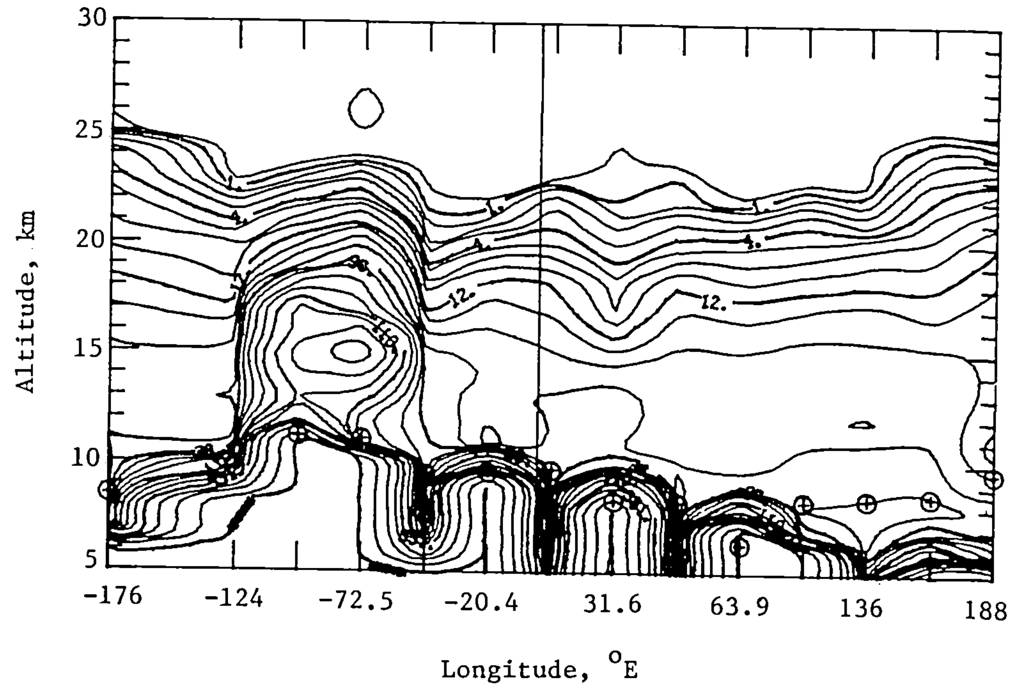


(a) Extinction isopleth.

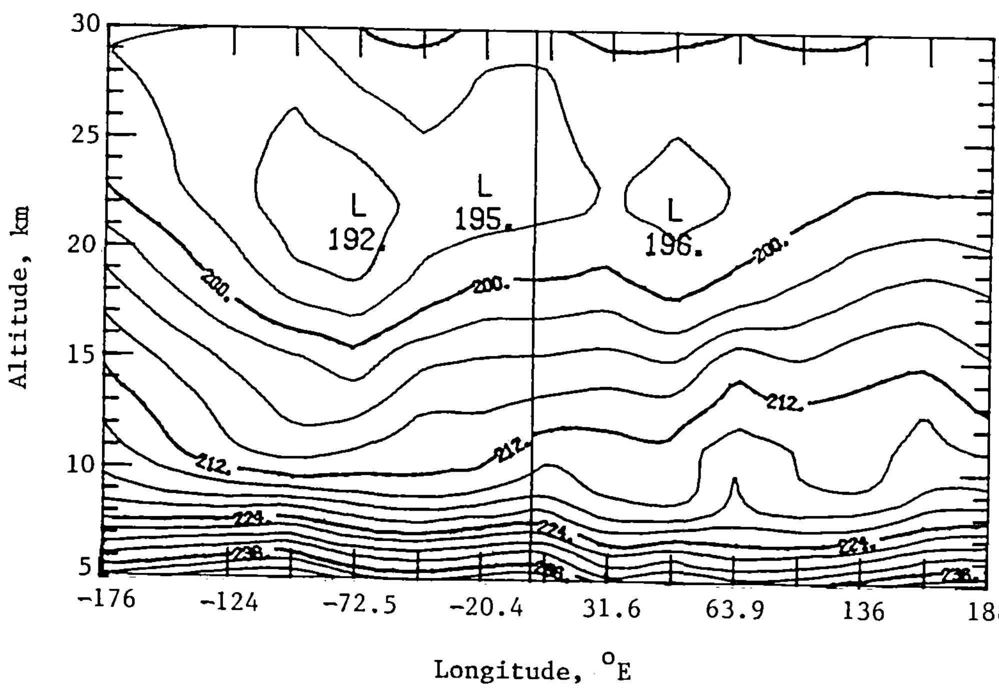


(b) Temperature contours.

Figure 46.- Antarctic extinction isopleth and temperature contours for June 25.65 to 26.66, 1980, at latitudes from 64.7° to 64.8° S corresponding to orbits 8436 to 8450.

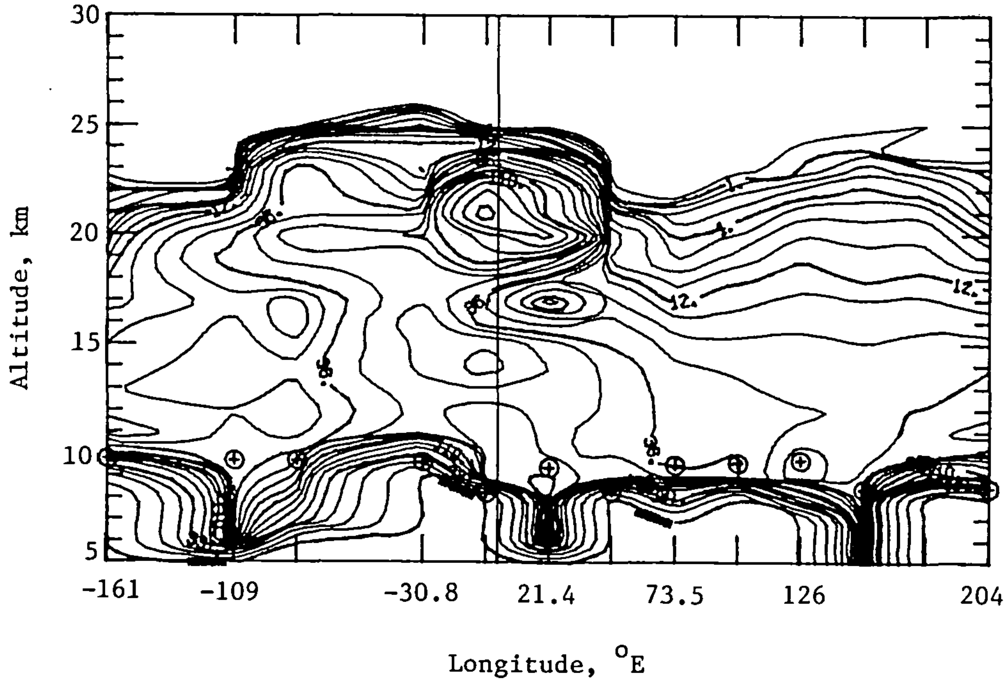


(a) Extinction isopleth.

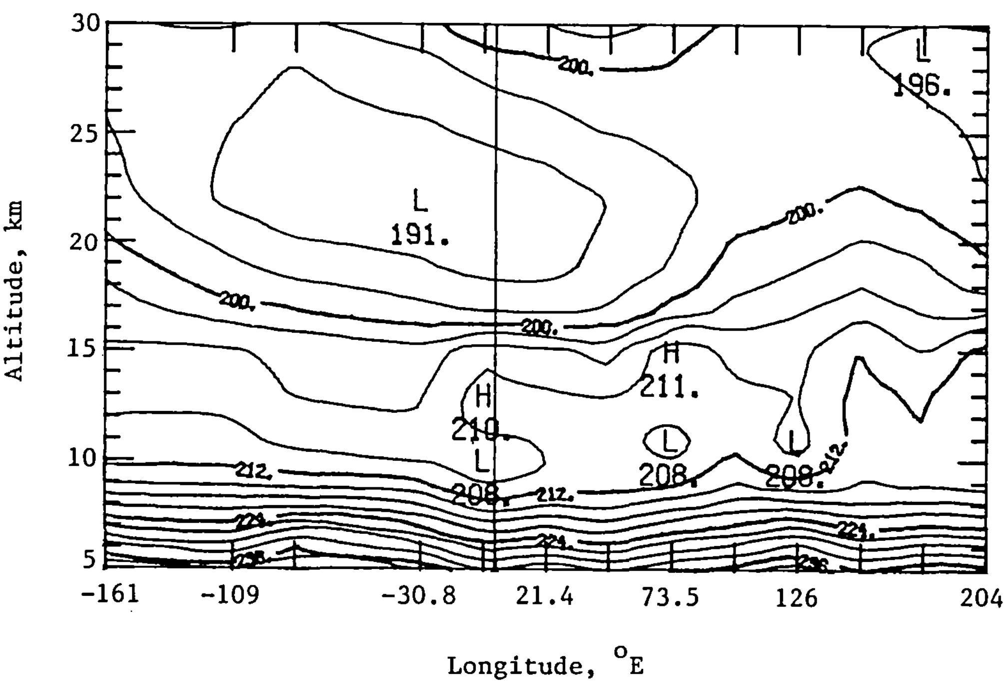


(b) Temperature contours.

Figure 47.- Antarctic extinction isopleth and temperature contours for June 29.05 to 30.07, 1980, at a latitude of 64.9° S corresponding to orbits 8483 to 8497.

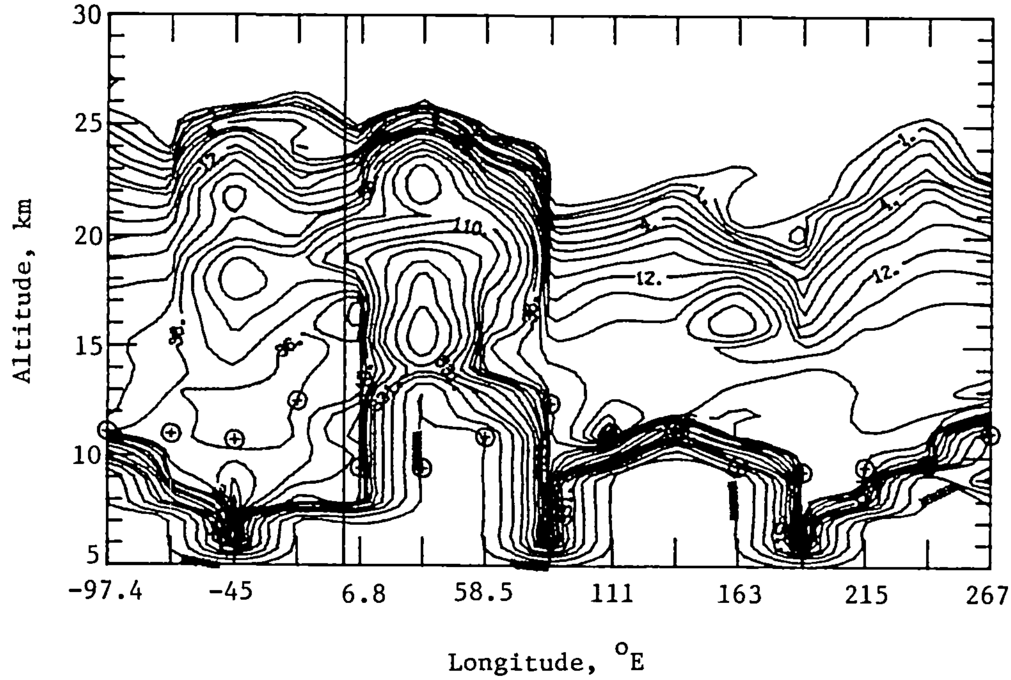


(a) Extinction isopleth.

