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Meteorological Atlas of the Northern Hemisphere Lower Stratosphere for January and February 1989 During the Airborne Arctic Stratospheric Expedition

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Meteorological Atlas of the Northern Hemisphere Lower Stratosphere for January and February 1989 During the Airborne Arctic Stratospheric Expedition

by

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PREFACE Northern Hemisphere meteorological data for the months of January and February 1989 in the lower stratosphere are shown. National Meteorological Center (NMC) data, and Total Ozone Mapping Spectrometer (TOMS) data are used to display polar stereographic projections of 100 mb temperatures, 50 mb temperatures, 50 mb geopotential heights, total ozone, and Ertel's potential vorticity (Epv) on both 400 K and 460 K isentropic surfaces. In addition, latitude/height cross sections at 10°E of balanced wind isotachs, wind vectors, potential temperature, and temperature are also shown. Horizontal traces of NASA ER-2 and DC-8 flight tracks are also included. Vertical profiles of NMC temperatures following flight paths of both aircraft are shown. In addition, vertical profiles of wind speed are contoured following the ER-2 for estimating the lateral penetration into the polar vortex, while vertical profiles of Ertel's potential vorticity are included for estimating the vertical penetration of the DC-8 into the stratosphere.

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1. INTRODUCTION

The Airborne Arctic Stratospheric Expedition (AASE) was primarily conducted over the January and February 1989 time period. The goals of the mission, as stated in the original mission document, were: 1) to study the production and loss mechanisms of ozone in the north polar stratospheric environment, and 2) to study the effect on the ozone distribution of the Arctic polar vortex and of the cold temperatures associated with the formation of polar stratospheric clouds (PSC). The mission was performed using the high-altitude NASA ER-2 aircraft, and the long-range NASA DC-8 aircraft. Both of these planes were operated out of Stavanger Norway (59°N, 5.6°E) from January to mid-February 1989

The purpose of this atlas is to provide a meteorological background for the AASE mission. The atlas also provides experimenters with both a cross check on their results, a global perspective with which to view those results, and an introduction to the National Meteorological Center (NMC) stratospheric analyses.

The atlas is divided into 4 sections. The first section describes the NMC and Total Ozone Mapping Spectrometer (TOMS) data used herein. The second section shows daily plots of: 50 mb temperature (polar stereographic projection), 100 mb temperature (polar projection), 50 mb geopotential height (polar projection), TOMS total ozone (polar projection), Ertel's potential vorticity (Epv) on both 400 K and 460 K isentropic surfaces (both on separate polar projections), a cross section at 10°E of temperature and potential temperature (latitude vs. altitude contour), and a cross section of balanced wind isotachs and wind vectors at 10°E (latitude vs. altitude contour). The third section shows the horizontal trace of the ER-2 and DC-8 flight tracks (polar projections). Finally, the fourth section shows the vertical profiles of temperatures and winds following the ER-2 flight track, and vertical profiles of temperatures and Epv following the DC-8 flight track.

2. DATA DESCRIPTIONS

A. National Meteorological Center data (NMC)

The NMC geopotential heights and temperatures used here are derived from two analysis systems: 1) tropospheric fields from 1000 mb to 100 mb, and 2) stratospheric analyses from 70 mb to 0.4 mb. Both analysis systems use National Environmental Satellite Data Information Service (NESDIS) satellite derived temperature profiles. These profiles serve as the an integral component of both analysis systems.

The tropospheric portion of the NESDIS temperature retrieval uses High Resolution Infrared Sounder (HIRS II) and Microwave Sounding Unit (MSU) data from both the NOAA-10 and NOAA-11 satellites. In the stratosphere, the NOAA-10 HIRS II and MSU radiances are combined with mapped NOAA-11 Stratospheric Sounding Unit (SSU) radiances. The mapped NOAA-11 SSU radiances have been interpolated to the NOAA-10 HIRS II and MSU measurement locations.

The operational analyses now use satellite temperature retrievals based on a minimum variance simultaneous retrieval method (Goldberg et al., 1988; Fleming et al. 1988; and Fleming et al. 1986). The minimum variance retrieval method is not dependent on week-old regression coefficients of co-located radiosonde data with satellite radiances as was done in the past. It is also important to note, however, that the NMC data are independent of ozone, since the HIRS channel 2 (9.6um) which is sensitive to ozone, is not utilized in the temperature retrievals (Smith et al., 1979).

The Global Data Acquisition System (GDAS) 1000 mb to 100 mb tropospheric fields are 1200 GMT daily global operational analyses (described by McPherson et al.,

1979). These tropospheric analyses result from optimal interpolation of radiosonde observations (RAOBS) and the NESDIS NOAA-10 and NOAA-11 satellite temperature retrievals with first-guess fields provided by the NMC prediction model.

The Northern Hemisphere stratospheric analyses developed by the NMC Climate Analysis Center are 1200 GMT operational analyses at the 70-0.4 mb pressure levels, produced from satellite temperature retrievals and RAOBS via a modified Cressman analysis (Gelman et al., 1987). The NESDIS satellite temperature retrievals serve as the first-guess field for the analyses. The NMC analyses below 10 mb are heavily dependent on RAOBS (particularly over the continents), but less dependent on the RAOBs and more dependent on the TOVS retrievals over ocean areas and ice covered regions.

B. Balanced Winds, Ertel's Potential Vorticity, and Potential Temperature.

Balanced winds, Ertel's potential vorticity, and potential temperature are derived at NASA/GSFC from the NMC heights and temperatures. The balanced winds are iteratively calculated from the balance between the momentum equations assuming small vertical velocities (generally true), see Randel (1987). the Epv is calculated from,

$$Q = -g\,(\xi+f)\,\frac{\partial\theta}{\partial p} \qquad (1)$$

Here, Q is Epv, ξ is the relative vorticity (calculated from balanced winds) g is 9.81 m/s^2, f is the planetary vorticity, and θ is the potential temperature. The potential temperature is calculated directly from the temperatures, $\theta = T\,(p_0/p)^{\gamma}$, where $\gamma=2/7$, and $p_0=1000$ mb. The NMC fields used in these calculations have not been smoothed. Typical mid-latitude values for the quantities in (1) are 10^{-4} 1/s for the absolute vorticity, and 10^{-2} K m s^2/kg for the pressure derivative of potential temperature at 420 K. Therefore, Q is on the order of 10^{-5} K m^2/(kg s),

hence, the polar stereographic Epv plots have been scaled with a factor of 10^5, and one Epv unit is 10^{-5} K m^2/(kg s).

C. Total Ozone Mapping Spectrometer (TOMS)

The total ozone fields are obtained from the TOMS gridded analyses (see Krueger et al., 1989). The TOMS instrument is aboard the Nimbus-7 satellite. This satellite is a sun-synchronous polar orbiter (approximately 14 orbits/day) with a near local noon equator crossing. TOMS is a cross-course scanning instrument which samples backscattered radiation at six wavelengths (312.5, 317.5, 331.2, 339.8, 360, and 380 nm). The cross nadir scan is sequentially performed in three degree steps from ±51°, producing 35 total ozone measurements over a 2800 km line approximately perpendicular to the sub-orbital track. The resolution ranges from approximately 50 km at nadir to 200 km at the ±51° scan points (~1400 km to the left/right of the sub-orbital track). The TOMS scanning capability in conjunction with ~14 orbits/day yields global daily total ozone pictures. The data set used here result from TOMS data which are averaged onto a 2° latitude by 5° longitude grid. In addition, the data have been approximately normalized to Dobson spectrophotometer network averages.

3. SECTION II FIGURES

Each day (29 December 1988 to 28 February 1989, denoted as 881201 and 890228, respectively) consists of a set of 8 plots on two separate pages with each plot separately titled and dated. Each day is set up to be viewed on the left and right hand sides of the pages. The first page has polar stereographic projections of NMC 100 mb temperature, NMC 50 mb temperatures, TOMS total ozone, and NMC 50 mb geopotential heights. The second page has 2 polar stereographic plots of NMC Epv on the 400 K and 460 K isentropic surfaces. In addition, two latitude/height cross sectional plots at 10°E of 1) temperature (solid line) and potential temperature (dashed line); and 2) balanced wind isotachs ($\sqrt{(u^2+v^2)}$) and wind vectors (vector convention: an eastward wind is up, a northward wind is to the right). On ER-2 flight dates, the ER-2 flight tracks are superimposed on the latitude/altitude cross sections as the thick solid line.

4. SECTION III FIGURES

This section displays the ER-2 and DC-8 flight tracks for all of the flights during the mission (including arrival and departure ferry flights from NASA/AMES). The ER-2 flight tracks are shown in Section IIIa, while the DC-8 flight tracks are shown in Section IIIb. In order to better understand the meteorological conditions during a flight for particular days, it is useful to make viewgraphs of these figures to overlay on the polar projections of section II.

5. SECTION IV FIGURES

This section is split into two parts. Section IVa displays vertical profiles

of data following the ER-2 flights, while Section IVb shows the vertical profiles following the DC-8 flight. These data have been termed "curtain files", since the vertical profiles suggest a vertical curtain hanging in the atmosphere. The ER-2 data are displayed in the first portion of this section. The ER-2 curtain files (IVa) are plotted for temperatures and balanced wind isotachs, while the DC-8 curtain files (IVb) are plotted for the temperatures and Epv , see equation 1 (potential temperature is indicated by a dashed line). The Epv curtain files for the DC-8 have a logarithmic contour interval, in order to facilitate ease of interpretation

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Section II

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FIGURE CAPTIONS, SECTION II

First Page

Top left: NMC 100 mb temperature on a polar stereographic projection. The maximum, minimum and contour increment are noted on the figure base. The outer circle corresponds to 30°N, with an additional latitude circle at 60°N. The prime meridian is at the bottom.

Bottom left: As in top left, but for 50 mb temperatures. Units are K.

Top right: As in top left, but for TOMS total ozone. Units are Dobson Units (DU)

Bottom right: As in top left, but for 50 mb geopotential heights. Units are geopotential meters (m).

Second Page

Top left: Ertel's potential vorticity on a 400 K isentropic surface (constant potential temperature). The outer circle corresponds to 30°N with an additional latitude circle at 60°N. The prime meridian is at the bottom. The Epv data (MKS units of K m^2/kg s) is scaled by 10^5.

Bottom left: As in top left, but for the 460 K isentropic surface.

Top right: Latitude/height cross section at 10°E of temperature (solid lines, units are K), and potential temperature (dashed lines, units of K).

Bottom right: As in the top right, but for balanced wind vectors and isotachs (5 m/s contour increment). The vector orientation shows a westerly (easterly) wind vector pointing upward (downward), and a northerly (southerly) wind pointing to the left (right). Note: a westerly wind blows from west to east, while a northerly wind blows from north to south.

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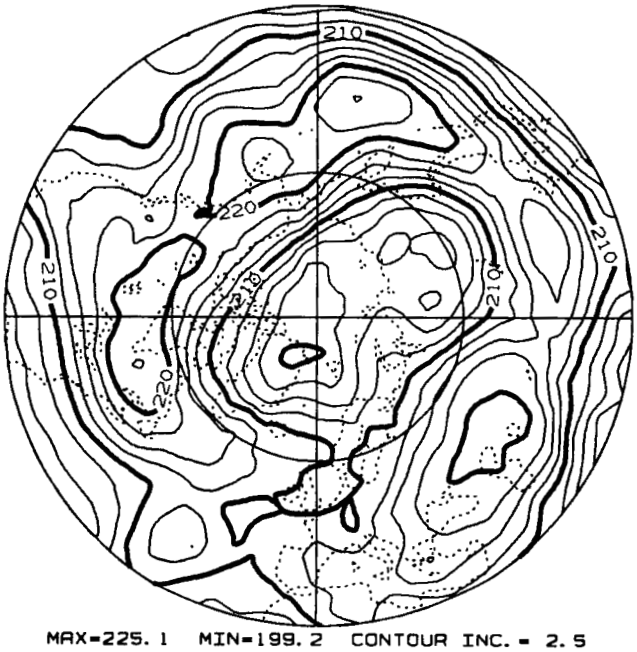

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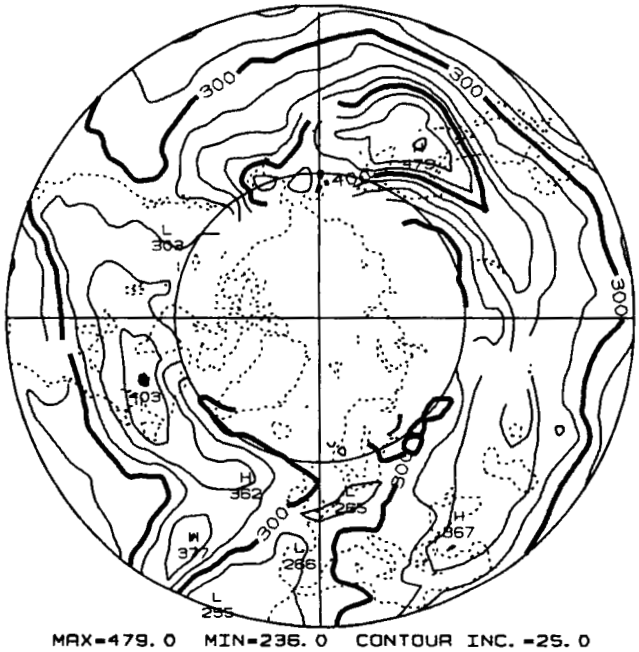

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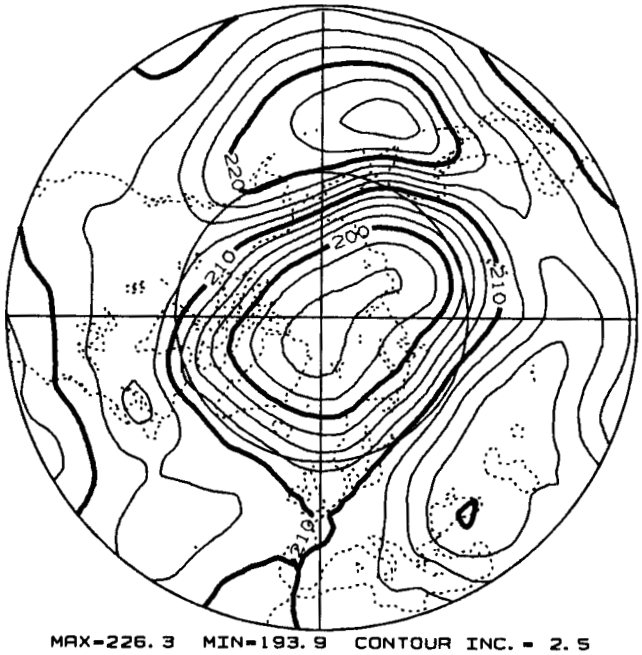

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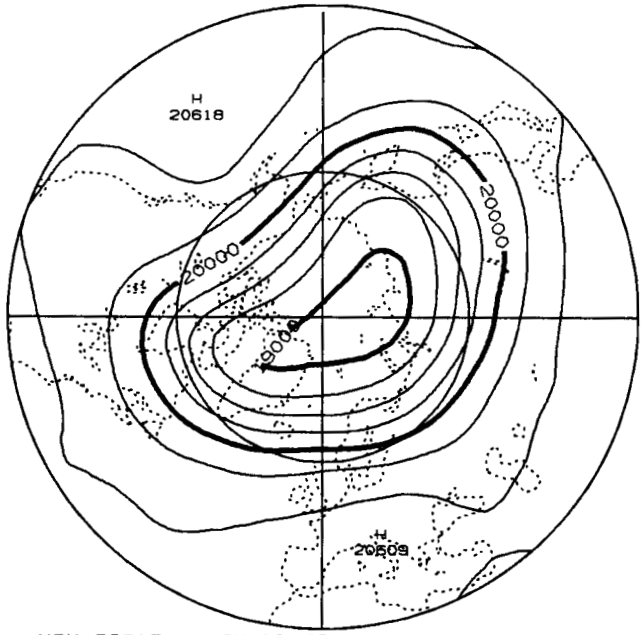

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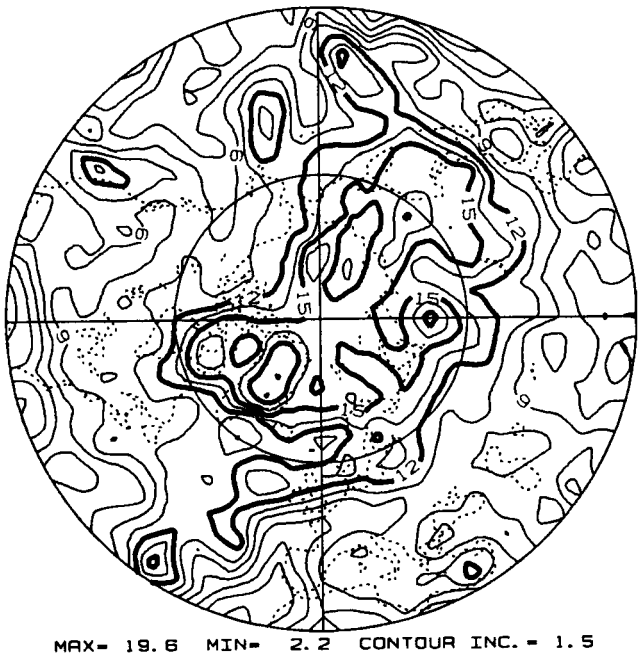

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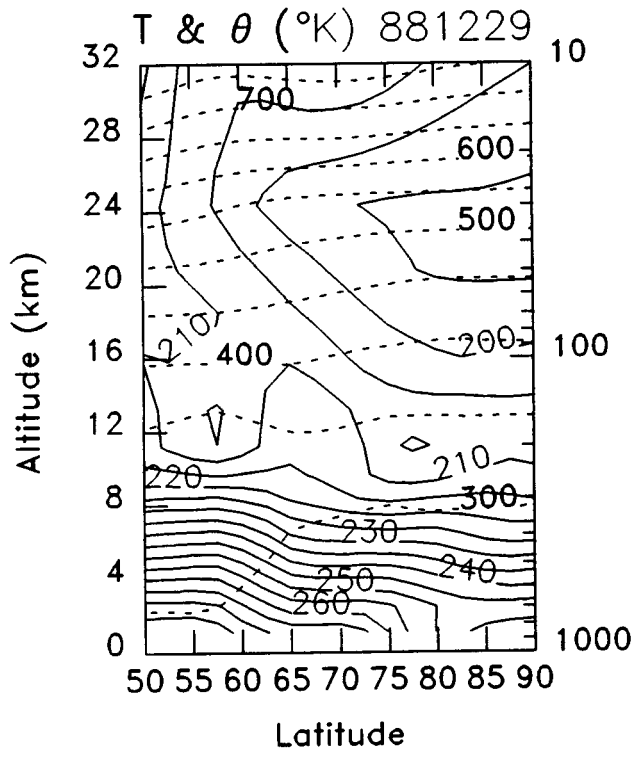

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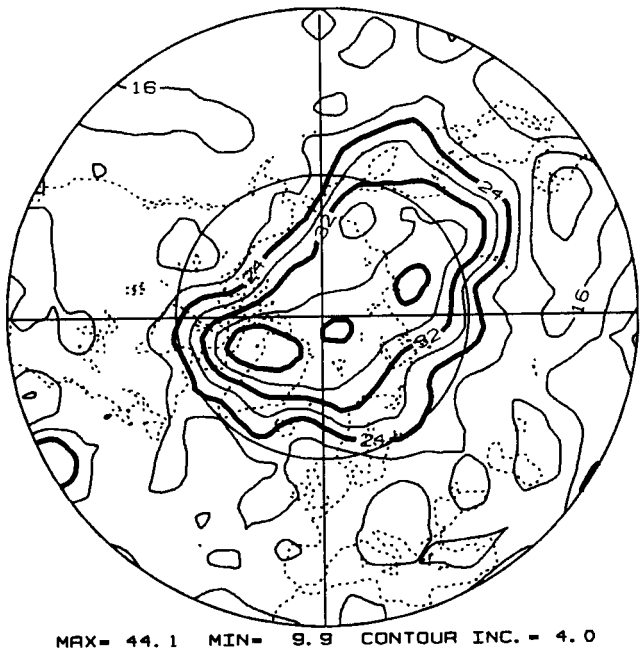

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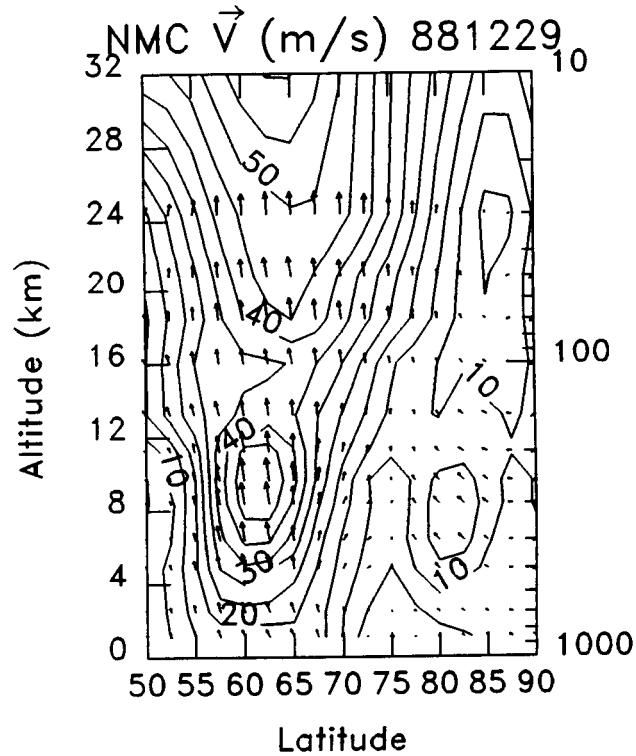

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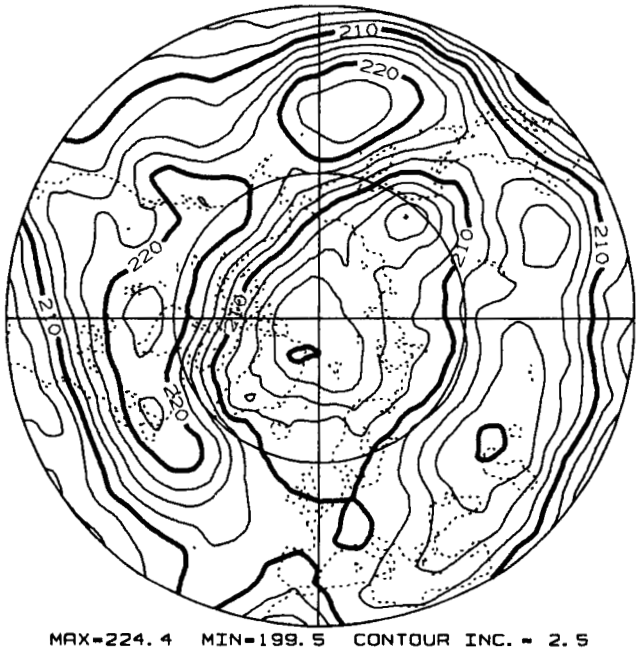

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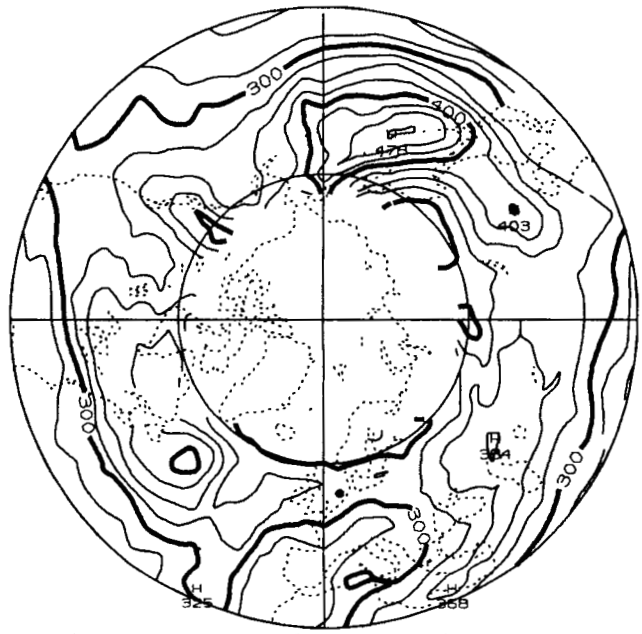

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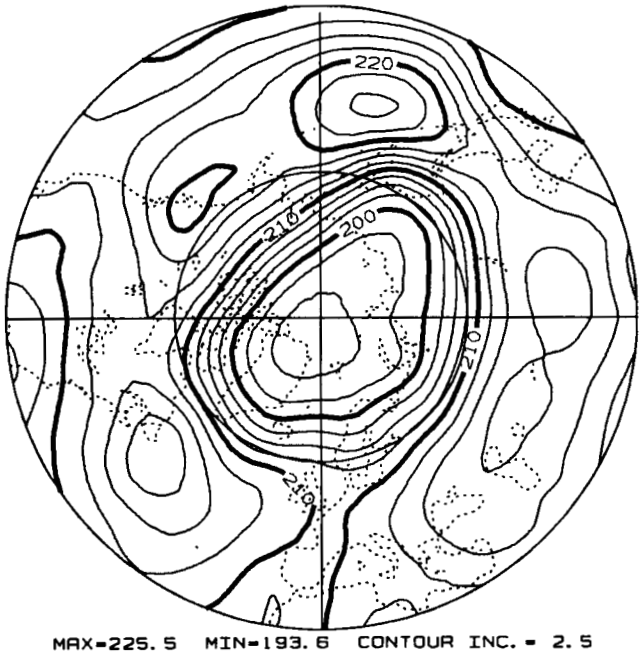

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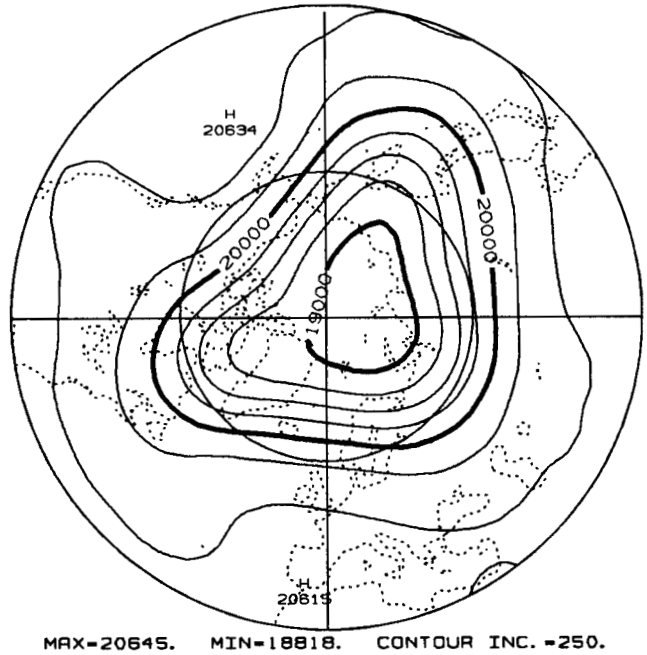

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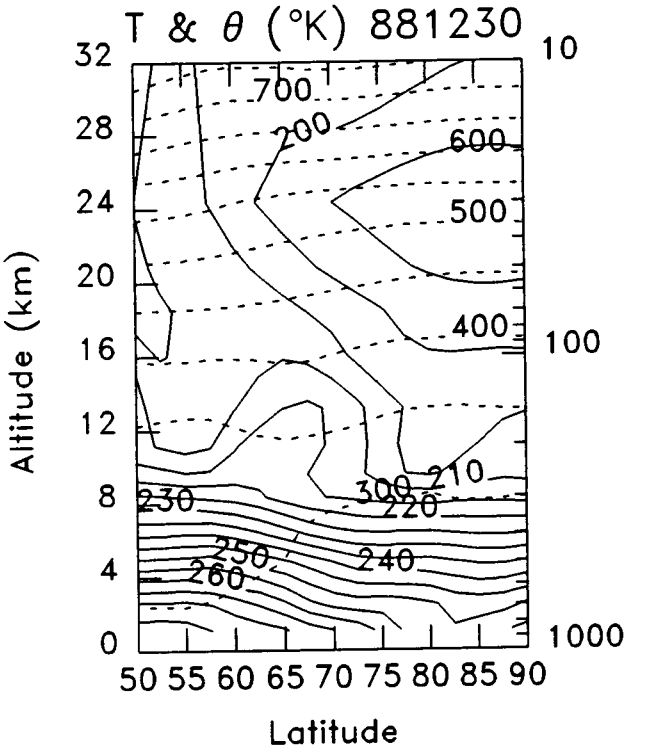
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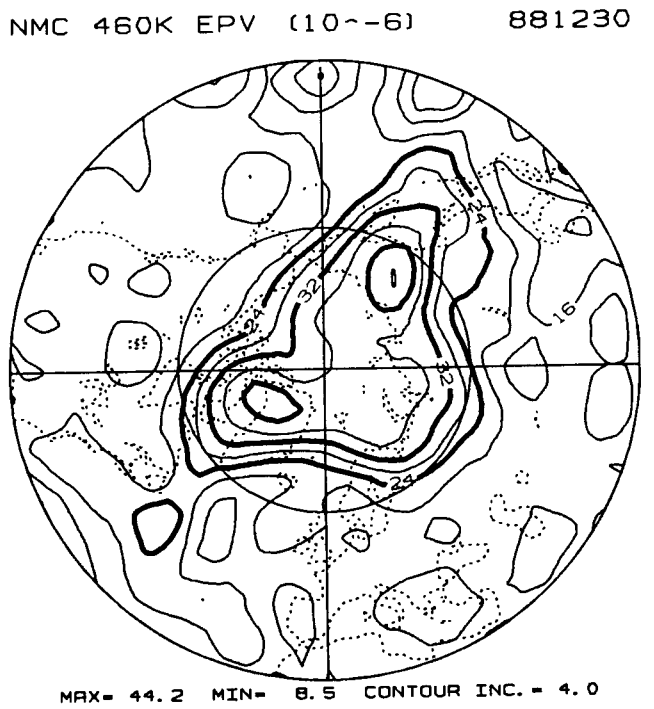
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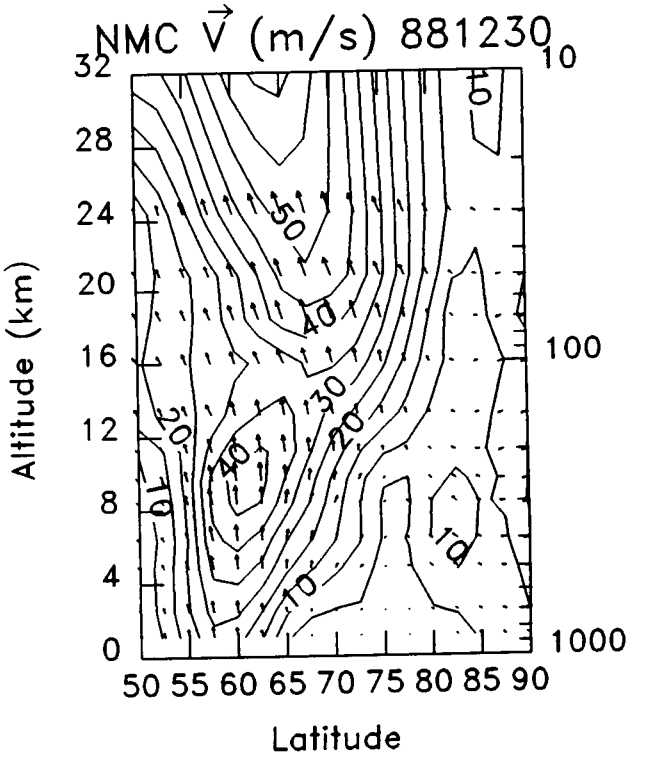
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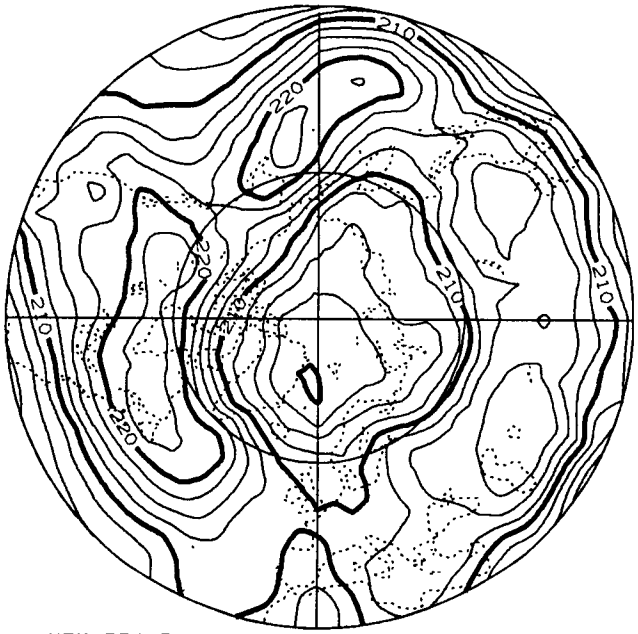

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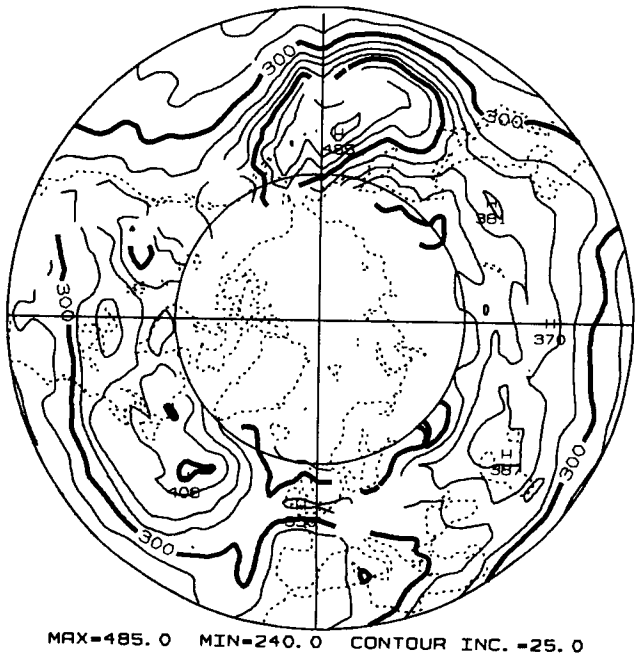

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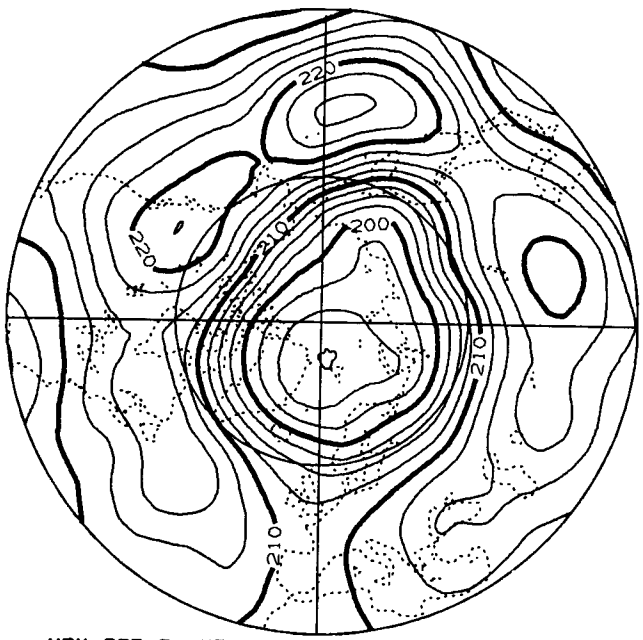

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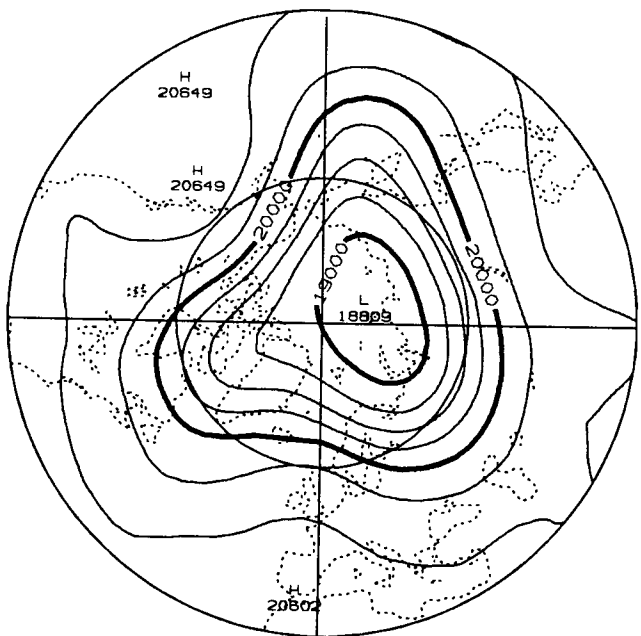

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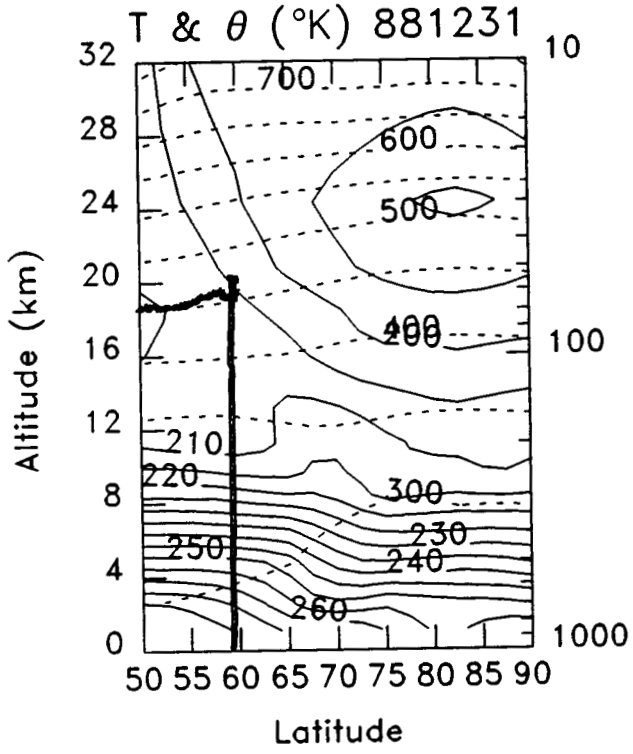
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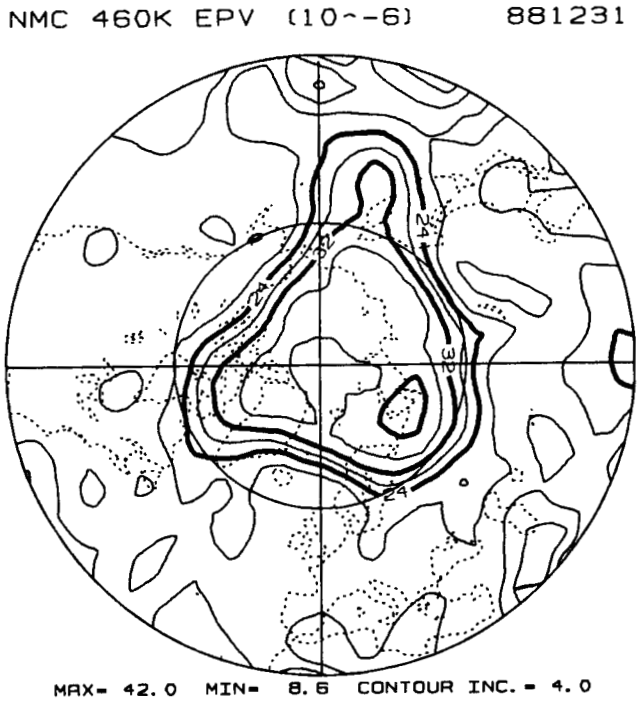
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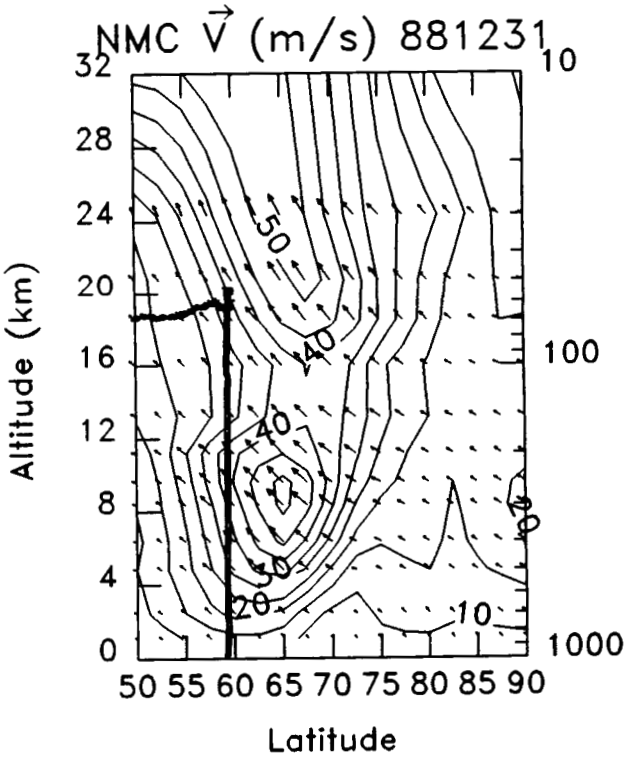
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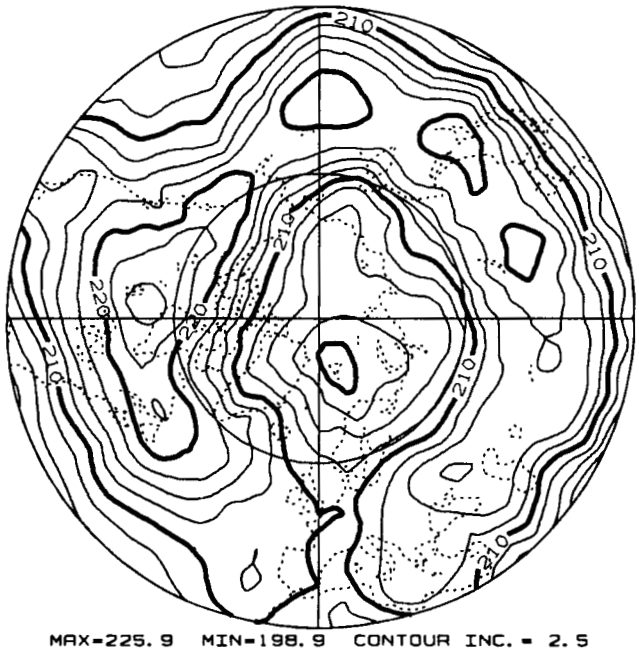

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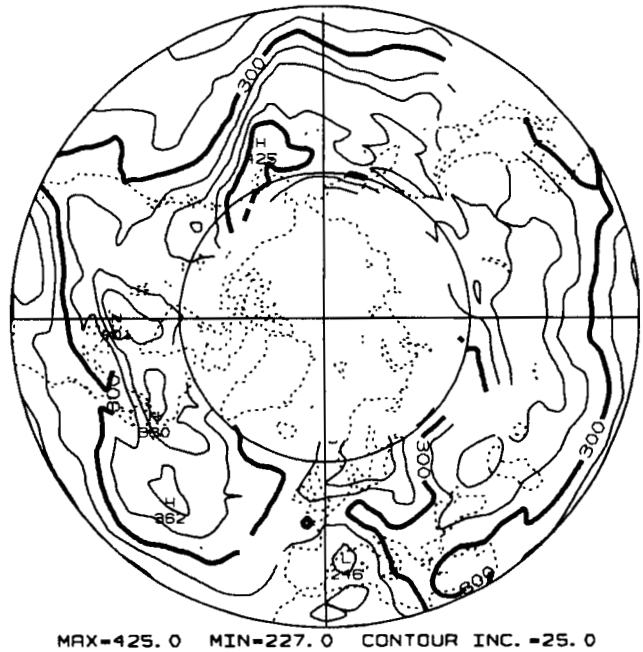

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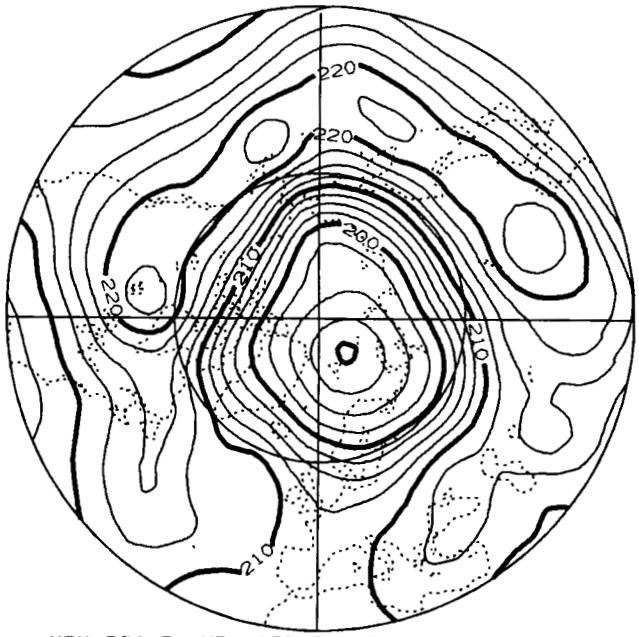
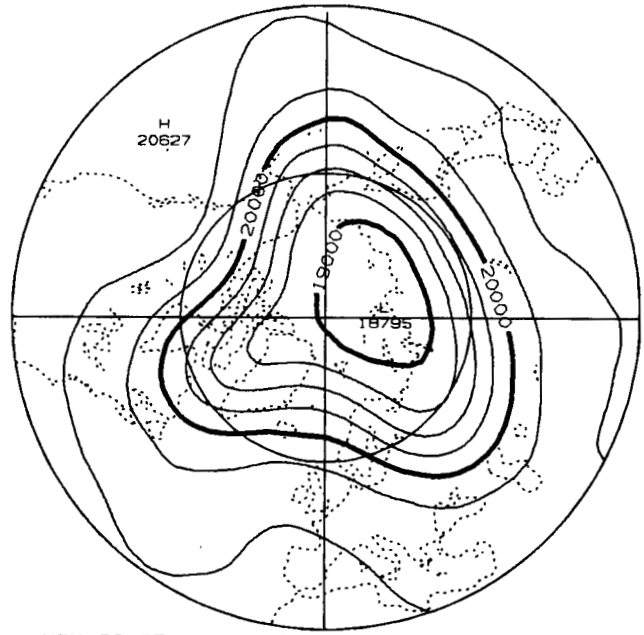
NMC 50MB TEMP. (K) 890101

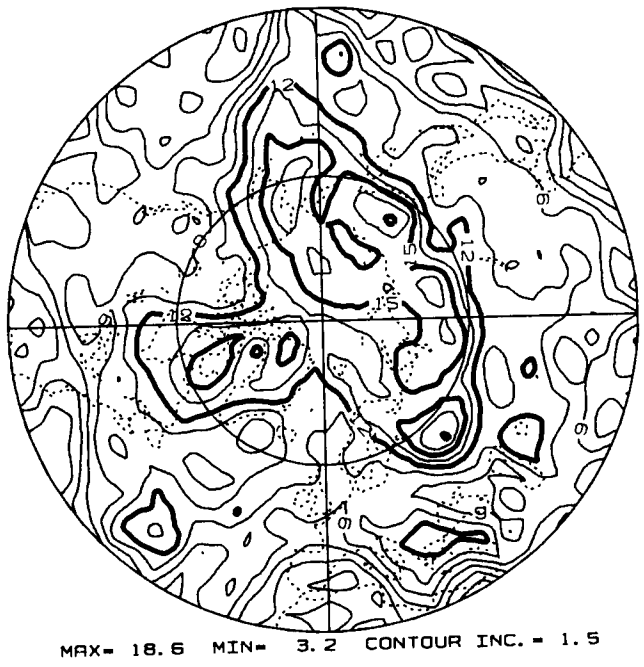


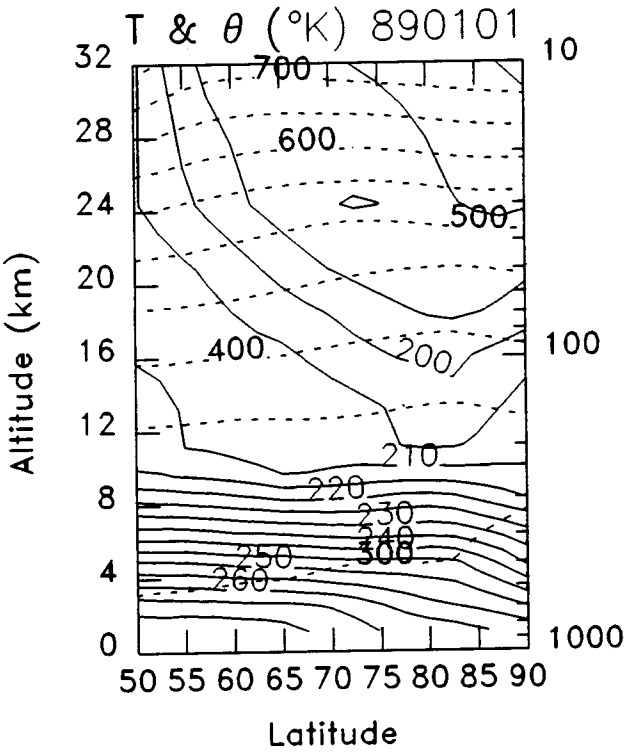
MAX=224.6 MIN=189.8 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890101



MAX=20627. MIN=18795. CONTOUR INC.=250.


NMC 400K EPV (10^-6) 890101
MAX= 18.6 MIN= 3.2 CONTOUR INC. = 1.5


T & θ (°K) 890101
Altitude (km)
Latitude
700
600
500
400
200
210
220
230
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300
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260
32
28
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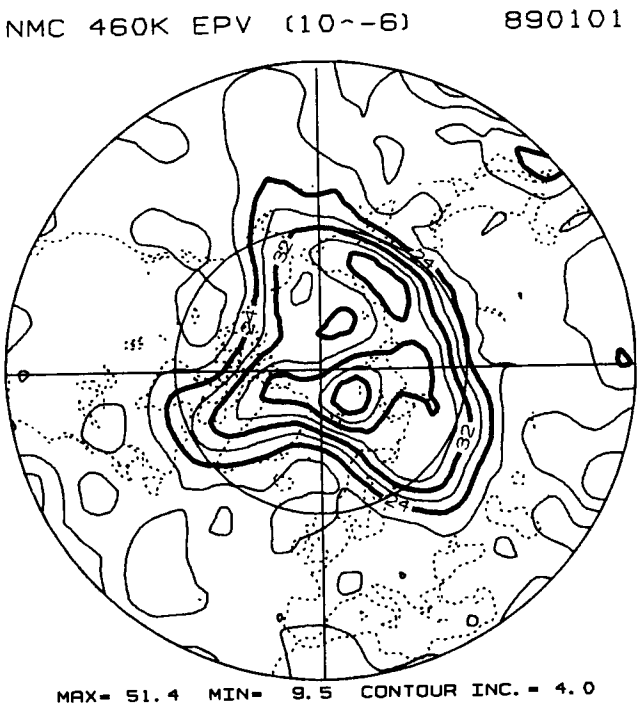
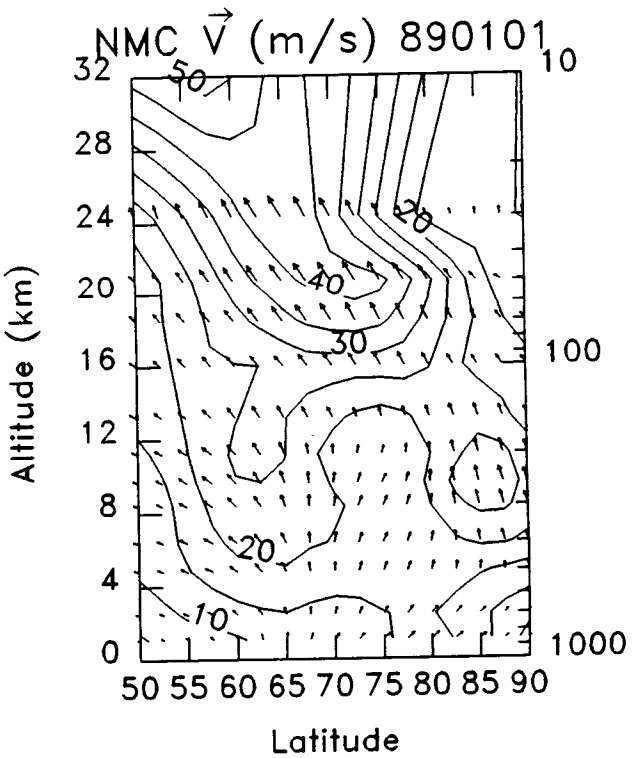
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890101
MAX= 51.4 MIN= 9.5 CONTOUR INC. = 4.0


NMC V (m/s) 890101
Altitude (km)
Latitude
50
40
30
20
10
32
28
24
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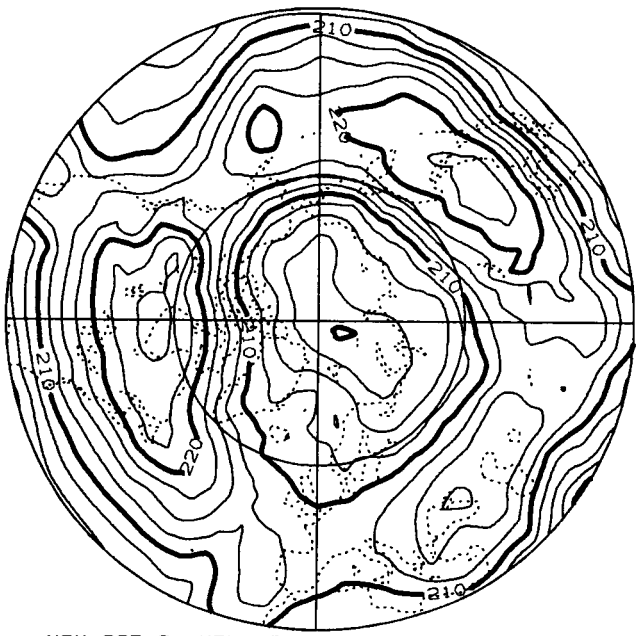
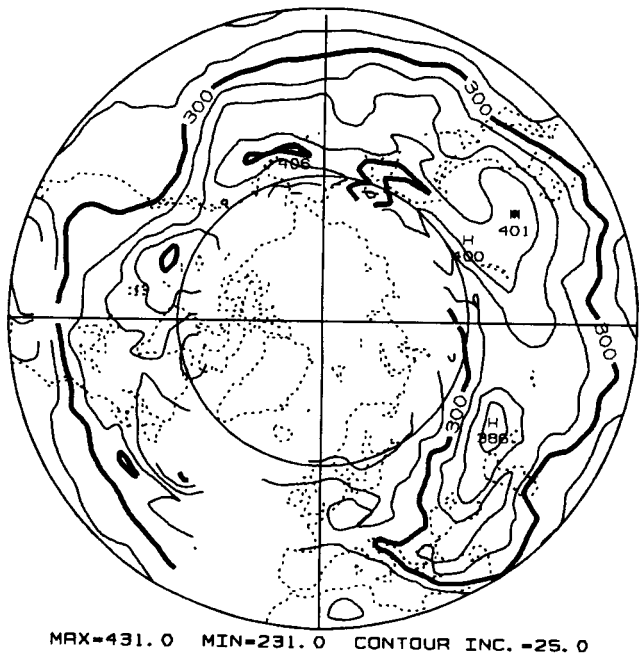
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890102



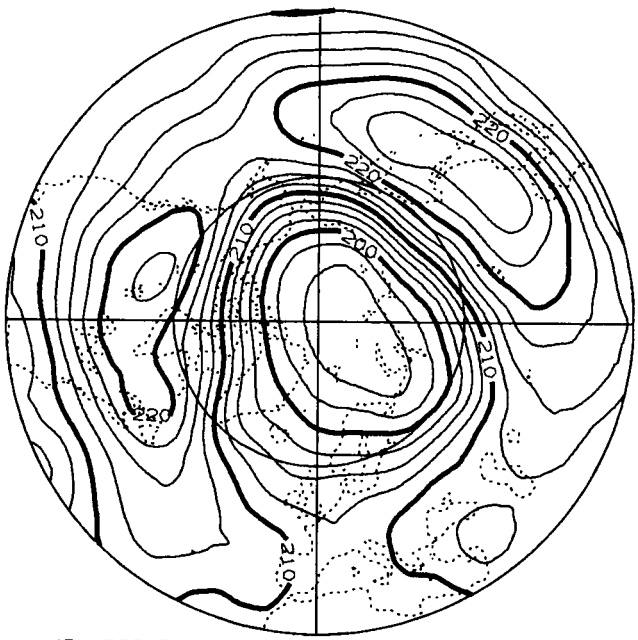
MAX=225.9 MIN=199.6 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890102



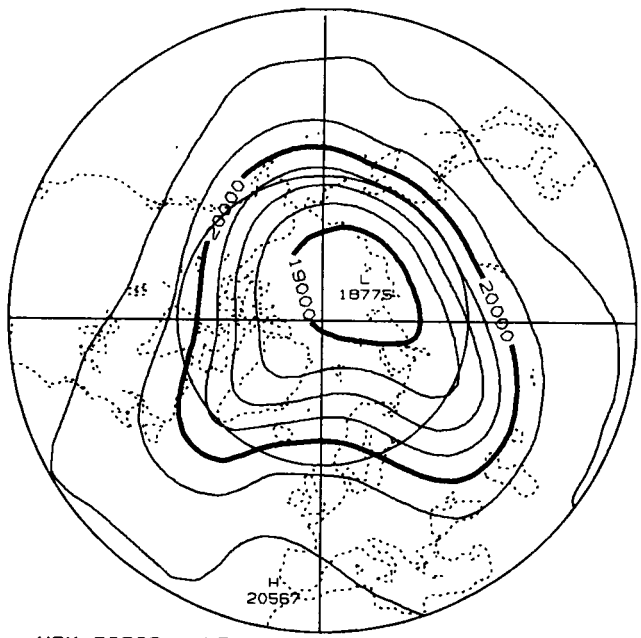
MAX=431.0 MIN=231.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890102



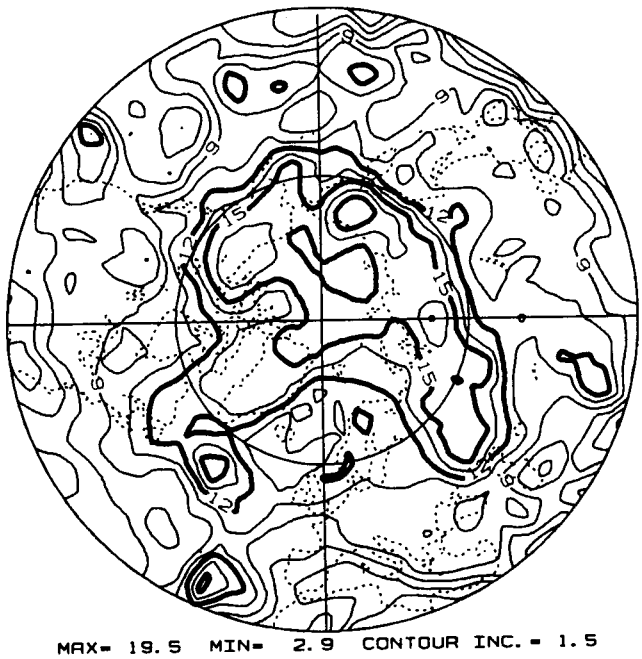
MAX=226.9 MIN=192.9 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890102



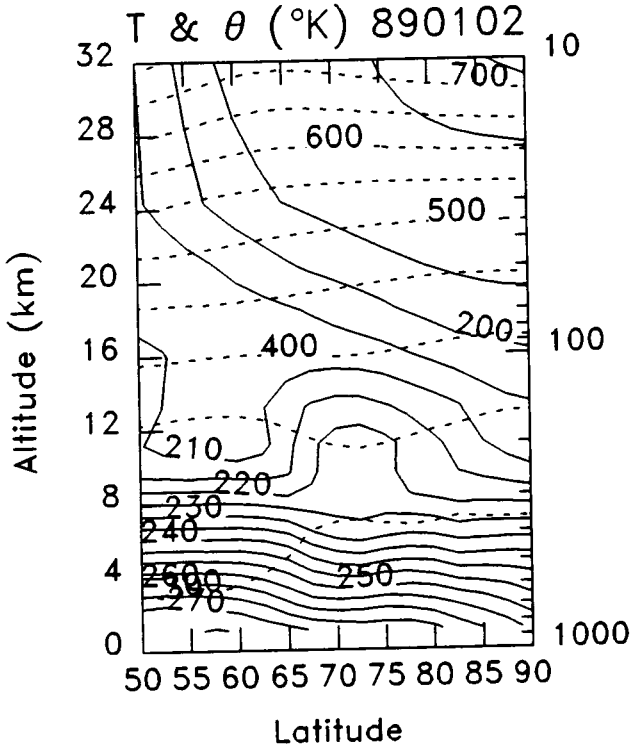
MAX=20609. MIN=18775. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890102

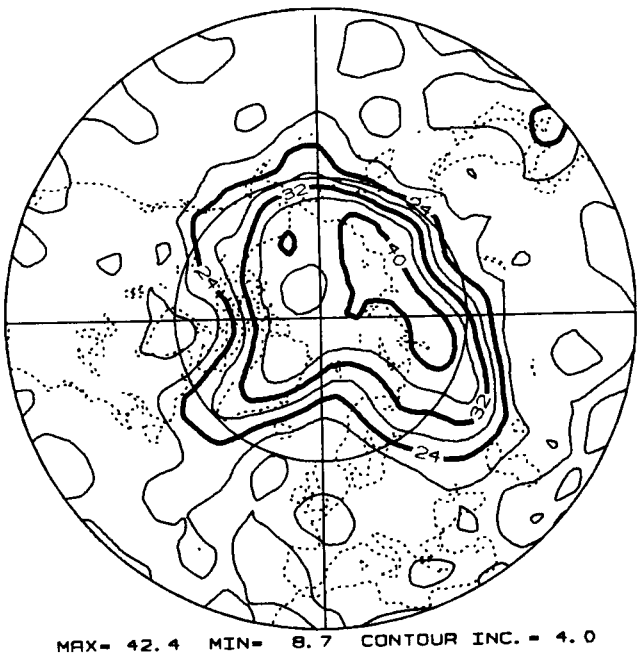


MAX= 19.5 MIN= 2.9 CONTOUR INC. = 1.5

T & θ (°K) 890102

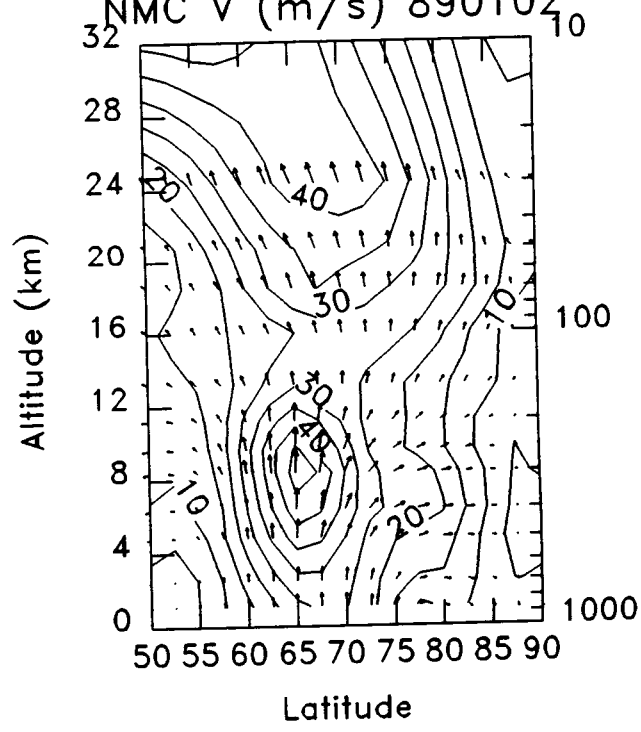


NMC 460K EPV (10^-6) 890102

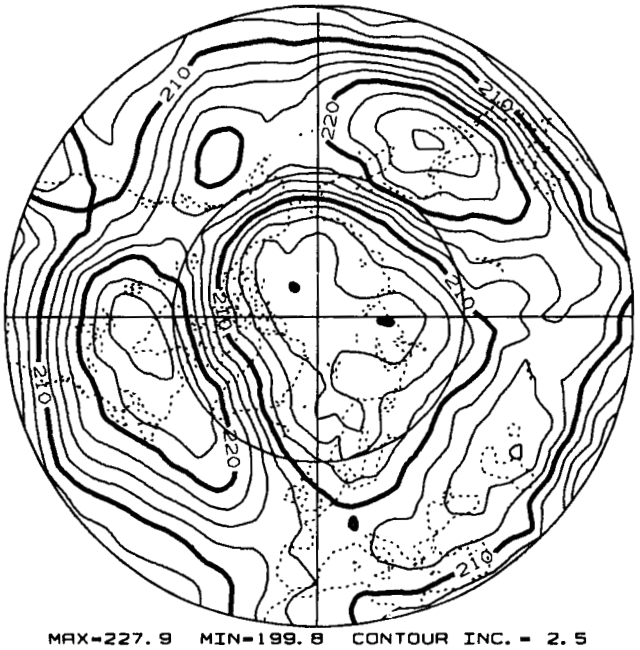


MAX= 42.4 MIN= 8.7 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890102

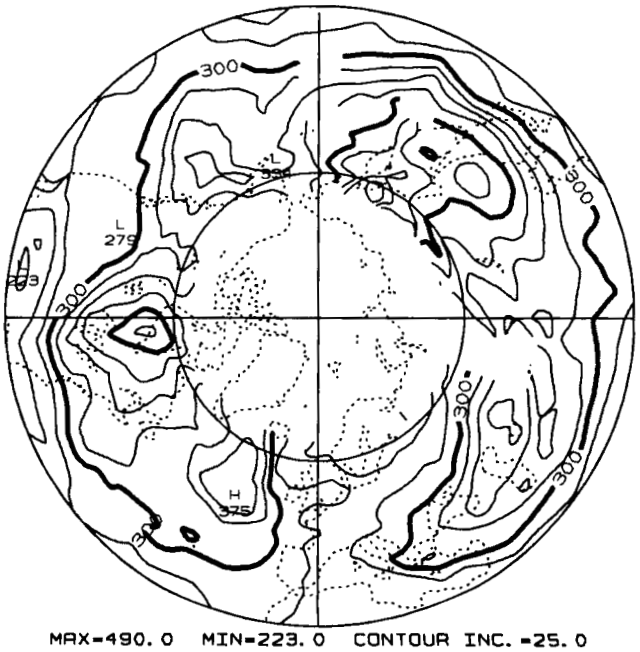


NMC 100MB TEMP. (K) 890103



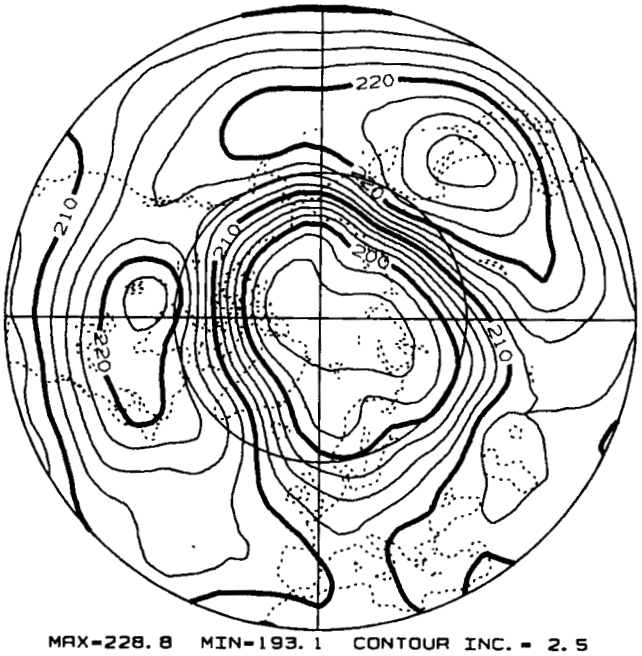
MAX=227.9 MIN=199.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890103



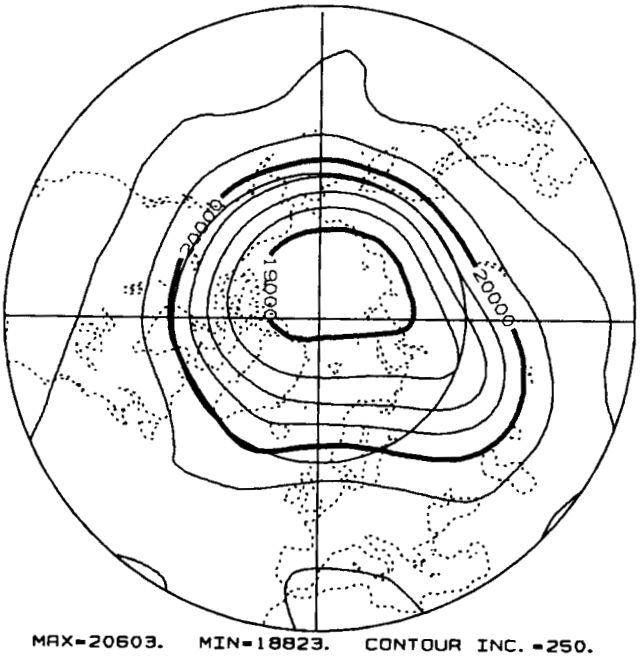
MAX=490.0 MIN=223.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890103

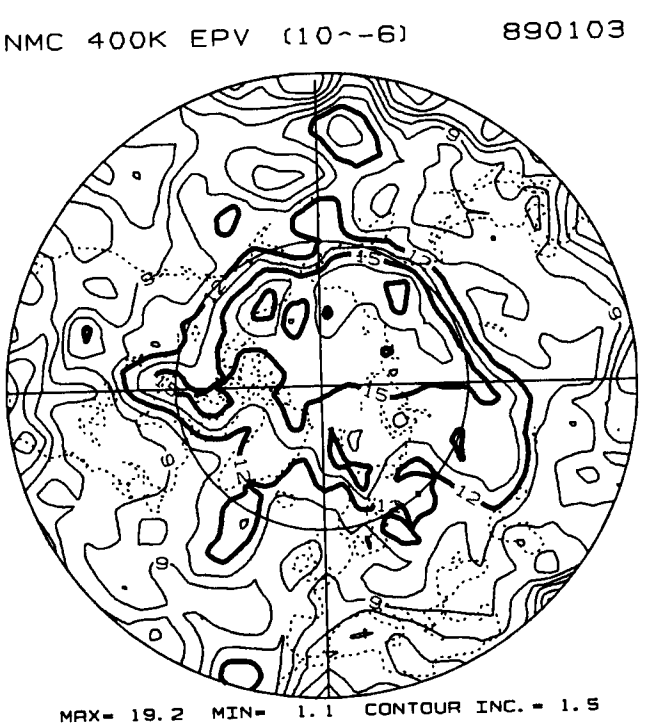


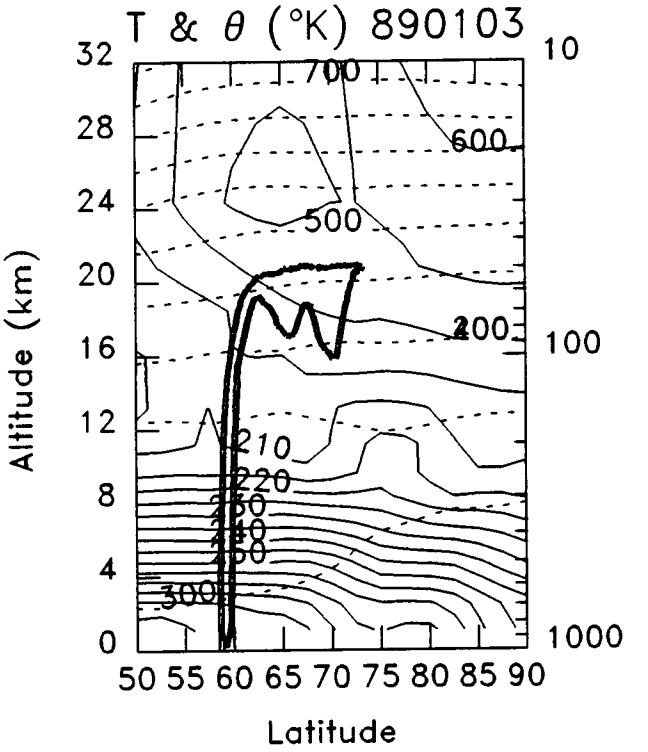
MAX=228.8 MIN=193.1 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890103



MAX=20603. MIN=18823. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890103
MAX= 19.2 MIN= 1.1 CONTOUR INC. = 1.5


T & θ (°K) 890103
Altitude (km)
Latitude
700
600
500
400
300
210
220
230
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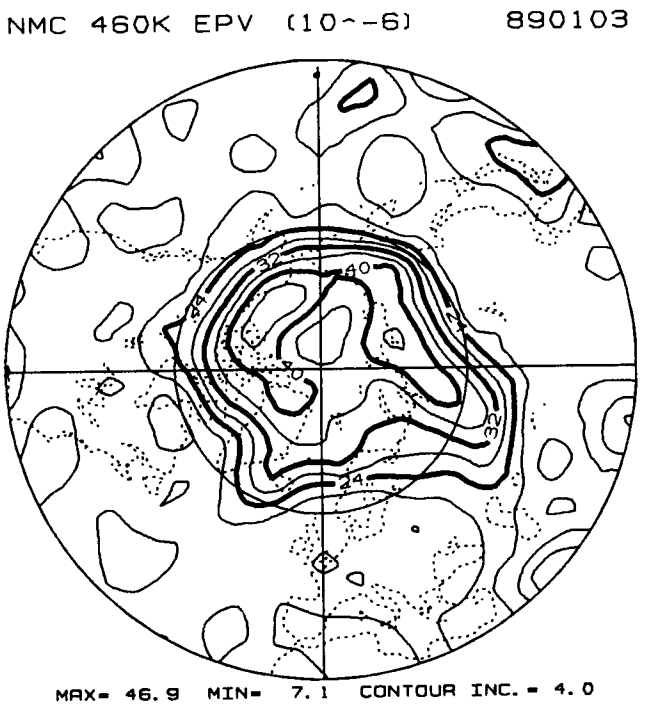
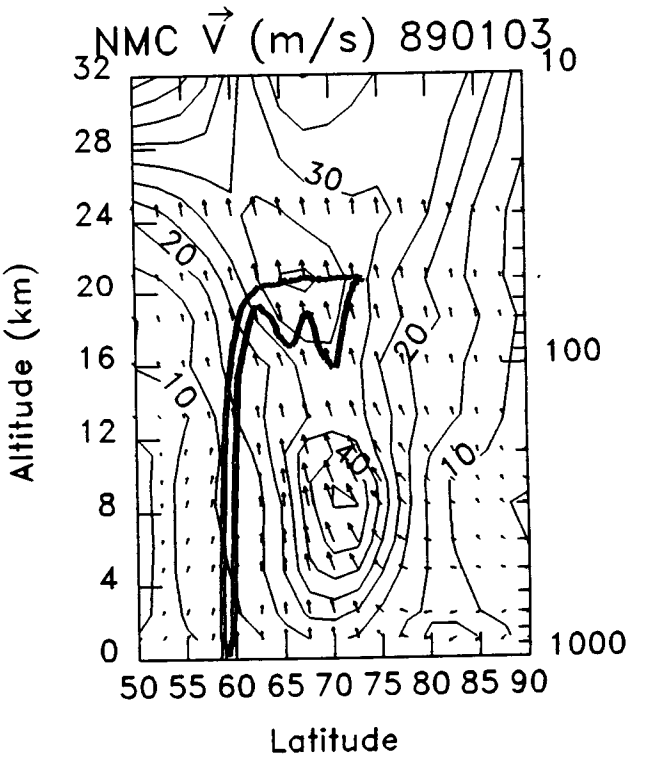
250
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890103
MAX= 46.9 MIN= 7.1 CONTOUR INC. = 4.0


NMC V (m/s) 890103
Altitude (km)
Latitude
30
20
10
32
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24
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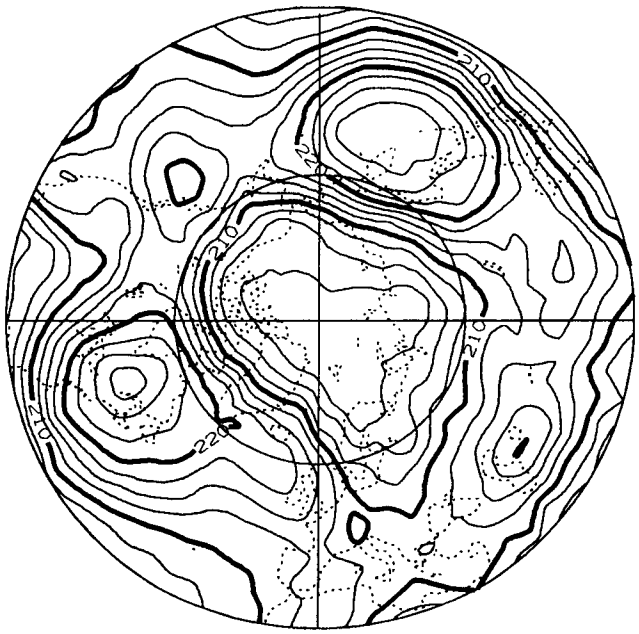
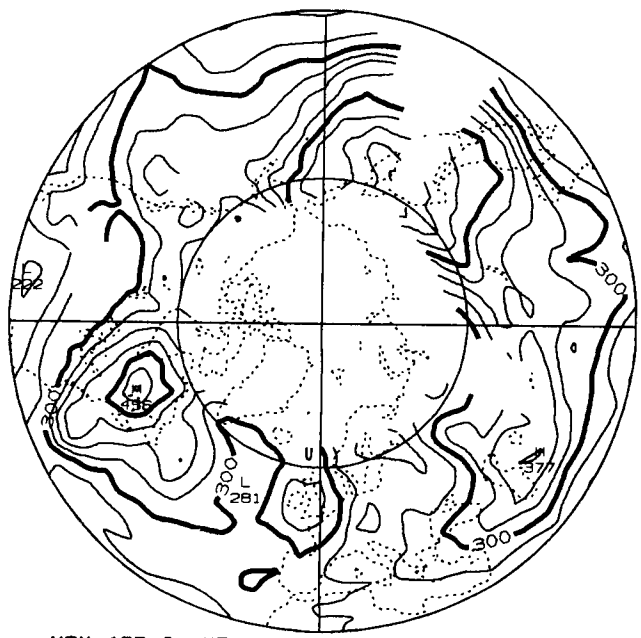
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890104



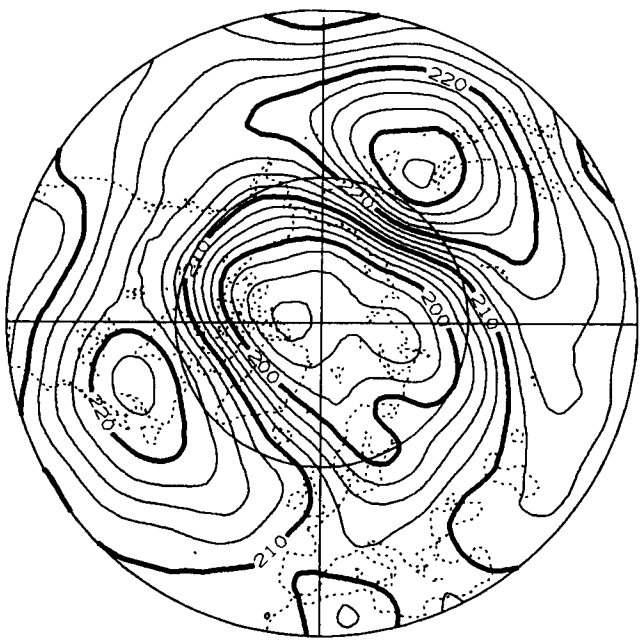
MAX=229.6 MIN=200.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890104



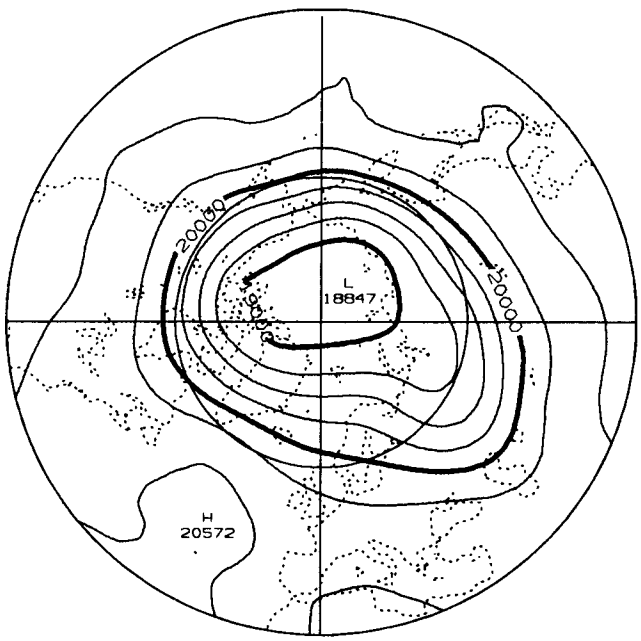
MAX=487.0 MIN=222.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890104



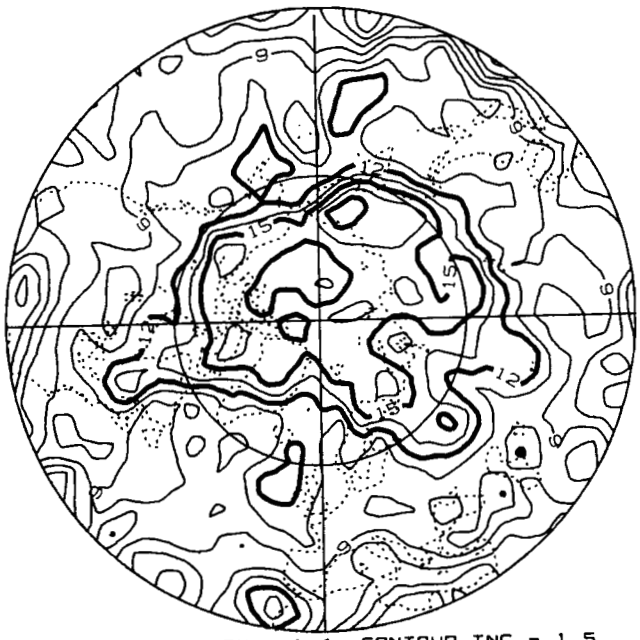
MAX=233.0 MIN=191.7 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890104



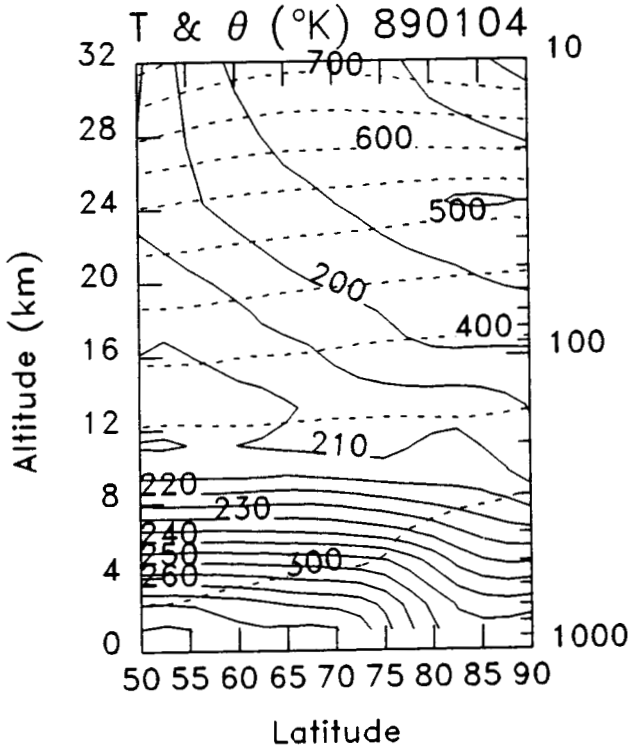
MAX=20588. MIN=18847. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890104

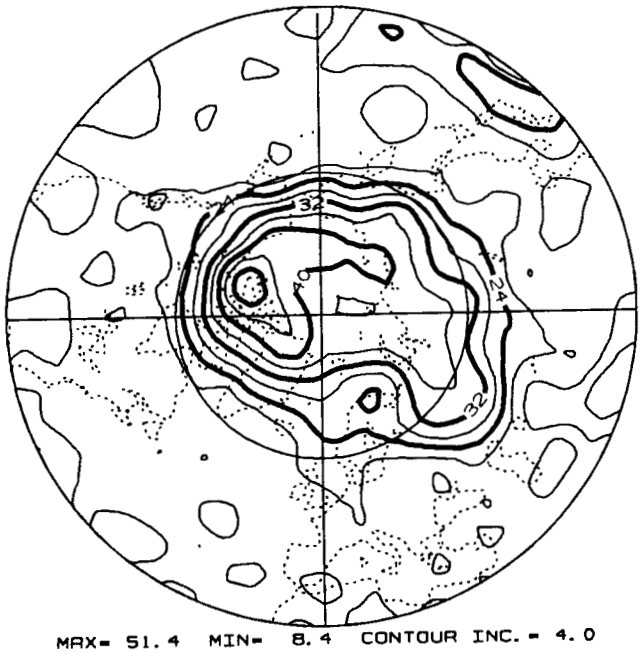


MAX= 19.0 MIN= 1.4 CONTOUR INC. = 1.5

T & θ (°K) 890104

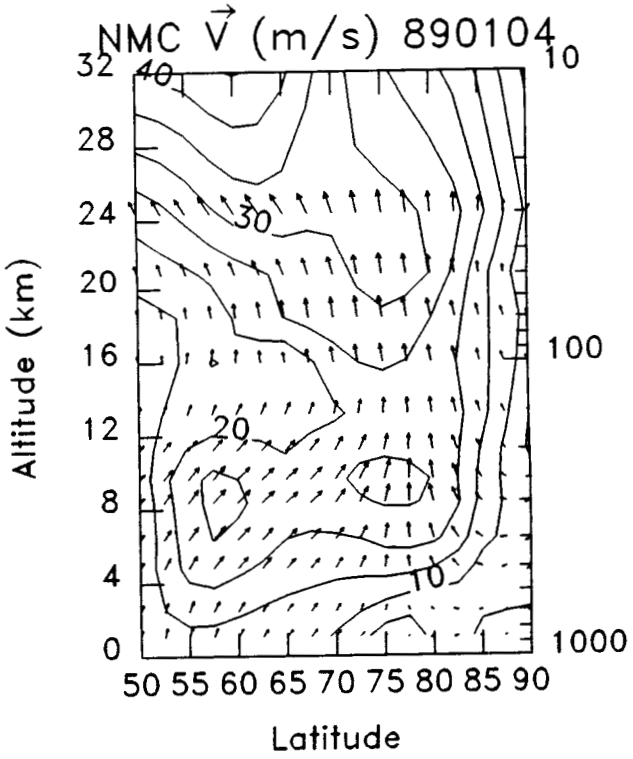


NMC 460K EPV (10^-6) 890104

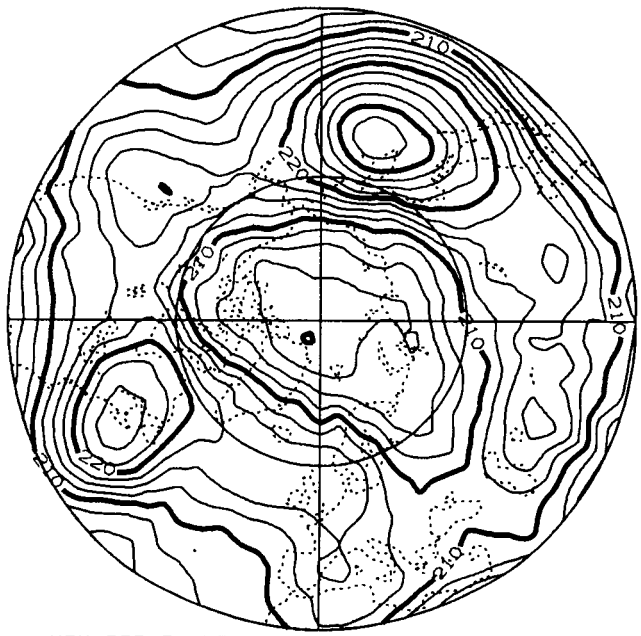


MAX= 51.4 MIN= 8.4 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890104

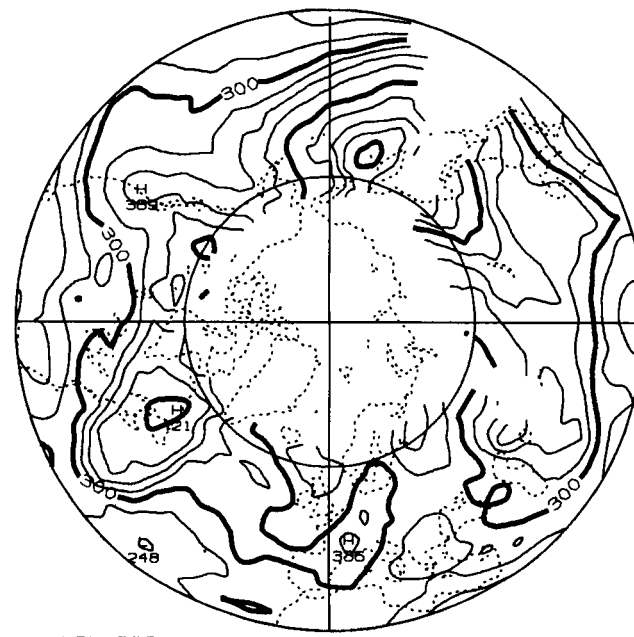


NMC 100MB TEMP. (K) 890105



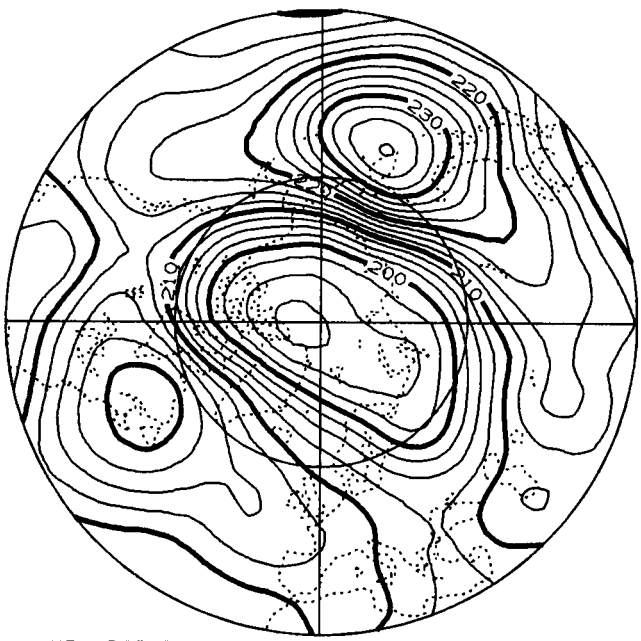
MAX=233.9 MIN=199.7 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890105



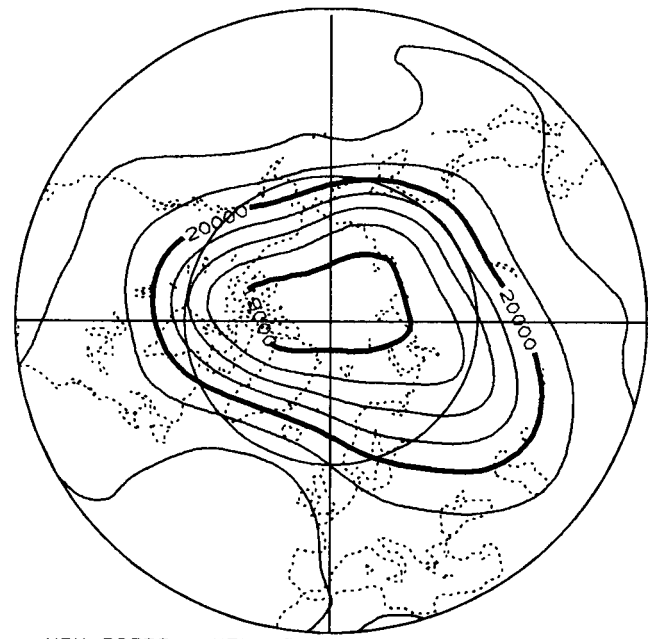
MAX=507.0 MIN=228.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890105

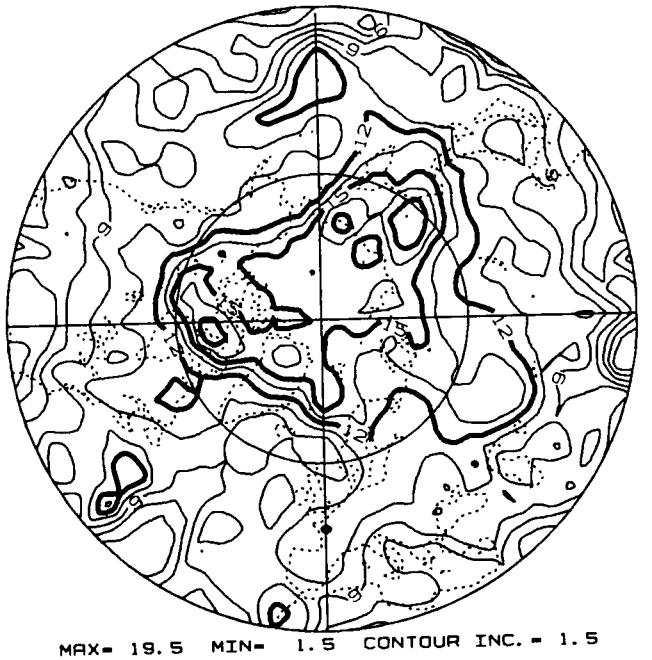


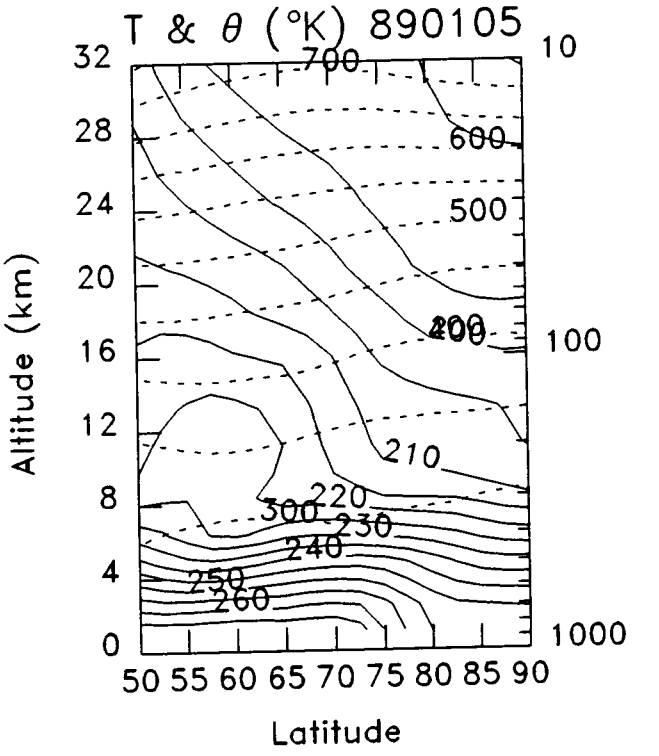
MAX=237.8 MIN=191.5 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890105



MAX=20688. MIN=18860. CONTOUR INC.=250.