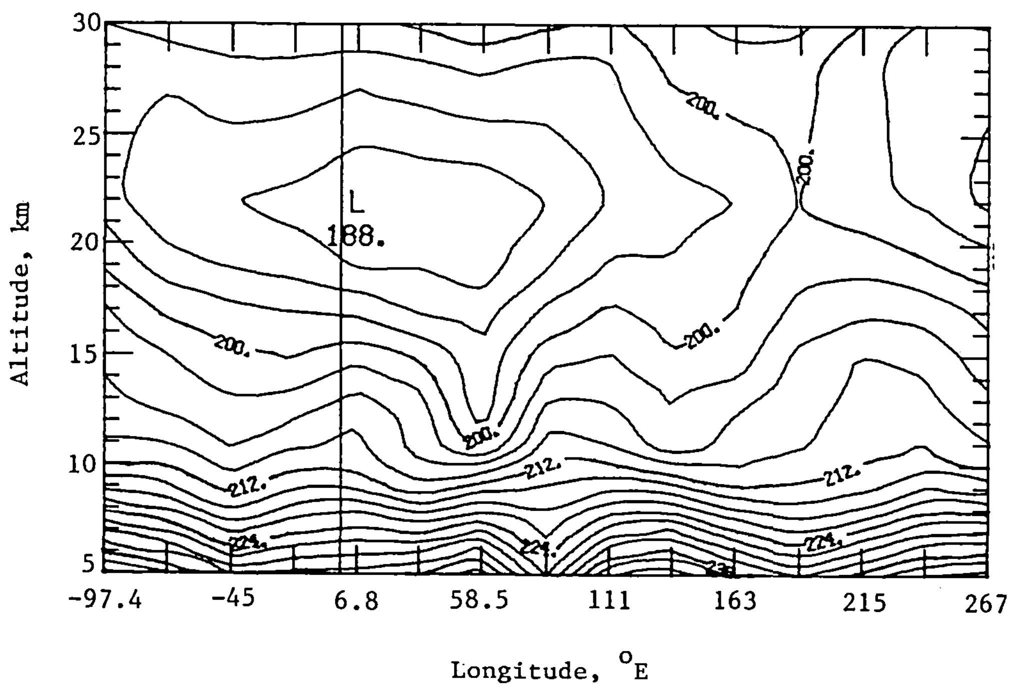


(b) Temperature contours.

Figure 48.- Antarctic extinction isopleth and temperature contours for July 7.01 to 8.03, 1980, at latitudes from 65.5° to 65.6° S corresponding to orbits 8593 to 8607.

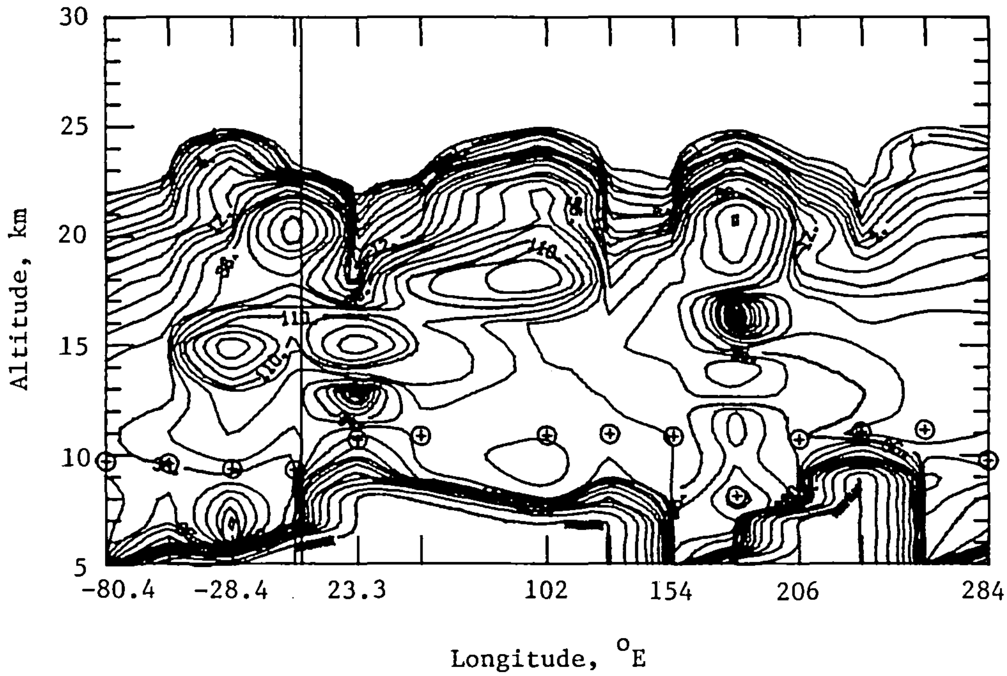


(a) Extinction isopleth.

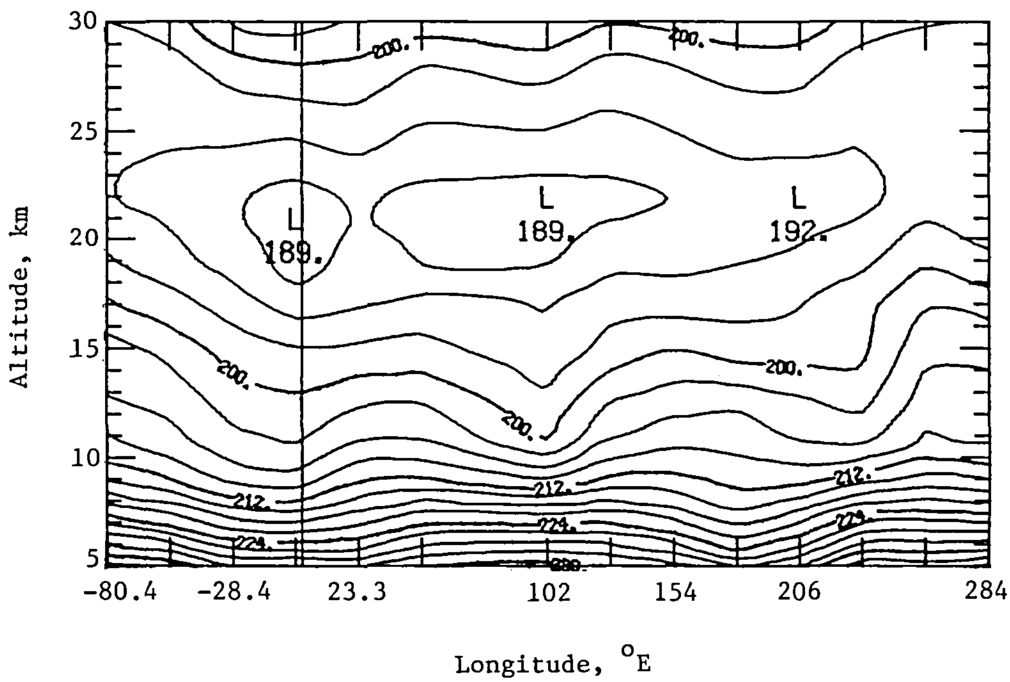


(b) Temperature contours.

Figure 49.- Antarctic extinction isopleth and temperature contours for July 15.84 to 16.85, 1980, at latitudes from 66.5° to 66.6° S corresponding to orbits 8715 to 8729.

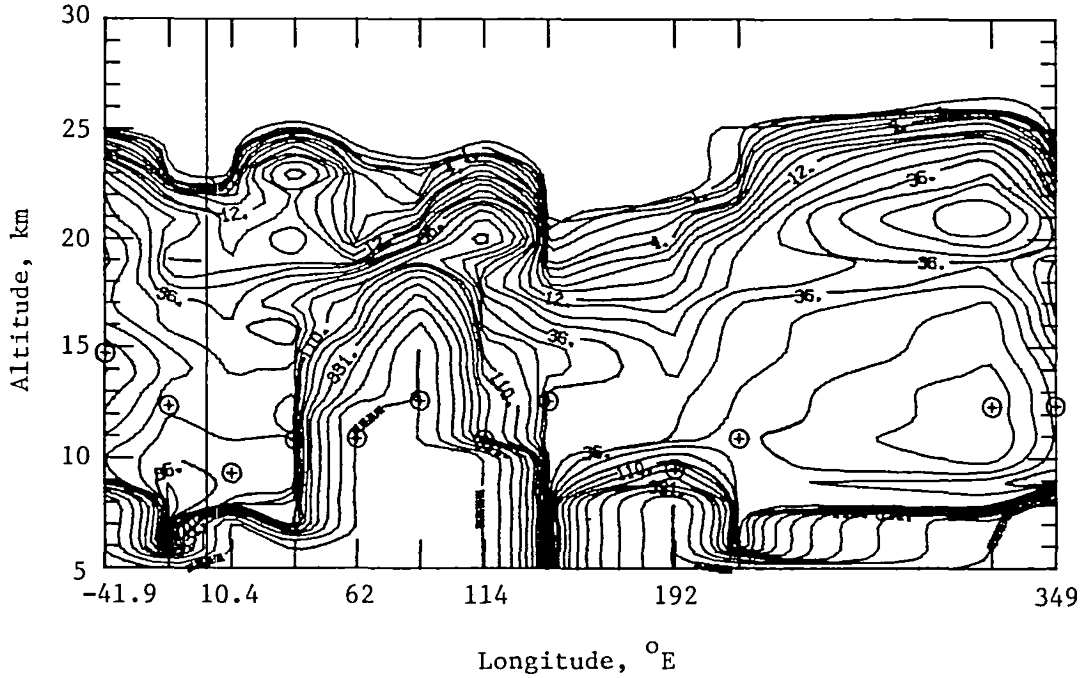


(a) Extinction isopleth.

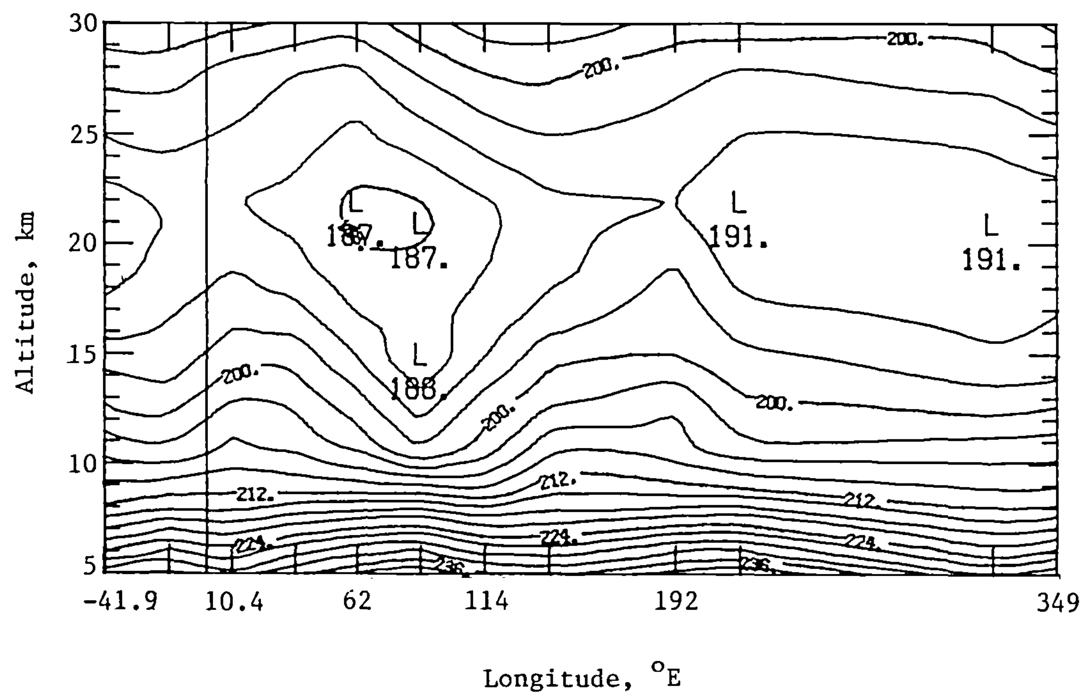


(b) Temperature contours.

Figure 50.- Antarctic extinction isopleth and temperature contours for July 23.80 to 24.81, 1980, at latitudes from 67.7° to 67.8° S corresponding to orbits 8825 to 8839.

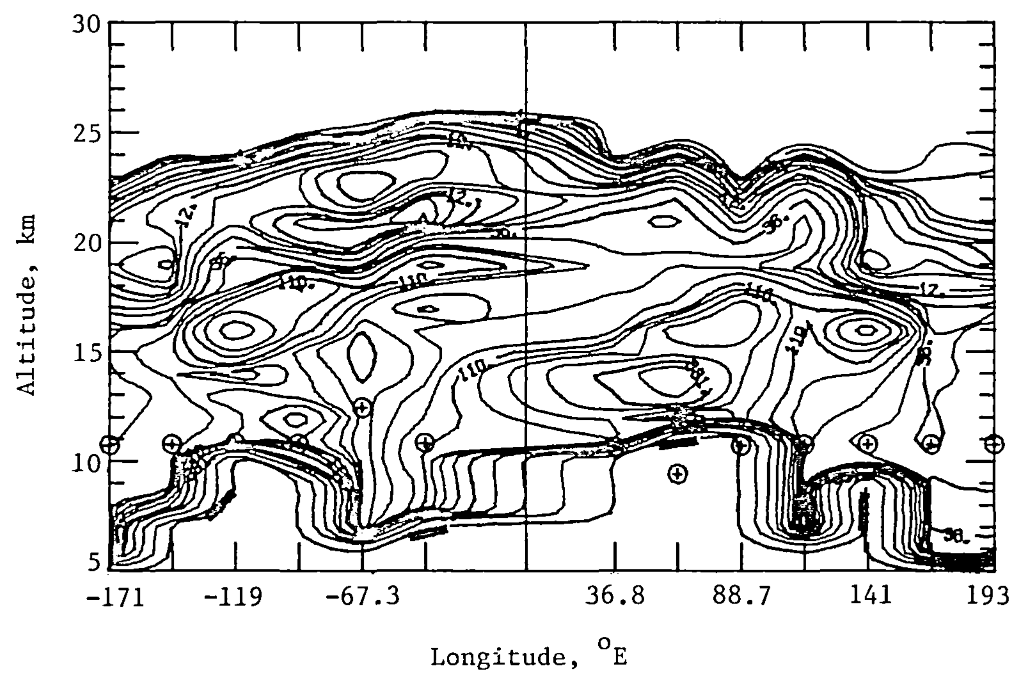


(a) Extinction isopleth.

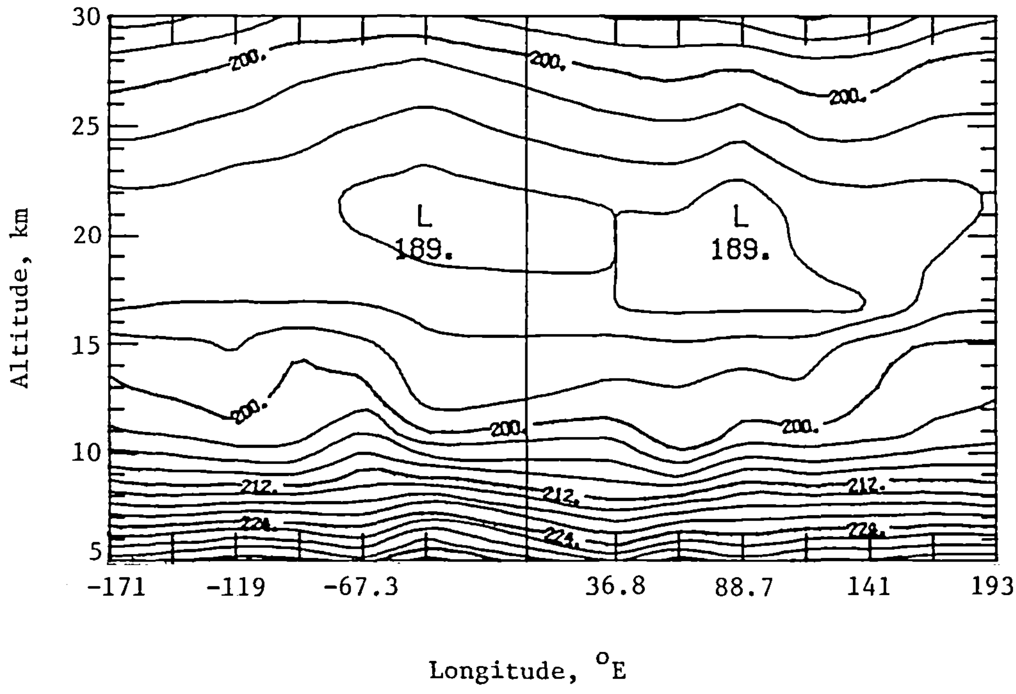


(b) Temperature contours.

Figure 51.- Antarctic extinction isopleth and temperature contours for August 1.63 to 2.71, 1980, at latitudes from 69.4° to 69.6° S corresponding to orbits 8947 to 8962.

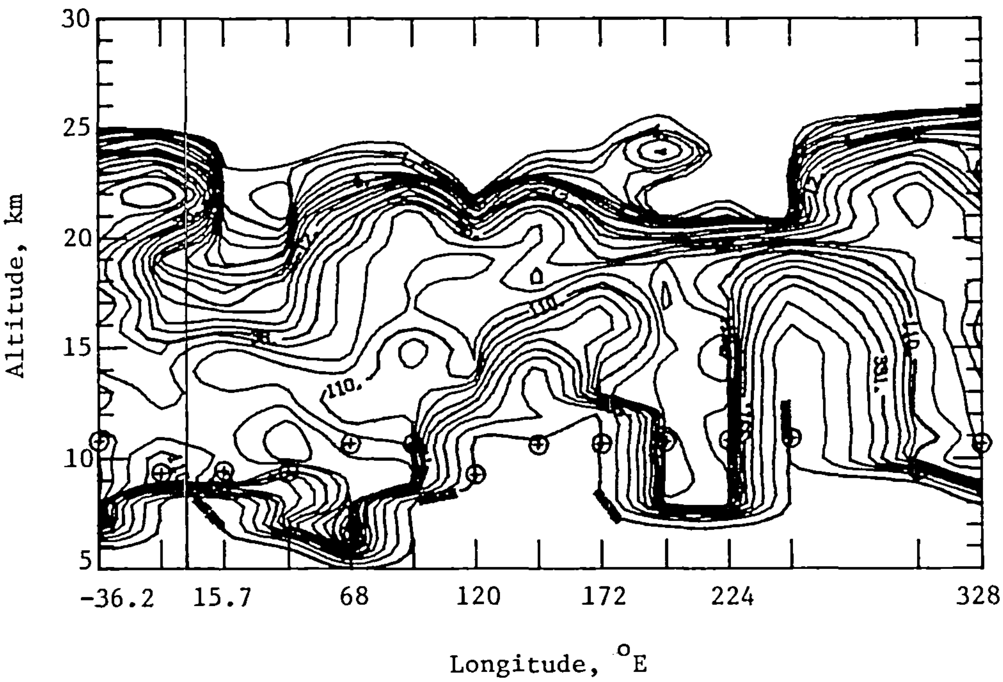


(a) Extinction isopleth.

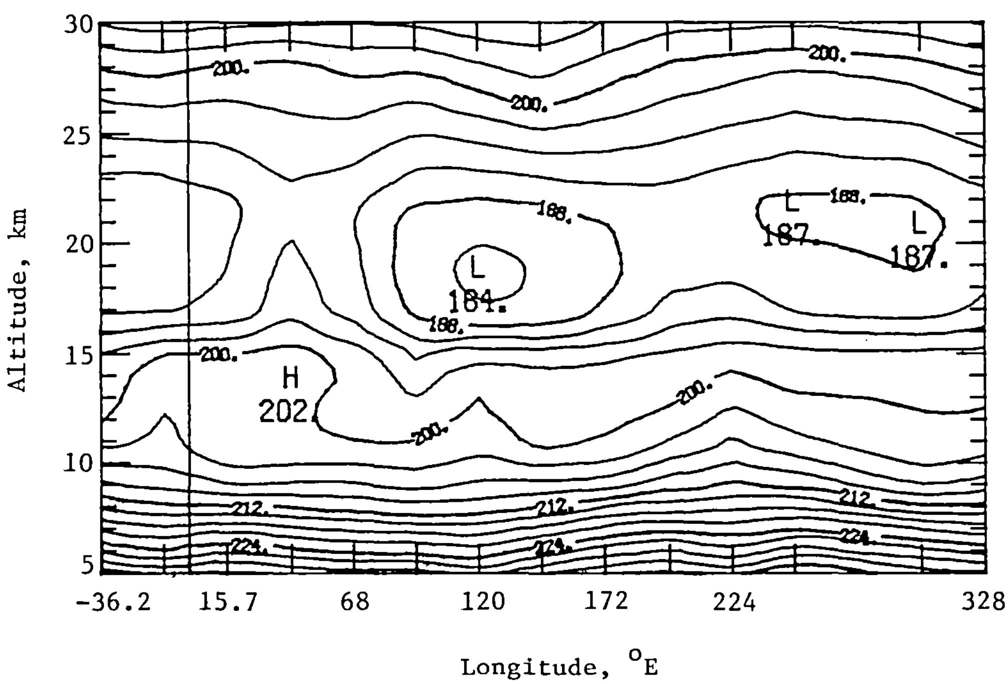


(b) Temperature contours.

Figure 52.- Antarctic extinction isopleth and temperature contours for August 8.07 to 9.08, 1980, at latitudes from 70.8° to 71.0° S corresponding to orbits 9036 to 9050.