NMC 400K EPV (10^-6) 890105
MAX= 19.5 MIN= 1.5 CONTOUR INC. = 1.5


T & θ (°K) 890105
Altitude (km)
Latitude
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400
300
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0
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100
1000
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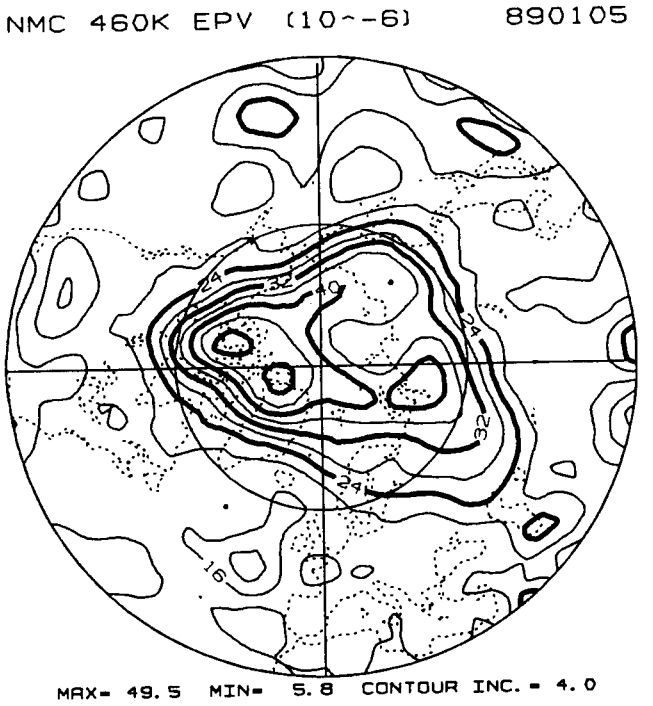
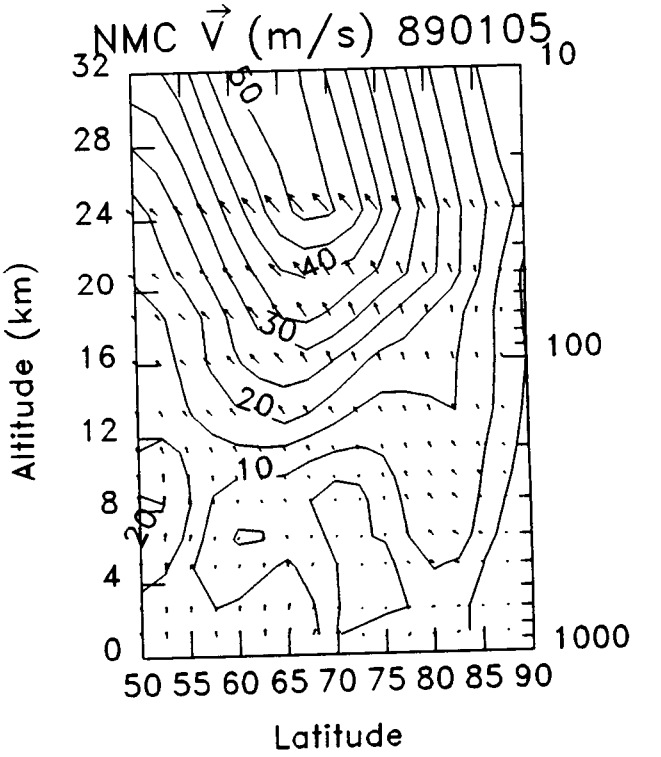

NMC 460K EPV (10^-6) 890105
MAX= 49.5 MIN= 5.8 CONTOUR INC. = 4.0


NMC V (m/s) 890105
Altitude (km)
Latitude
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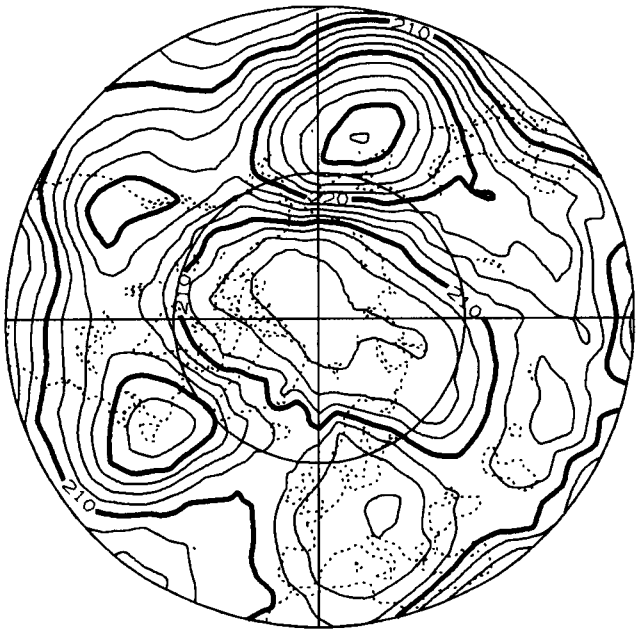
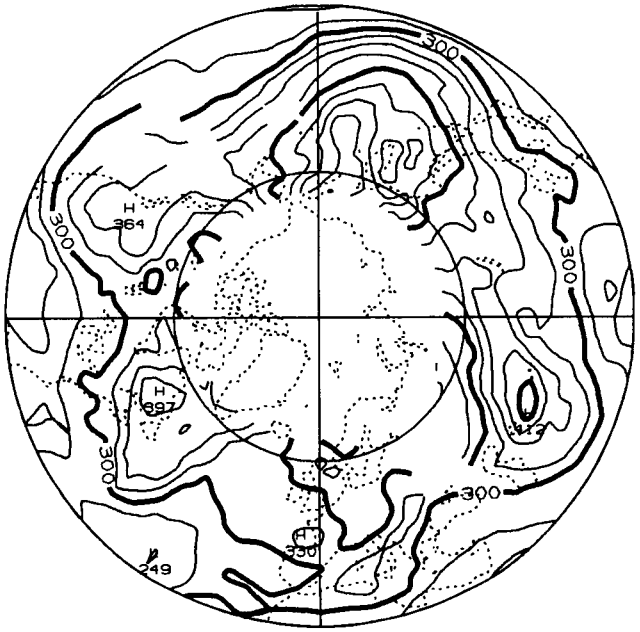
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890106



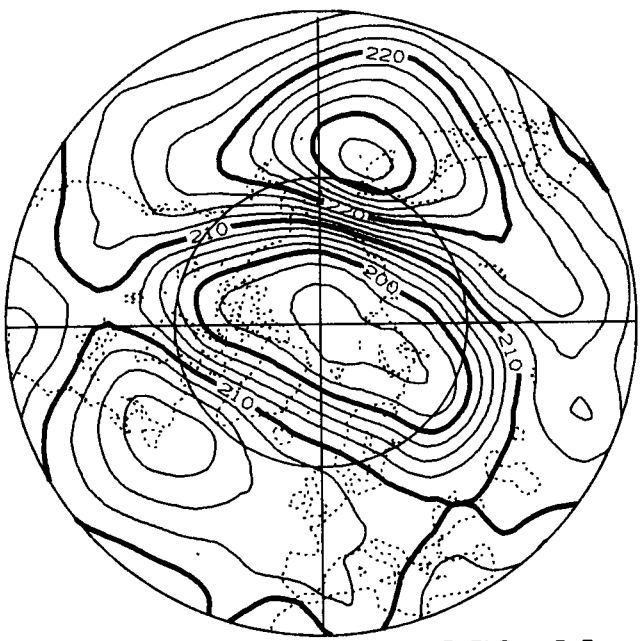
MAX=232.6 MIN=201.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890106



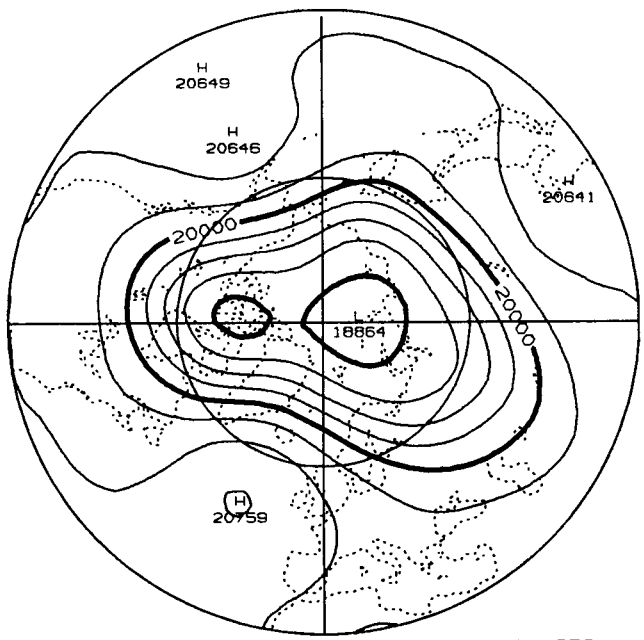
MAX=501.0 MIN=227.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890106

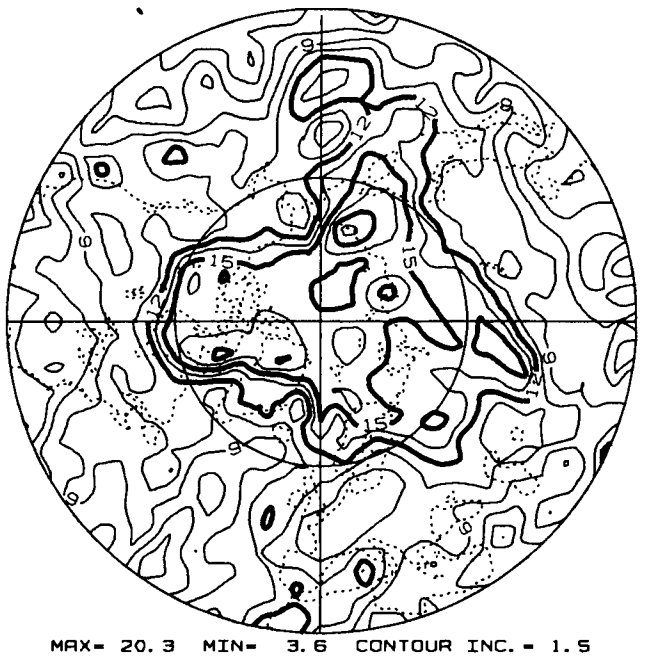


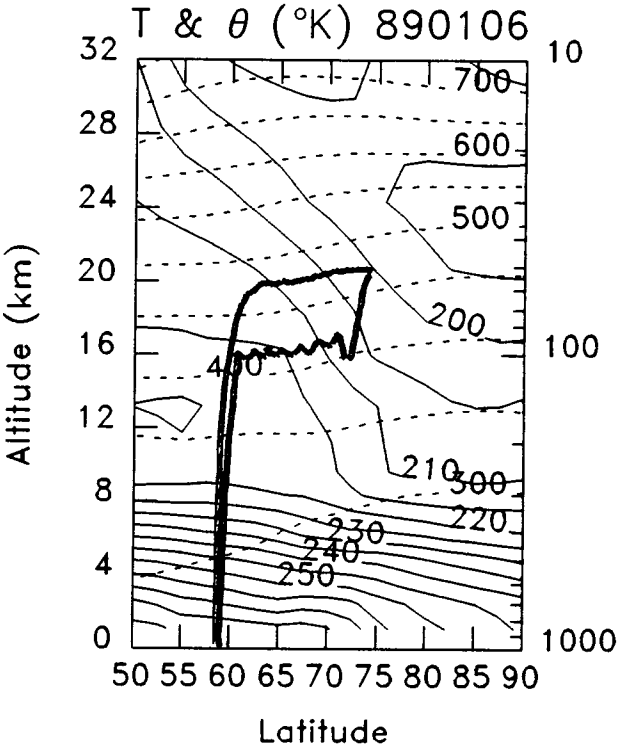
MAX=233.6 MIN=194.2 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890106



MAX=20759. MIN=18864. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890106
MAX= 20.3 MIN= 3.6 CONTOUR INC. = 1.5


T & θ (°K) 890106
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Latitude
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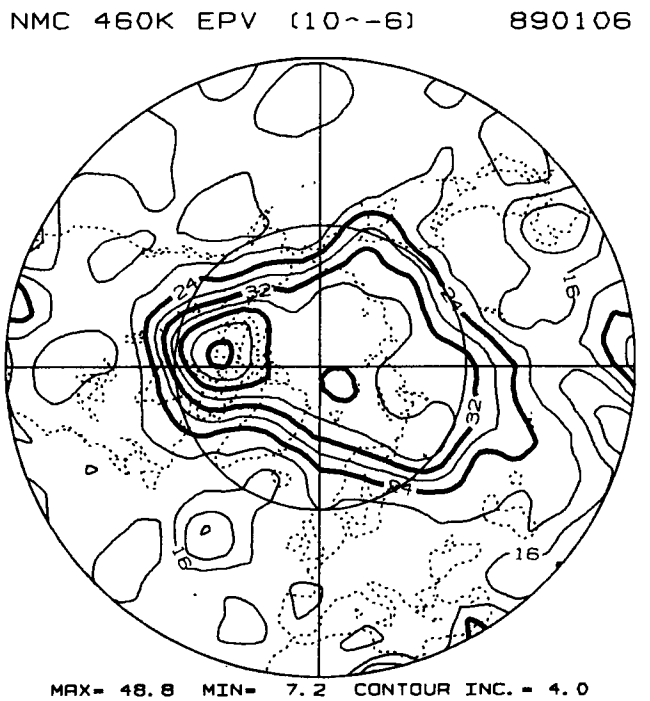
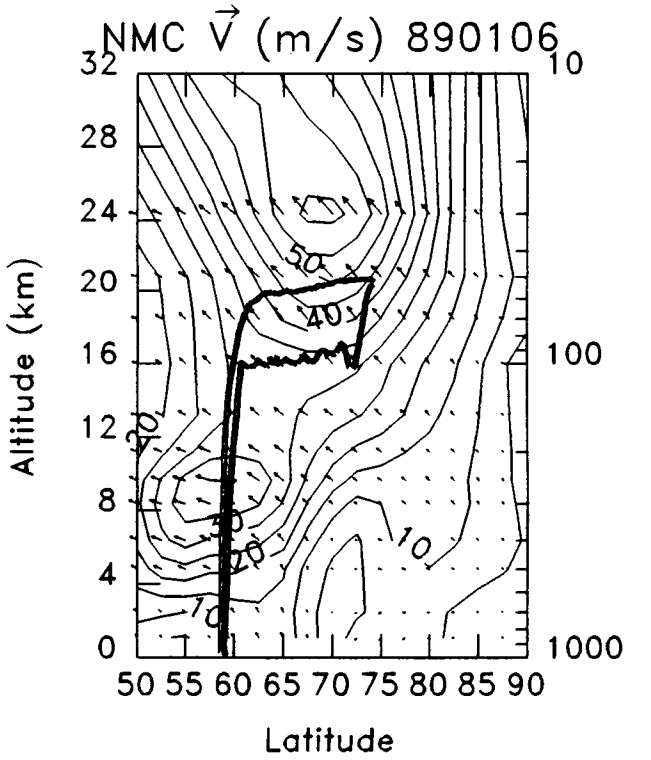
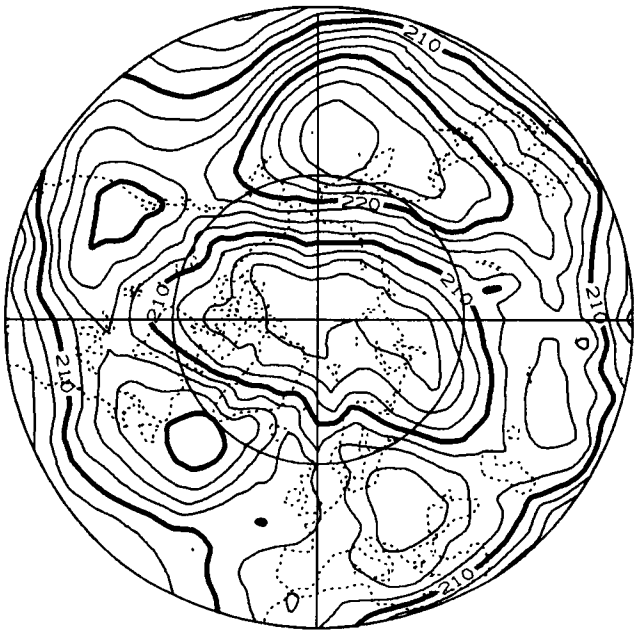
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890106
MAX= 48.8 MIN= 7.2 CONTOUR INC. = 4.0

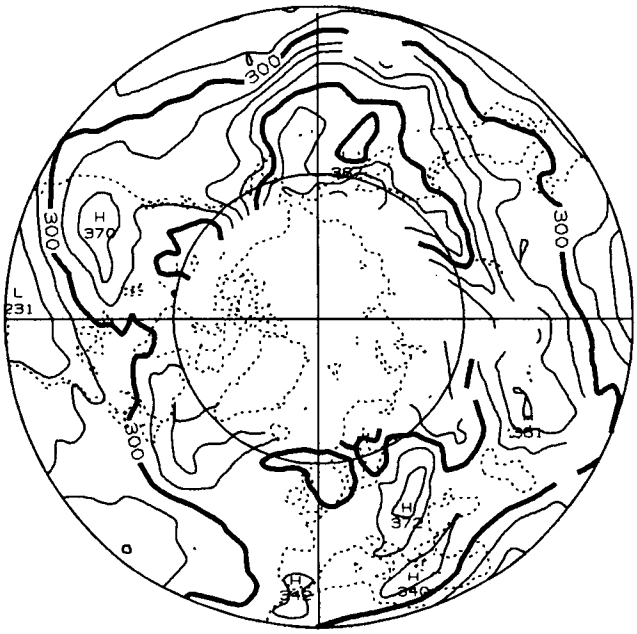

NMC V (m/s) 890106
Altitude (km)
Latitude
50
40
30
20
10
0
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890107



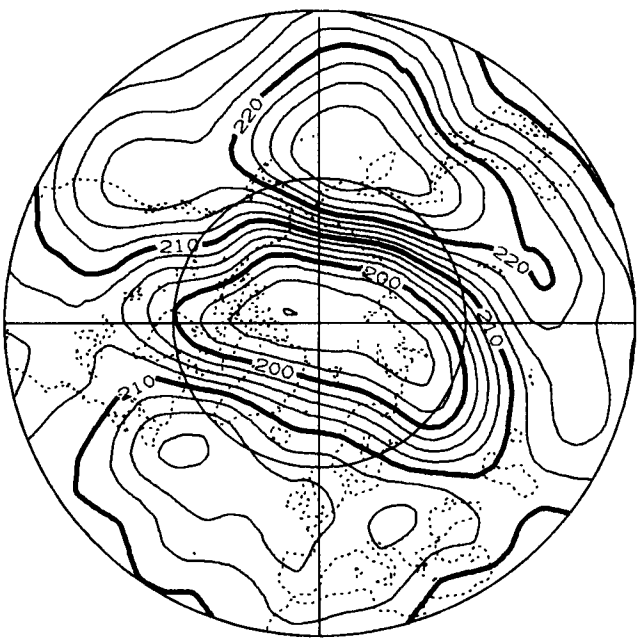
MAX=229.2 MIN=200.0 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890107



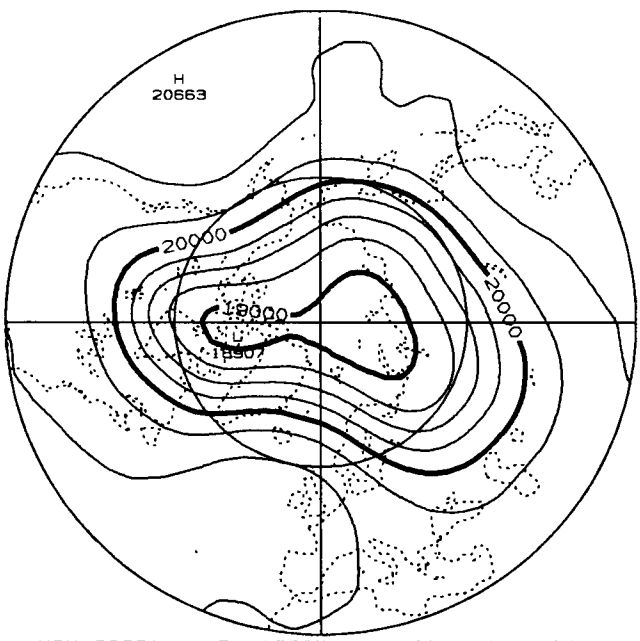
MAX=482.0 MIN=231.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890107



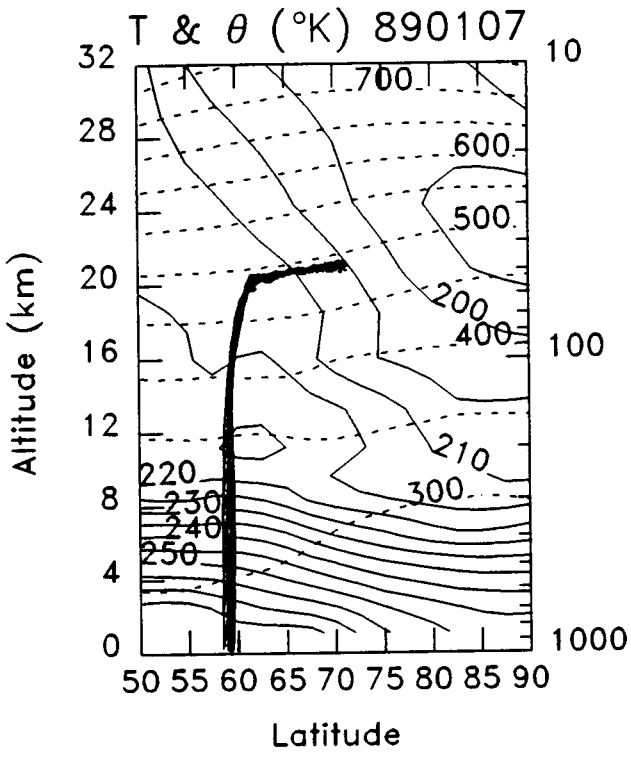
MAX=230.0 MIN=192.4 CONTOUR INC. = 2.5

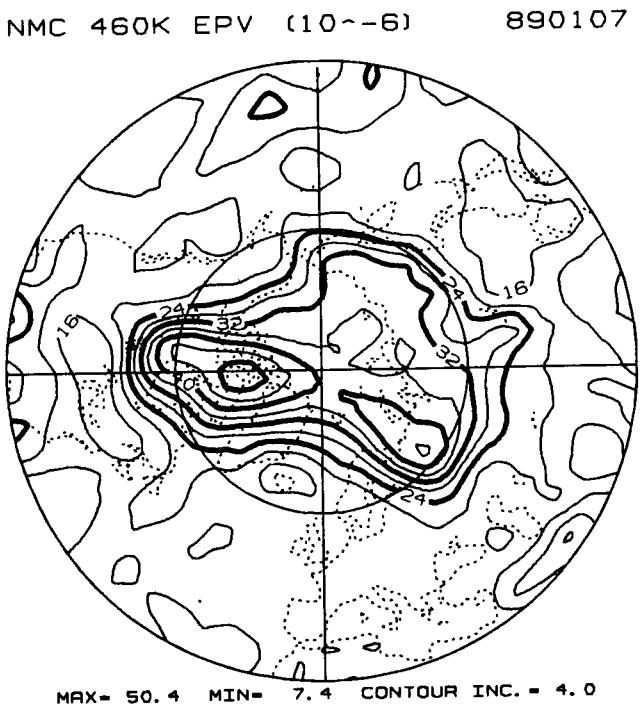
NMC 50MB GEOP HGT (M) 890107

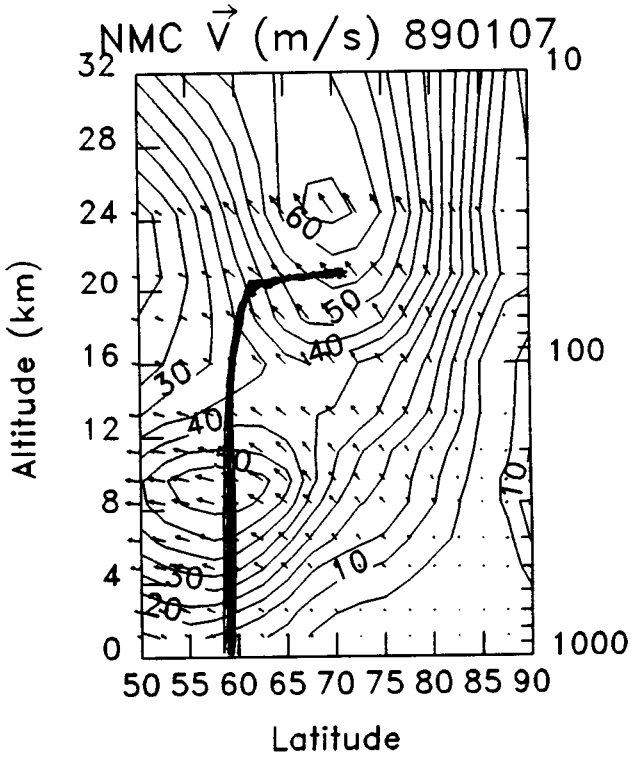


MAX=20691. MIN=18867. CONTOUR INC. =250.

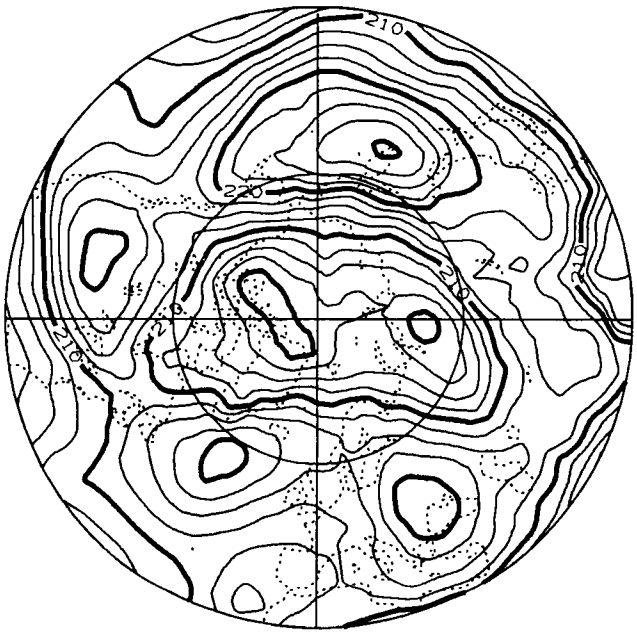
NMC 400K EPV (10^-6) 890107
MAX= 19.6 MIN= 2.6 CONTOUR INC. = 1.5


T & θ (°K) 890107
Altitude (km)
Latitude
700
600
500
400
300
220
230
240
250


NMC 460K EPV (10^-6) 890107
MAX= 50.4 MIN= 7.4 CONTOUR INC. = 4.0

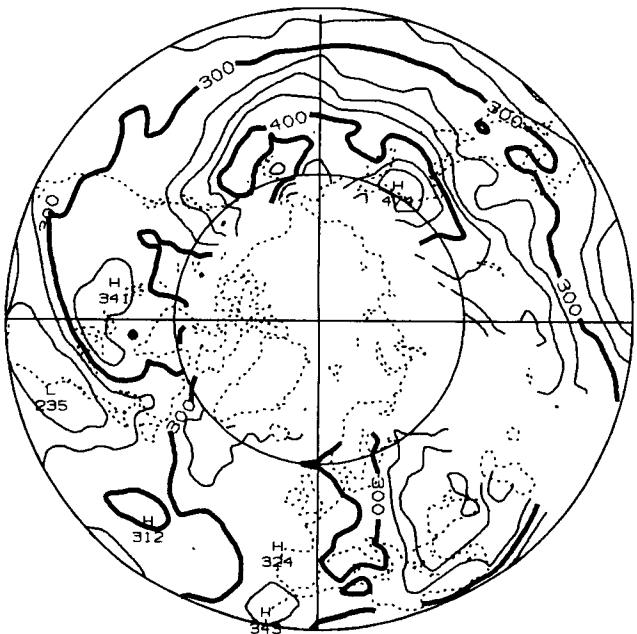

NMC V (m/s) 890107
Altitude (km)
Latitude

NMC 100MB TEMP. (K) 890108



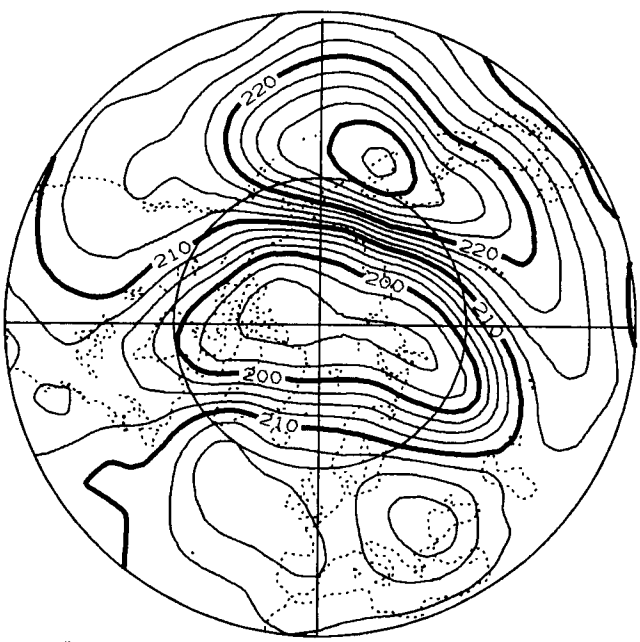
MAX=230.5 MIN=198.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890108



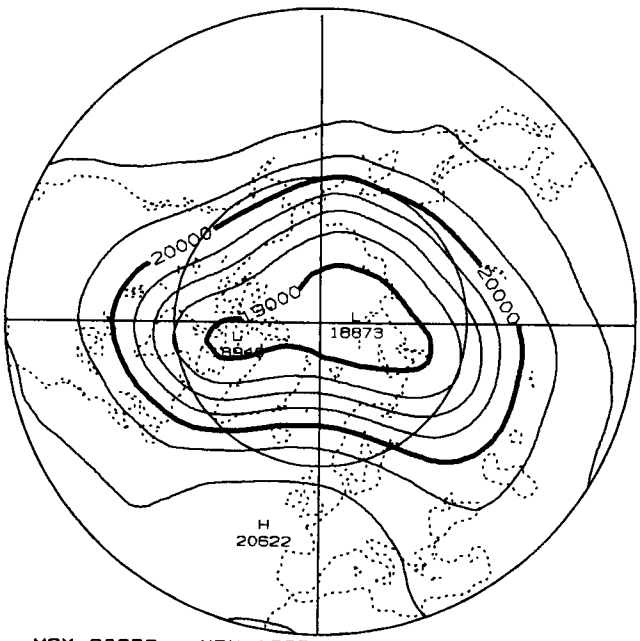
MAX=474.0 MIN=225.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890108

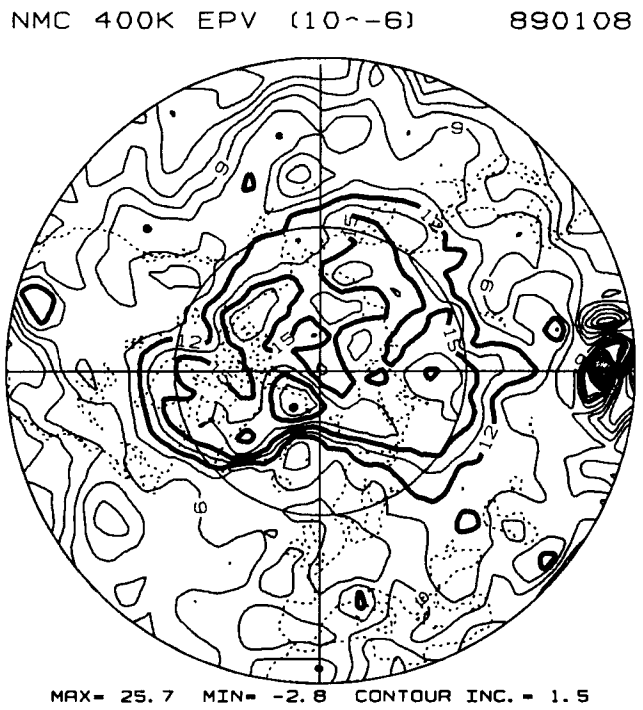


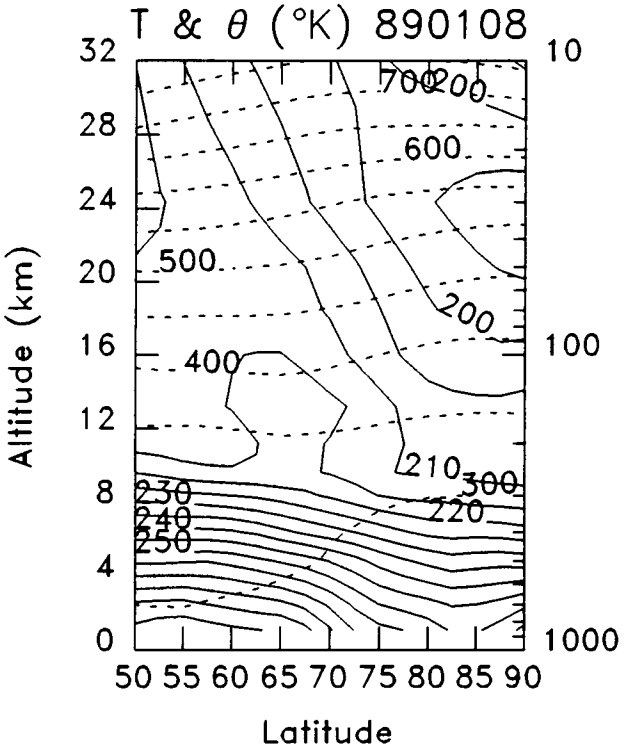
MAX=233.3 MIN=193.3 CONTOUR INC. = 2.5

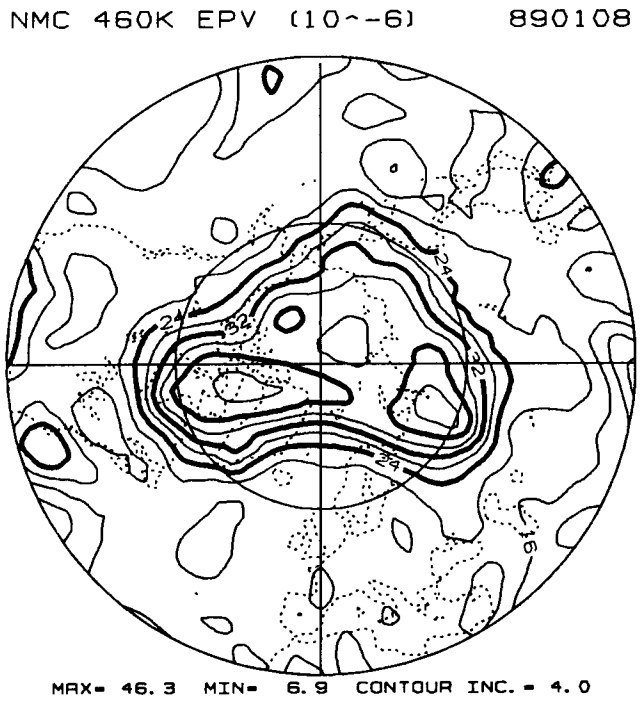
NMC 50MB GEOP HGT (M) 890108

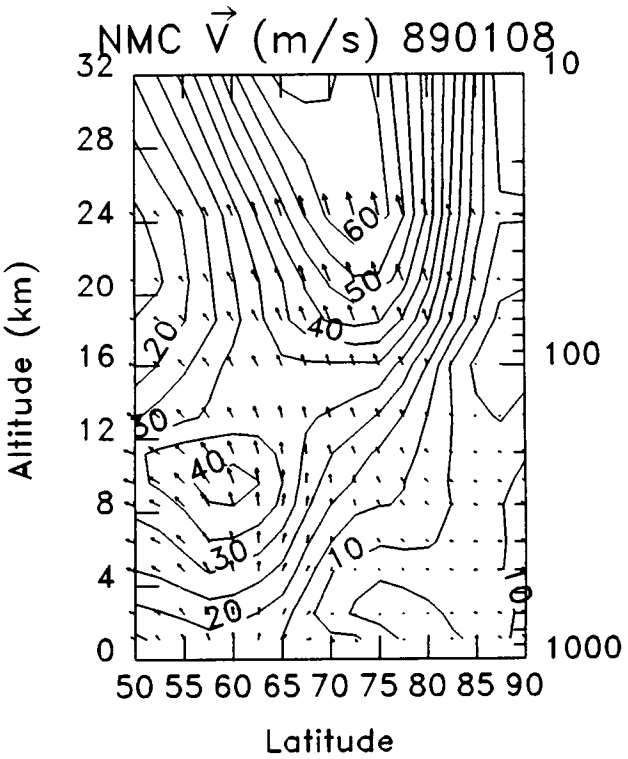


MAX=20679. MIN=18873. CONTOUR INC. =250.

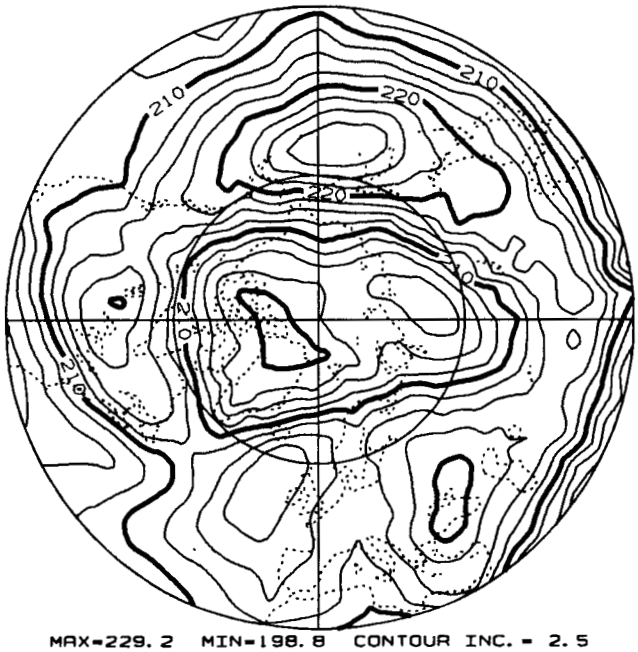

NMC 400K EPV (10^-6) 890108
MAX= 25.7 MIN= -2.8 CONTOUR INC. = 1.5


T & θ (°K) 890108
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
700
600
500
400
300
200
210
220
230
240
250


NMC 460K EPV (10^-6) 890108
MAX= 46.3 MIN= 6.9 CONTOUR INC. = 4.0

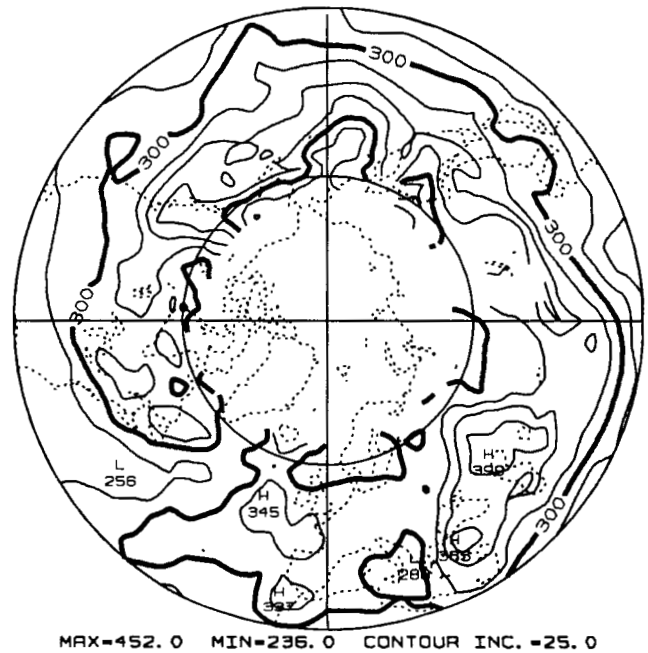

NMC V (m/s) 890108
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
60
50
40
30
20
10
0

NMC 100MB TEMP. (K) 890109



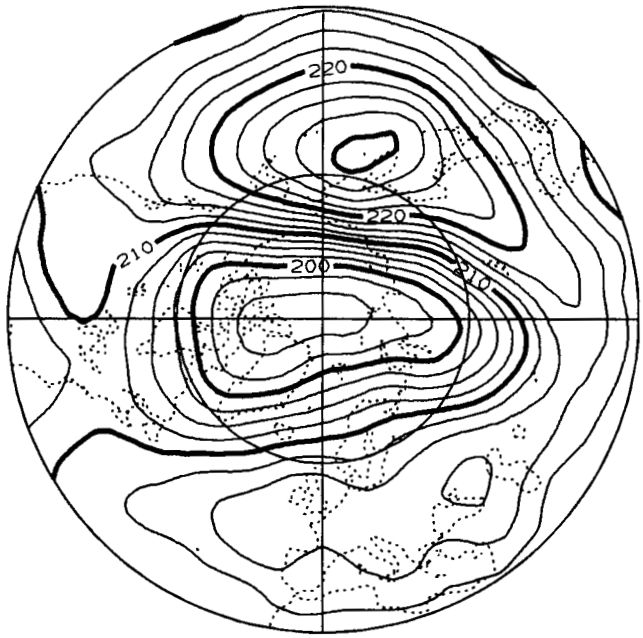
MAX=229.2 MIN=198.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890109



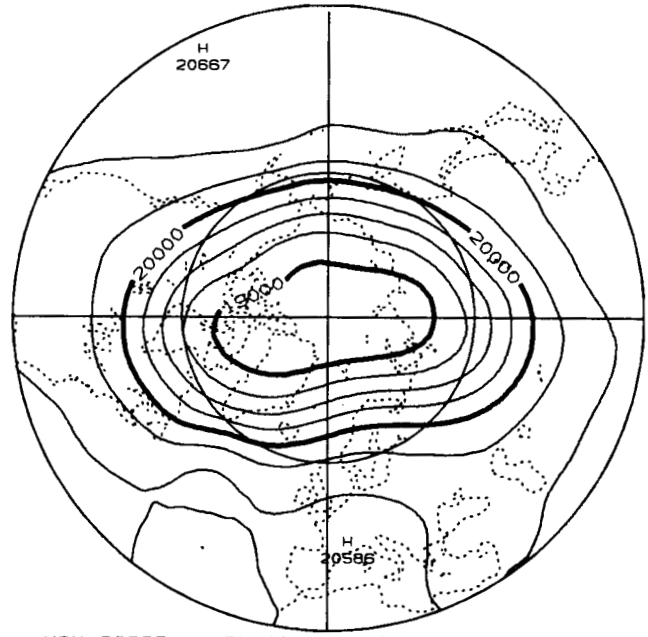
MAX=452.0 MIN=236.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890109

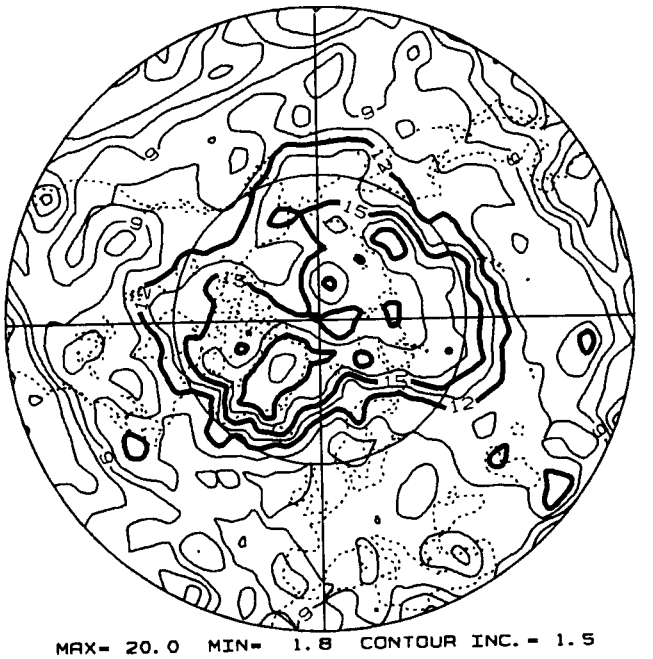


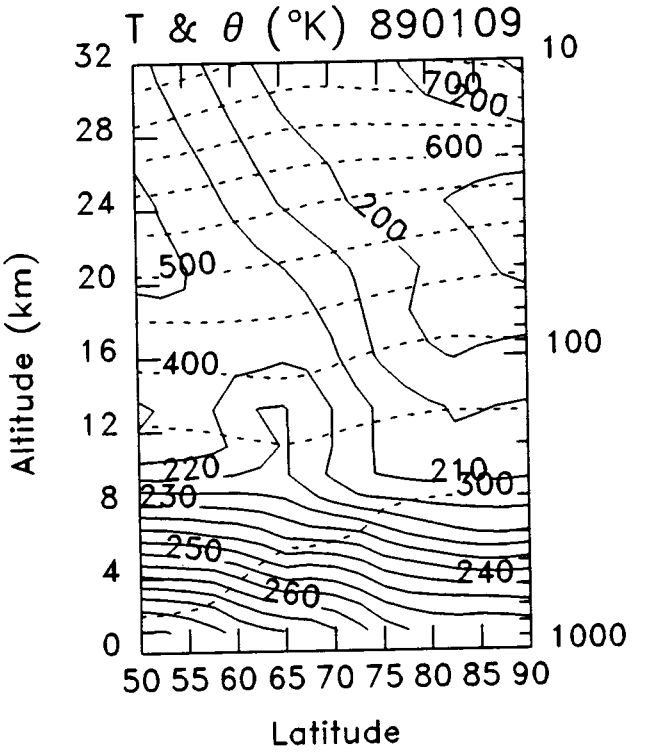
MAX=230.6 MIN=193.8 CONTOUR INC. = 2.5

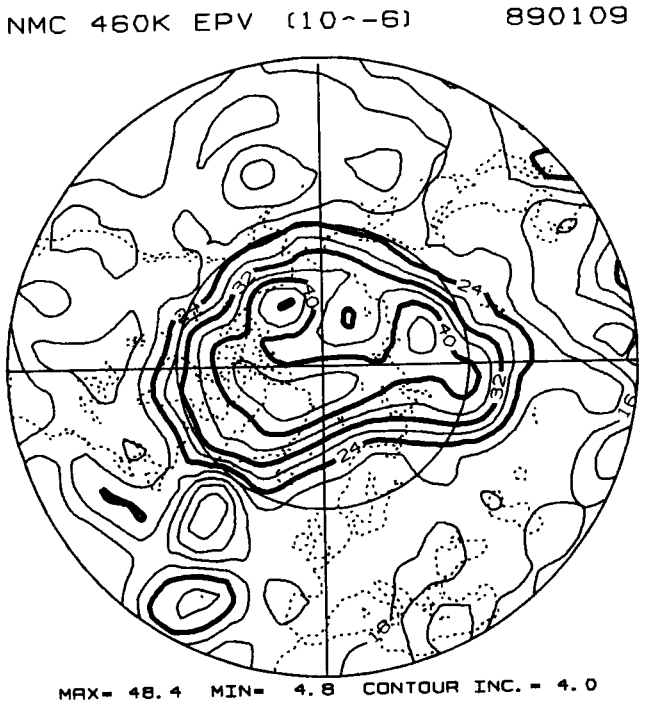
NMC 50MB GEOP HGT (M) 890109

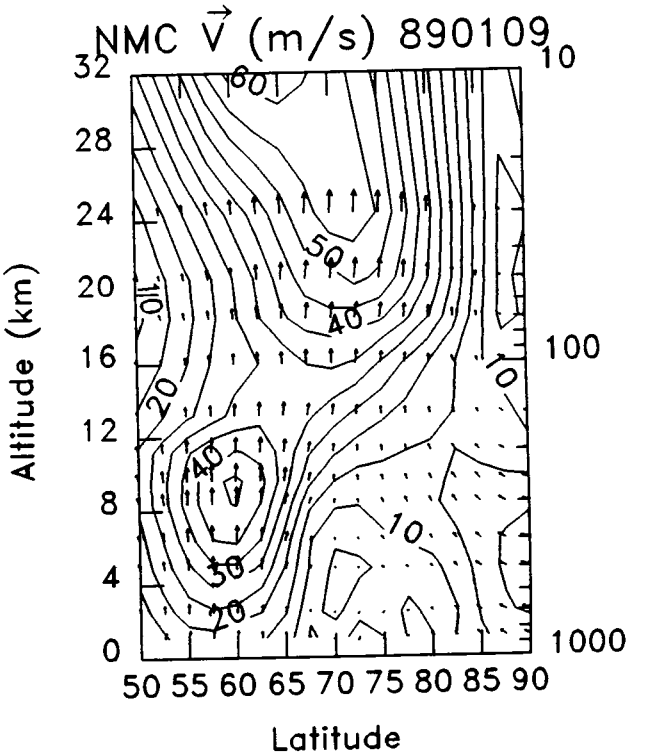


MAX=20667. MIN=18771. CONTOUR INC. =250.

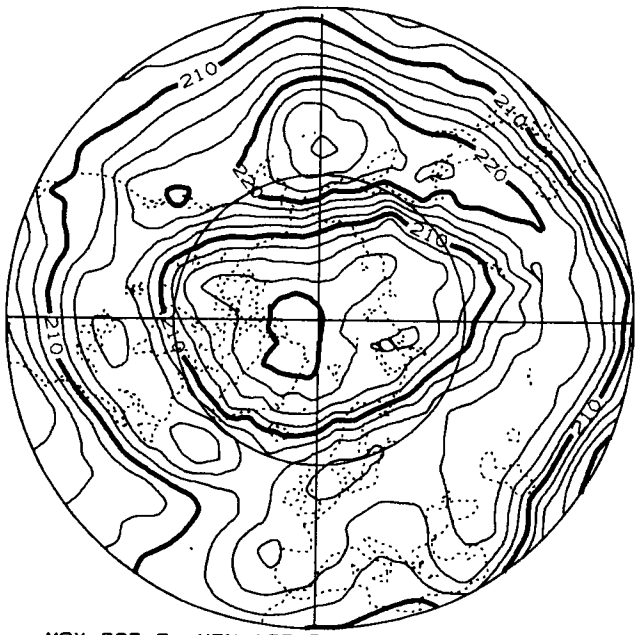

NMC 400K EPV (10^-6) 890109
MAX= 20.0 MIN= 1.8 CONTOUR INC.= 1.5


T & θ (°K) 890109
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
700
600
500
400
300
240
250
260
220
230
210


NMC 460K EPV (10^-6) 890109
MAX= 48.4 MIN= 4.8 CONTOUR INC.= 4.0

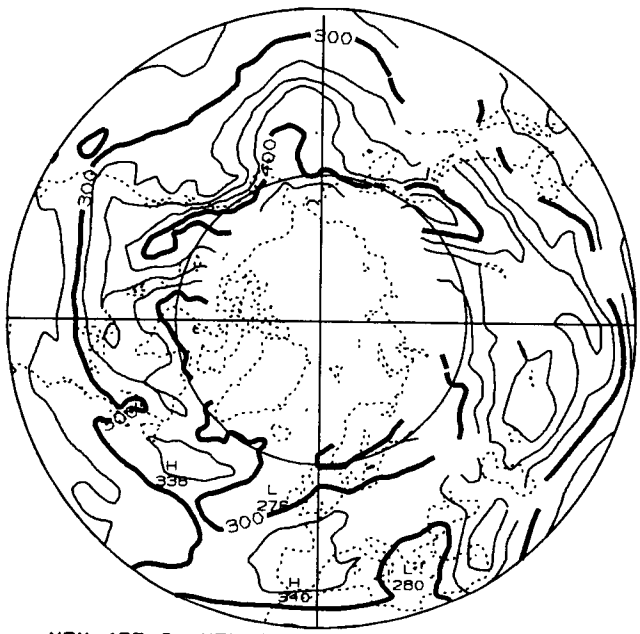

NMC V (m/s) 890109
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
60
50
40
30
20
10

NMC 100MB TEMP. (K) 890110



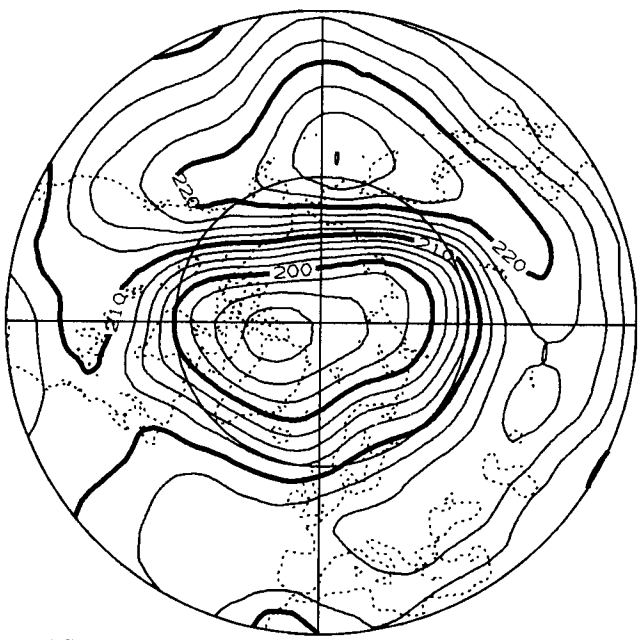
MAX=227.9 MIN=198.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890110



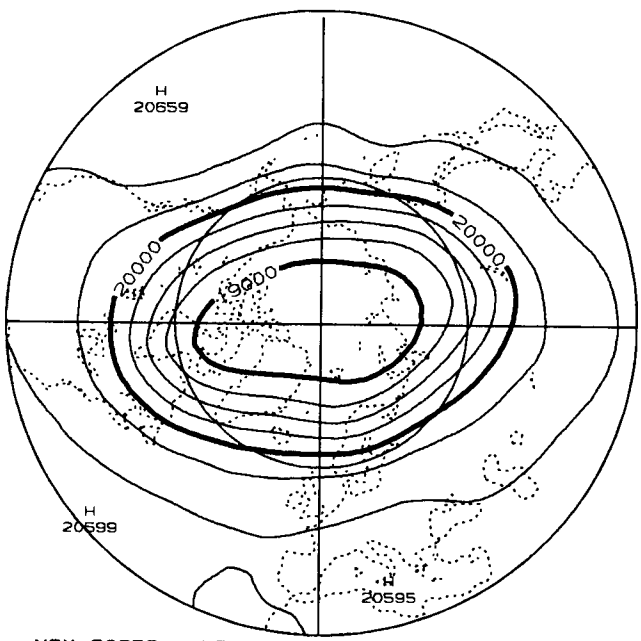
MAX=457.0 MIN=237.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890110

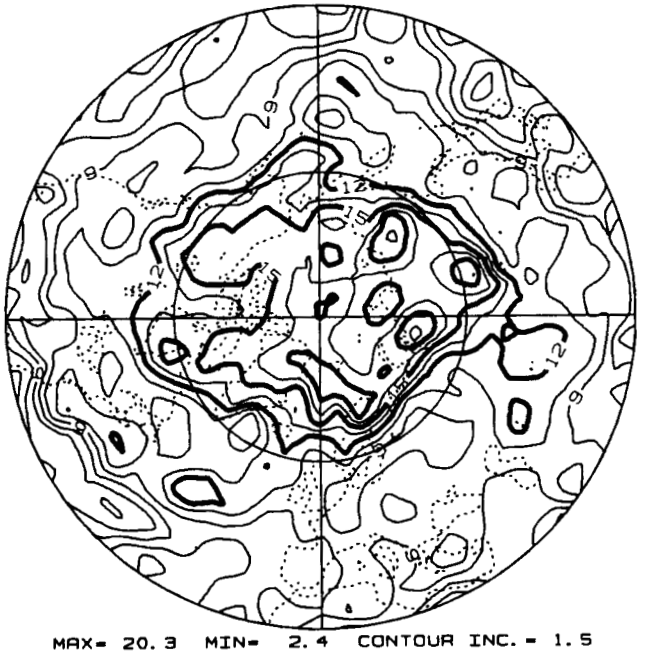


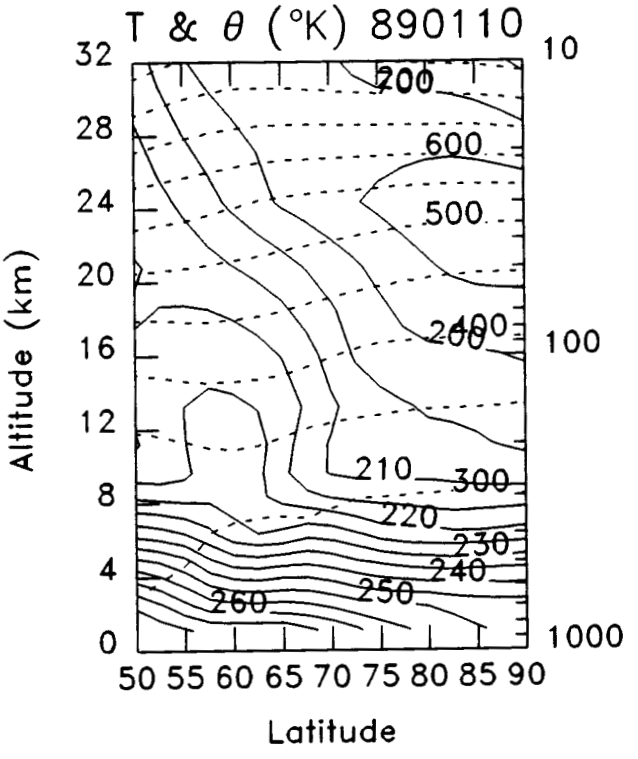
MAX=227.5 MIN=190.8 CONTOUR INC. = 2.5

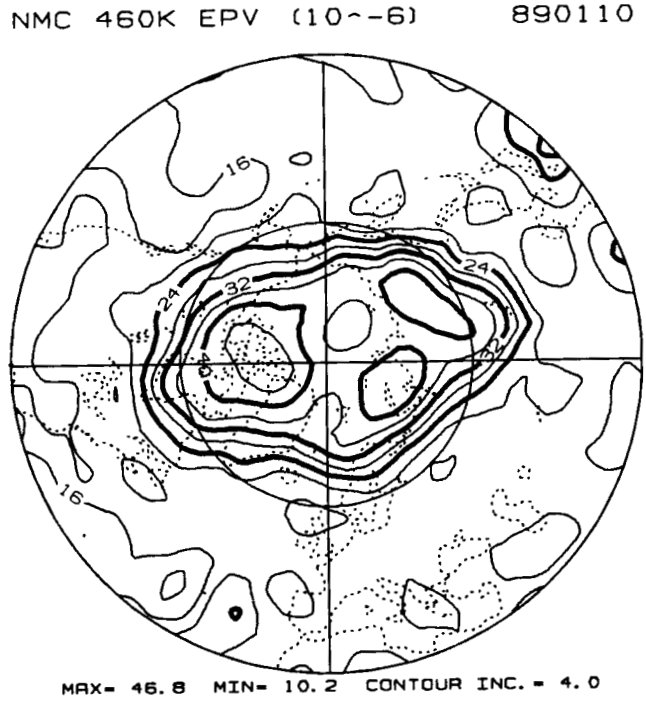
NMC 50MB GEOP HGT (M) 890110

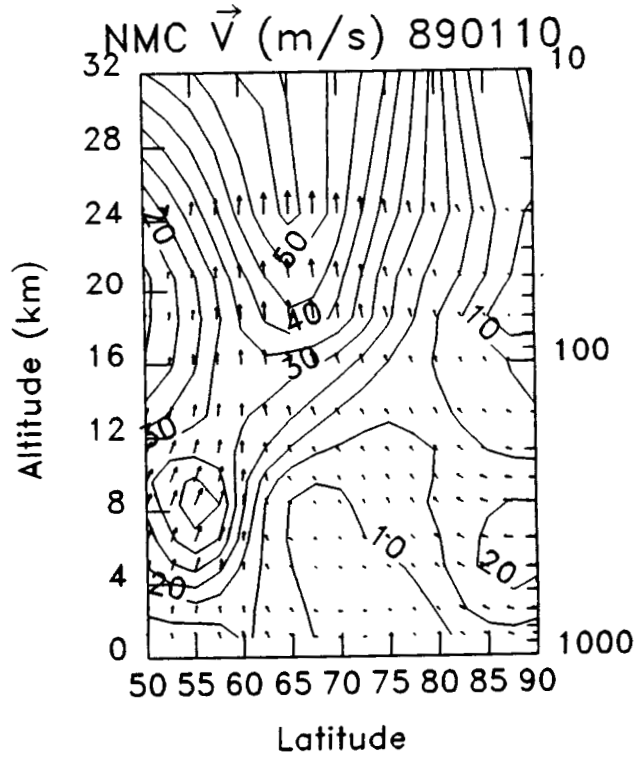


MAX=20659. MIN=18760. CONTOUR INC. =250.

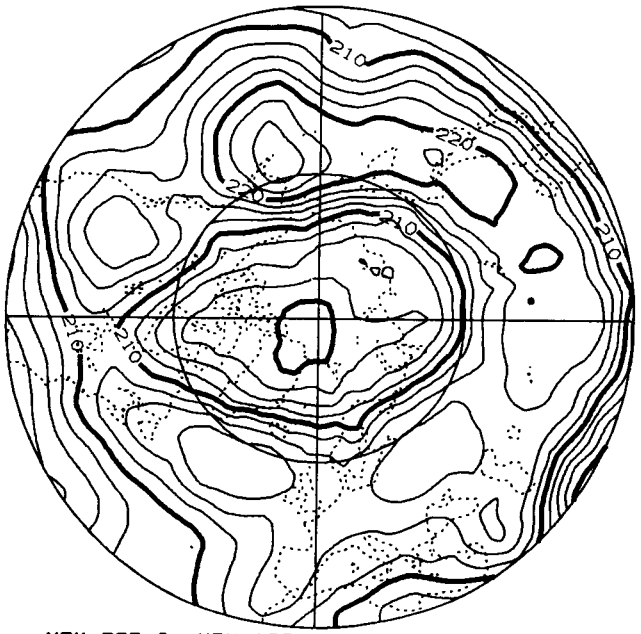

NMC 400K EPV (10^-6) 890110
MAX= 20.3 MIN= 2.4 CONTOUR INC. = 1.5


T & θ (°K) 890110
Altitude (km)
Latitude
200
600
500
400
300
210
220
230
240
250
260
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890110
MAX= 46.8 MIN= 10.2 CONTOUR INC. = 4.0

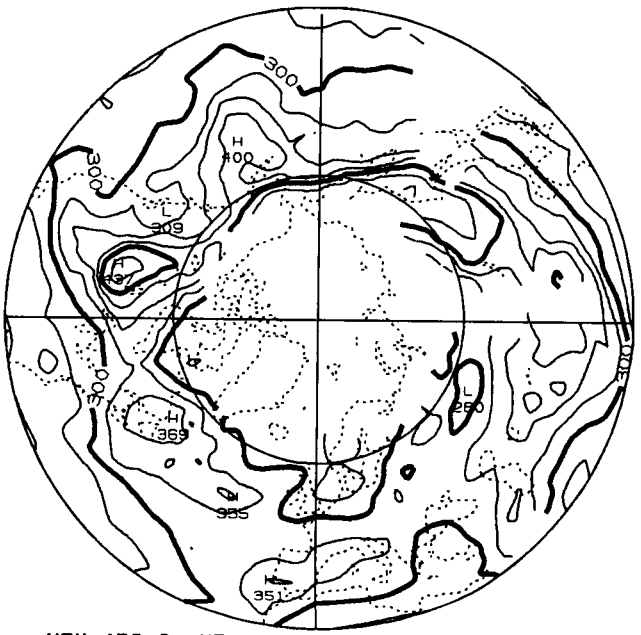

NMC V (m/s) 890110
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890111



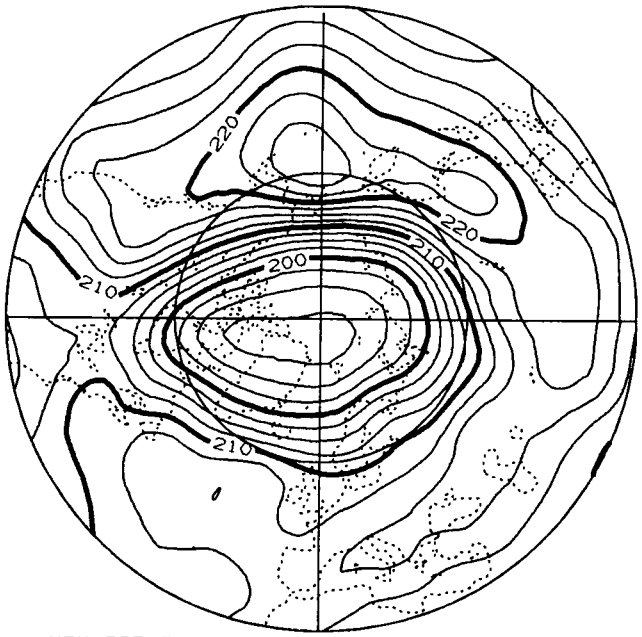
MAX=227.0 MIN=198.8 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890111



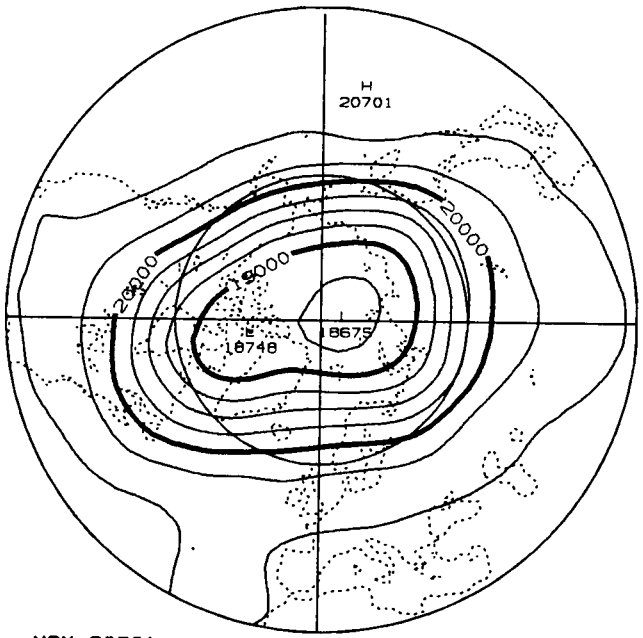
MAX=450.0 MIN=243.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890111

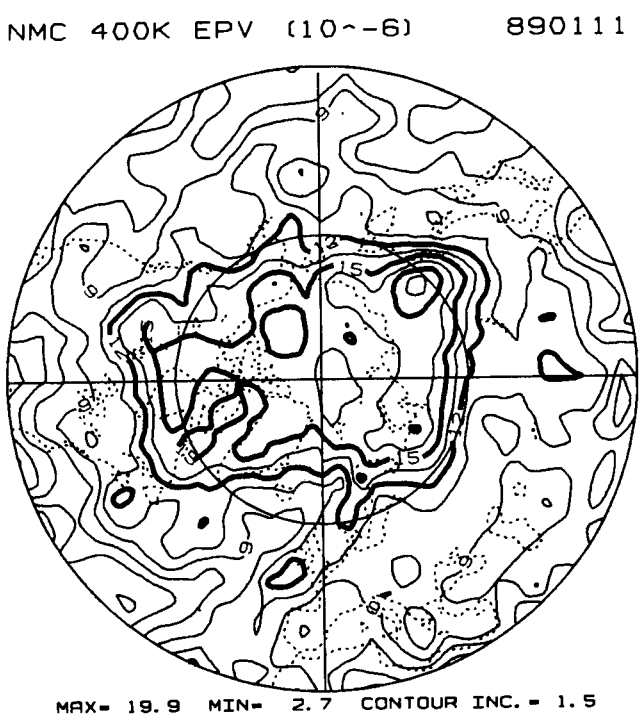


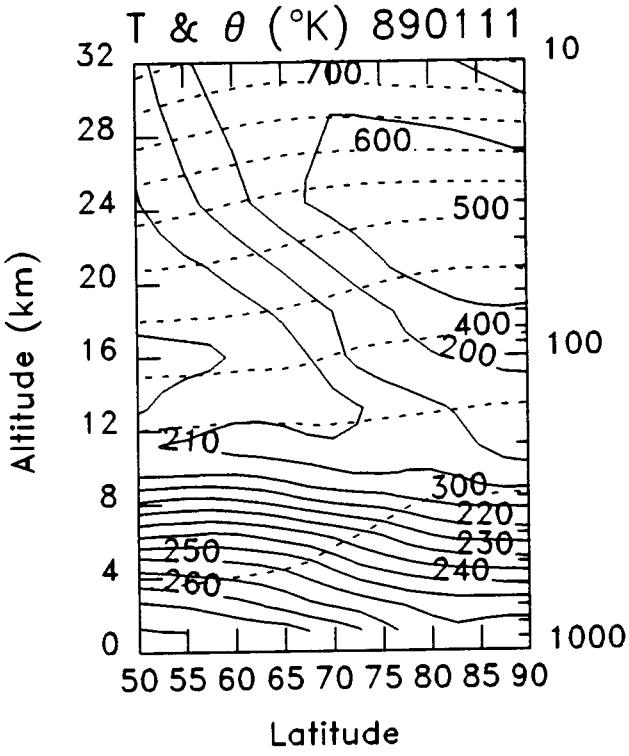
MAX=227.2 MIN=191.5 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890111



MAX=20701. MIN=18675. CONTOUR INC.=250.


NMC 400K EPV (10^-6) 890111
MAX= 19.9 MIN= 2.7 CONTOUR INC.= 1.5


T & θ (°K) 890111
Altitude (km)
Latitude
700
600
500
400
200
210
300
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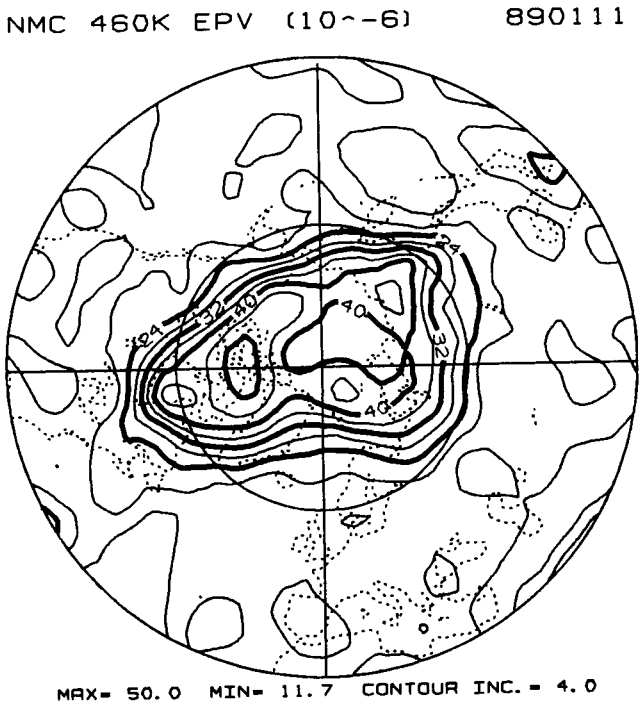
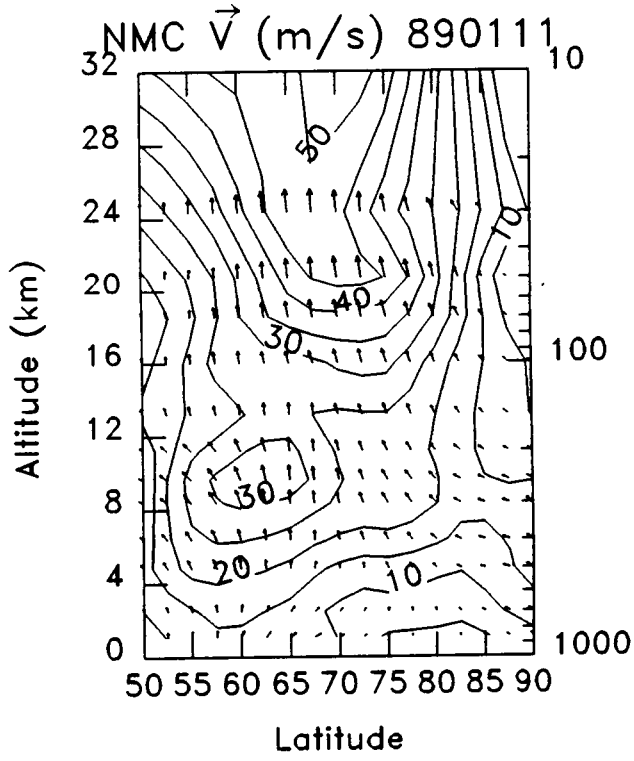
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

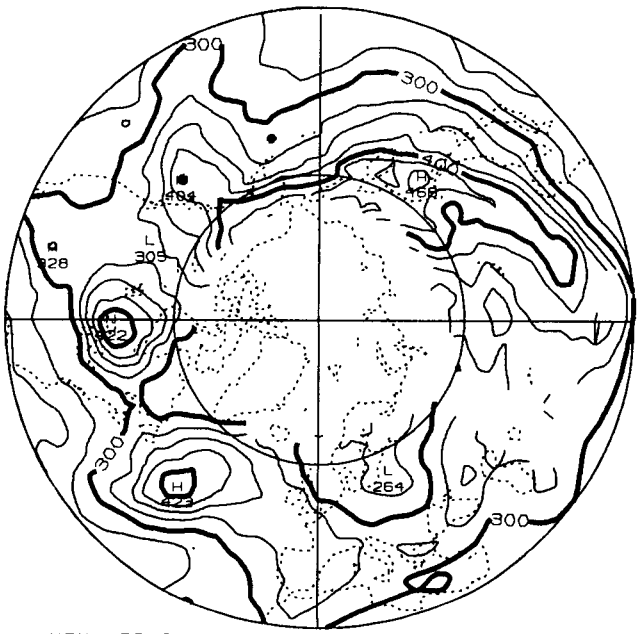

NMC 460K EPV (10^-6) 890111
MAX= 50.0 MIN= 11.7 CONTOUR INC.= 4.0


NMC V (m/s) 890111
Altitude (km)
Latitude
50
40
30
20
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890112

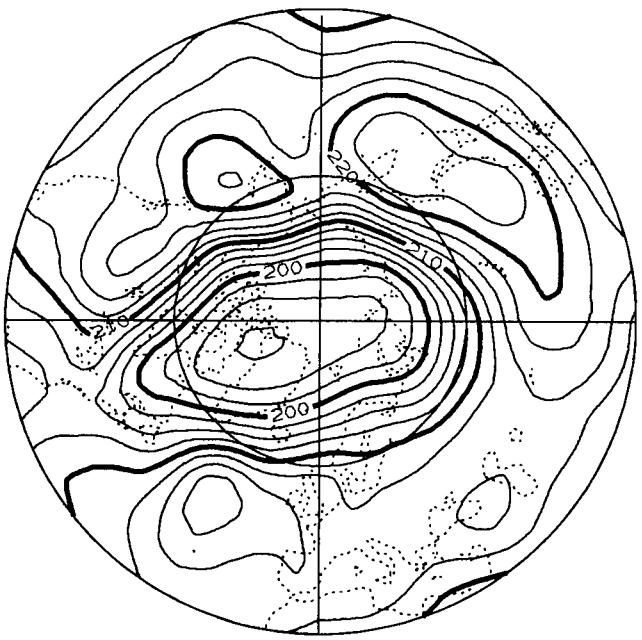
MAX=225.4 MIN=197.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890112



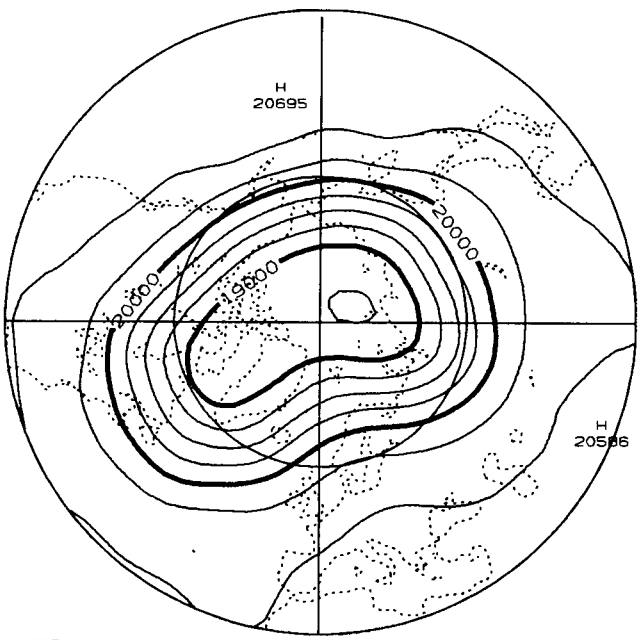
MAX=468.0 MIN=233.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890112

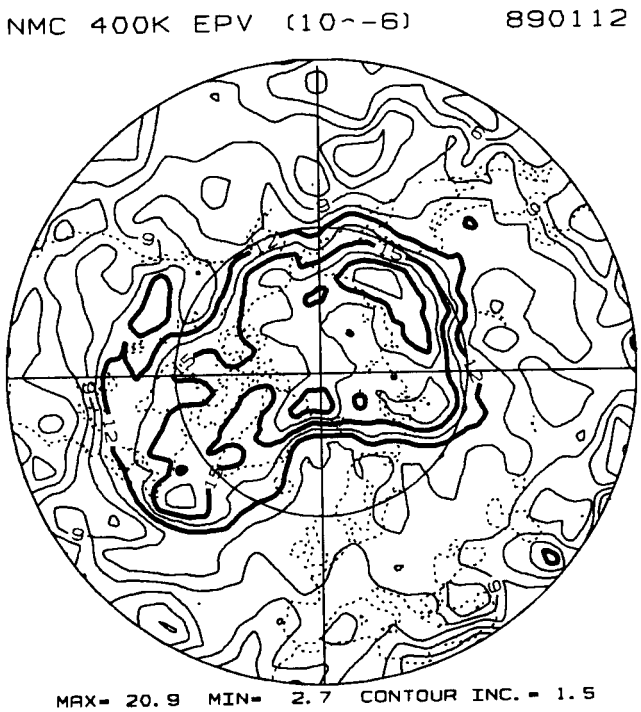


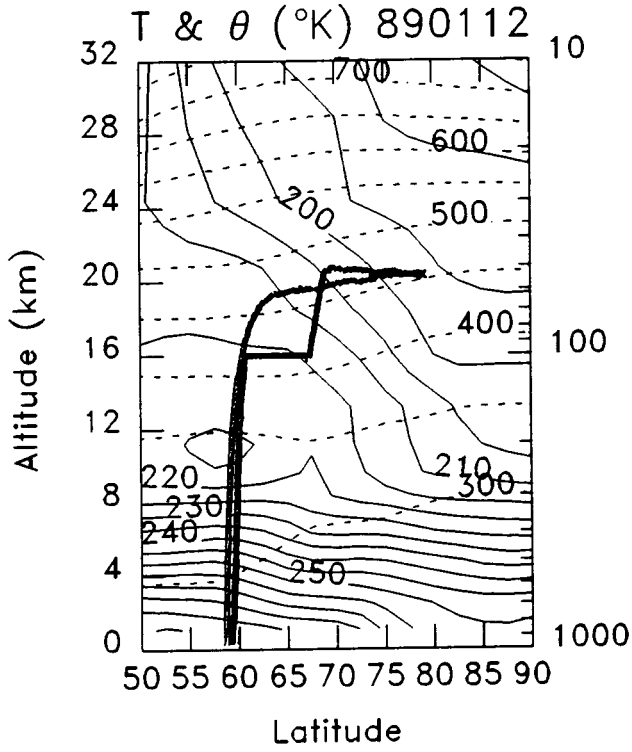
MAX=225.0 MIN=192.3 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890112



MAX=20695. MIN=18730. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890112
MAX= 20.9 MIN= 2.7 CONTOUR INC. = 1.5


T & θ (°K) 890112
Altitude (km)
Latitude
700
600
500
400
300
250
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230
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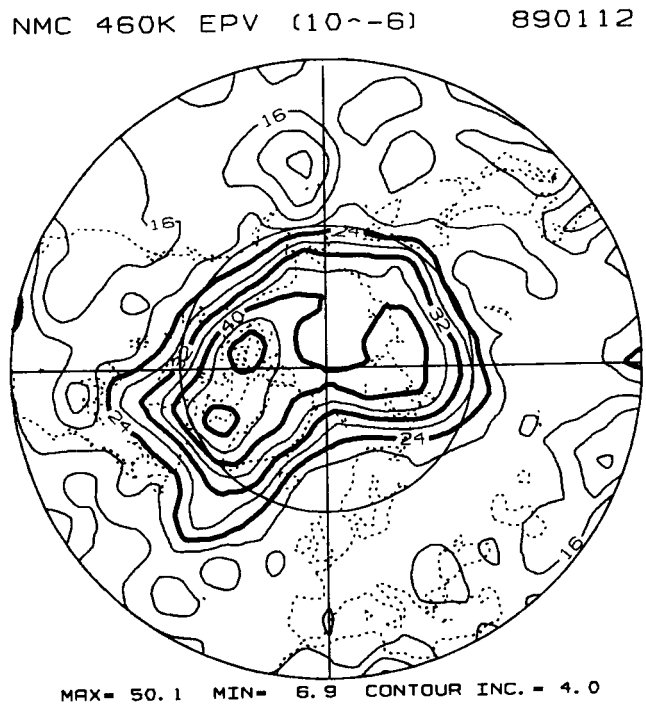
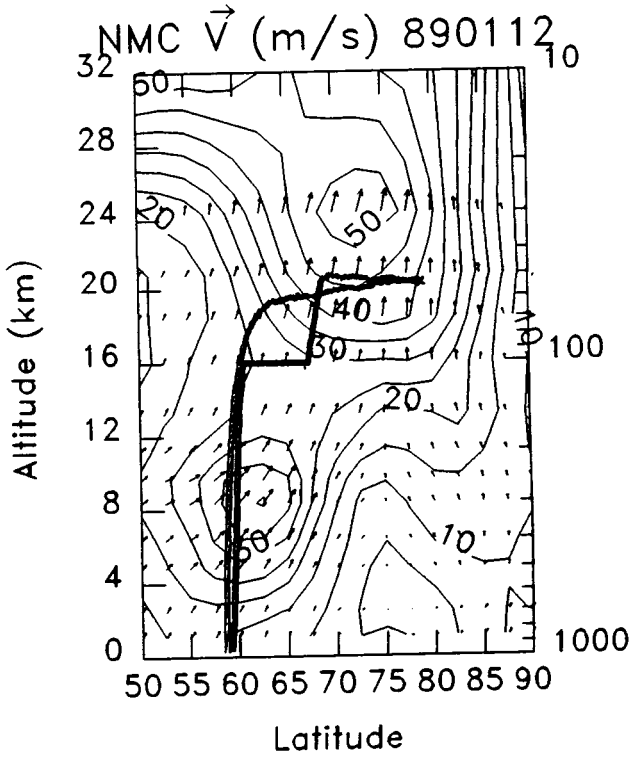
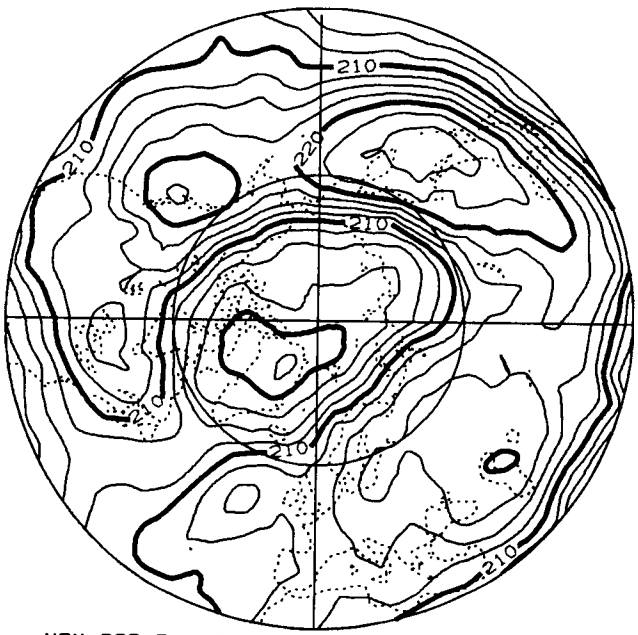
210
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890112
MAX= 50.1 MIN= 6.9 CONTOUR INC. = 4.0

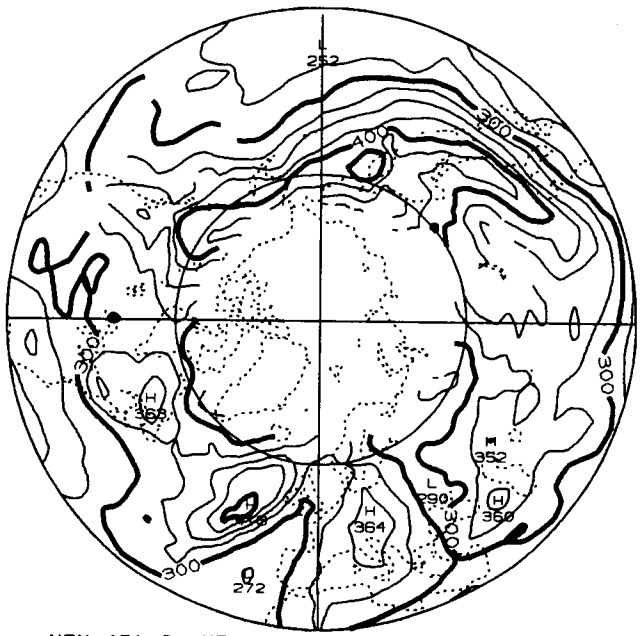

NMC V (m/s) 890112
Altitude (km)
Latitude
50
40
30
20
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890113



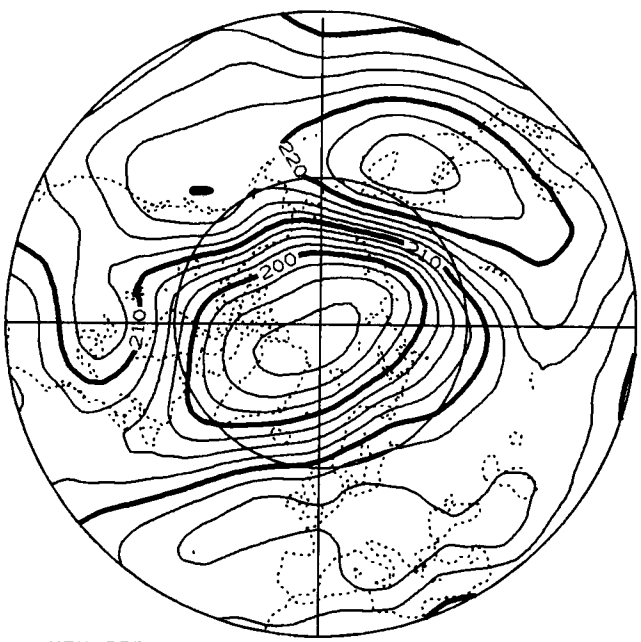
MAX=226.2 MIN=196.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890113



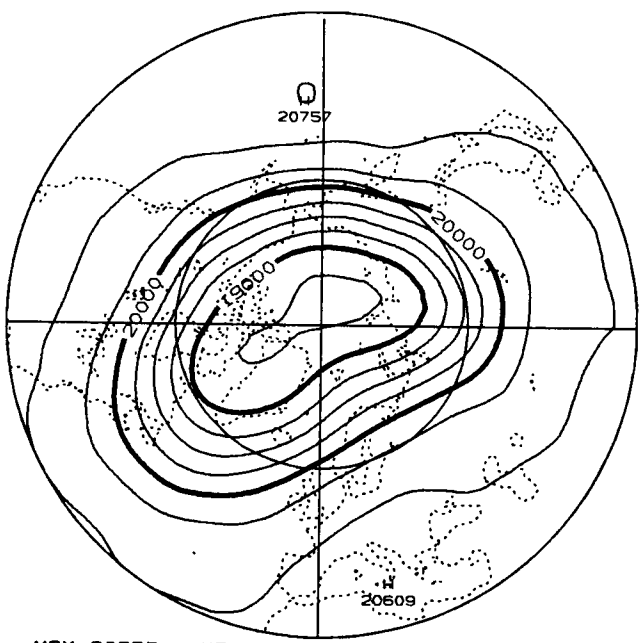
MAX=481.0 MIN=234.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890113



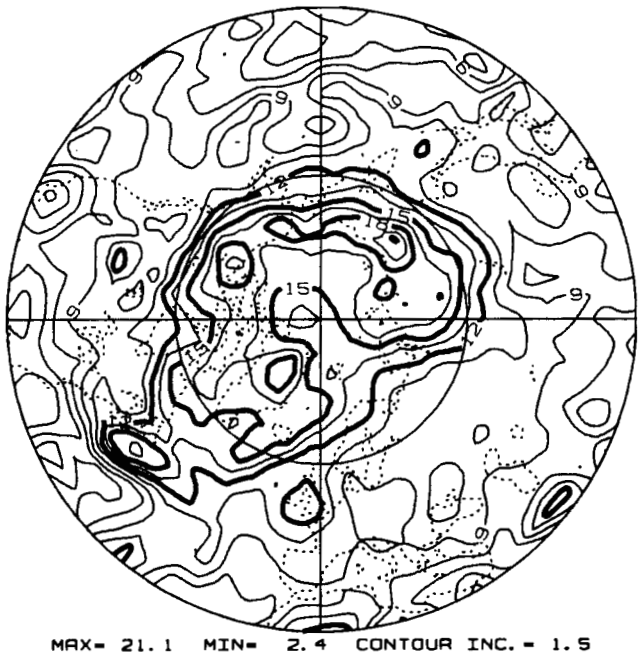
MAX=226.6 MIN=191.1 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890113

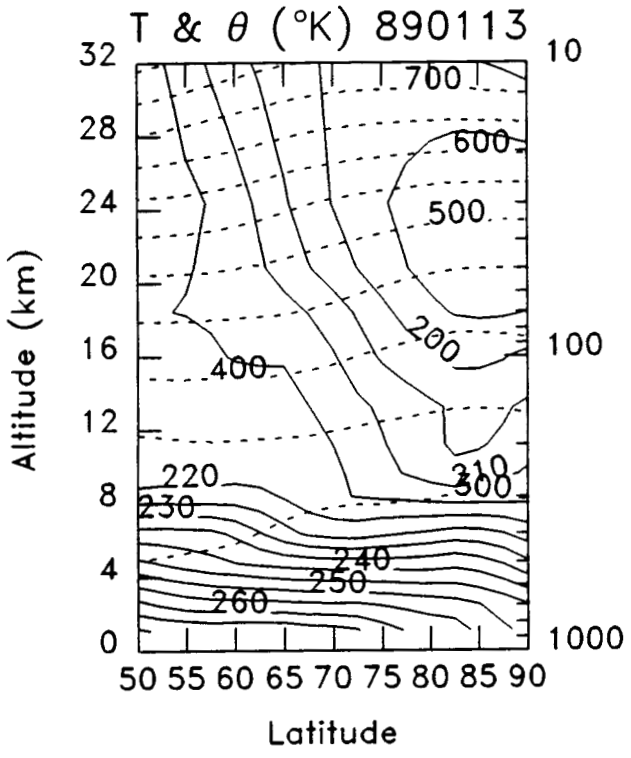


MAX=20757. MIN=18696. CONTOUR INC. =250.

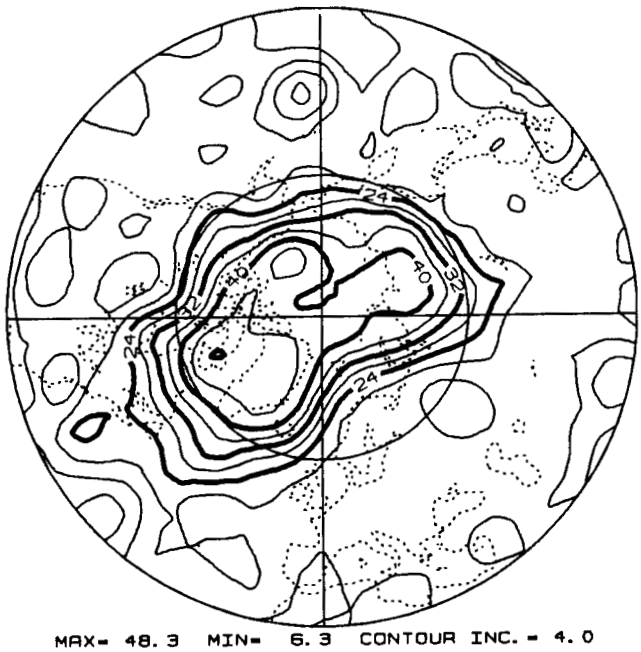
NMC 400K EPV (10^-6) 890113



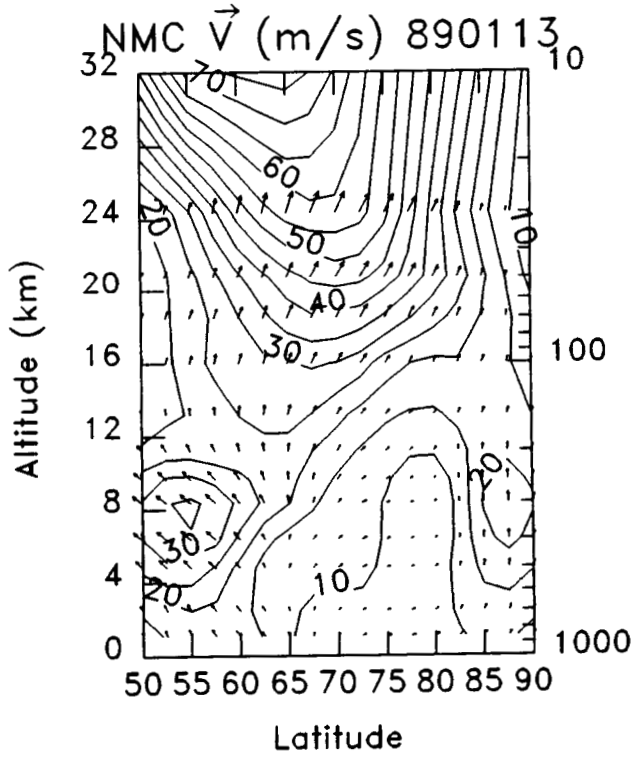
MAX= 21.1 MIN= 2.4 CONTOUR INC.= 1.5



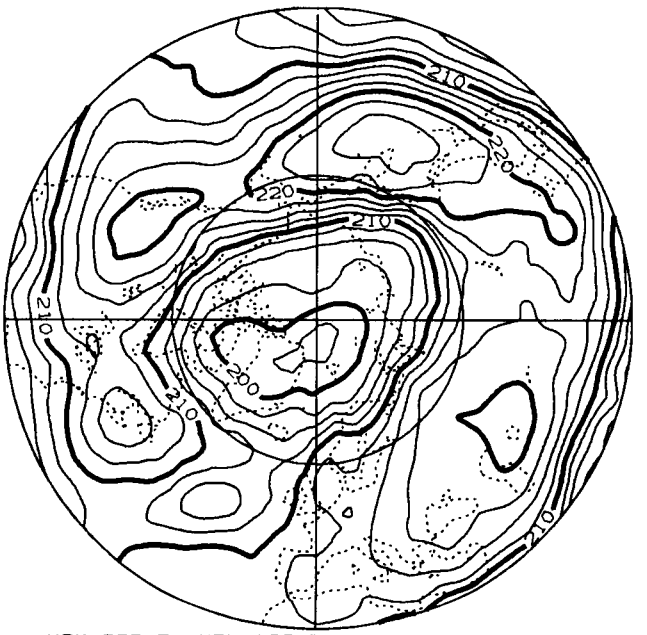
NMC 460K EPV (10^-6) 890113



MAX= 48.3 MIN= 6.3 CONTOUR INC.= 4.0

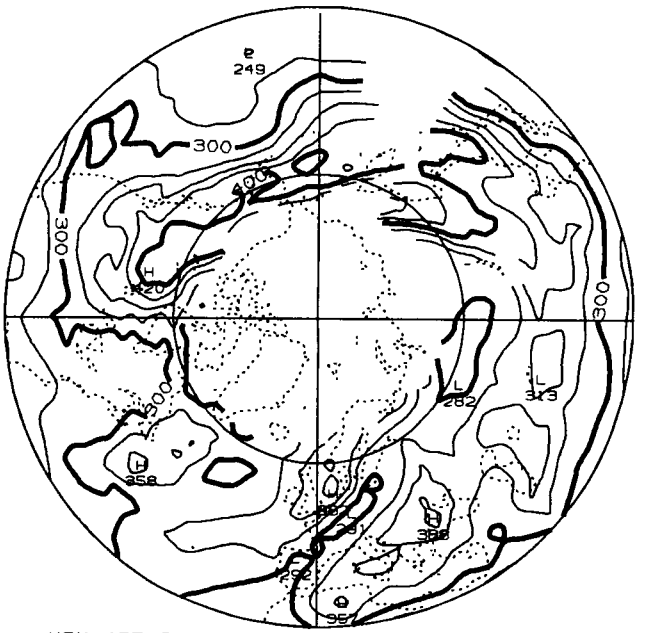


NMC 100MB TEMP. (K) 890114



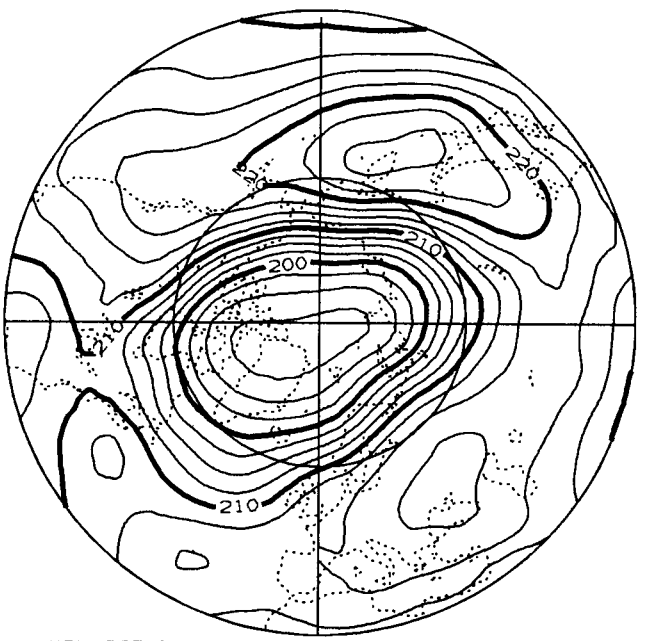
MAX=226.5 MIN=196.5 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890114



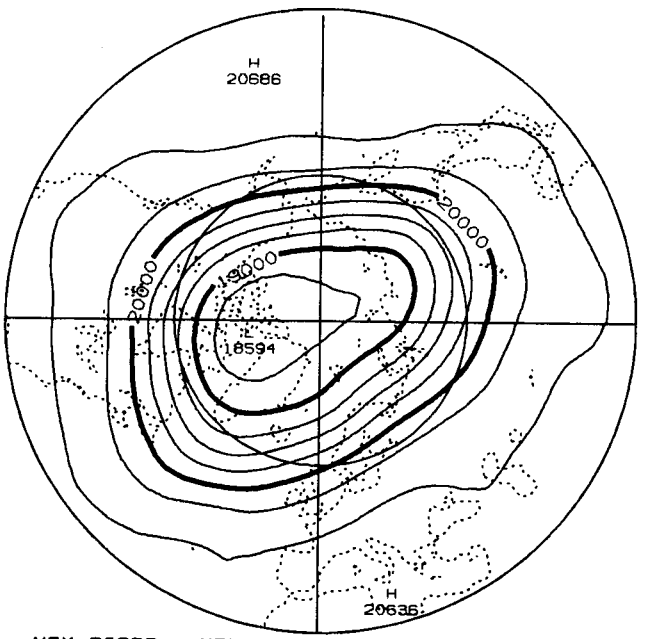
MAX=467.0 MIN=248.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890114



MAX=225.7 MIN=191.4 CONTOUR INC. = 2.5

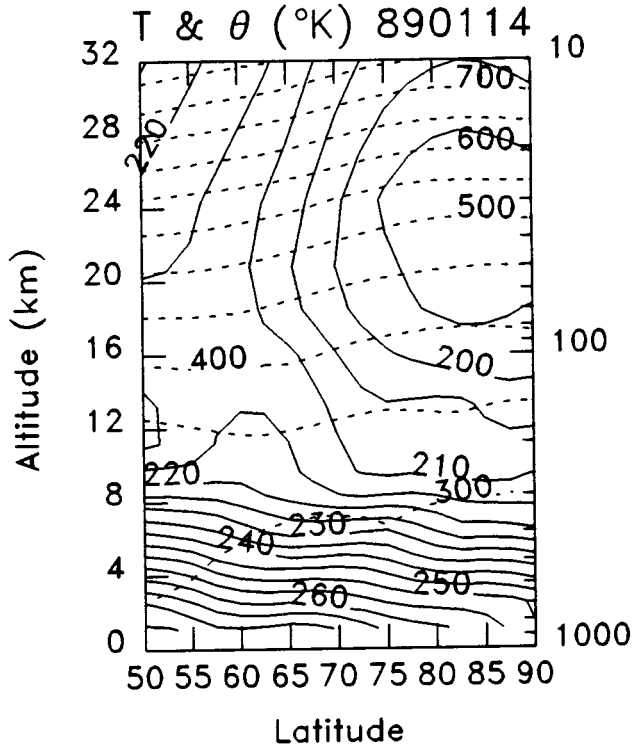
NMC 50MB GEOP HGT (M) 890114



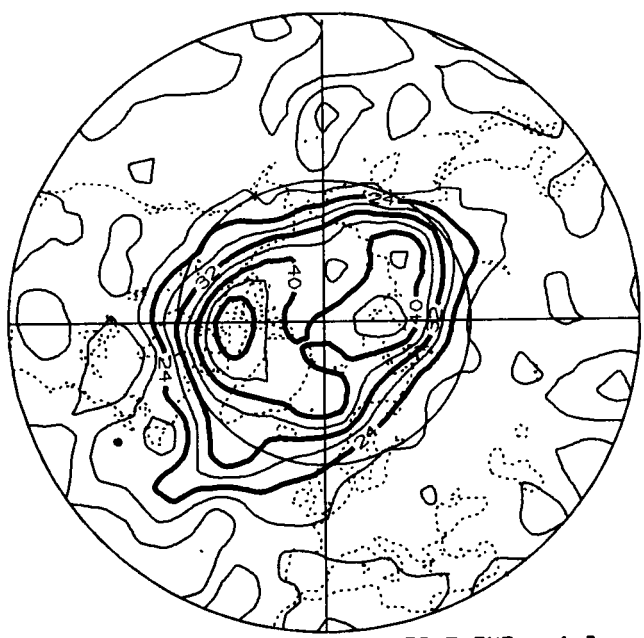
MAX=20686. MIN=18594. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890114

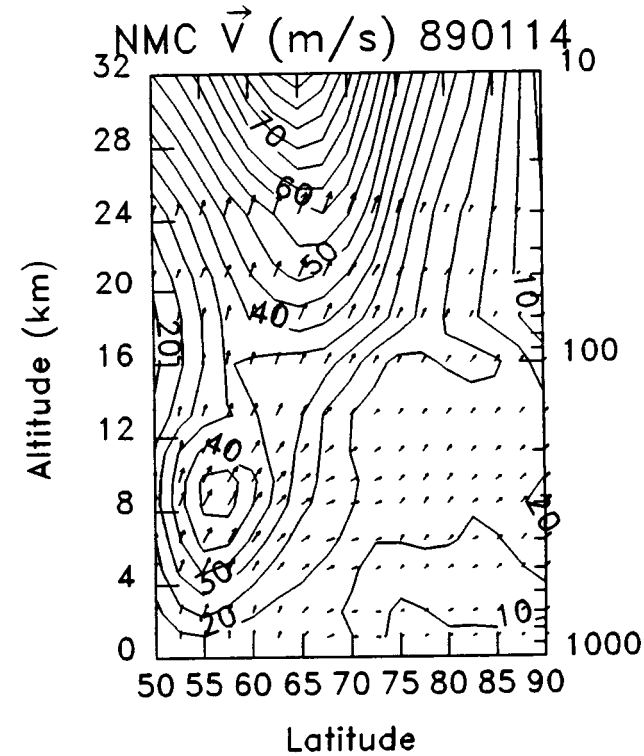
MAX= 19.6 MIN= 2.5 CONTOUR INC. = 1.5



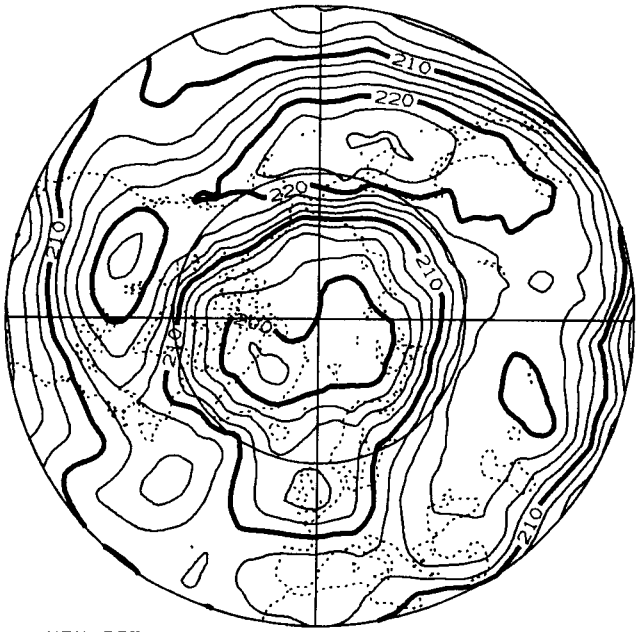
NMC 460K EPV (10^-6) 890114



MAX= 51.2 MIN= 10.1 CONTOUR INC. = 4.0

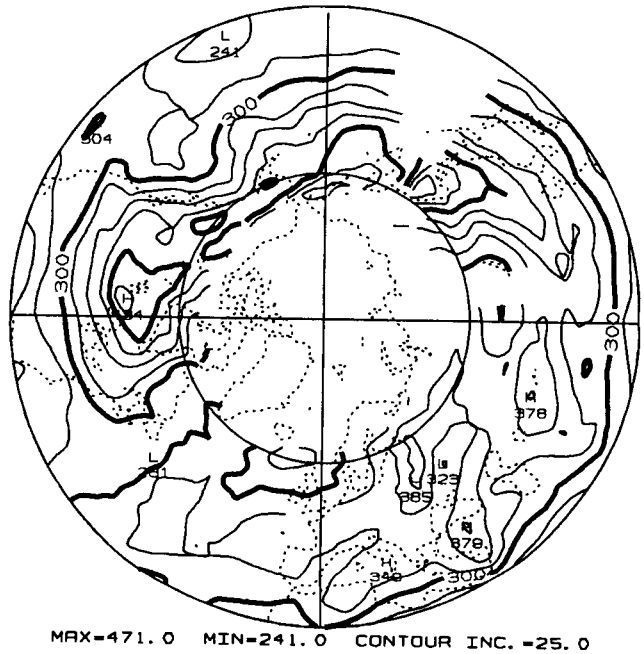


NMC 100MB TEMP. (K) 890115



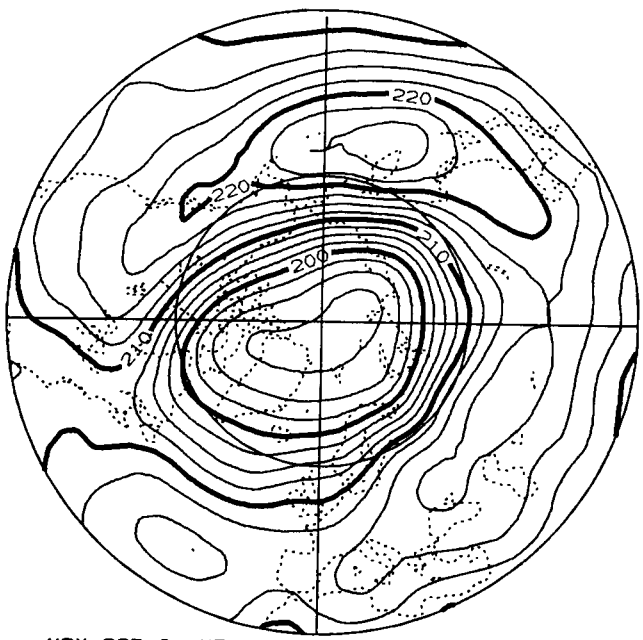
MAX=225.3 MIN=196.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890115