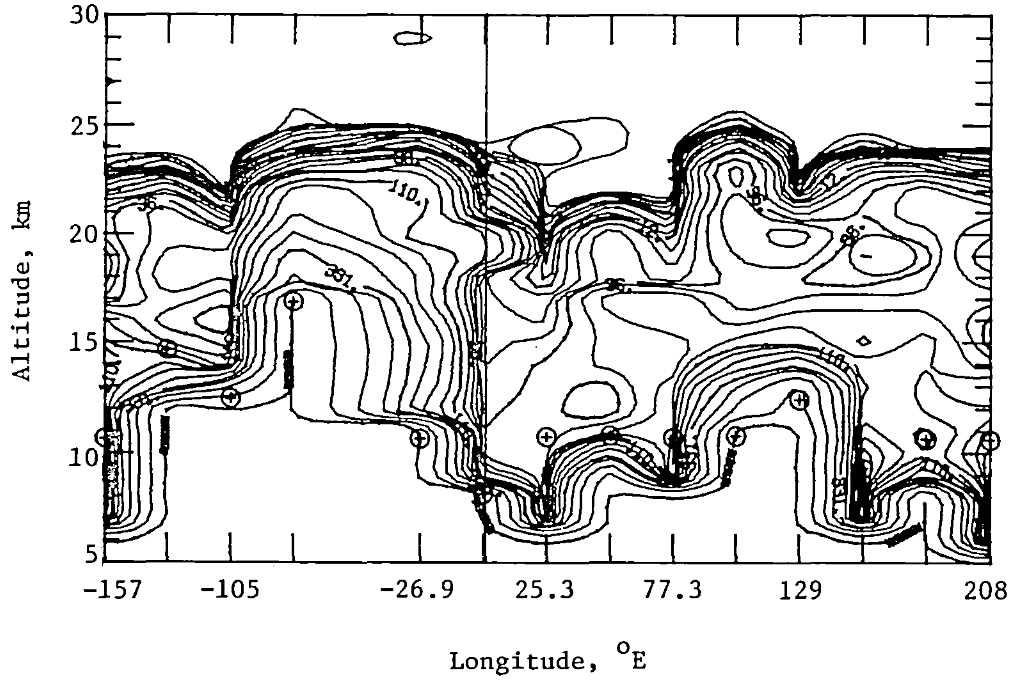


(a) Extinction isopleth.

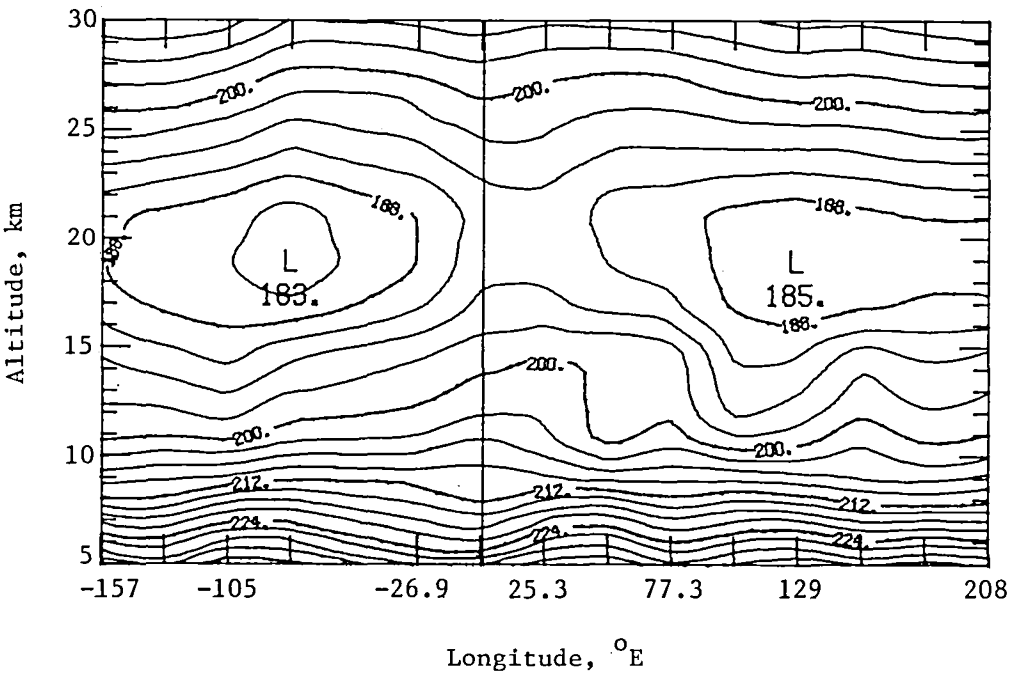


(b) Temperature contours.

Figure 53.- Antarctic extinction isopleth and temperature contours for August 12.70 to 13.71, 1980, at latitudes from 71.9° to 72.1° S corresponding to orbits 9100 to 9114.

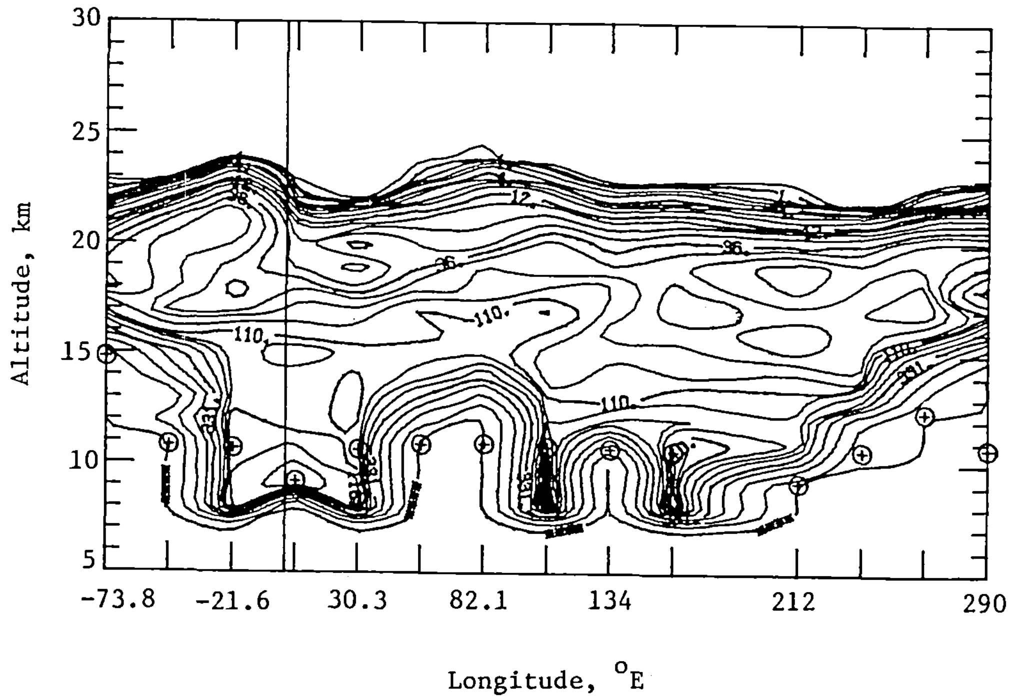


(a) Extinction isopleth.

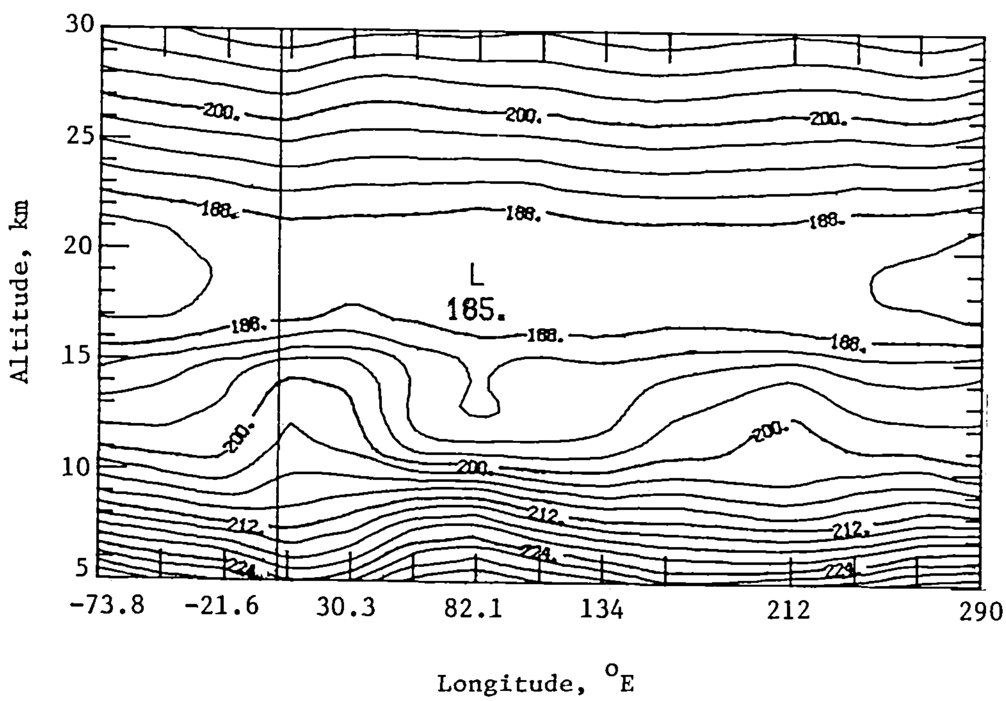


(b) Temperature contours.

Figure 54.- Antarctic extinction isopleth and temperature contours for August 17.04 to 18.05, 1980, at latitudes from 73.0° to 73.2° S corresponding to orbits 9160 to 9174.

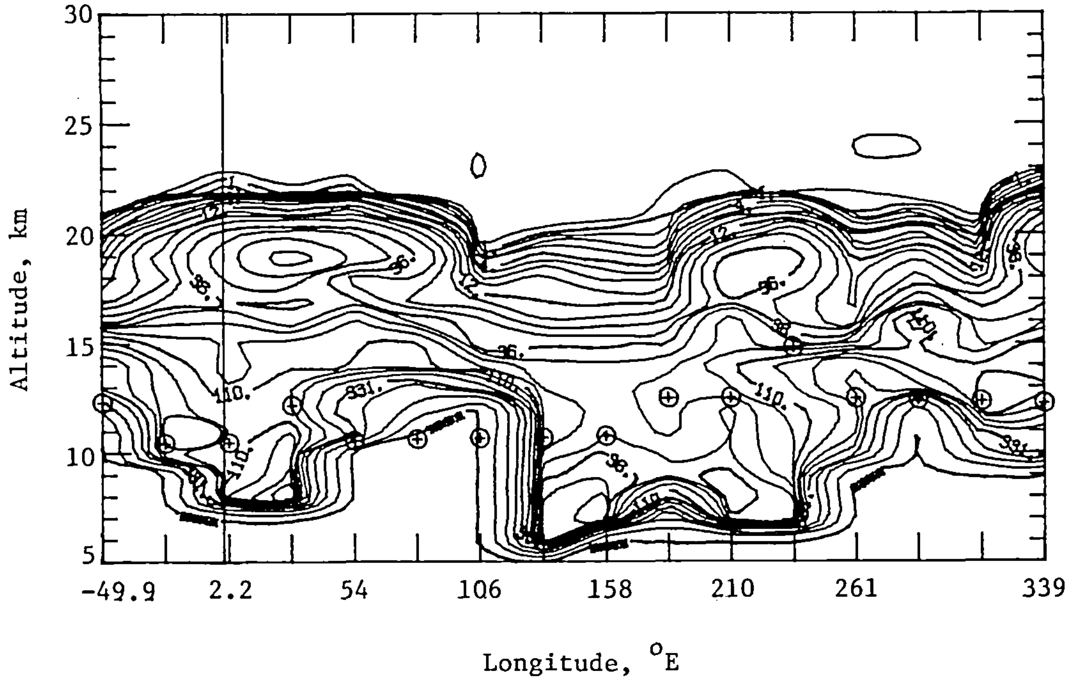


(a) Extinction isopleth.

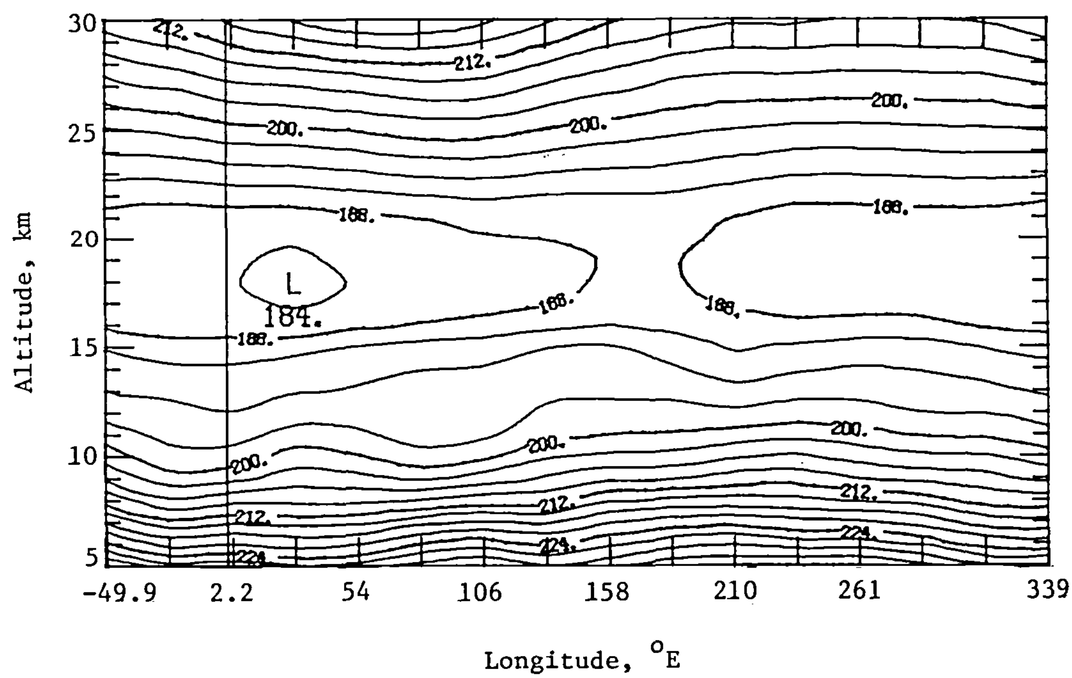


(b) Temperature contours.

Figure 55.- Antarctic extinction isopleth and temperature contours for August 28.83 to 29.85, 1980, at latitudes from 76.0° to 76.2° S corresponding to orbits 9323 to 9337.

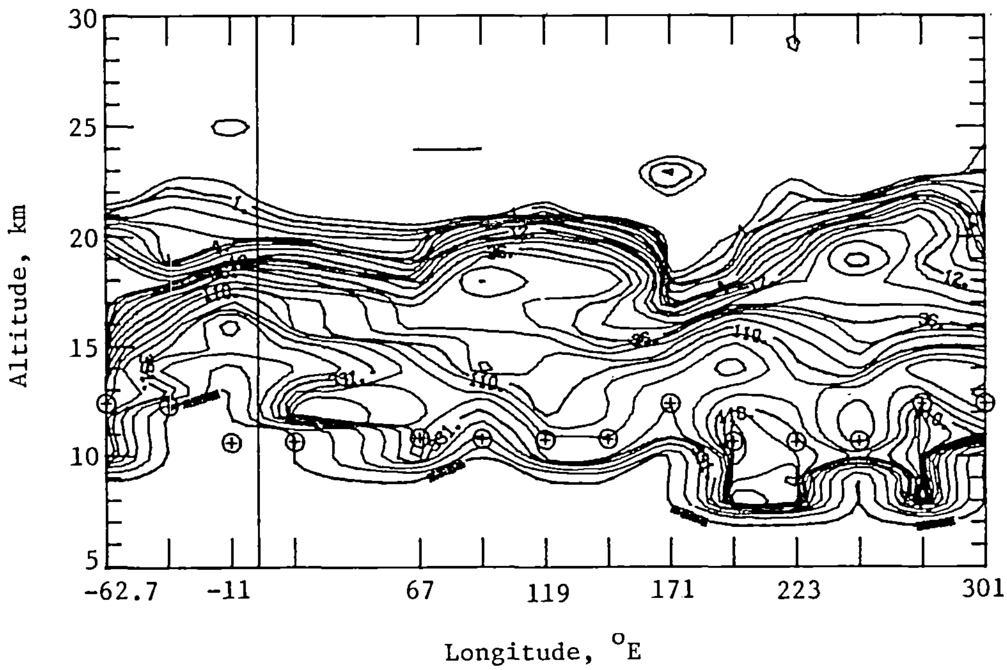


(a) Extinction isopleth.

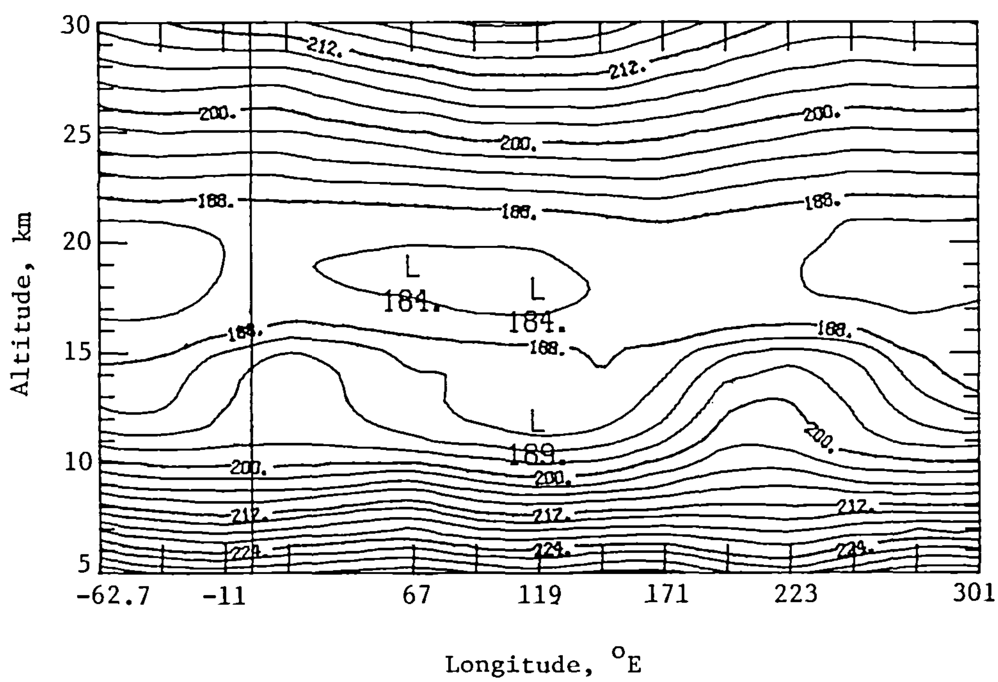


(b) Temperature contours.

Figure 56.- Antarctic extinction isopleth and temperature contours for September 5.72 to 6.81, 1980, at latitudes from 77.8° to 78.1° S corresponding to orbits 9432 to 9447.

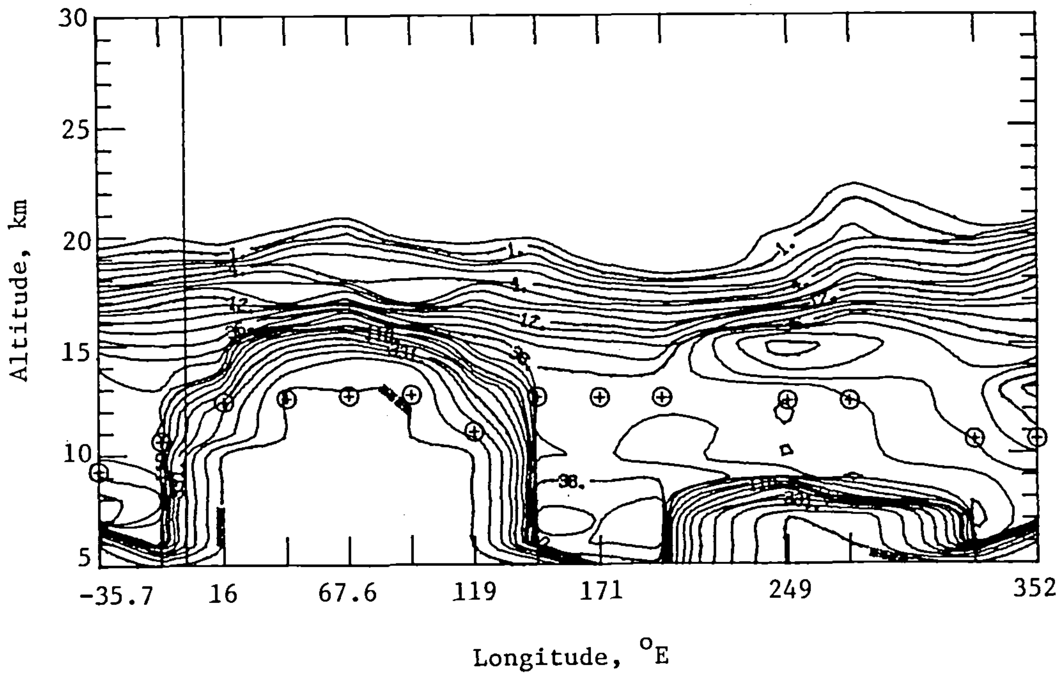


(a) Extinction isopleth.

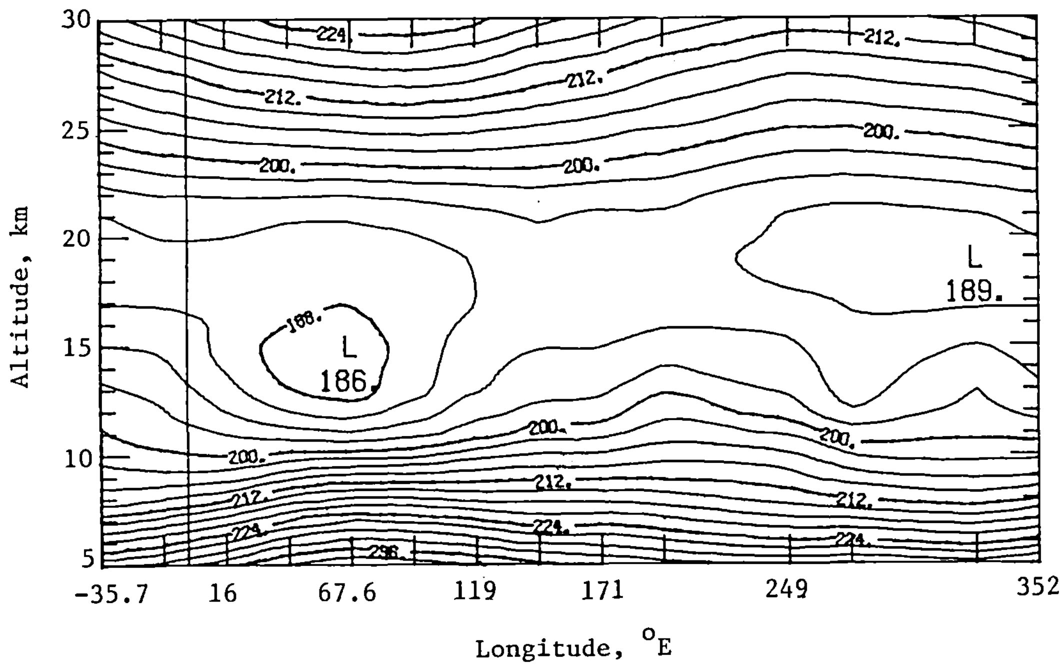


(b) Temperature contours.