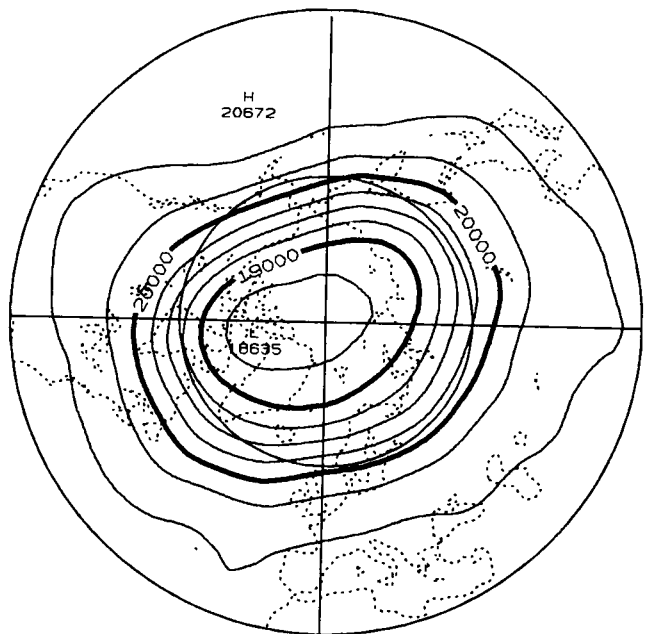
MAX=471.0 MIN=241.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890115



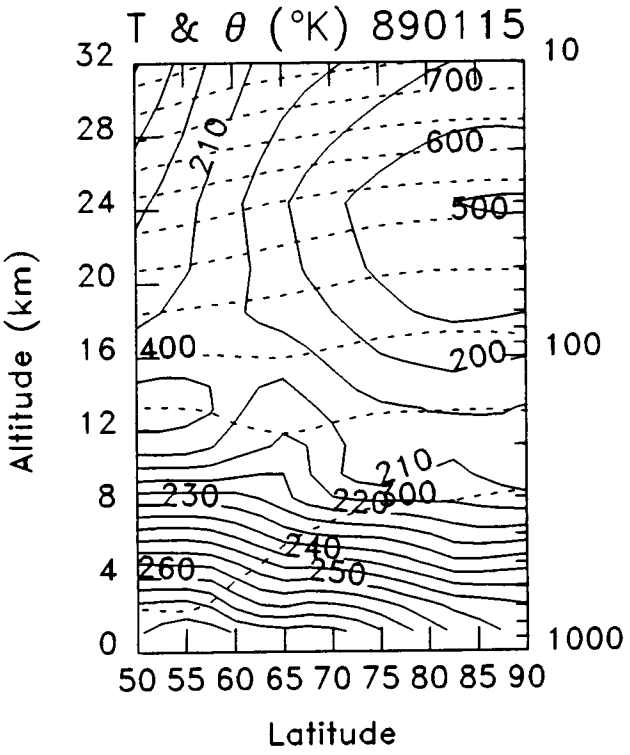
MAX=227.0 MIN=191.3 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890115



MAX=20672. MIN=18635. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890115
MAX= 20.6 MIN= 2.8 CONTOUR INC. = 1.5


T & θ (°K) 890115
Altitude (km)
Latitude
32
28
24
20
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1000
50 55 60 65 70 75 80 85 90
700
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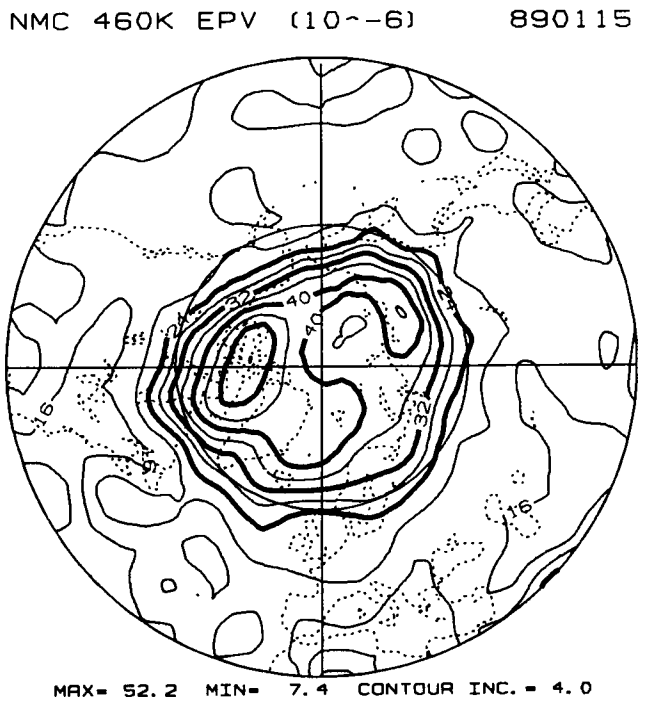
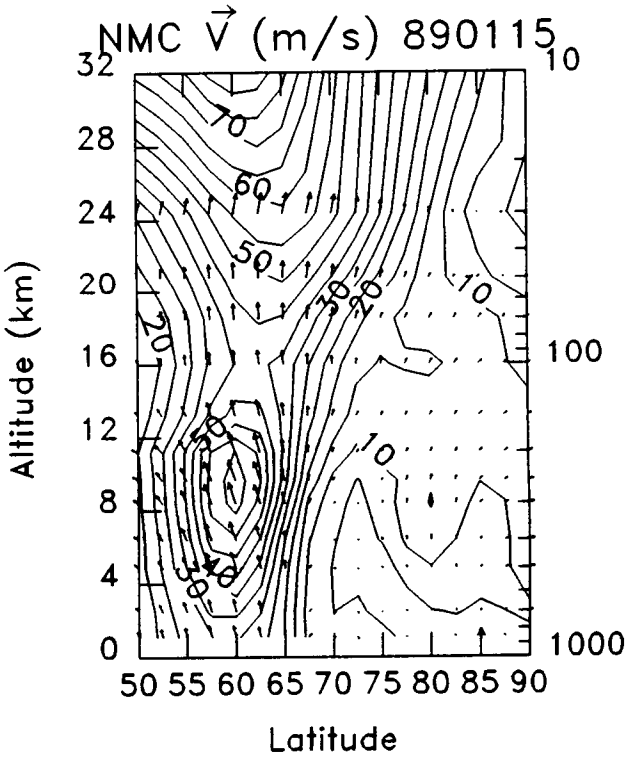
260
250
240
230
220
210
200


NMC 460K EPV (10^-6) 890115
MAX= 52.2 MIN= 7.4 CONTOUR INC. = 4.0


NMC V (m/s) 890115
Altitude (km)
Latitude
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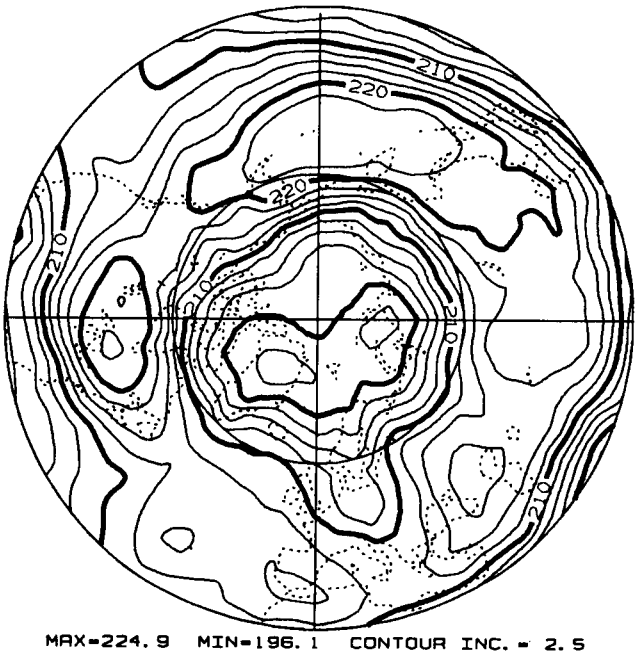
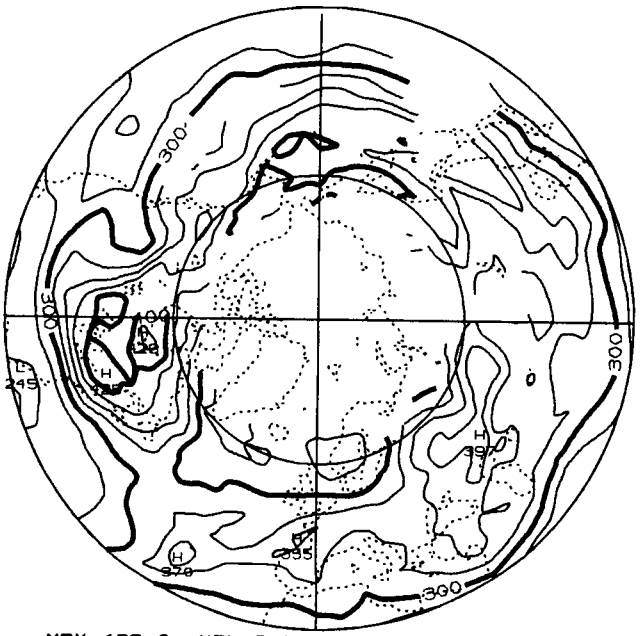
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
70
60
50
40
30
20
10

NMC 100MB TEMP. (K) 890116

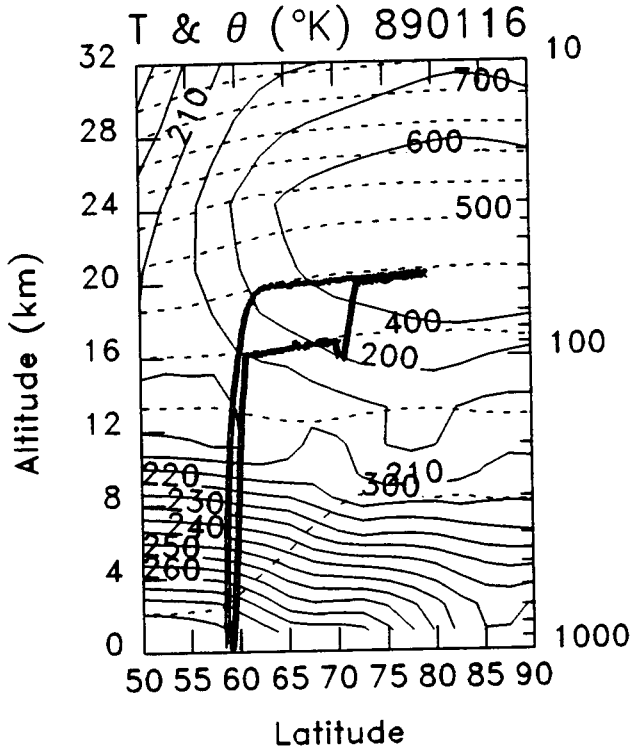


MAX=224.9 MIN=196.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890116


300
300
300
300
245
H
H
H

NMC 400K EPV (10^-6) 890116
MAX= 20.9 MIN= 1.9 CONTOUR INC. = 1.5


T & θ (°K) 890116
Altitude (km)
Latitude
32
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24
20
16
12
8
4
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10
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1000
50 55 60 65 70 75 80 85 90
700
600
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400
300
200
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230
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250
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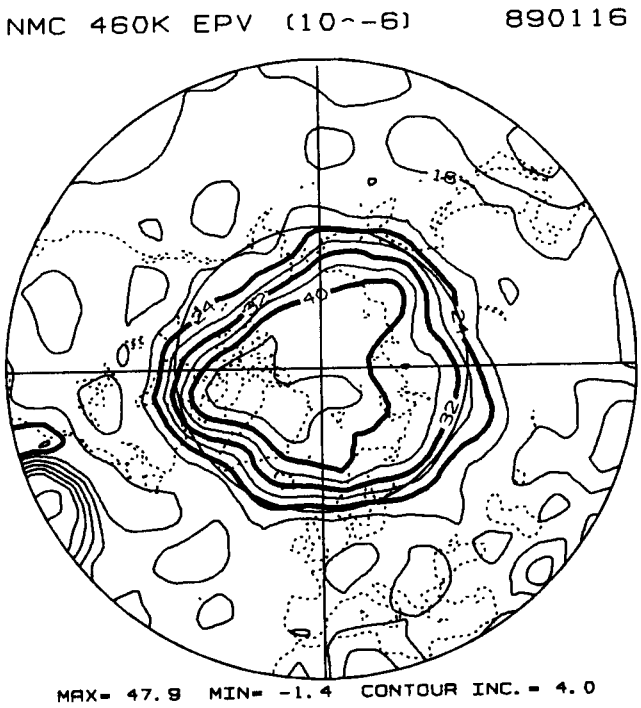
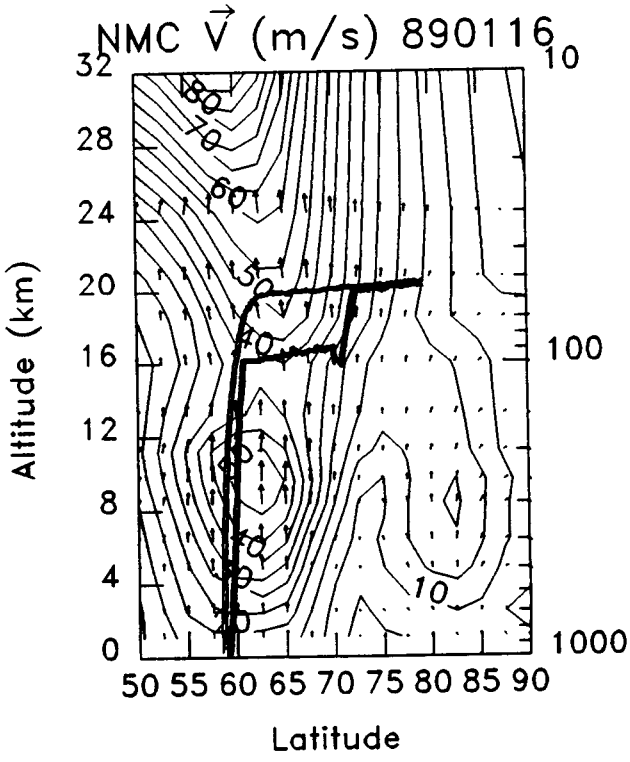

NMC 460K EPV (10^-6) 890116
MAX= 47.9 MIN= -1.4 CONTOUR INC. = 4.0


NMC V (m/s) 890116
Altitude (km)
Latitude
32
28
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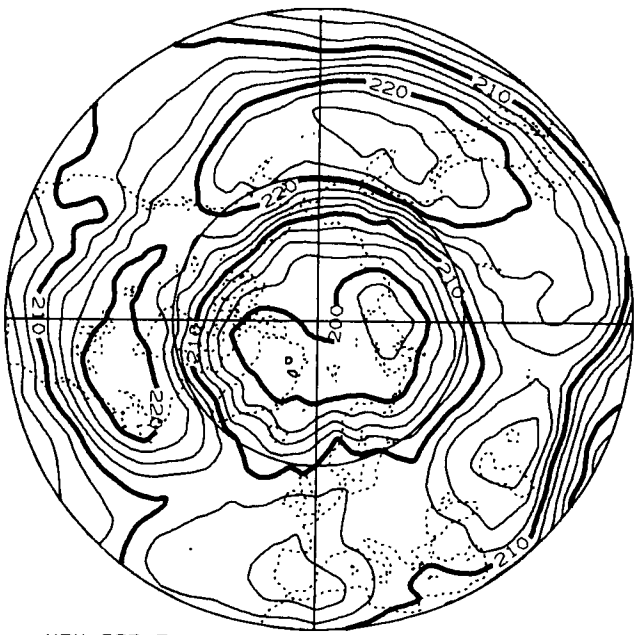
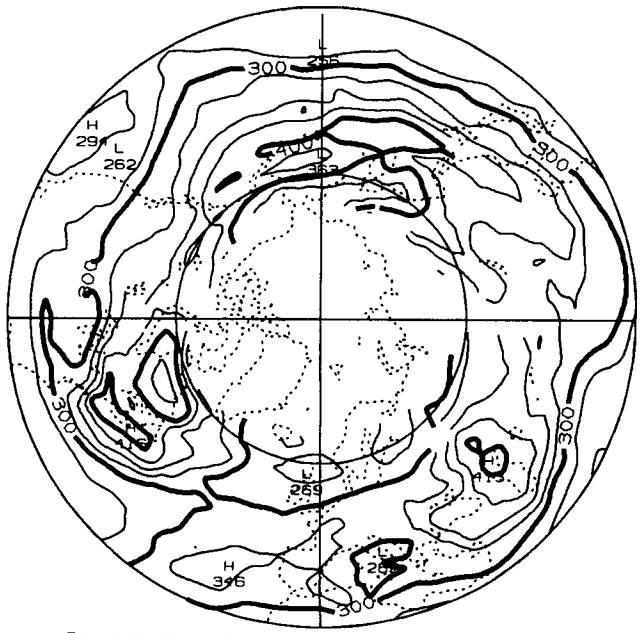
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890117



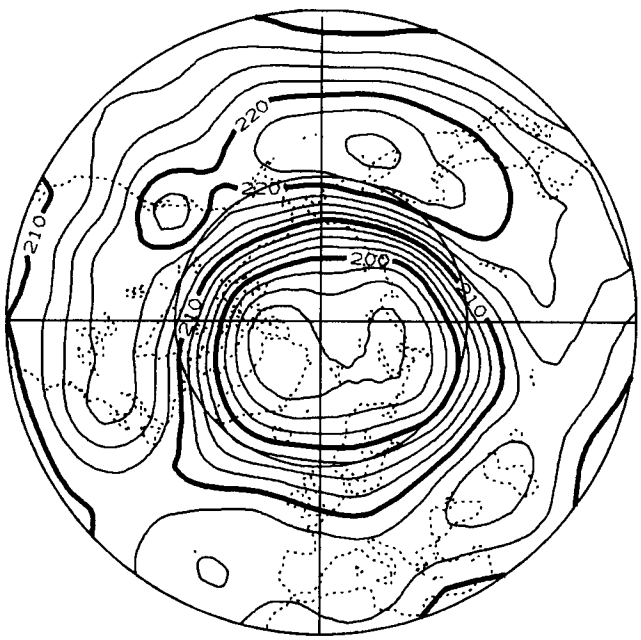
MAX=225.7 MIN=195.4 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890117



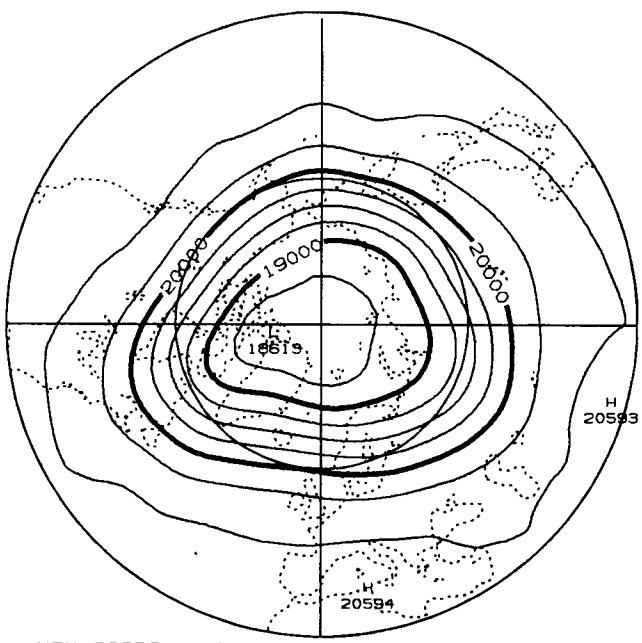
MAX=448.0 MIN=249.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890117

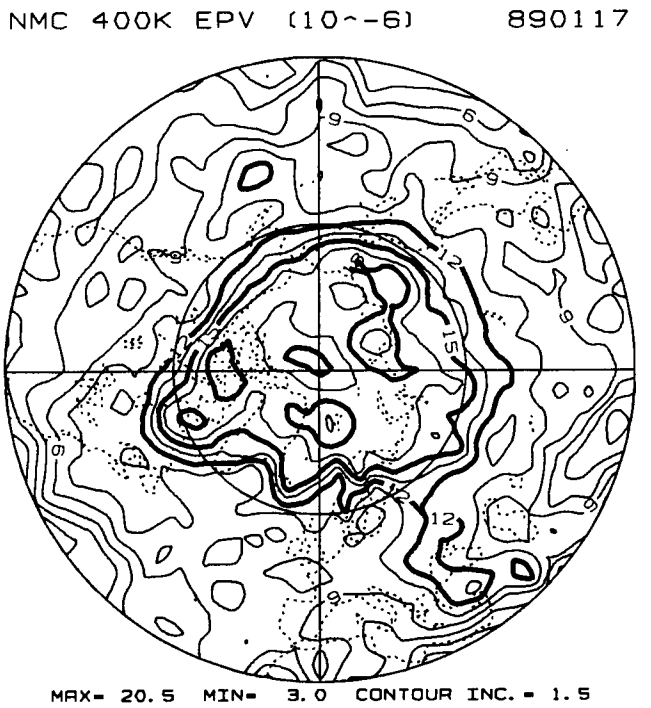


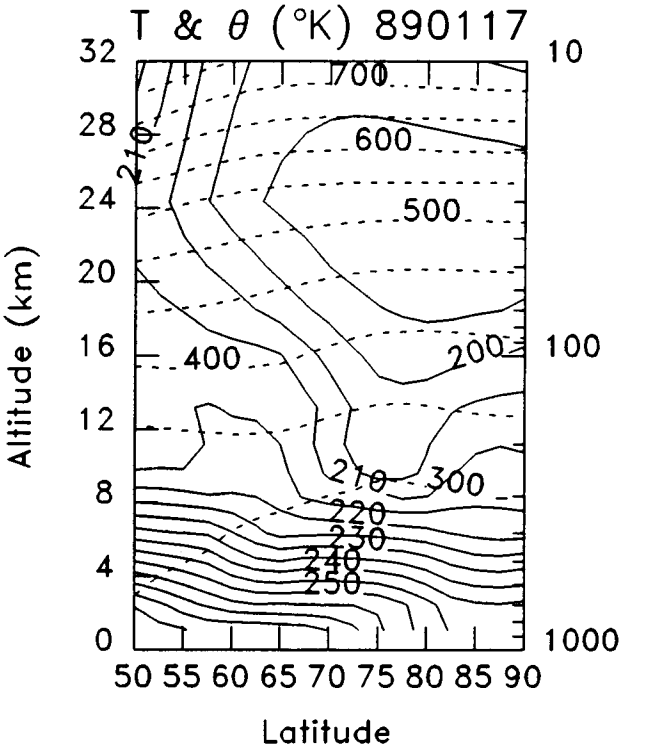
MAX=225.6 MIN=190.0 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890117



MAX=20658. MIN=18613. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890117
MAX= 20.5 MIN= 3.0 CONTOUR INC. = 1.5


T & θ (°K) 890117
Altitude (km)
Latitude
700
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500
400
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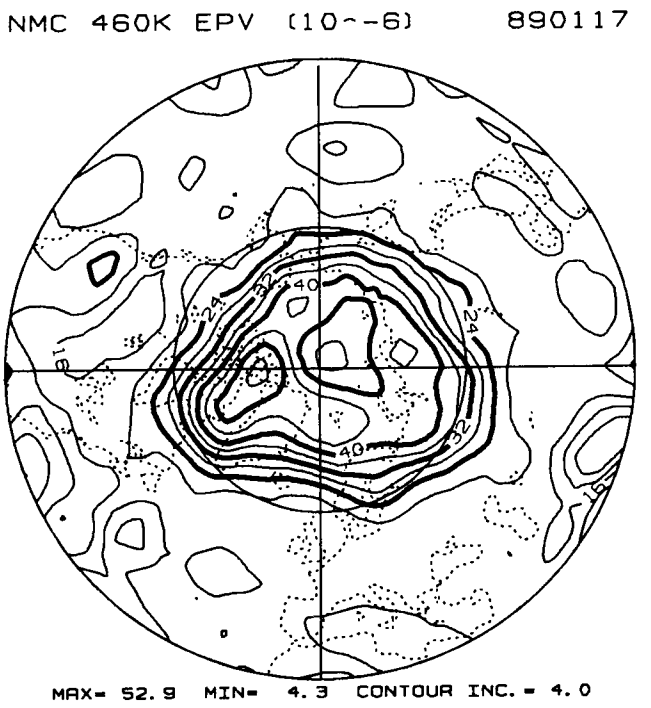
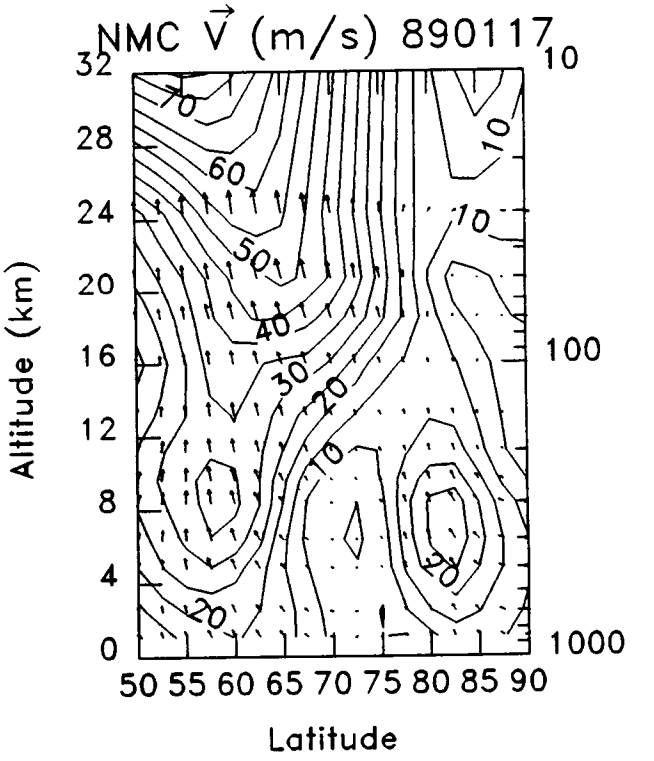
240
250
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890117
MAX= 52.9 MIN= 4.3 CONTOUR INC. = 4.0


NMC V (m/s) 890117
Altitude (km)
Latitude
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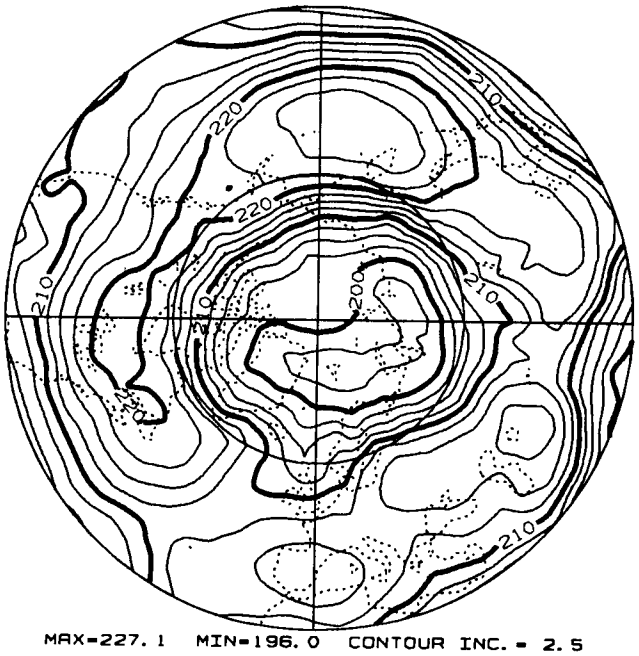
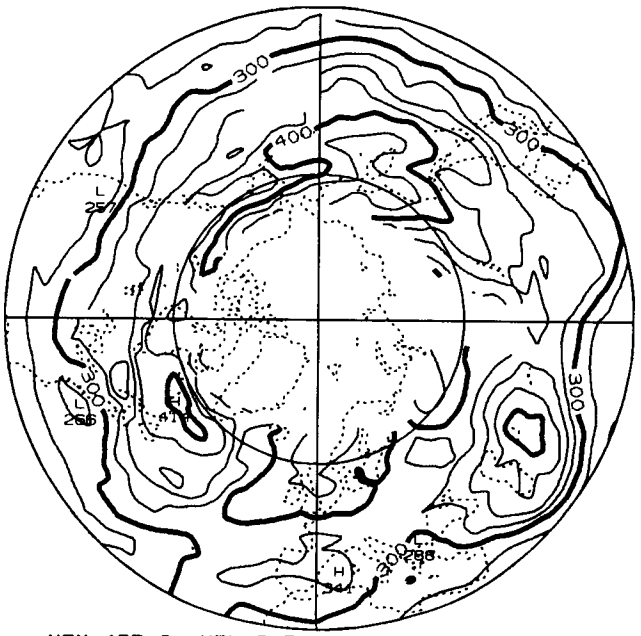
50
40
30
20
10
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890118



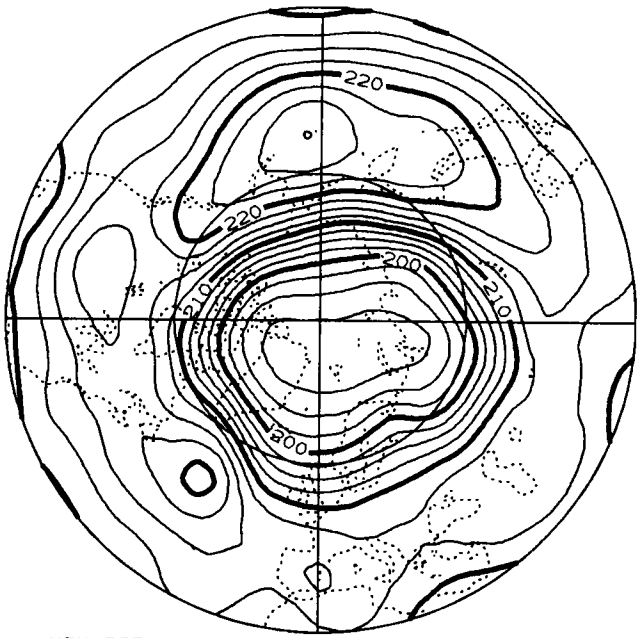
MAX=227.1 MIN=196.0 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890118



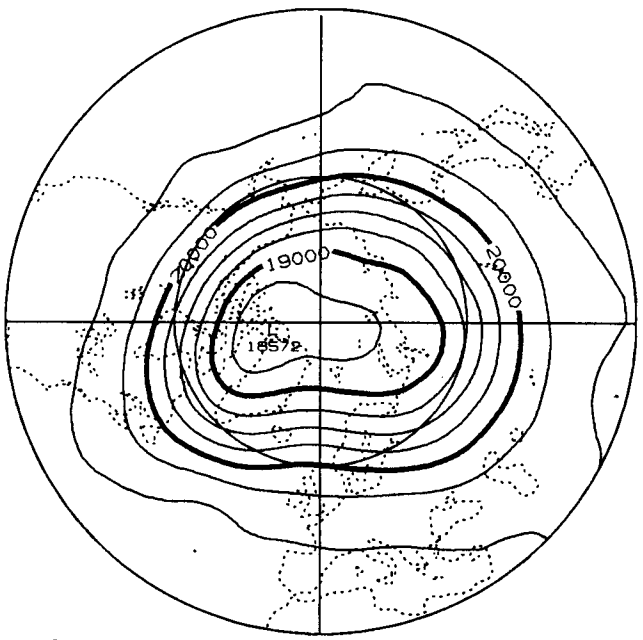
MAX=455.0 MIN=247.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890118



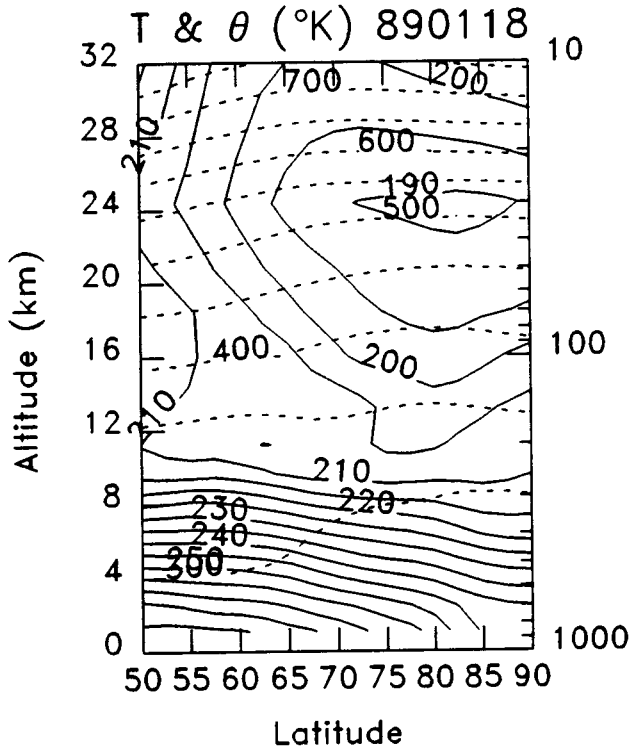
MAX=227.6 MIN=191.0 CONTOUR INC.= 2.5

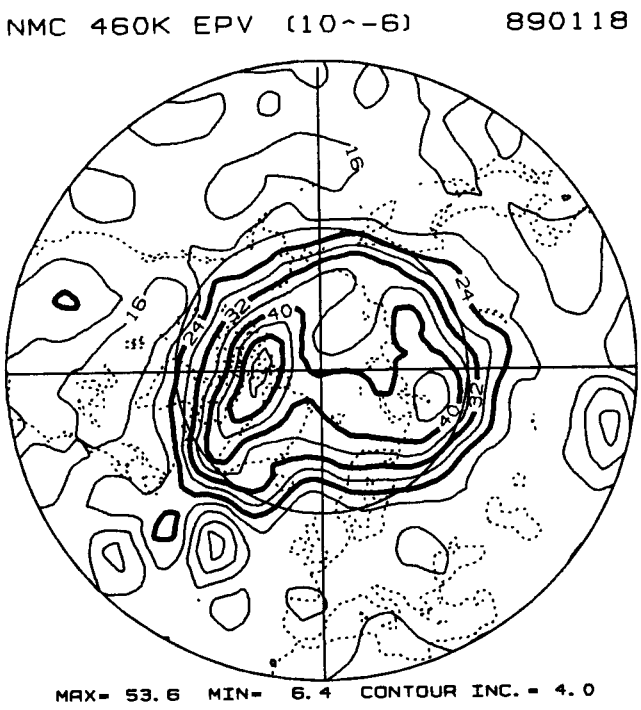
NMC 50MB GEOP HGT (M) 890118

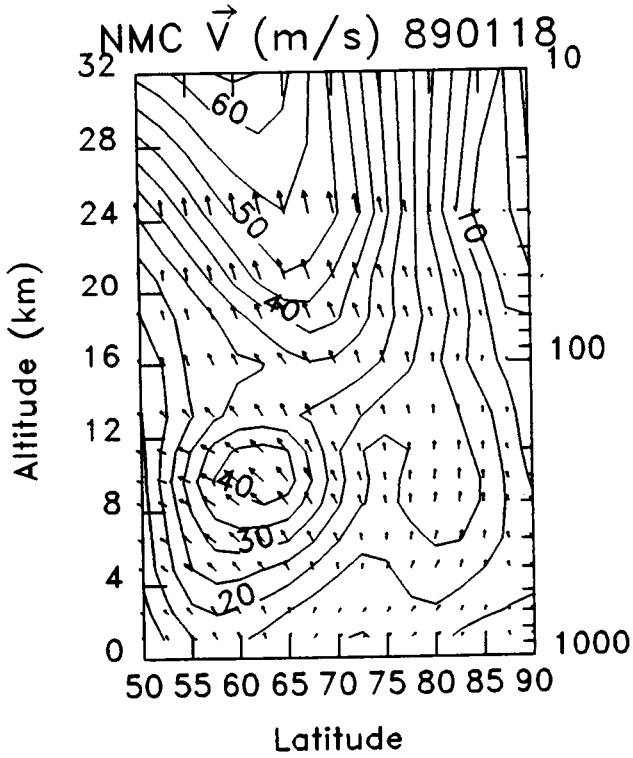


MAX=20613. MIN=18572. CONTOUR INC.=250.

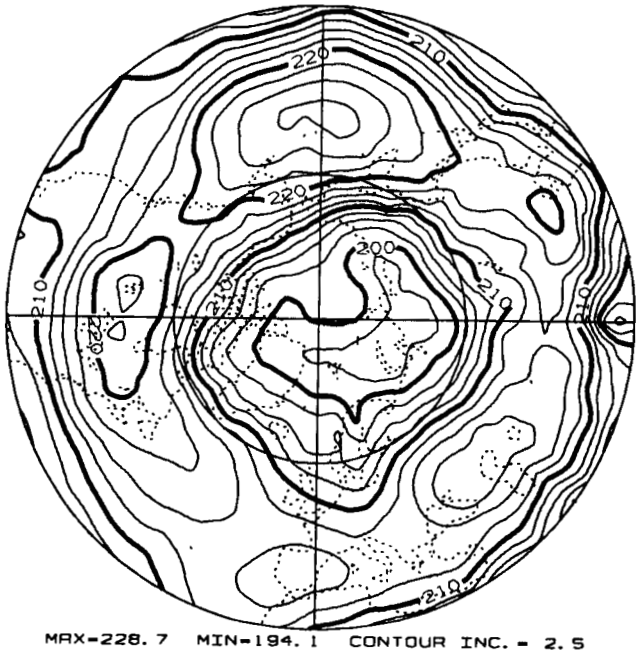
NMC 400K EPV (10^-6) 890118
MAX= 20.1 MIN= 2.8 CONTOUR INC. = 1.5


T & θ (°K) 890118
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
700
200
600
190
500
400
200
210
220
230
240
260


NMC 460K EPV (10^-6) 890118
MAX= 53.6 MIN= 6.4 CONTOUR INC. = 4.0

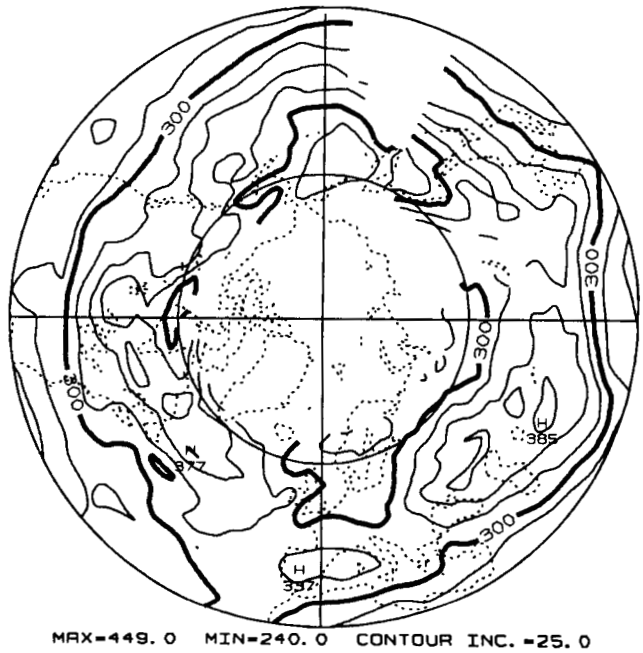

NMC V (m/s) 890118
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
60
50
40
10
40
30
20

NMC 100MB TEMP. (K) 890119



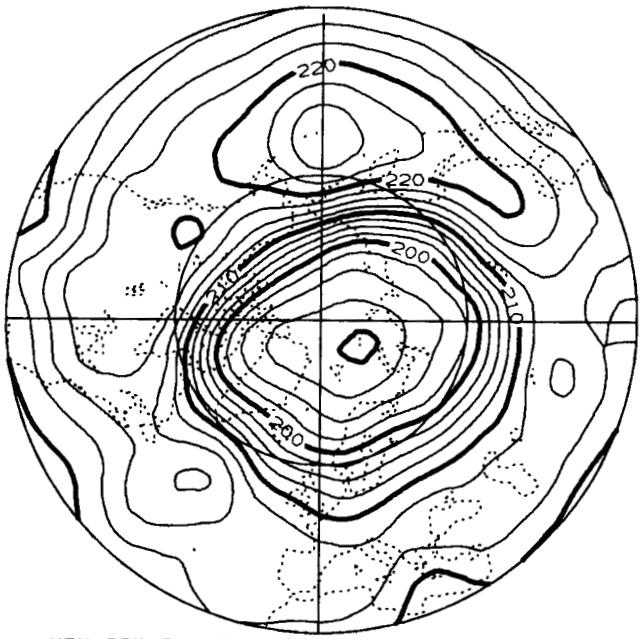
MAX=228.7 MIN=194.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890119



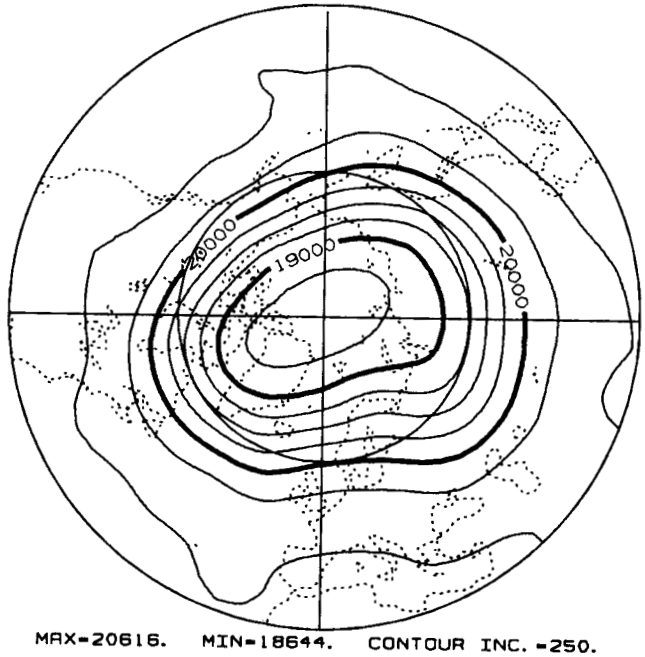
MAX=449.0 MIN=240.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890119

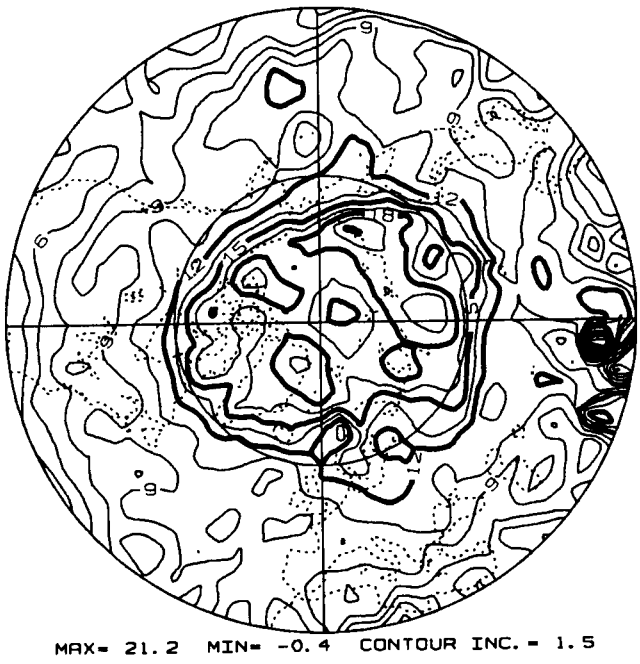


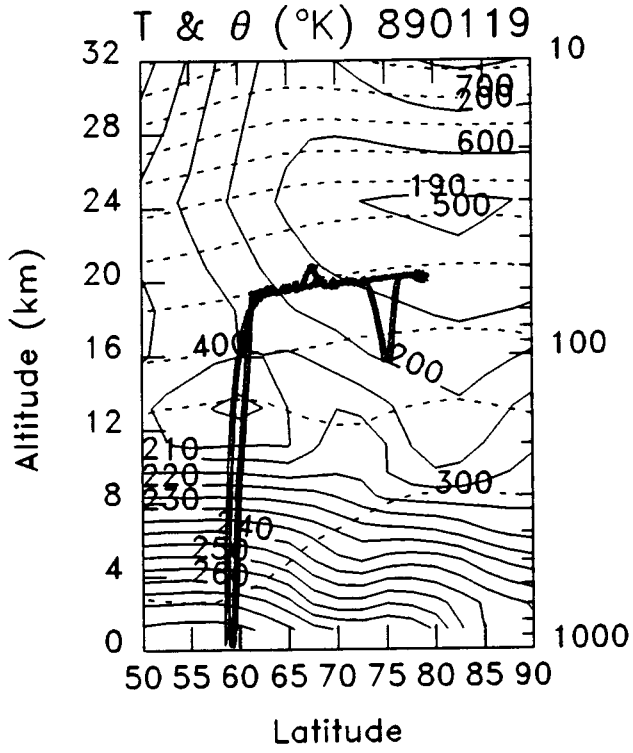
MAX=227.2 MIN=189.5 CONTOUR INC. = 2.5

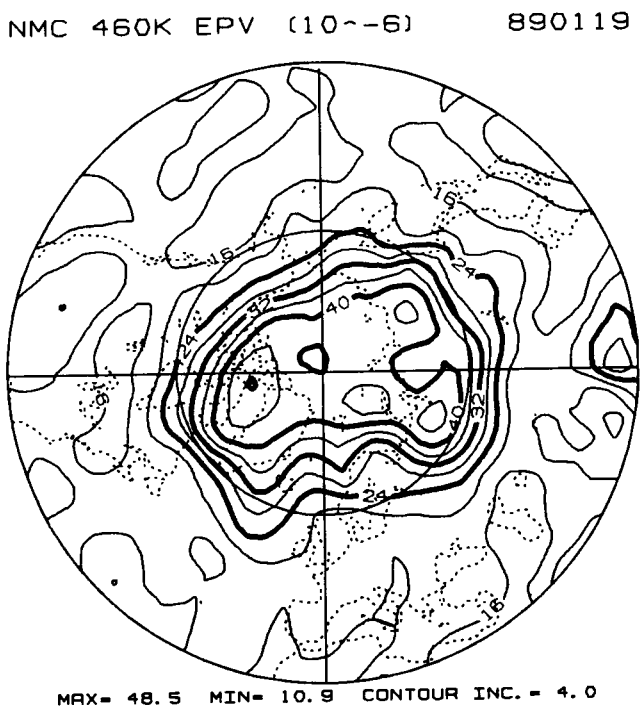
NMC 50MB GEOP HGT (M) 890119

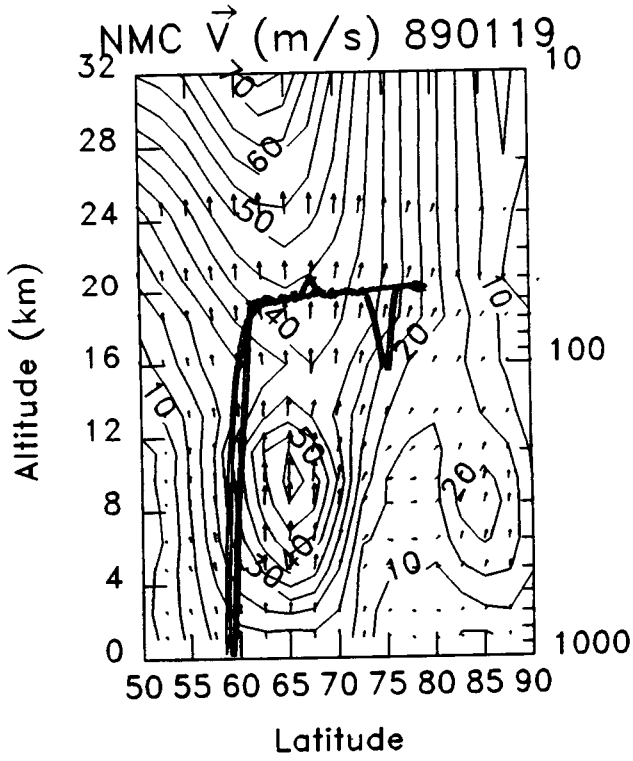


MAX=20616. MIN=18644. CONTOUR INC. =250.

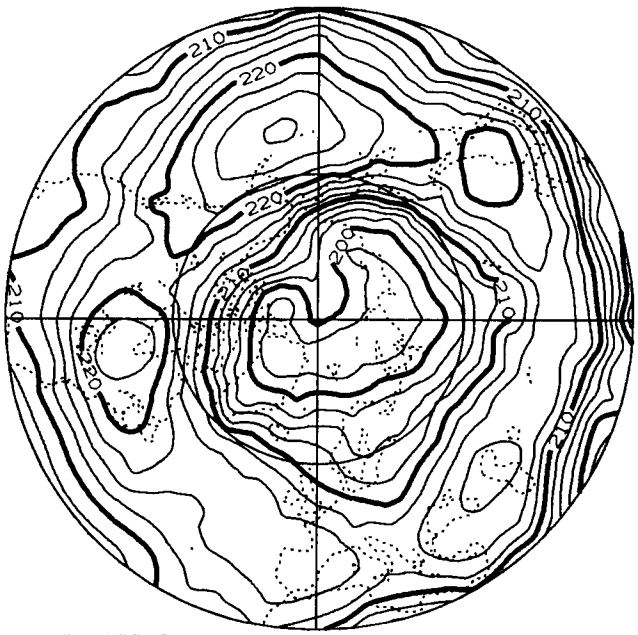

NMC 400K EPV (10^-6) 890119
MAX= 21.2 MIN= -0.4 CONTOUR INC. = 1.5


T & θ (°K) 890119
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
700
600
500
400
300
210
220
230
240
250
260


NMC 460K EPV (10^-6) 890119
MAX= 48.5 MIN= 10.9 CONTOUR INC. = 4.0

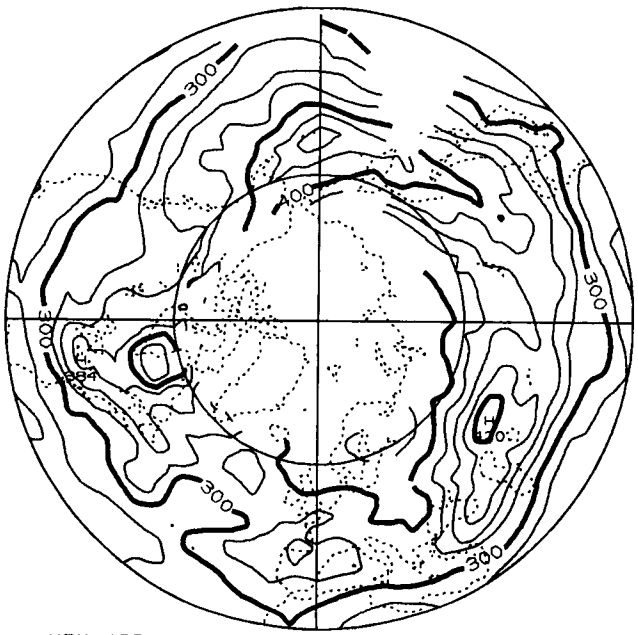

NMC V (m/s) 890119
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890120



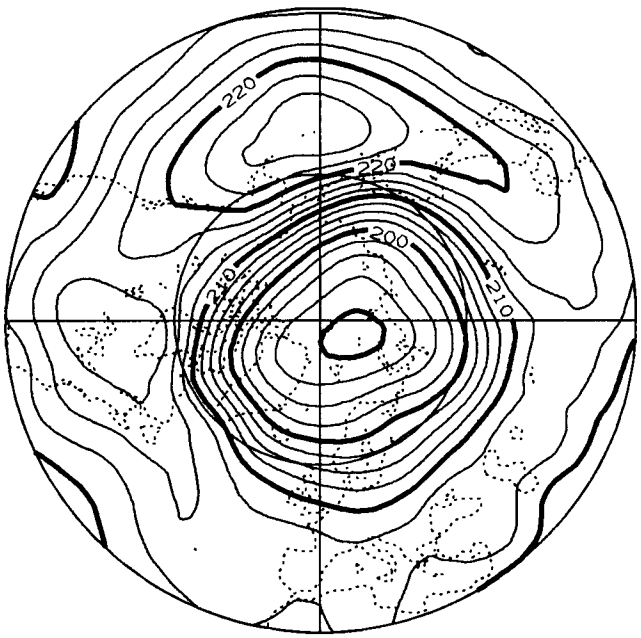
MAX=227.9 MIN=195.0 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890120



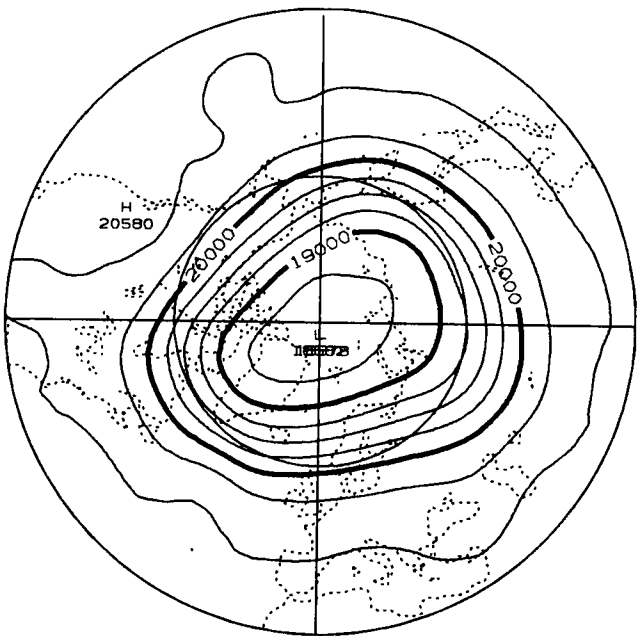
MAX=462.0 MIN=240.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890120



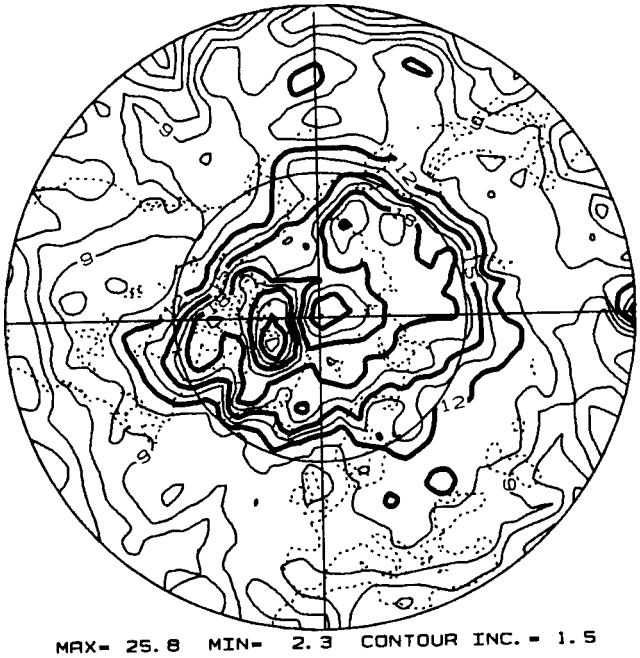
MAX=227.5 MIN=189.0 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890120



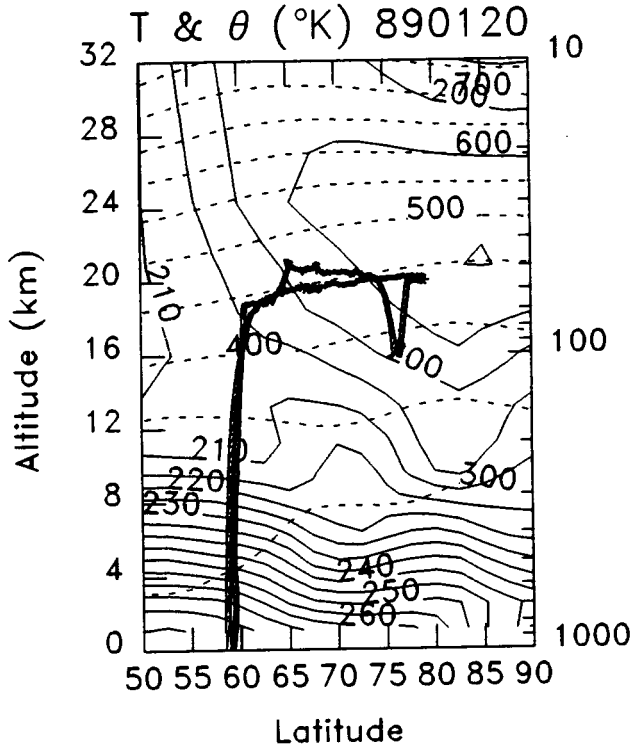
MAX=20608. MIN=18578. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890120

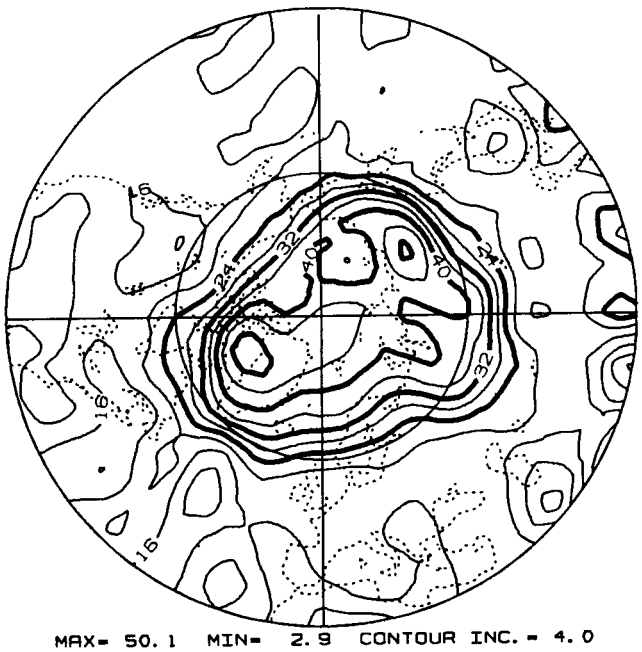


MAX= 25.8 MIN= 2.3 CONTOUR INC. = 1.5

T & θ (°K) 890120

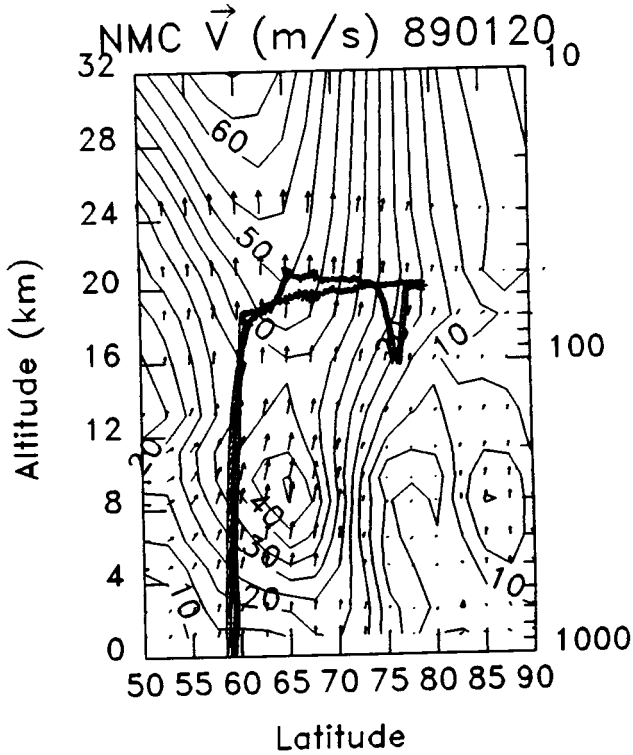


NMC 460K EPV (10^-6) 890120

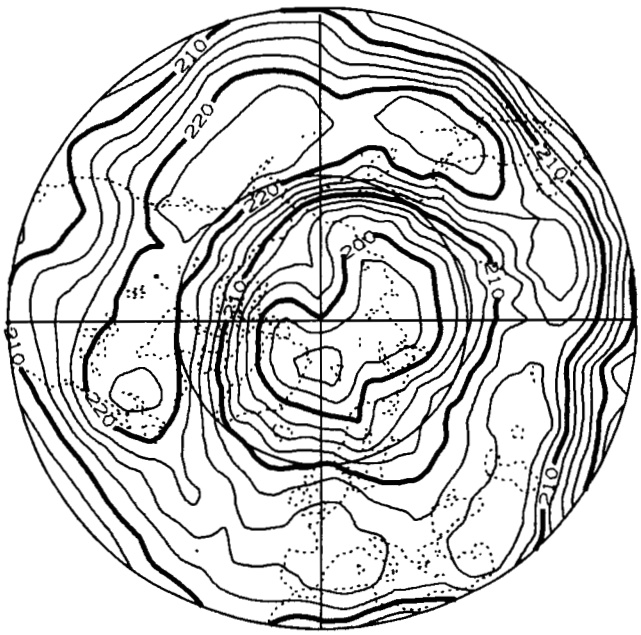


MAX= 50.1 MIN= 2.9 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890120

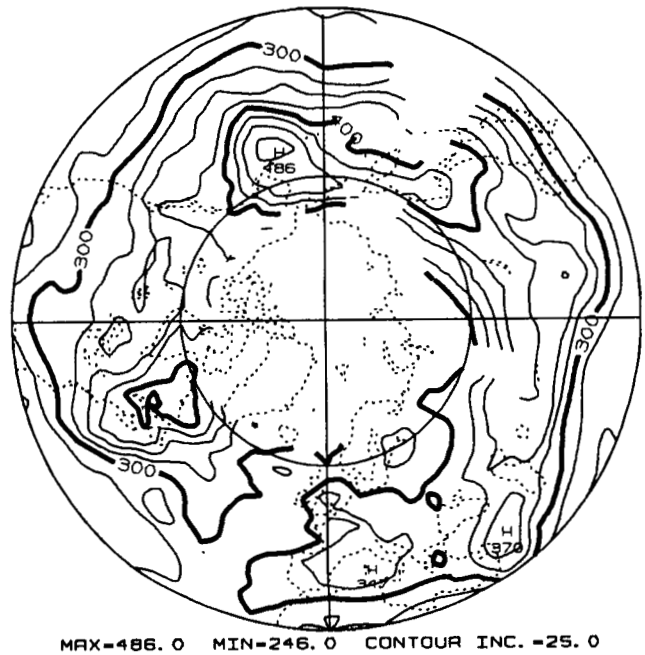


NMC 100MB TEMP. (K) 890121



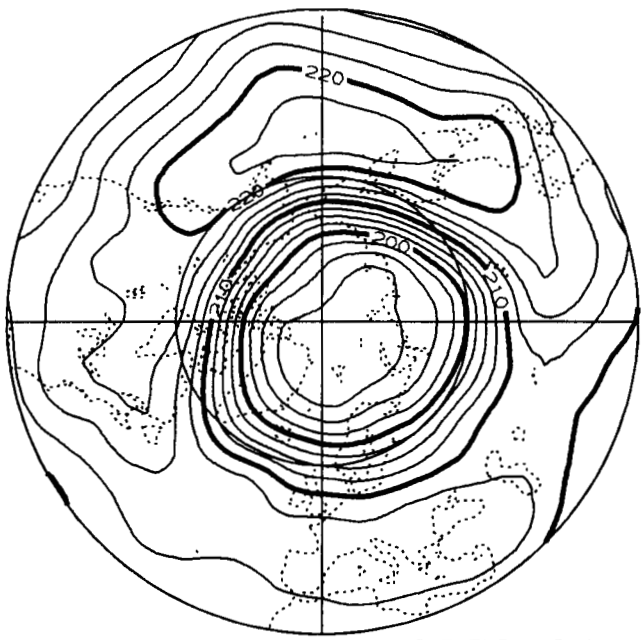
MAX=224.6 MIN=193.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890121



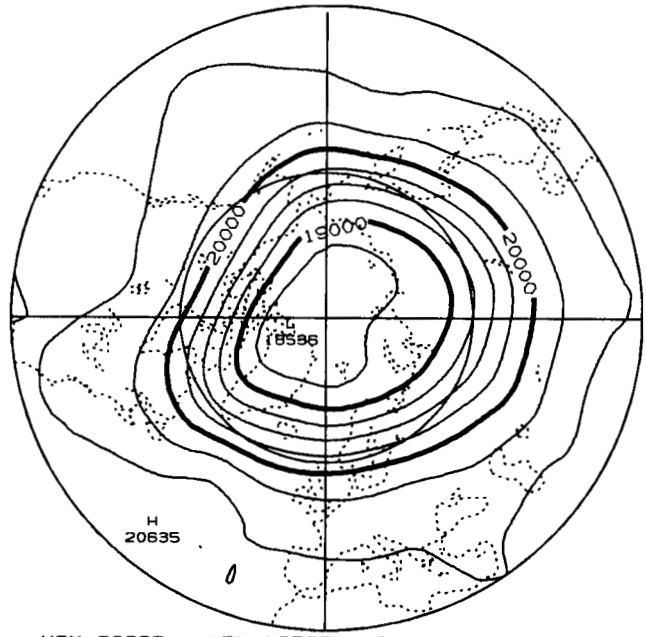
MAX=486.0 MIN=246.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890121



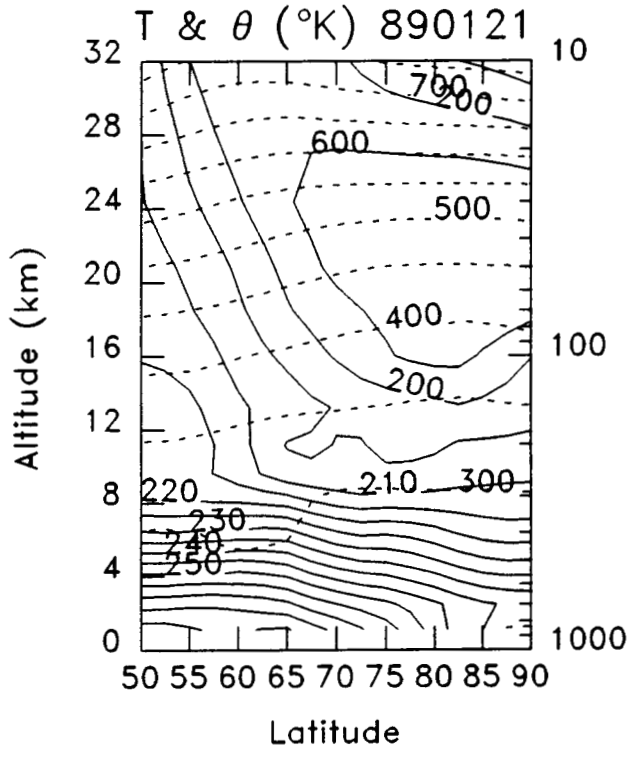
MAX=224.1 MIN=190.0 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890121



MAX=20635. MIN=18536. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890121
MAX= 22.6 MIN= 2.3 CONTOUR INC. = 1.5


T & θ (°K) 890121
Altitude (km)
Latitude
700
600
500
400
300
200
220
230
240
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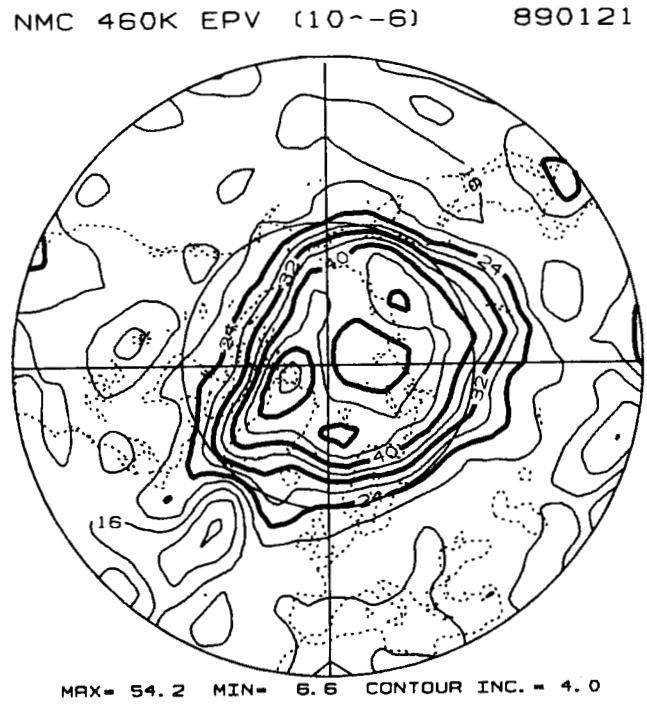
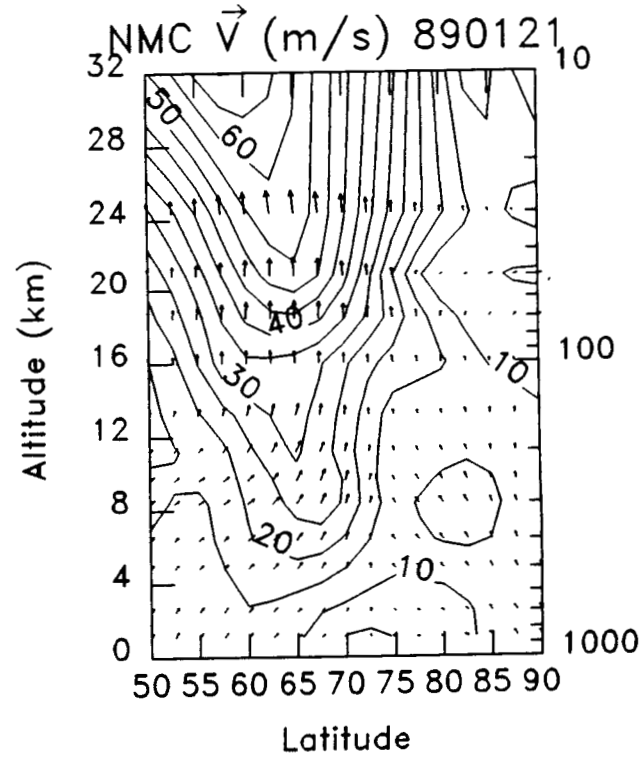
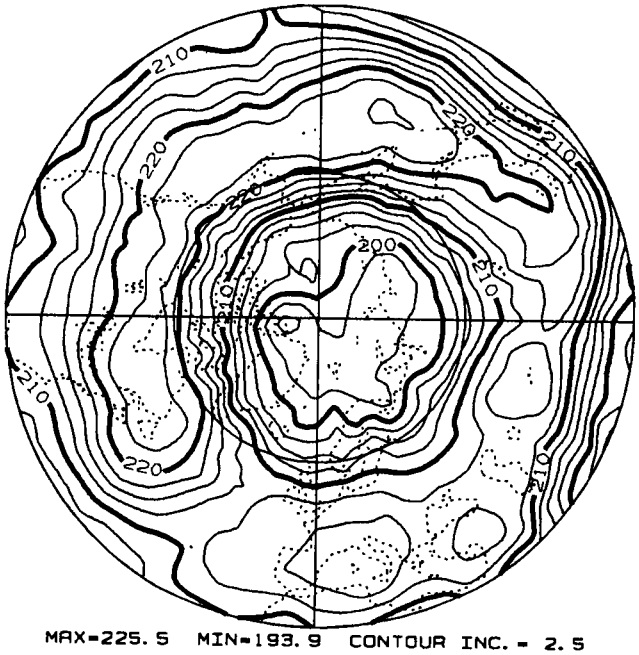
210
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890121
MAX= 54.2 MIN= 6.6 CONTOUR INC. = 4.0

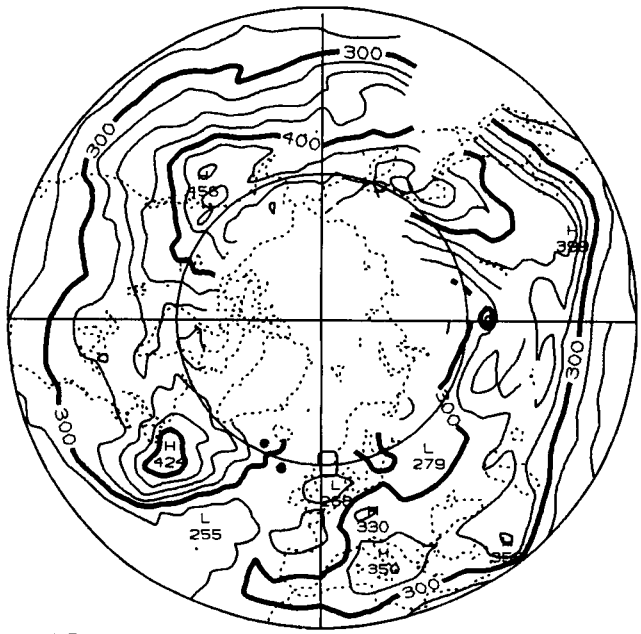

NMC V (m/s) 890121
Altitude (km)
Latitude
50
60
40
30
20
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890122



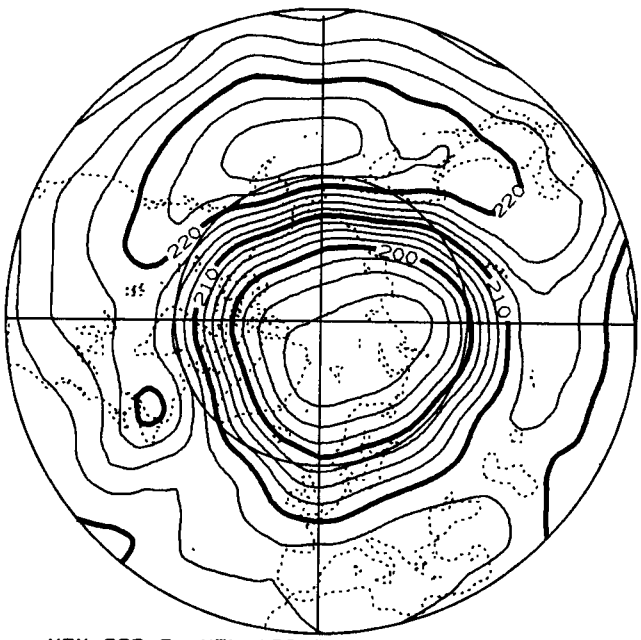
MAX=225.5 MIN=193.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890122



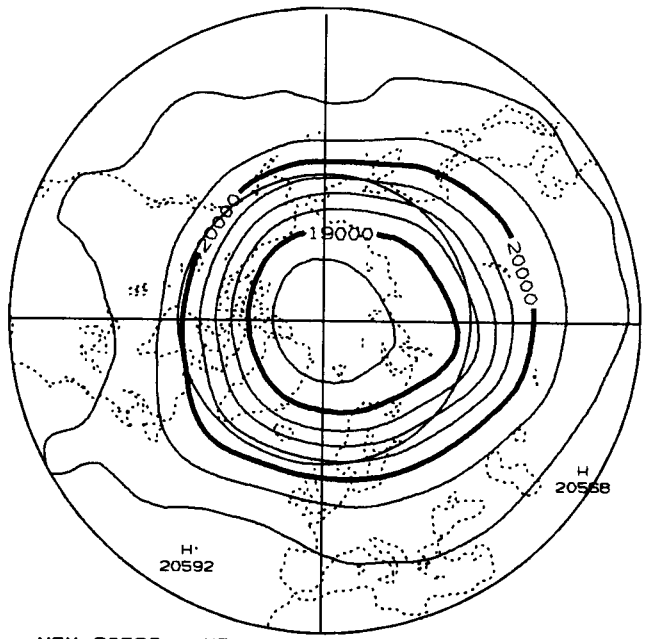
MAX=476.0 MIN=243.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890122



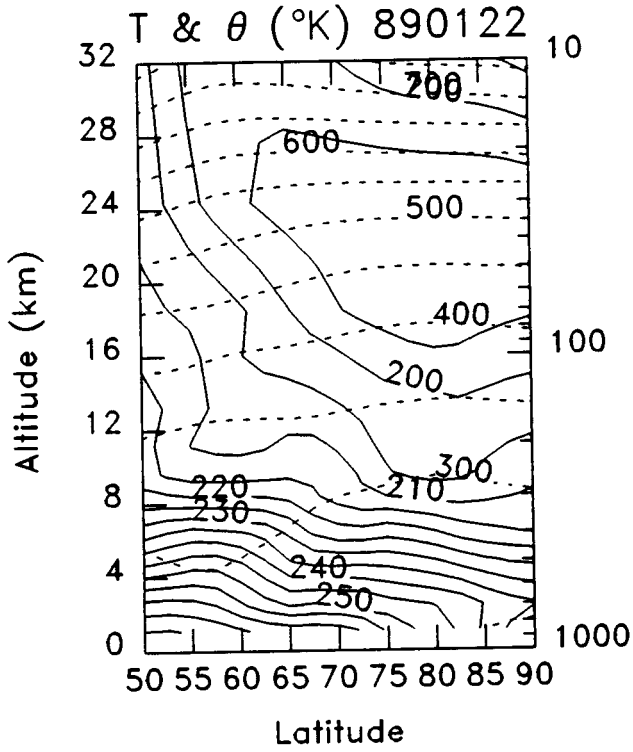
MAX=226.8 MIN=190.3 CONTOUR INC. = 2.5

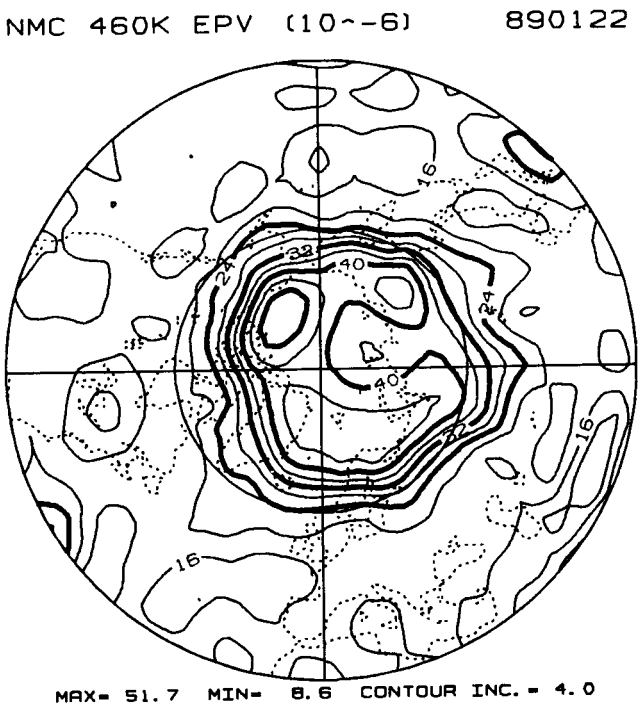
NMC 50MB GEOP HGT (M) 890122

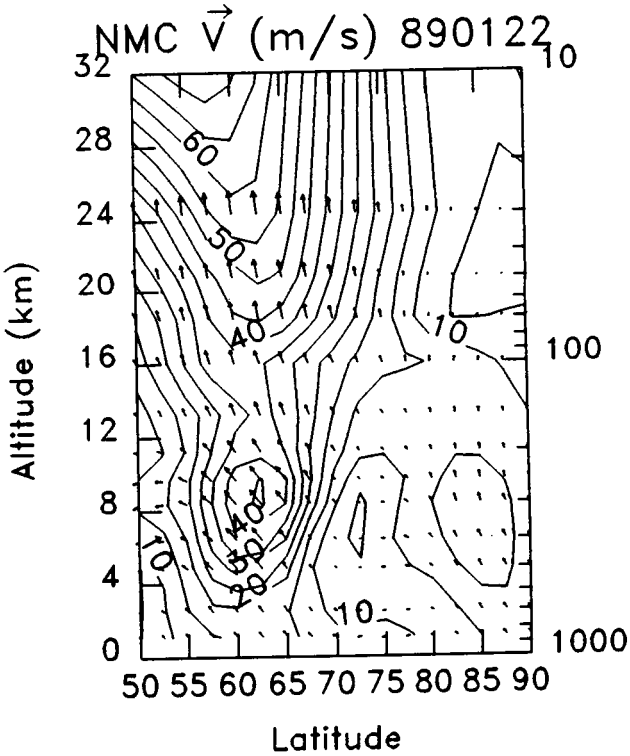


MAX=20592. MIN=18619. CONTOUR INC. =250.

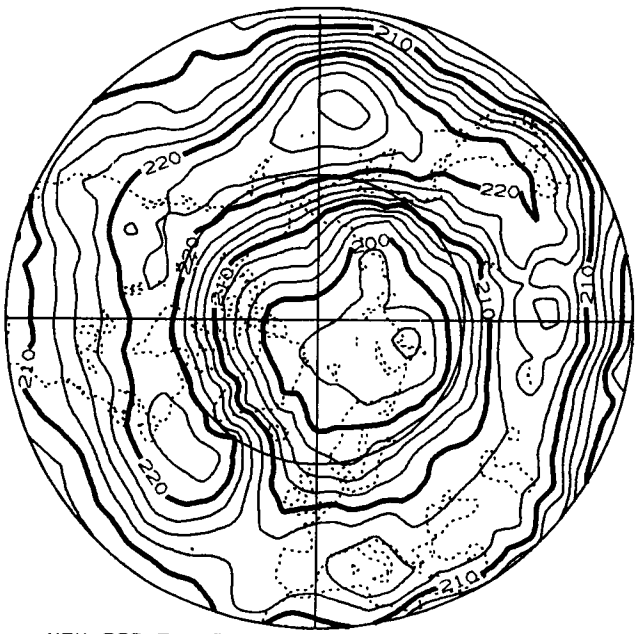
NMC 400K EPV (10^-6) 890122
MAX= 24.2 MIN= 2.0 CONTOUR INC. = 1.5


T & θ (°K) 890122
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
200
600
500
400
200
300
210
220
230
240
250


NMC 460K EPV (10^-6) 890122
MAX= 51.7 MIN= 8.6 CONTOUR INC. = 4.0

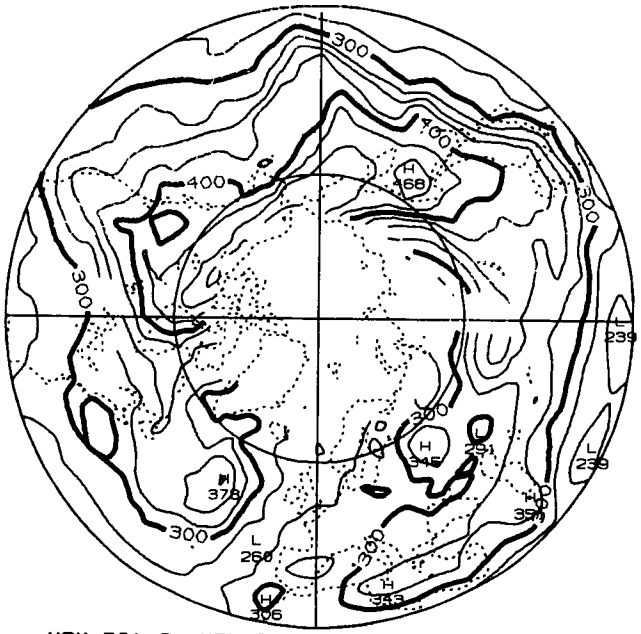

NMC V (m/s) 890122
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
60
50
40
10
40
50
20
10

NMC 100MB TEMP. (K) 890123



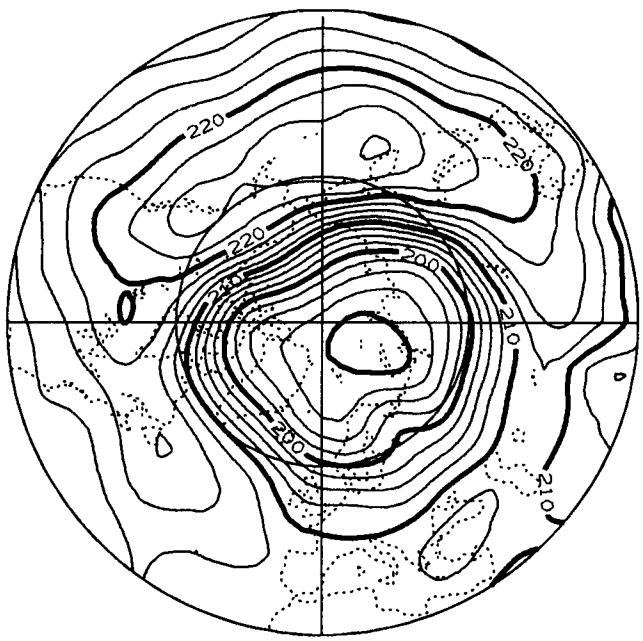
MAX=228.5 MIN=193.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890123



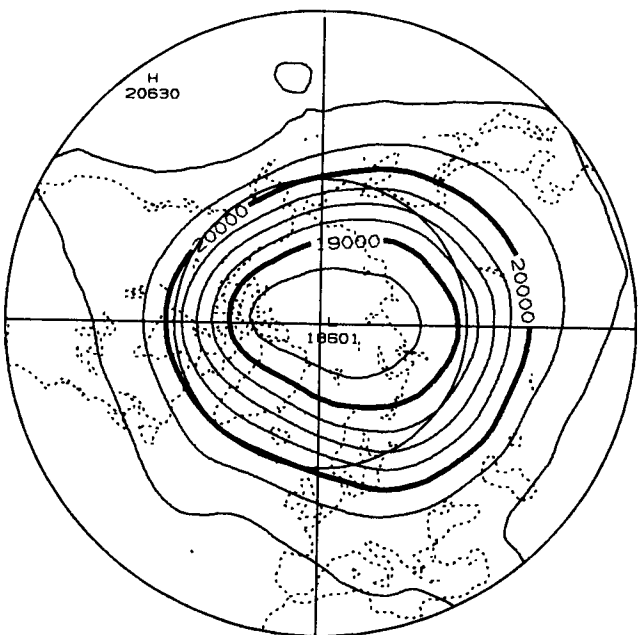
MAX=501.0 MIN=239.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890123

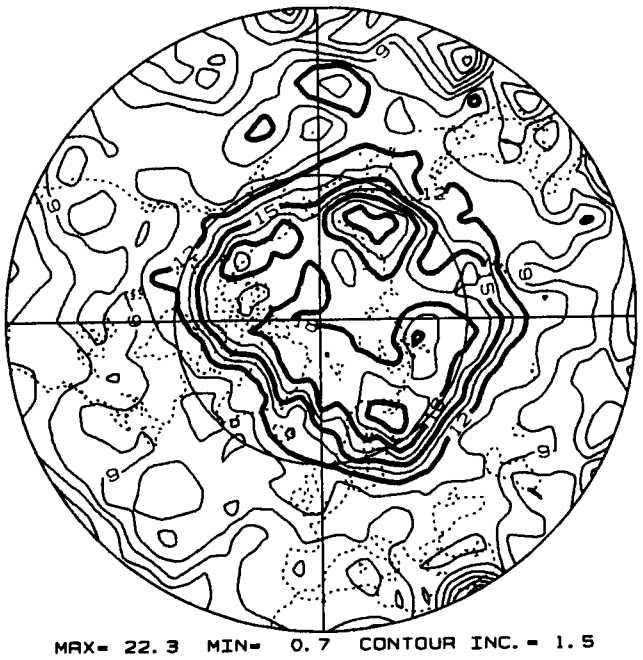


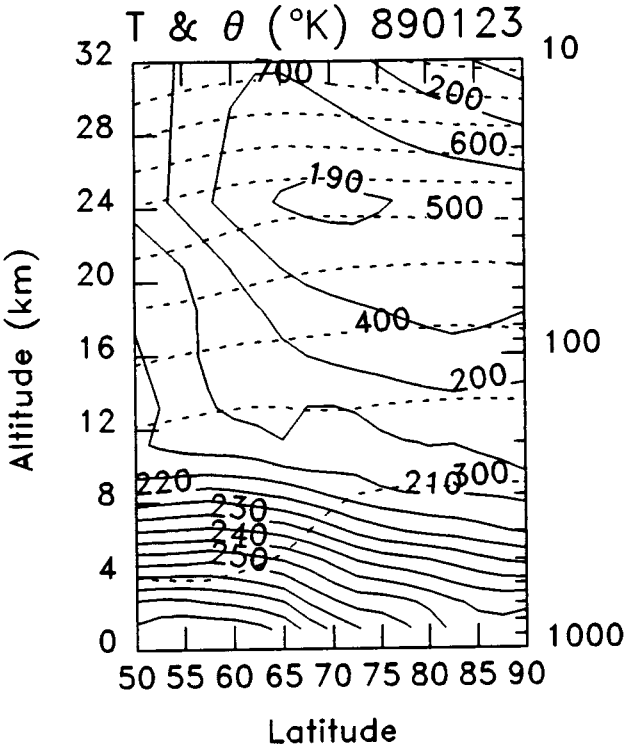
MAX=227.7 MIN=188.4 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890123



MAX=20674. MIN=18601. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890123
MAX= 22.3 MIN= 0.7 CONTOUR INC. = 1.5


T & θ (°K) 890123
Altitude (km)
Latitude
32
28
24
20
16
12
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4
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100
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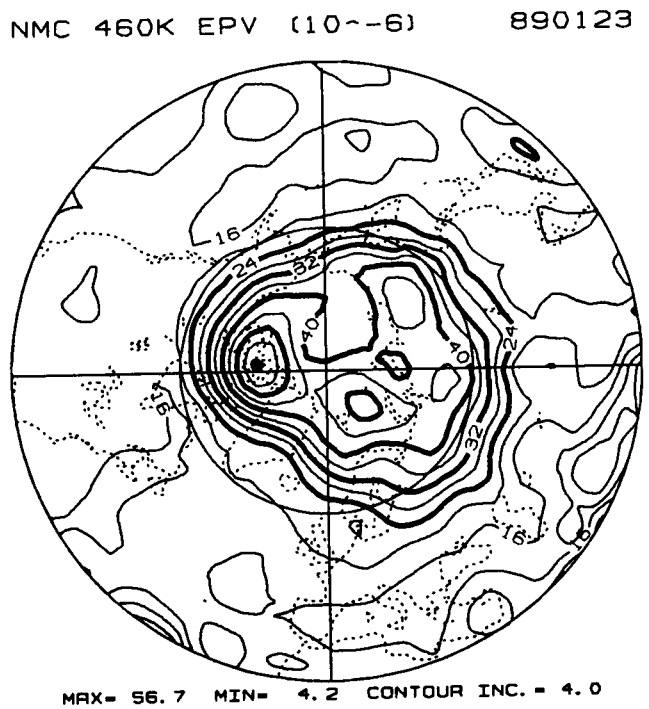
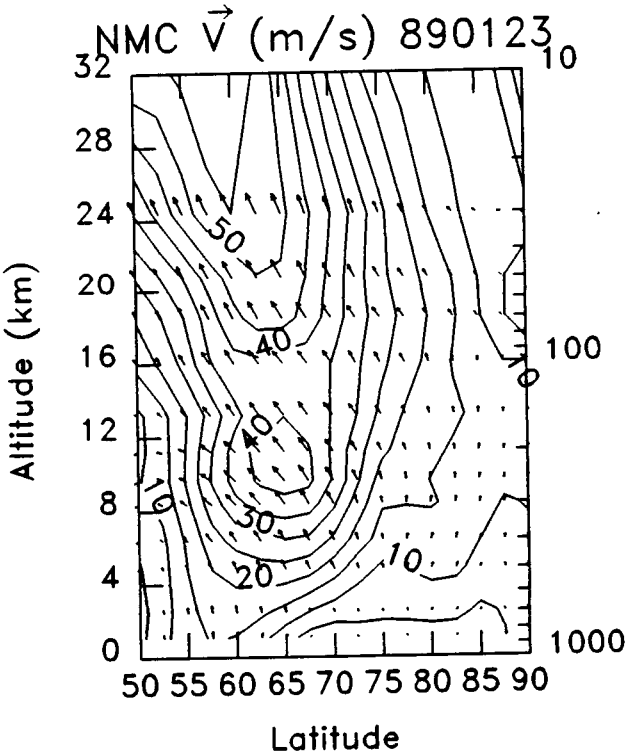
700
200
600
190
500
400
200
300
210
220
230
240
250


NMC 460K EPV (10^-6) 890123
MAX= 56.7 MIN= 4.2 CONTOUR INC. = 4.0


NMC V (m/s) 890123
Altitude (km)
Latitude
32
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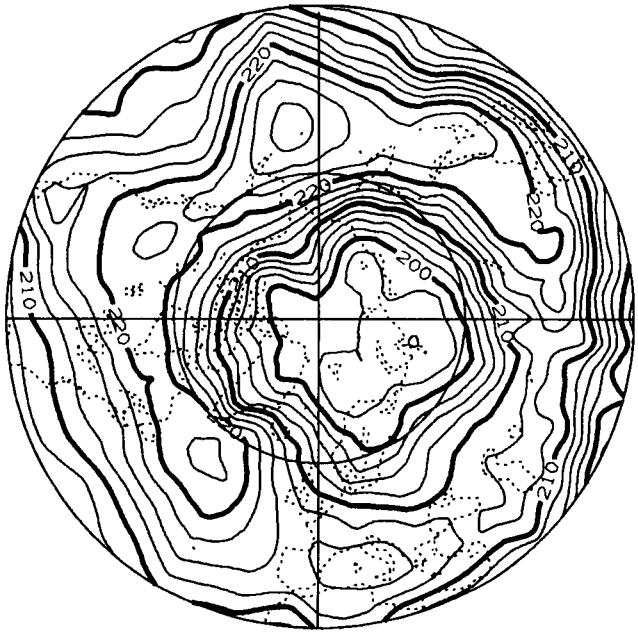
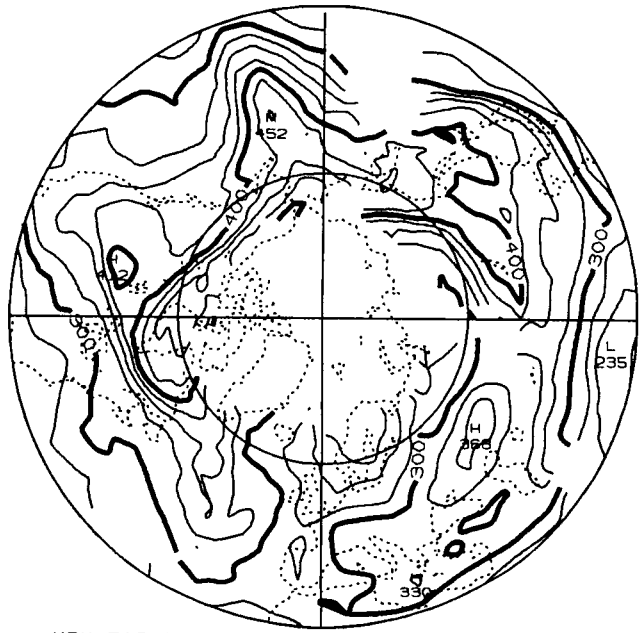
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
50
40
30
20
10
0

NMC 100MB TEMP. (K) 890124



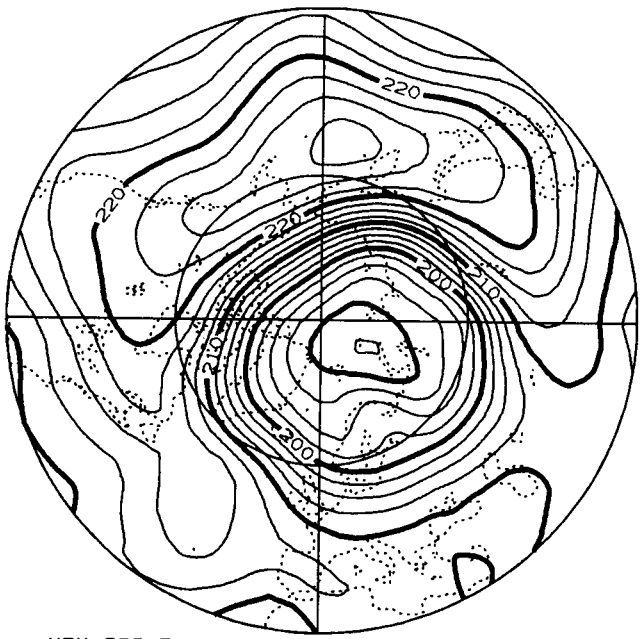
MAX=228.5 MIN=194.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890124



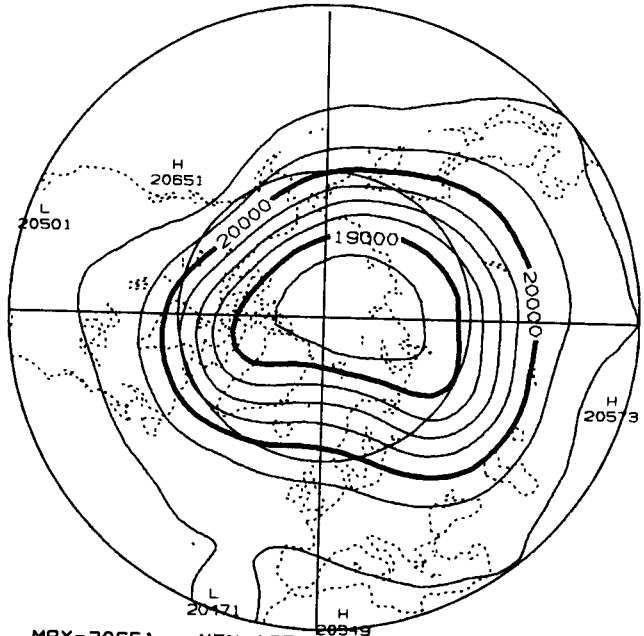
MAX=519.0 MIN=209.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890124



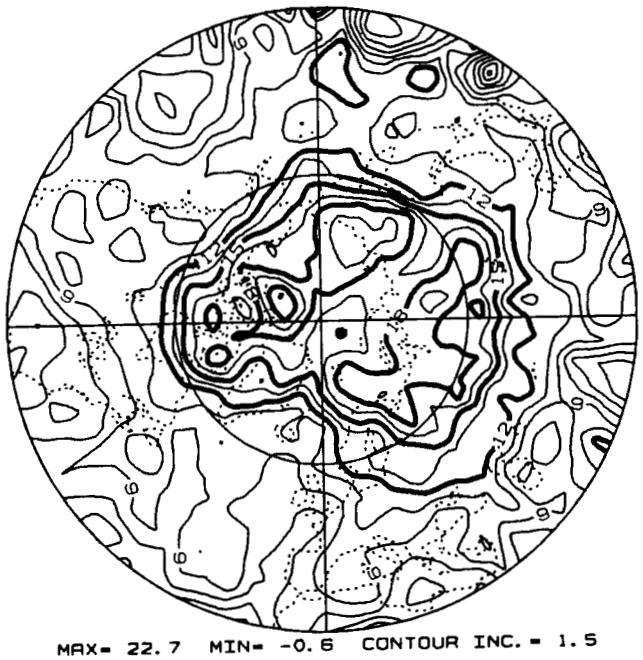
MAX=228.7 MIN=187.3 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890124



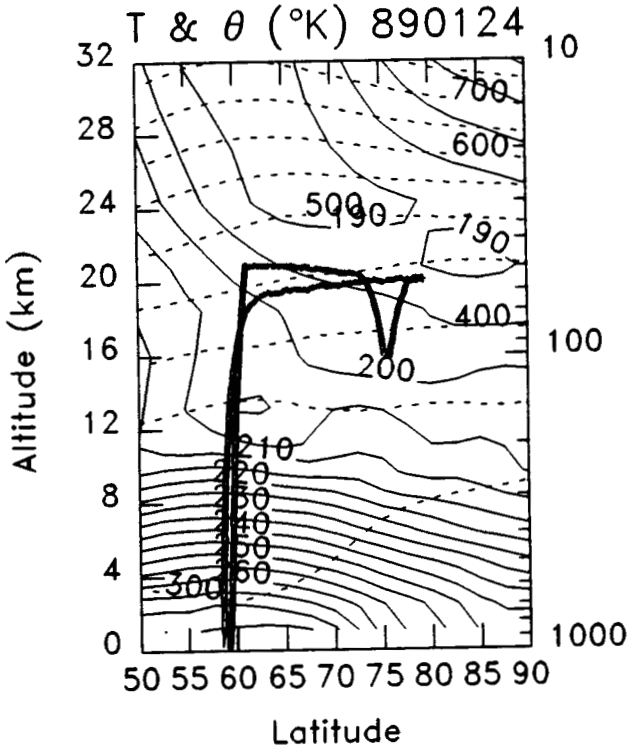
MAX=20651. MIN=18550. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890124