Figure 57.- Antarctic extinction isopleth and temperature contours for September 9.85 to 10.86, 1980, at latitudes from 78.7° to 79.0° S corresponding to orbits 9489 to 9503.

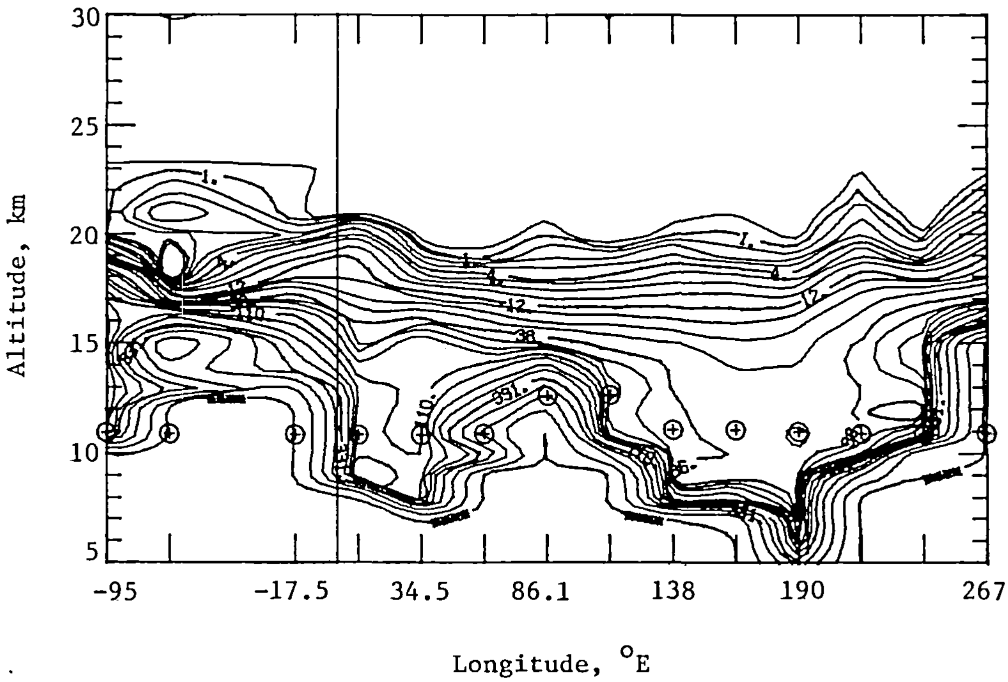


(a) Extinction isopleth.

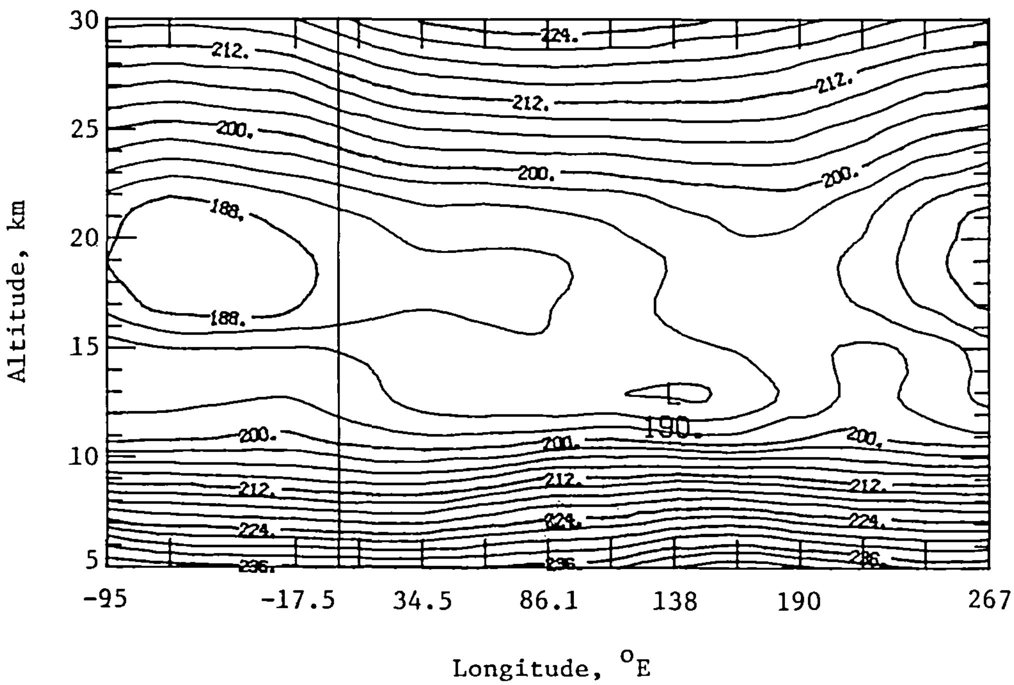


(b) Temperature contours.

Figure 58.- Antarctic extinction isopleth and temperature contours for September 18.75 to 19.83, 1980, at latitudes from 80.2° to 80.3° S corresponding to orbits 9612 to 9627.

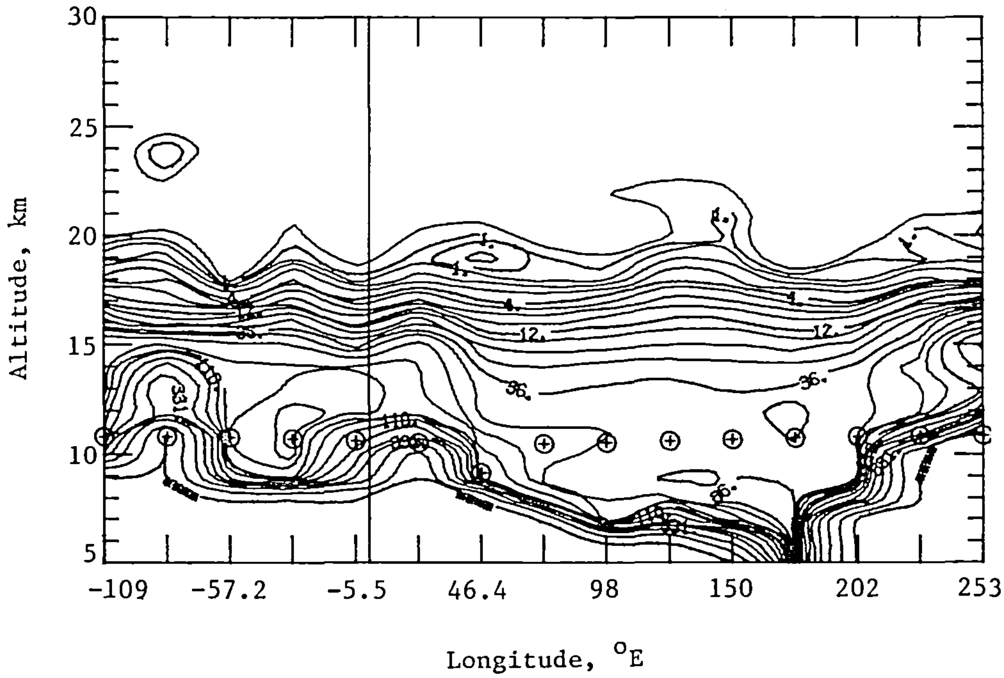


(a) Extinction isopleth.

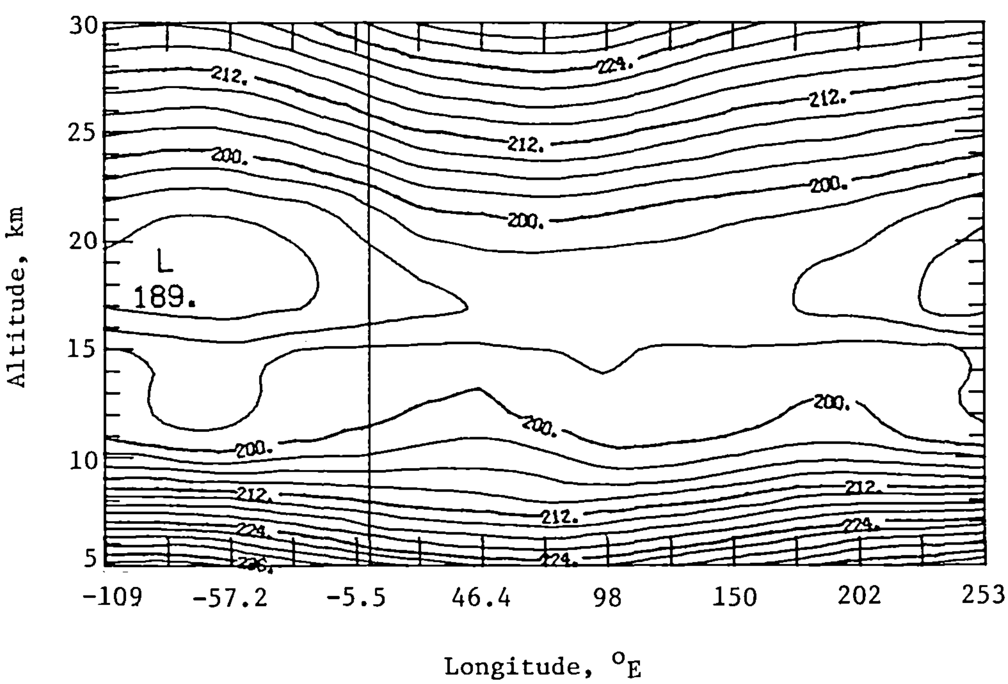


(b) Temperature contours.

Figure 59.- Antarctic extinction isopleth and temperature contours for September 22.00 to 23.01, 1980, at latitudes from 80.5° to 80.6° S corresponding to orbits 9657 to 9671.

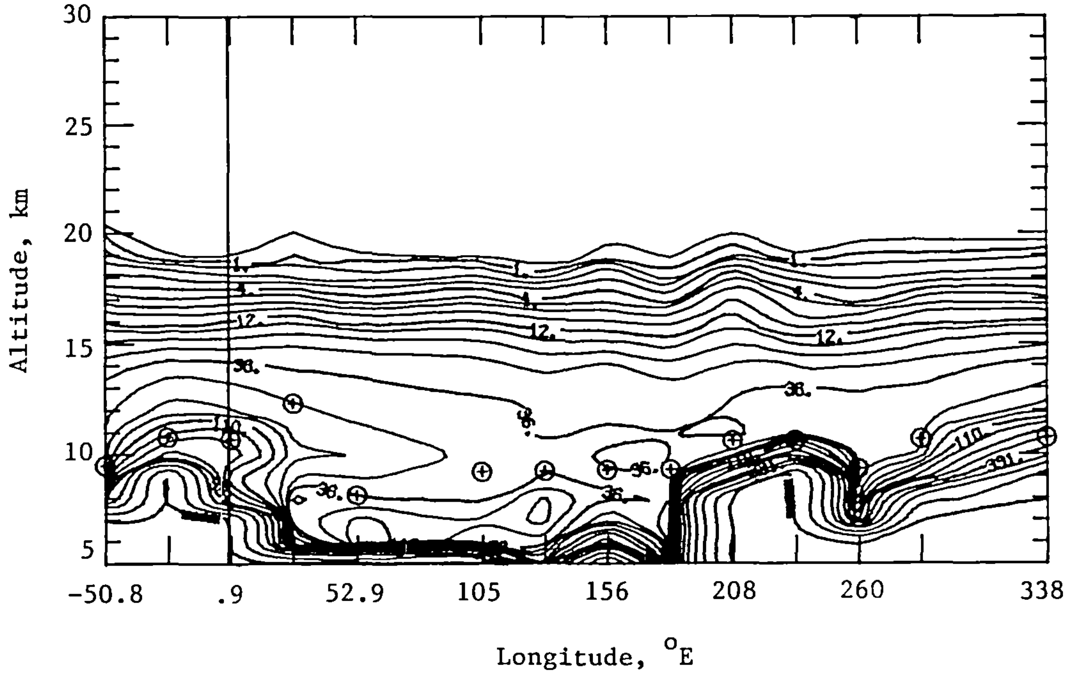


(a) Extinction isopleth.

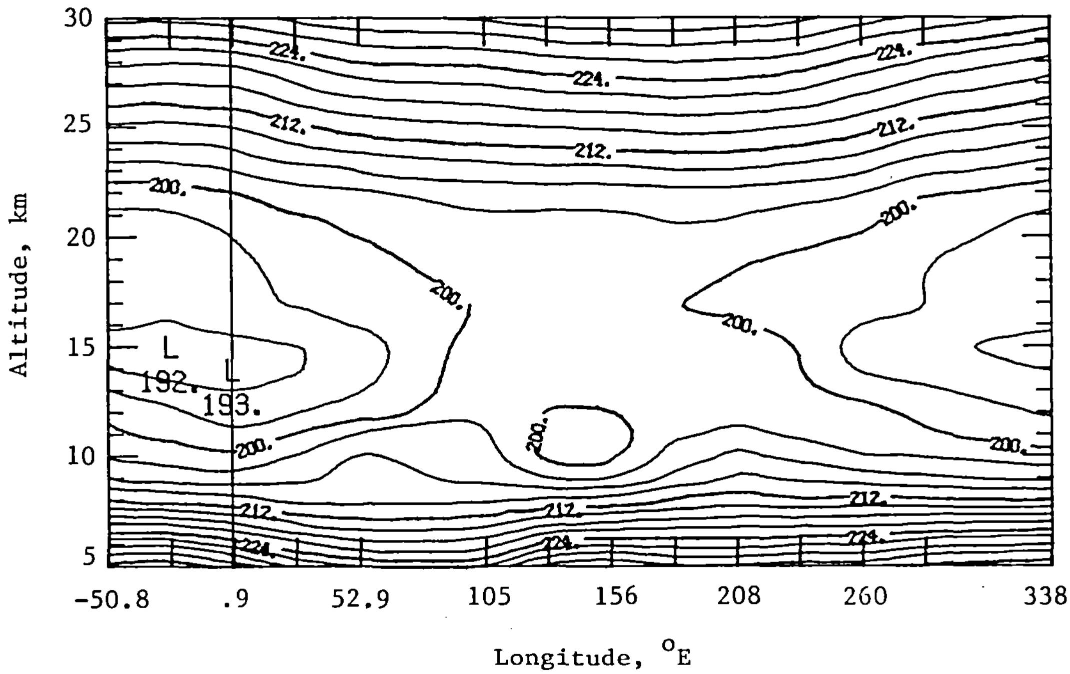


(b) Temperature contours.

Figure 60.- Antarctic extinction isopleth and temperature contours for September 28.08 to 29.09, 1980, at a latitude of 80.7° S corresponding to orbits 9741 to 9755.

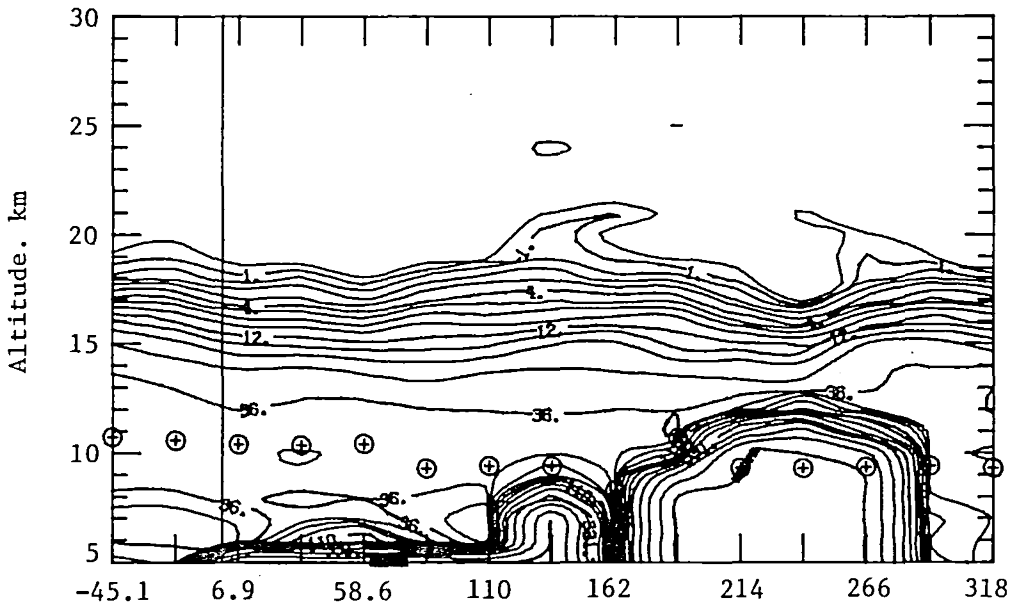


(a) Extinction isopleth.

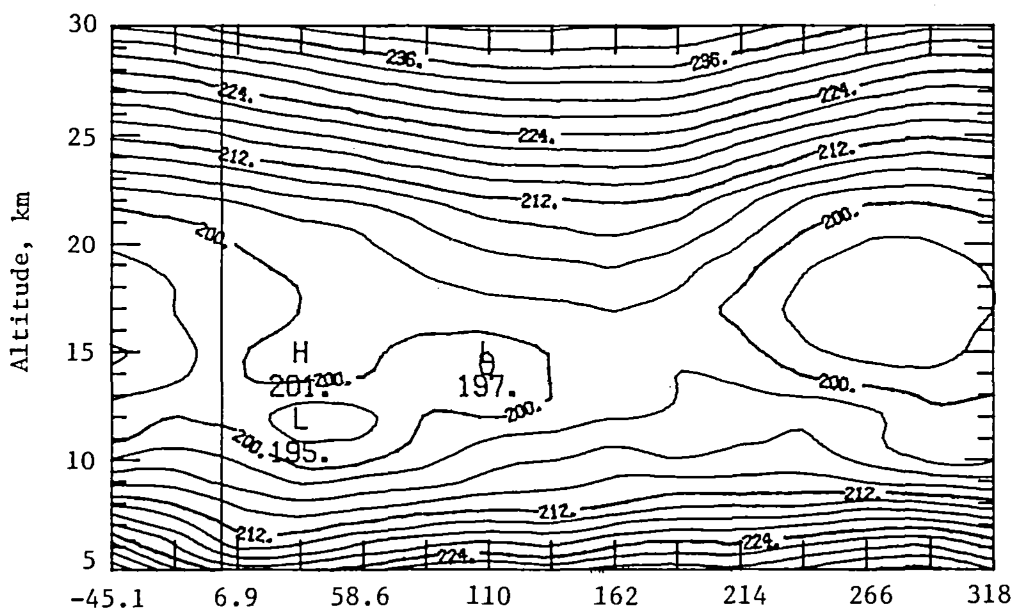


(b) Temperature contours.

Figure 61.- Antarctic extinction isopleth and temperature contours for October 5.89 to 6.98, 1980, at latitudes from 80.1° to 80.0° S corresponding to orbits 9849 to 9864.

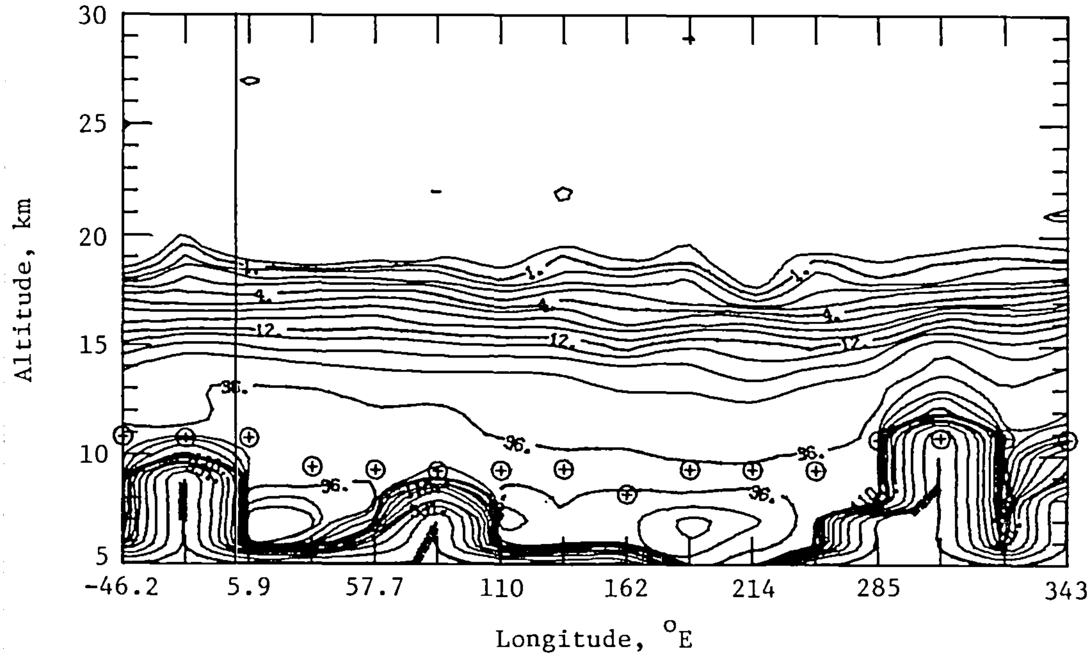


(a) Extinction isopleth.