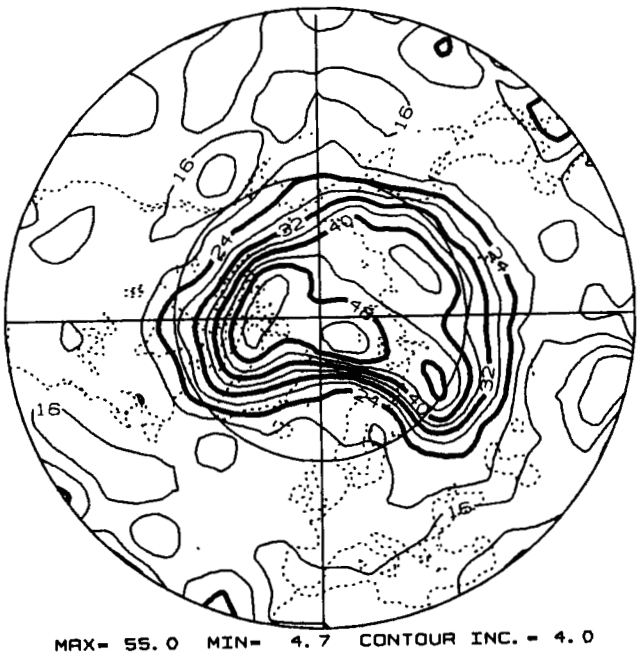


MAX= 22.7 MIN= -0.6 CONTOUR INC. = 1.5

T & θ (°K) 890124

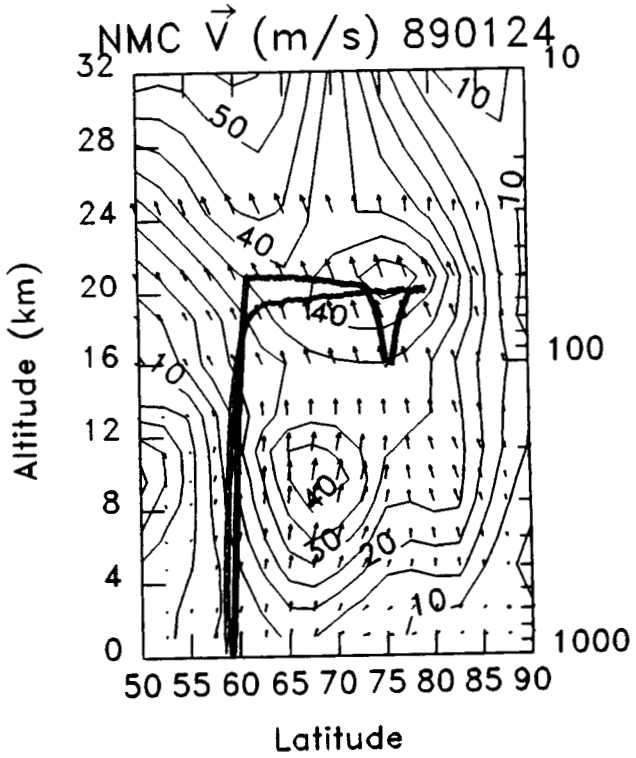


NMC 460K EPV (10^-6) 890124

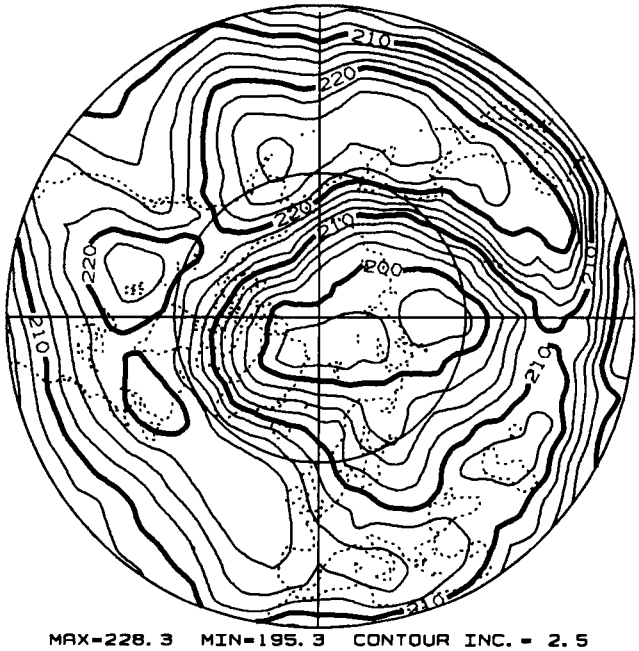


MAX= 55.0 MIN= 4.7 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890124

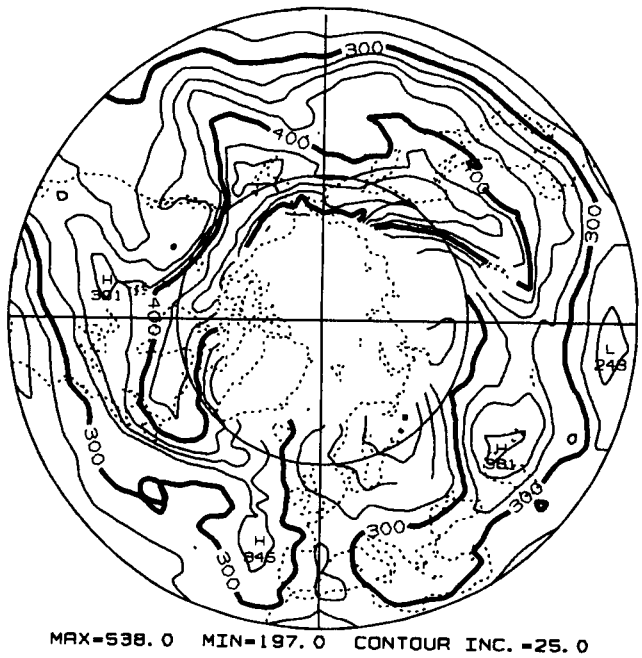


NMC 100MB TEMP. (K) 890125



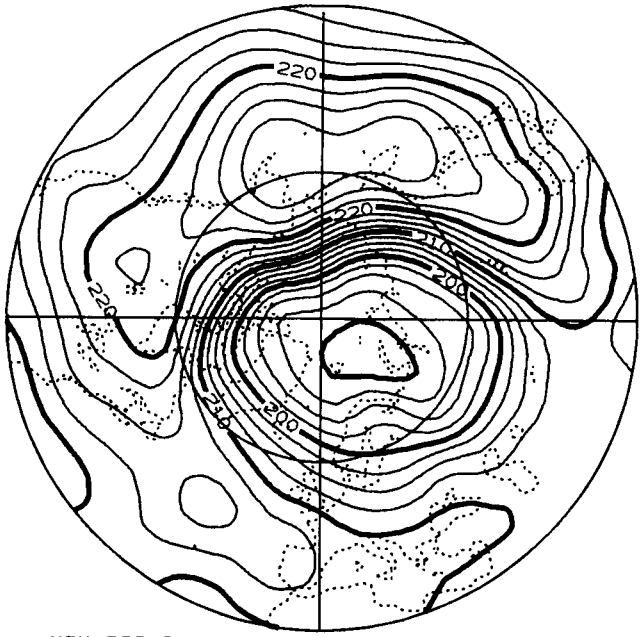
MAX=228.3 MIN=195.3 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890125



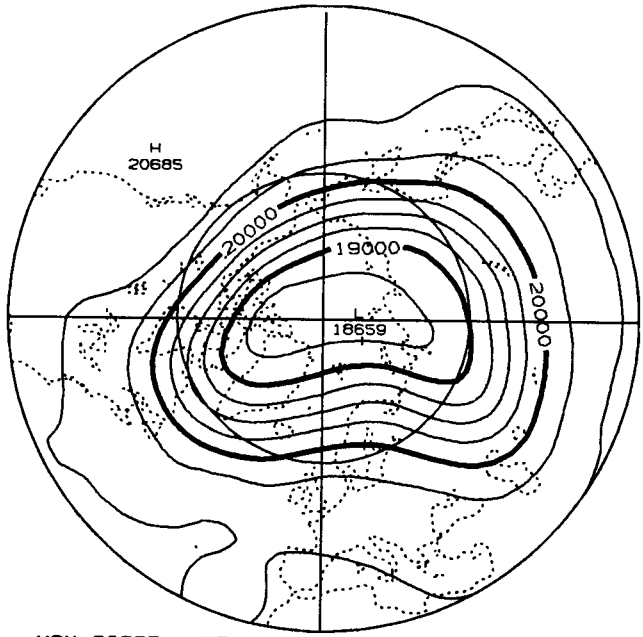
MAX=538.0 MIN=197.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890125



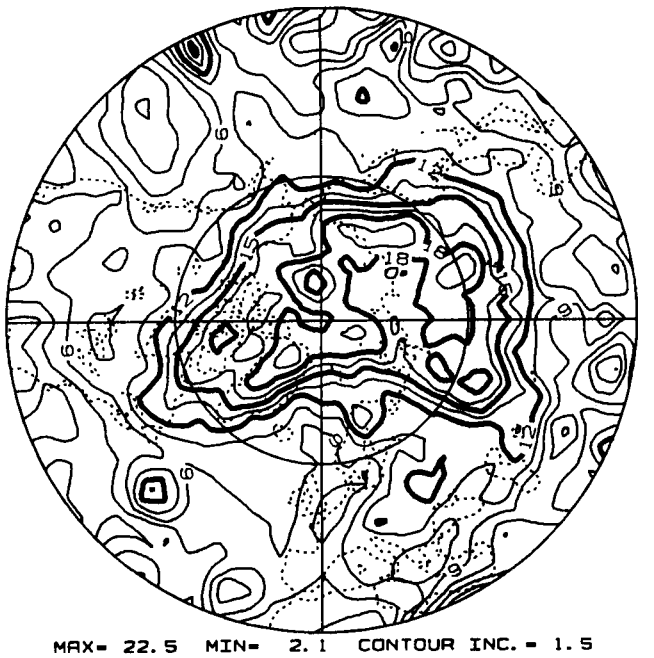
MAX=230.0 MIN=188.2 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890125



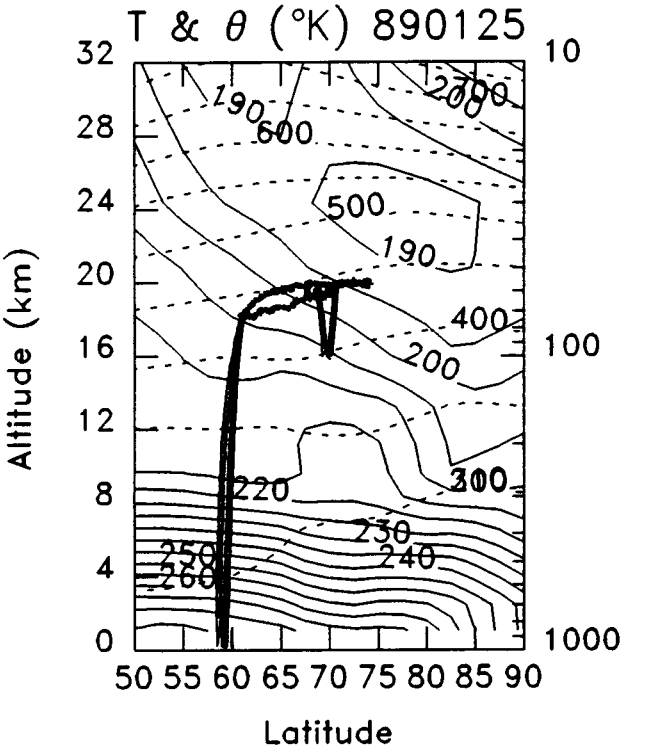
MAX=20685. MIN=18607. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890125

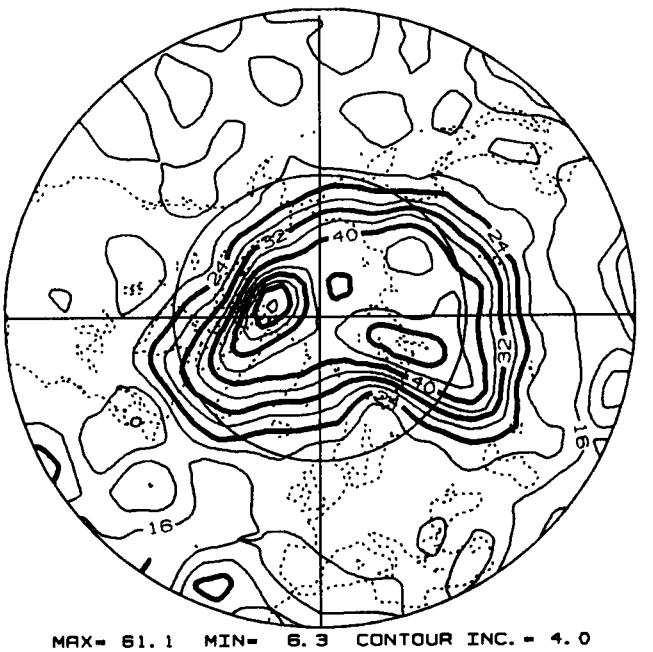


MAX= 22.5 MIN= 2.1 CONTOUR INC. = 1.5

T & θ (°K) 890125

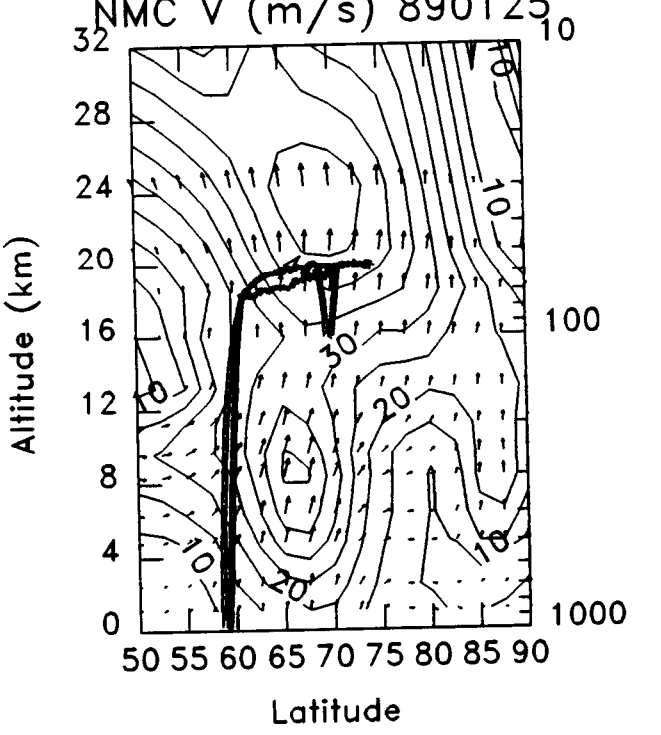


NMC 460K EPV (10^-6) 890125

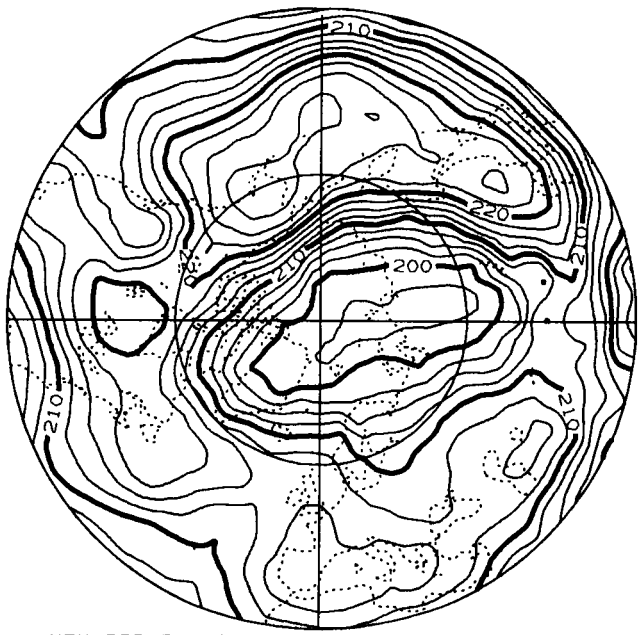


MAX= 61.1 MIN= 6.3 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890125

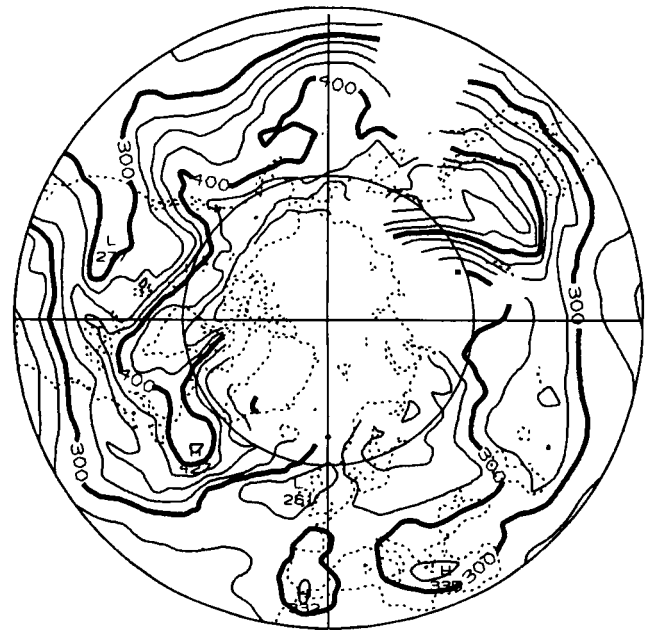


NMC 100MB TEMP. (K) 890126



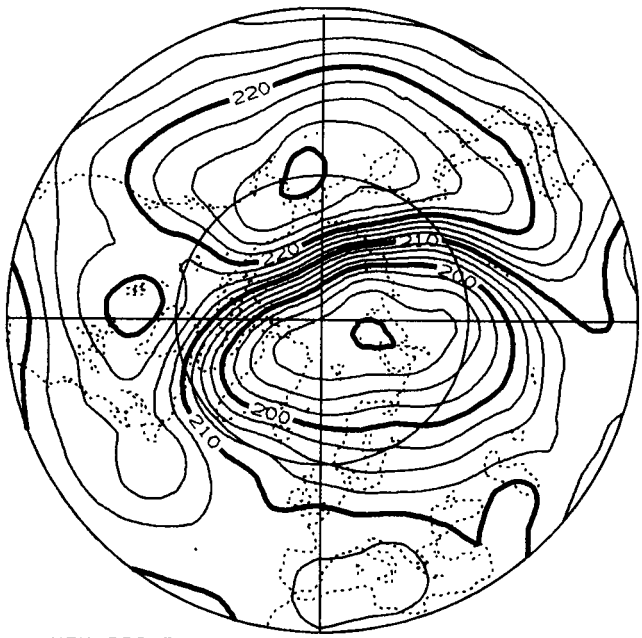
MAX=229.2 MIN=192.0 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890126



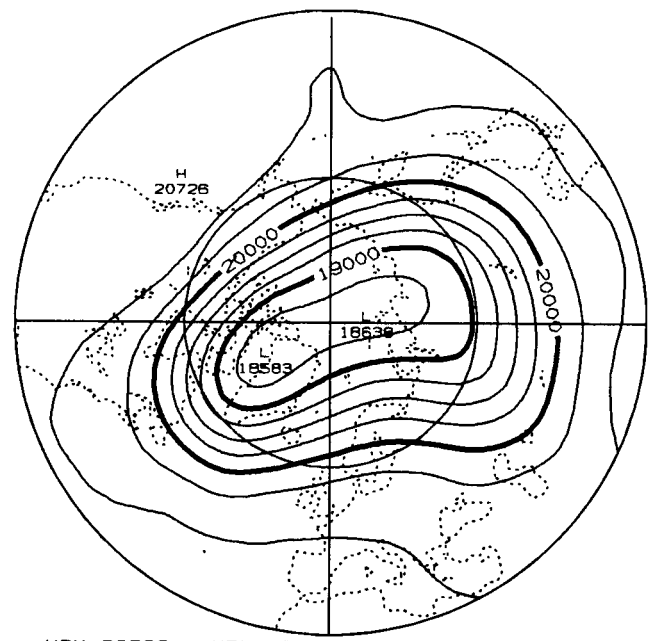
MAX=498.0 MIN=220.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890126



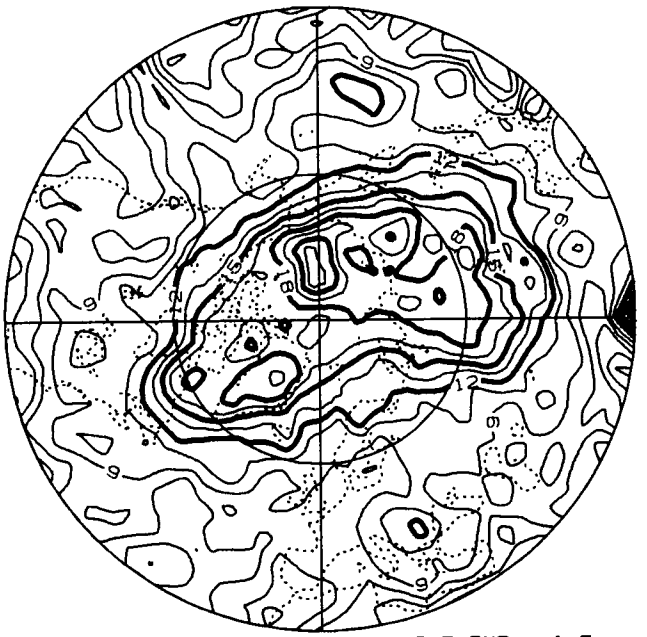
MAX=230.8 MIN=189.8 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890126



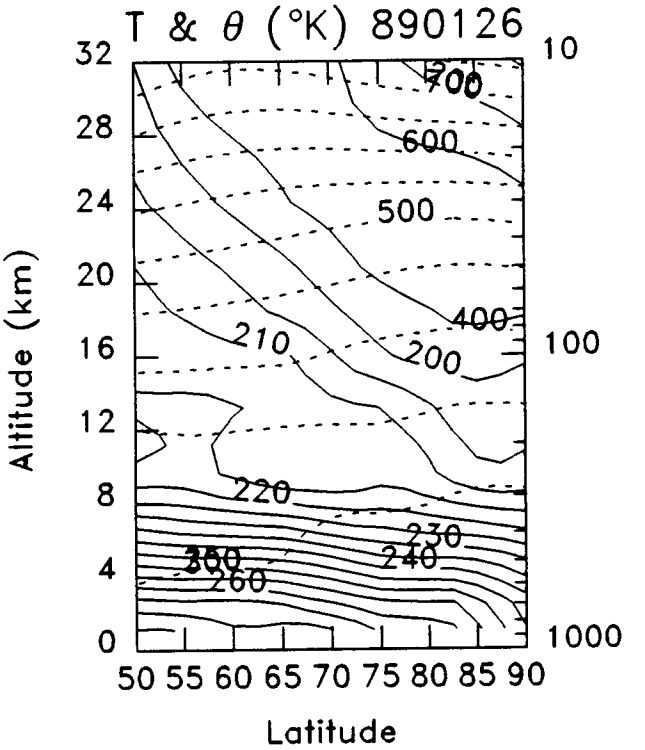
MAX=20726. MIN=18583. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890126

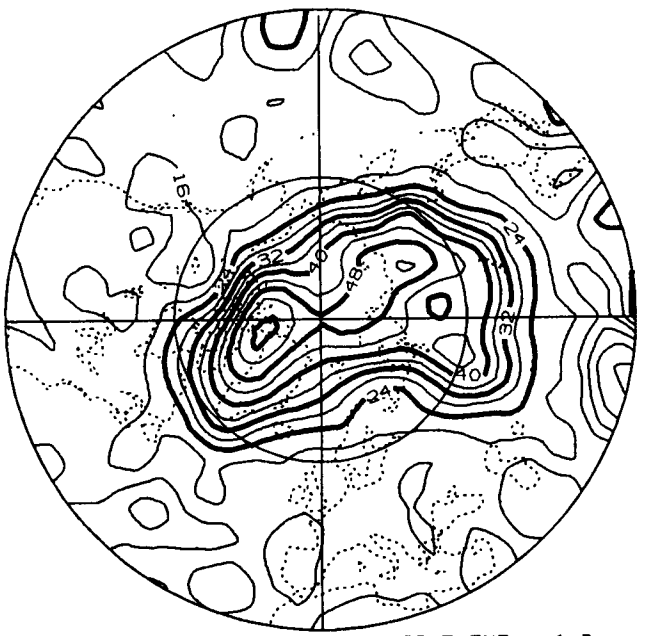


MAX= 23.3 MIN= 2.4 CONTOUR INC. = 1.5

T & θ (°K) 890126

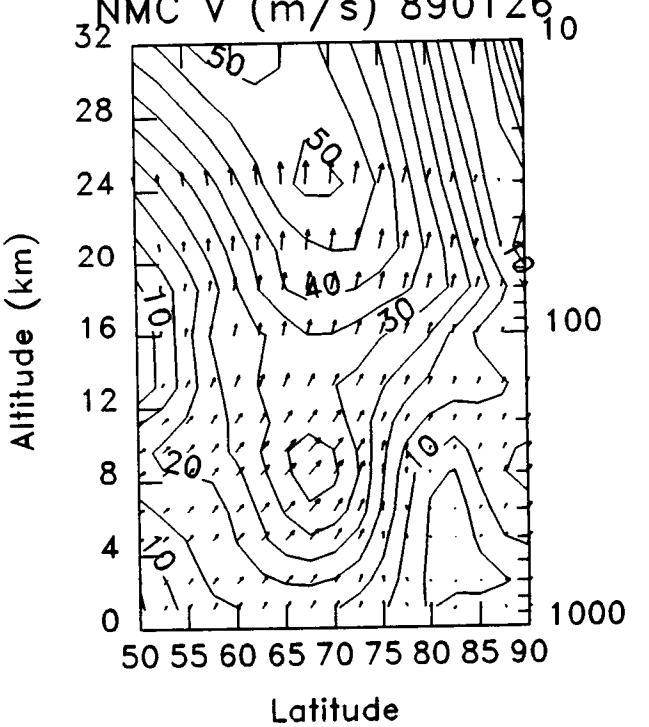


NMC 460K EPV (10^-6) 890126

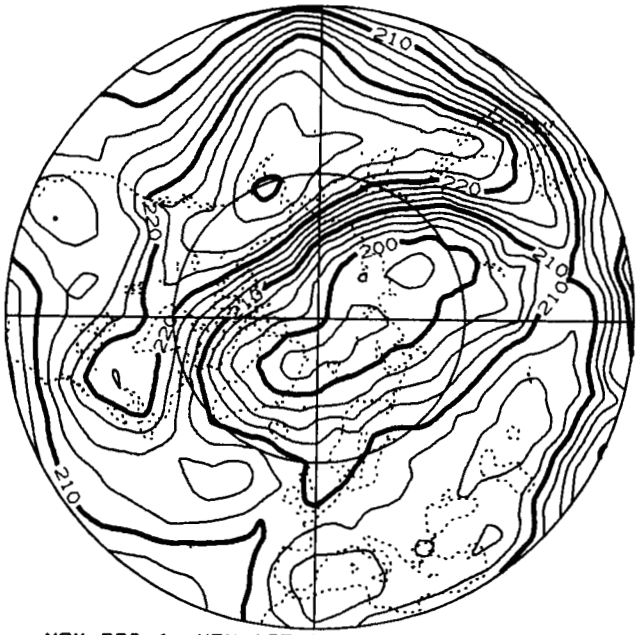


MAX= 57.2 MIN= 2.5 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890126

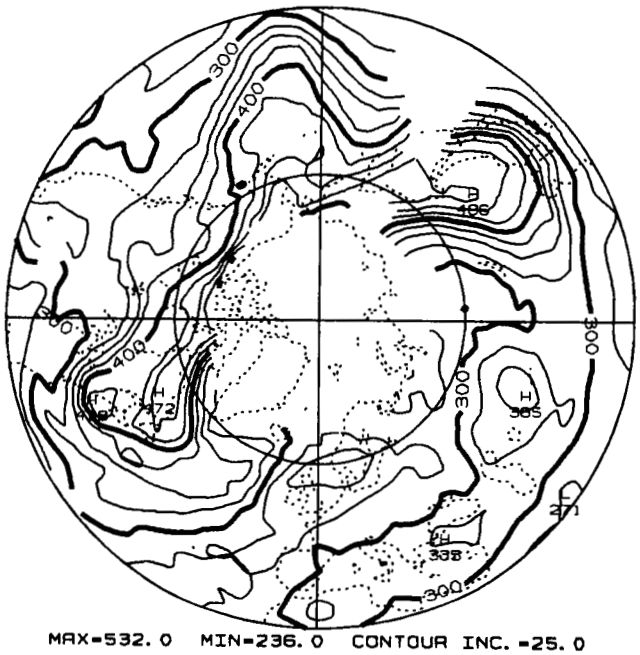


NMC 100MB TEMP. (K) 890127



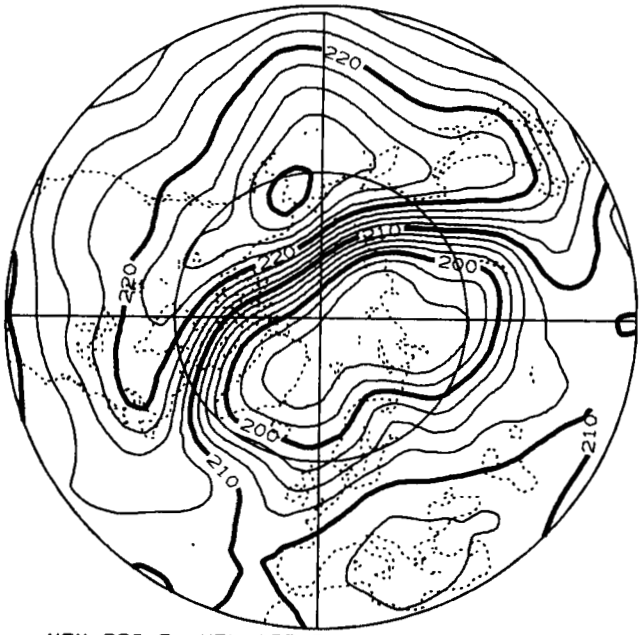
MAX=230.4 MIN=195.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890127



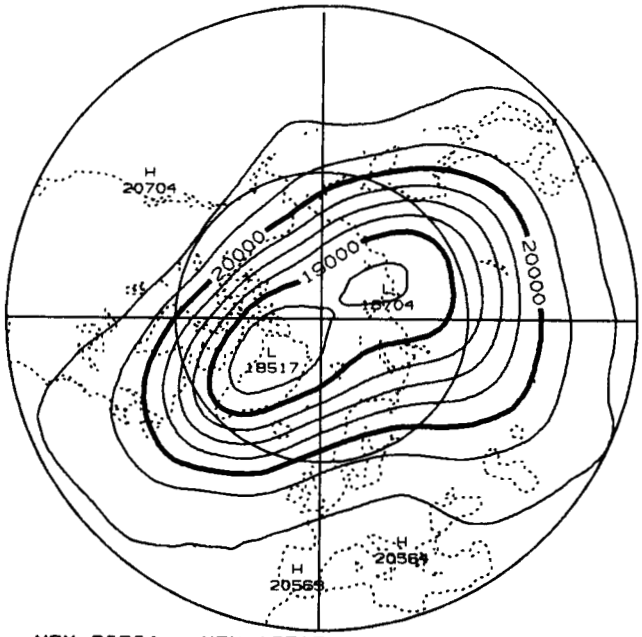
MAX=532.0 MIN=236.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890127

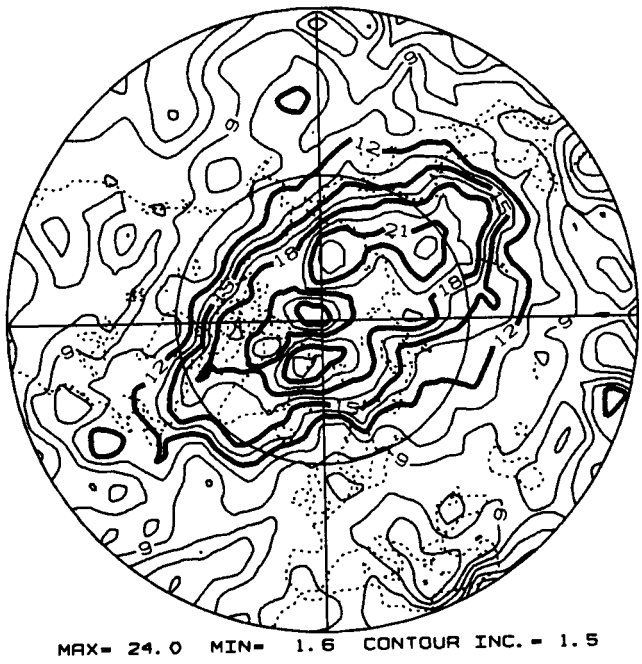


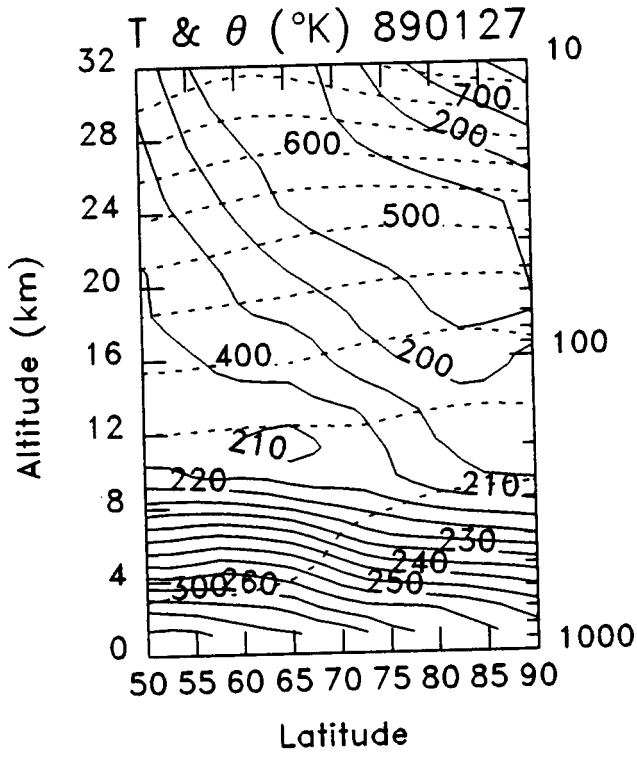
MAX=230.8 MIN=192.6 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890127



MAX=20704. MIN=18517. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890127
MAX= 24.0 MIN= 1.6 CONTOUR INC. = 1.5


T & θ (°K) 890127
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
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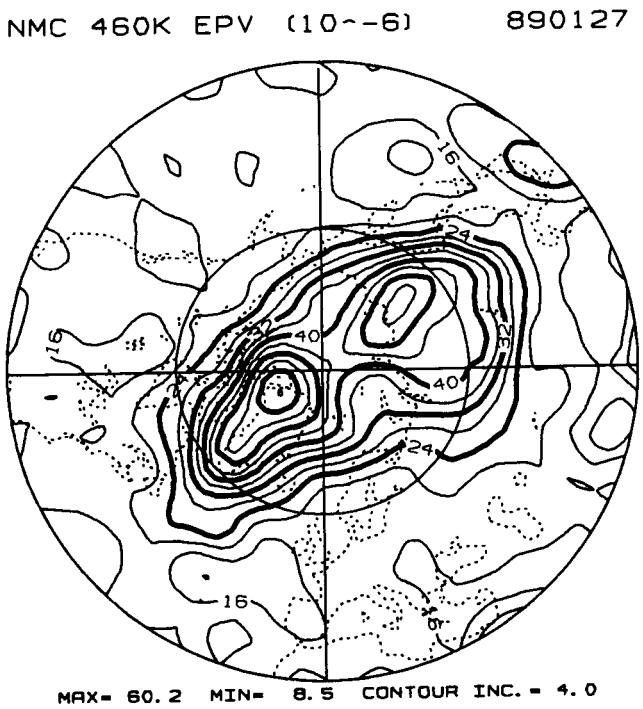
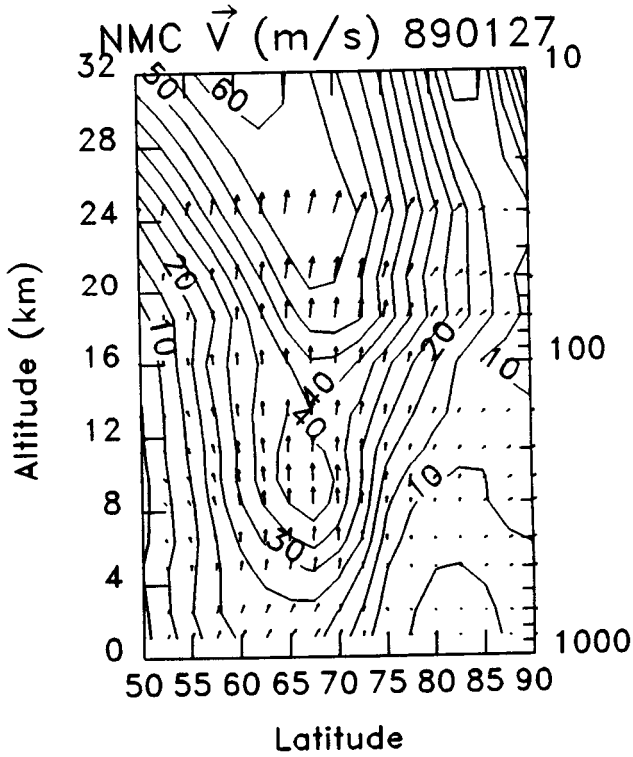
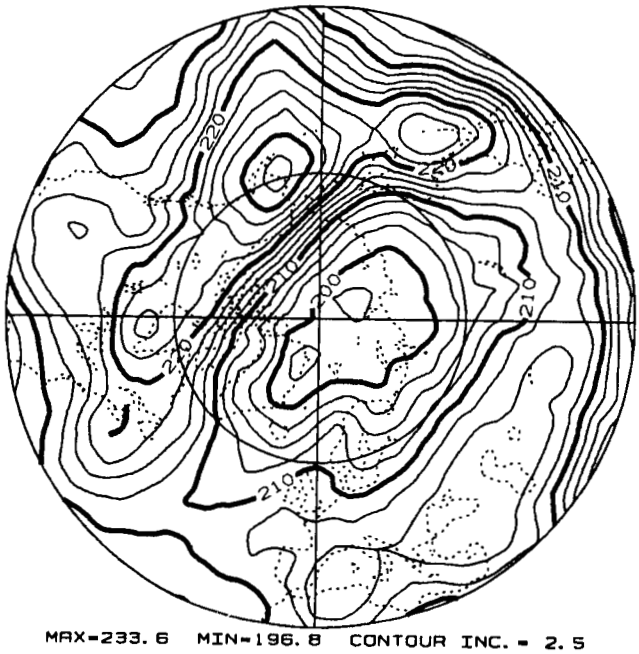
700
600
500
400
300
200
210
220
230
240
250
260


NMC 460K EPV (10^-6) 890127
MAX= 60.2 MIN= 8.5 CONTOUR INC. = 4.0

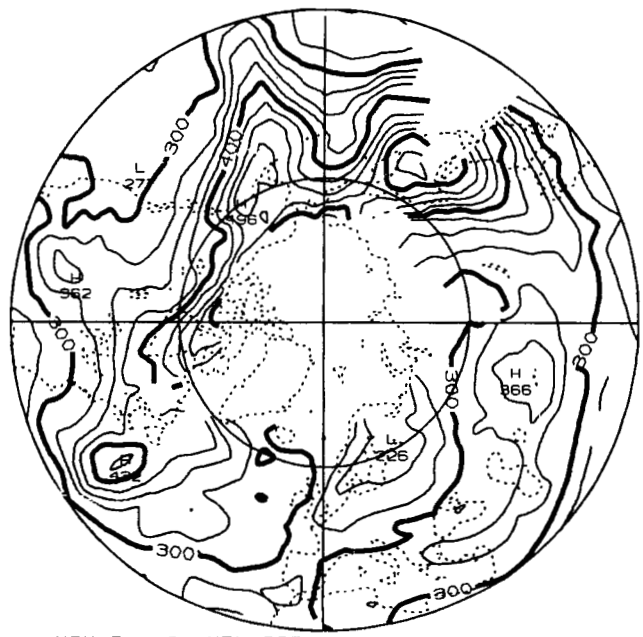

NMC V (m/s) 890127
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
50
60
40
30
20
10

NMC 100MB TEMP. (K) 890128



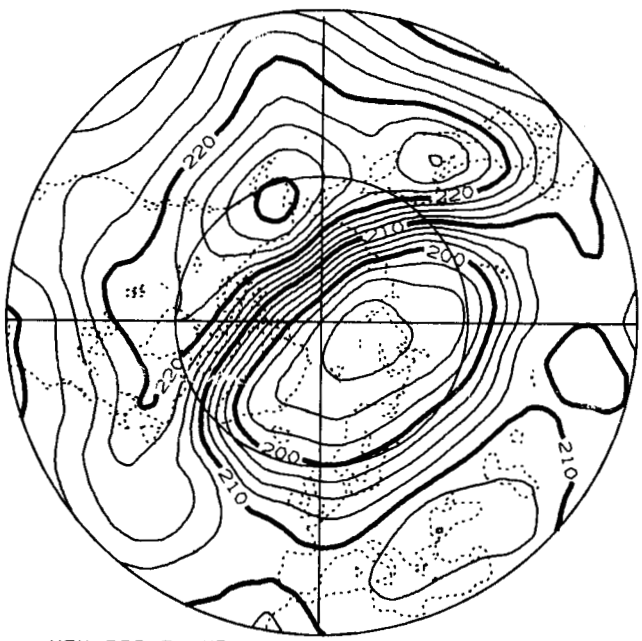
MAX=233.6 MIN=196.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890128



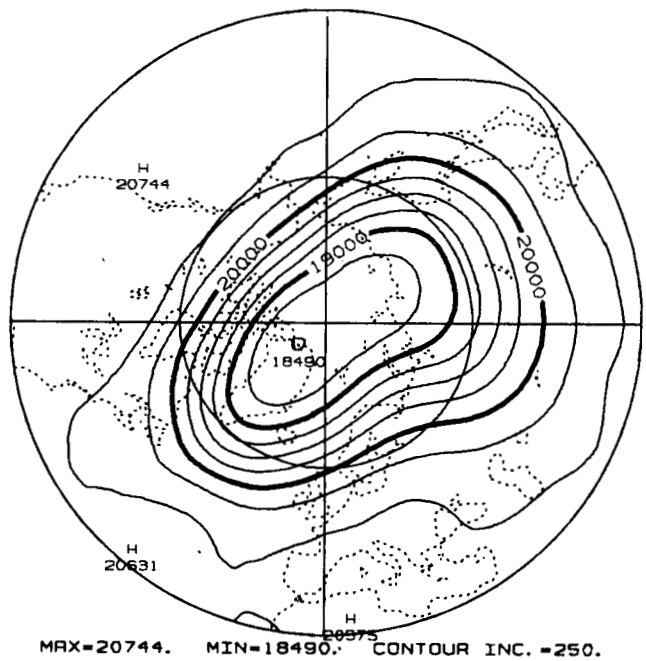
MAX=543.0 MIN=226.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890128



MAX=230.8 MIN=190.4 CONTOUR INC. = 2.5

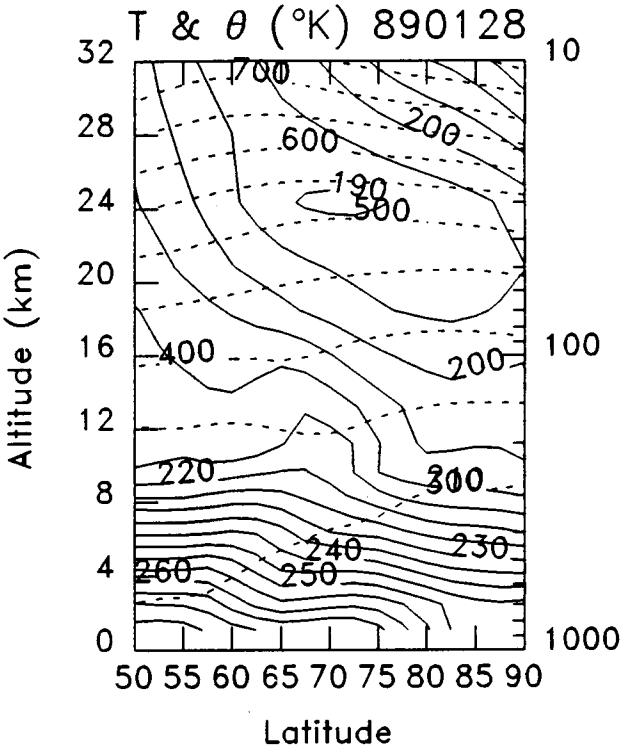
NMC 50MB GEOP HGT (M) 890128



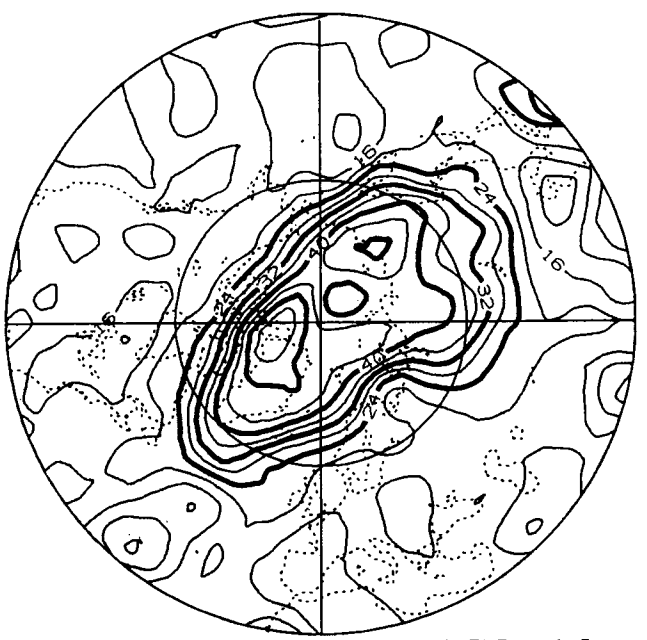
MAX=20744. MIN=18490. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890128

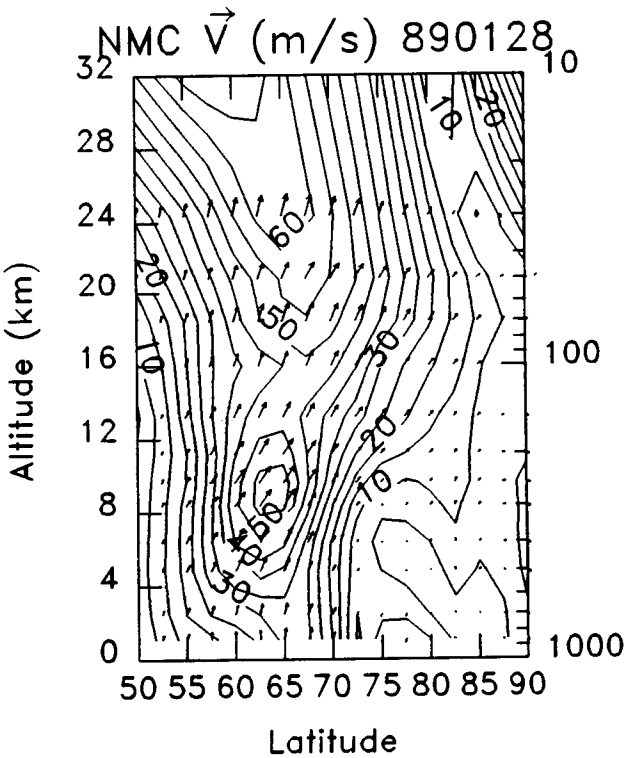
MAX= 24.2 MIN= 2.3 CONTOUR INC. = 1.5



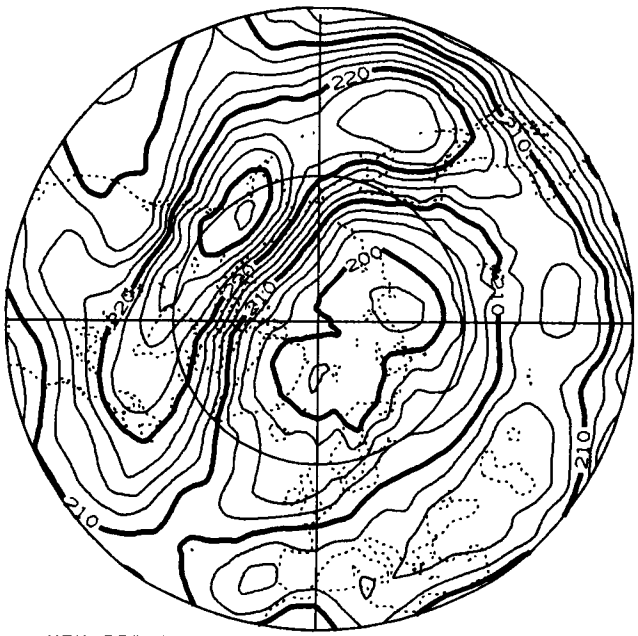
NMC 460K EPV (10^-6) 890128



MAX= 55.8 MIN= 7.0 CONTOUR INC. = 4.0

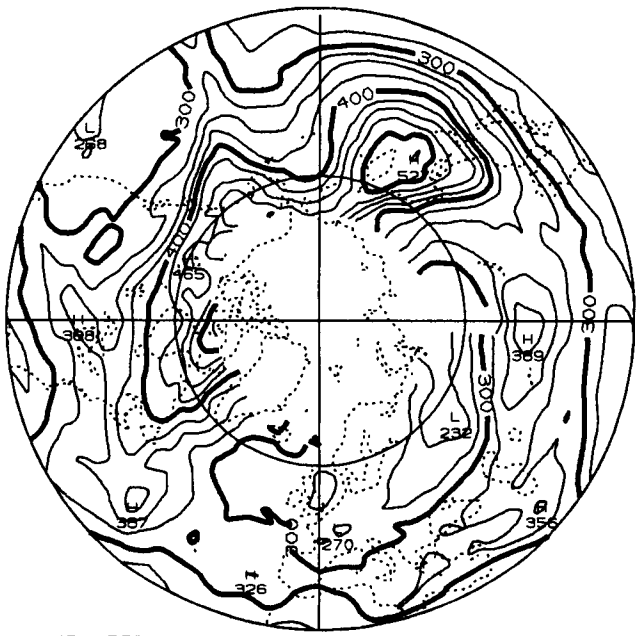


NMC 100MB TEMP. (K) 890129



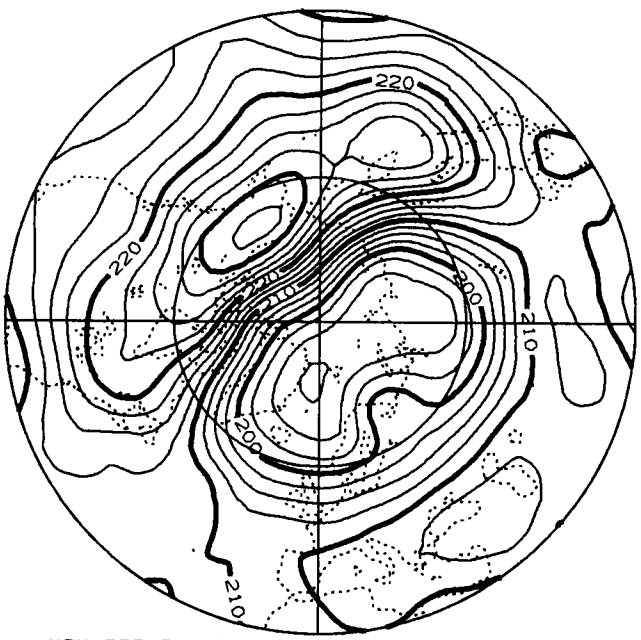
MAX=233.3 MIN=196.2 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890129



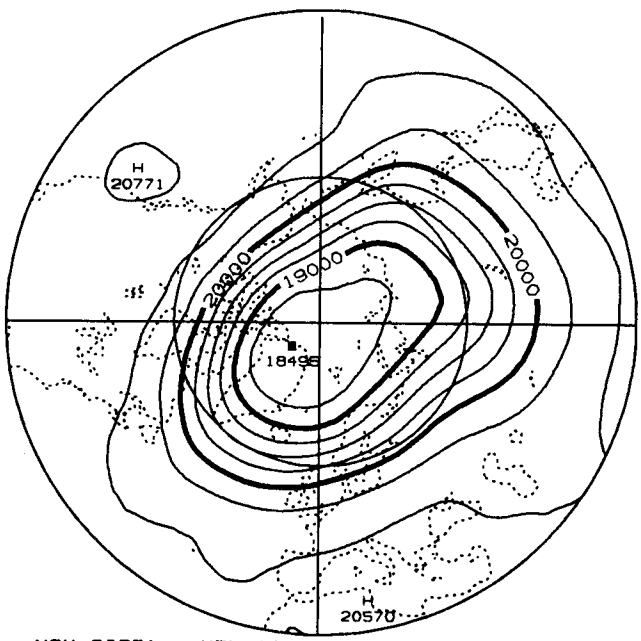
MAX=557.0 MIN=232.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890129



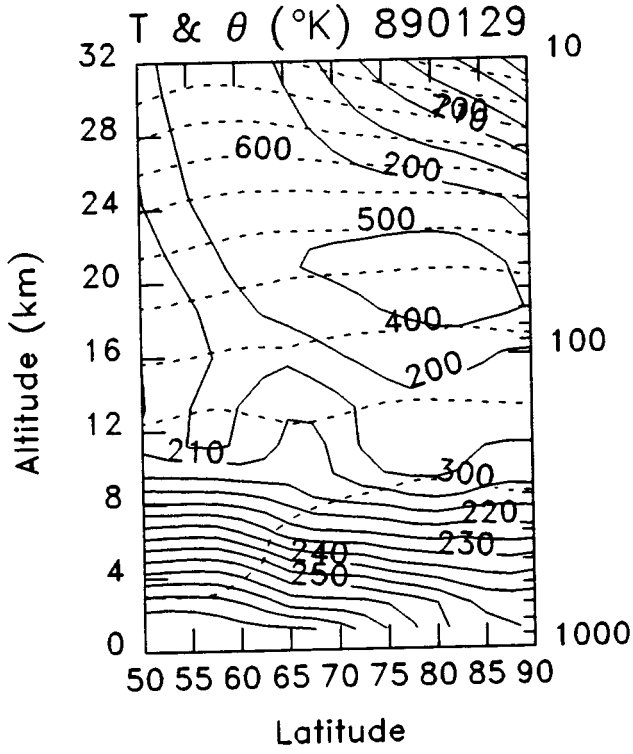
MAX=233.2 MIN=192.1 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890129



MAX=20771. MIN=18495. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890129
MAX= 23.3 MIN= 2.9 CONTOUR INC. = 1.5


T & θ (°K) 890129
Altitude (km)
Latitude
θ
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240
250
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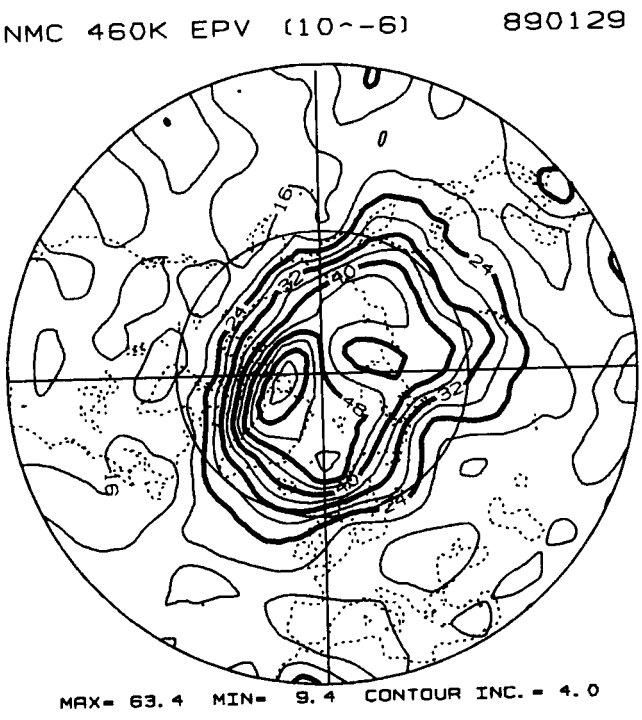
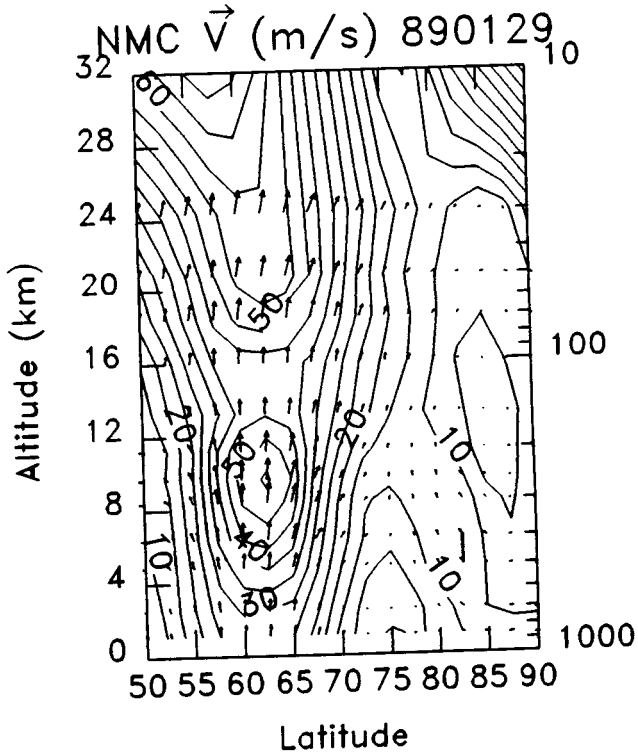
0 4 8 12 16 20 24 28 32
10 100 1000

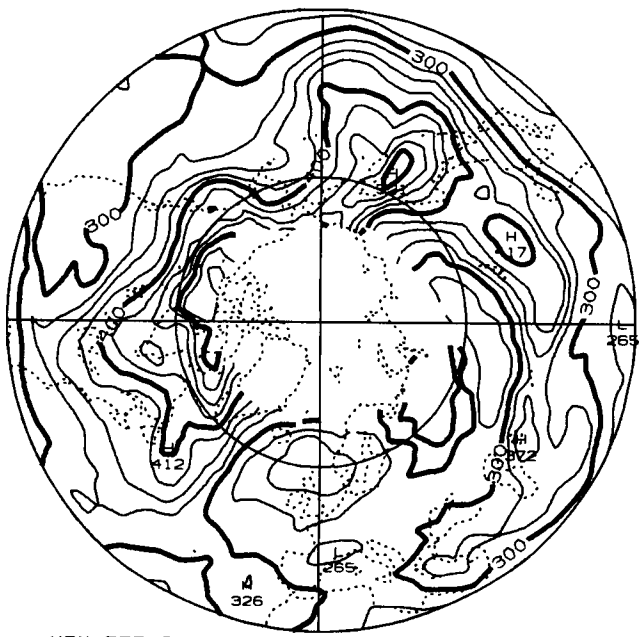

NMC 460K EPV (10^-6) 890129
MAX= 63.4 MIN= 9.4 CONTOUR INC. = 4.0


NMC V (m/s) 890129
Altitude (km)
Latitude
50 55 60 65 70 75 80 85 90
0 4 8 12 16 20 24 28 32
10 100 1000

NMC 100MB TEMP. (K) 890130

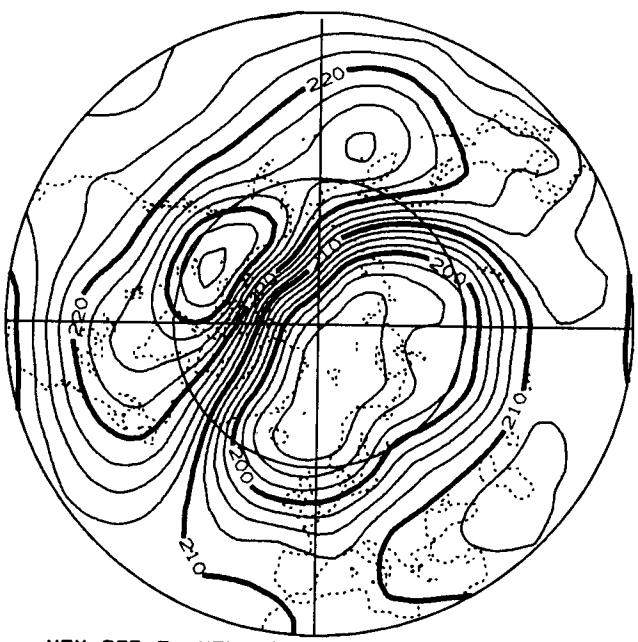
MAX=231.3 MIN=194.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890130



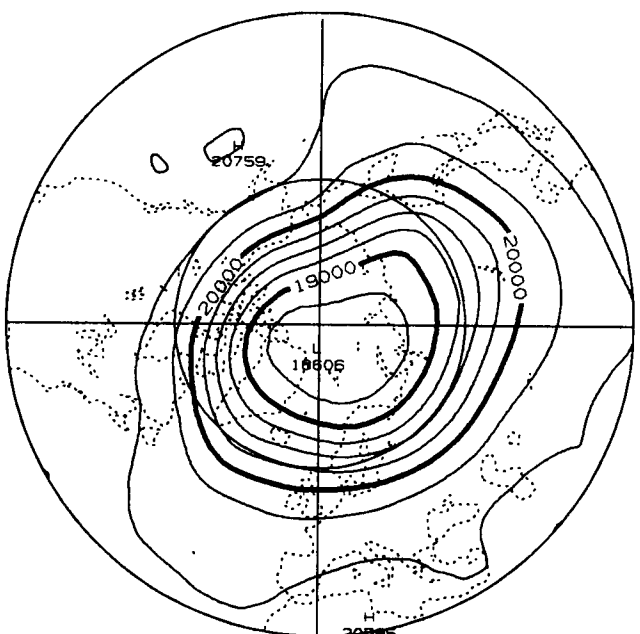
MAX=557.0 MIN=234.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890130



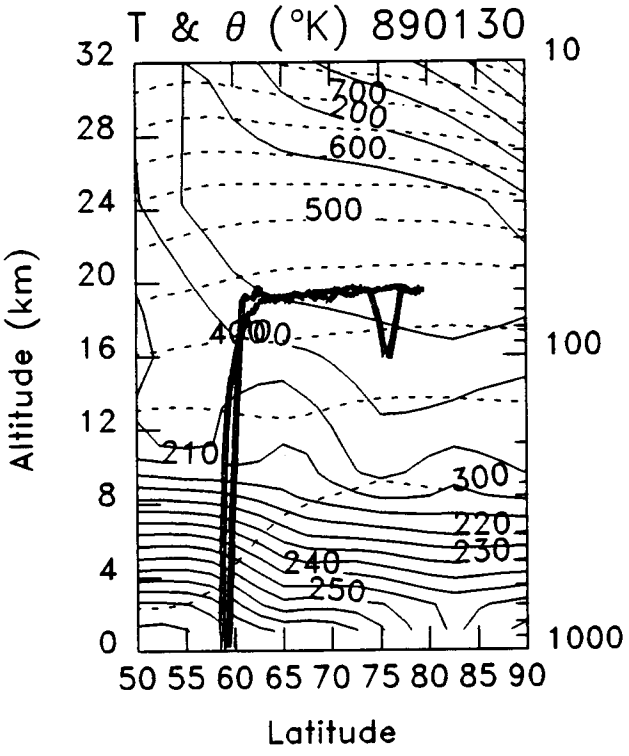
MAX=235.7 MIN=190.0 CONTOUR INC. = 2.5

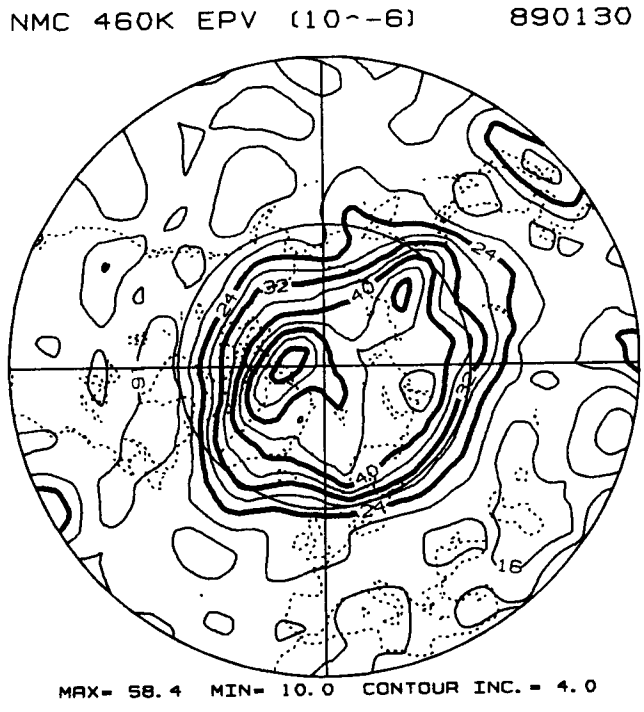
NMC 50MB GEOP HGT (M) 890130

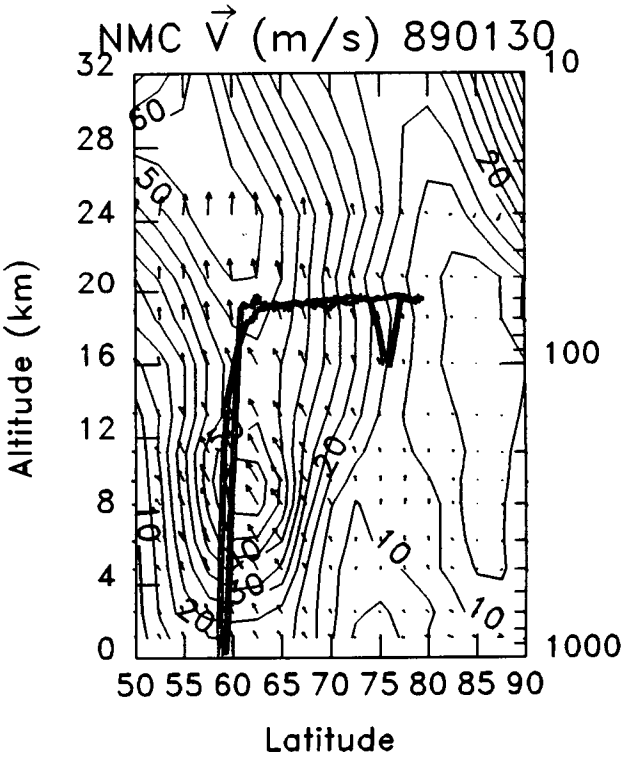


MAX=20759. MIN=18596. CONTOUR INC. =250.

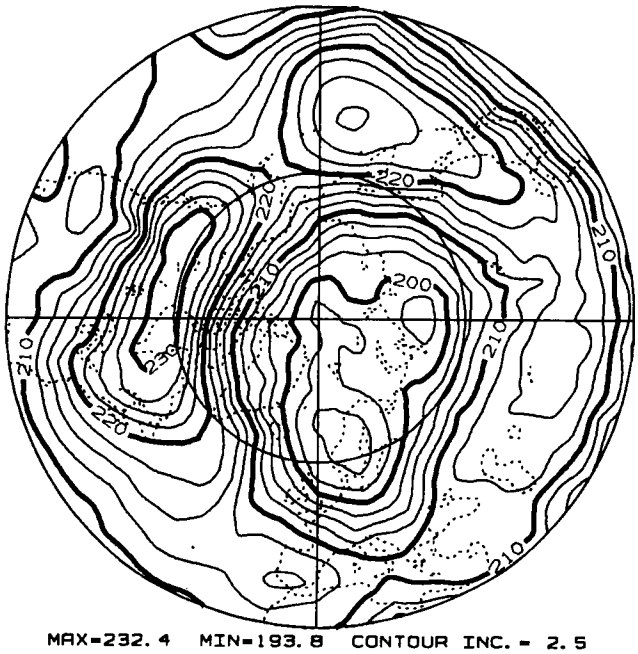
NMC 400K EPV (10^-6) 890130
MAX= 23.3 MIN= 3.1 CONTOUR INC. = 1.5


T & θ (°K) 890130
Altitude (km)
Latitude
700
200
600
500
400
210
300
220
230
240
250
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890130
MAX= 58.4 MIN= 10.0 CONTOUR INC. = 4.0

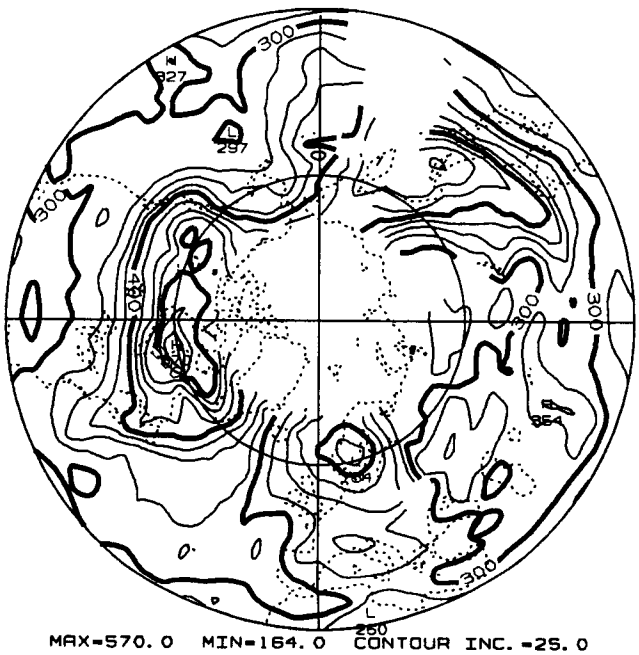

NMC V (m/s) 890130
Altitude (km)
Latitude
60
50
30
20
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890131



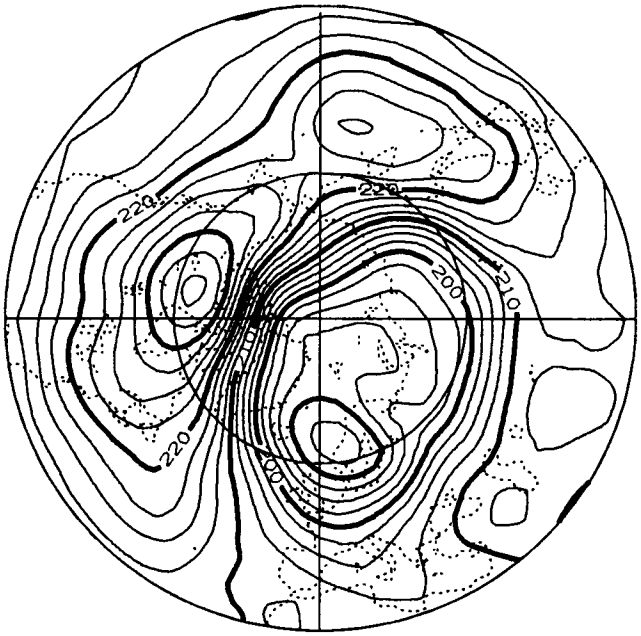
MAX=232.4 MIN=193.8 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890131



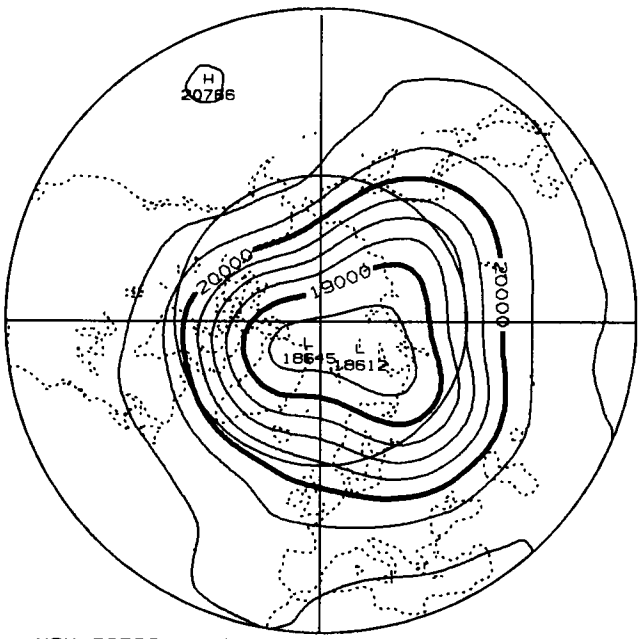
MAX=570.0 MIN=164.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890131



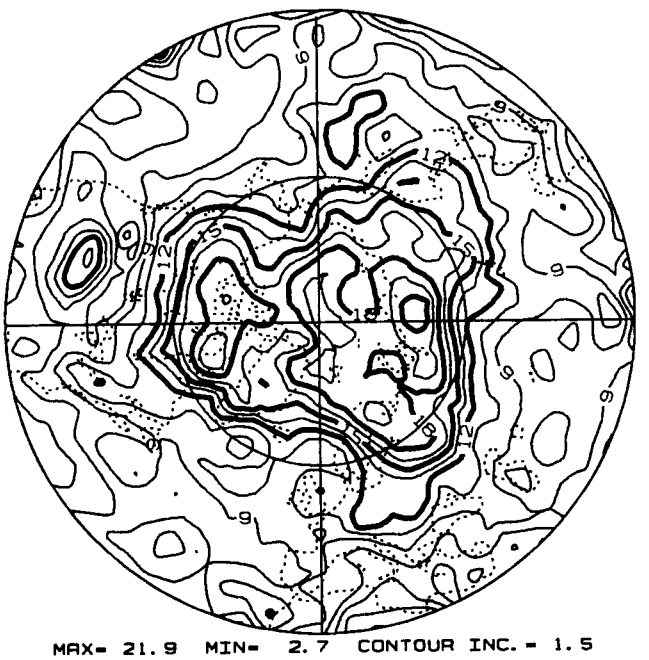
MAX=235.6 MIN=186.2 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890131

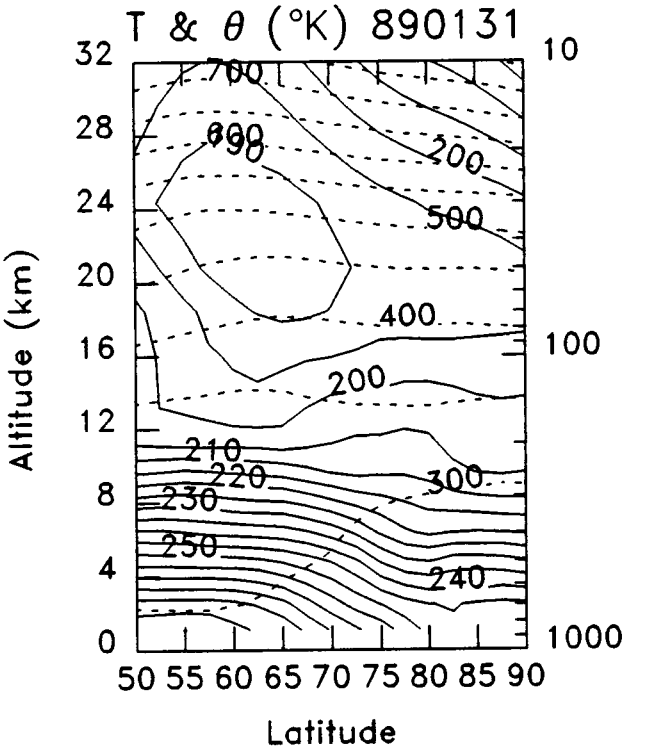


MAX=20766. MIN=18612. CONTOUR INC.=250.

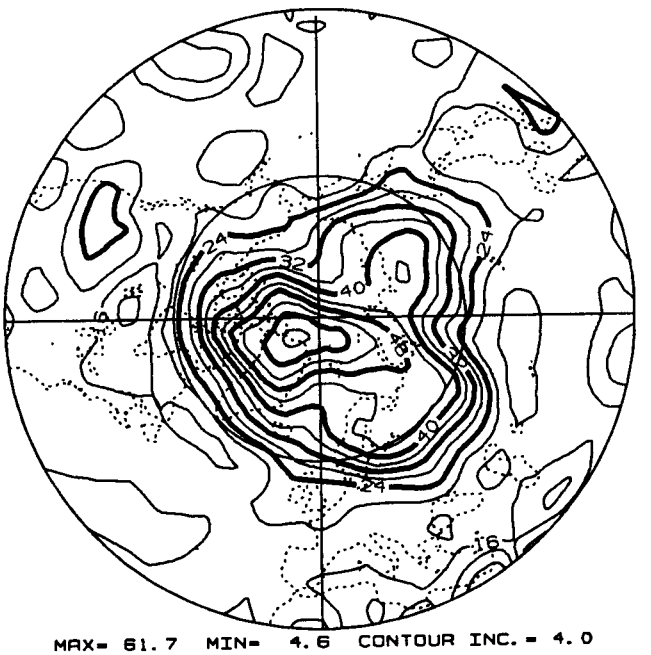
NMC 400K EPV (10^-6) 890131



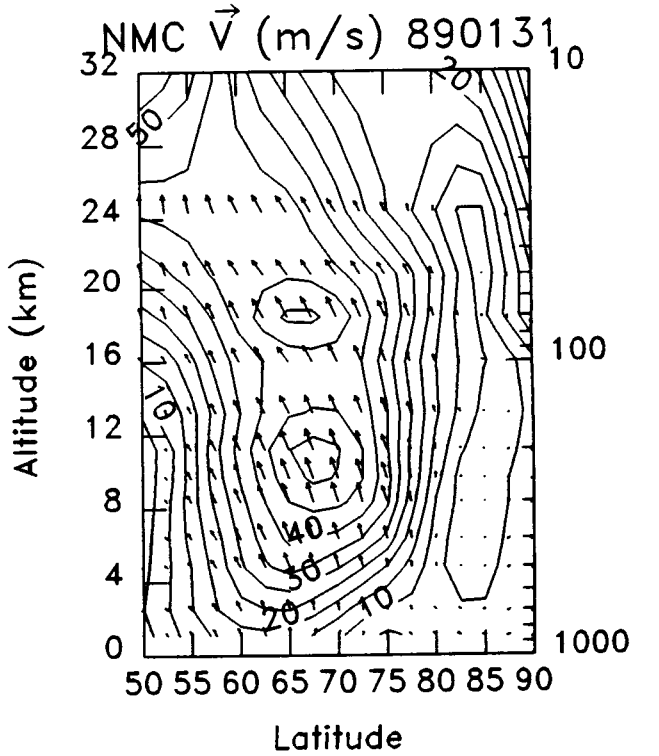
MAX= 21.9 MIN= 2.7 CONTOUR INC. = 1.5



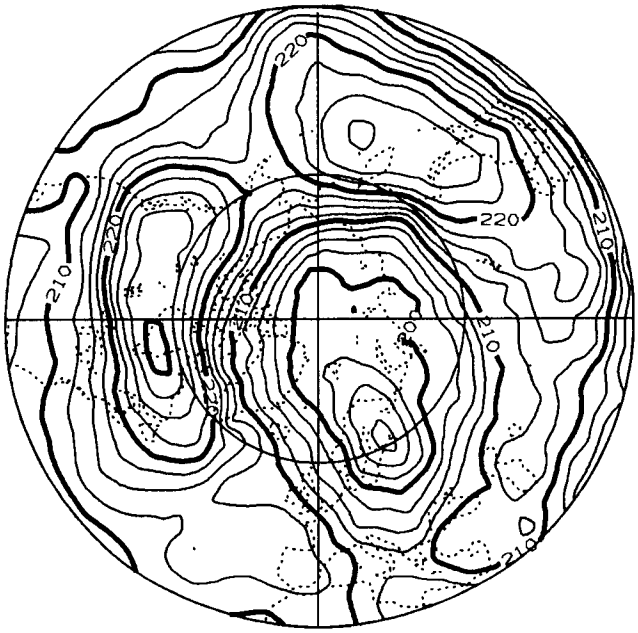
NMC 460K EPV (10^-6) 890131



MAX= 61.7 MIN= 4.6 CONTOUR INC. = 4.0

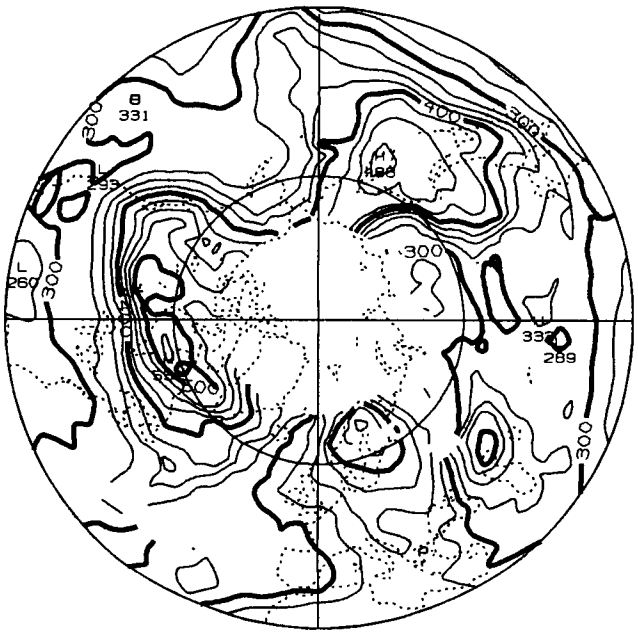


NMC 100MB TEMP. (K) 890201



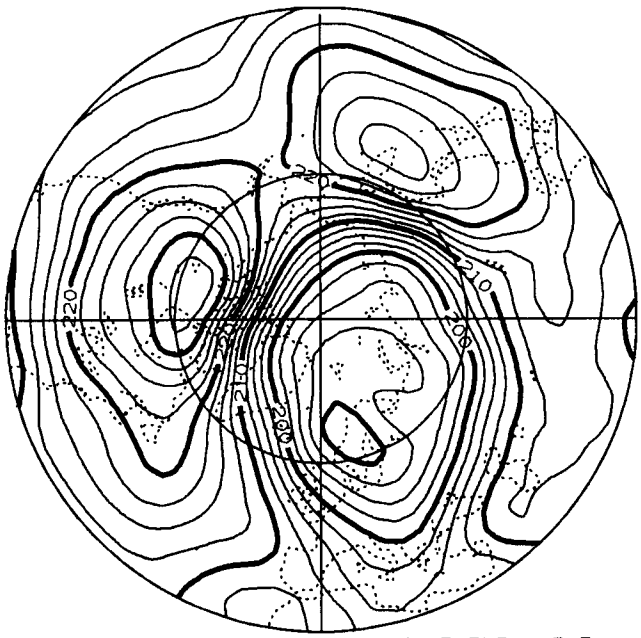
MAX=231.0 MIN=191.8 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890201



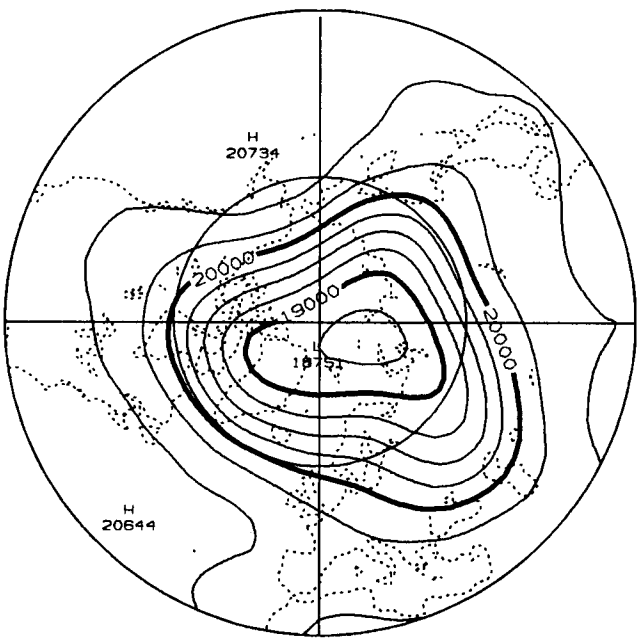
MAX=531.0 MIN=146.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890201

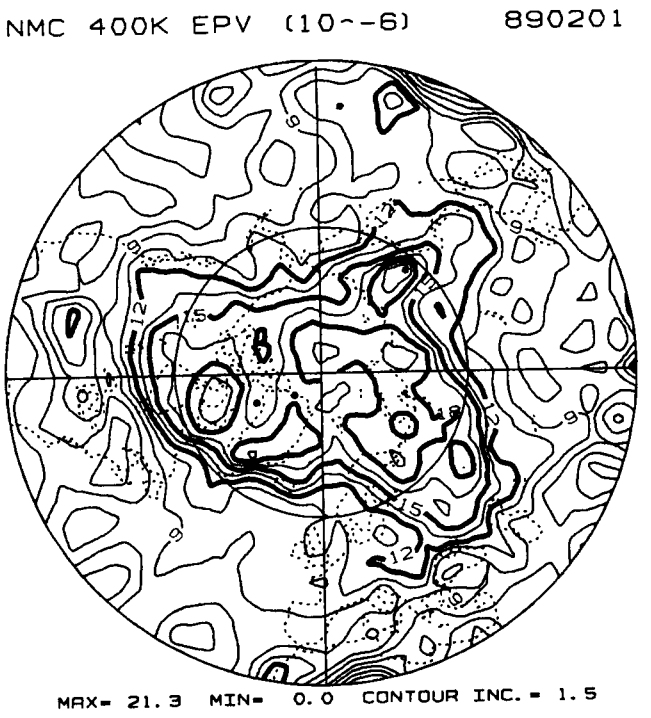


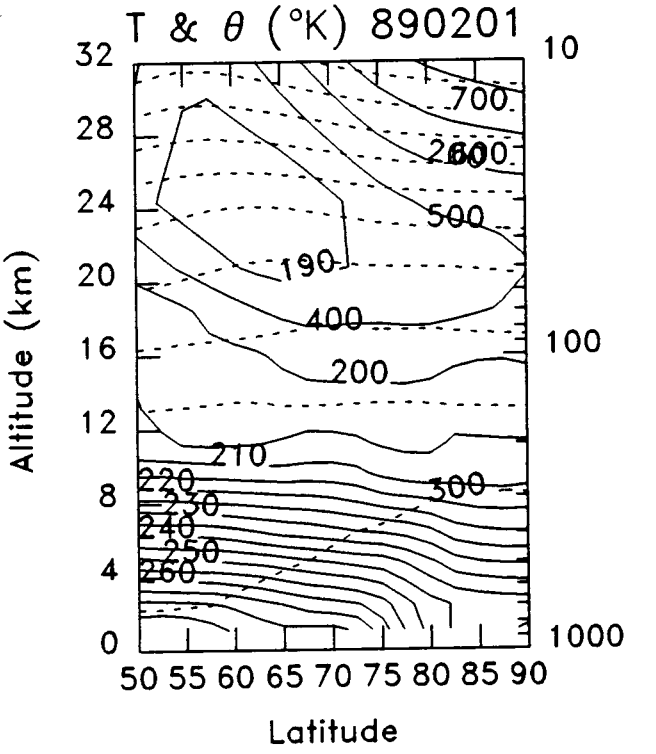
MAX=234.0 MIN=188.1 CONTOUR INC.= 2.5

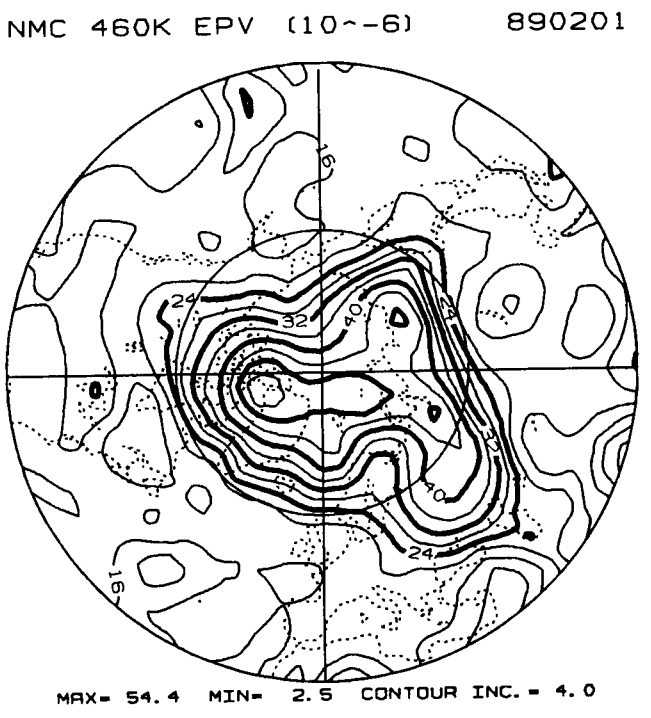
NMC 50MB GEOP HGT (M) 890201

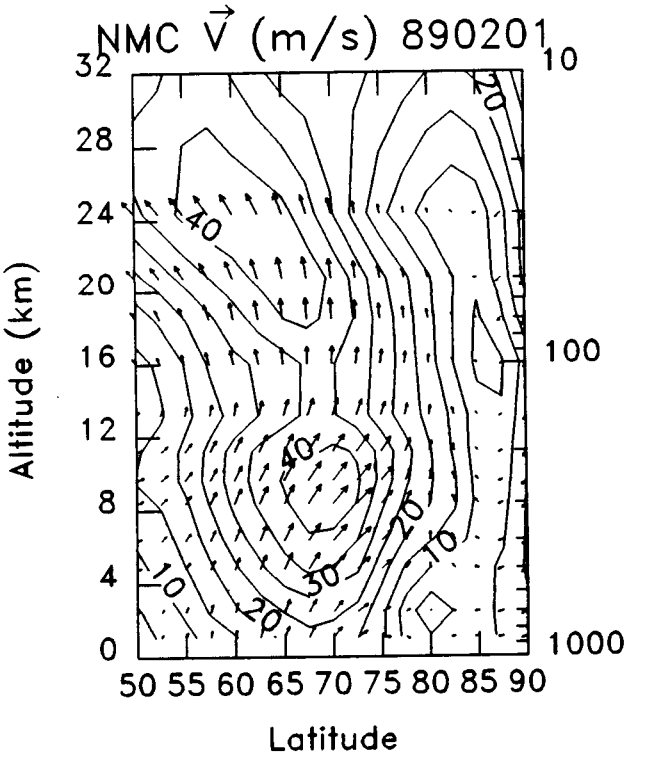


MAX=20734. MIN=18670. CONTOUR INC.=250.

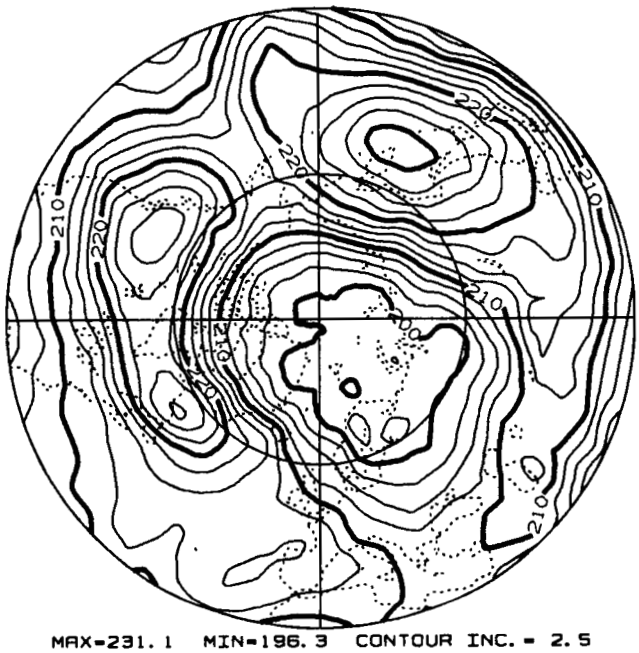

NMC 400K EPV (10^-6) 890201
MAX= 21.3 MIN= 0.0 CONTOUR INC. = 1.5


T & θ (°K) 890201
Altitude (km)
Latitude
700
600
500
190
400
200
210
220
230
240
250
260
300


NMC 460K EPV (10^-6) 890201
MAX= 54.4 MIN= 2.5 CONTOUR INC. = 4.0

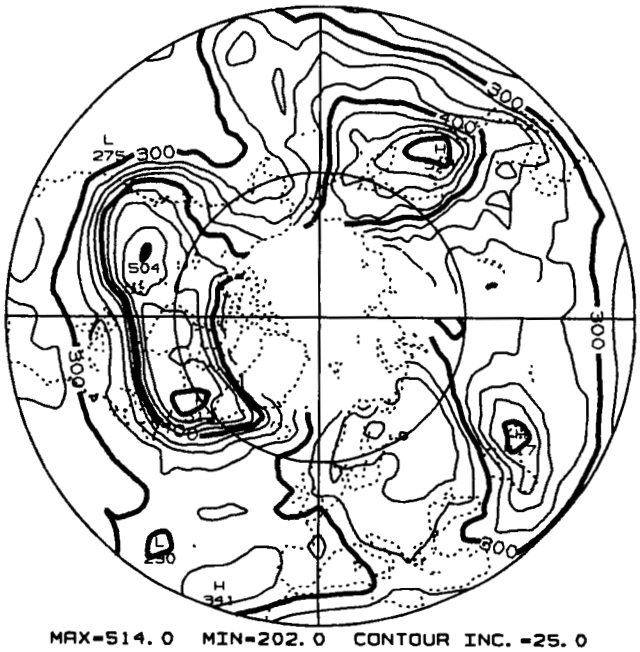

NMC V (m/s) 890201
Altitude (km)
Latitude

NMC 100MB TEMP. (K) 890202



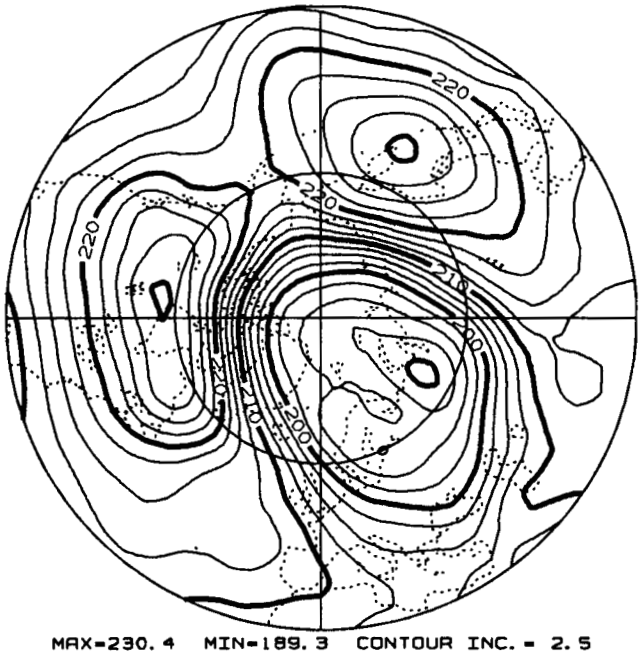
MAX=231.1 MIN=196.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890202



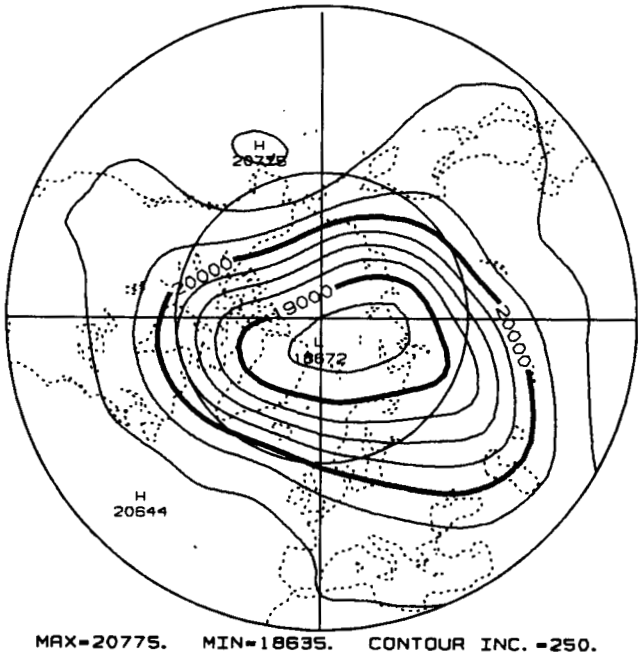
MAX=514.0 MIN=202.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890202

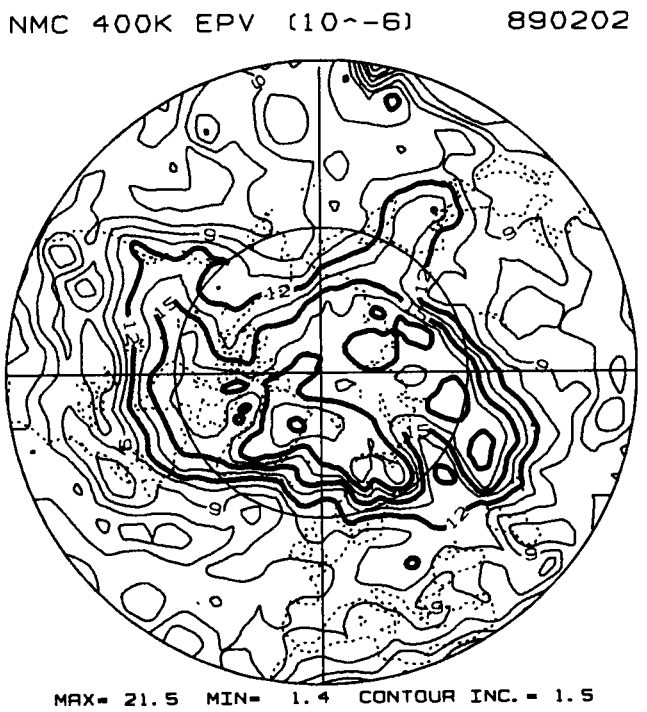


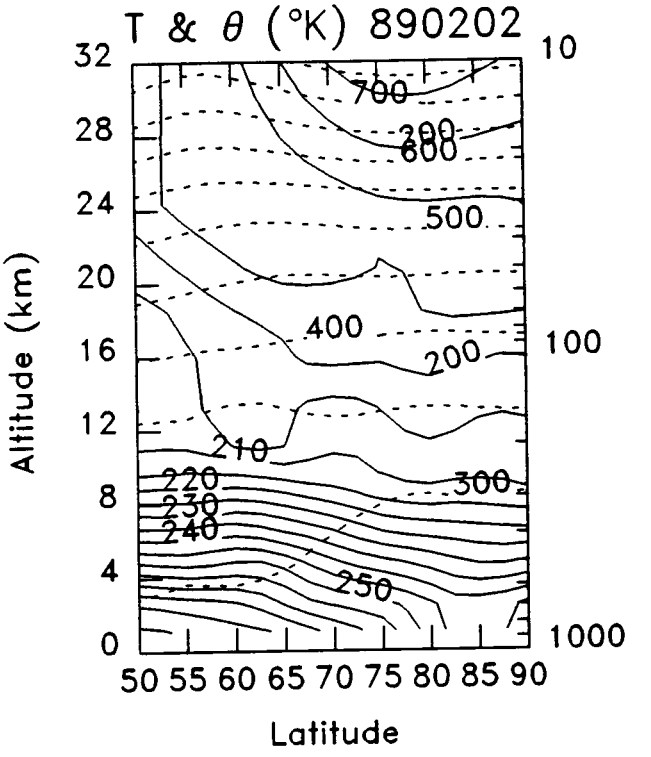
MAX=230.4 MIN=189.3 CONTOUR INC. = 2.5

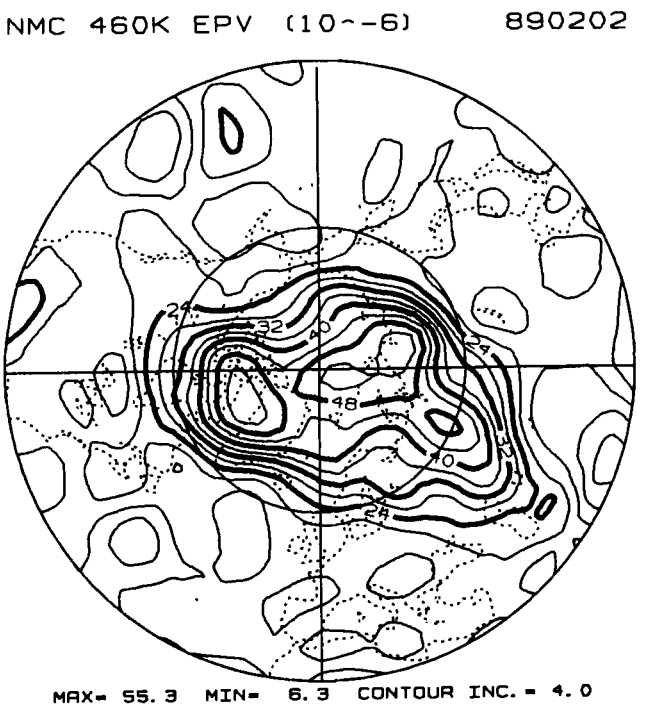
NMC 50MB GEOP HGT (M) 890202

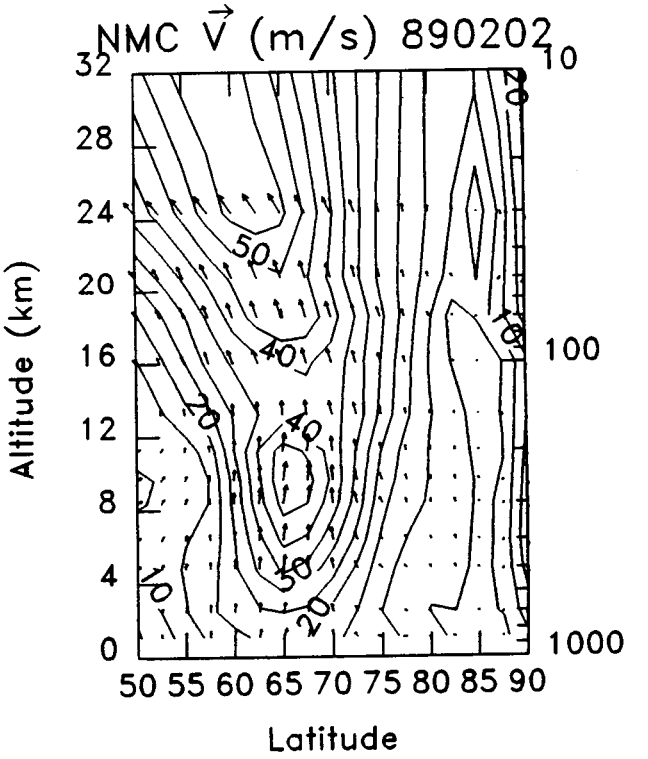


MAX=20775. MIN=18635. CONTOUR INC. =250.