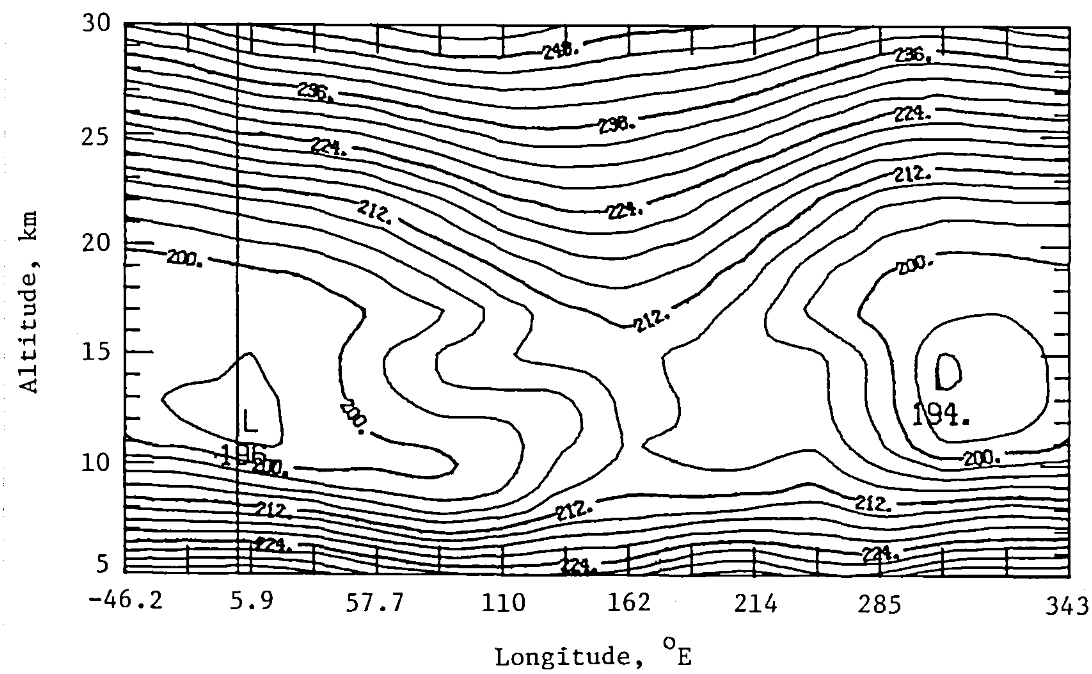


(b) Temperature contours.

Figure 62.- Antarctic extinction isopleth and temperature contours for October 12.98 to 14.00, 1980, at latitudes from 79.0° to 78.7° S corresponding to orbits 9947 to 9961.

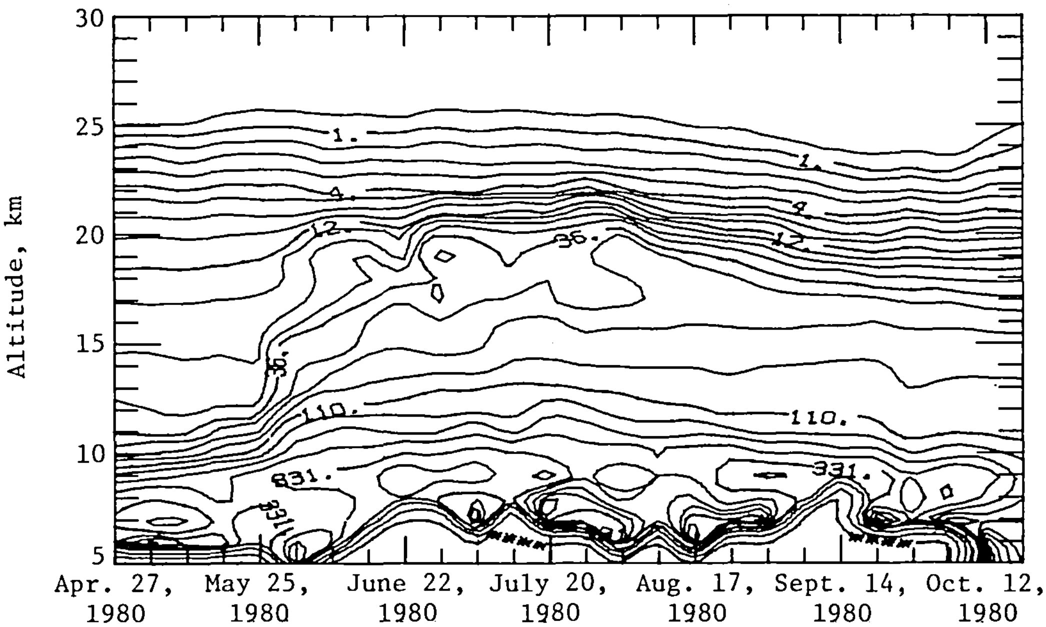


(a) Extinction isopleth.

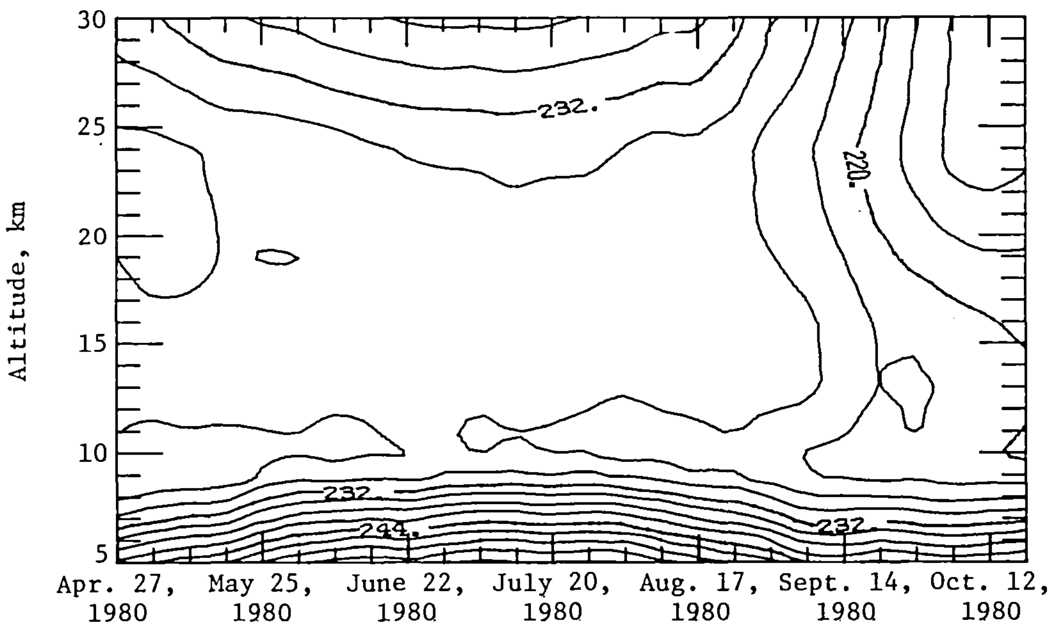


(b) Temperature contours.

Figure 63.- Antarctic extinction isopleth and temperature contours for October 20.94 to 22.03, 1980, at latitudes from 77.1° to 76.8° S corresponding to orbits 10 057 to 10 072.

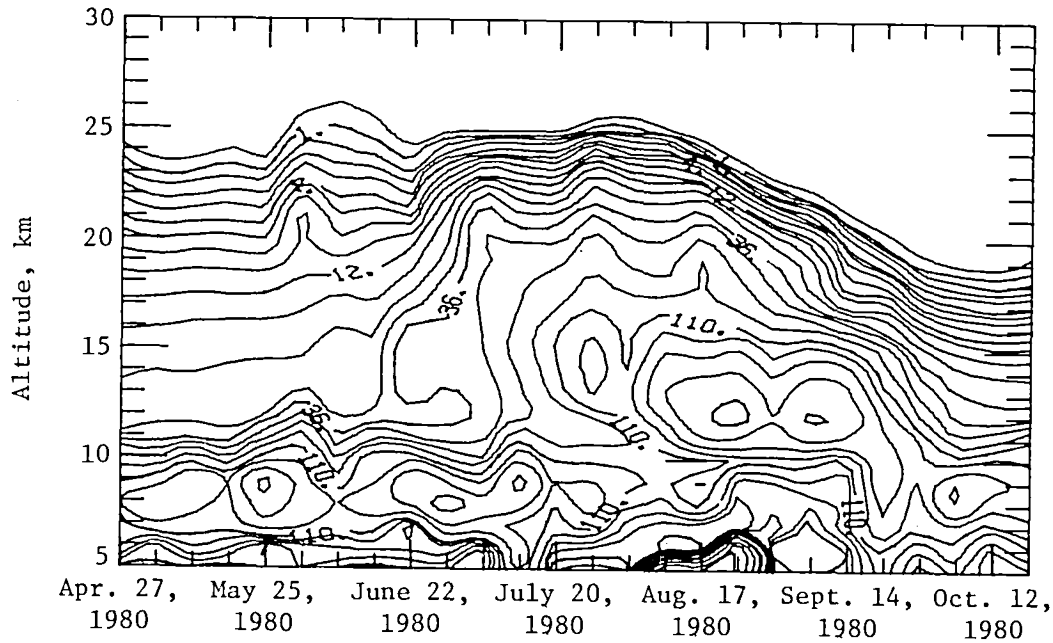


(a) Aerosol extinction at 1 μm in units of 10^{-5} km^{-1}.

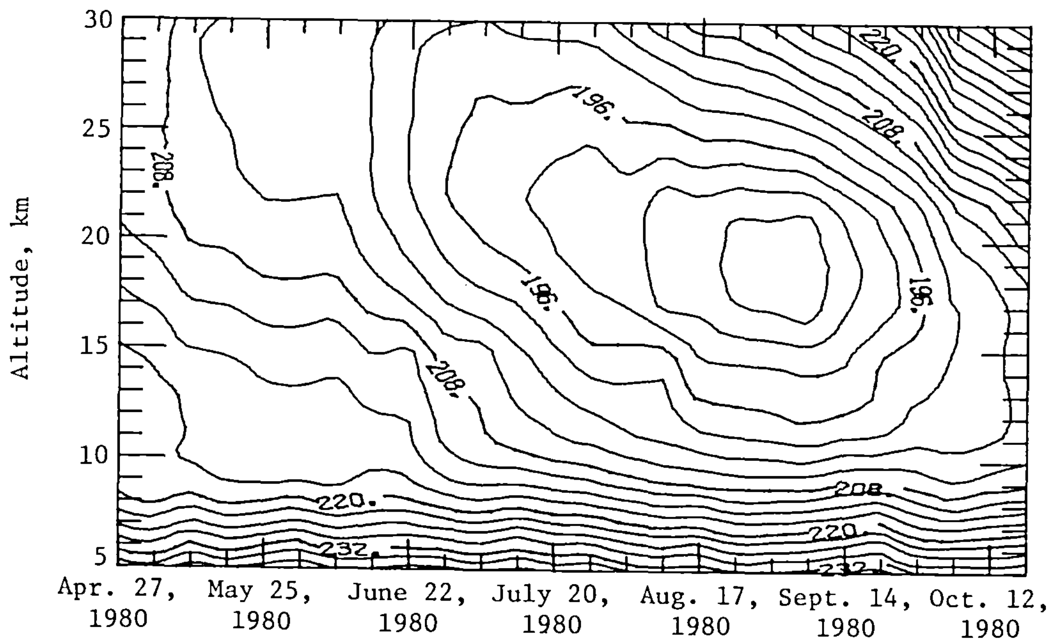


(b) Temperature field in kelvin at location of aerosol measurement.

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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16. Abstract

The Stratospheric Aerosol Measurement (SAM) II sensor is aboard the 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. 1980 to Oct. 1980) 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 1.0 μm for this time period are 2 to 4 times 10^{-4} km^{-1} for the Antarctic and 2 to 4 times 10^{-4} km^{-1} at the beginning to 1 to 2 times 10^{-3} km^{-1} at the end of the time period for the Arctic. Stratospheric optical depths are 0.002 to 0.003 for the Antarctic and 0.002 to 0.003 at the beginning to 0.005 to 0.006 at the end of the time period for the Arctic. 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 fourth 6 months of data to be used in atmospheric and climatic studies is reported.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
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