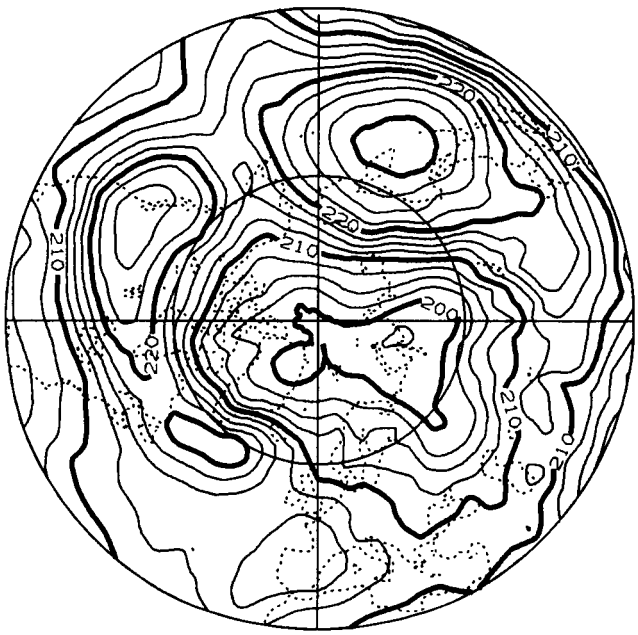

NMC 400K EPV (10^-6) 890202
MAX= 21.5 MIN= 1.4 CONTOUR INC. = 1.5


T & θ (°K) 890202
Altitude (km)
Latitude
700
600
500
400
300
200
210
220
230
240
250


NMC 460K EPV (10^-6) 890202
MAX= 55.3 MIN= 6.3 CONTOUR INC. = 4.0

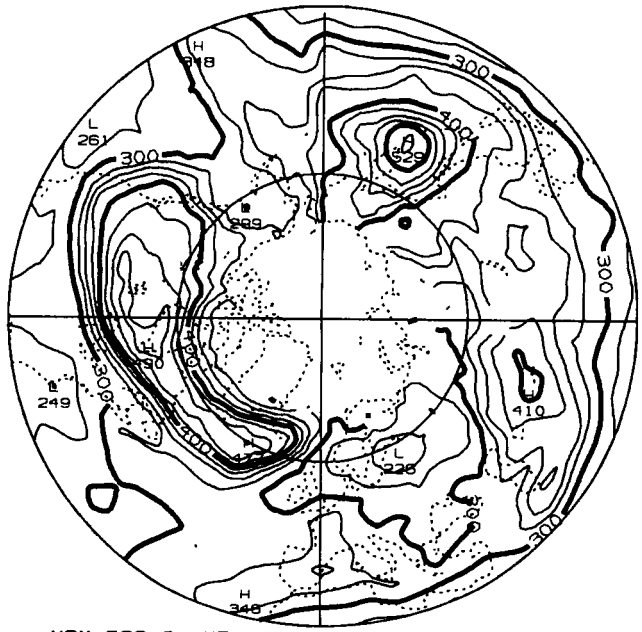

NMC V (m/s) 890202
Altitude (km)
Latitude

NMC 100MB TEMP. (K) 890203



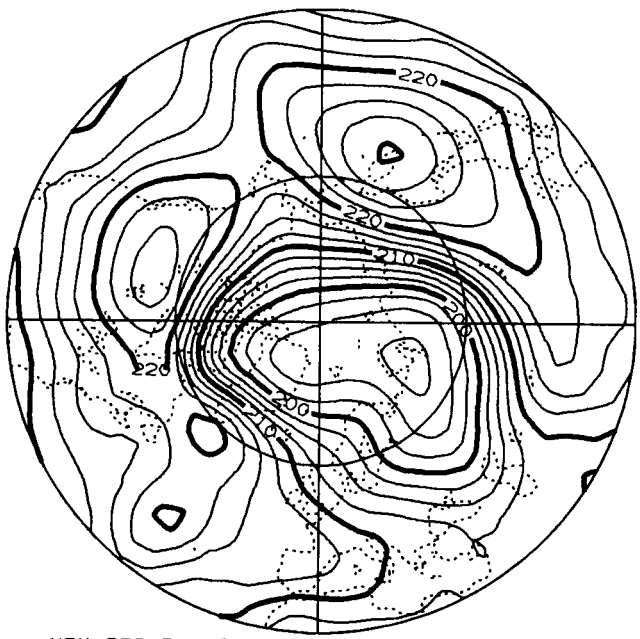
MAX=232.3 MIN=197.3 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890203



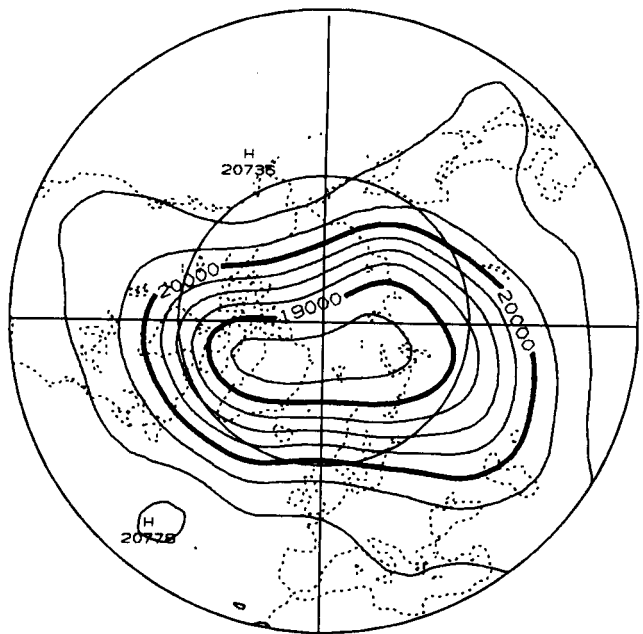
MAX=529.0 MIN=226.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890203



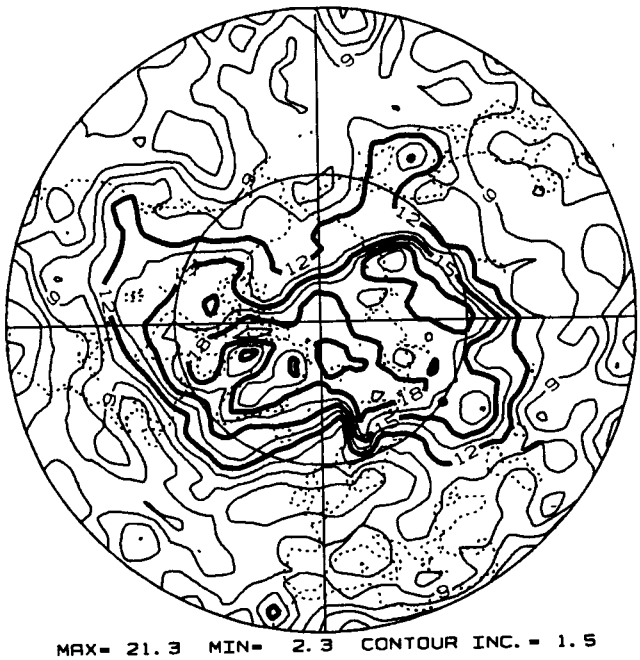
MAX=230.2 MIN=191.7 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890203



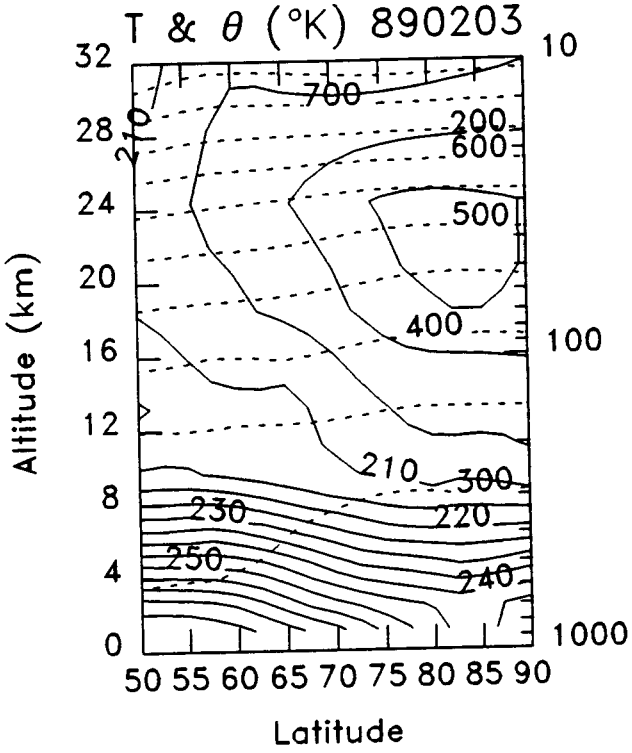
MAX=20778. MIN=18624. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890203

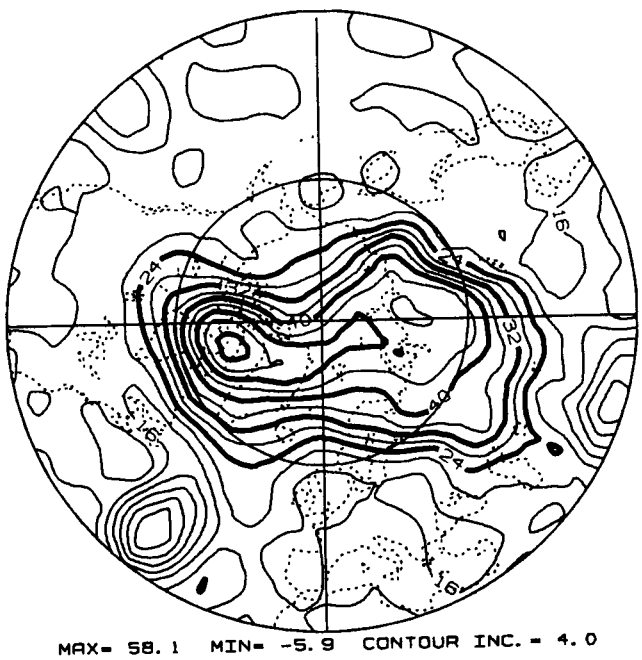


MAX= 21.3 MIN= 2.3 CONTOUR INC.= 1.5

T & θ (°K) 890203

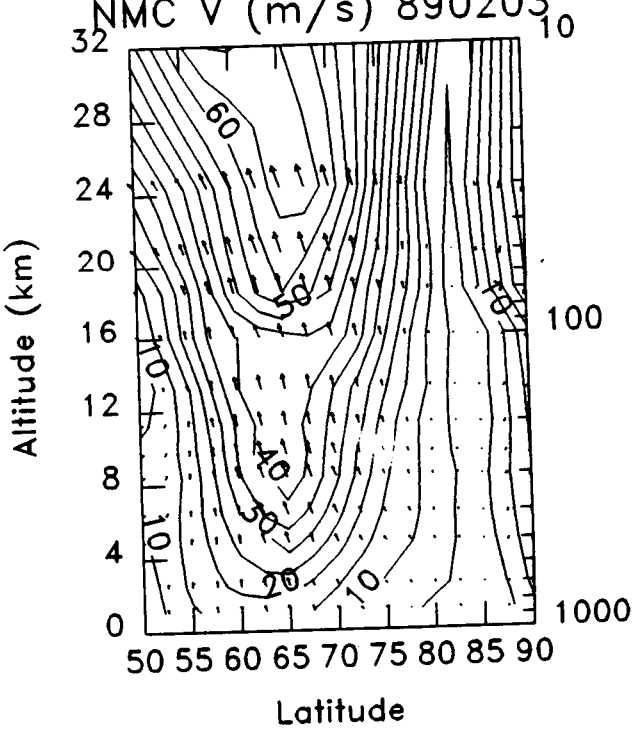


NMC 460K EPV (10^-6) 890203

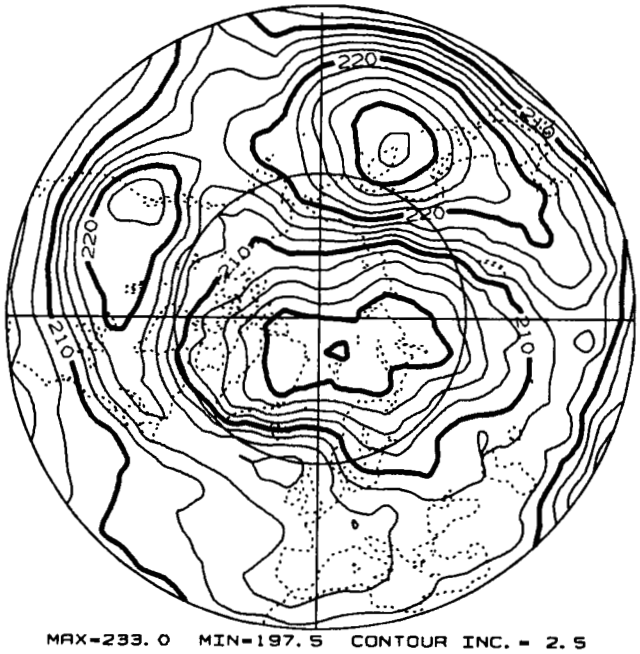


MAX= 58.1 MIN= -5.9 CONTOUR INC.= 4.0

NMC $\vec{V}$ (m/s) 890203

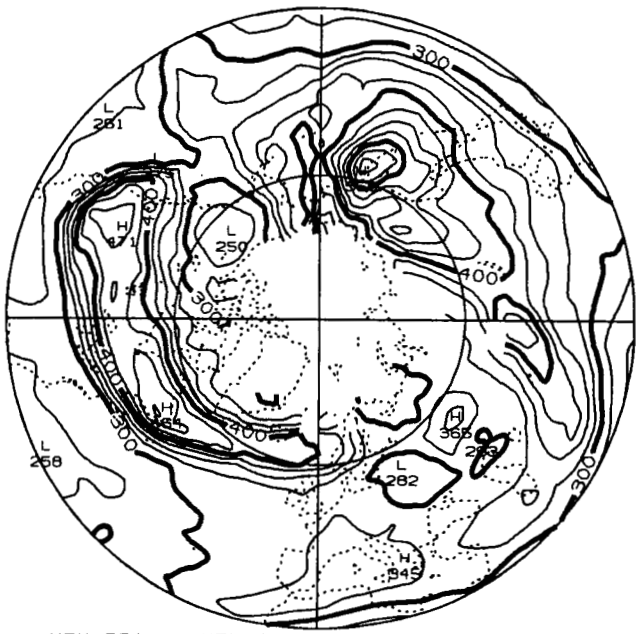


NMC 100MB TEMP. (K) 890204



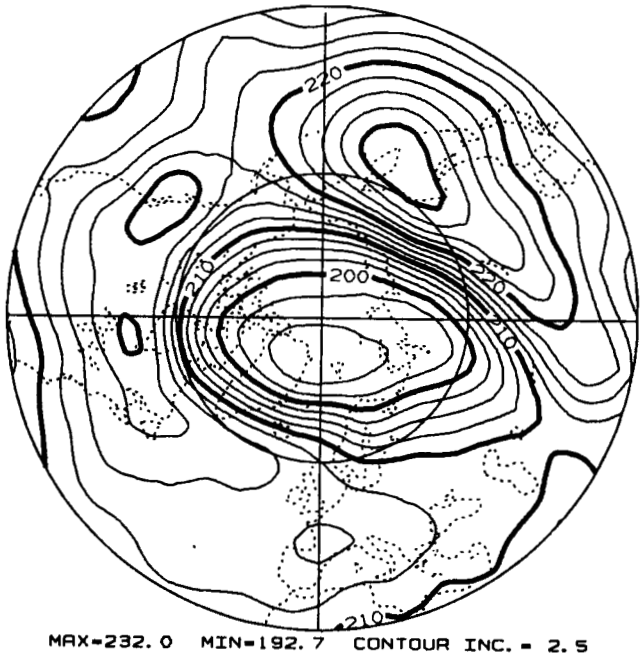
MAX=233.0 MIN=197.5 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890204



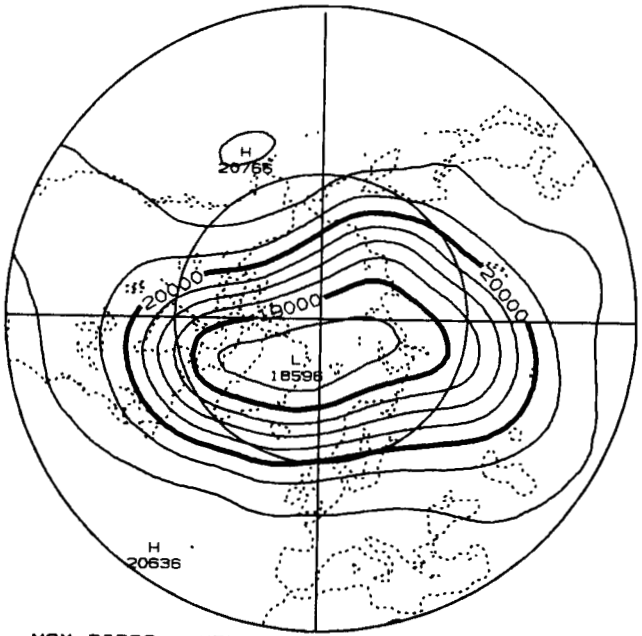
MAX=558.0 MIN=247.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890204

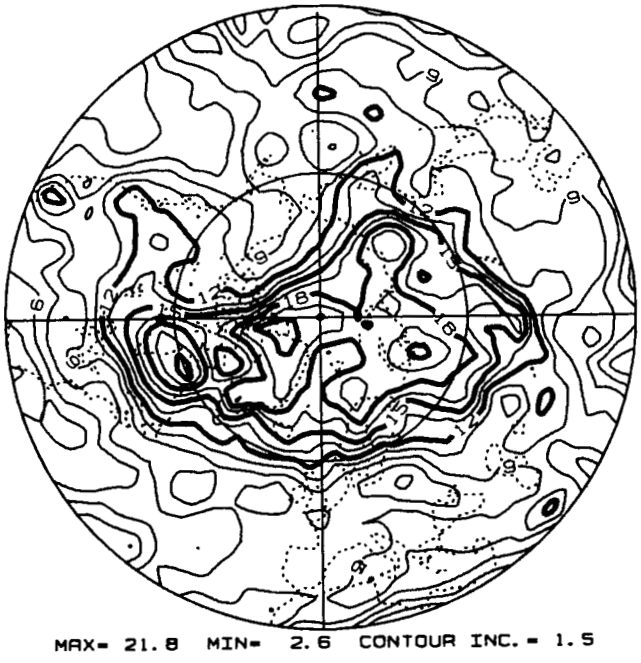


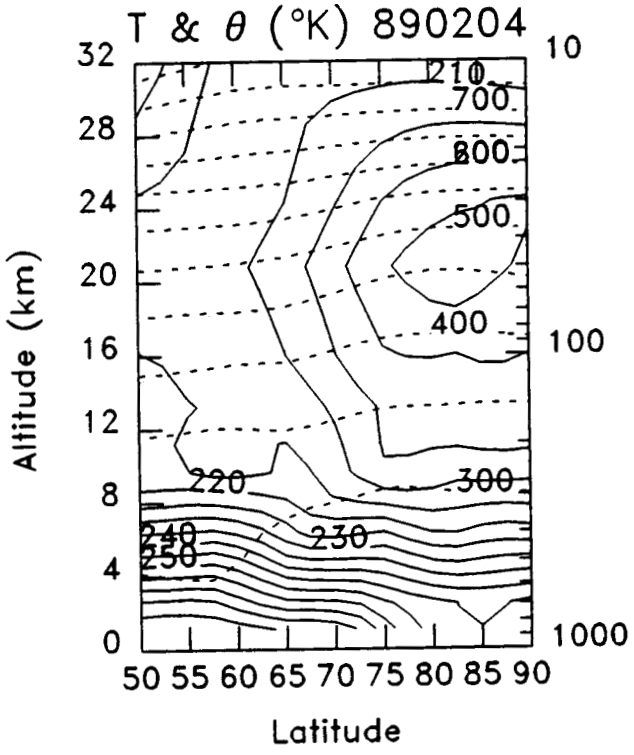
MAX=232.0 MIN=192.7 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890204



MAX=20766. MIN=18596. CONTOUR INC.=250.


NMC 400K EPV (10^-6) 890204
MAX= 21.8 MIN= 2.6 CONTOUR INC. = 1.5


T & θ (°K) 890204
Altitude (km)
Latitude
32
28
24
20
16
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100
1000
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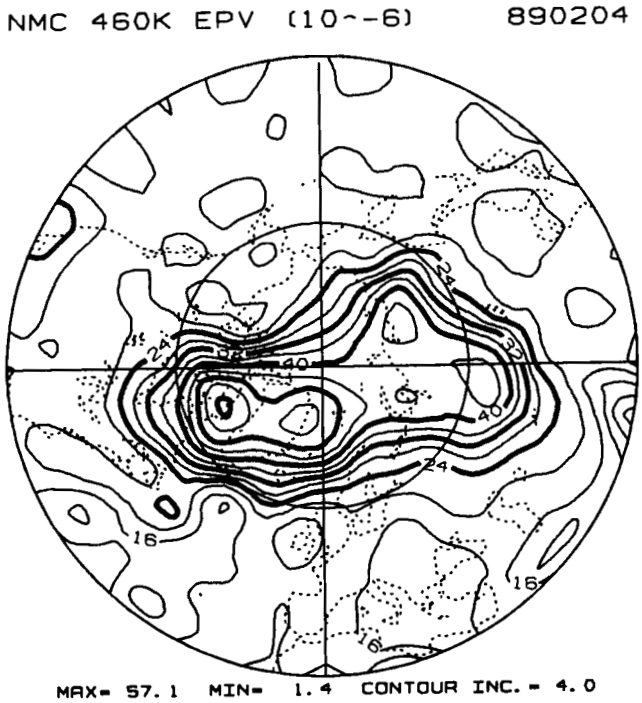
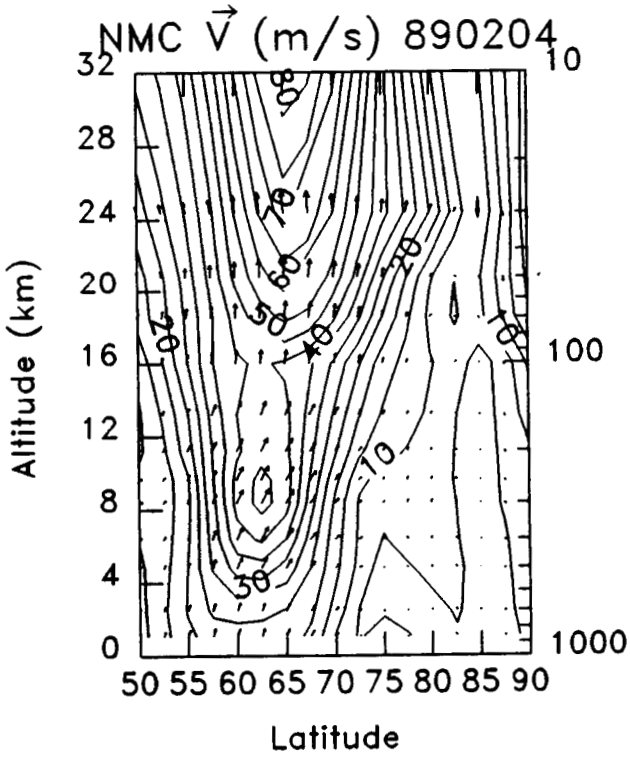
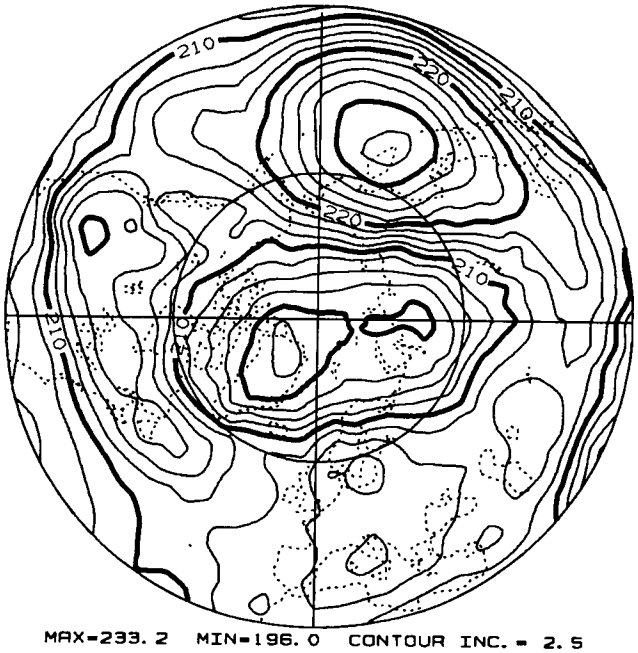
230


NMC 460K EPV (10^-6) 890204
MAX= 57.1 MIN= 1.4 CONTOUR INC. = 4.0

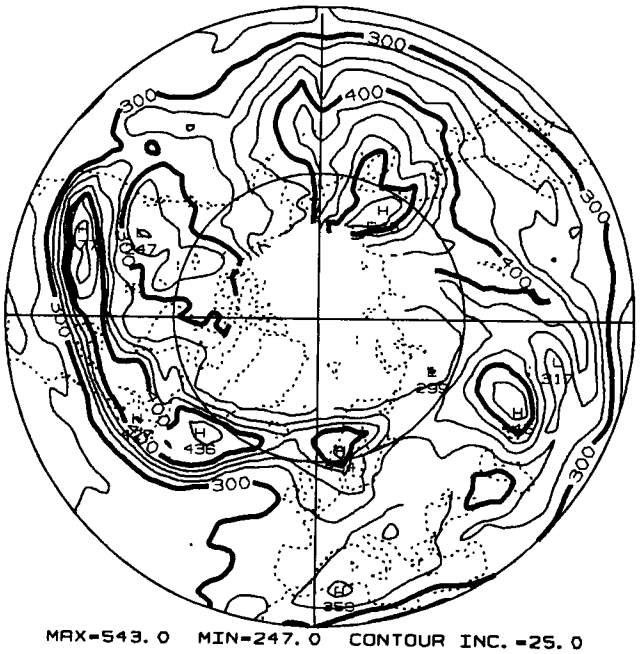

NMC V⃗ (m/s) 890204
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890205



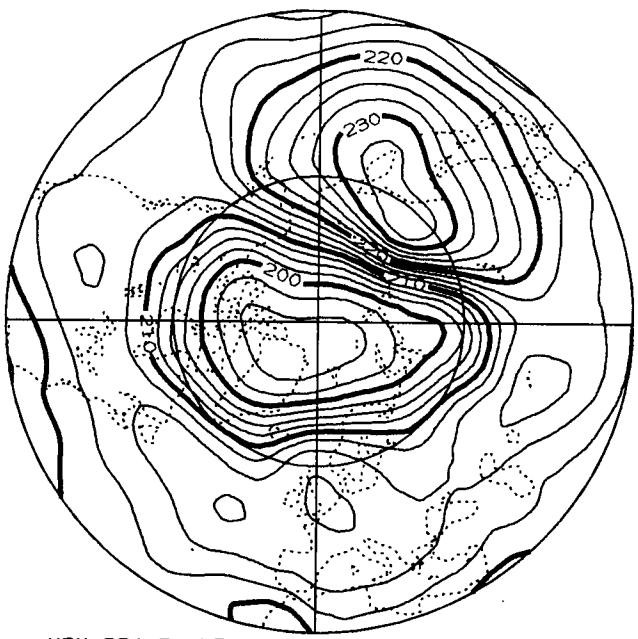
MAX=233.2 MIN=196.0 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890205



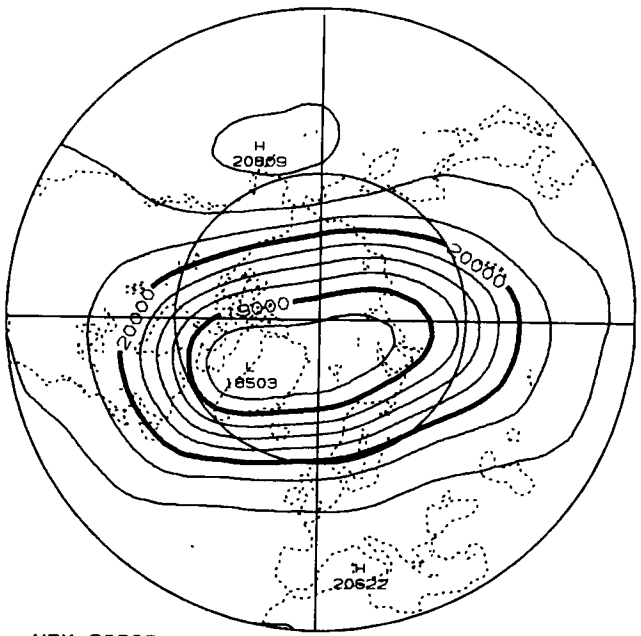
MAX=543.0 MIN=247.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890205

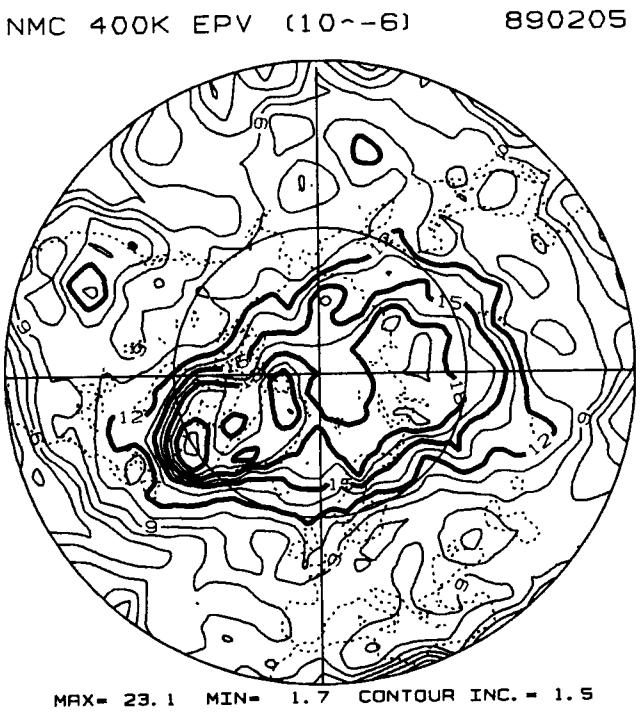


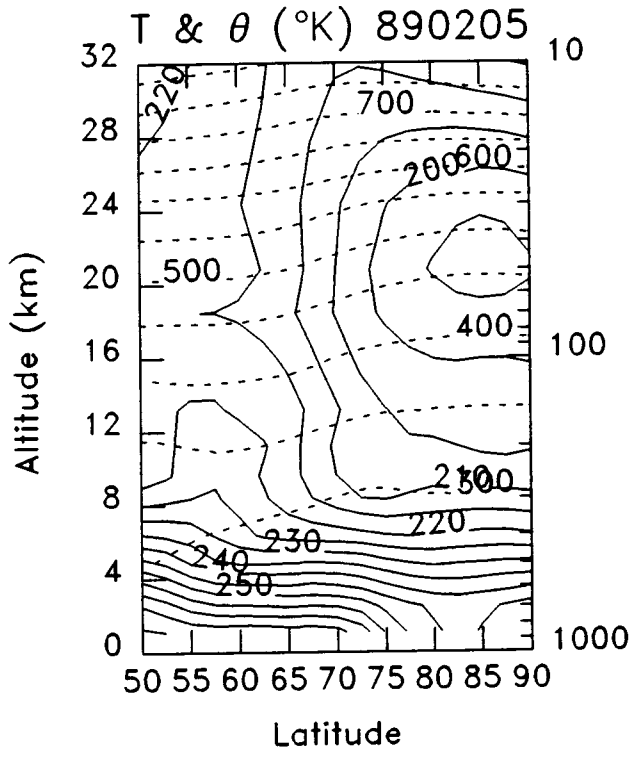
MAX=234.3 MIN=193.2 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890205



MAX=20809. MIN=18503. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890205
MAX= 23.1 MIN= 1.7 CONTOUR INC. = 1.5


T & θ (°K) 890205
Altitude (km)
Latitude
32
28
24
20
16
12
8
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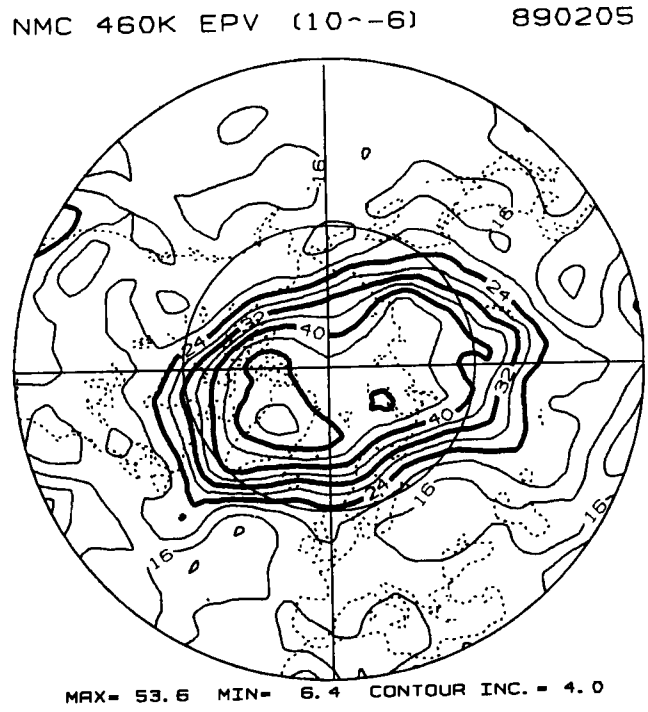
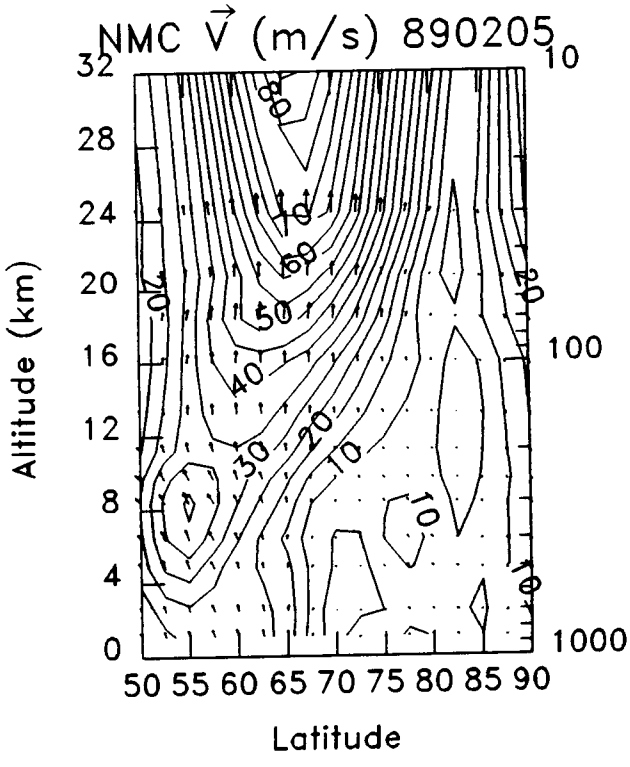
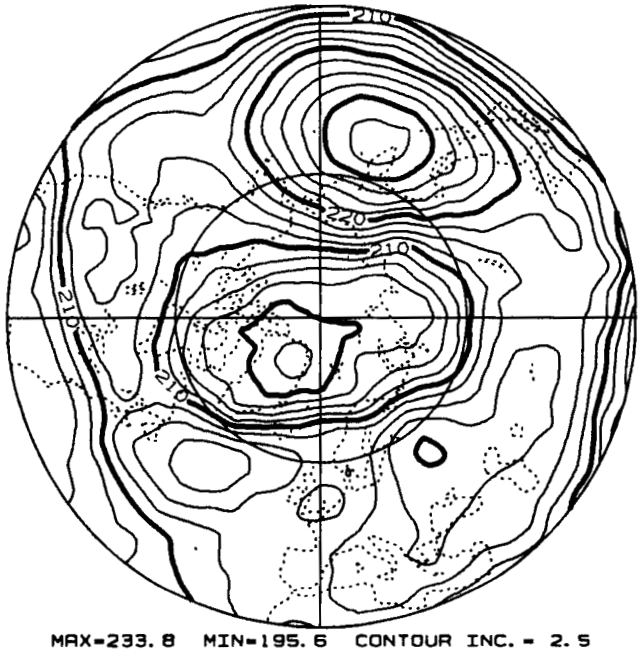
0
10
100
1000
50 55 60 65 70 75 80 85 90
220
700
600
500
400
300
230
240
250


NMC 460K EPV (10^-6) 890205
MAX= 53.6 MIN= 6.4 CONTOUR INC. = 4.0

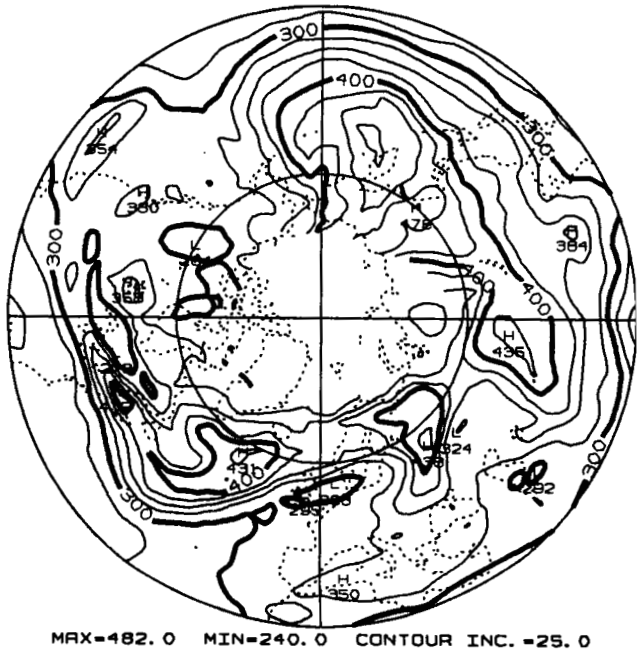

NMC V (m/s) 890205
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890206



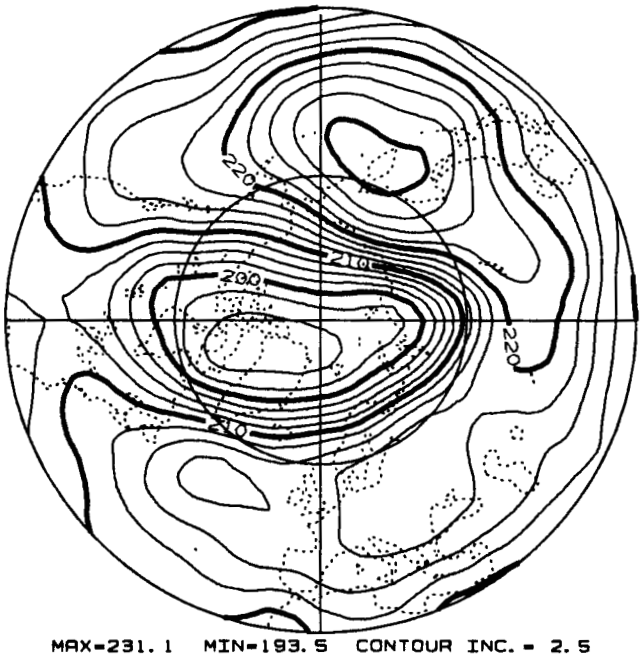
MAX=233.8 MIN=195.6 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890206



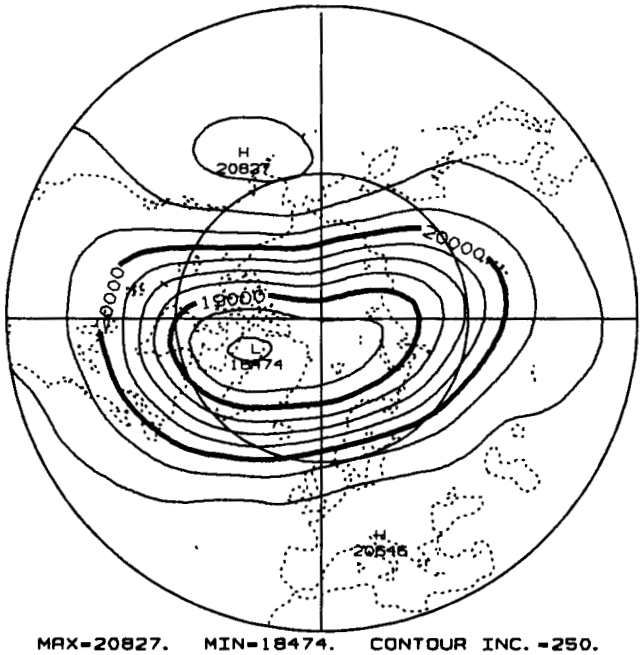
MAX=482.0 MIN=240.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890206



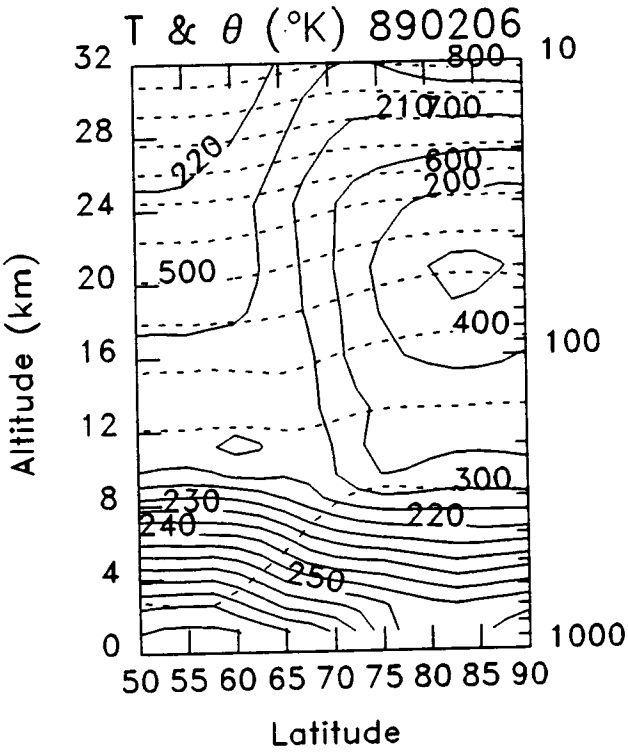
MAX=231.1 MIN=193.5 CONTOUR INC.= 2.5

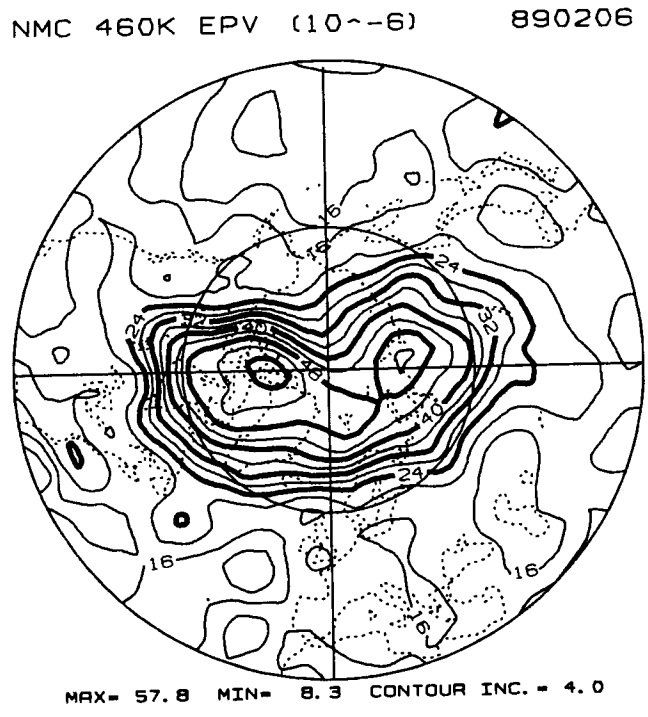
NMC 50MB GEOP HGT (M) 890206

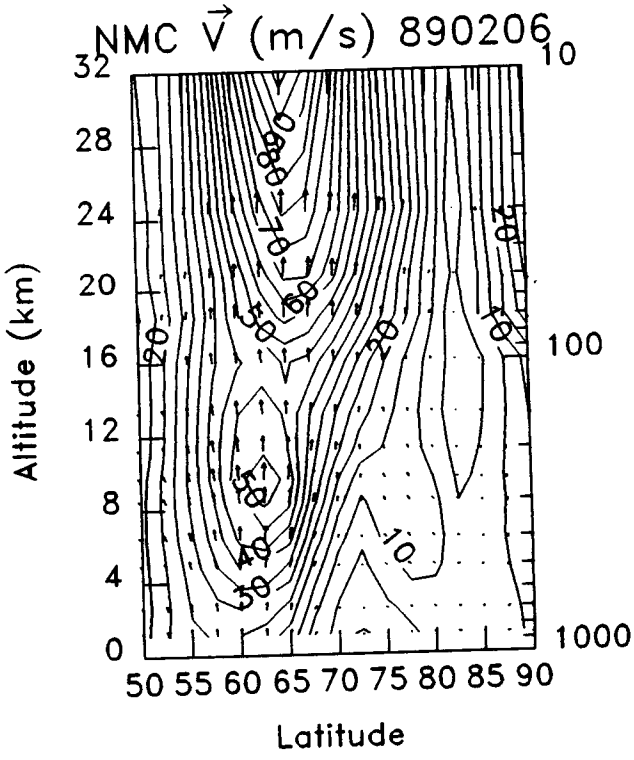


MAX=20827. MIN=18474. CONTOUR INC.=250.

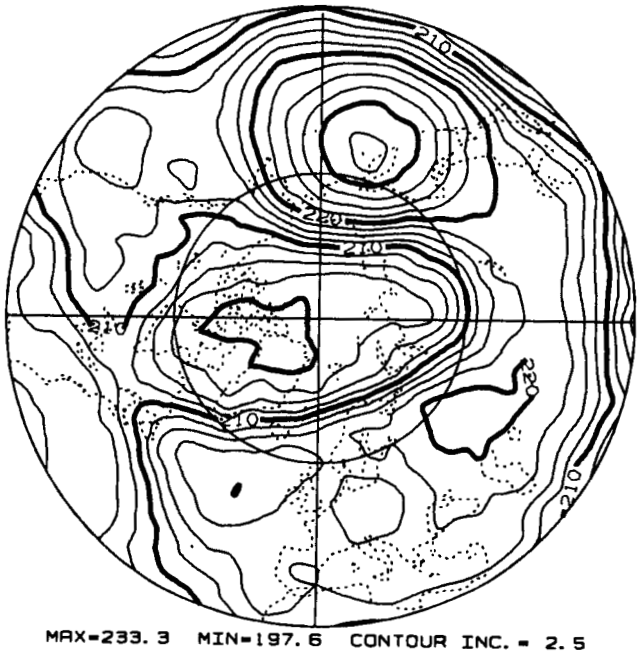
NMC 400K EPV (10^-6) 890206
MAX= 25.2 MIN= 1.2 CONTOUR INC. = 1.5


T & θ (°K) 890206
Altitude (km)
Latitude
800
700
600
500
400
300
220
230
240
250
210
200
10
100
1000


NMC 460K EPV (10^-6) 890206
MAX= 57.8 MIN= 8.3 CONTOUR INC. = 4.0

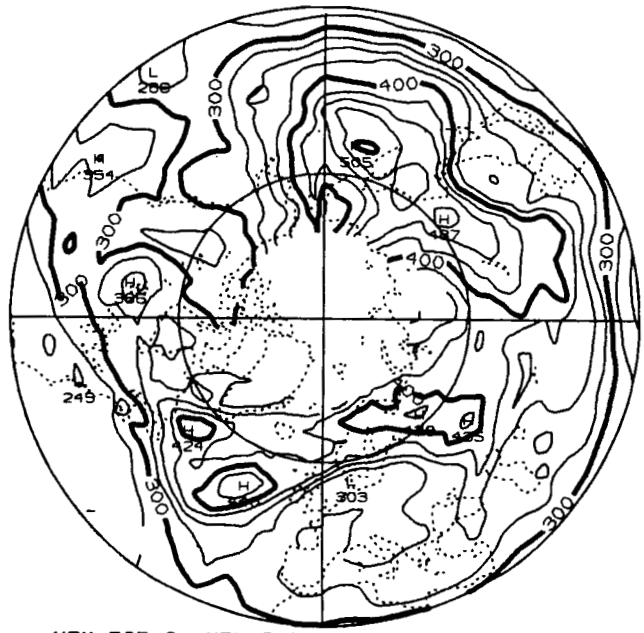

NMC V (m/s) 890206
Altitude (km)
Latitude
10
100
1000

NMC 100MB TEMP. (K) 890207



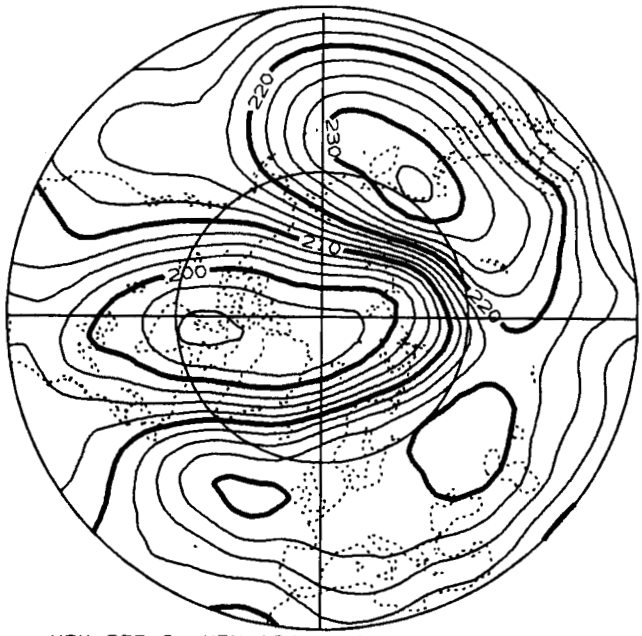
MAX=233.3 MIN=197.6 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890207



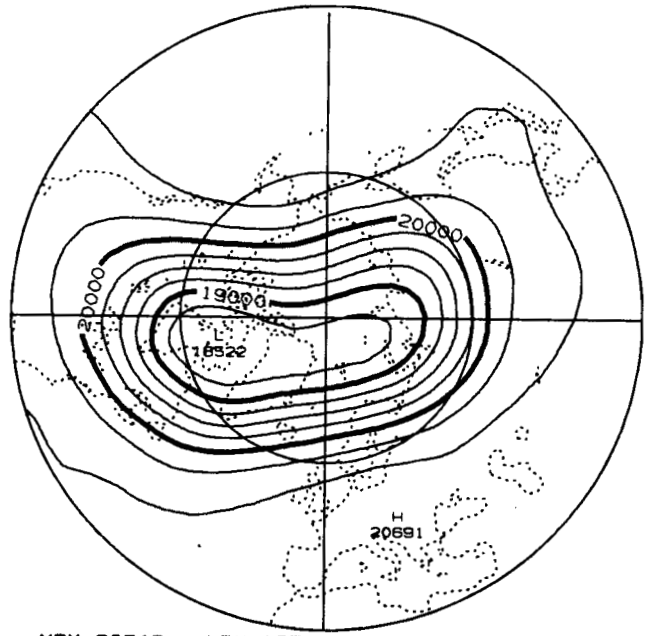
MAX=505.0 MIN=242.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890207

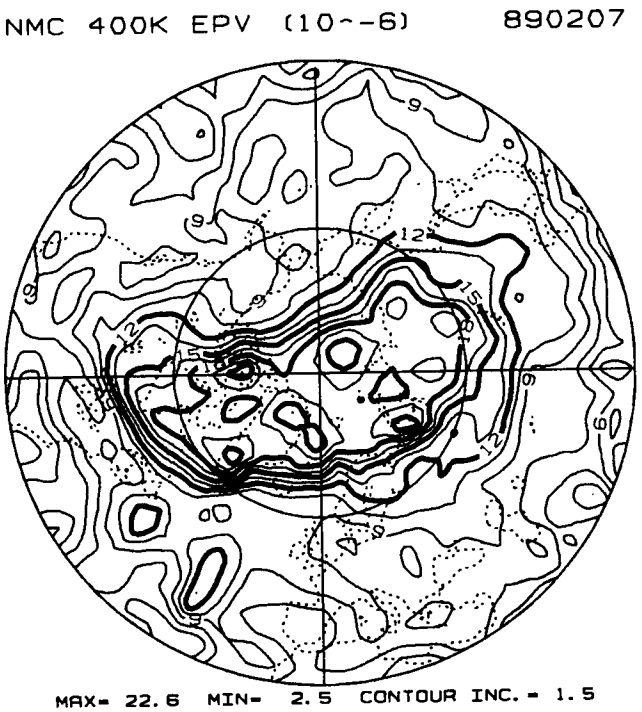


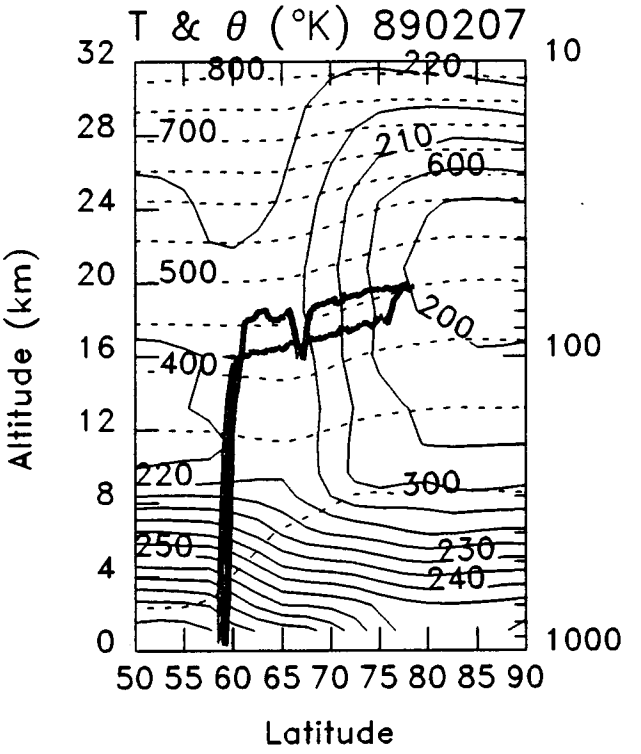
MAX=233.0 MIN=194.4 CONTOUR INC. = 2.5

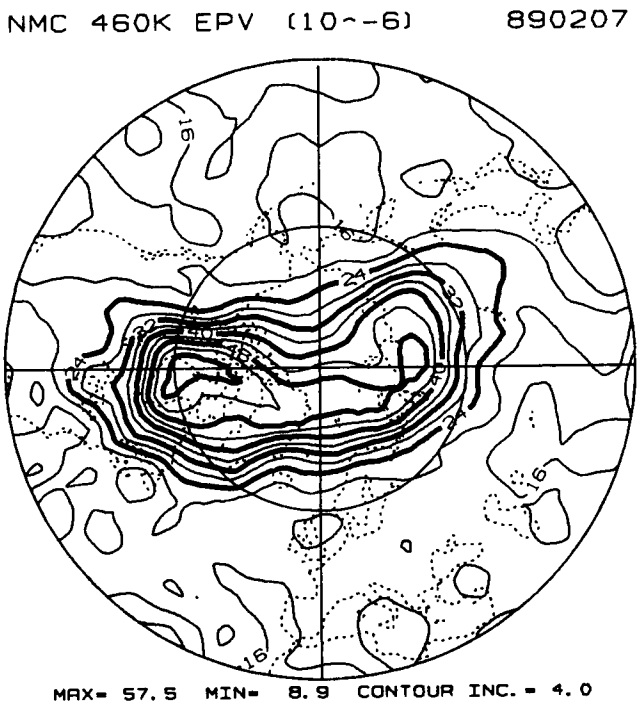
NMC 50MB GEOP HGT (M) 890207

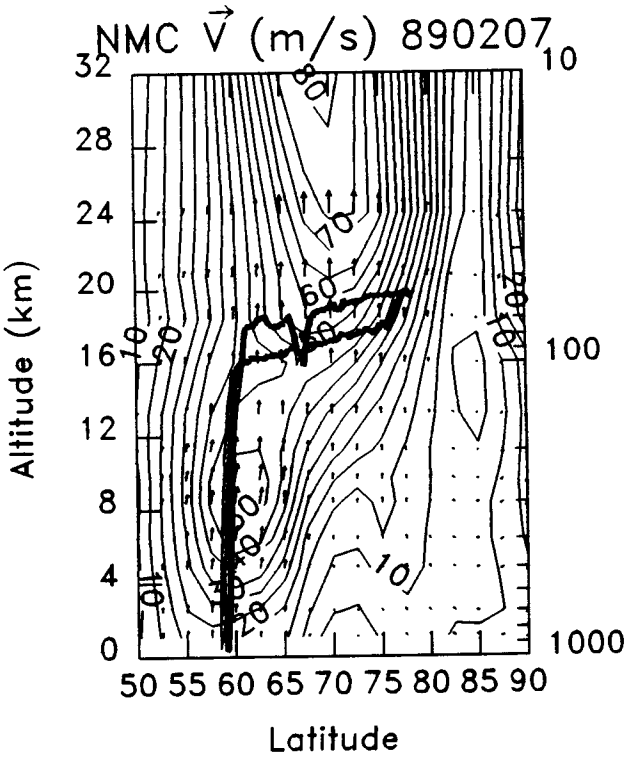


MAX=20743. MIN=18522. CONTOUR INC. =250.

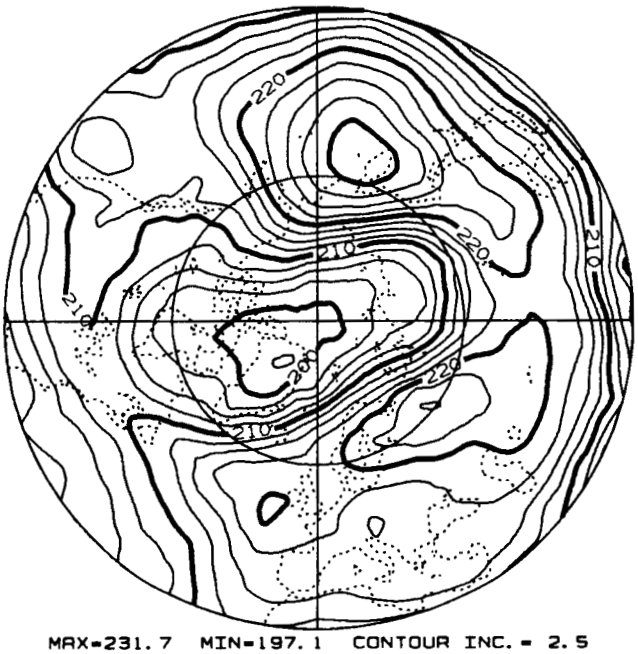

NMC 400K EPV (10^-6) 890207
MAX= 22.6 MIN= 2.5 CONTOUR INC. = 1.5


T & θ (°K) 890207
Altitude (km)
Latitude
800
700
600
500
400
300
220
210
200
250
240
230


NMC 460K EPV (10^-6) 890207
MAX= 57.5 MIN= 8.9 CONTOUR INC. = 4.0

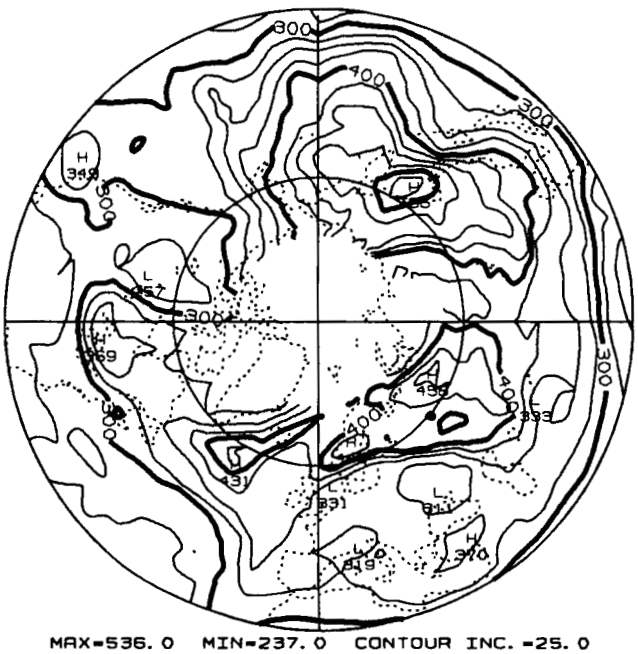

NMC V (m/s) 890207
Altitude (km)
Latitude

NMC 100MB TEMP. (K) 890208



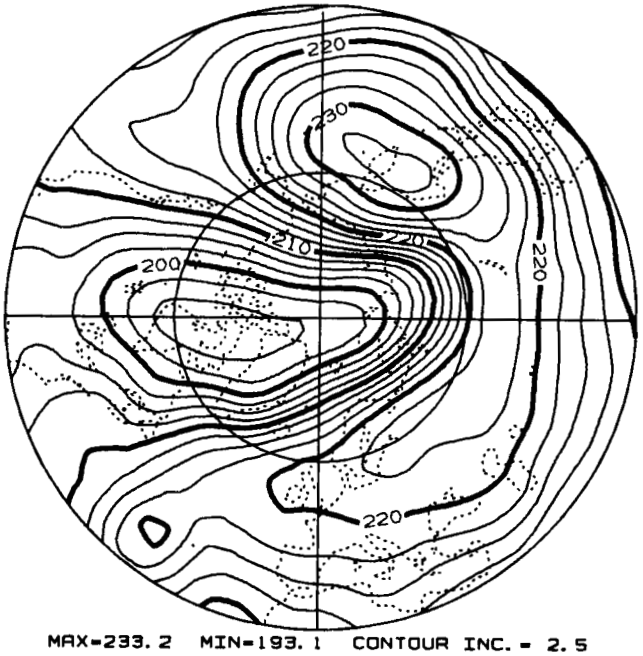
MAX=231.7 MIN=197.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890208



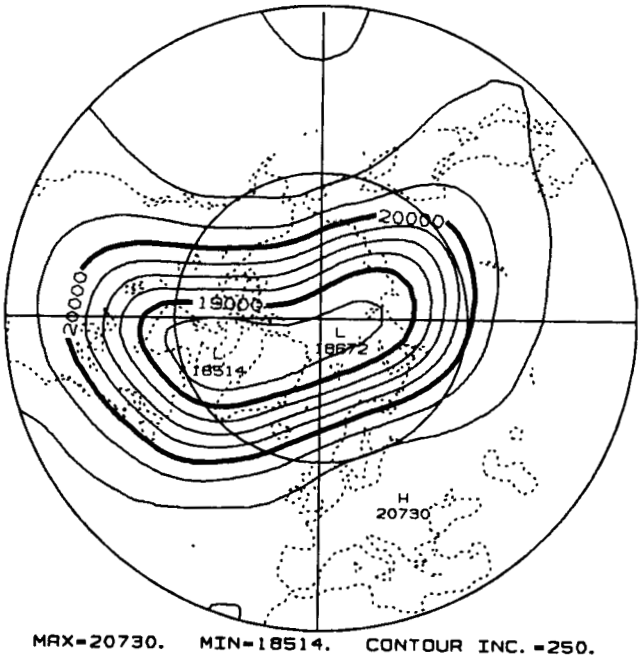
MAX=536.0 MIN=237.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890208

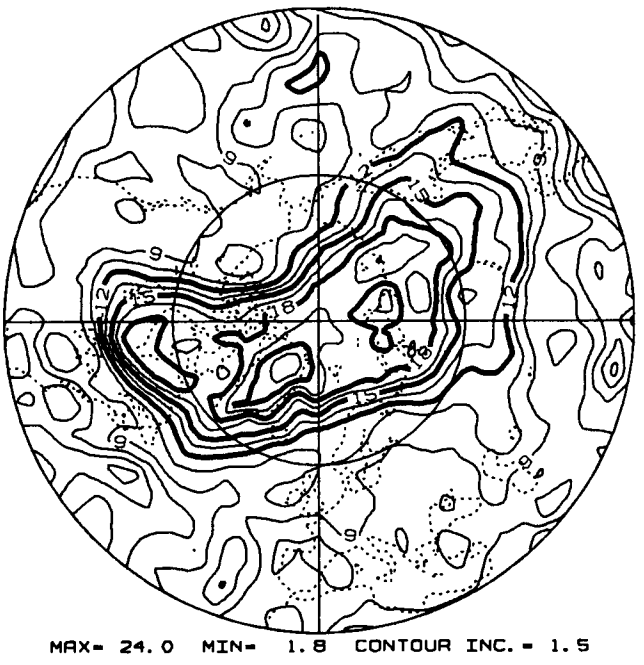


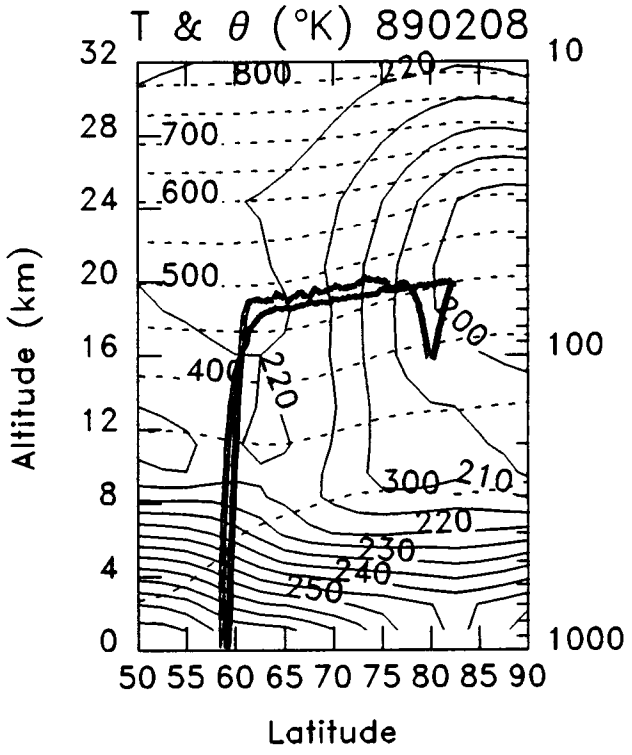
MAX=233.2 MIN=193.1 CONTOUR INC. = 2.5

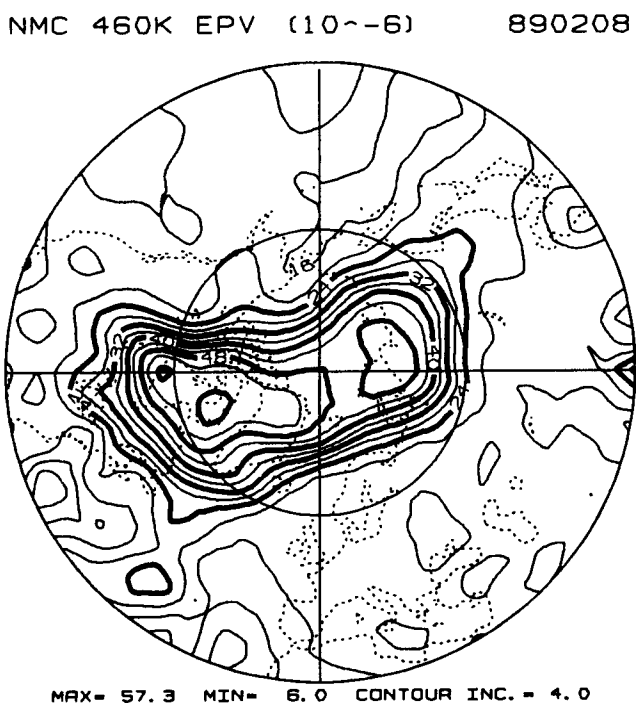
NMC 50MB GEOP HGT (M) 890208

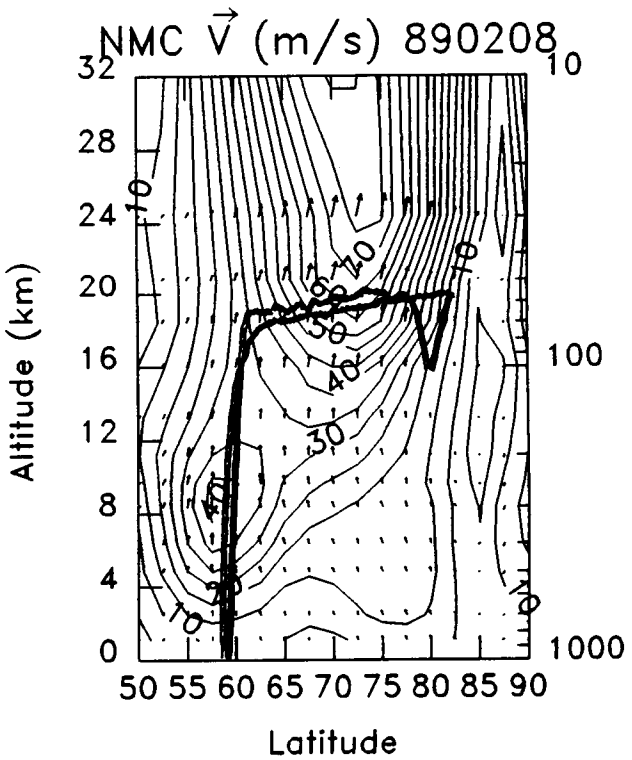


MAX=20730. MIN=18514. CONTOUR INC. =250.

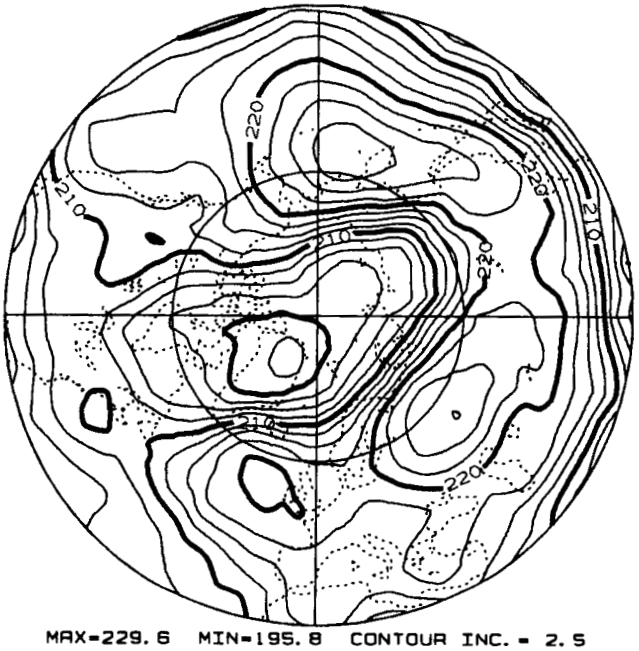

NMC 400K EPV (10^-6) 890208
MAX= 24.0 MIN= 1.8 CONTOUR INC.= 1.5


T & θ (°K) 890208
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
800
700
600
500
400
300
220
210
230
240
250


NMC 460K EPV (10^-6) 890208
MAX= 57.3 MIN= 6.0 CONTOUR INC.= 4.0

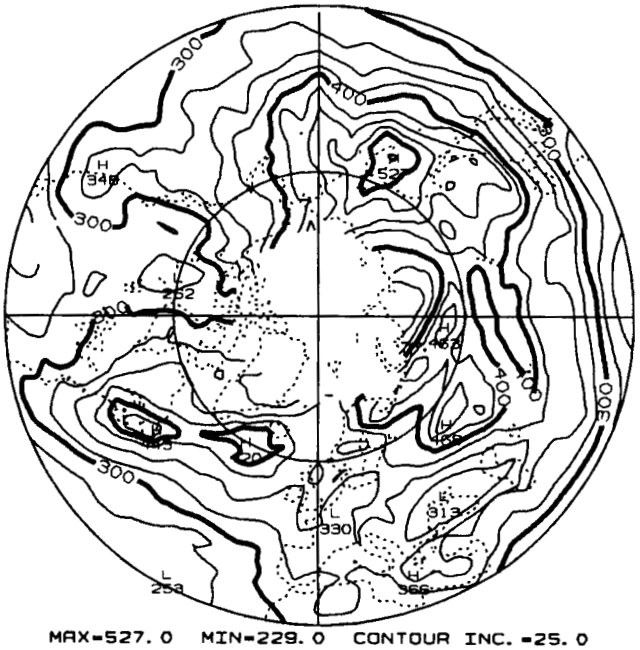

NMC V (m/s) 890208
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
10
20
30
40
50

NMC 100MB TEMP. (K) 890209



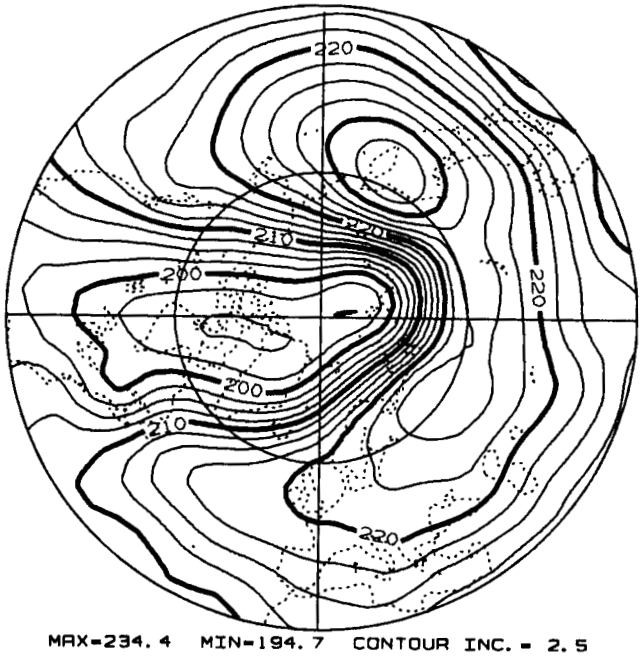
MAX=229.6 MIN=195.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890209



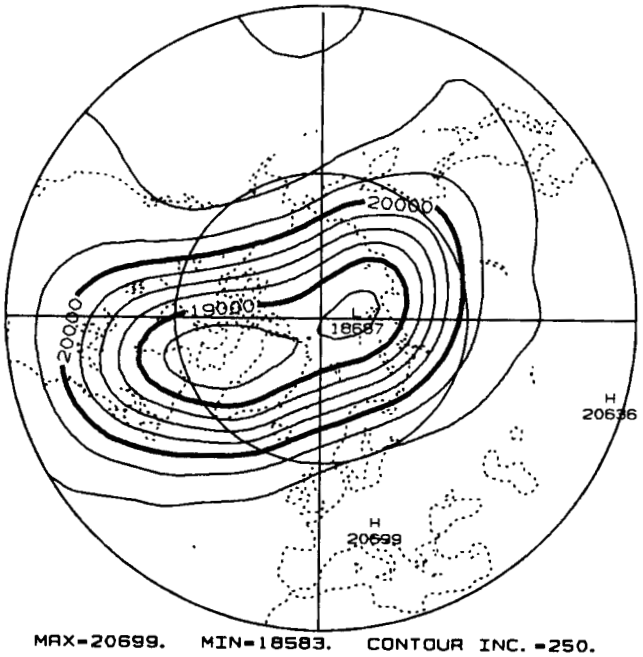
MAX=527.0 MIN=229.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890209



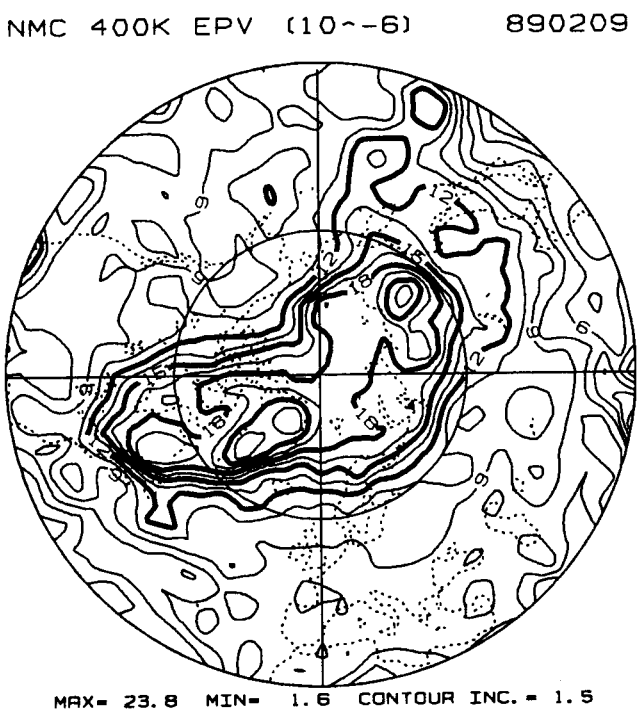
MAX=234.4 MIN=194.7 CONTOUR INC. = 2.5

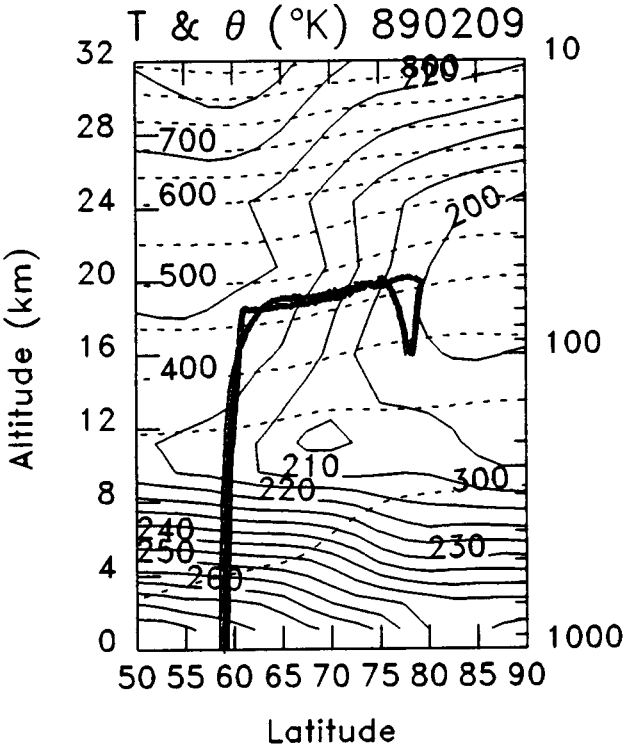
NMC 50MB GEOP HGT (M) 890209



MAX=20699. MIN=18583. CONTOUR INC. =250.

C-2


NMC 400K EPV (10^-6) 890209
MAX= 23.8 MIN= 1.6 CONTOUR INC. = 1.5


T & θ (°K) 890209
Altitude (km)
Latitude
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700
600
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400
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28
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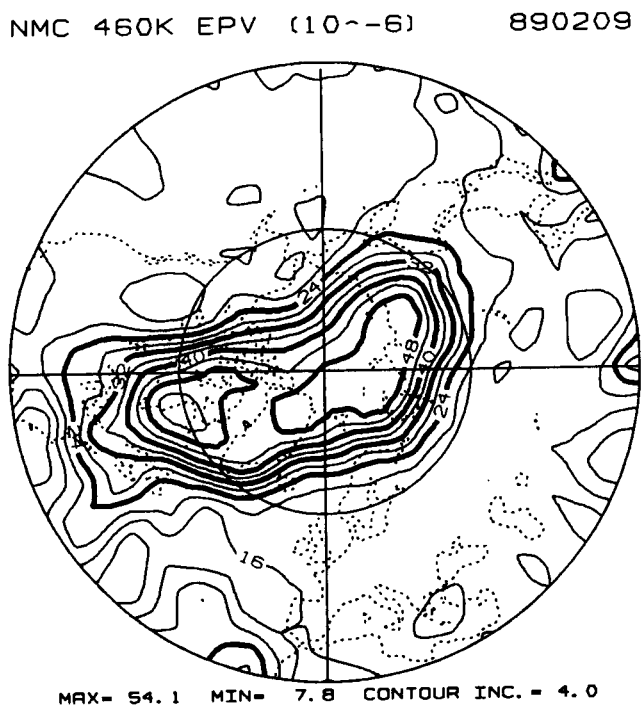
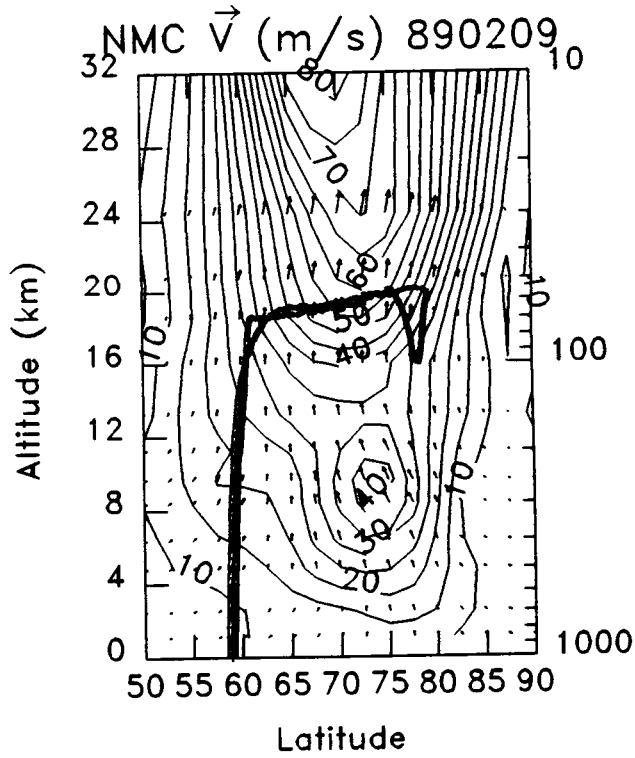
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890209
MAX= 54.1 MIN= 7.8 CONTOUR INC. = 4.0


NMC V (m/s) 890209
Altitude (km)
Latitude
80
70
60
50
40
30
20
10
32
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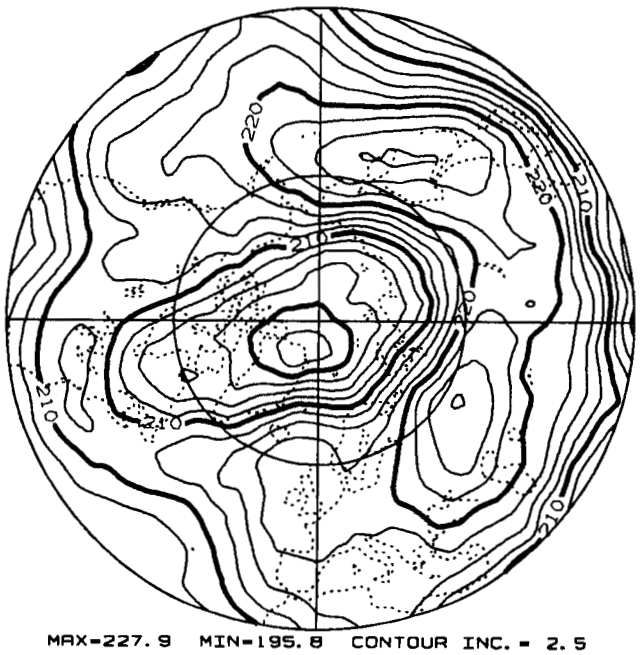
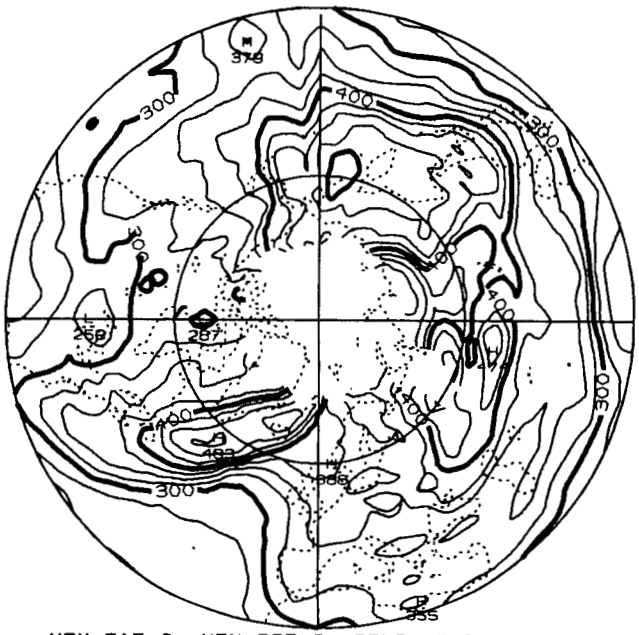
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890210



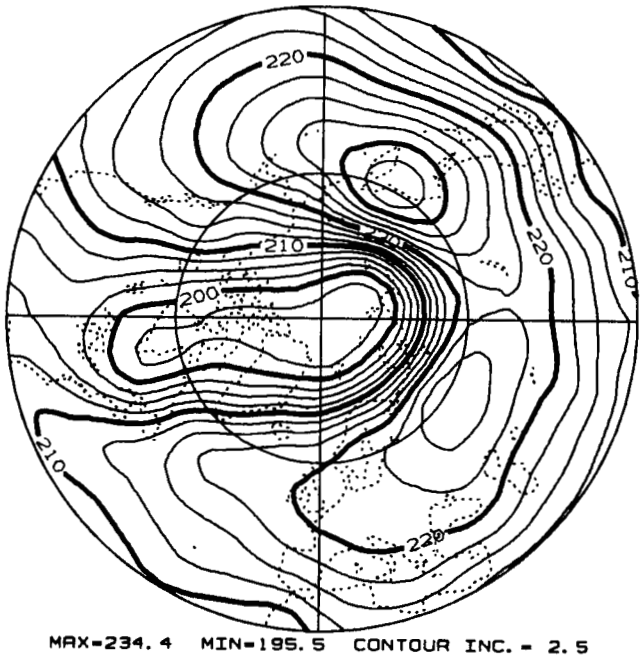
MAX=227.9 MIN=195.8 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890210



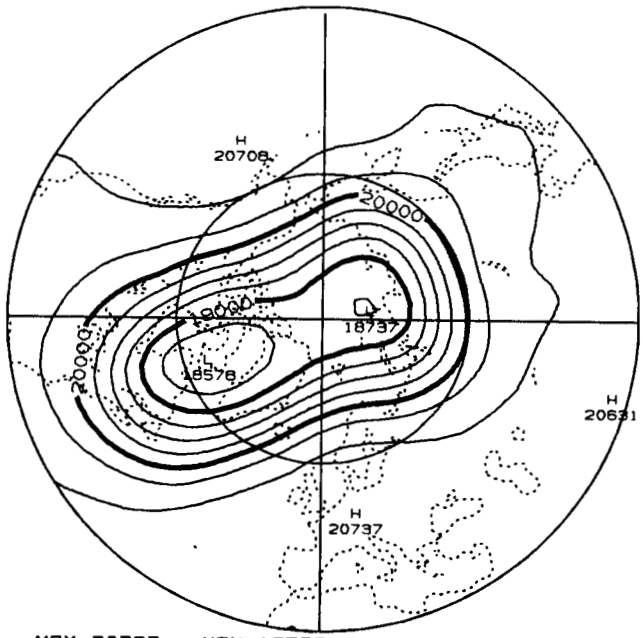
MAX=515.0 MIN=227.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890210

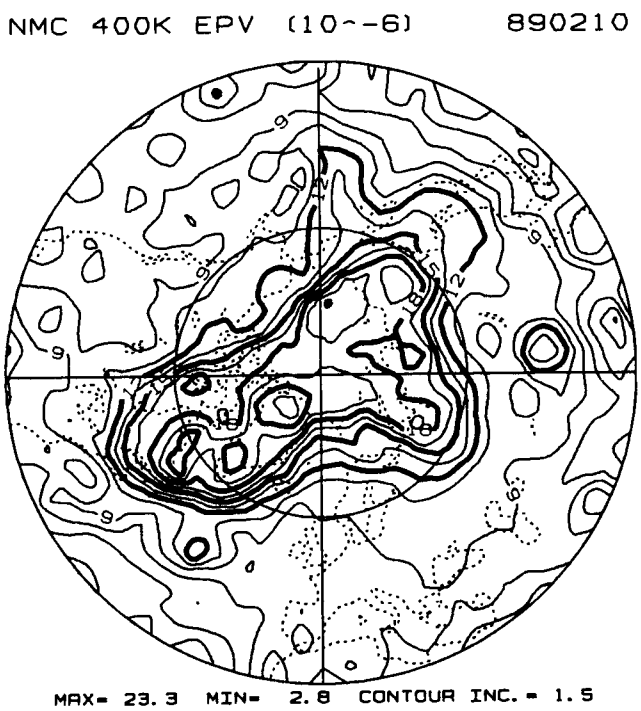


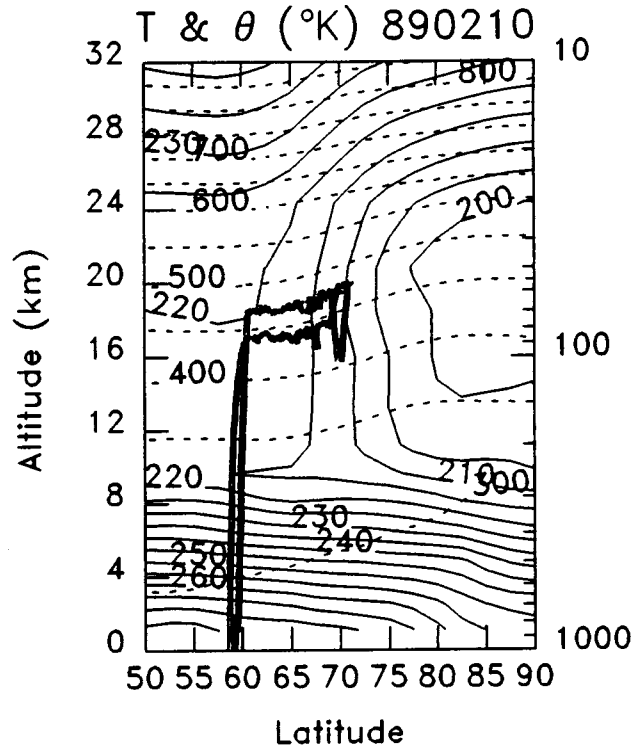
MAX=234.4 MIN=195.5 CONTOUR INC.= 2.5

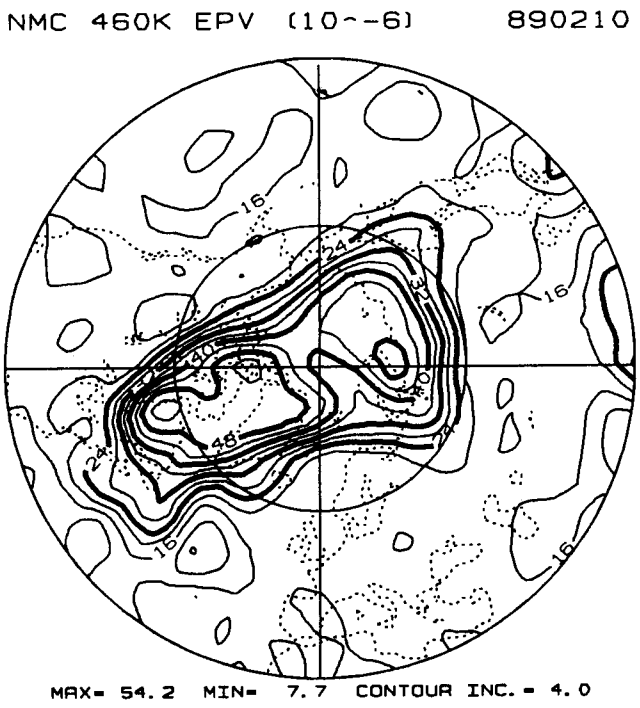
NMC 50MB GEOP HGT (M) 890210

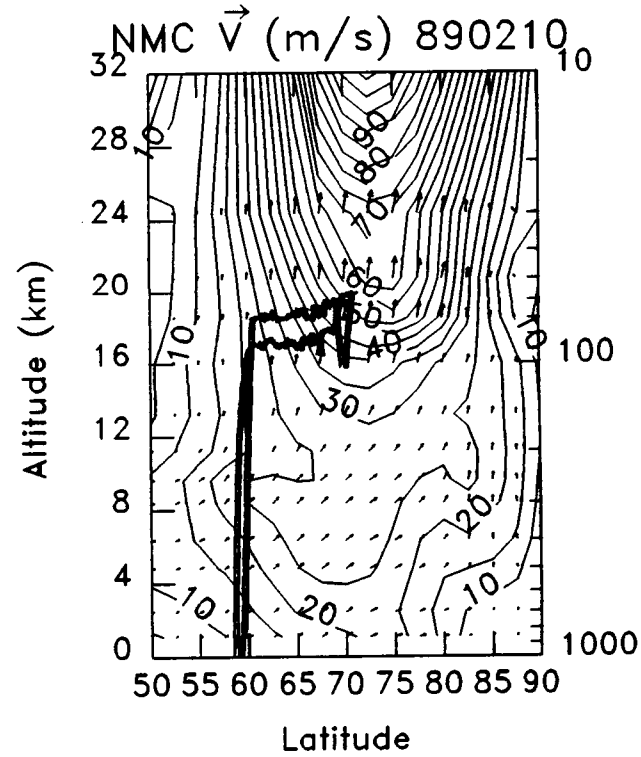


MAX=20737. MIN=18578. CONTOUR INC.=250.

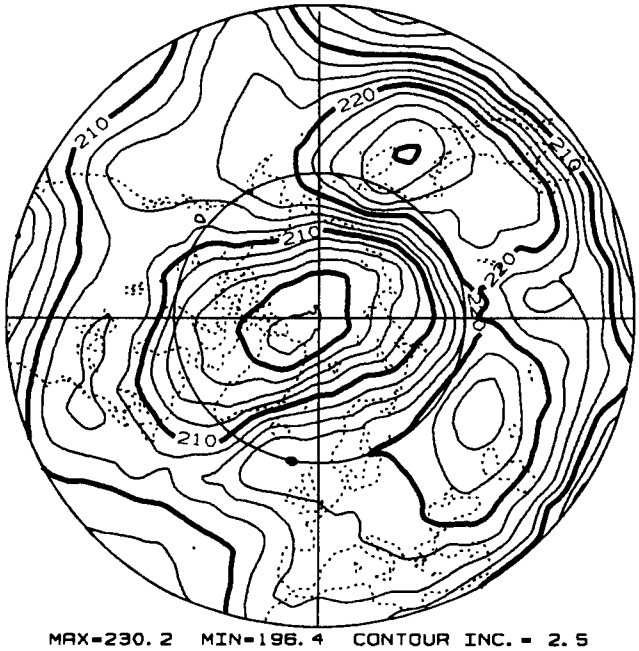

NMC 400K EPV (10^-6) 890210
MAX= 23.3 MIN= 2.8 CONTOUR INC. = 1.5


T & θ (°K) 890210
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
800
700
600
500
400
220
230
240
250
260
200
210
300


NMC 460K EPV (10^-6) 890210
MAX= 54.2 MIN= 7.7 CONTOUR INC. = 4.0

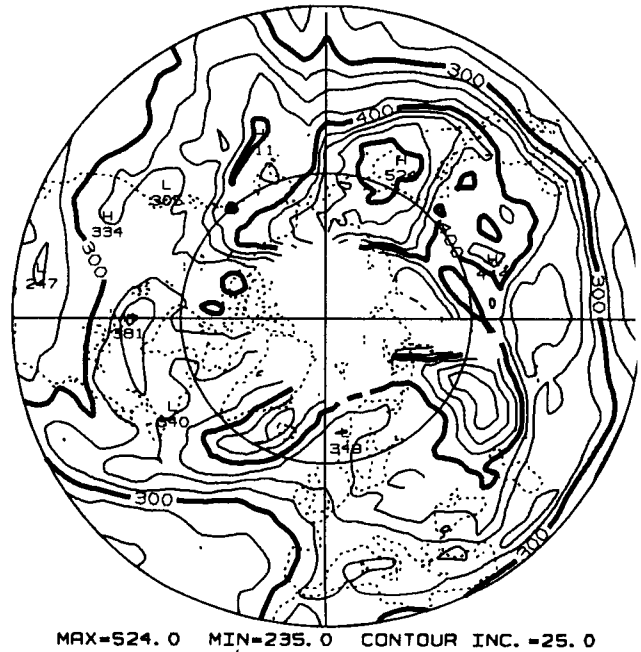

NMC V (m/s) 890210
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
10
20
30
40
50
60
70
80
90

NMC 100MB TEMP. (K) 890211



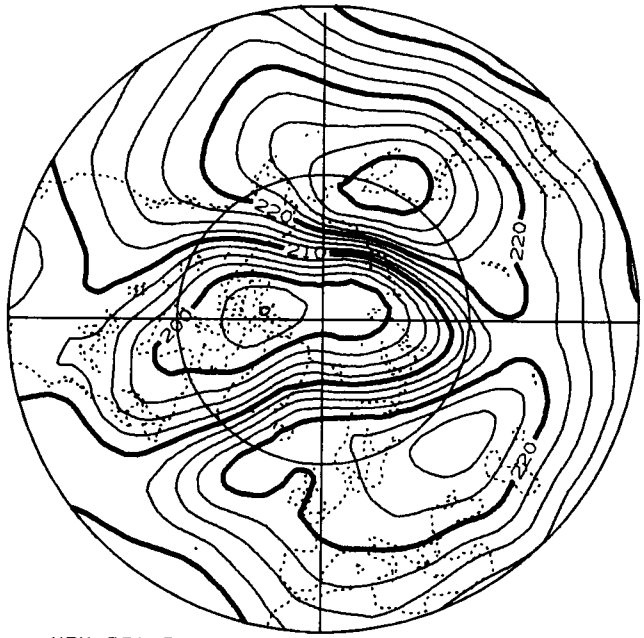
MAX=230.2 MIN=196.4 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890211



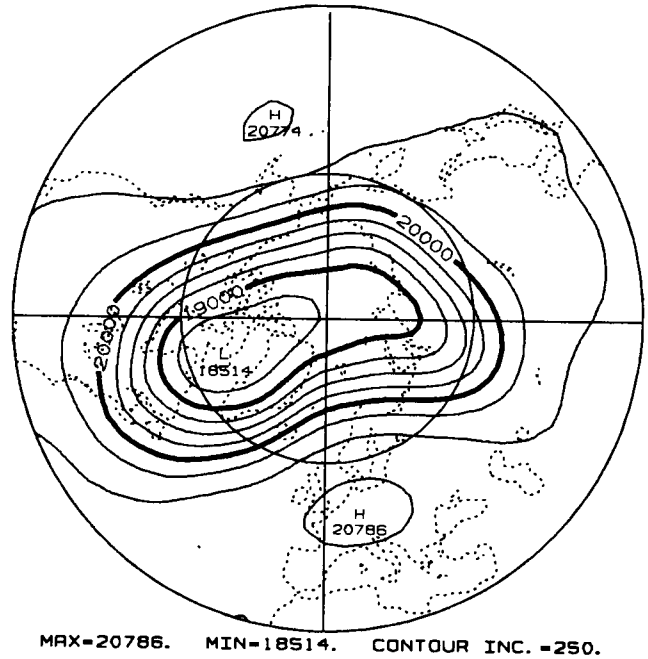
MAX=524.0 MIN=235.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890211



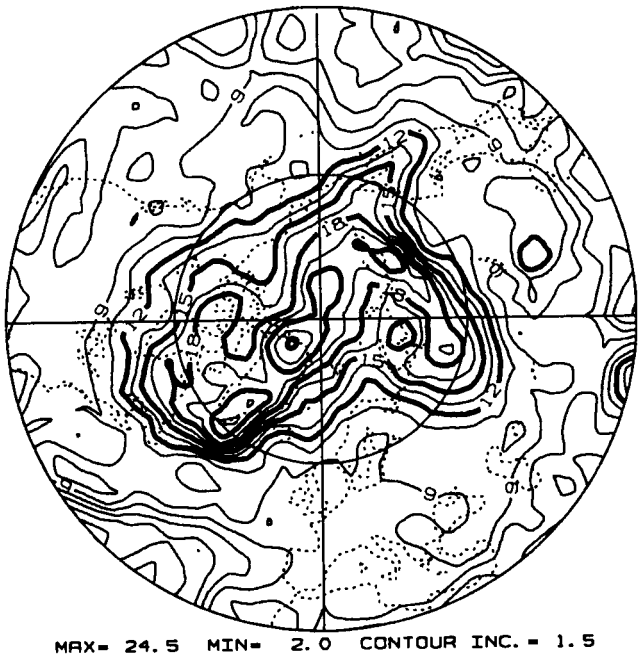
MAX=231.8 MIN=194.9 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890211



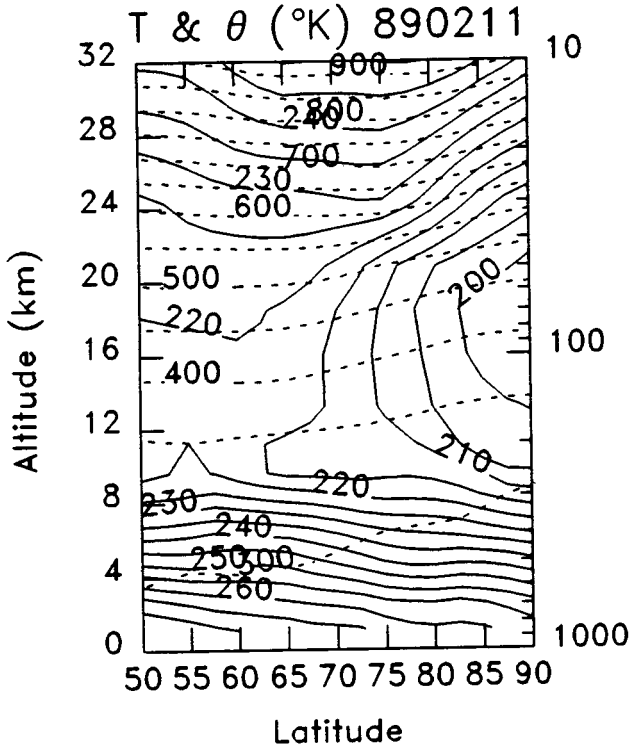
MAX=20786. MIN=18514. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890211

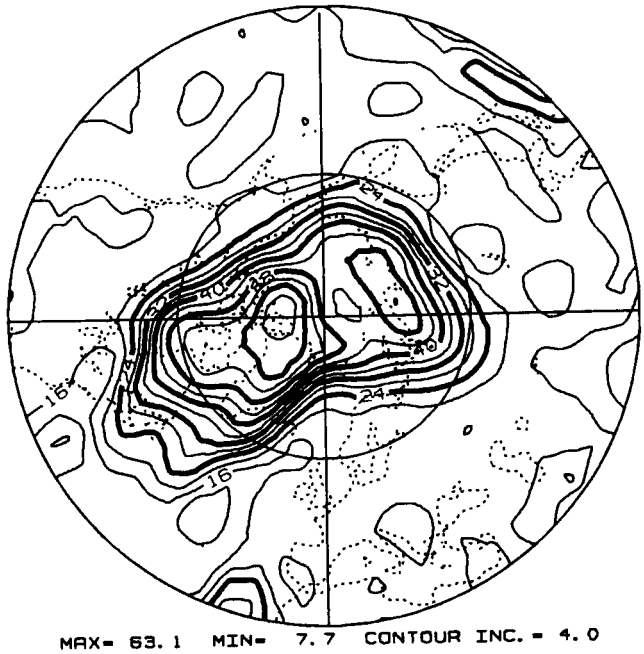


MAX= 24.5 MIN= 2.0 CONTOUR INC. = 1.5

T & θ (°K) 890211

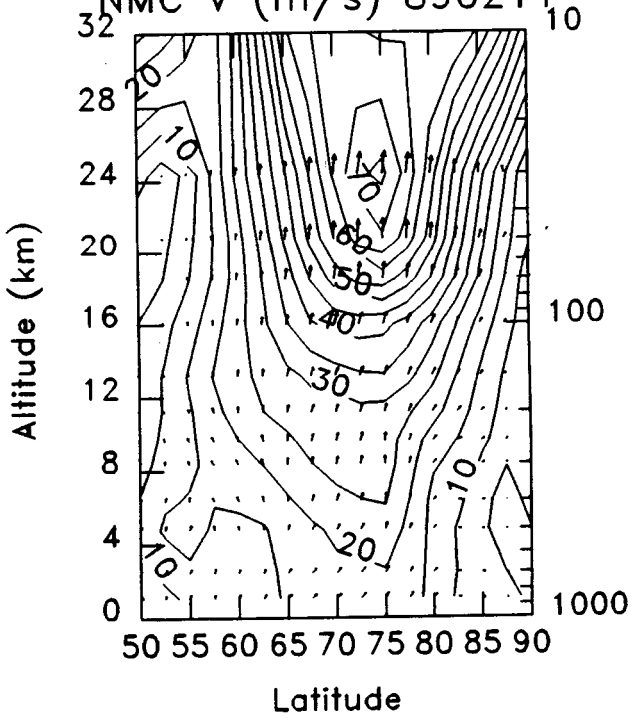


NMC 460K EPV (10^-6) 890211

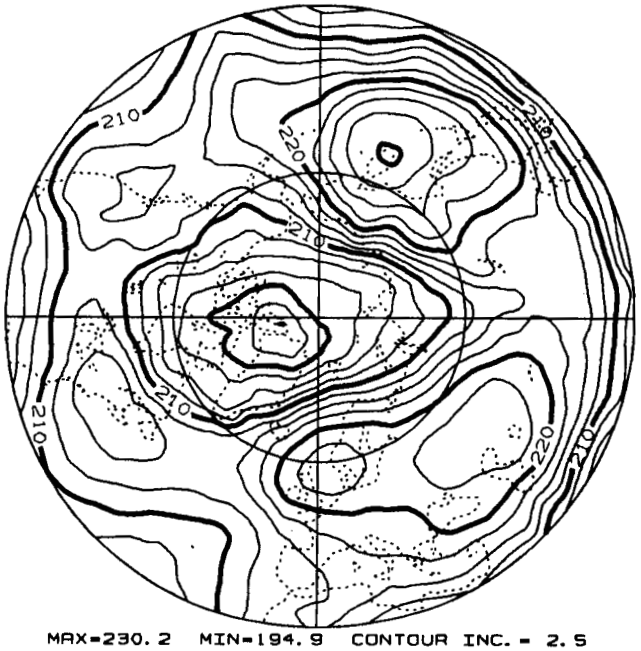


MAX= 63.1 MIN= 7.7 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890211

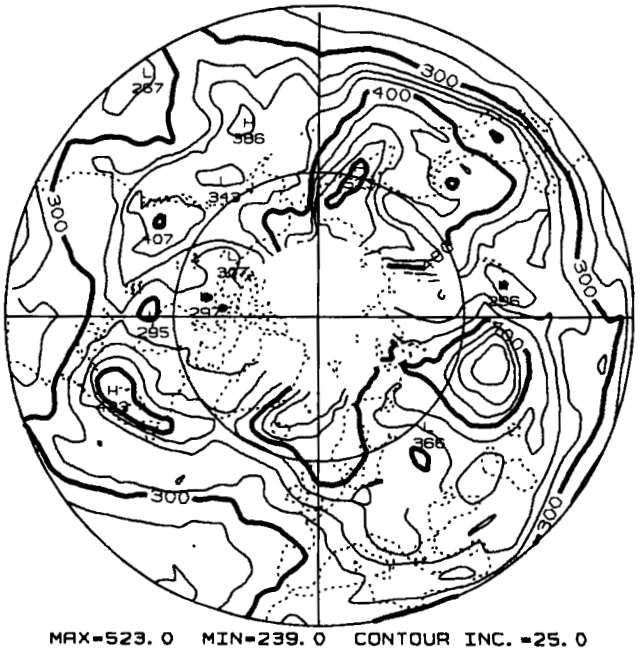


NMC 100MB TEMP. (K) 890212



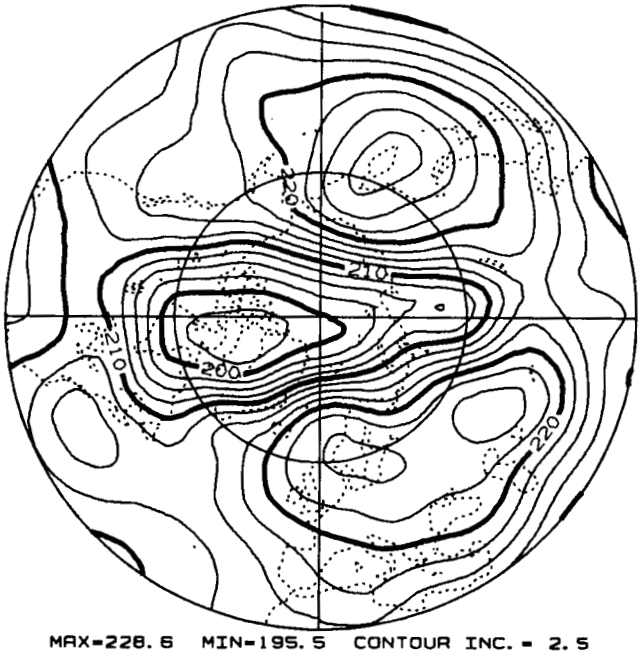
MAX=230.2 MIN=194.9 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890212



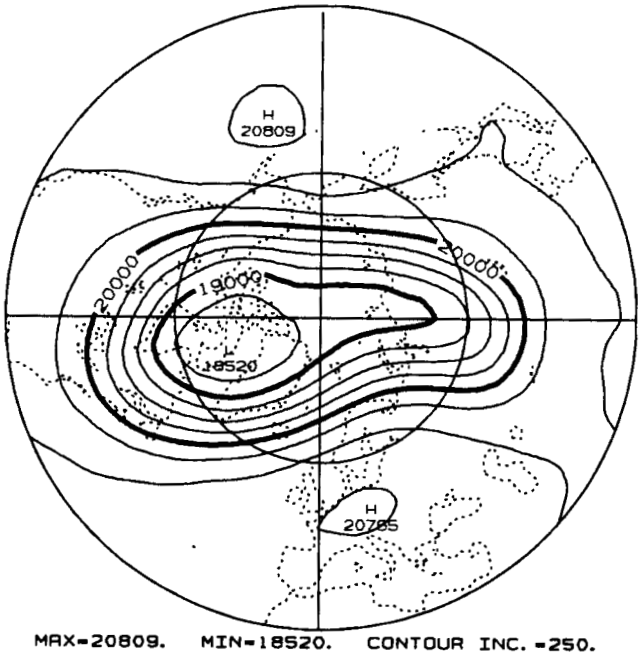
MAX=523.0 MIN=239.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890212



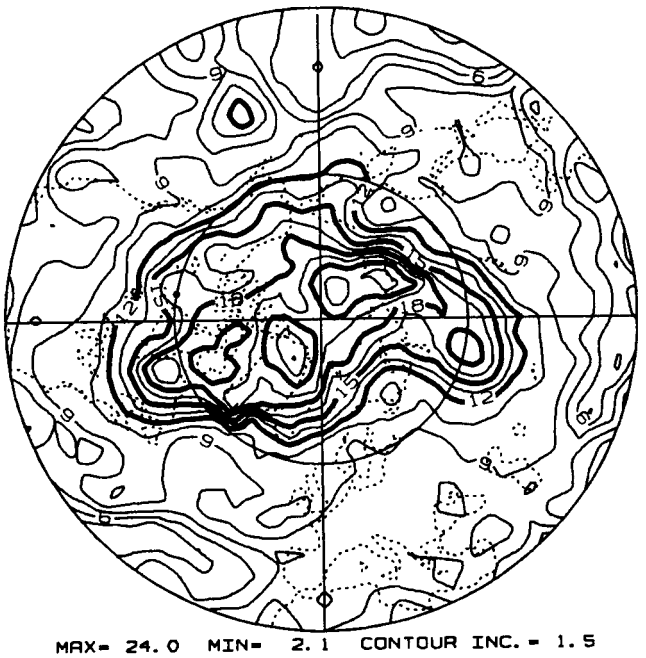
MAX=228.6 MIN=195.5 CONTOUR INC.= 2.5

NMC 50MB GEOP HGT (M) 890212



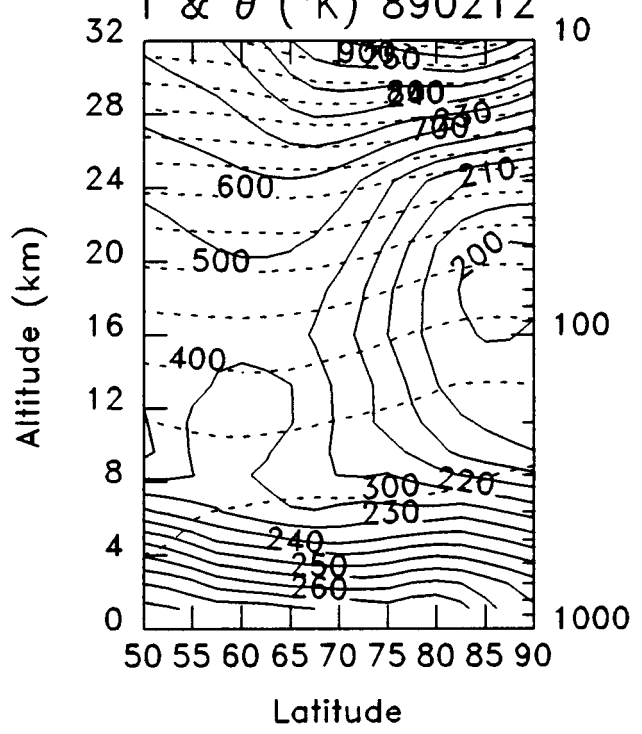
MAX=20809. MIN=18520. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890212

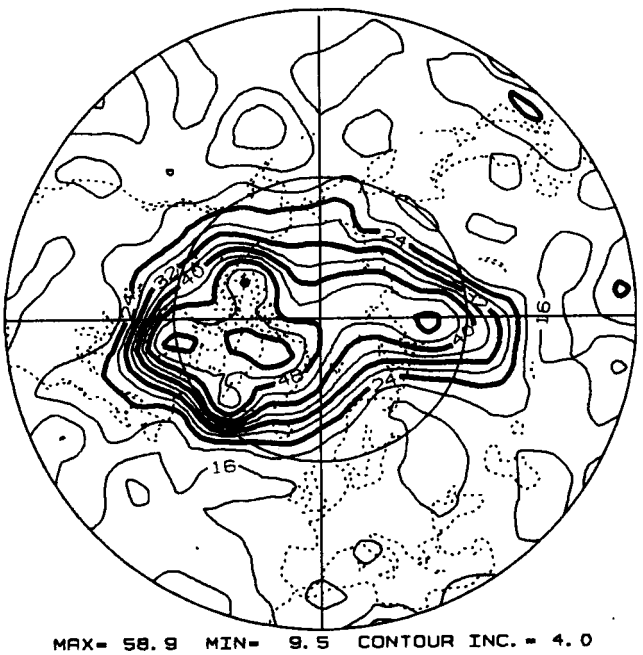


MAX= 24.0 MIN= 2.1 CONTOUR INC. = 1.5

T & θ (°K) 890212

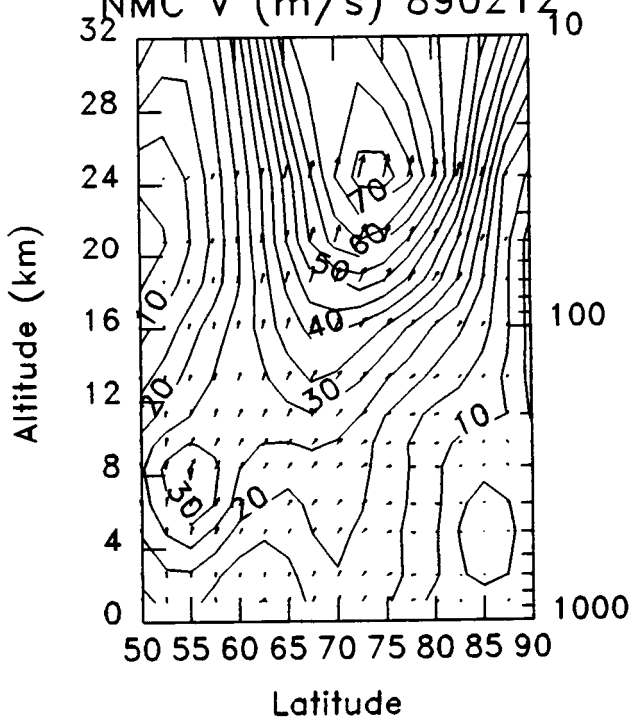


NMC 460K EPV (10^-6) 890212

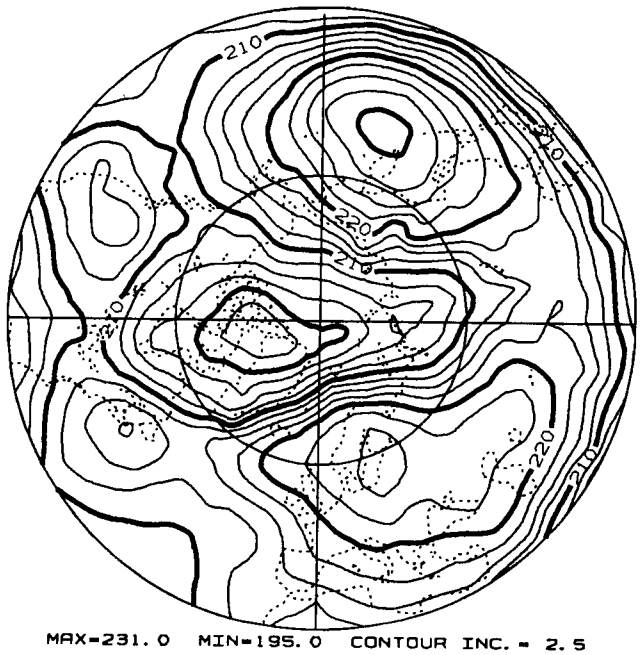


MAX= 58.9 MIN= 9.5 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890212

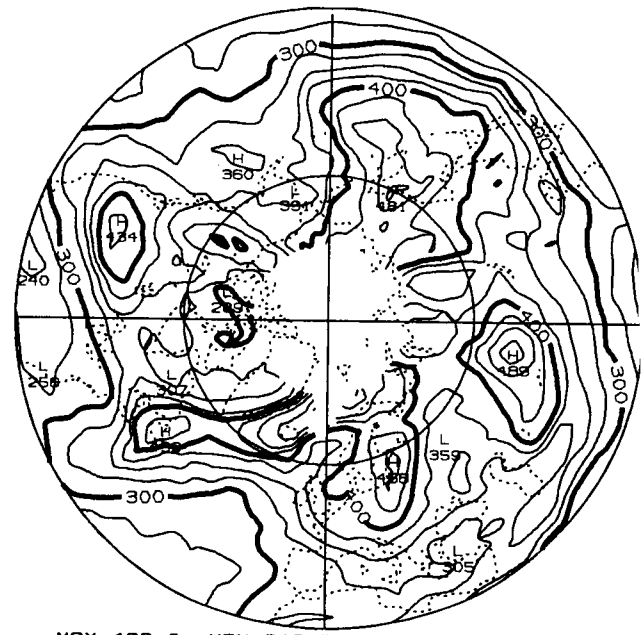


NMC 100MB TEMP. (K) 890213



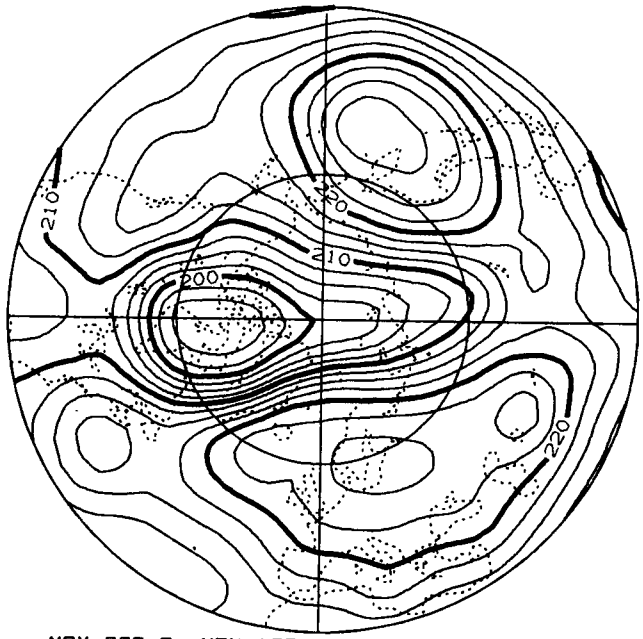
MAX=231.0 MIN=195.0 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890213



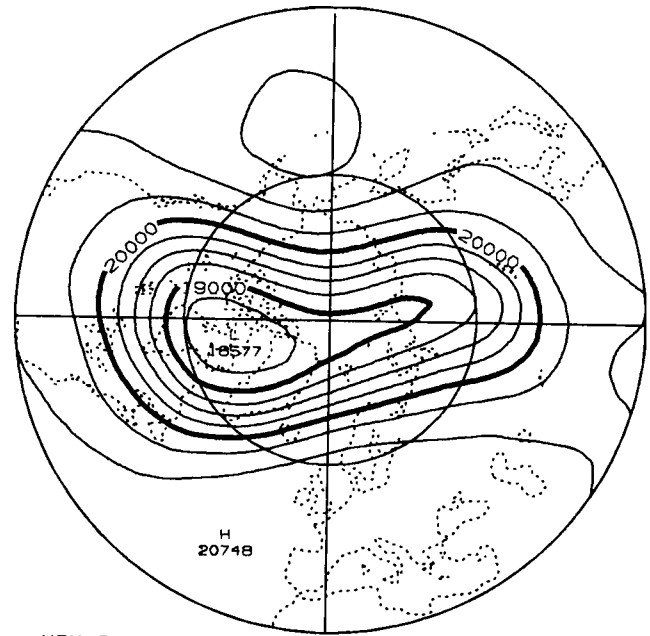
MAX=493.0 MIN=240.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890213



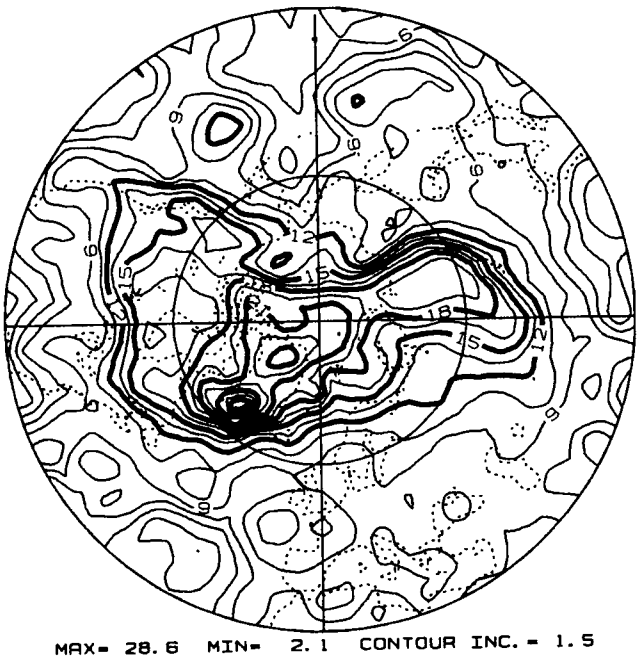
MAX=229.6 MIN=193.1 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890213

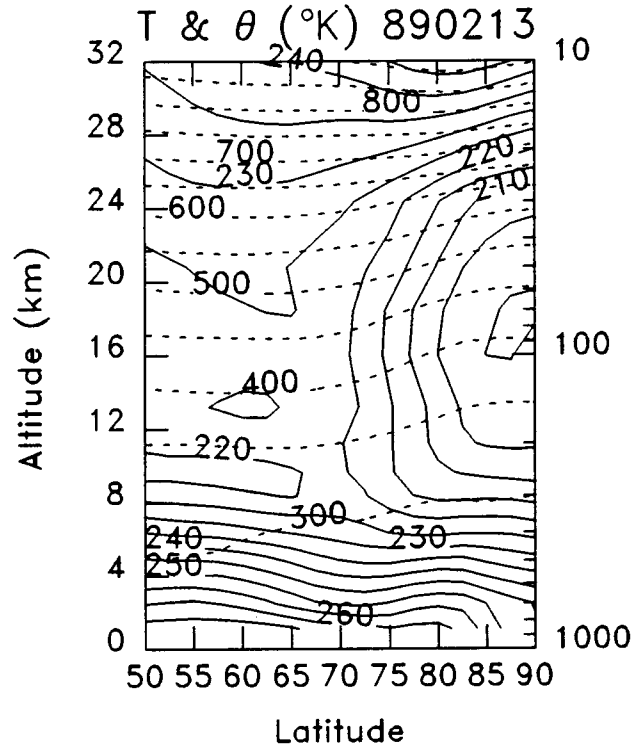


MAX=20826. MIN=18577. CONTOUR INC. =250.

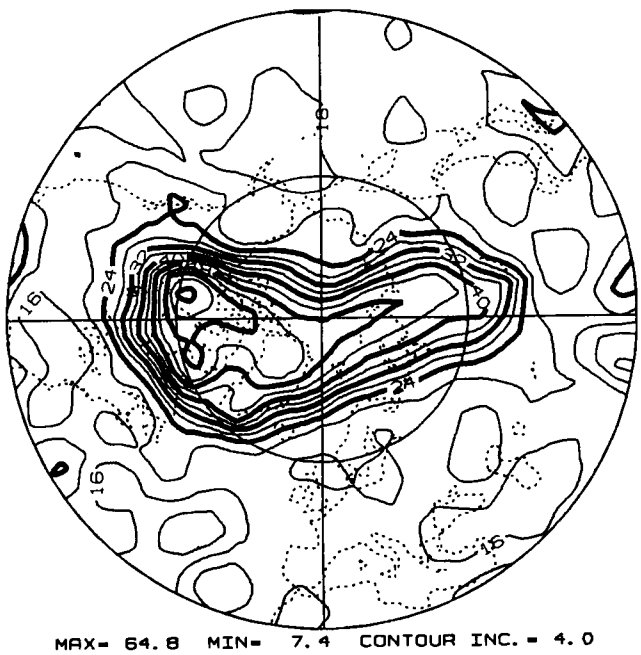
NMC 400K EPV (10^-6) 890213



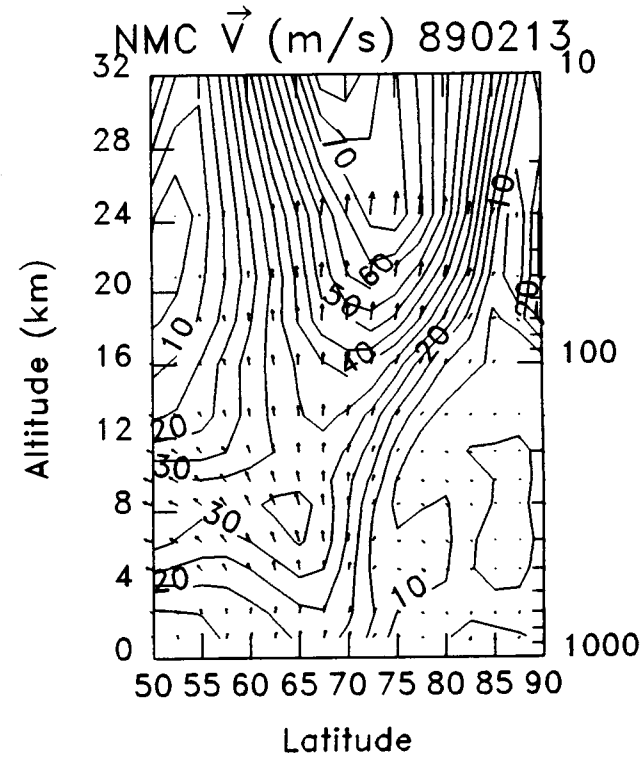
MAX= 28.6 MIN= 2.1 CONTOUR INC. = 1.5



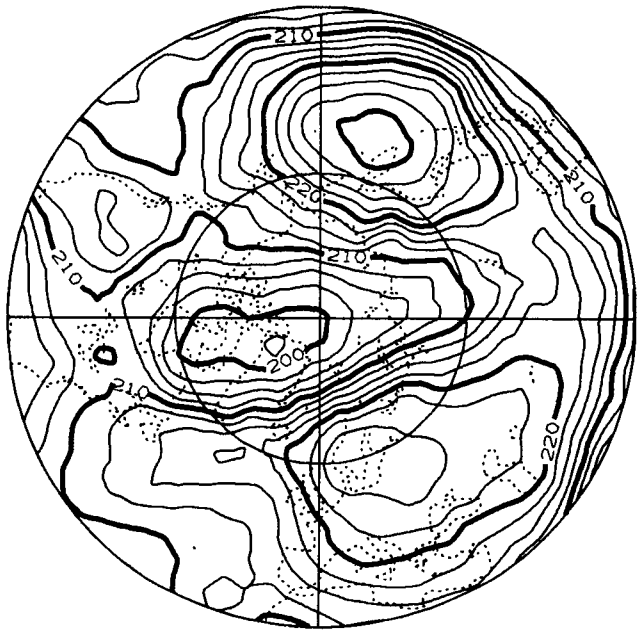
NMC 460K EPV (10^-6) 890213



MAX= 64.8 MIN= 7.4 CONTOUR INC. = 4.0

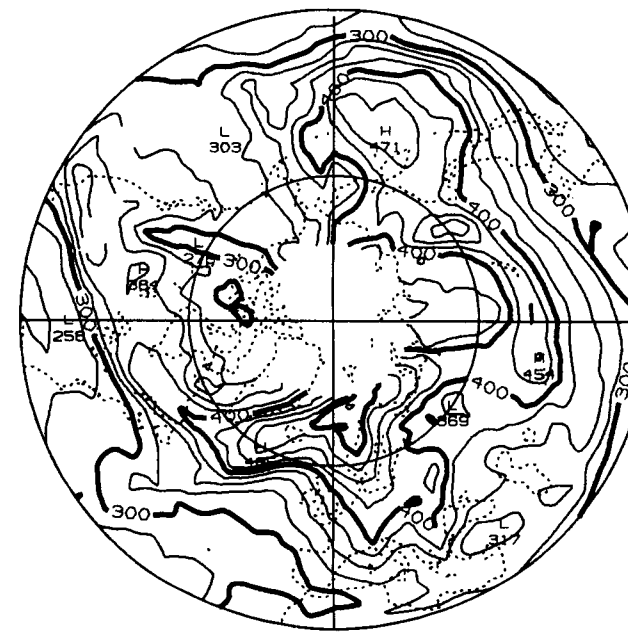


NMC 100MB TEMP. (K) 890214



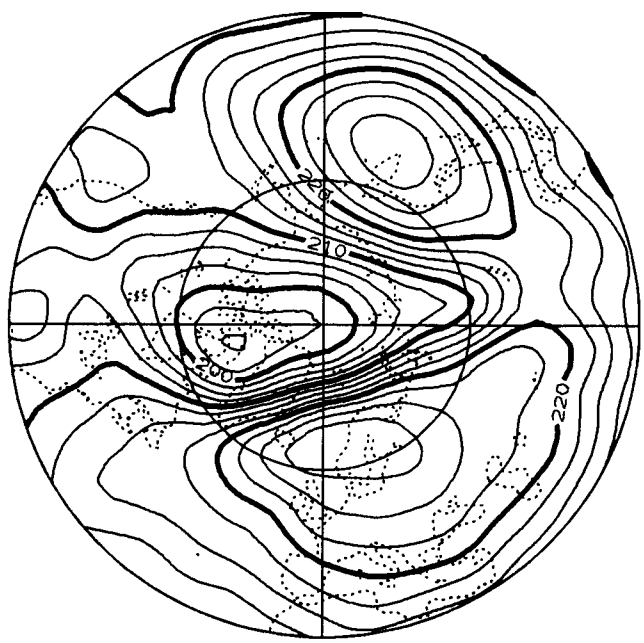
MAX=231.6 MIN=197.2 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890214



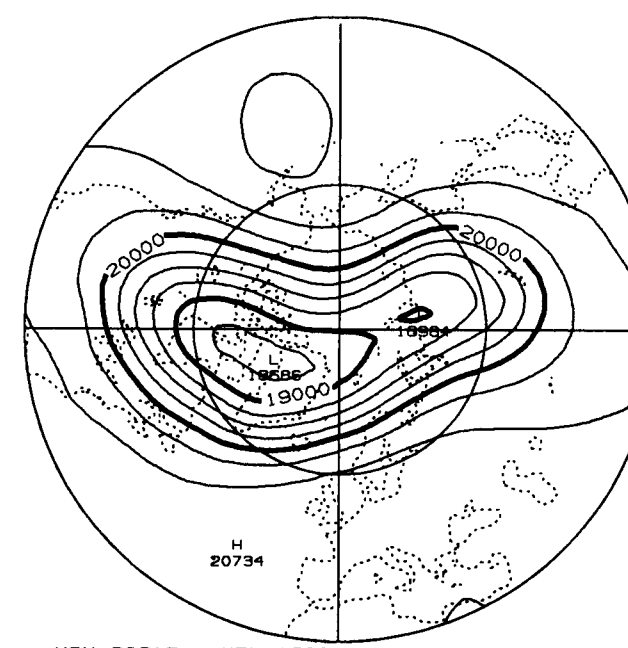
MAX=531.0 MIN=247.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890214



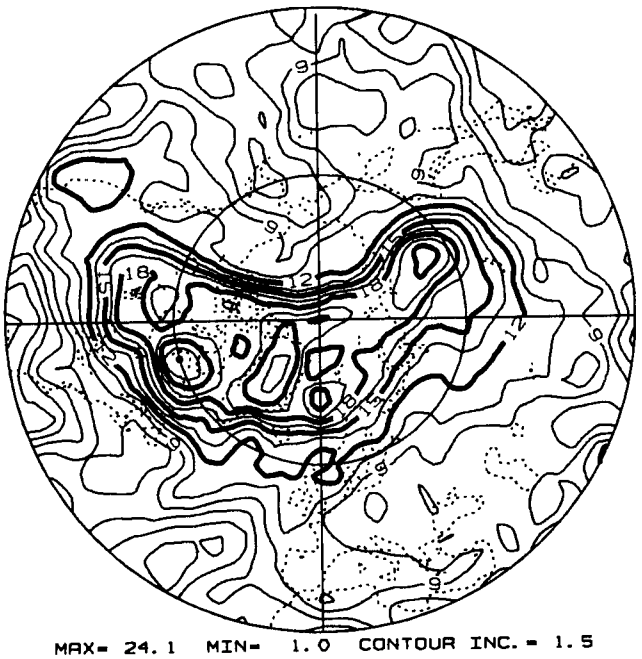
MAX=229.8 MIN=194.7 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890214

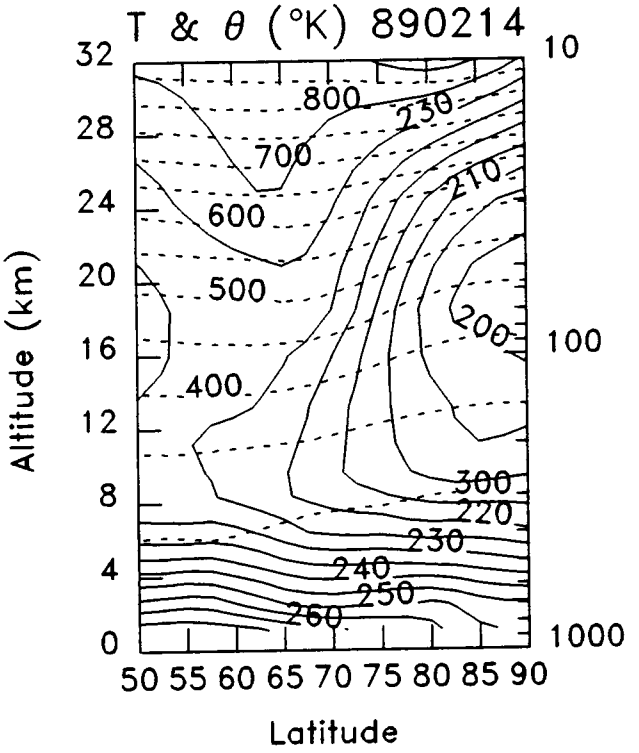


MAX=20815. MIN=18686. CONTOUR INC. =250.

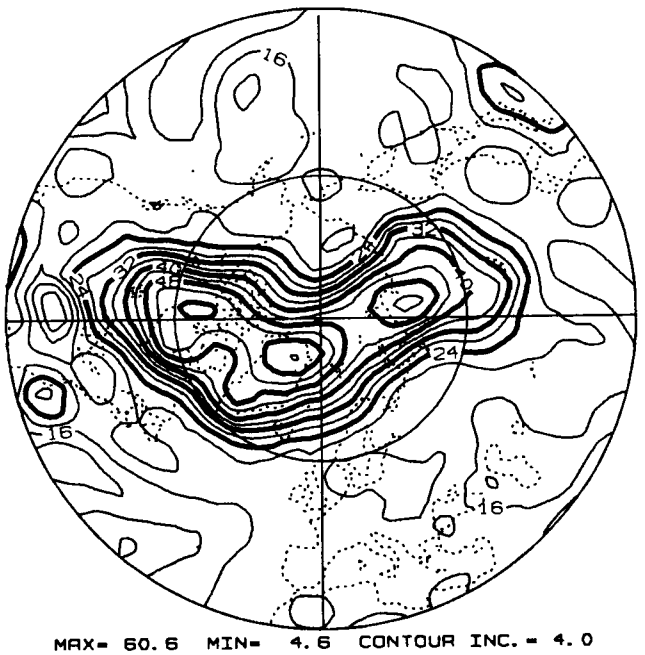
NMC 400K EPV (10^-6) 890214



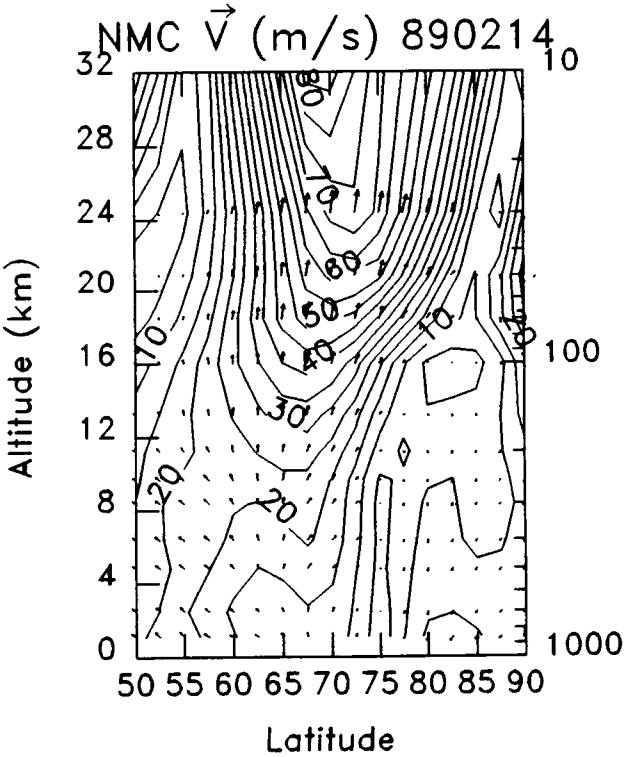
MAX= 24.1 MIN= 1.0 CONTOUR INC.= 1.5



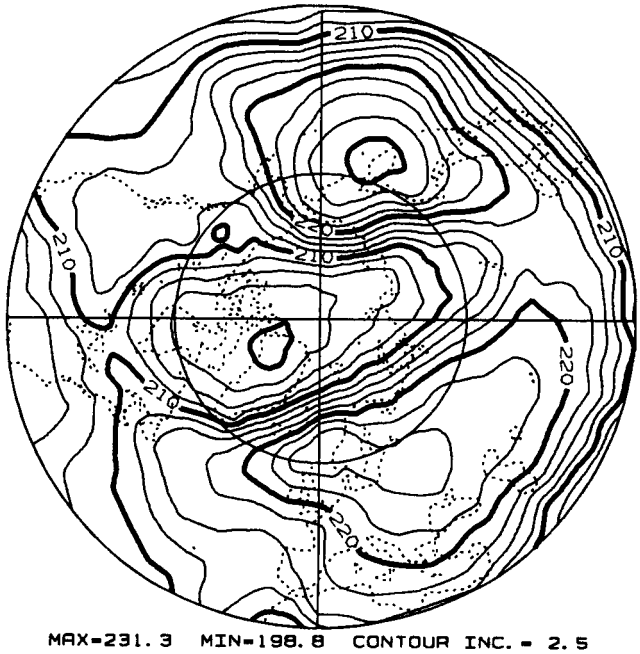
NMC 460K EPV (10^-6) 890214



MAX= 60.6 MIN= 4.6 CONTOUR INC.= 4.0

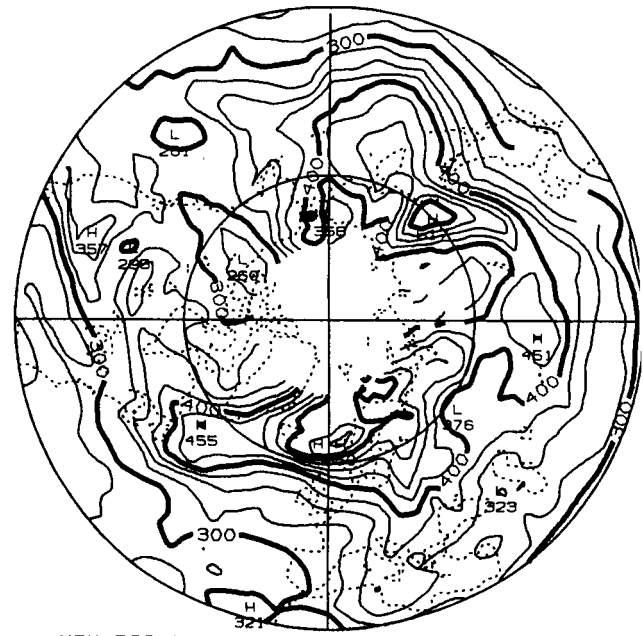


NMC 100MB TEMP. (K) 890215



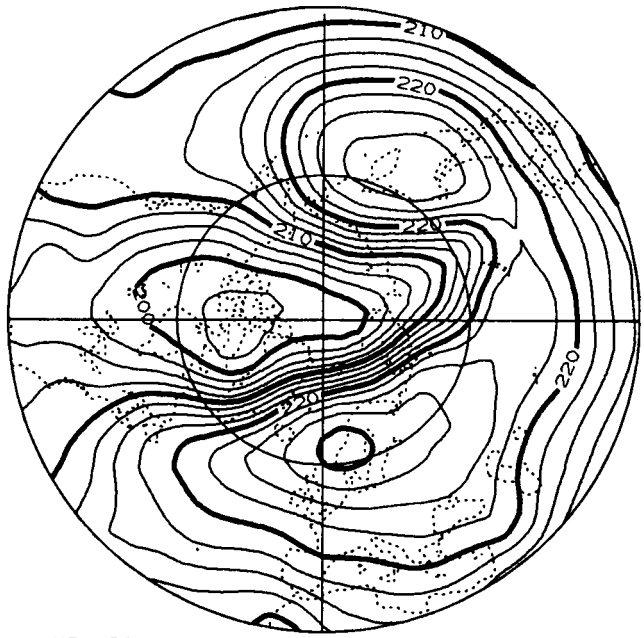
MAX=231.3 MIN=198.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890215



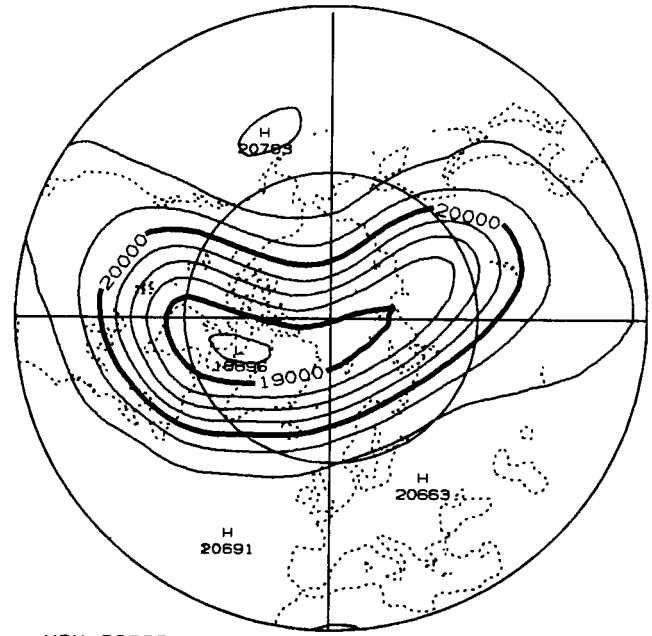
MAX=560.0 MIN=243.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890215



MAX=231.1 MIN=196.2 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890215

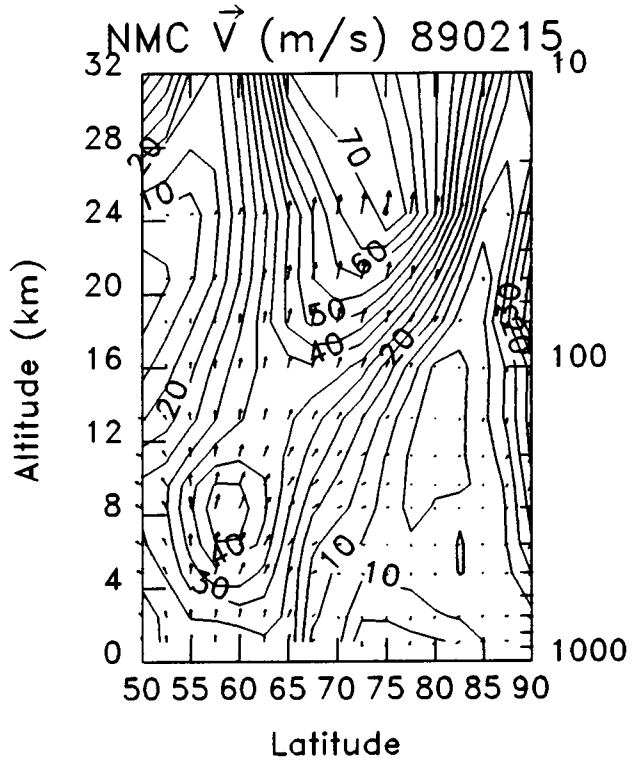


MAX=20763. MIN=18696. CONTOUR INC. =250.

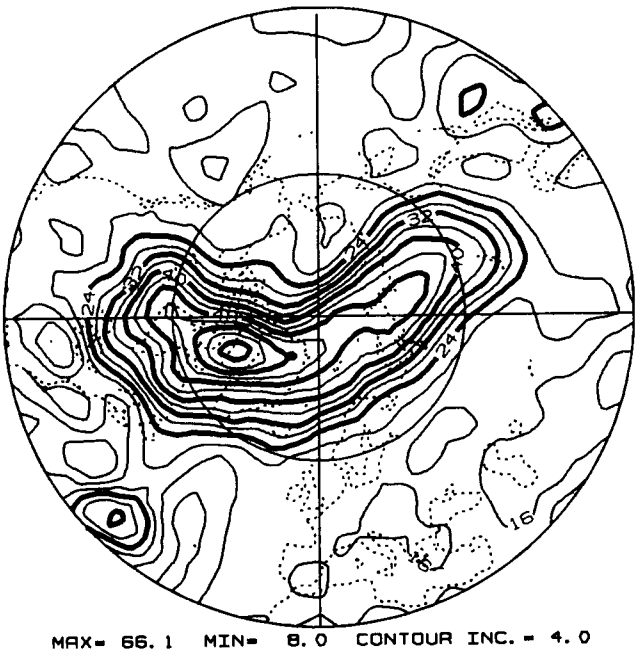
NMC 400K EPV (10^-6) 890215

MAX= 24.6 MIN= 1.1 CONTOUR INC. = 1.5

NMC $\vec{V}$ (m/s) 890215

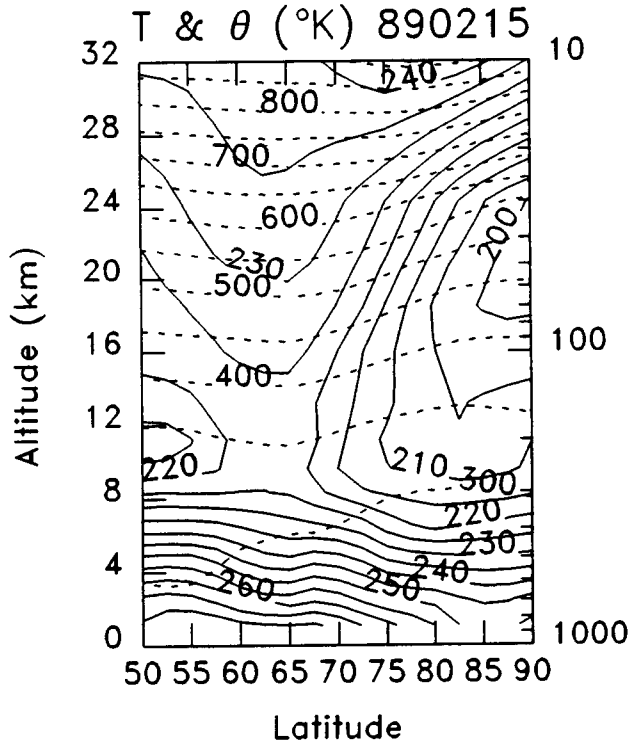


NMC 460K EPV (10^-6) 890215

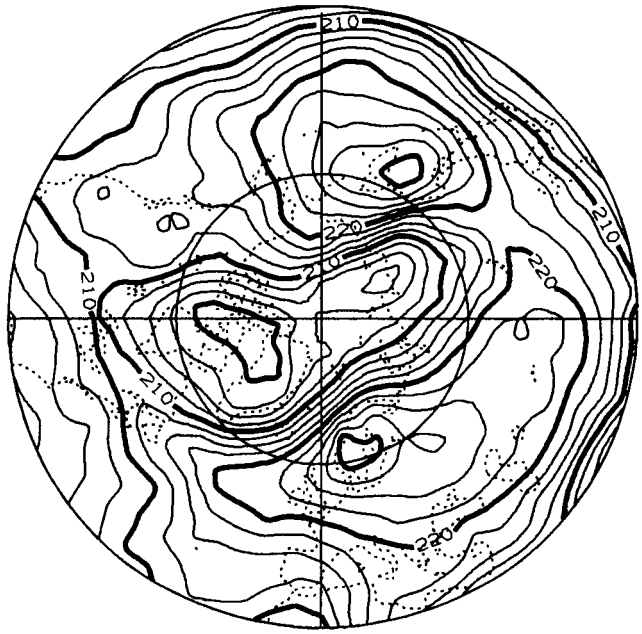


MAX= 66.1 MIN= 8.0 CONTOUR INC. = 4.0

T & θ (°K) 890215

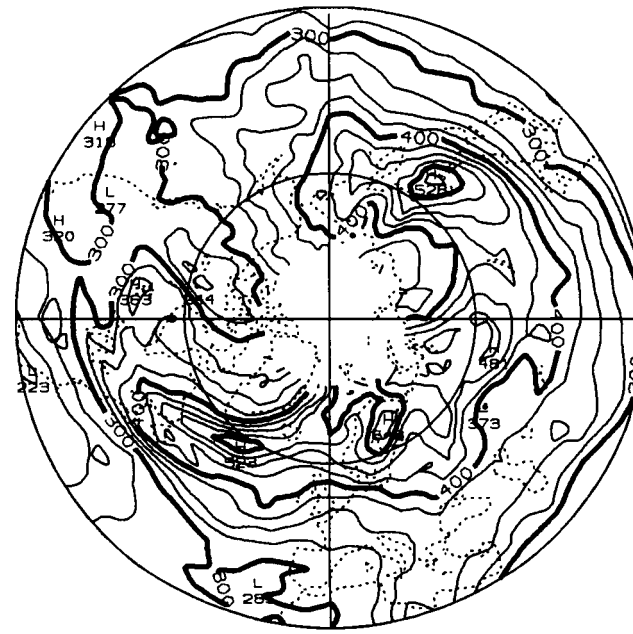


NMC 100MB TEMP. (K) 890216



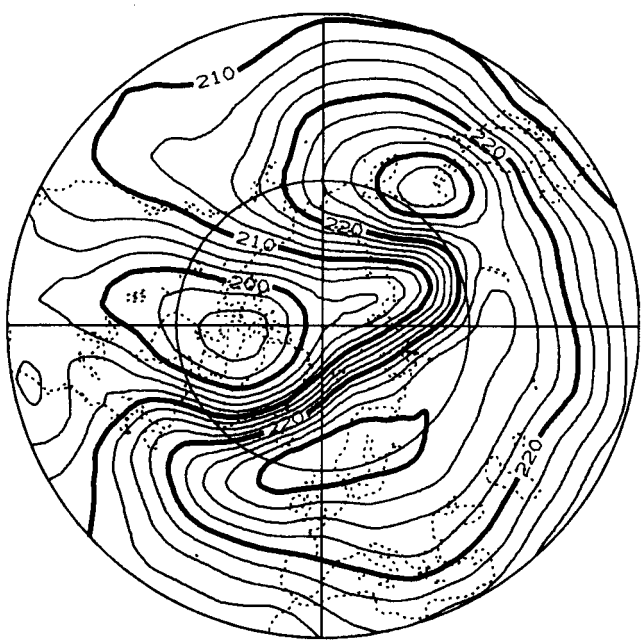
MAX=231.7 MIN=198.6 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890216



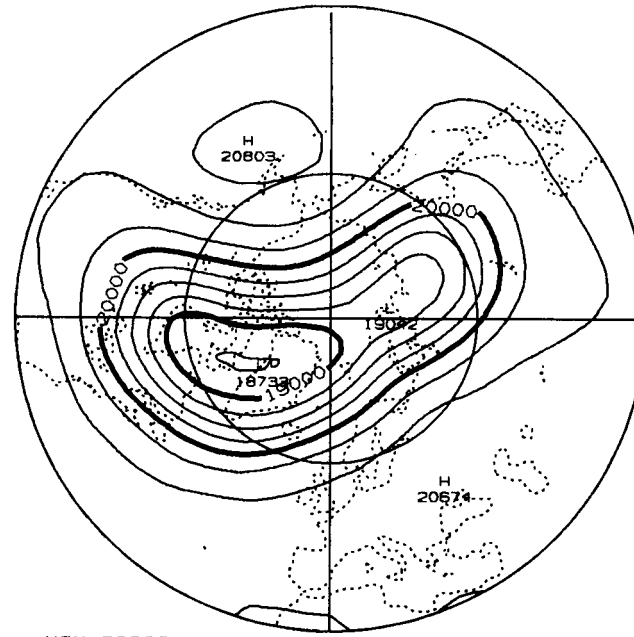
MAX=561.0 MIN=223.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890216



MAX=234.5 MIN=193.6 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890216

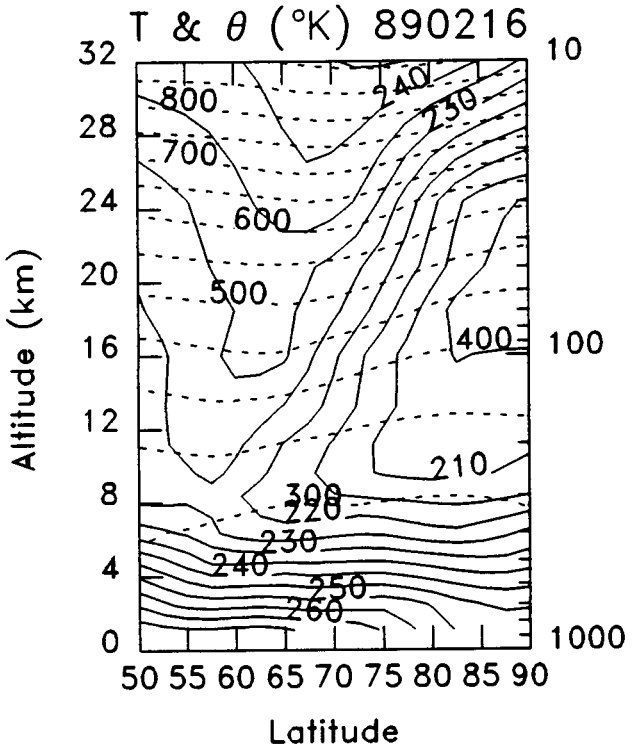


MAX=20803. MIN=18733. CONTOUR INC. =250.

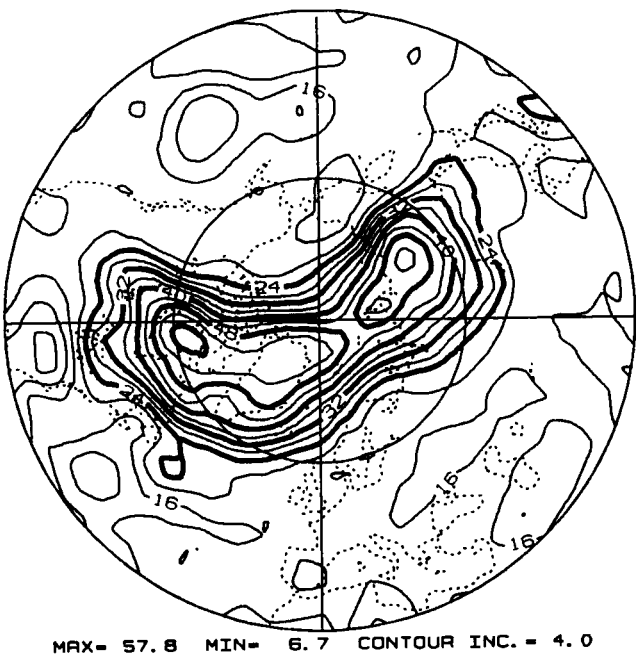
NMC 400K EPV (10^-6) 890216

MAX= 23.0 MIN= 1.3 CONTOUR INC. = 1.5

T & θ (°K) 890216

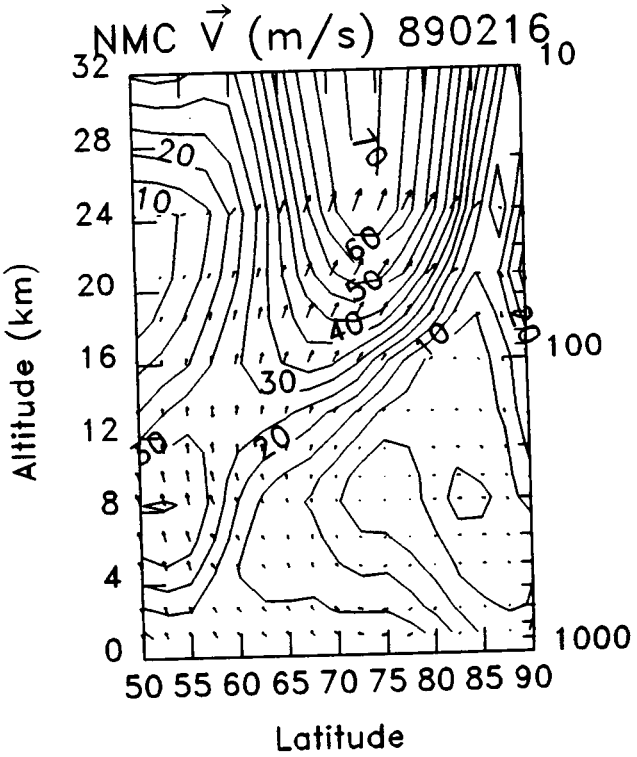


NMC 460K EPV (10^-6) 890216

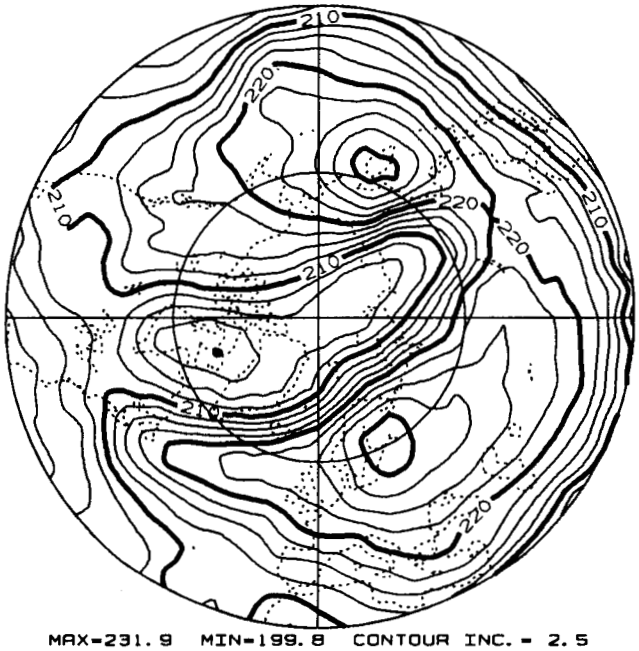


MAX= 57.8 MIN= 6.7 CONTOUR INC. = 4.0

NMC $\vec{V}$ (m/s) 890216

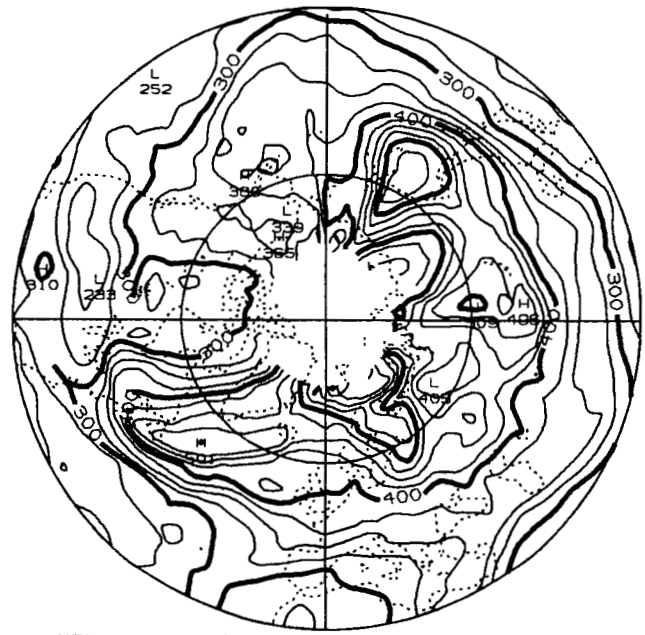


NMC 100MB TEMP. (K) 890217



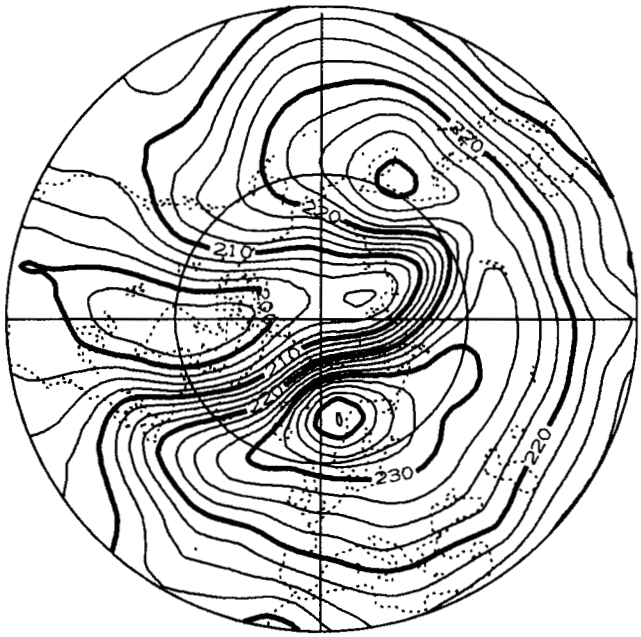
MAX=231.9 MIN=199.8 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890217



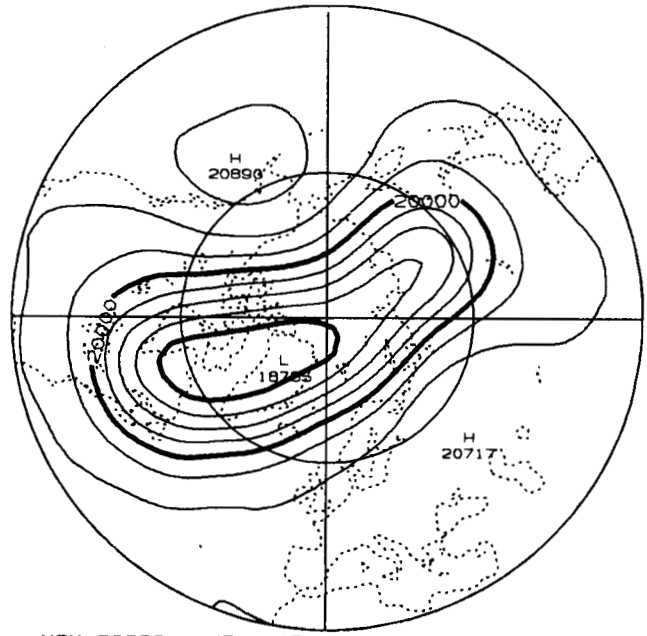
MAX=613.0 MIN=233.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890217

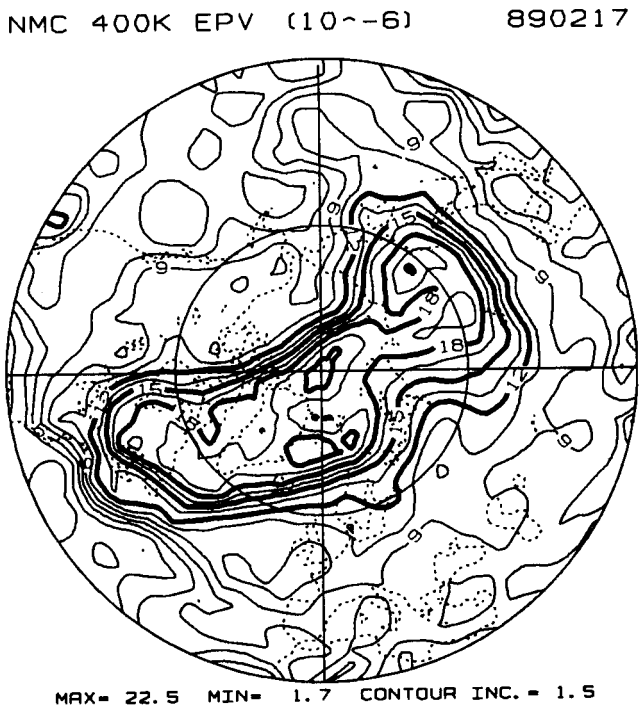


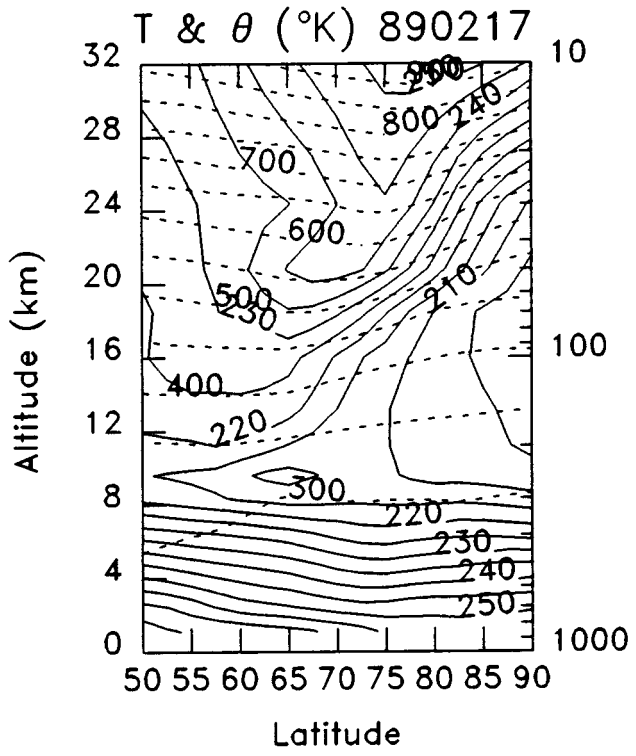
MAX=242.6 MIN=195.5 CONTOUR INC. = 2.5

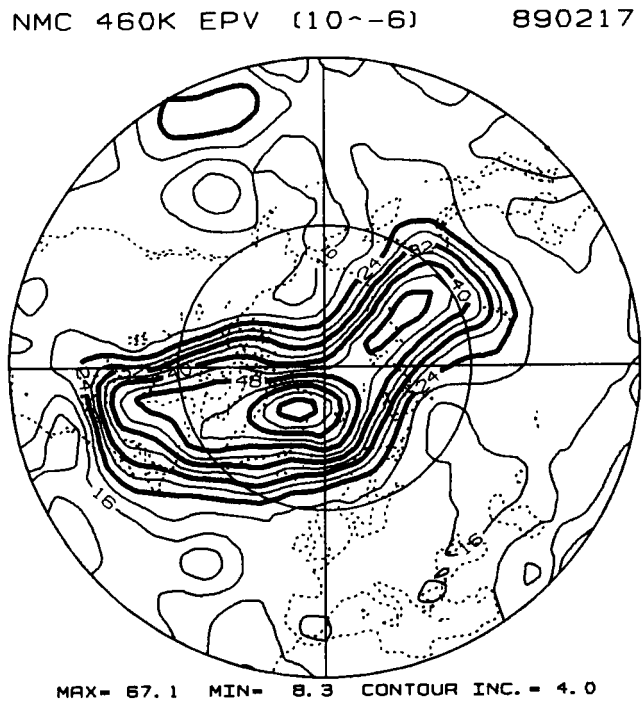
NMC 50MB GEOP HGT (M) 890217

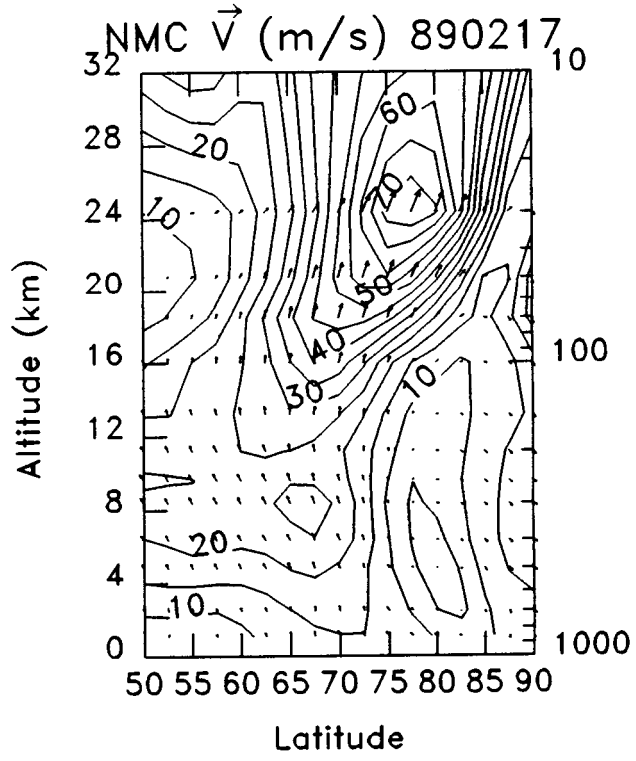


MAX=20890. MIN=18765. CONTOUR INC. =250.

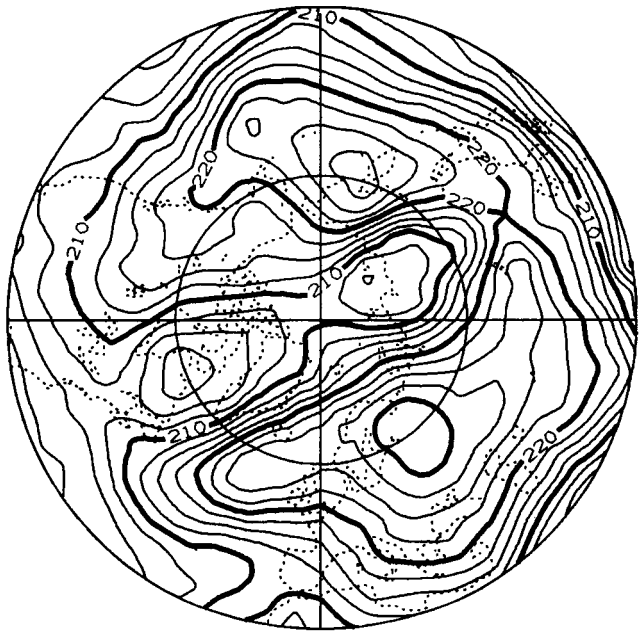

NMC 400K EPV (10^-6) 890217
MAX= 22.5 MIN= 1.7 CONTOUR INC. = 1.5


T & θ (°K) 890217
Altitude (km)
Latitude
50 55 60 65 70 75 80 85 90
0 4 8 12 16 20 24 28 32
10 100 1000
700
600
500
400
300
220
230
240
250
210


NMC 460K EPV (10^-6) 890217
MAX= 67.1 MIN= 8.3 CONTOUR INC. = 4.0

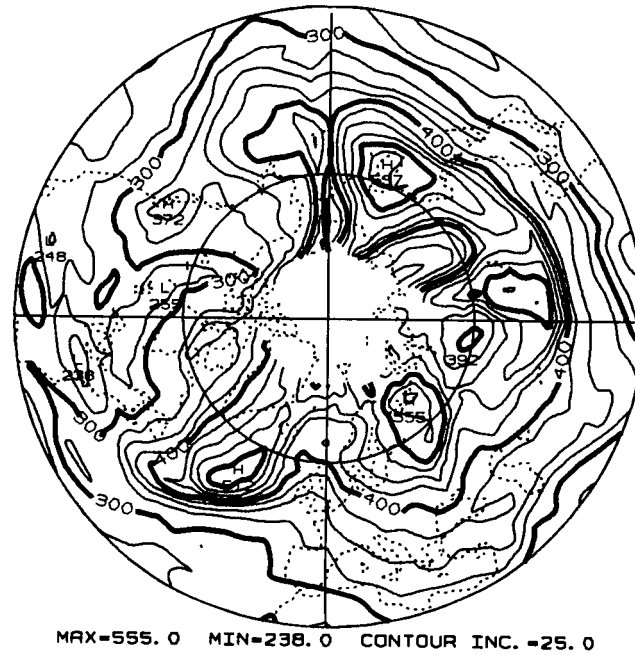

NMC V (m/s) 890217
Altitude (km)
Latitude
50 55 60 65 70 75 80 85 90
0 4 8 12 16 20 24 28 32
10 100 1000
60
20
10
70
50
40
30
10
20
10

NMC 100MB TEMP. (K) 890218



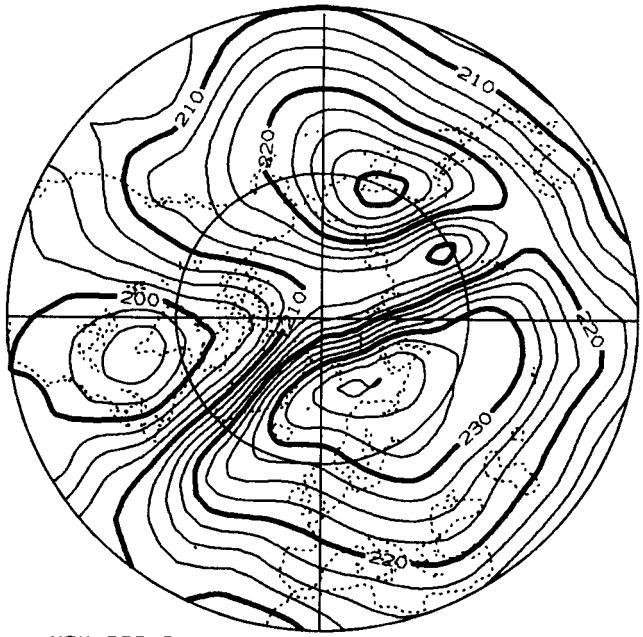
MAX=232.2 MIN=199.9 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890218



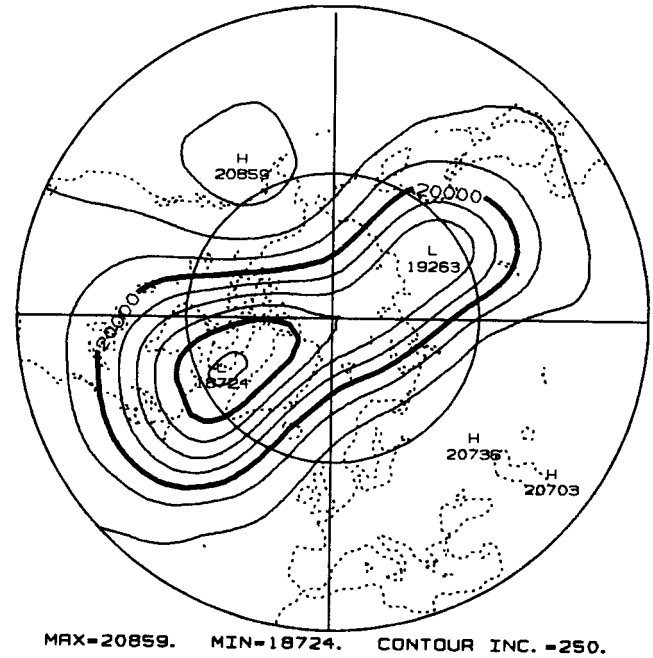
MAX=555.0 MIN=238.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890218



MAX=238.2 MIN=193.4 CONTOUR INC.= 2.5

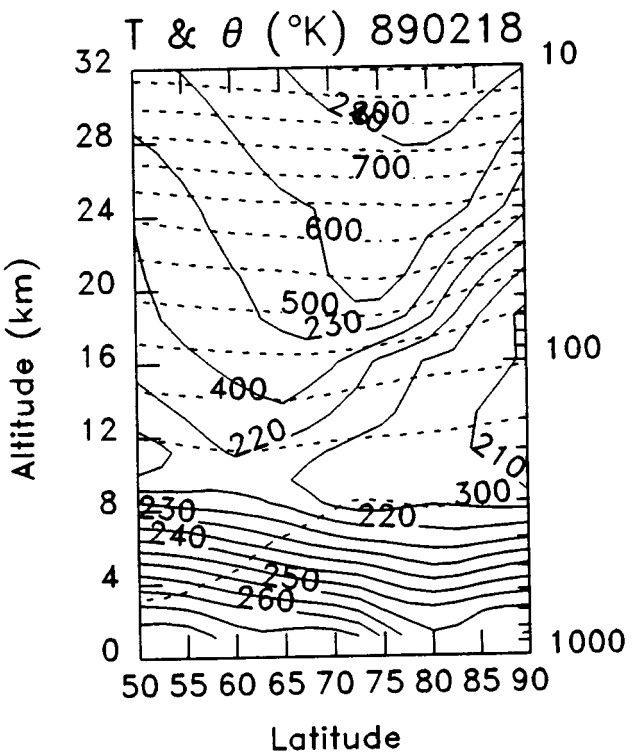
NMC 50MB GEOP HGT (M) 890218



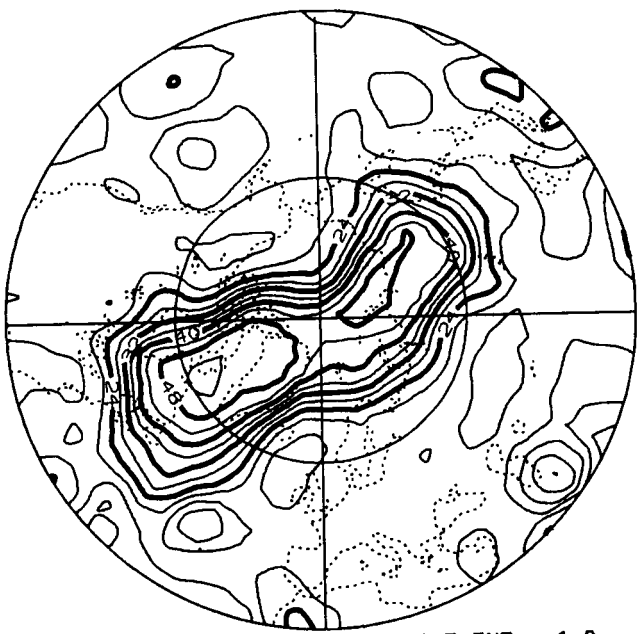
MAX=20859. MIN=18724. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890218

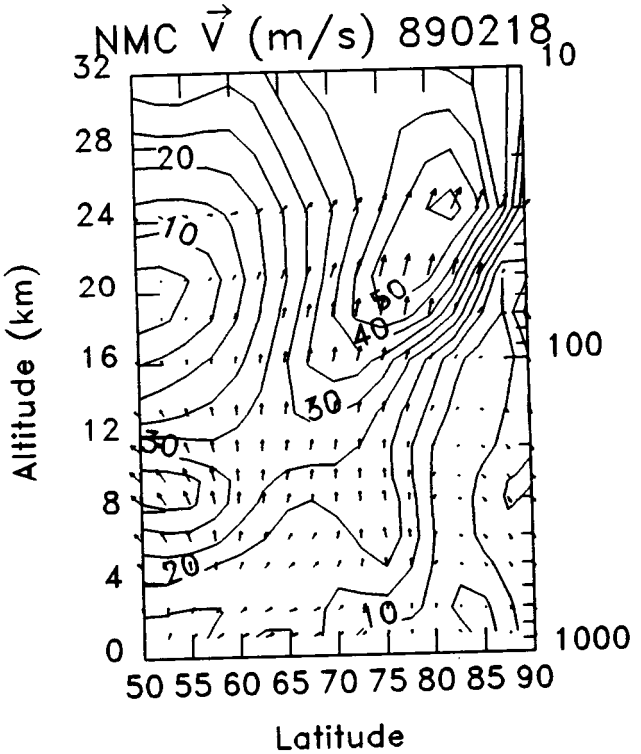
MAX= 24.8 MIN= 2.8 CONTOUR INC. = 1.5



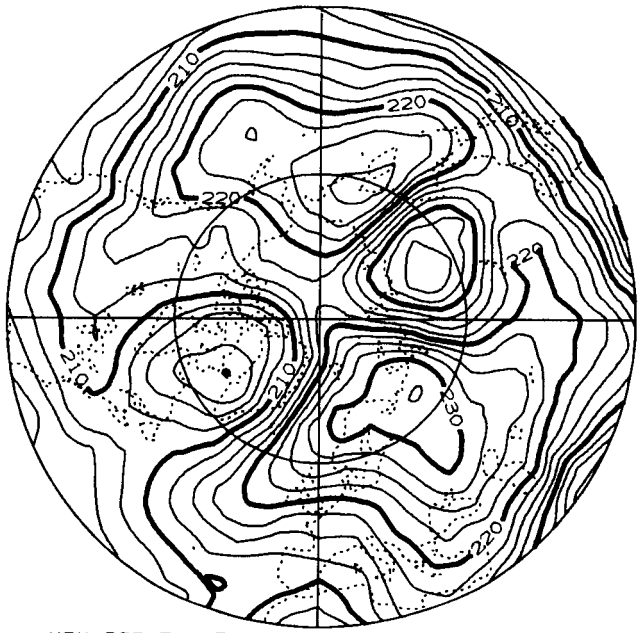
NMC 460K EPV (10^-6) 890218



MAX= 53.2 MIN= 3.8 CONTOUR INC. = 4.0

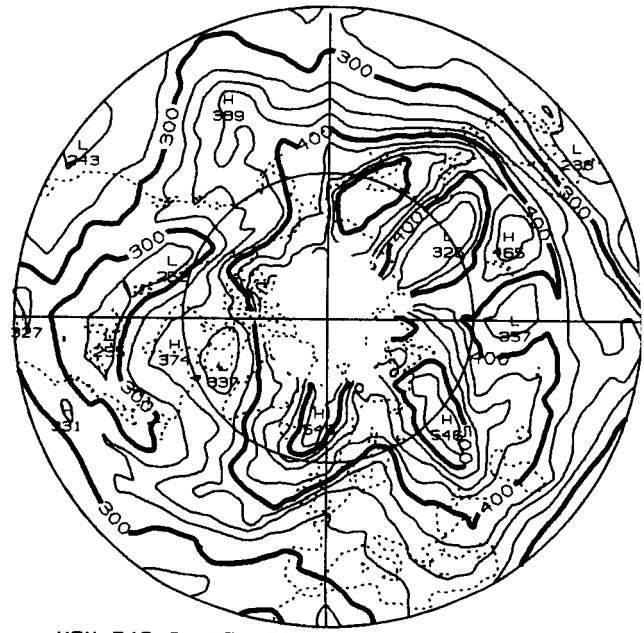


NMC 100MB TEMP. (K) 890219



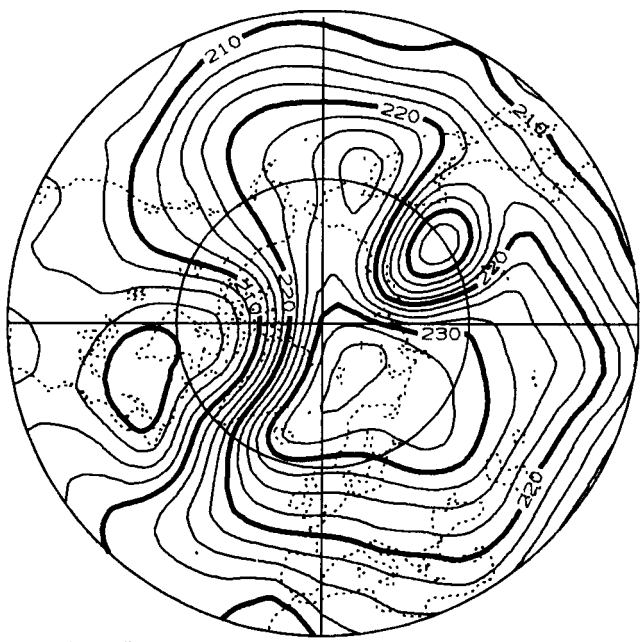
MAX=232.7 MIN=199.0 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890219



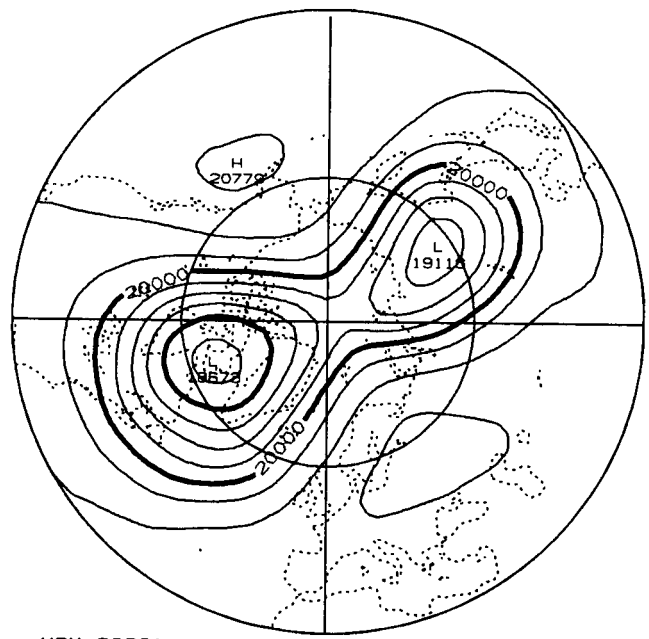
MAX=549.0 MIN=237.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890219

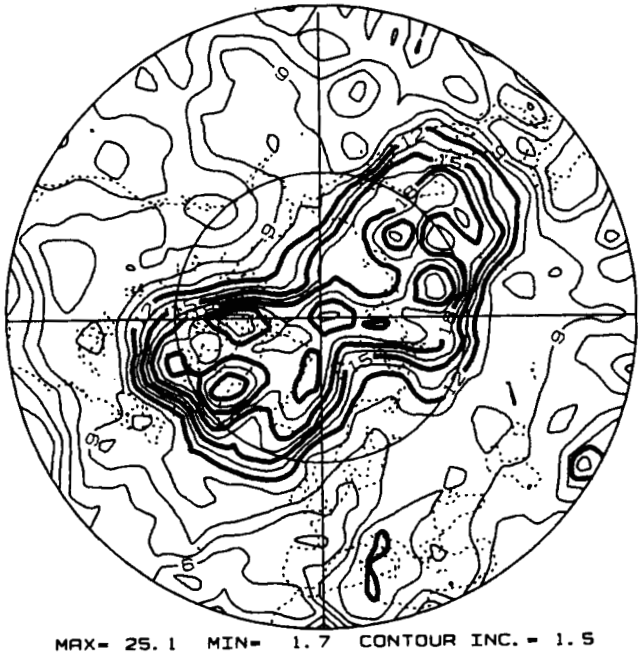


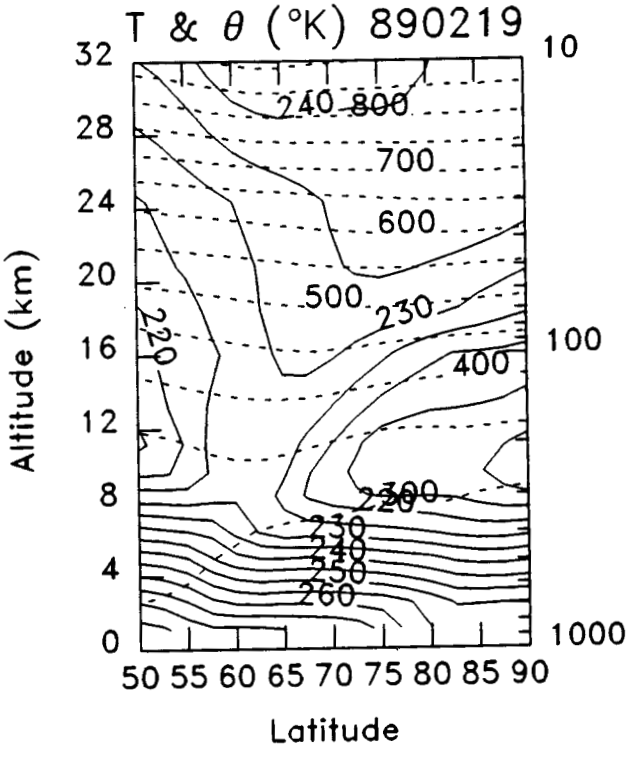
MAX=235.9 MIN=197.6 CONTOUR INC. = 2.5

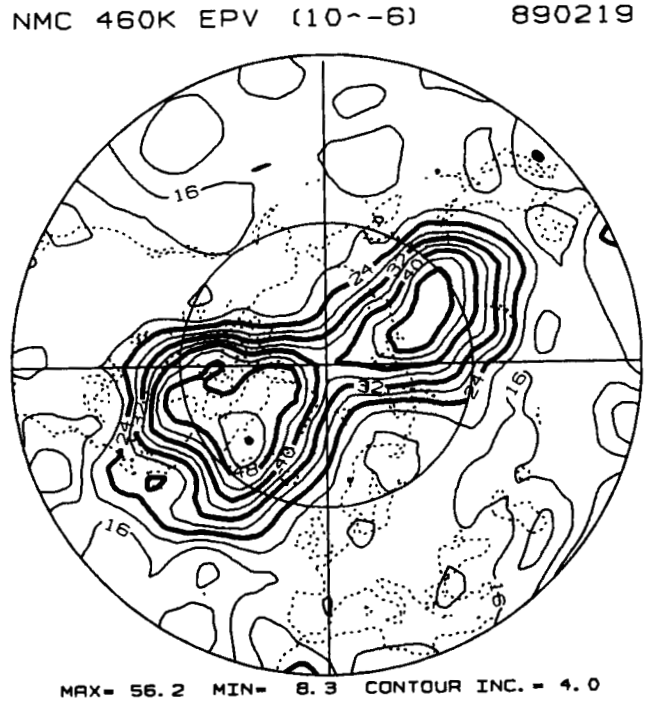
NMC 50MB GEOP HGT (M) 890219

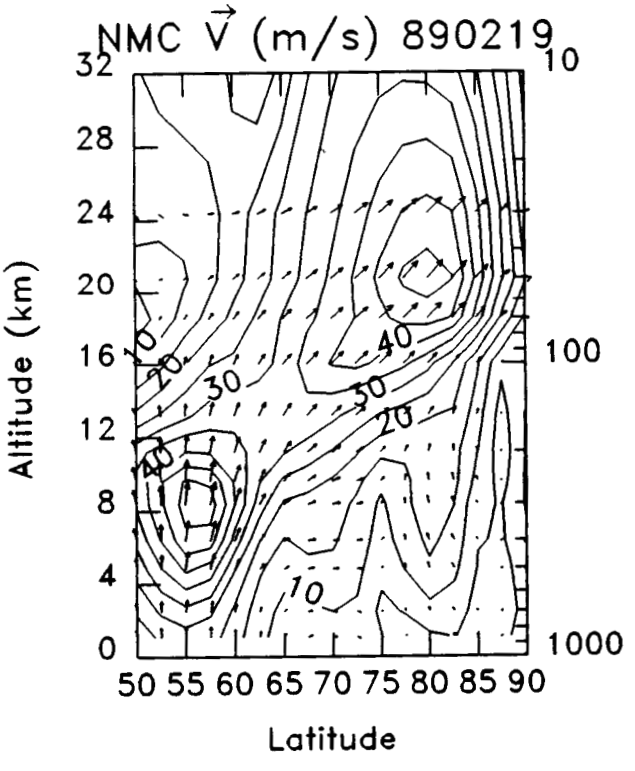


MAX=20801. MIN=18673. CONTOUR INC. =250.

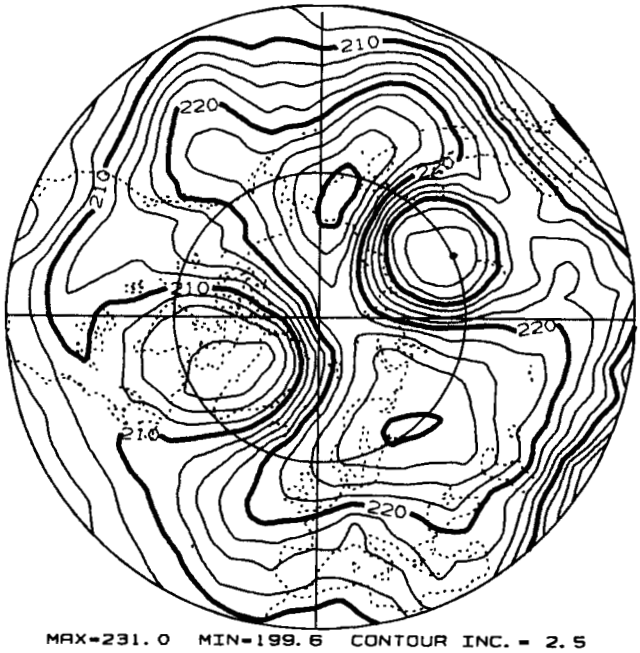

NMC 400K EPV (10^-6) 890219
MAX= 25.1 MIN= 1.7 CONTOUR INC.= 1.5


T & θ (°K) 890219
Altitude (km)
Latitude
240
800
700
600
500
230
400
220
300
230
240
250
260
50 55 60 65 70 75 80 85 90
32
28
24
20
16
12
8
4
0
10
100
1000


NMC 460K EPV (10^-6) 890219
MAX= 56.2 MIN= 8.3 CONTOUR INC.= 4.0

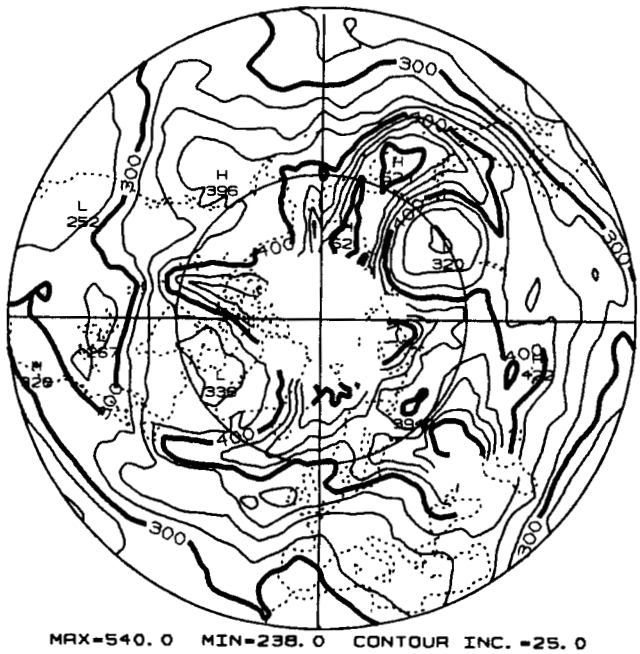

NMC V (m/s) 890219
Altitude (km)
Latitude
10
20
30
40
50
20
40
10
50 55 60 65 70 75 80 85 90
32
28
24
20
16
12
8
4
0
10
100
1000

NMC 100MB TEMP. (K) 890220



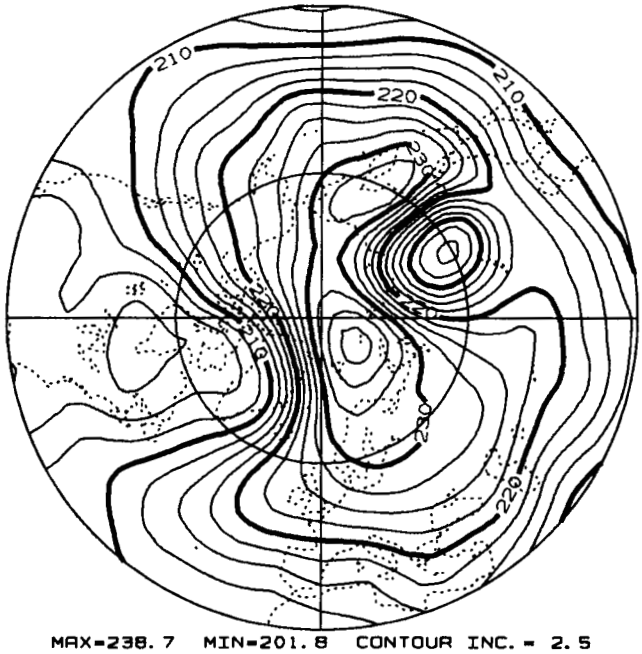
MAX=231.0 MIN=199.6 CONTOUR INC.= 2.5

TOMS TOTAL OZONE (DU) 890220



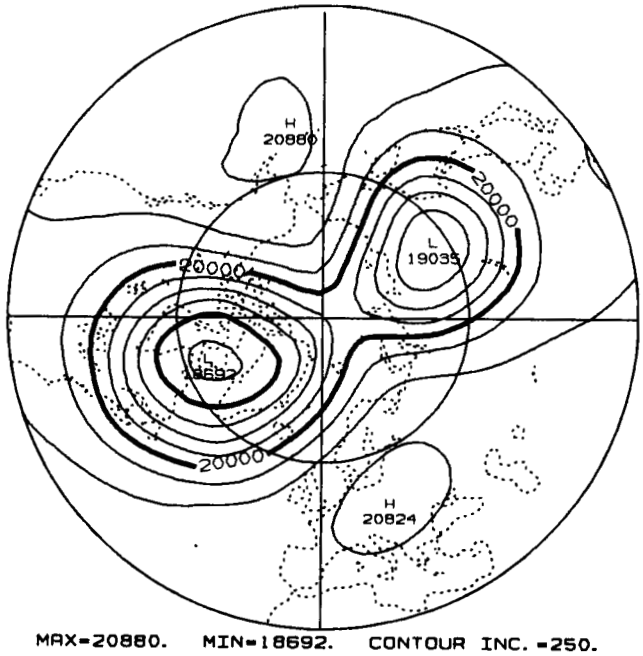
MAX=540.0 MIN=238.0 CONTOUR INC.=25.0

NMC 50MB TEMP. (K) 890220



MAX=238.7 MIN=201.8 CONTOUR INC.= 2.5

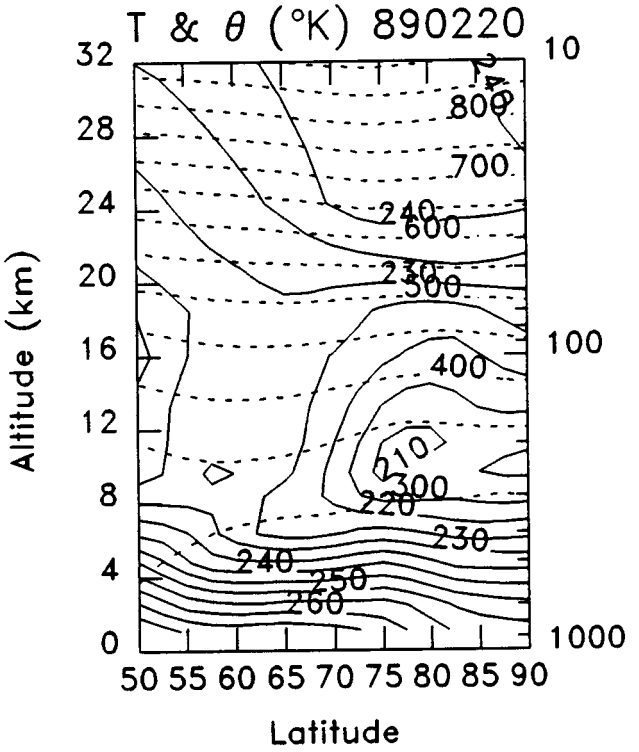
NMC 50MB GEOP HGT (M) 890220



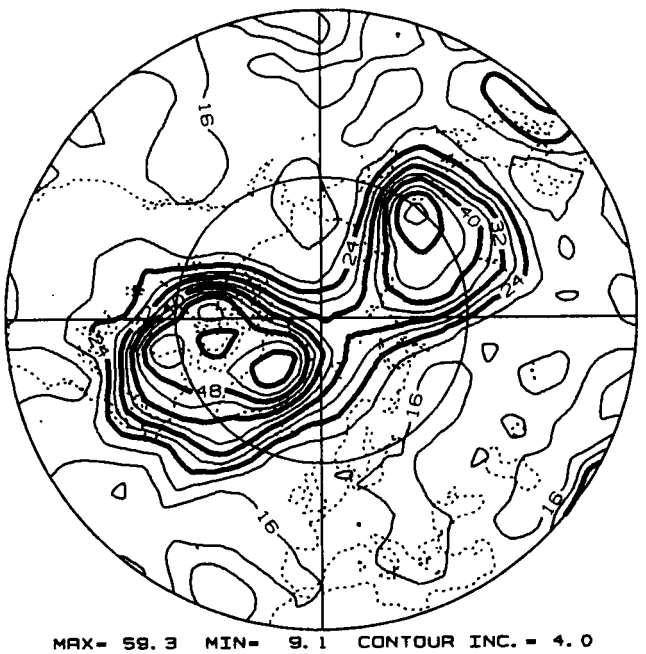
MAX=20880. MIN=18692. CONTOUR INC.=250.

NMC 400K EPV (10^-6) 890220

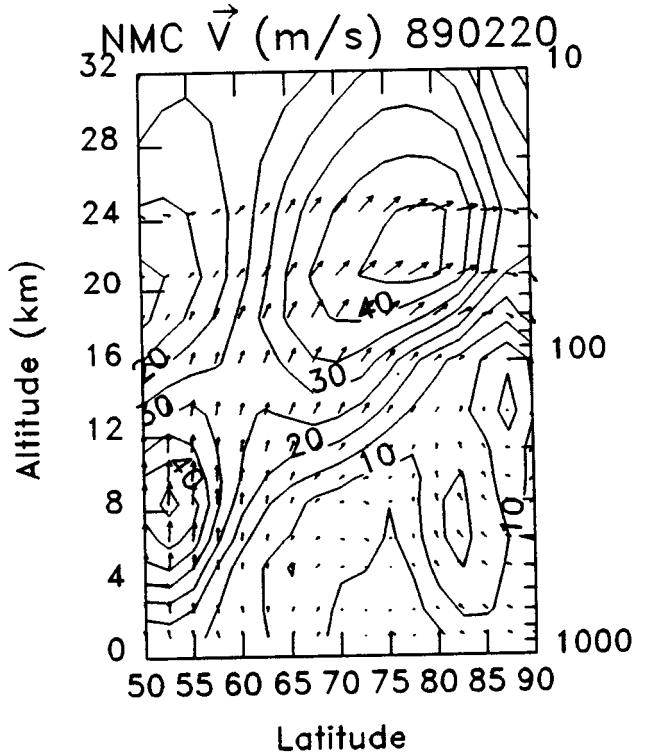
MAX= 24.8 MIN= 2.3 CONTOUR INC. = 1.5



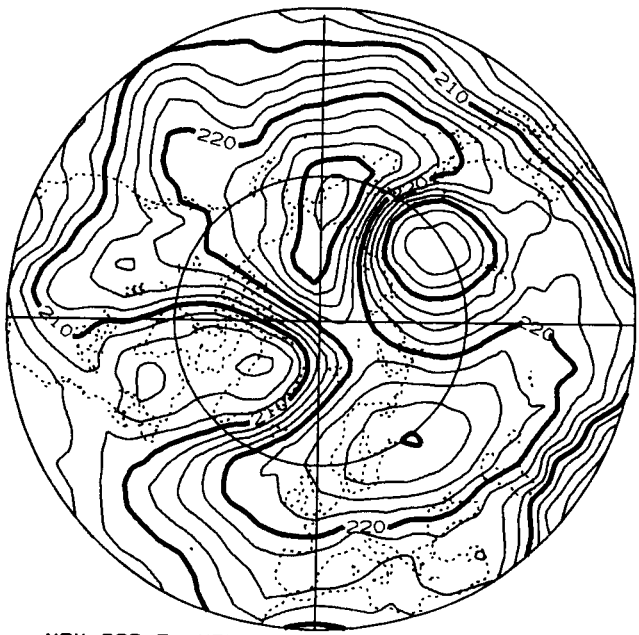
NMC 460K EPV (10^-6) 890220



MAX= 59.3 MIN= 9.1 CONTOUR INC. = 4.0

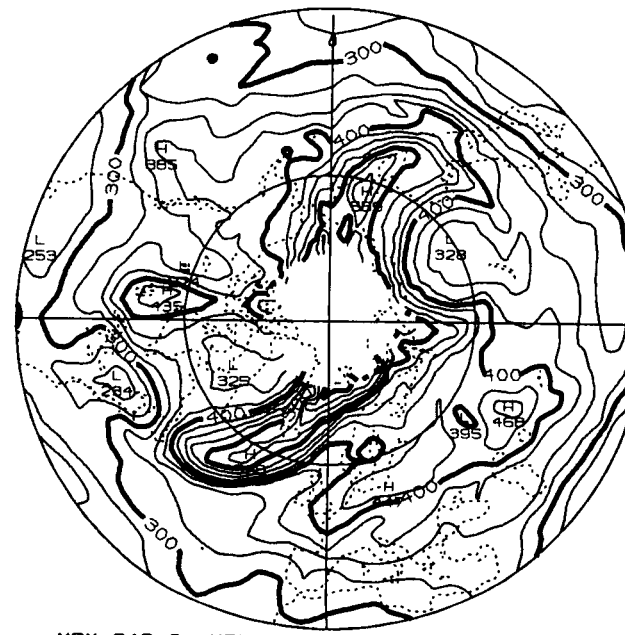


NMC 100MB TEMP. (K) 890221



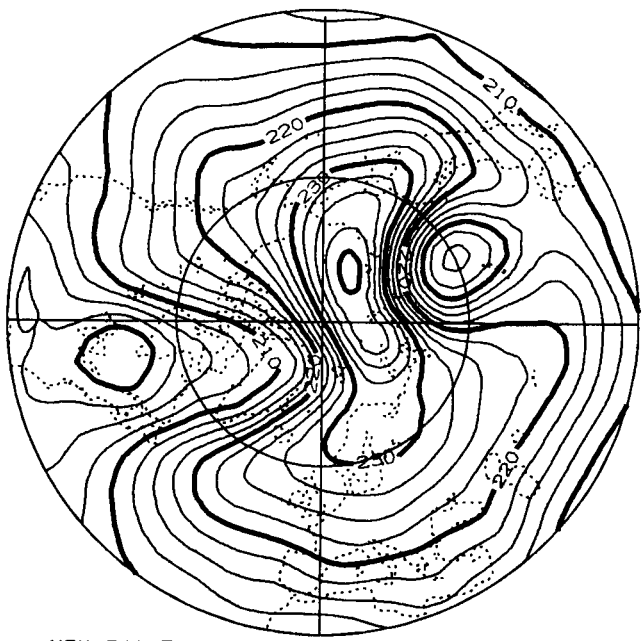
MAX=233.7 MIN=200.4 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890221



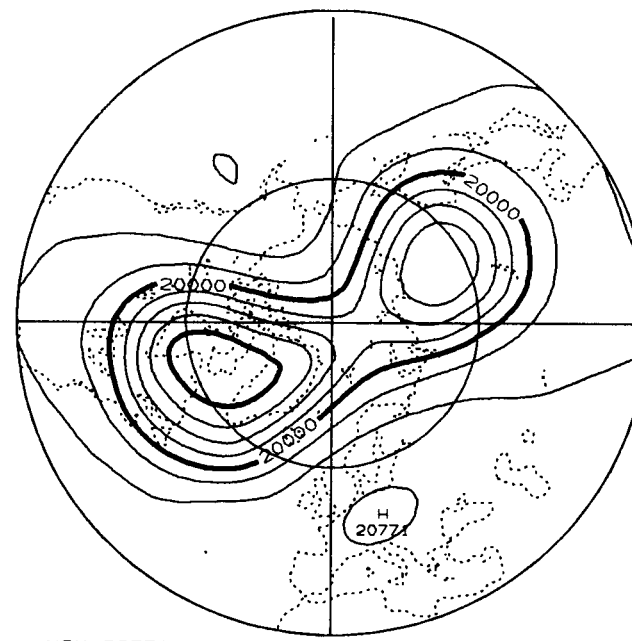
MAX=642.0 MIN=234.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890221



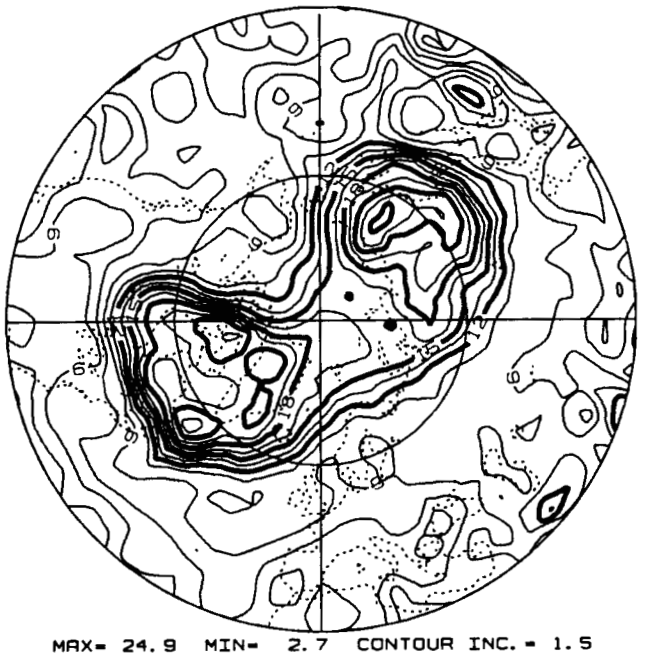
MAX=241.5 MIN=197.8 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890221

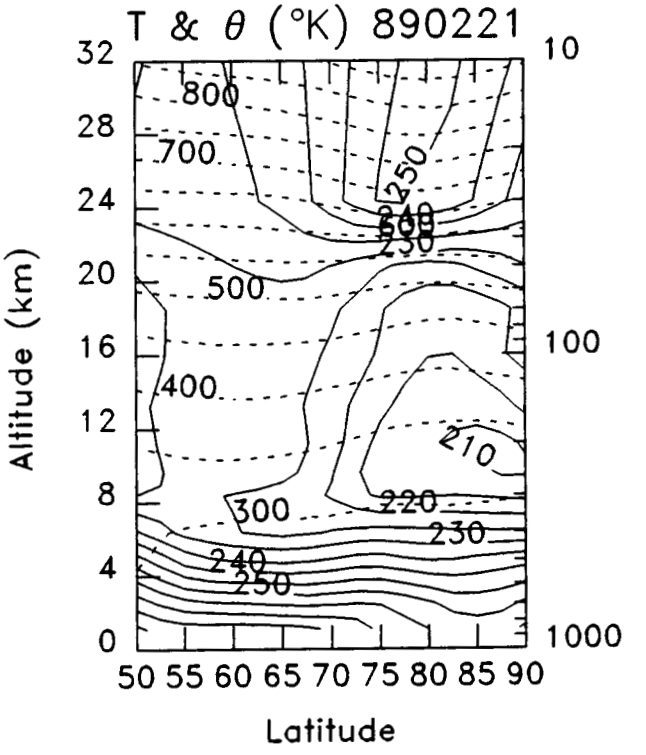


MAX=20771. MIN=18822. CONTOUR INC. =250.

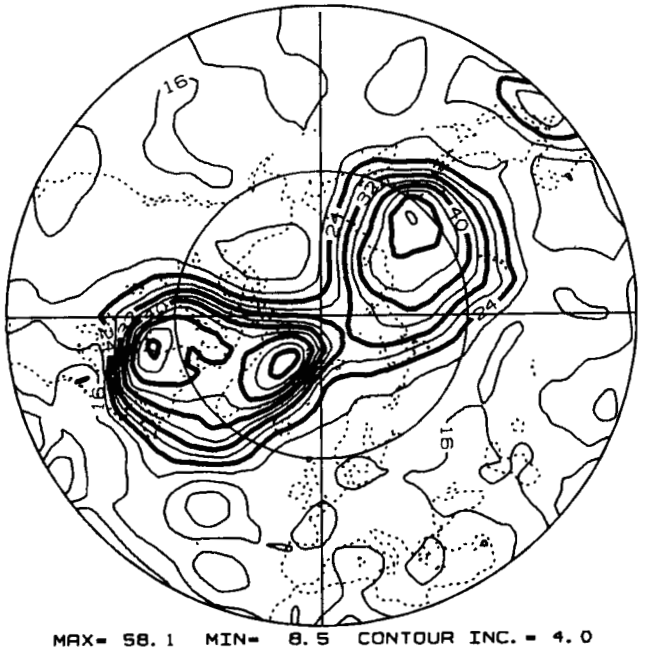
NMC 400K EPV (10^-6) 890221



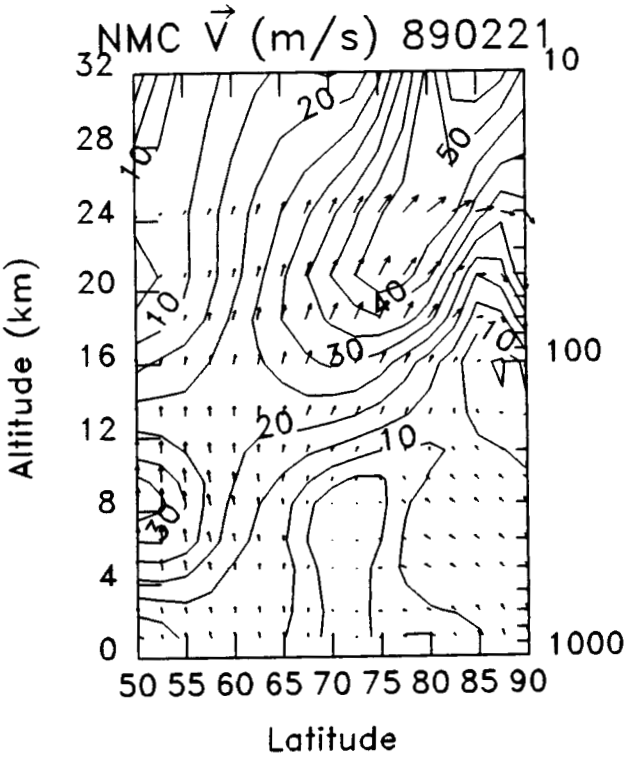
MAX= 24.9 MIN= 2.7 CONTOUR INC. = 1.5



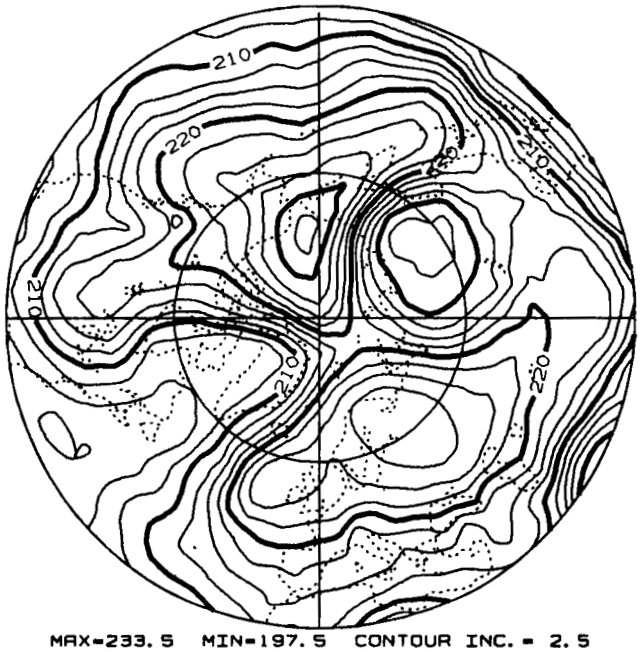
NMC 460K EPV (10^-6) 890221



MAX= 58.1 MIN= 8.5 CONTOUR INC. = 4.0

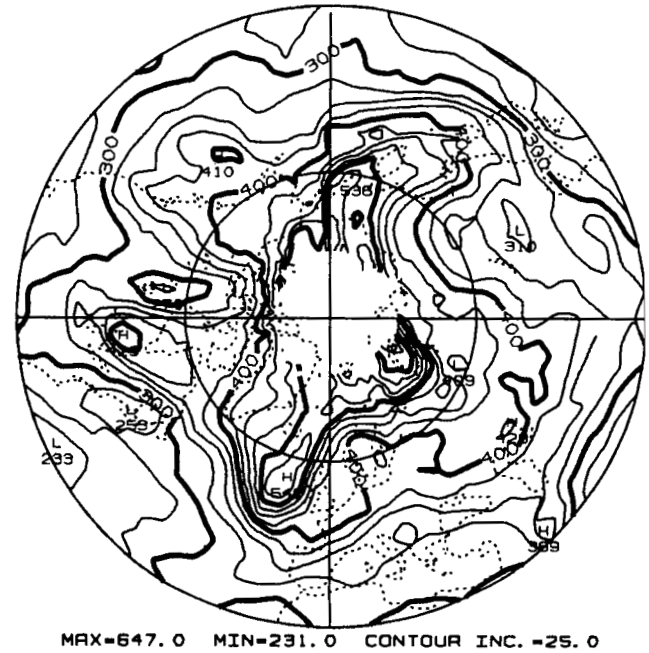


NMC 100MB TEMP. (K) 890222



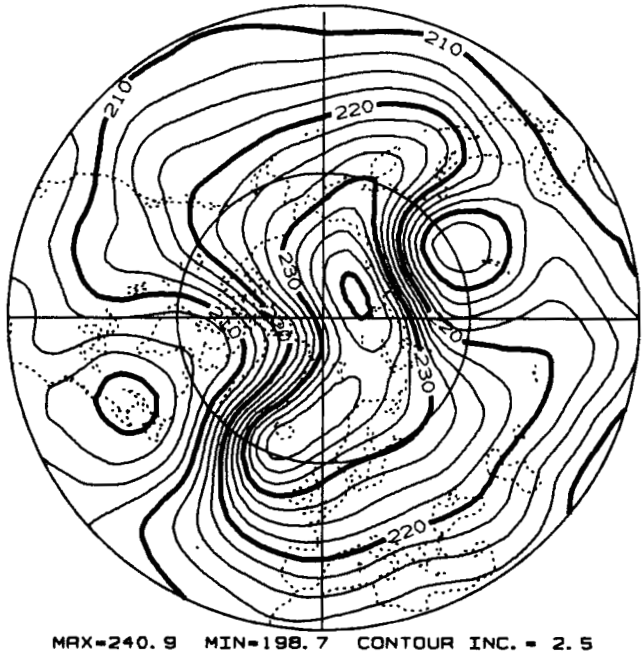
MAX=233.5 MIN=197.5 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890222



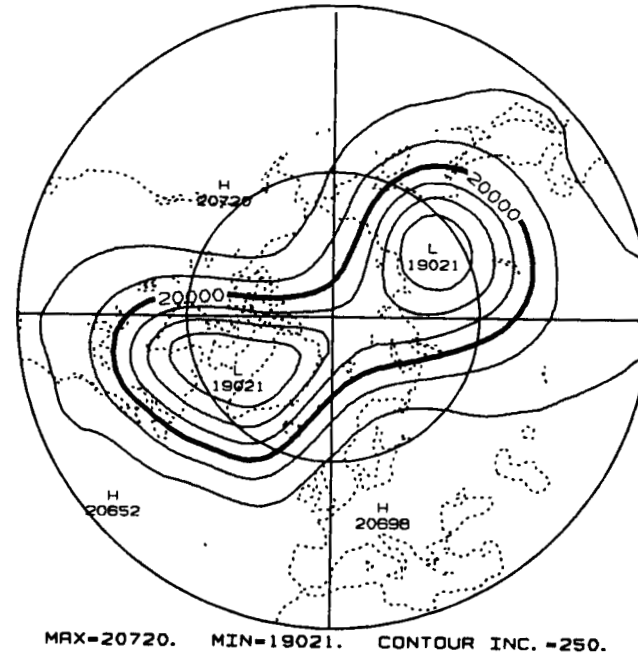
MAX=647.0 MIN=231.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890222



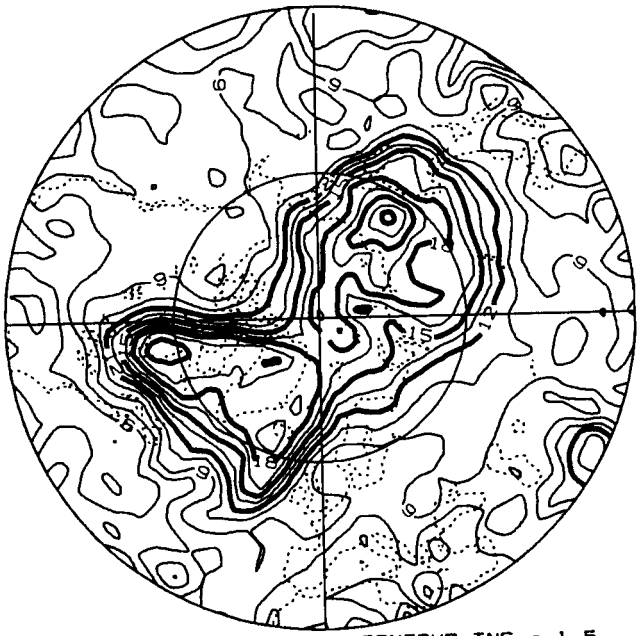
MAX=240.9 MIN=198.7 CONTOUR INC. = 2.5

NMC 50MB GEOP HGT (M) 890222



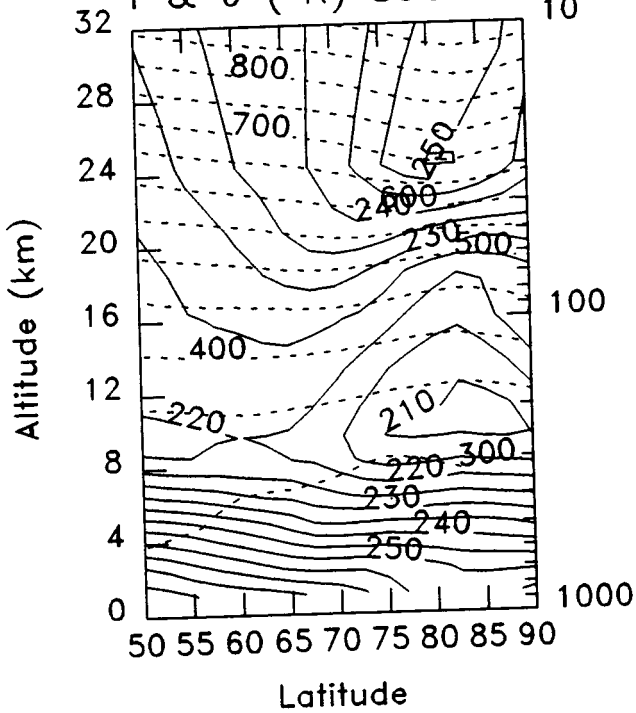
MAX=20720. MIN=19021. CONTOUR INC. =250.

NMC 400K EPV (10^-6) 890222

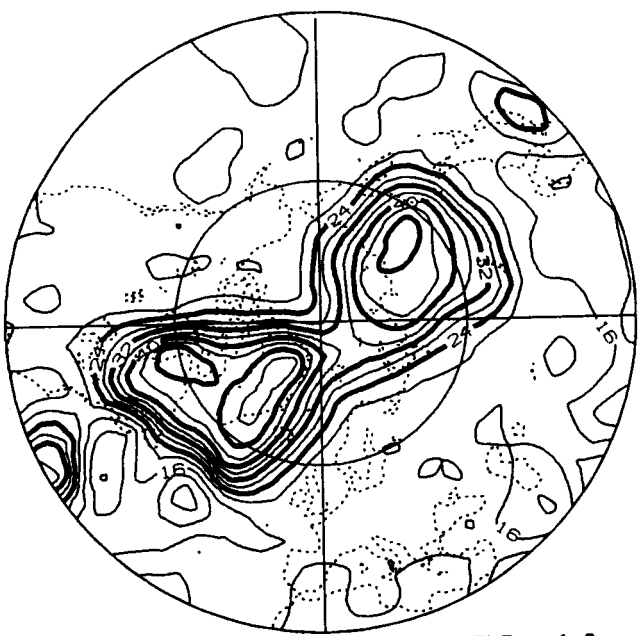


MAX= 25.2 MIN= 3.2 CONTOUR INC.= 1.5

T & θ (°K) 890222

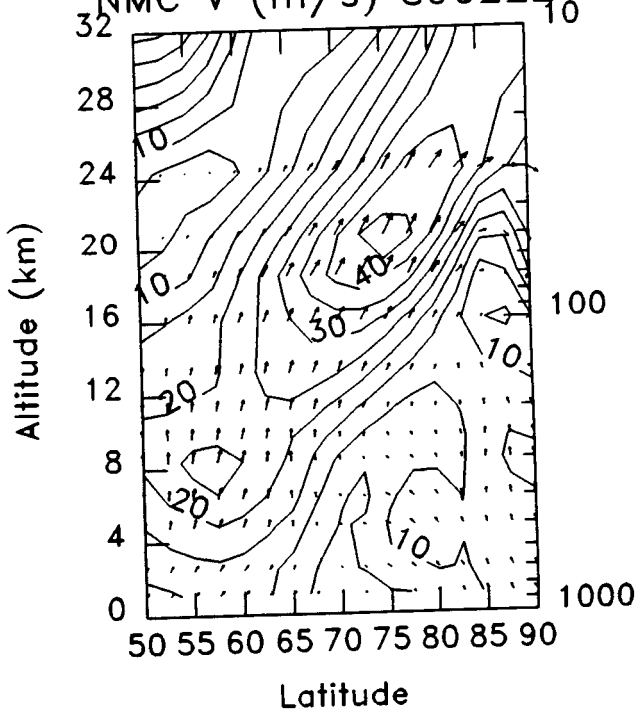


NMC 460K EPV (10^-6) 890222

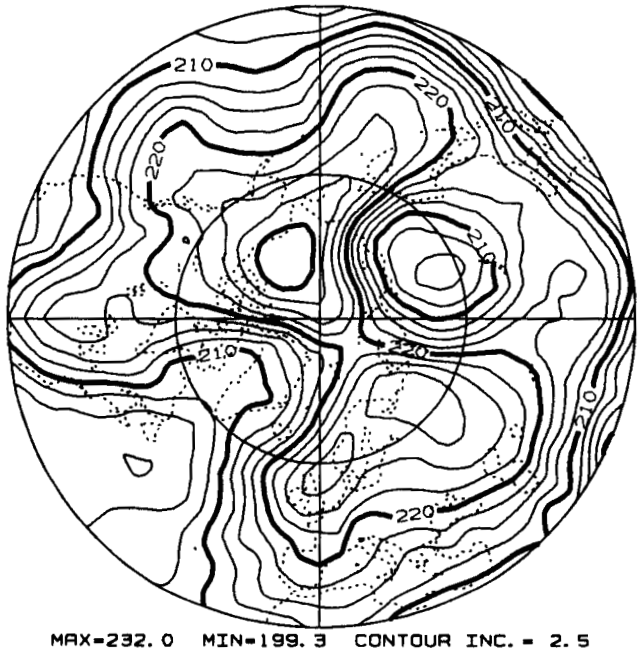


MAX= 54.5 MIN= 6.5 CONTOUR INC.= 4.0

NMC $\vec{V}$ (m/s) 890222

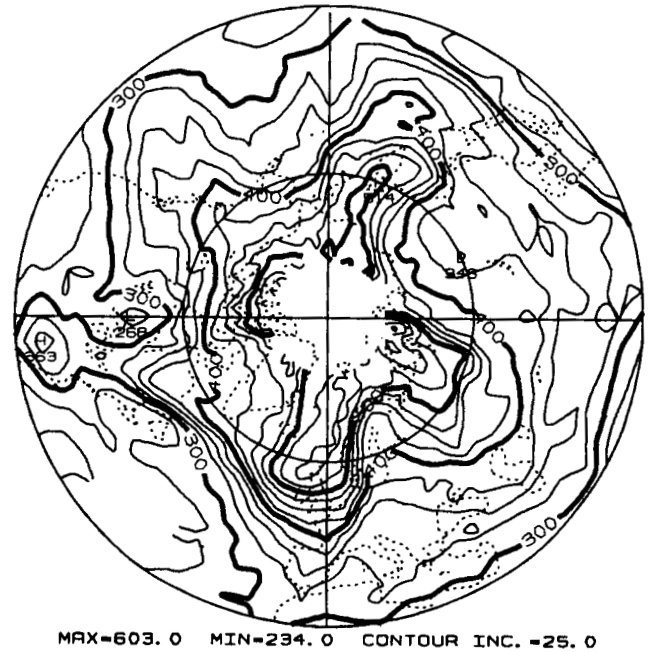


NMC 100MB TEMP. (K) 890223

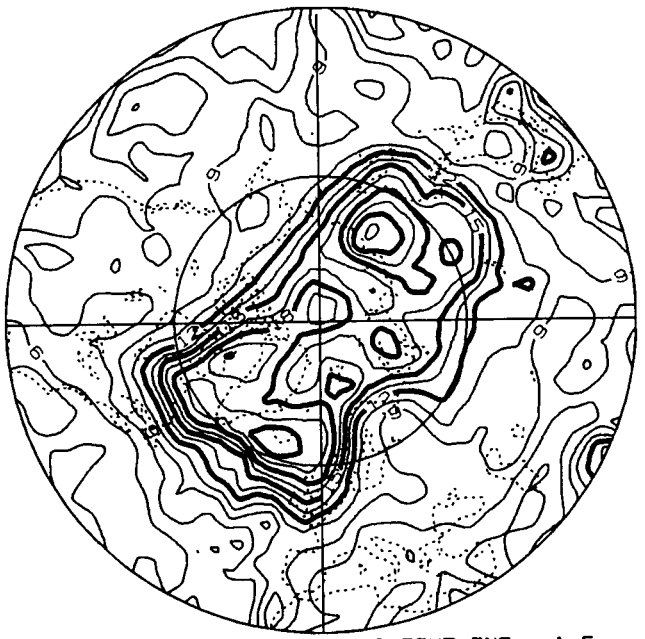


MAX=232.0 MIN=199.3 CONTOUR INC. = 2.5

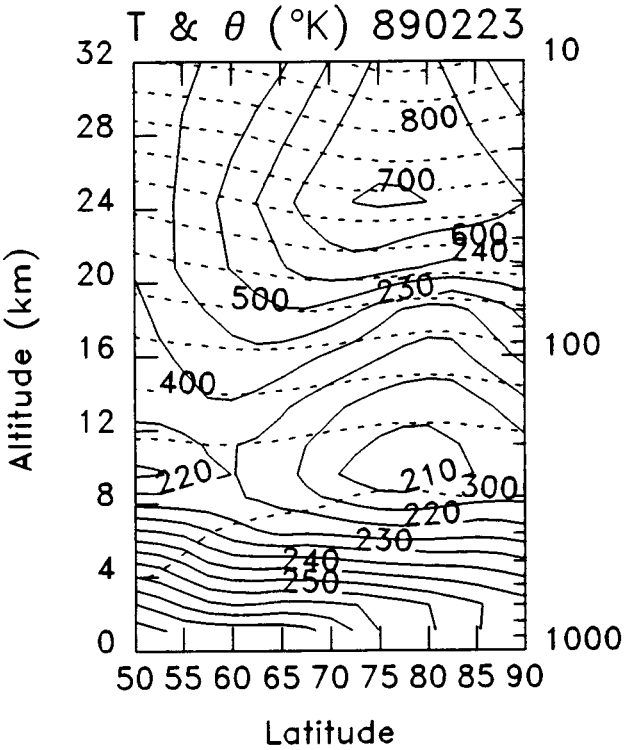
TOMS TOTAL OZONE (DU) 890223


300
300
300

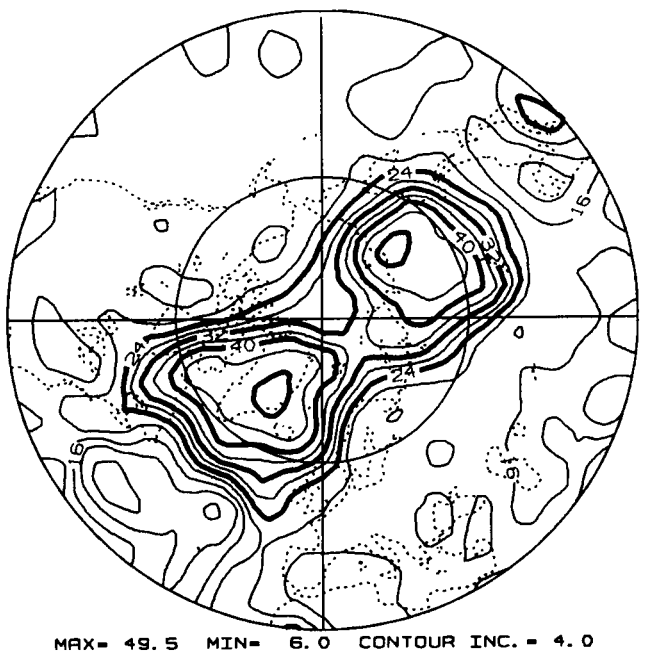
NMC 400K EPV (10^-6) 890223



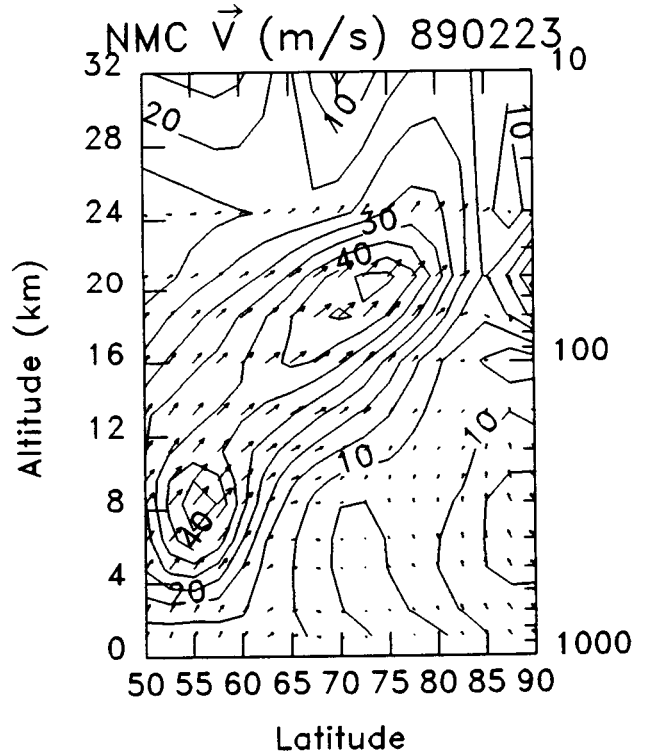
MAX= 22.9 MIN= 3.2 CONTOUR INC. = 1.5



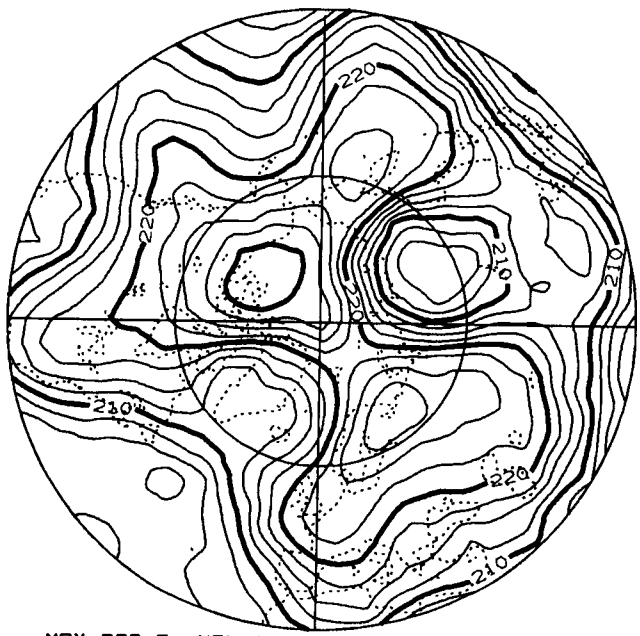
NMC 460K EPV (10^-6) 890223



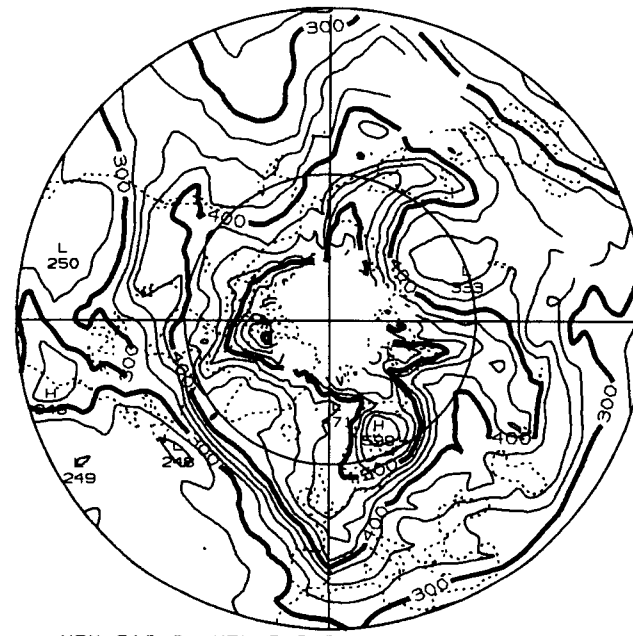
MAX= 49.5 MIN= 6.0 CONTOUR INC. = 4.0



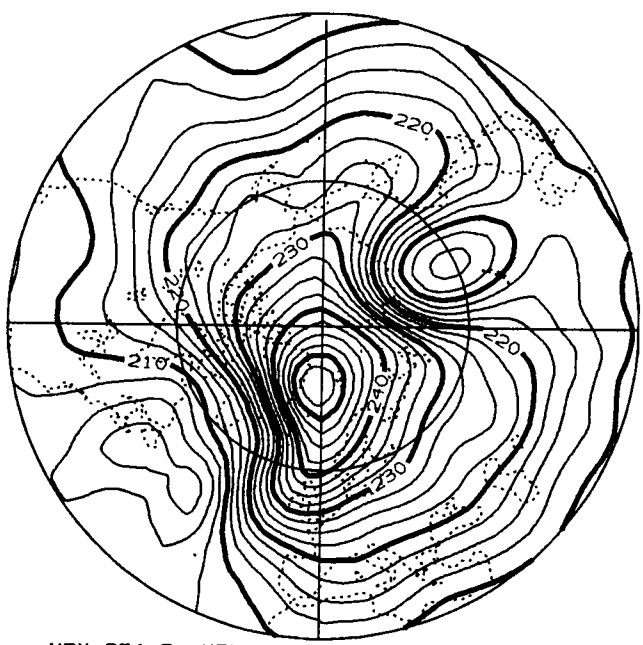
NMC 100MB TEMP. (K) 890224



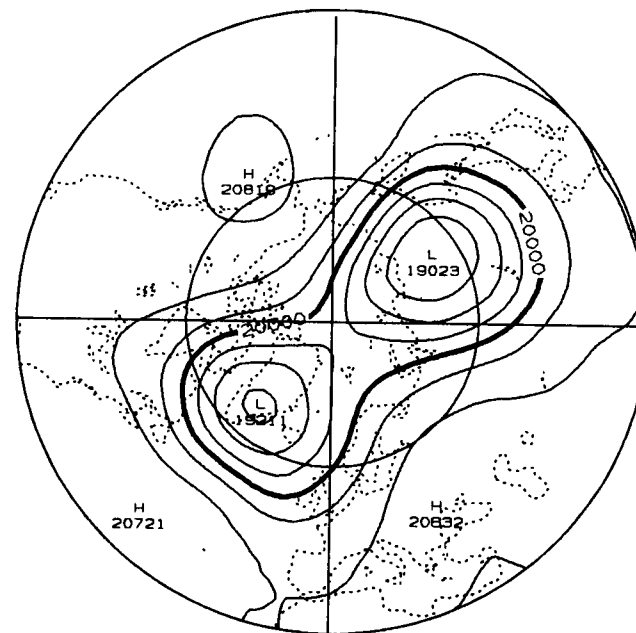
TOMS TOTAL OZONE (DU) 890224

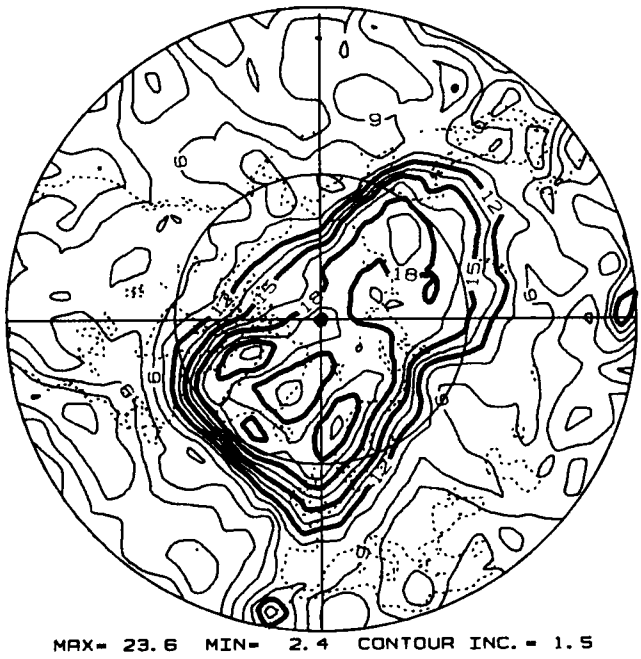


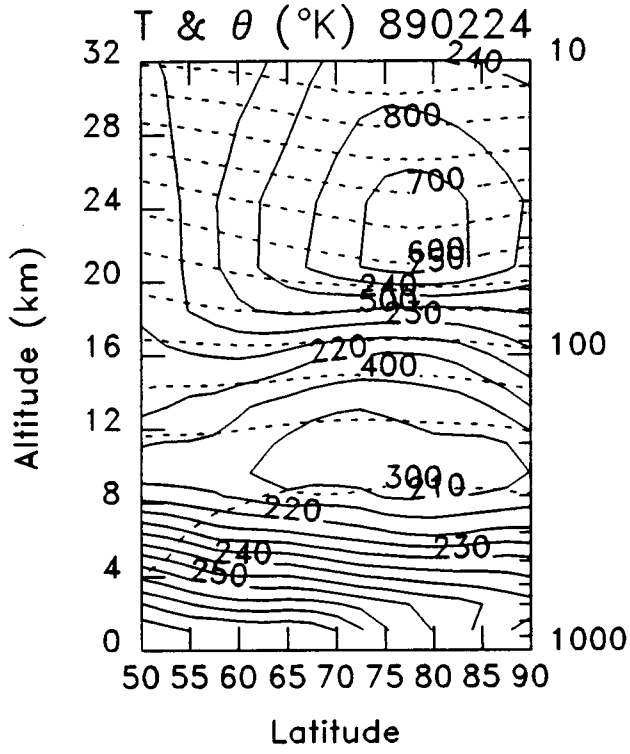
NMC 50MB TEMP. (K) 890224

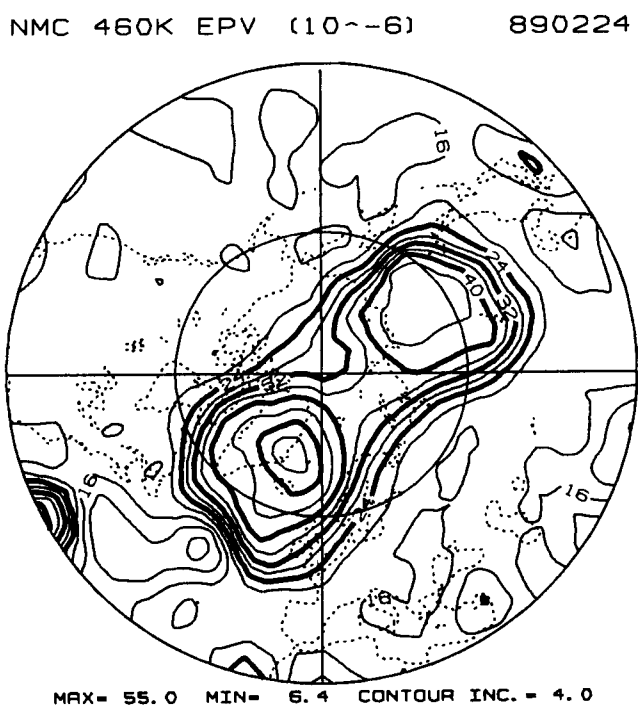


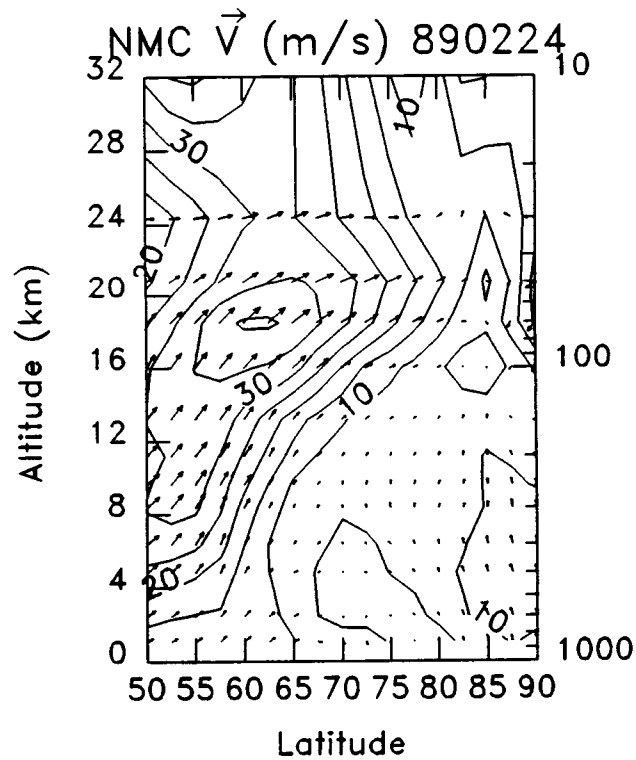
NMC 50MB GEOP HGT (M) 890224



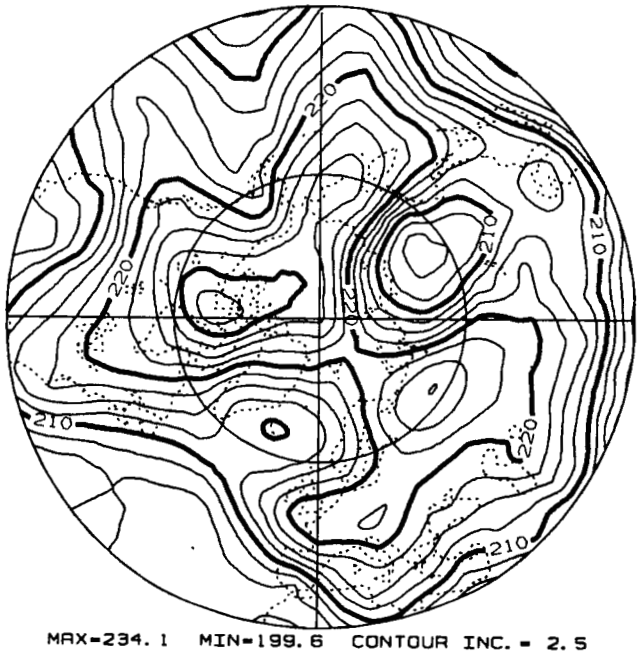

NMC 400K EPV (10^-6) 890224
MAX= 23.6 MIN= 2.4 CONTOUR INC. = 1.5


T & θ (°K) 890224
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
240
800
700
600
290
240
300
230
220
400
300
210
220
230
240
250


NMC 460K EPV (10^-6) 890224
MAX= 55.0 MIN= 6.4 CONTOUR INC. = 4.0

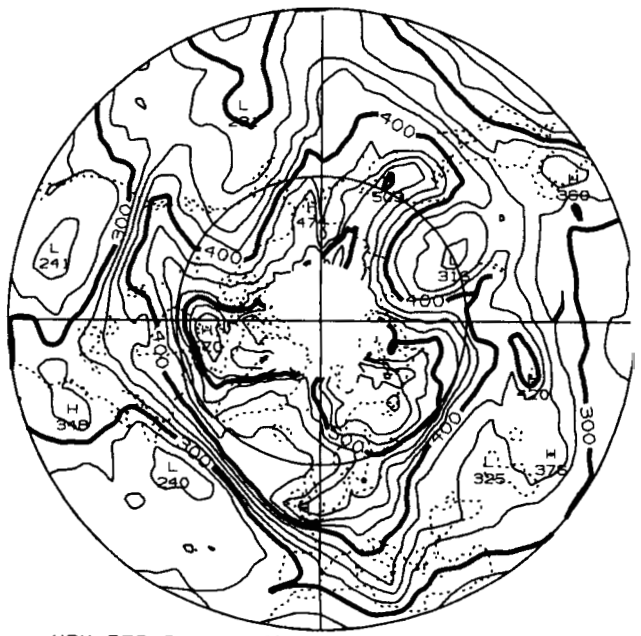

NMC V (m/s) 890224
Altitude (km)
Latitude
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90
30
10
20
30
10
20
10

NMC 100MB TEMP. (K) 890225



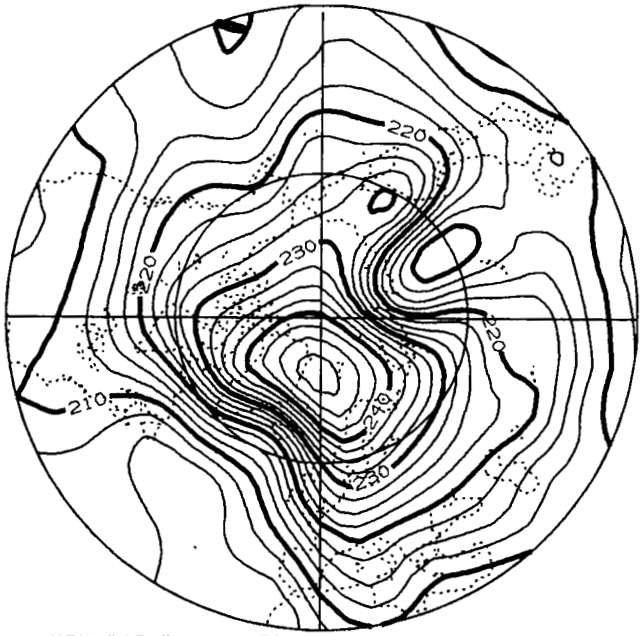
MAX=234.1 MIN=199.6 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890225



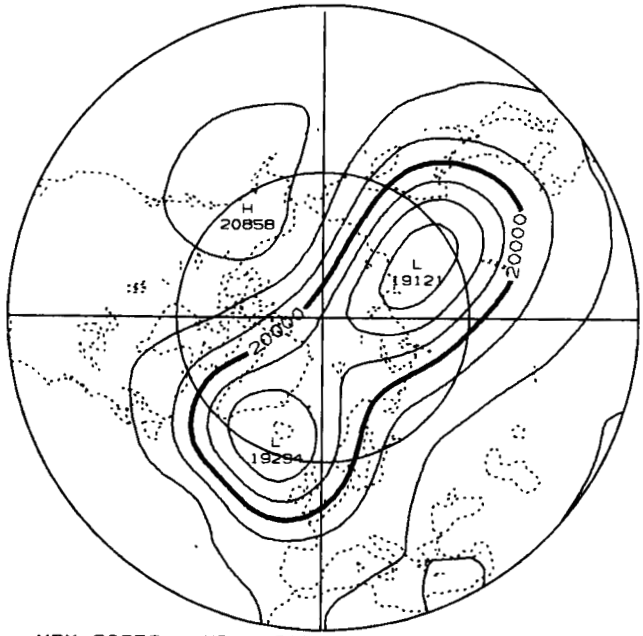
MAX=579.0 MIN=235.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890225



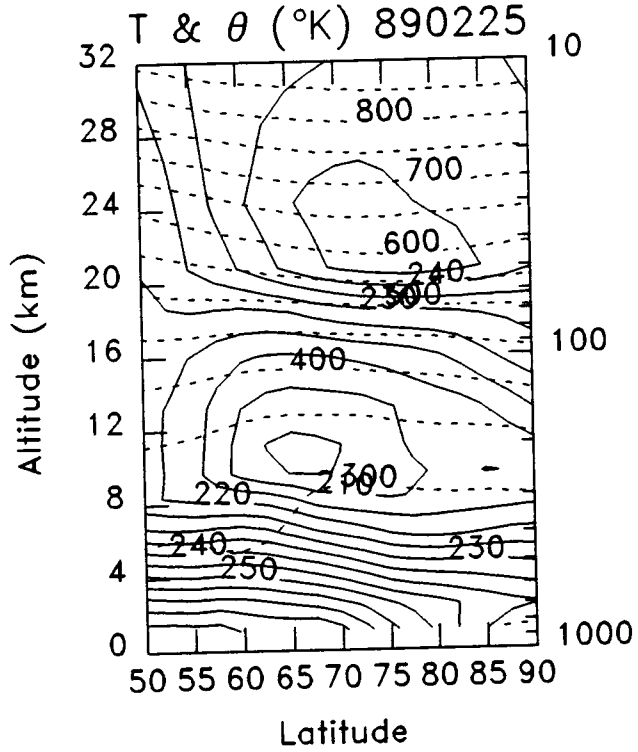
MAX=248.7 MIN=202.5 CONTOUR INC. = 2.5

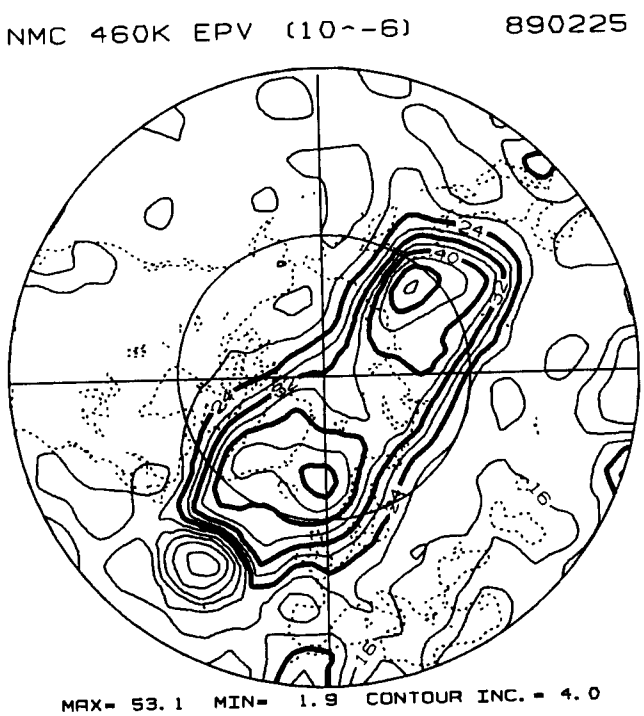
NMC 50MB GEOP HGT (M) 890225

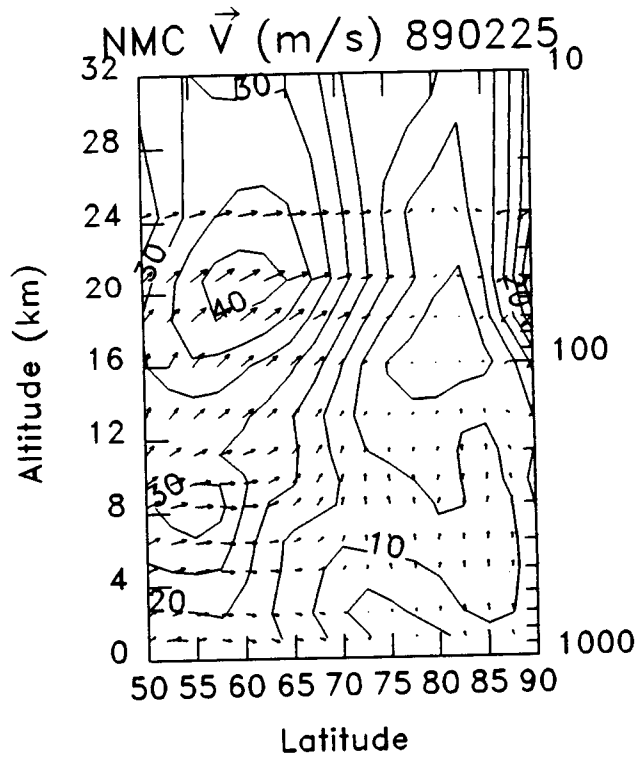


MAX=20858. MIN=19121. CONTOUR INC. =250.

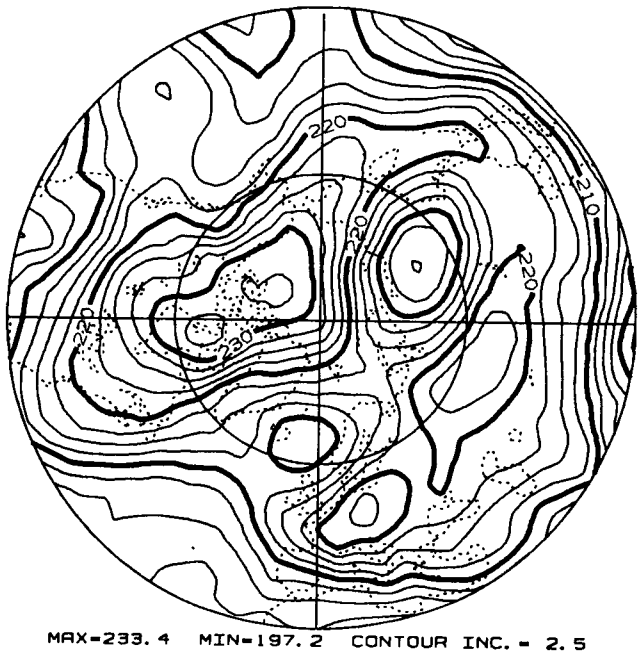
NMC 400K EPV (10^-6) 890225
MAX= 22.7 MIN= 3.3 CONTOUR INC. = 1.5


T & θ (°K) 890225
Altitude (km)
Latitude
800
700
600
400
300
250
240
230
220
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890225
MAX= 53.1 MIN= 1.9 CONTOUR INC. = 4.0

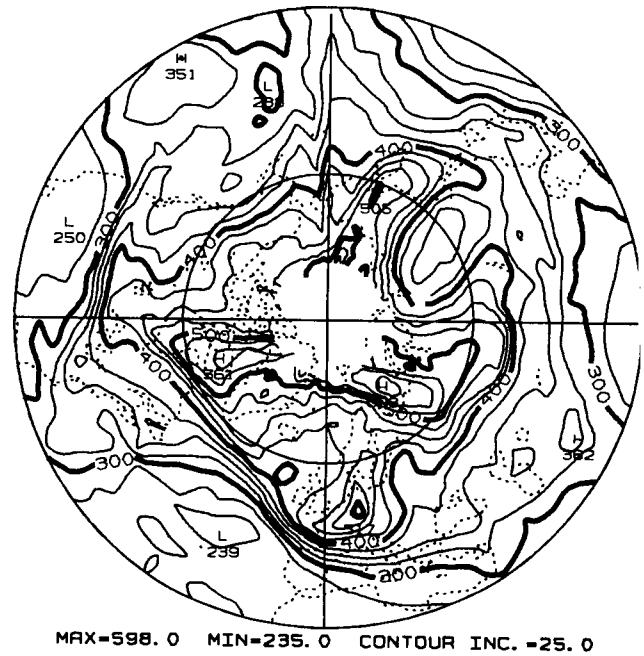

NMC V (m/s) 890225
Altitude (km)
Latitude
30
40
10
20
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890226



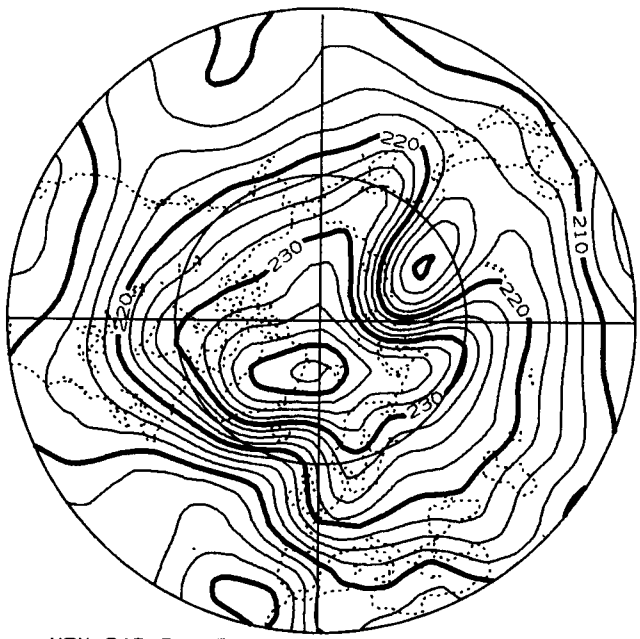
MAX=233.4 MIN=197.2 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890226



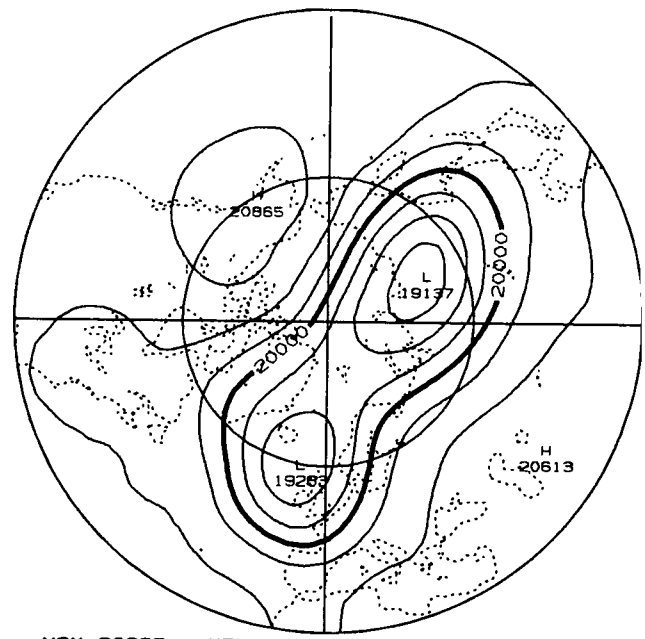
MAX=598.0 MIN=235.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890226

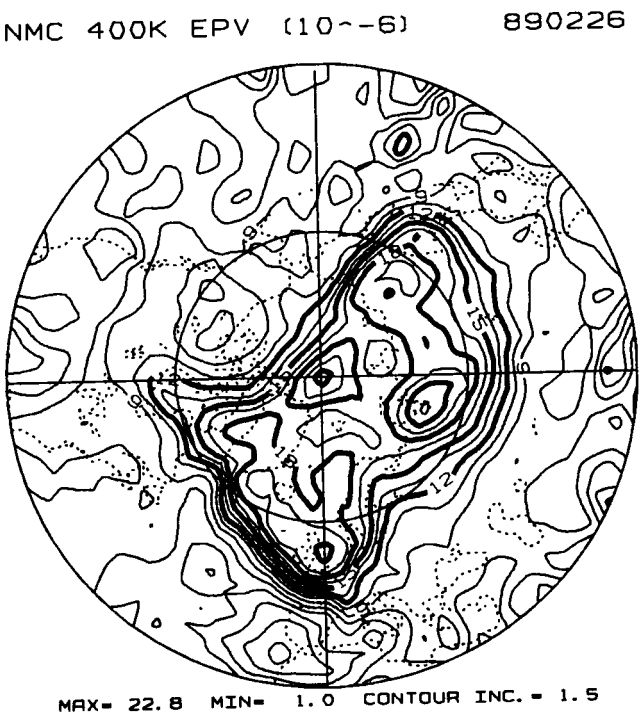


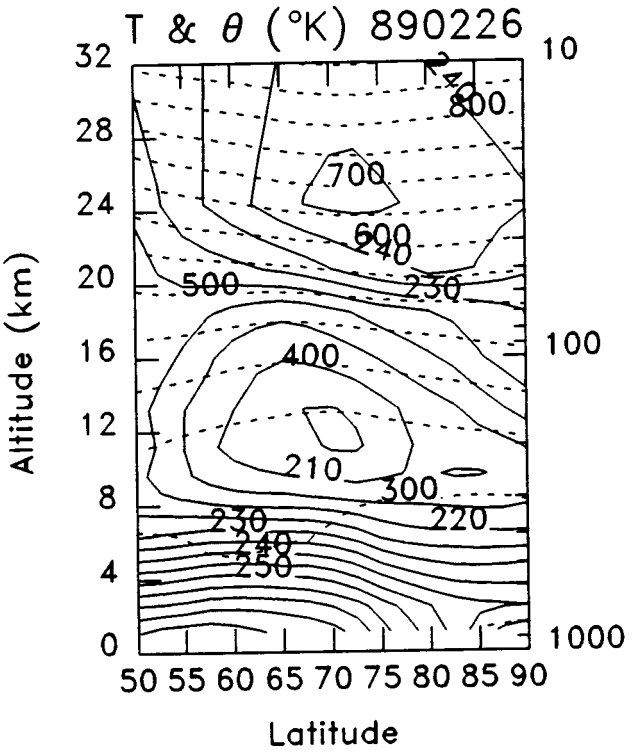
MAX=243.2 MIN=198.5 CONTOUR INC. = 2.5

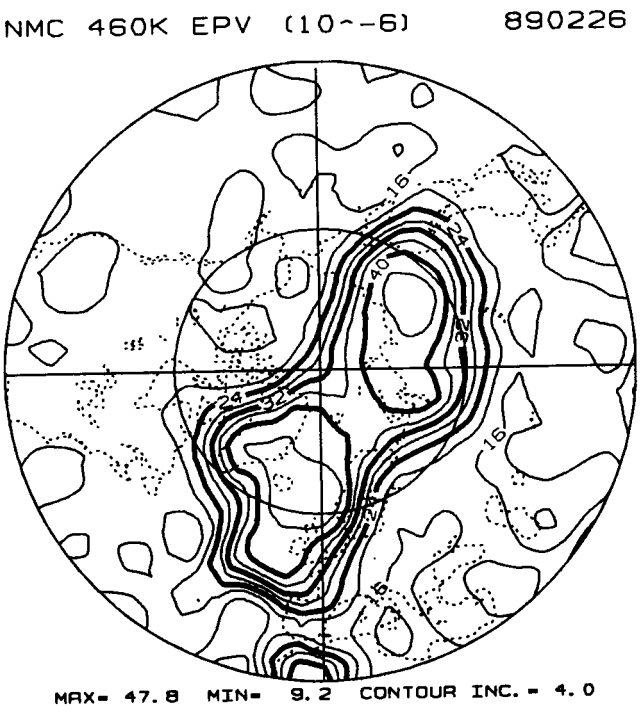
NMC 50MB GEOP HGT (M) 890226

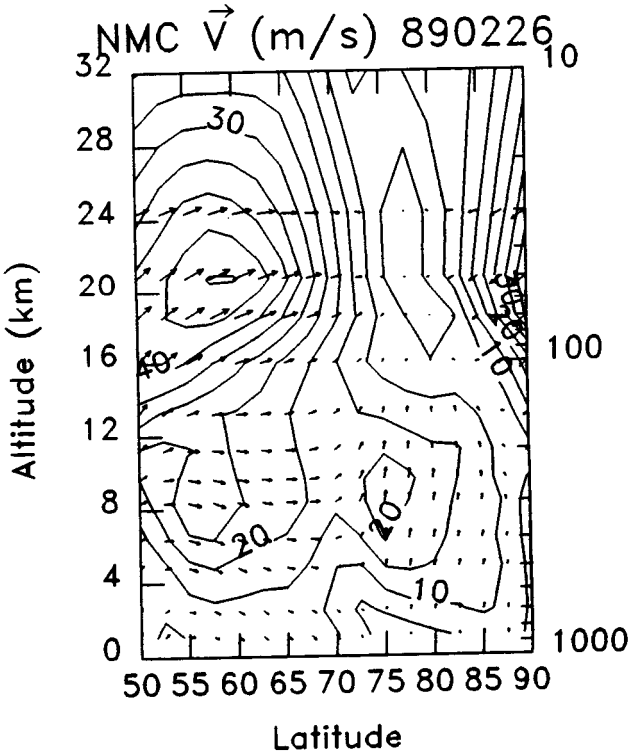


MAX=20865. MIN=19137. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890226
MAX= 22.8 MIN= 1.0 CONTOUR INC. = 1.5


T & θ (°K) 890226
Altitude (km)
Latitude
50 55 60 65 70 75 80 85 90
32 28 24 20 16 12 8 4 0
10 100 1000
800
700
600
240
230
500
400
210
300
220
230
240
250

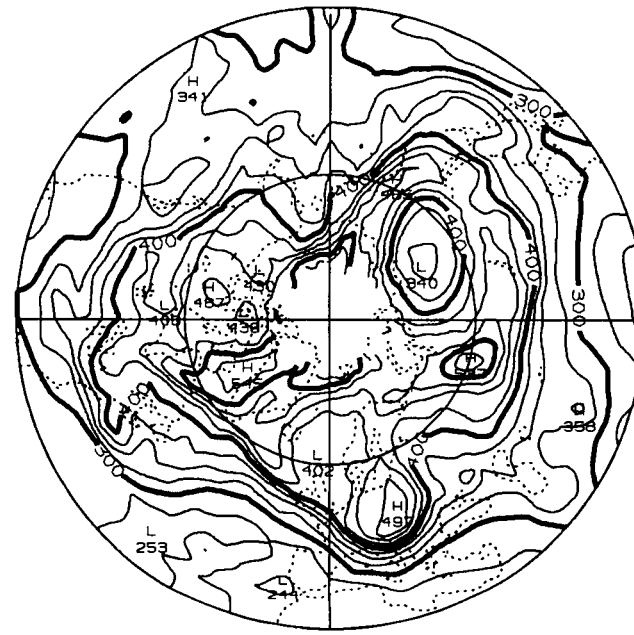

NMC 460K EPV (10^-6) 890226
MAX= 47.8 MIN= 9.2 CONTOUR INC. = 4.0


NMC V (m/s) 890226
Altitude (km)
Latitude
50 55 60 65 70 75 80 85 90
32 28 24 20 16 12 8 4 0
10 100 1000
30
40
20
10

NMC 100MB TEMP. (K) 890227

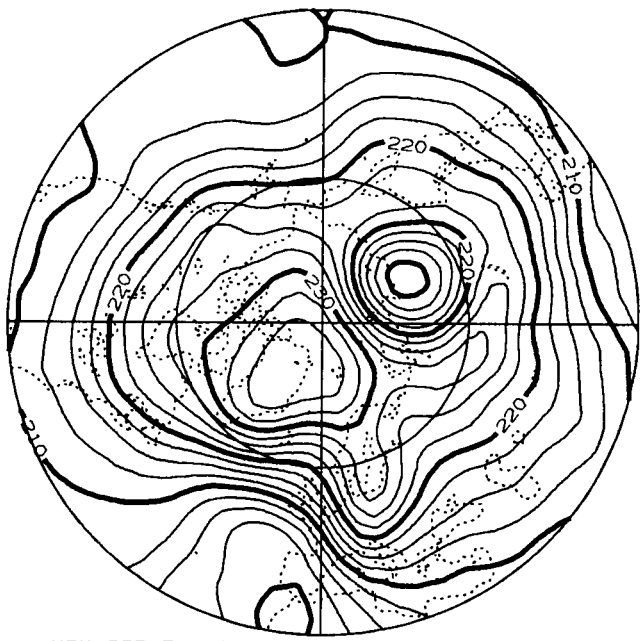
MAX=233.9 MIN=195.9 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 890227



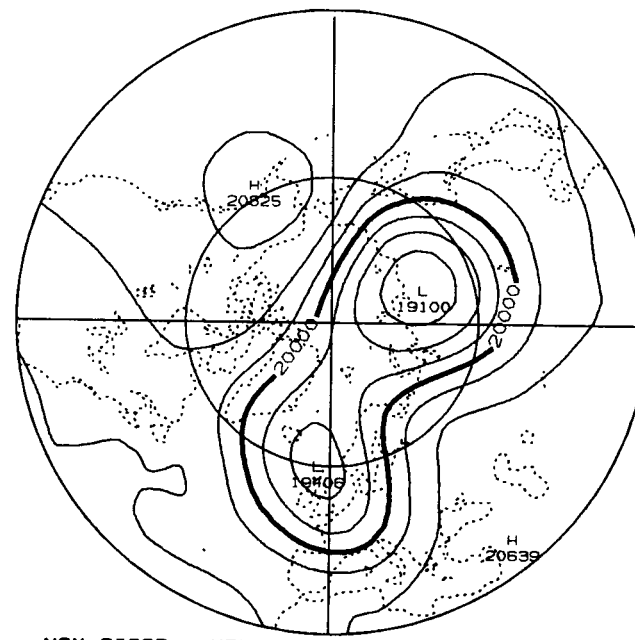
MAX=549.0 MIN=236.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890227



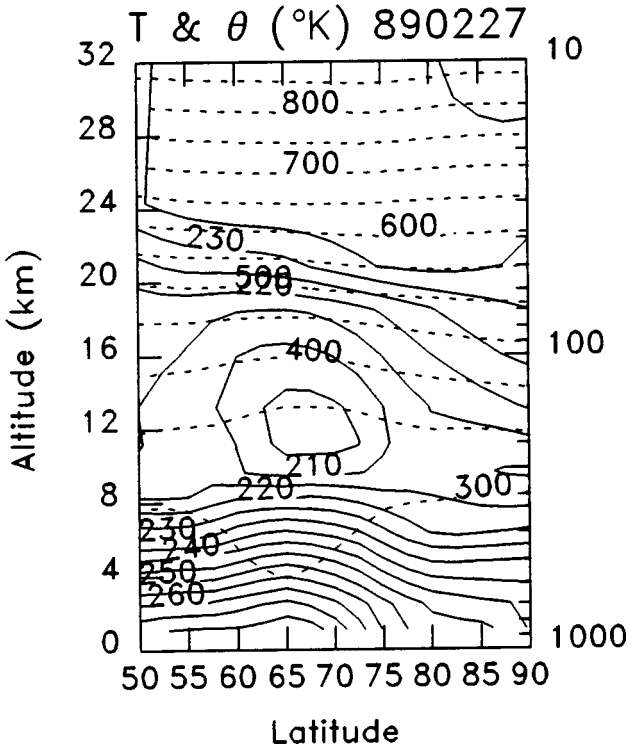
MAX=237.5 MIN=198.8 CONTOUR INC. = 2.5

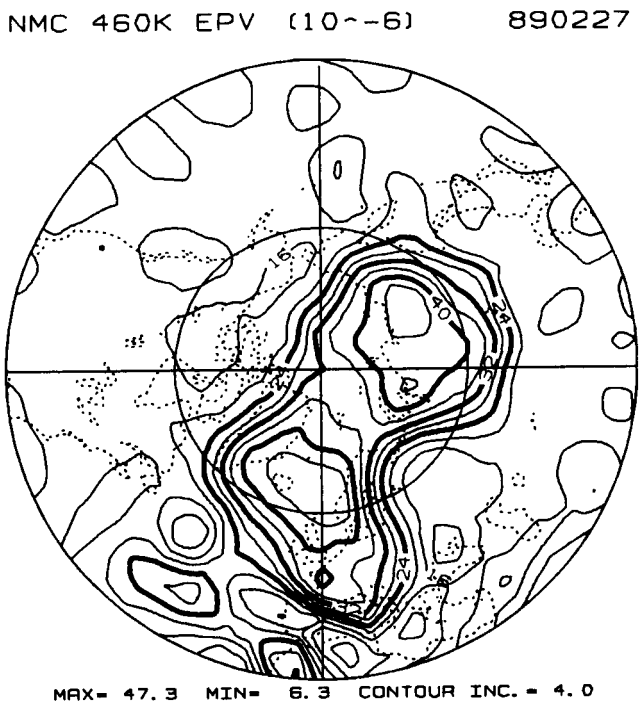
NMC 50MB GEOP HGT (M) 890227

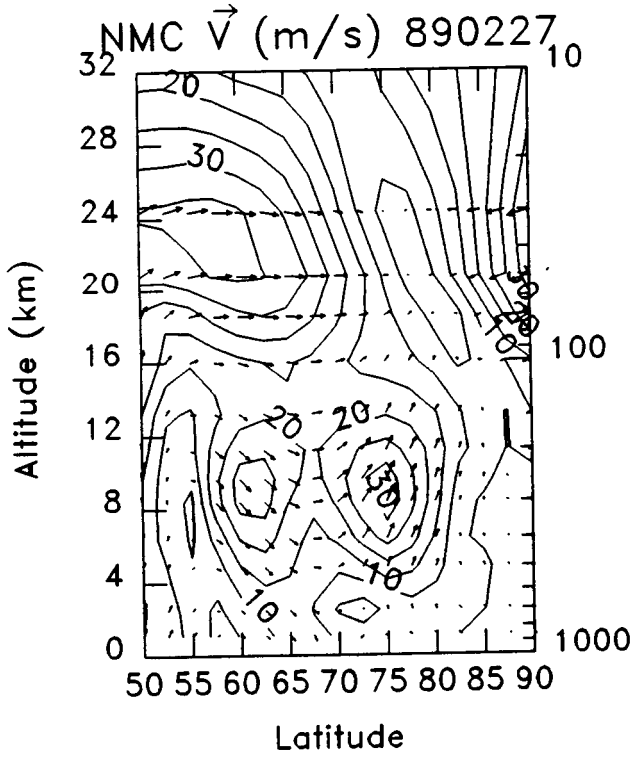


MAX=20825. MIN=19100. CONTOUR INC. =250.

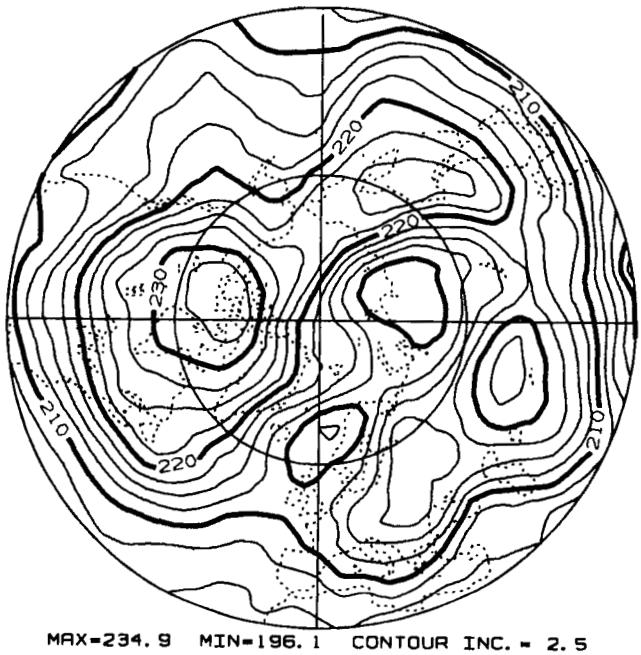
NMC 400K EPV (10^-6) 890227
MAX= 21.6 MIN= 0.8 CONTOUR INC. = 1.5


T & θ (°K) 890227
Altitude (km)
Latitude
800
700
600
500
400
300
230
220
210
240
250
260
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890227
MAX= 47.3 MIN= 6.3 CONTOUR INC. = 4.0

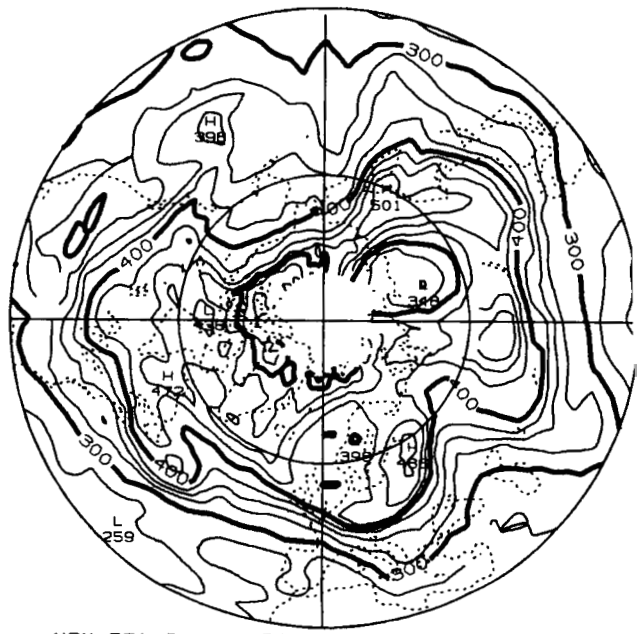

NMC V (m/s) 890227
Altitude (km)
Latitude
20
30
40
50
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

NMC 100MB TEMP. (K) 890228



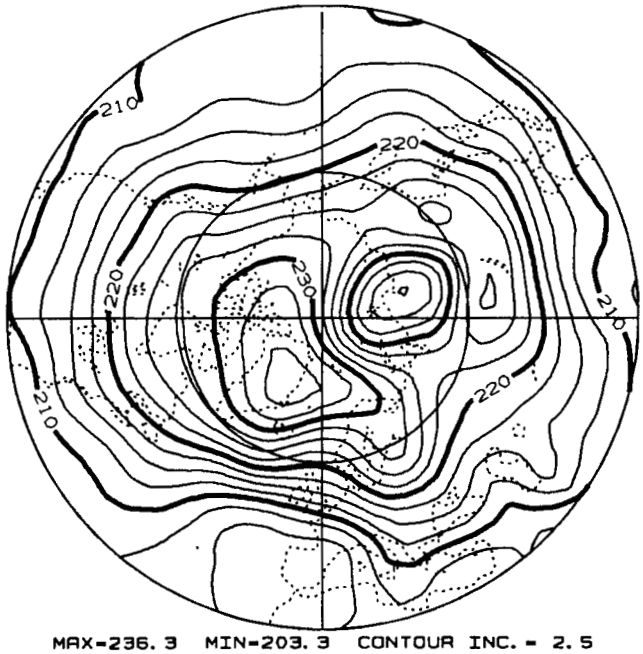
MAX=234.9 MIN=196.1 CONTOUR INC. = 2.5

TOMS TOTAL OZONE (DU) 89022E



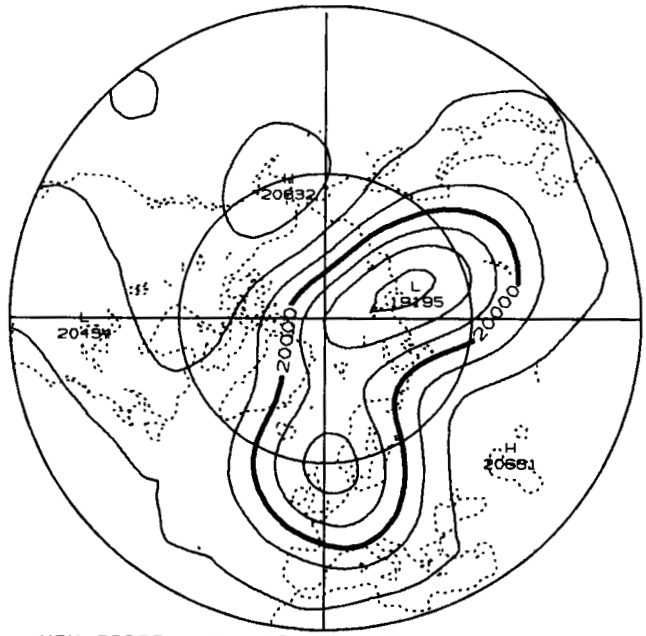
MAX=571.0 MIN=244.0 CONTOUR INC. =25.0

NMC 50MB TEMP. (K) 890228

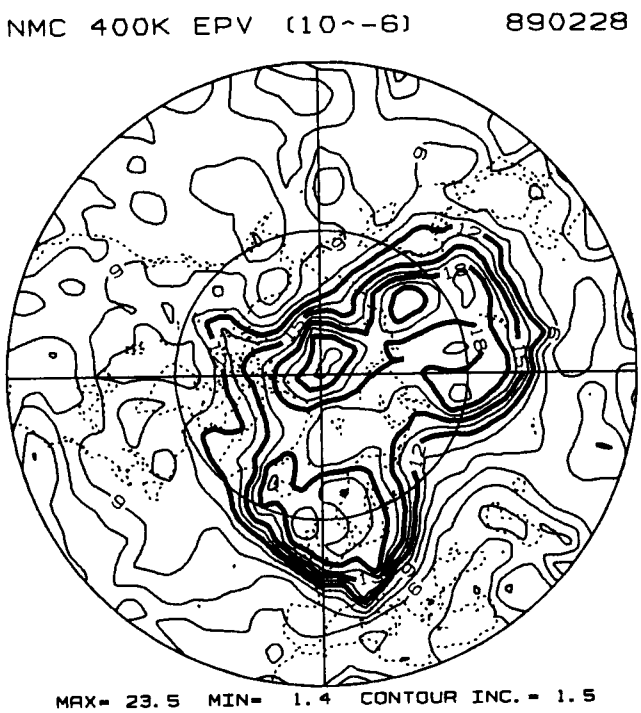


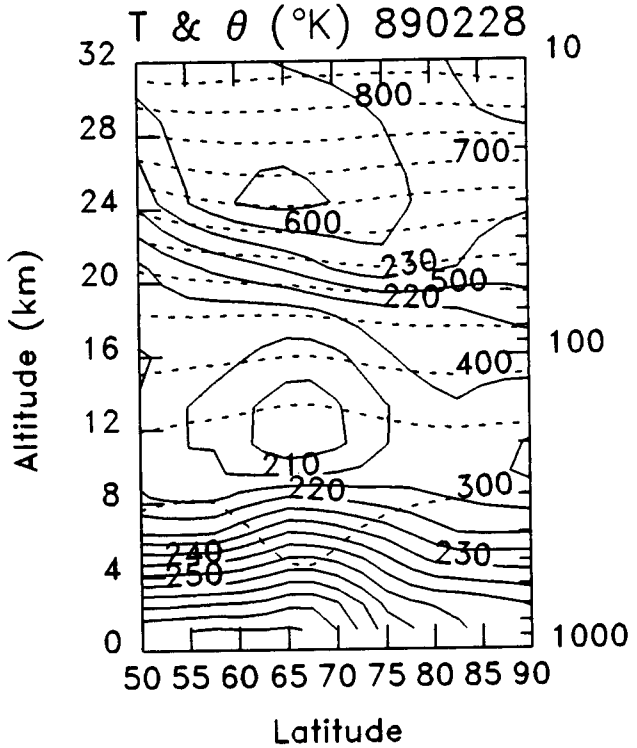
MAX=236.3 MIN=203.3 CONTOUR INC. = 2.5

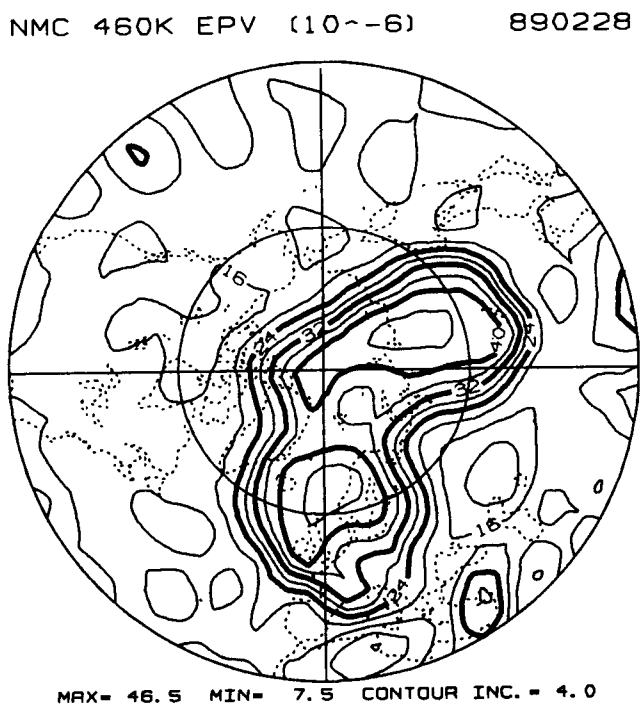
NMC 50MB GEOP HGT (M) 890228

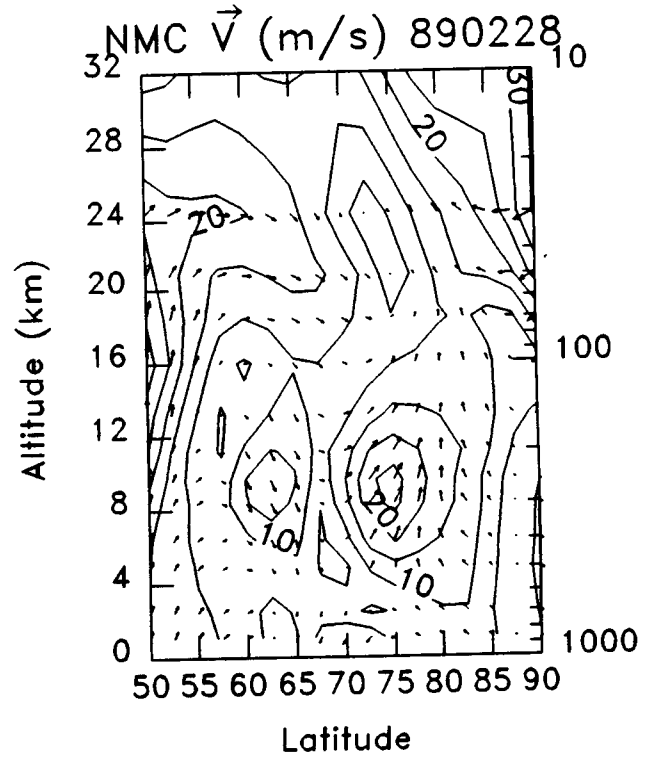


MAX=20832. MIN=19195. CONTOUR INC. =250.


NMC 400K EPV (10^-6) 890228
MAX= 23.5 MIN= 1.4 CONTOUR INC. = 1.5


T & θ (°K) 890228
Altitude (km)
Latitude
800
700
600
500
400
300
230
220
210
240
250
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90


NMC 460K EPV (10^-6) 890228
MAX= 46.5 MIN= 7.5 CONTOUR INC. = 4.0


NMC V (m/s) 890228
Altitude (km)
Latitude
30
20
10
32
28
24
20
16
12
8
4
0
10
100
1000
50 55 60 65 70 75 80 85 90

Section III

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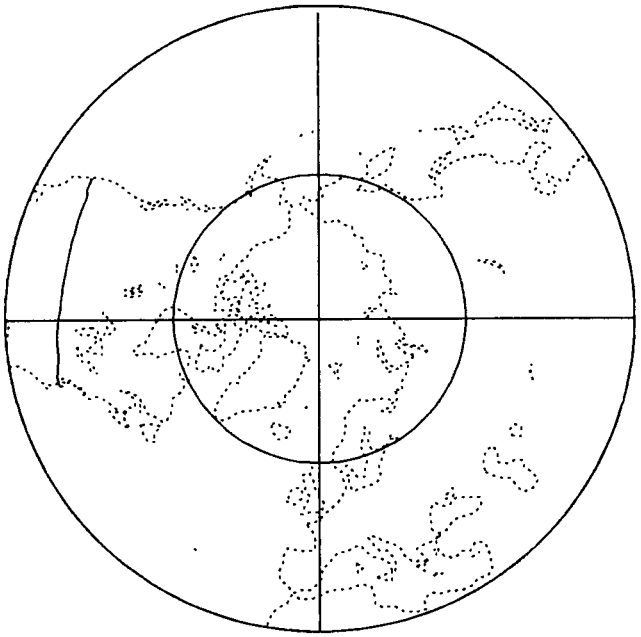
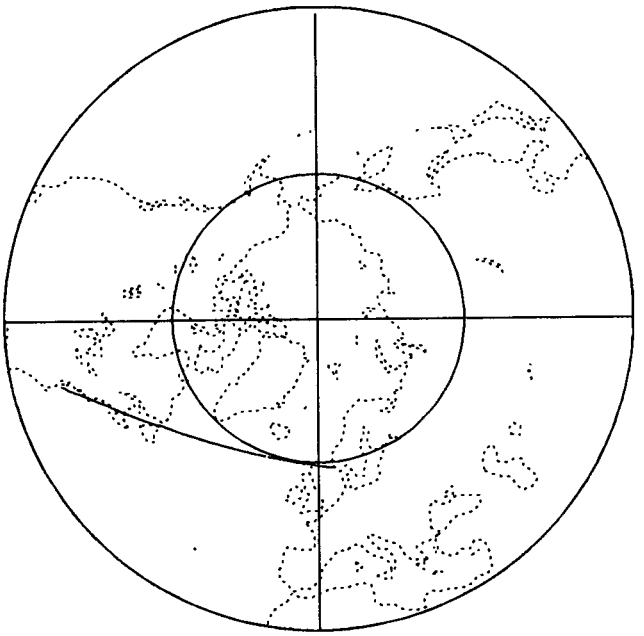
Section IIIa, ER-2 flight tracks

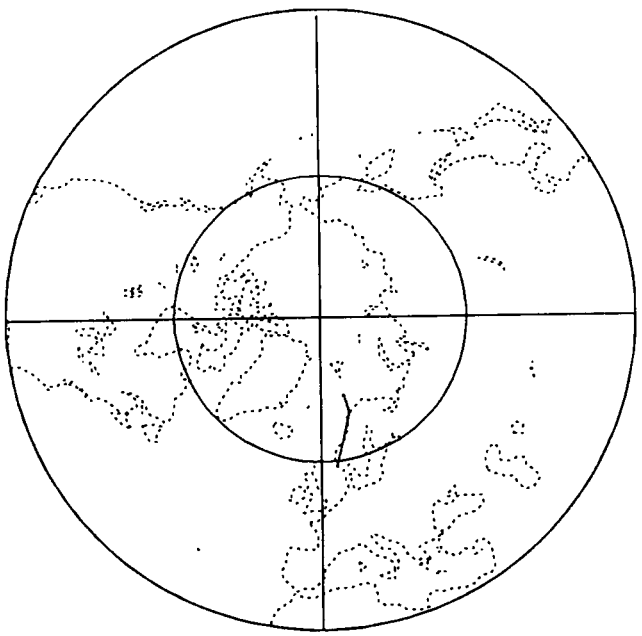
ER-2 FLIGHT TRACK 881229



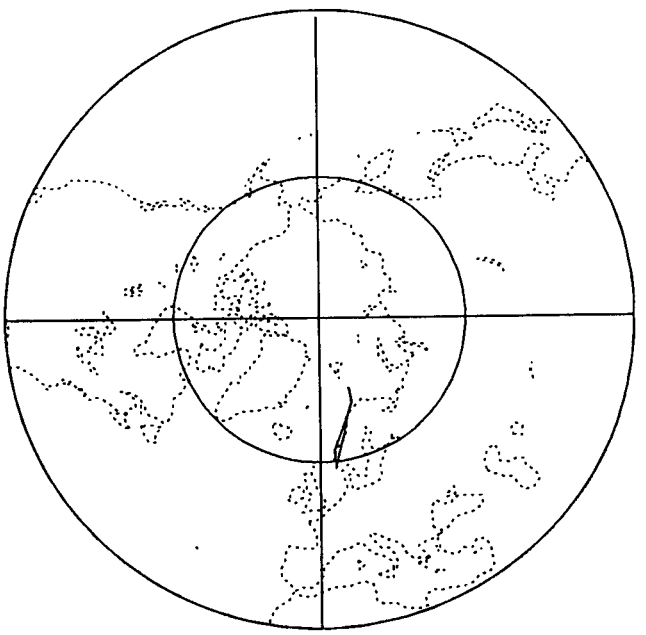
ER-2 FLIGHT TRACK 881231



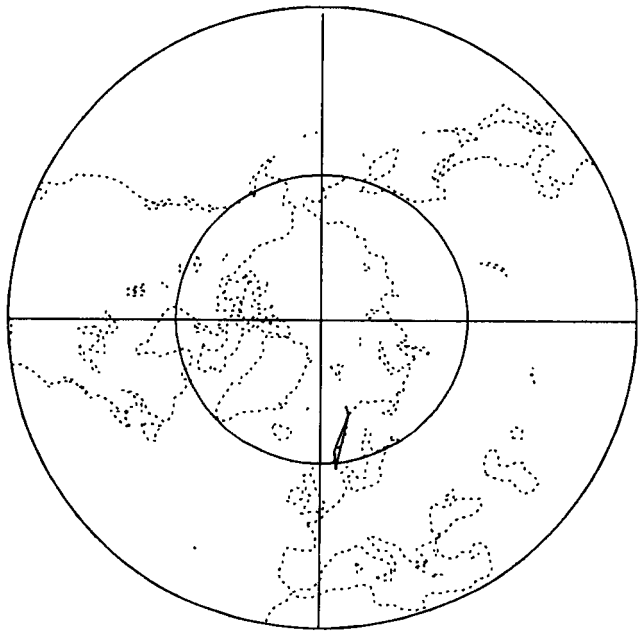
ER-2 FLIGHT TRACK 890103



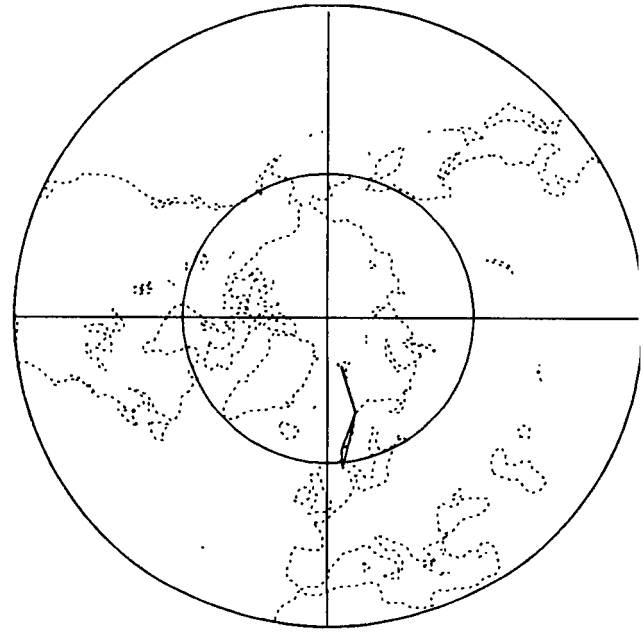
ER-2 FLIGHT TRACK 890106



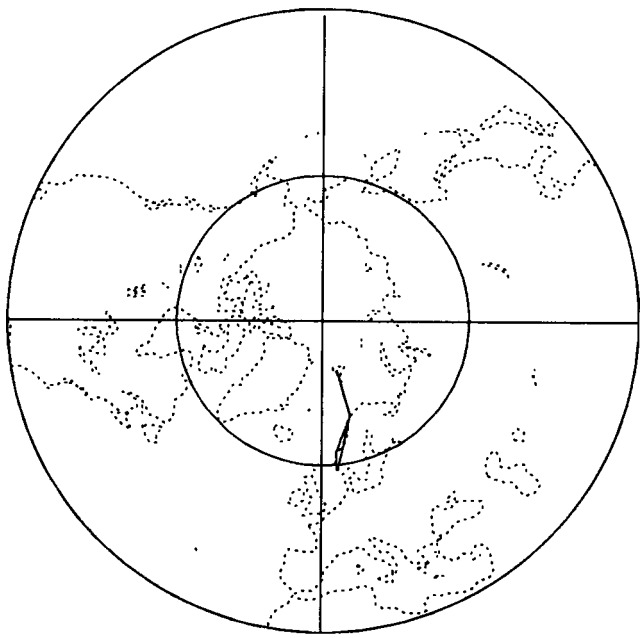
ER-2 FLIGHT TRACK 890107



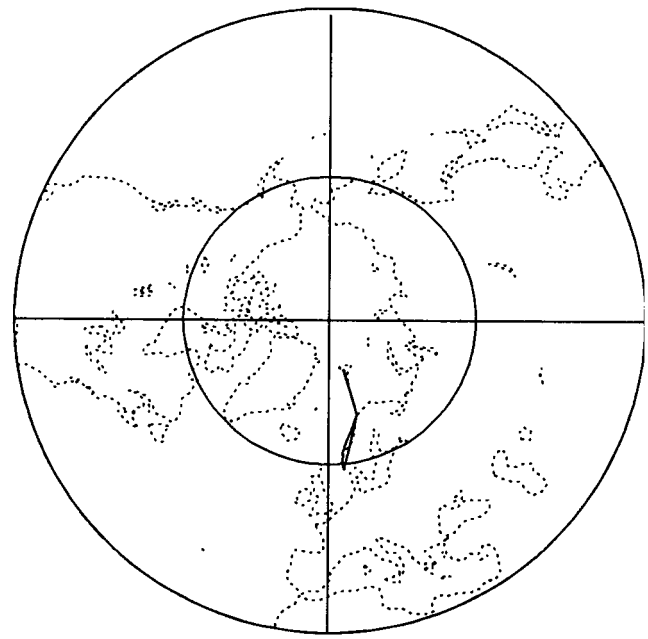
ER-2 FLIGHT TRACK 890112



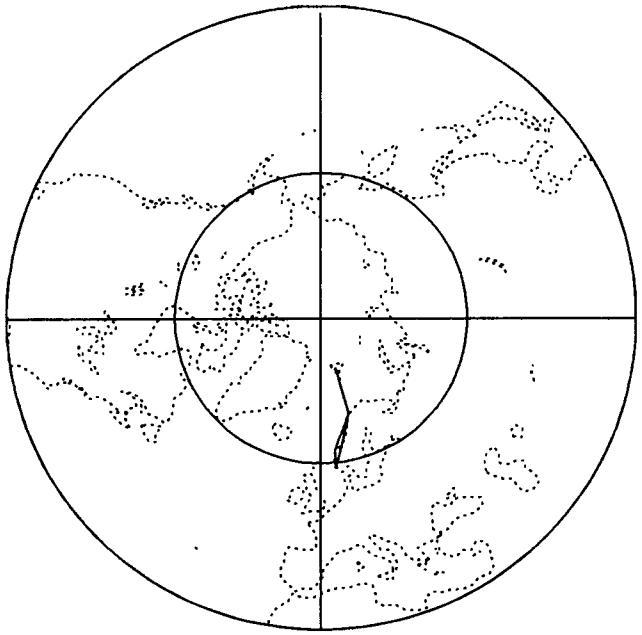
ER-2 FLIGHT TRACK 890116



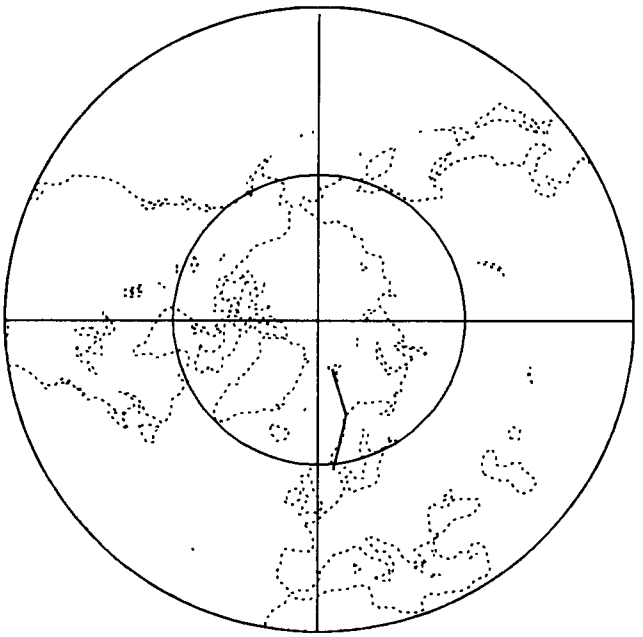
ER-2 FLIGHT TRACK 890119



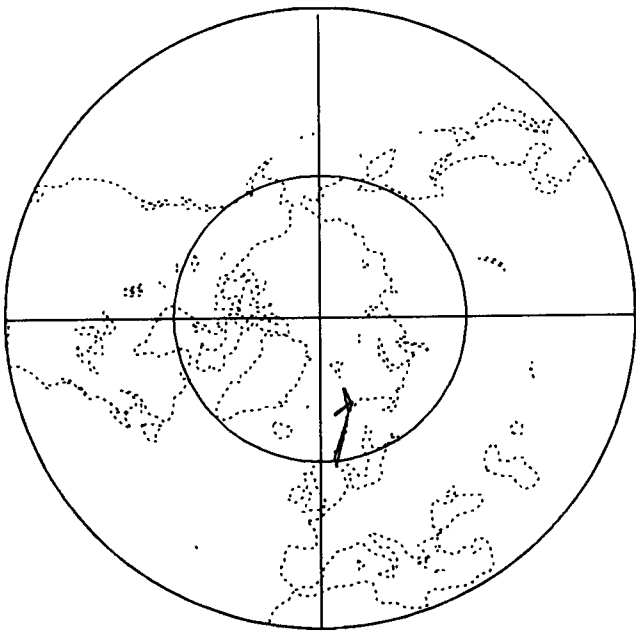
ER-2 FLIGHT TRACK 890120



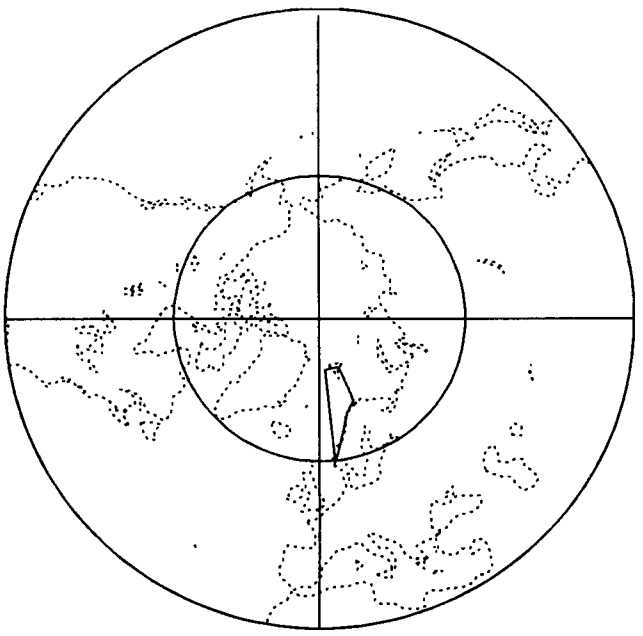
ER-2 FLIGHT TRACK 890124



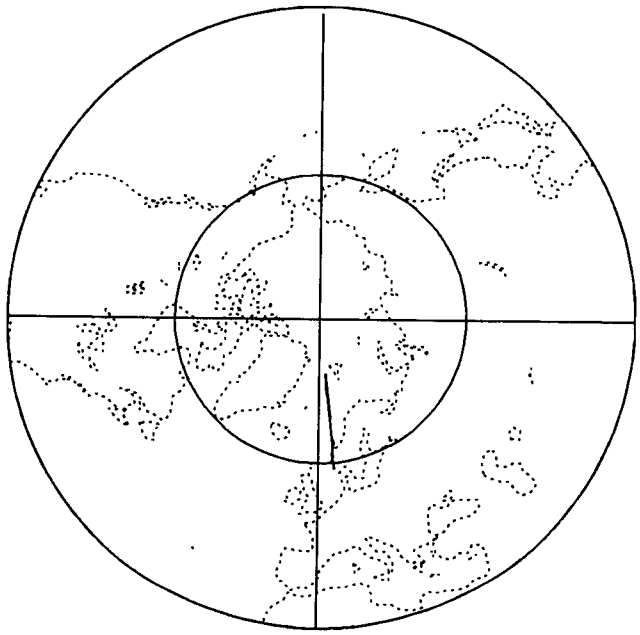
ER-2 FLIGHT TRACK 890125



ER-2 FLIGHT TRACK 890130



ER-2 FLIGHT TRACK 890207



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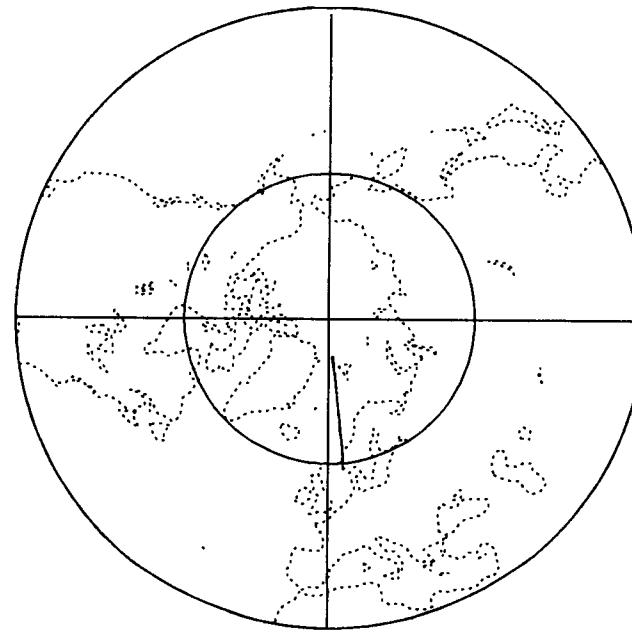

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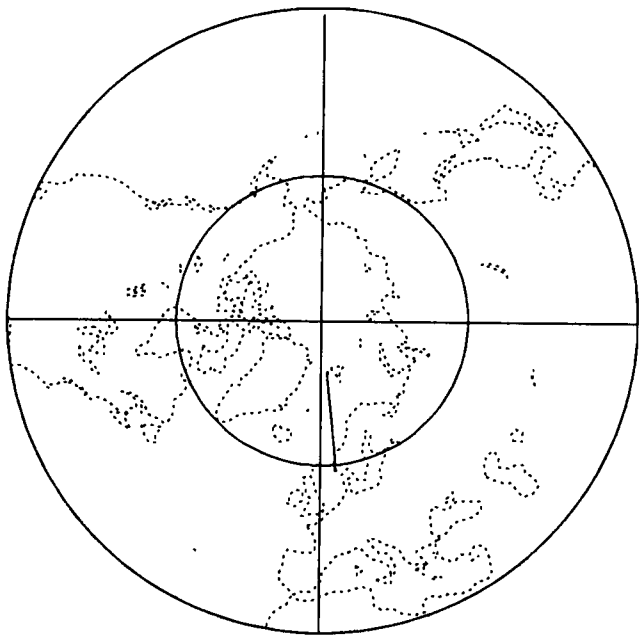
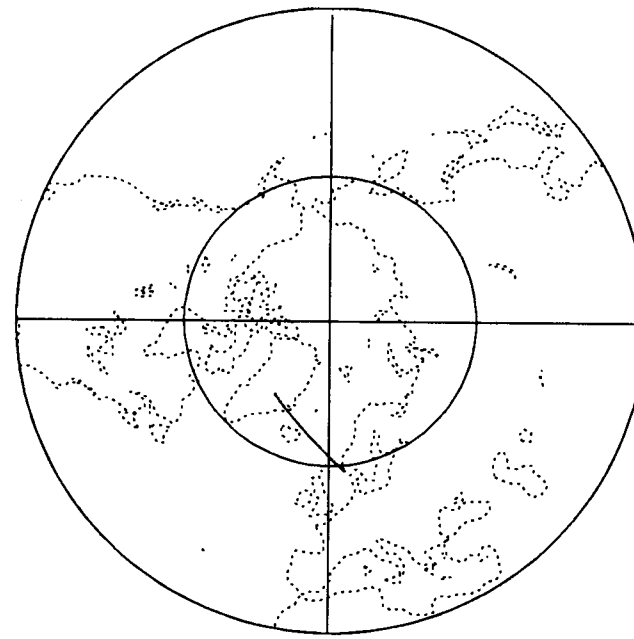


ER-2 FLIGHT TRACK 890210



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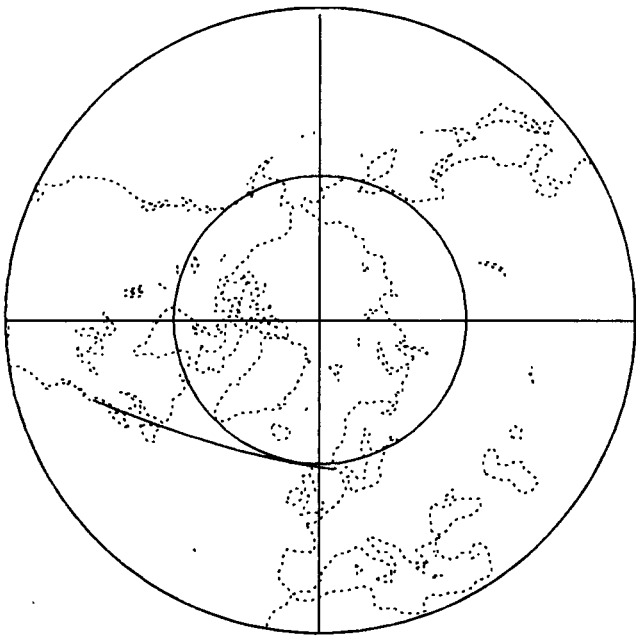
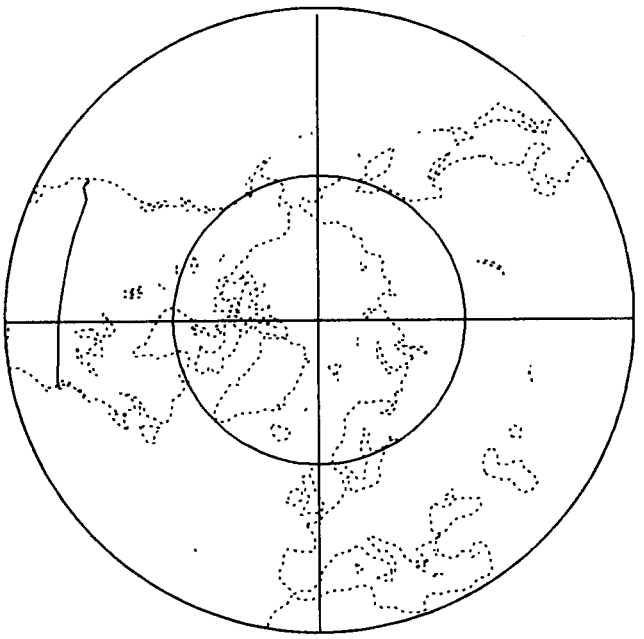
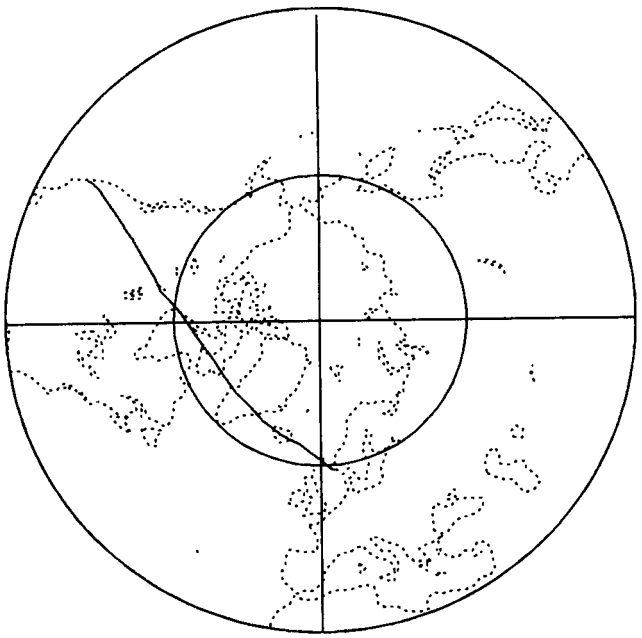


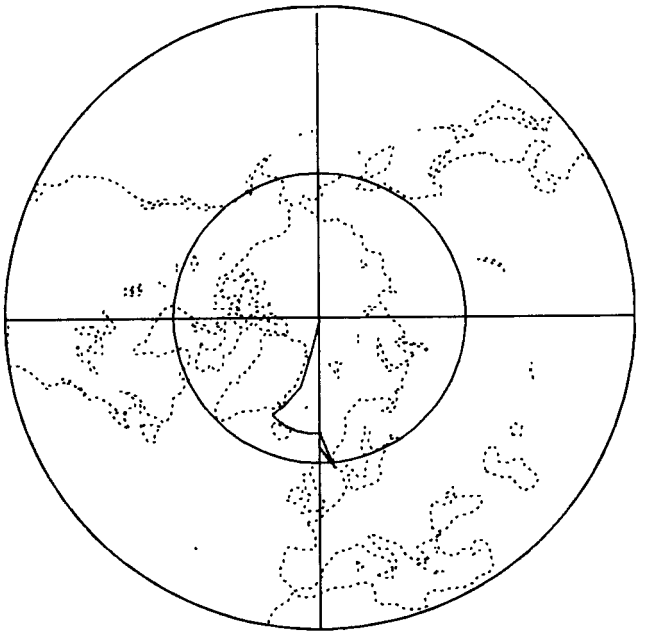
ER-2 FLIGHT TRACK 890221



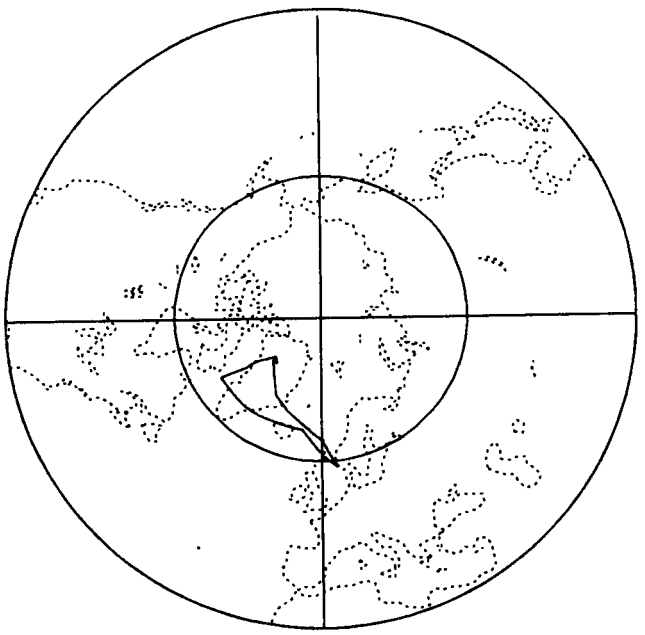
DC-8 FLIGHT TRACK 890102



DC-8 FLIGHT TRACK 890106



DC-8 FLIGHT TRACK 890109



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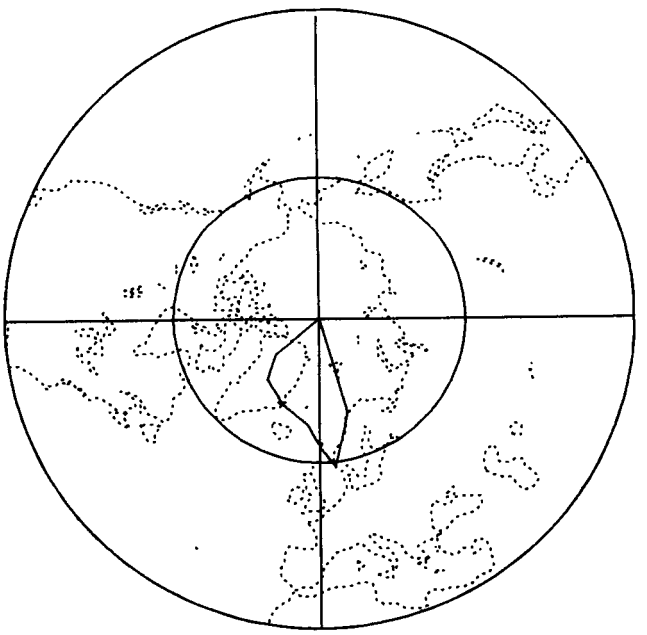

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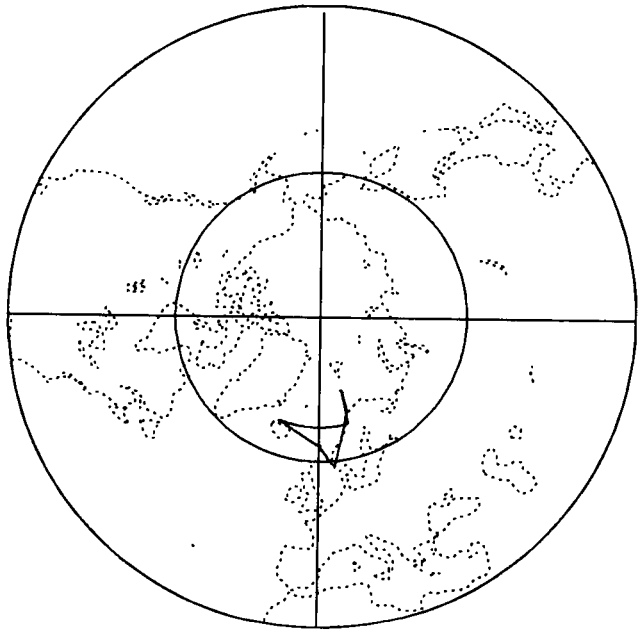

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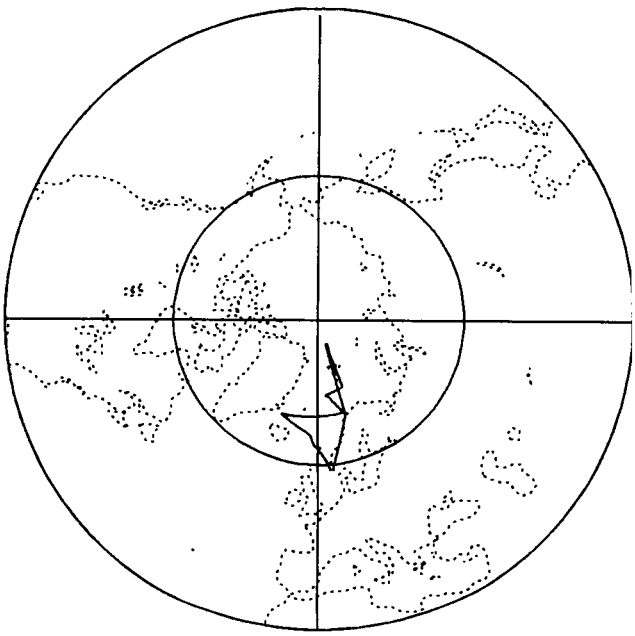

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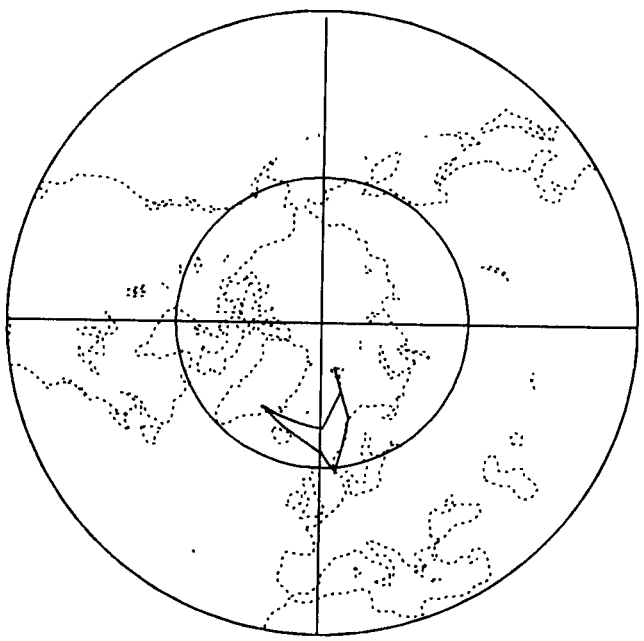

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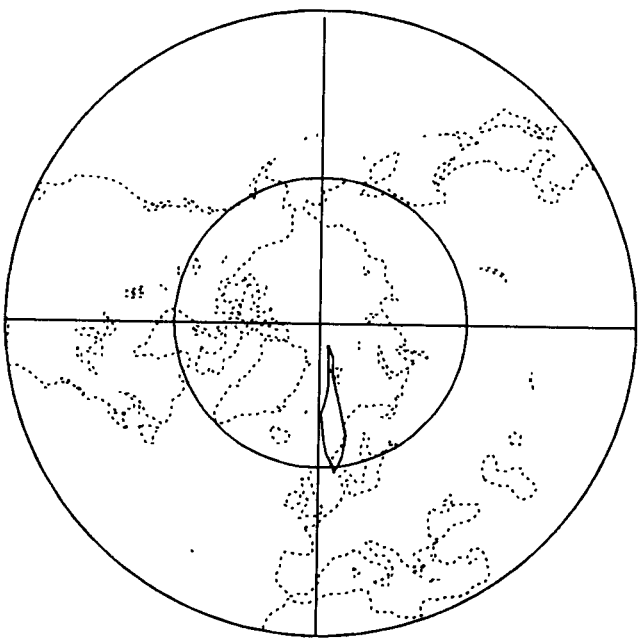
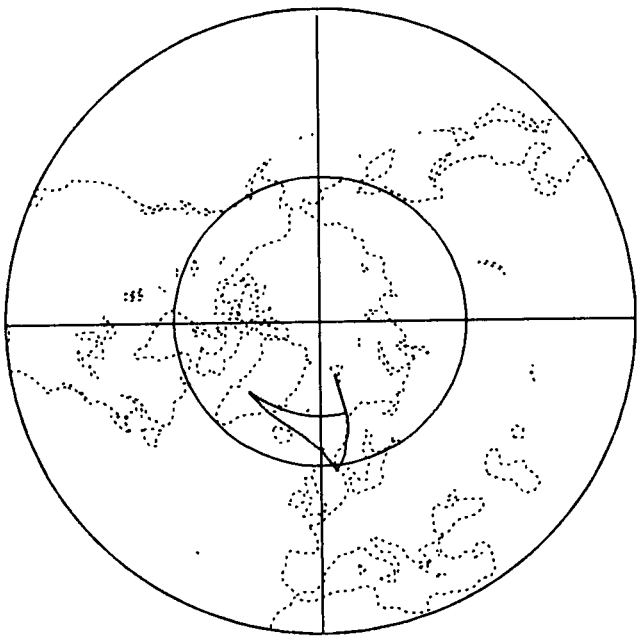
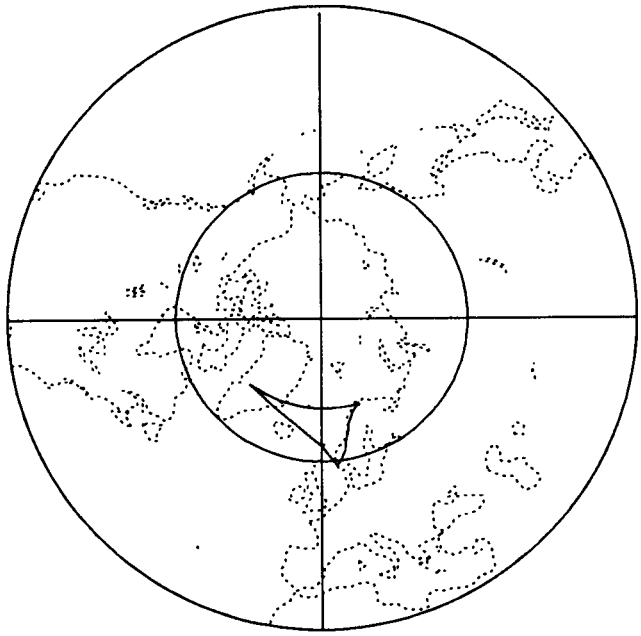


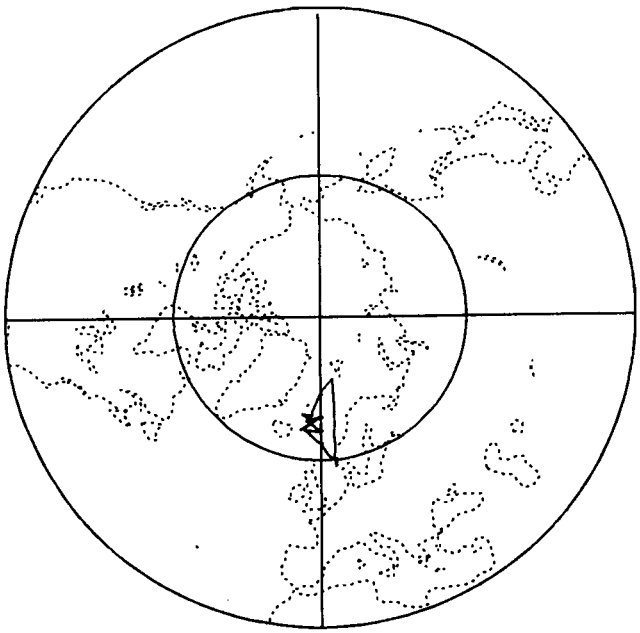
DC-8 FLIGHT TRACK 890126



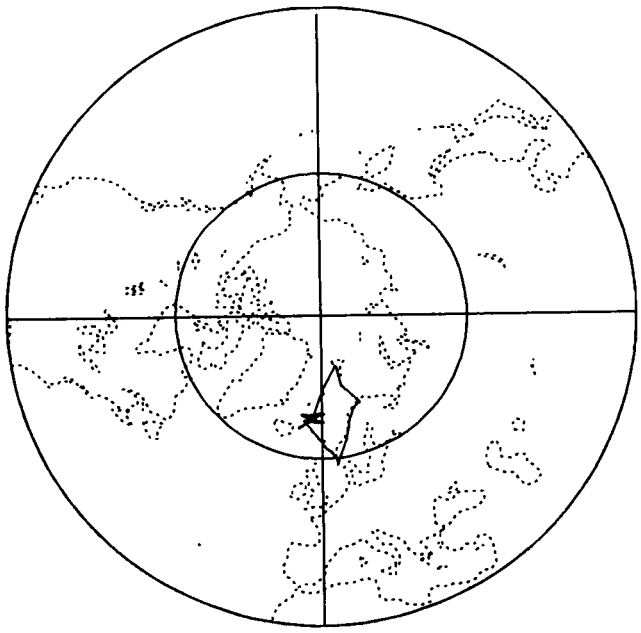
DC-8 FLIGHT TRACK 890129



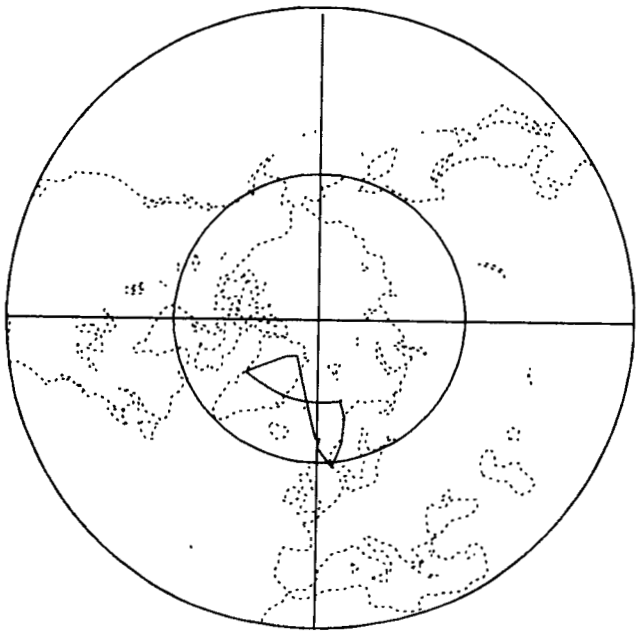
DC-8 FLIGHT TRACK 890131



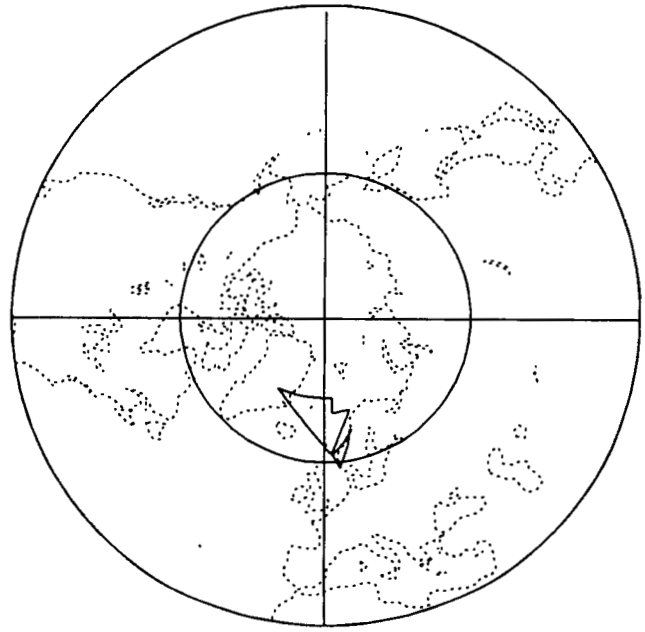
DC-8 FLIGHT TRACK 890202



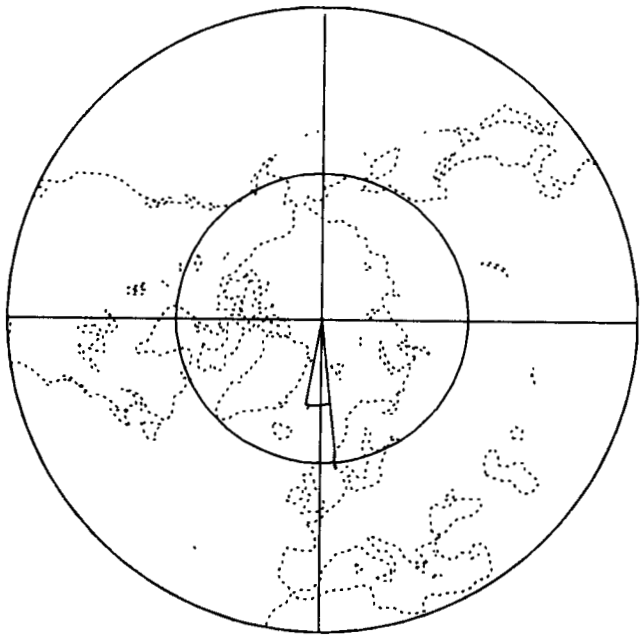
DC-8 FLIGHT TRACK 890205



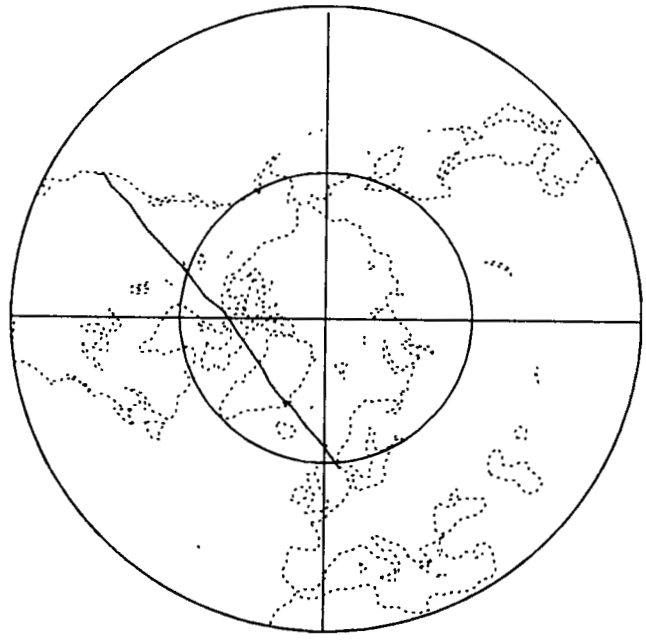
DC-8 FLIGHT TRACK 890207



DC-8 FLIGHT TRACK 890209



DC-8 FLIGHT TRACK 890215

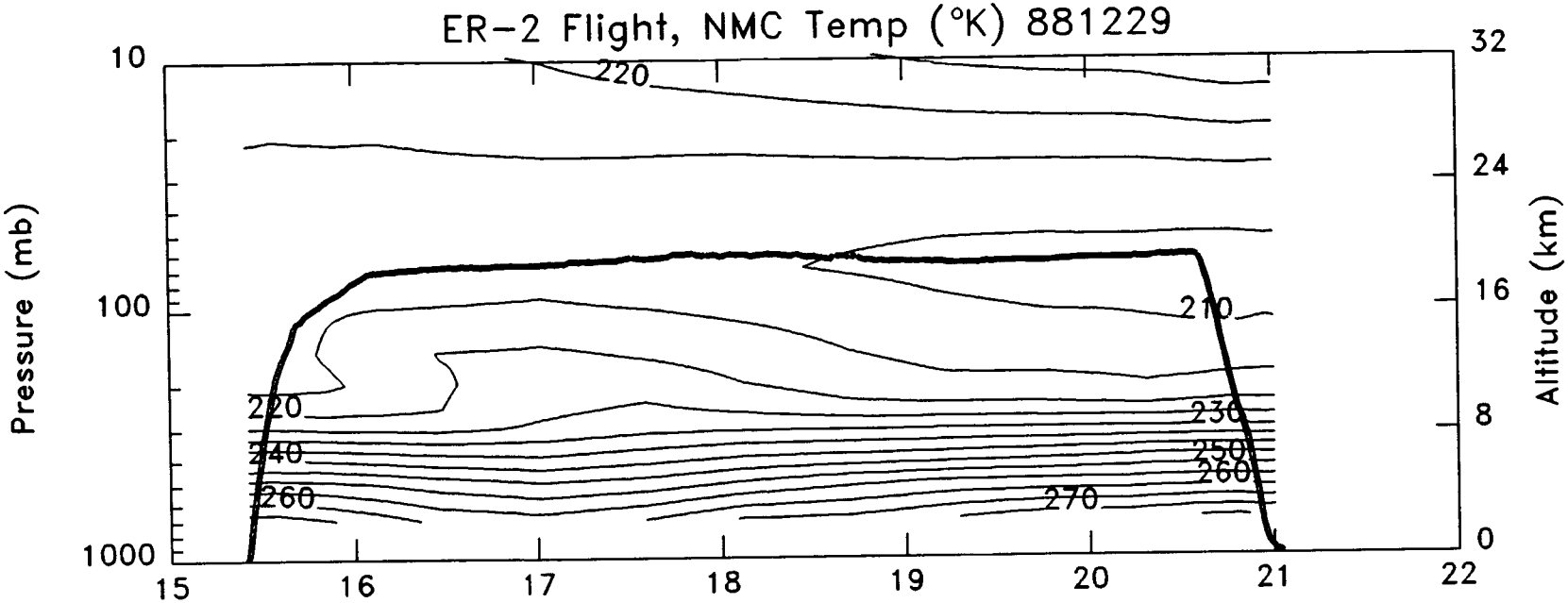


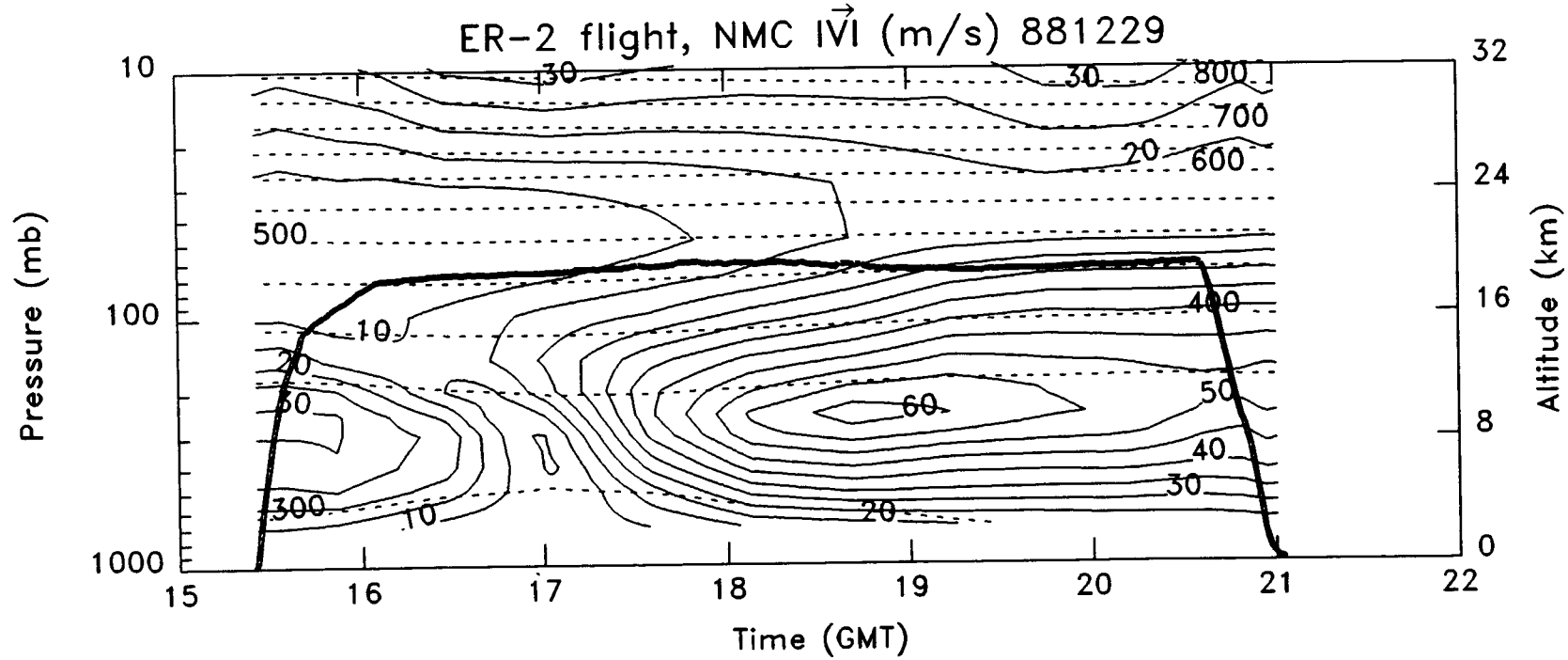
Section IV

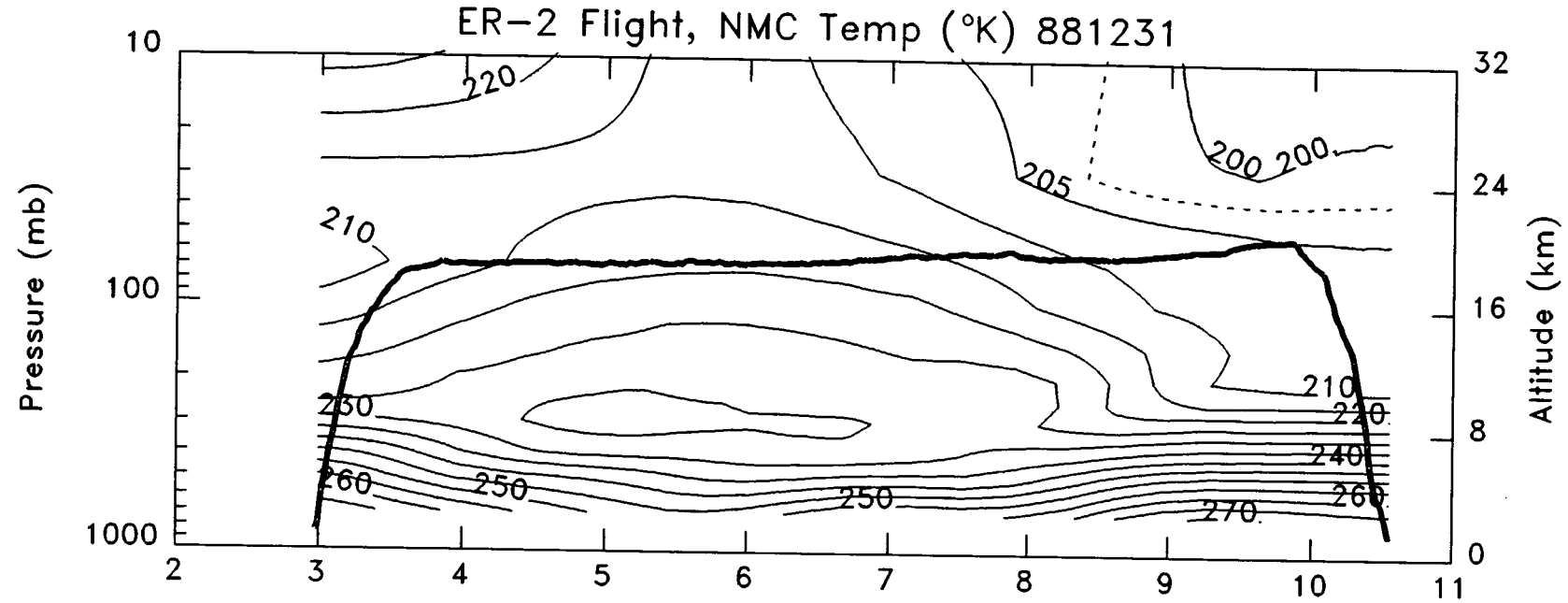
Section IVa, ER-2 Curtain files

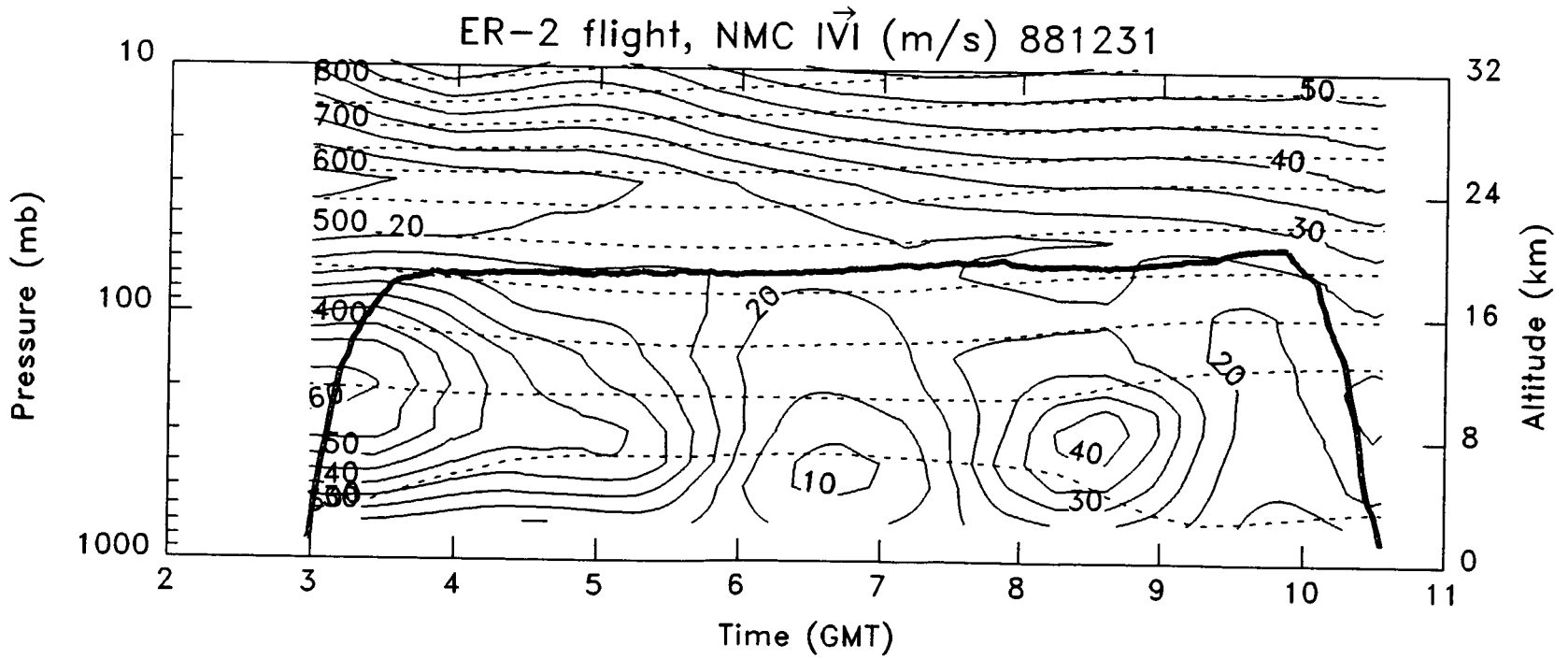
Top: Temperatures following the ER-2. The thin solid lines are at 5 K contour increments, while the dashed lines are at 2.5 K contour increments. The thick solid line indicates the ER-2 pressure altitude. The pressure scale is indicated on the left side of the figure, while the pressure altitude is on the right.

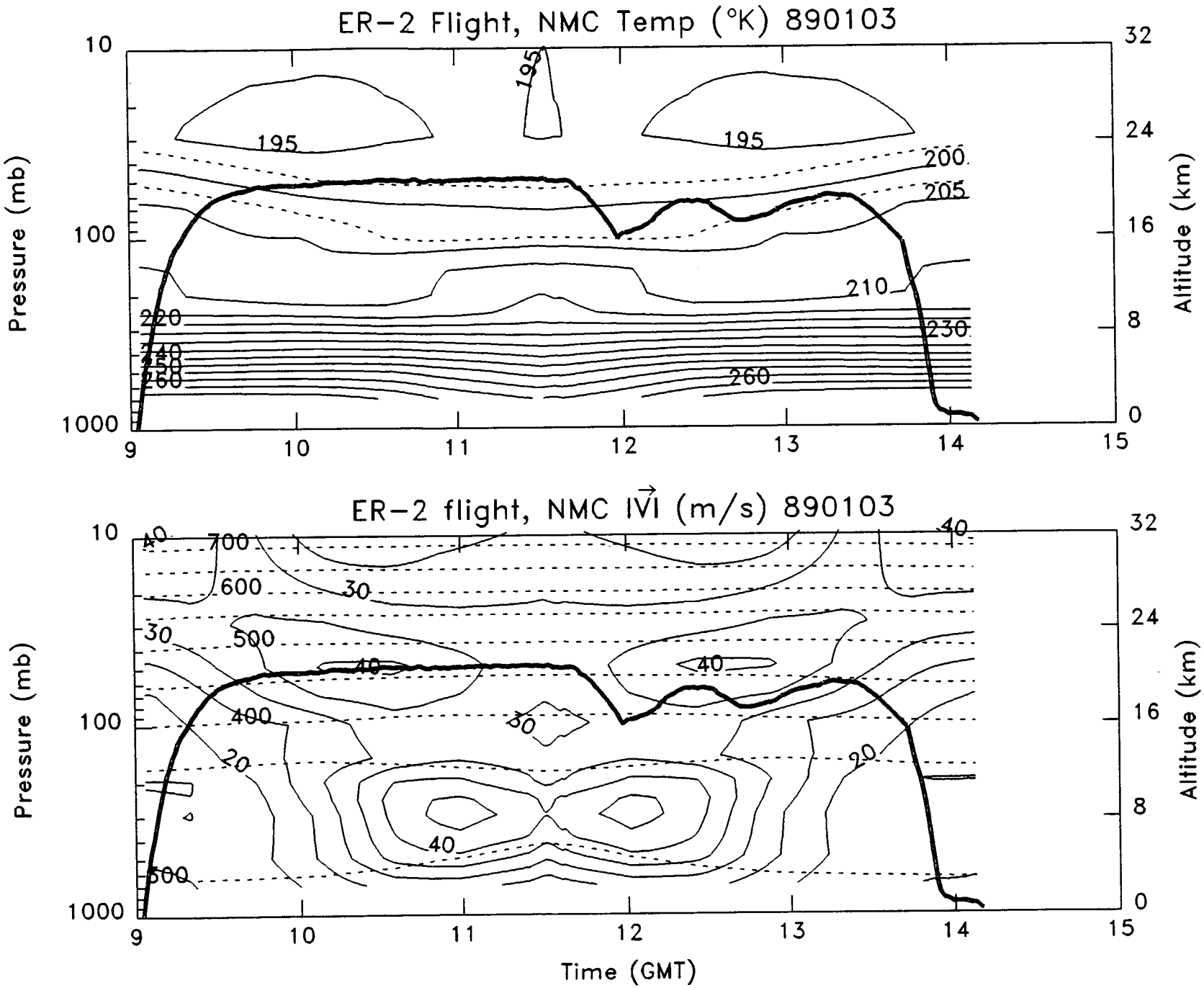
Bottom: As in the top figure, but for isotachs ($\sqrt{[u^2+v^2]}$, thin solid lines, 5m/s contour increments) and potential temperature (dashed lines, 50 K contour increments).

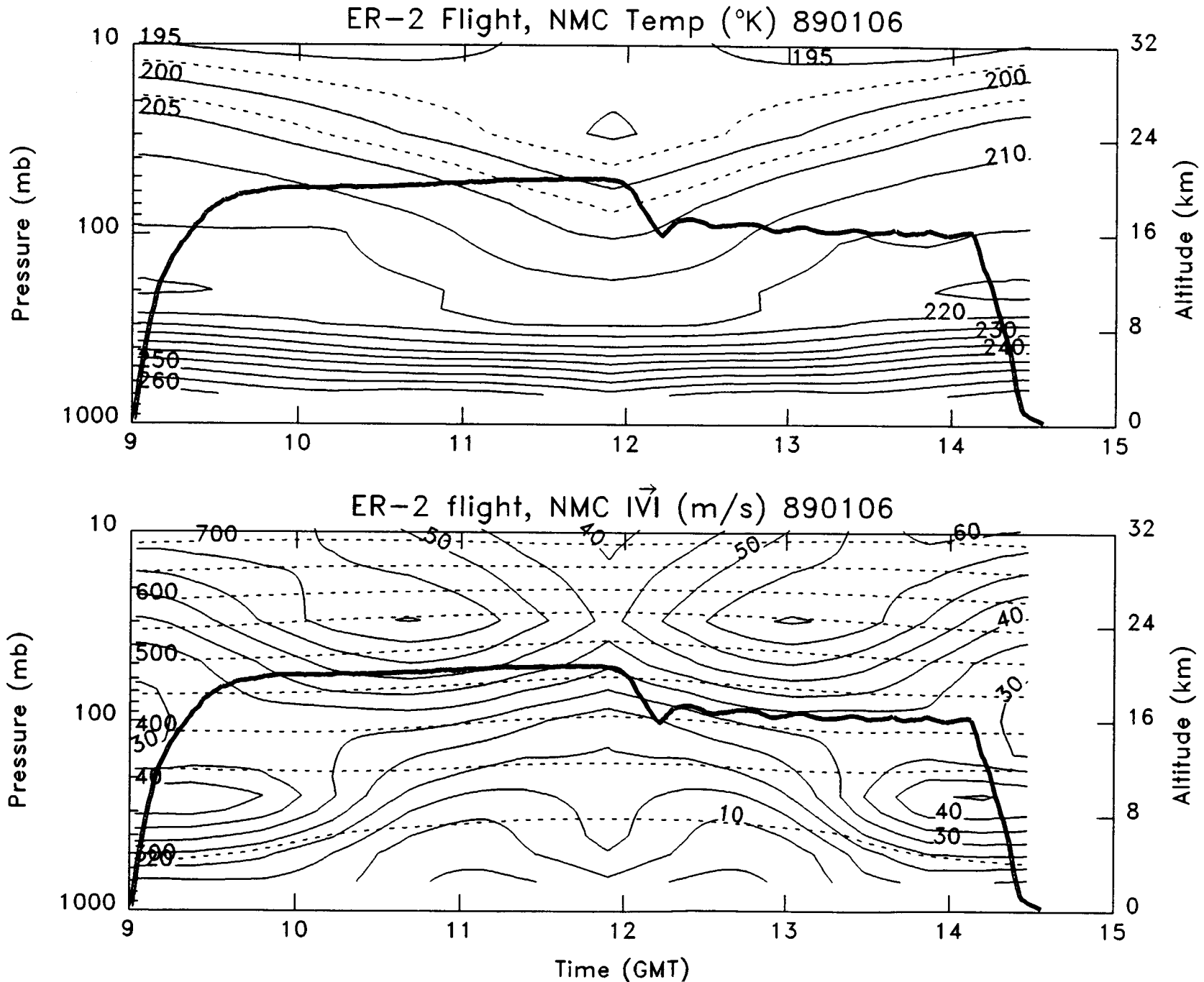

ER-2 Flight, NMC Temp (°K) 881229
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
15
16
17
18
19
20
21
22
220
210
230
240
250
260
270

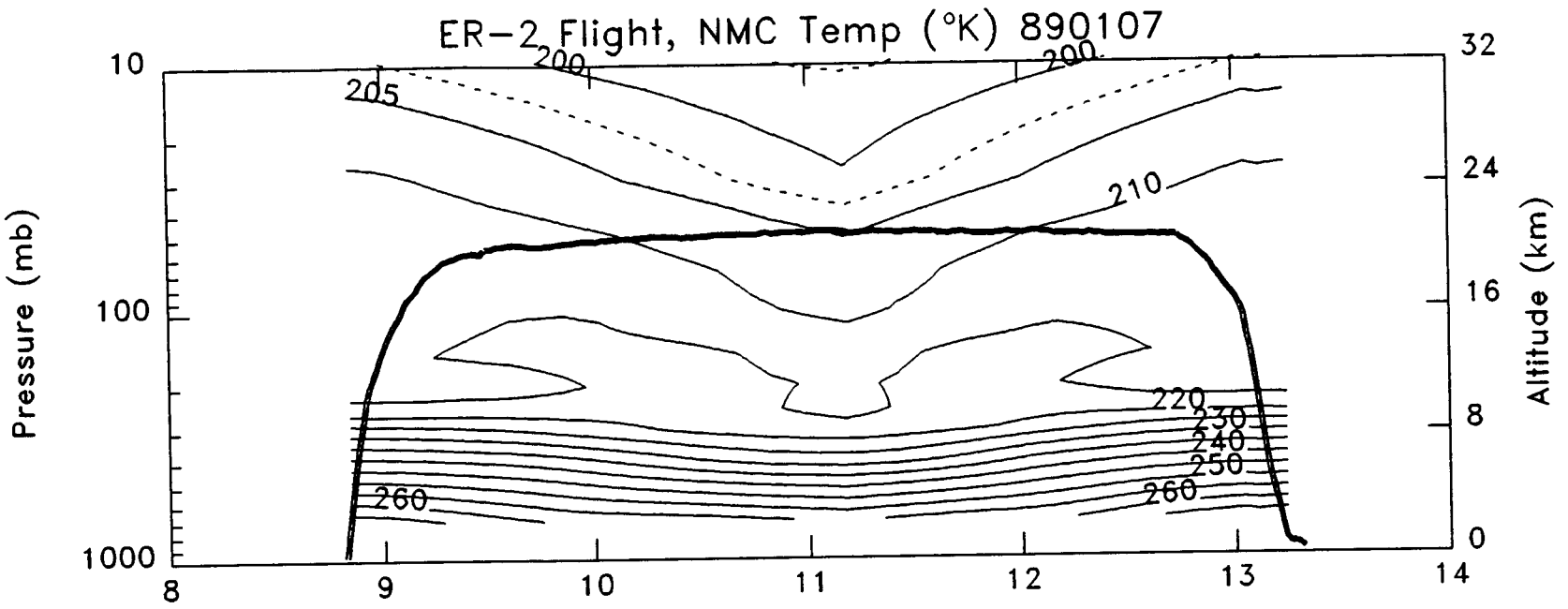

ER-2 flight, NMC |V| (m/s) 881229
Pressure (mb)
Altitude (km)
Time (GMT)
10
100
1000
32
24
16
8
0
15
16
17
18
19
20
21
22
30
800
700
600
500
400
300
60
50
40
20
10

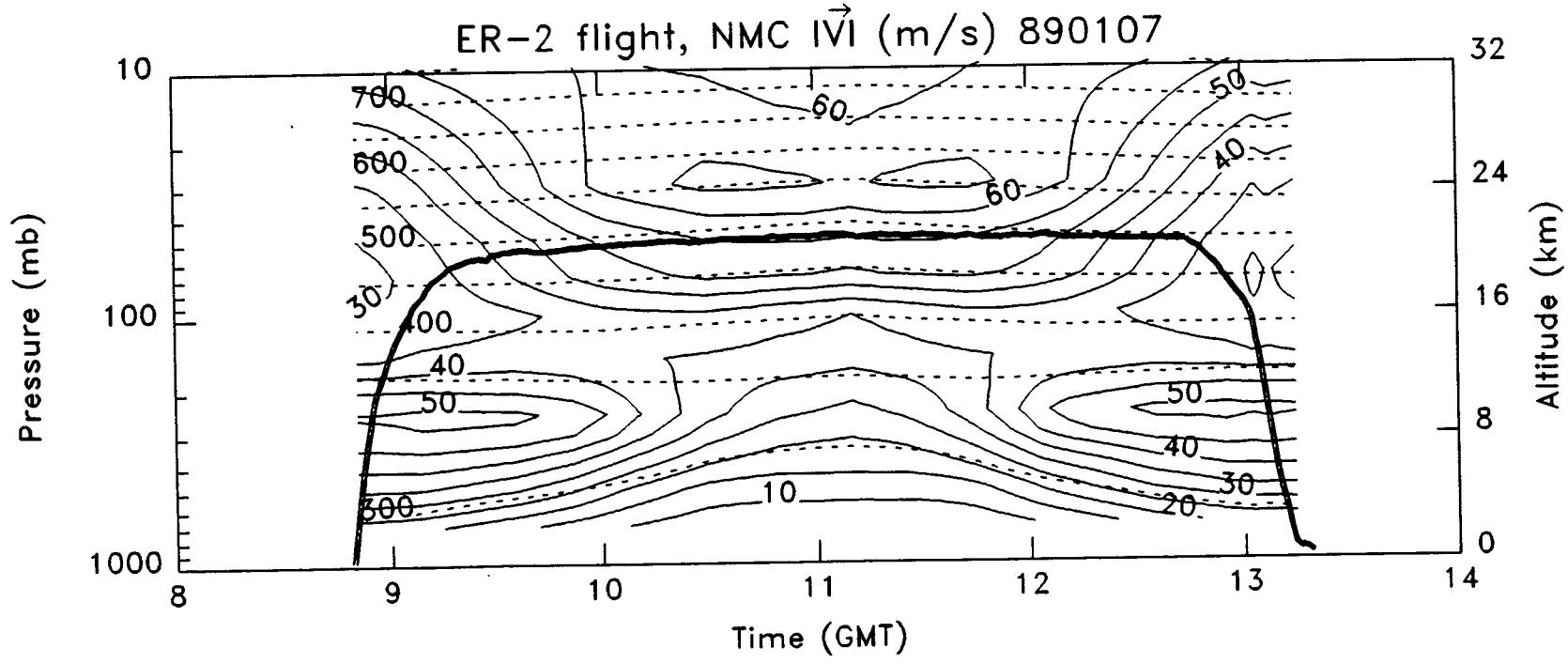

ER-2 Flight, NMC Temp (°K) 881231
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
2
3
4
5
6
7
8
9
10
11
220
205
200
210
250
260
270
240

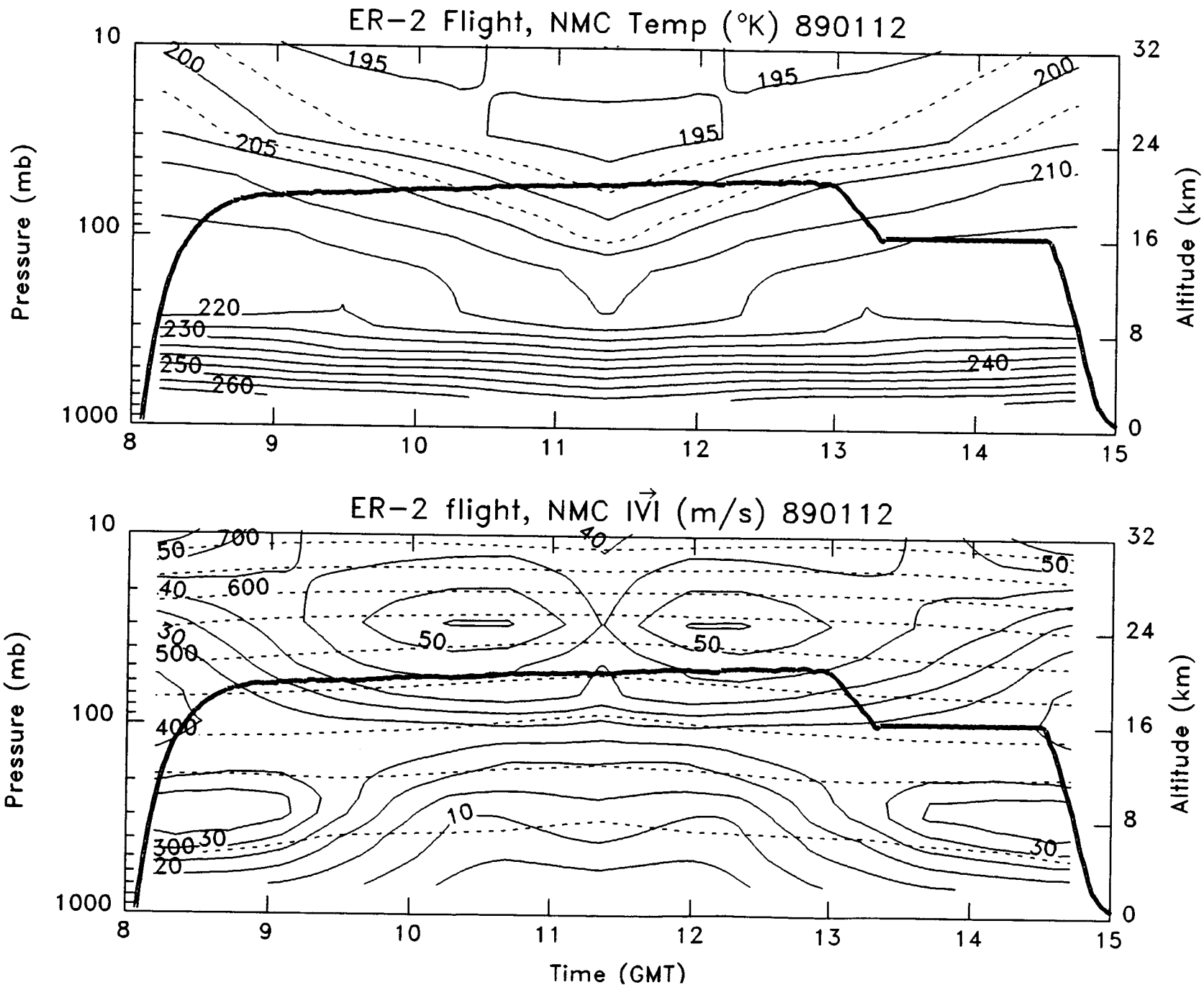

ER-2 flight, NMC |V| (m/s) 881231
Pressure (mb)
Altitude (km)
Time (GMT)
10
100
1000
32
24
16
8
0
2
3
4
5
6
7
8
9
10
11
800
700
600
500
400
60
50
40
20
10
30

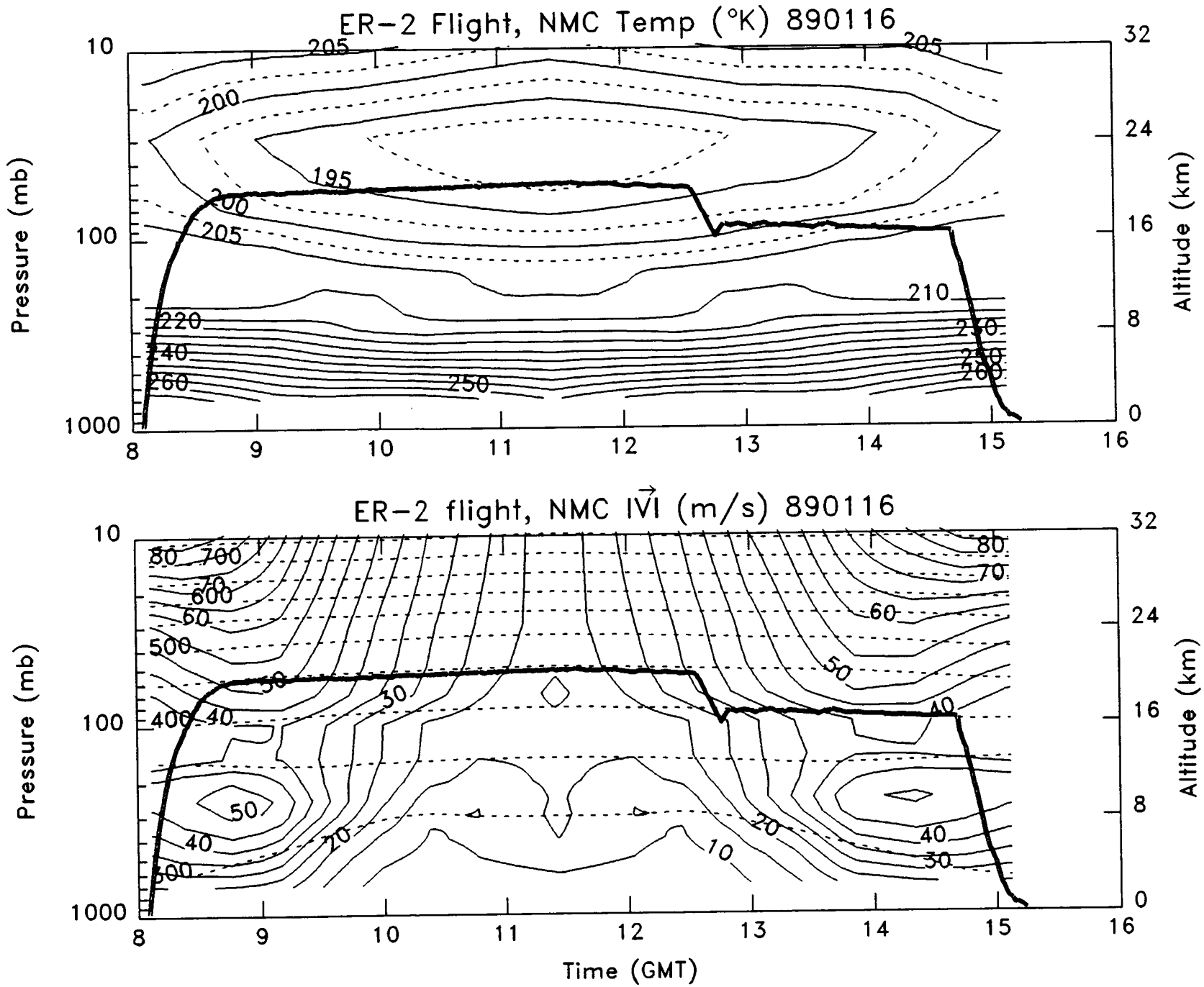

ER-2 Flight, NMC Temp (°K) 890103
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
195
200
205
210
220
230
240
250
260
ER-2 flight, NMC |V| (m/s) 890103
700
600
500
400
30
20
40
Time (GMT)

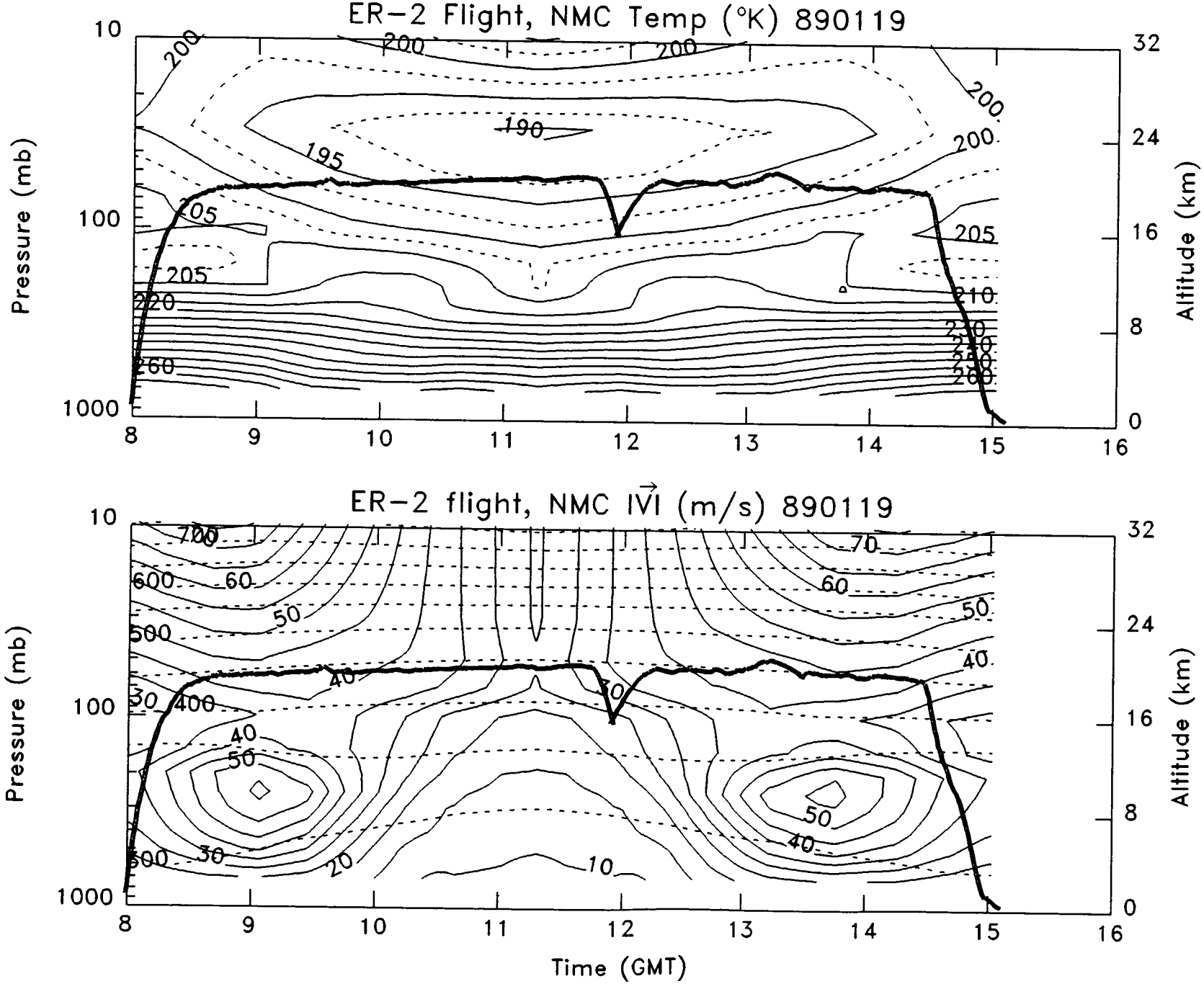

ER−2 Flight, NMC Temp (°K) 890106
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
195
200
205
210
220
230
240
250
260
ER−2 flight, NMC |V| (m/s) 890106
700
600
500
400
300
60
50
40
30
20
10
Time (GMT)

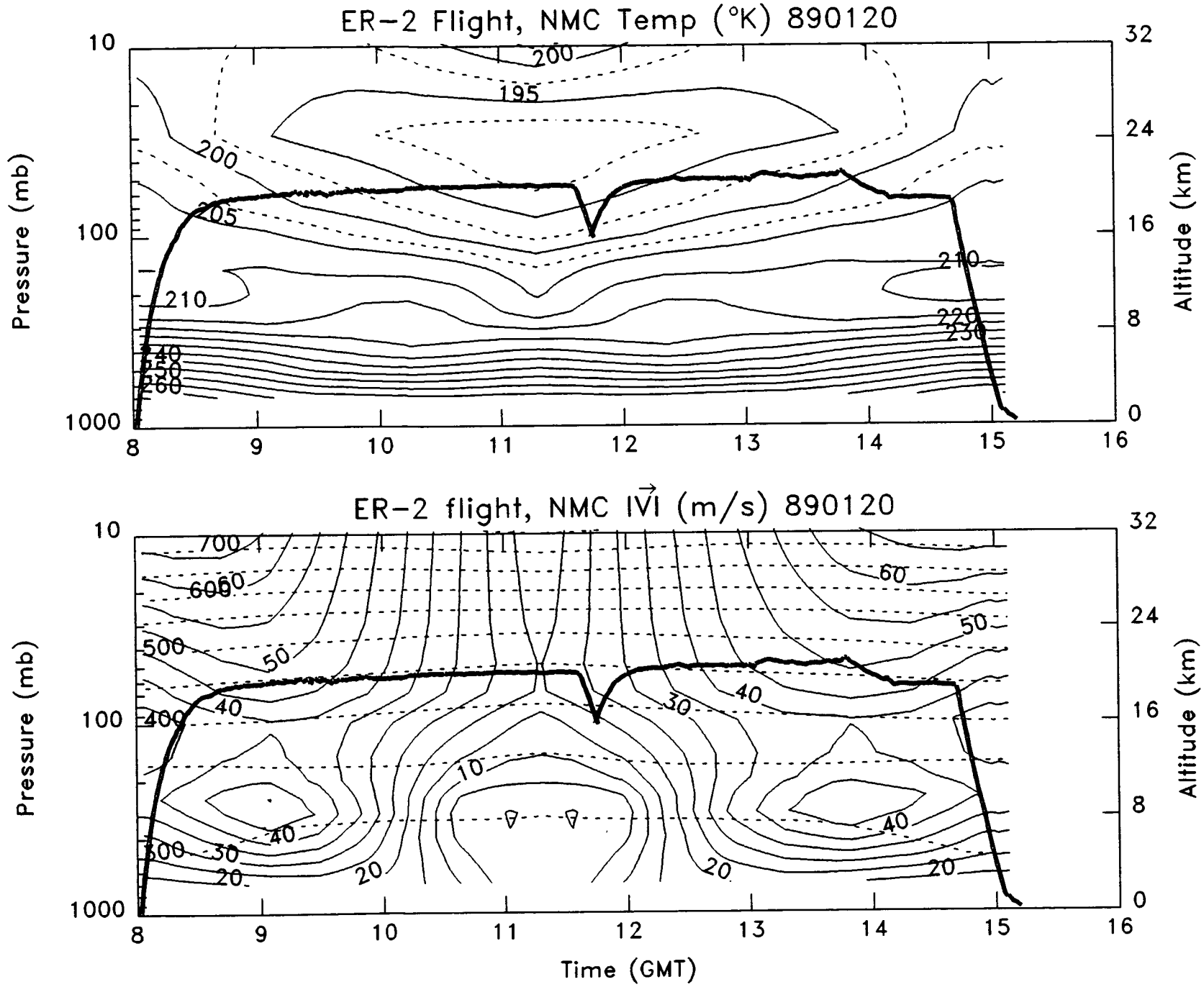

ER-2 Flight, NMC Temp (°K) 890107
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
200
205
210
220
230
240
250
260

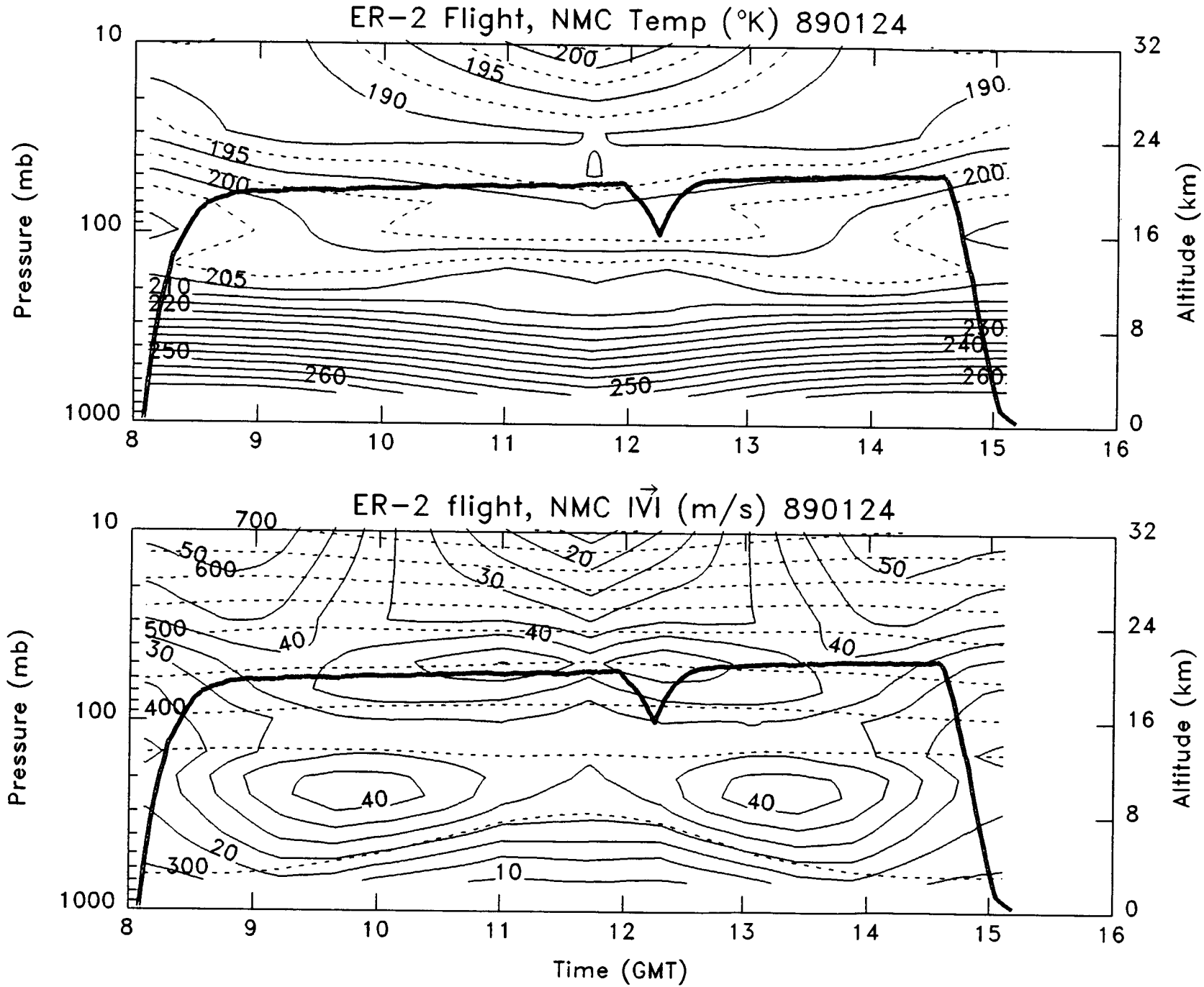

ER-2 flight, NMC |V| (m/s) 890107
Pressure (mb)
Altitude (km)
Time (GMT)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
700
600
500
400
300
60
50
40
30
20
10

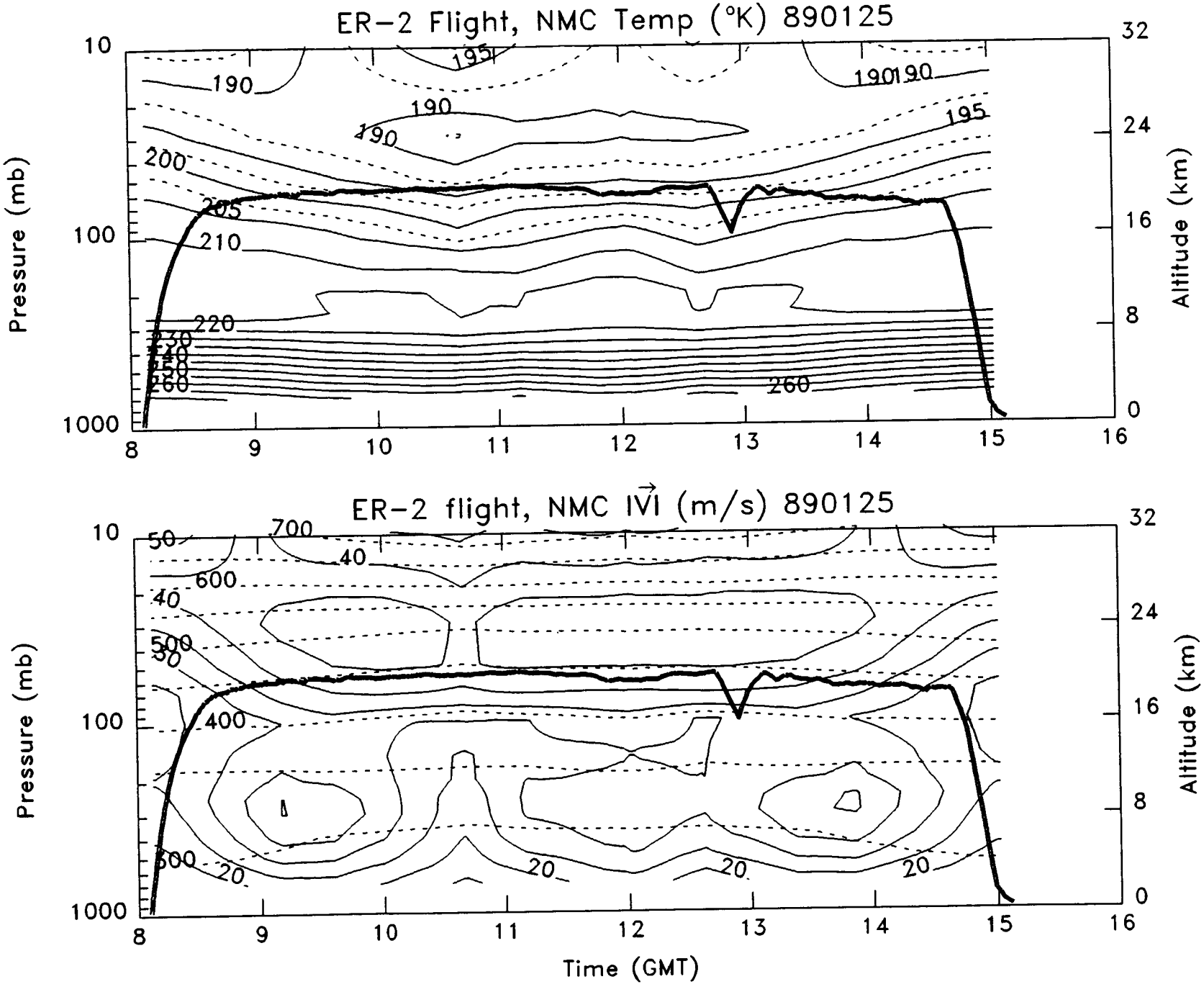

ER-2 Flight, NMC Temp (°K) 890112
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
200
195
205
210
220
230
250
260
240
8
9
10
11
12
13
14
15
ER-2 flight, NMC |V| (m/s) 890112
Pressure (mb)
Altitude (km)
Time (GMT)
700
600
500
400
300
20
50
40
30
10

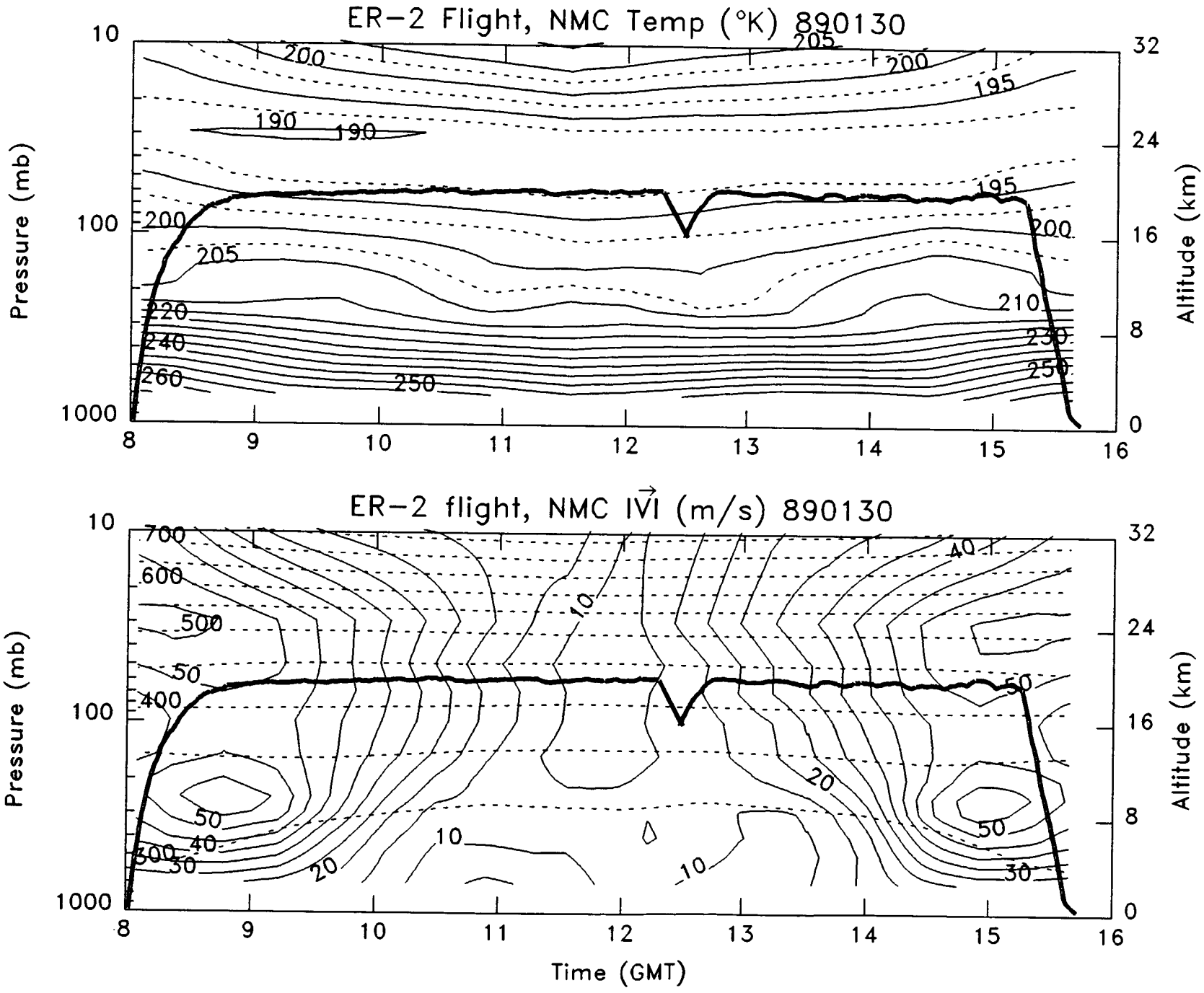

ER-2 Flight, NMC Temp (°K) 890116
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
205
200
195
210
220
240
260
250
8
9
10
11
12
13
14
15
16
ER-2 flight, NMC |V| (m/s) 890116
Pressure (mb)
Altitude (km)
Time (GMT)
80
70
60
50
40
30
20
10

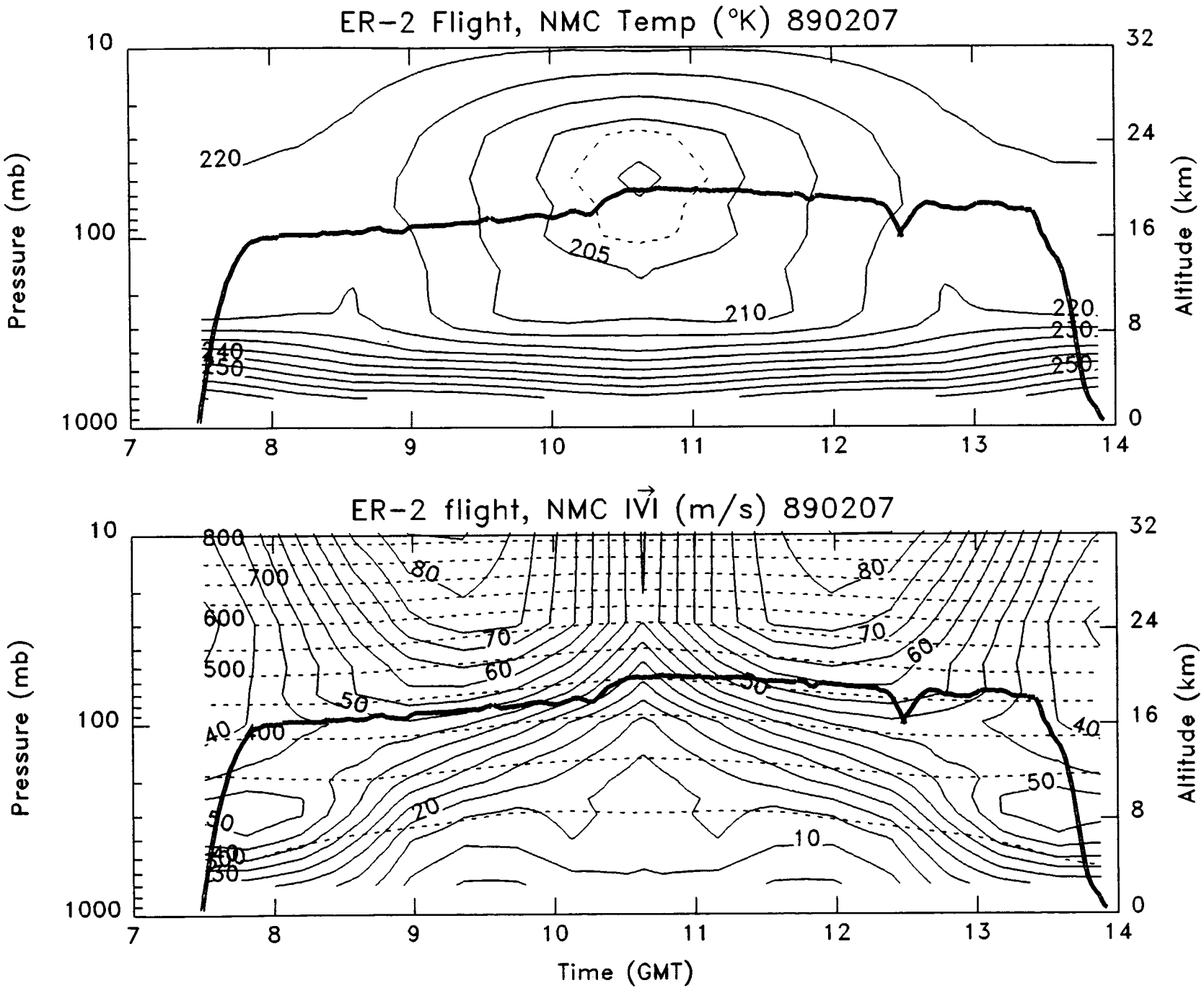

ER-2 Flight, NMC Temp (°K) 890119
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
15
16
200
195
190
205
210
220
260
ER-2 flight, NMC |V| (m/s) 890119
Time (GMT)
700
600
500
400
300
70
60
50
40
30
20
10

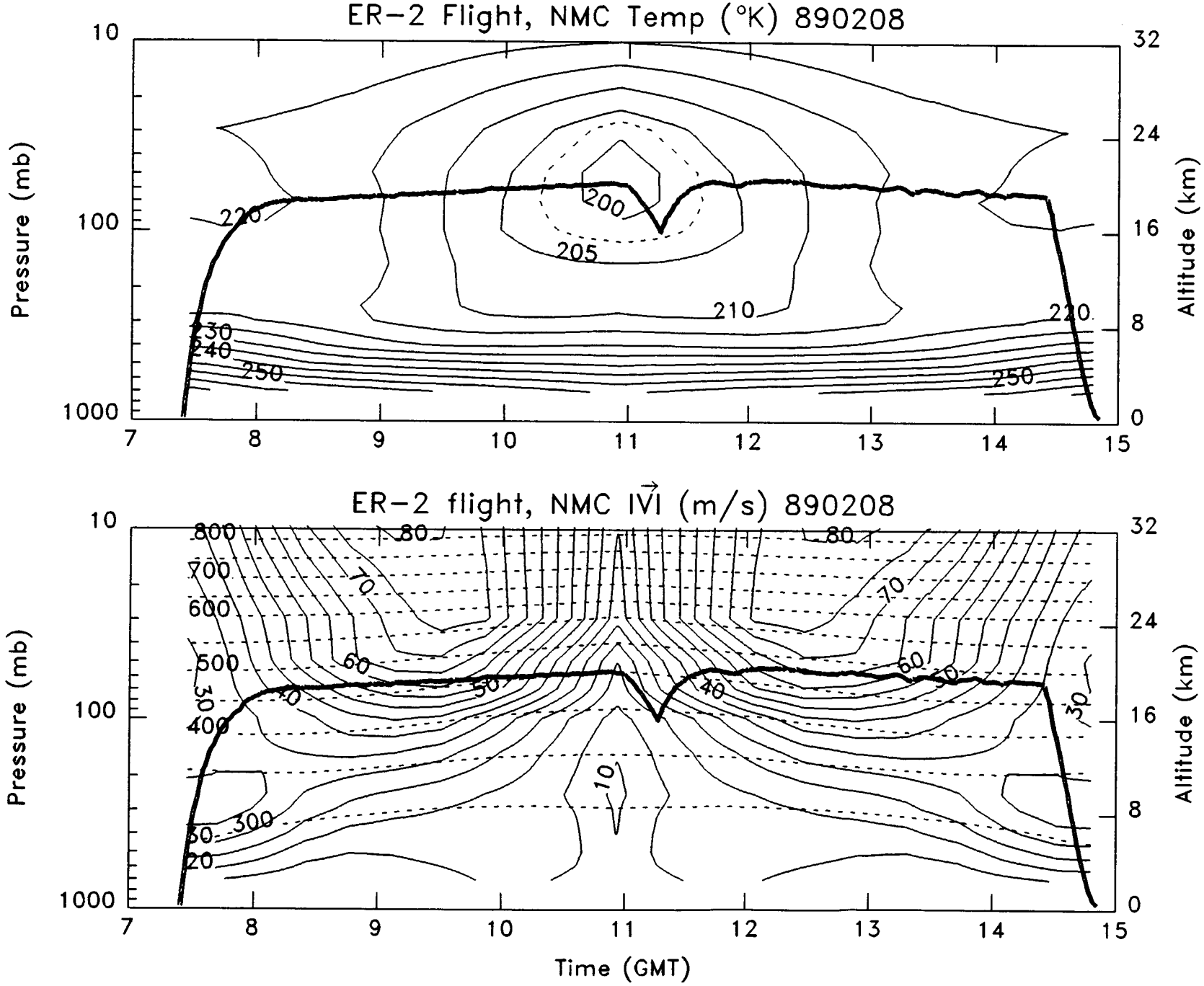

ER-2 Flight, NMC Temp (°K) 890120
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
200
195
200
205
210
210
220
230
240
250
260
8
9
10
11
12
13
14
15
16
ER-2 flight, NMC |V| (m/s) 890120
Pressure (mb)
Altitude (km)
Time (GMT)
700
600
60
500
50
40
400
30
10
300
20

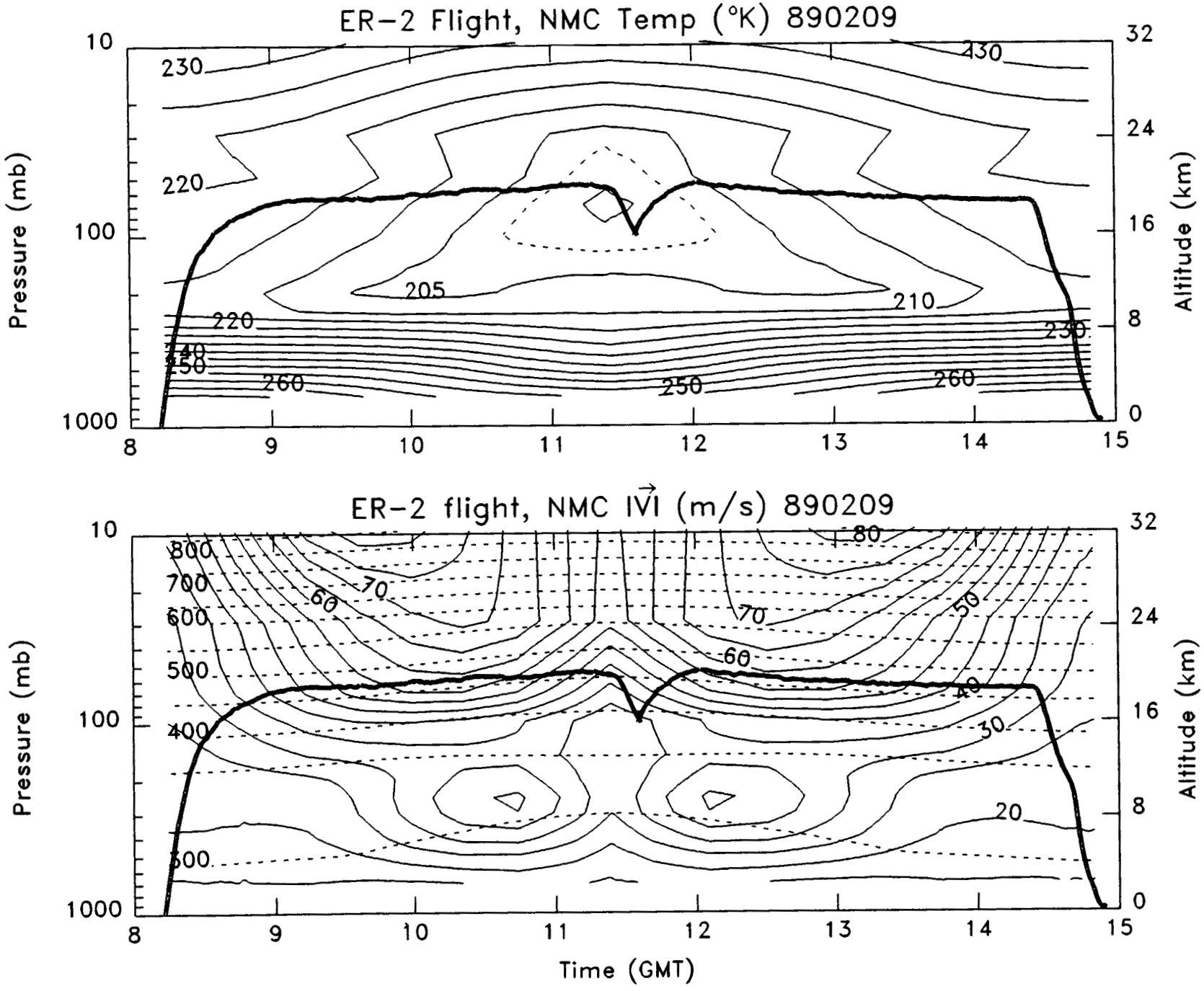

ER-2 Flight, NMC Temp (°K) 890124
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
15
16
190
195
200
205
210
220
230
240
250
260
ER-2 flight, NMC |V| (m/s) 890124
Pressure (mb)
Altitude (km)
Time (GMT)
700
600
500
400
300
50
30
20
40
10

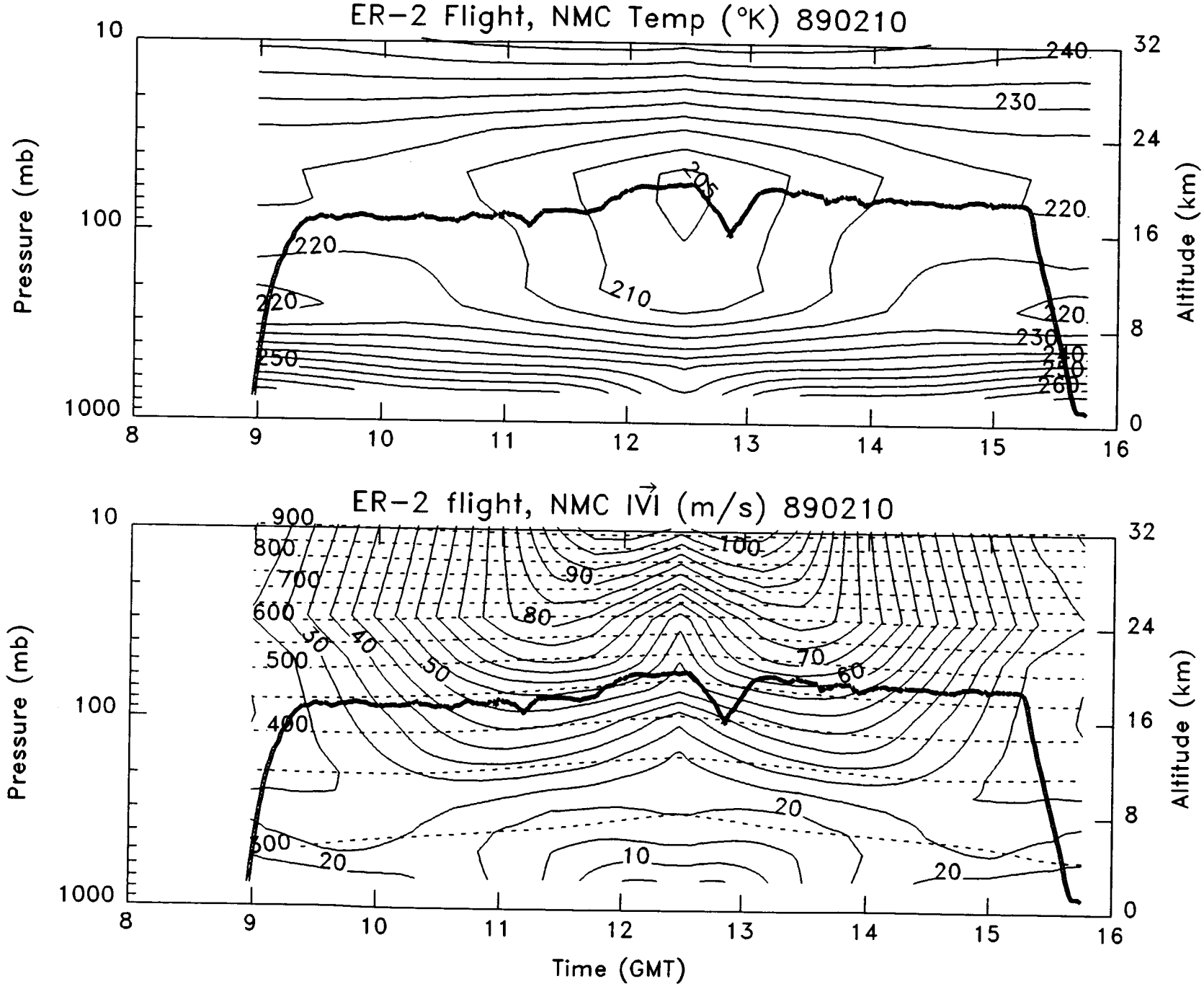

ER-2 Flight, NMC Temp (°K) 890125
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
15
16
195
190
200
205
210
220
230
240
250
260
ER-2 flight, NMC |V| (m/s) 890125
Time (GMT)
50
40
30
20
700
600
500
400
300

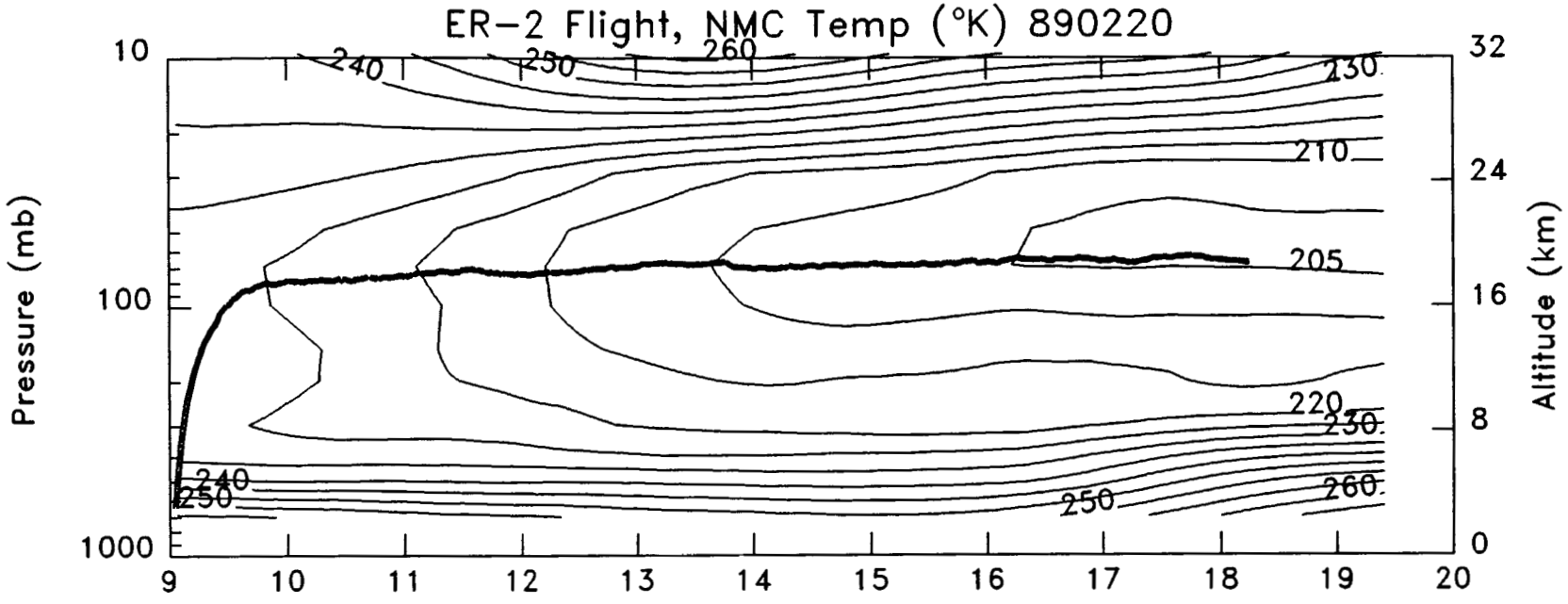

ER-2 Flight, NMC Temp (°K) 890130
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
15
16
200
205
190
195
210
220
240
260
250
ER-2 flight, NMC |V| (m/s) 890130
700
600
500
400
300
50
40
30
20
10
Time (GMT)

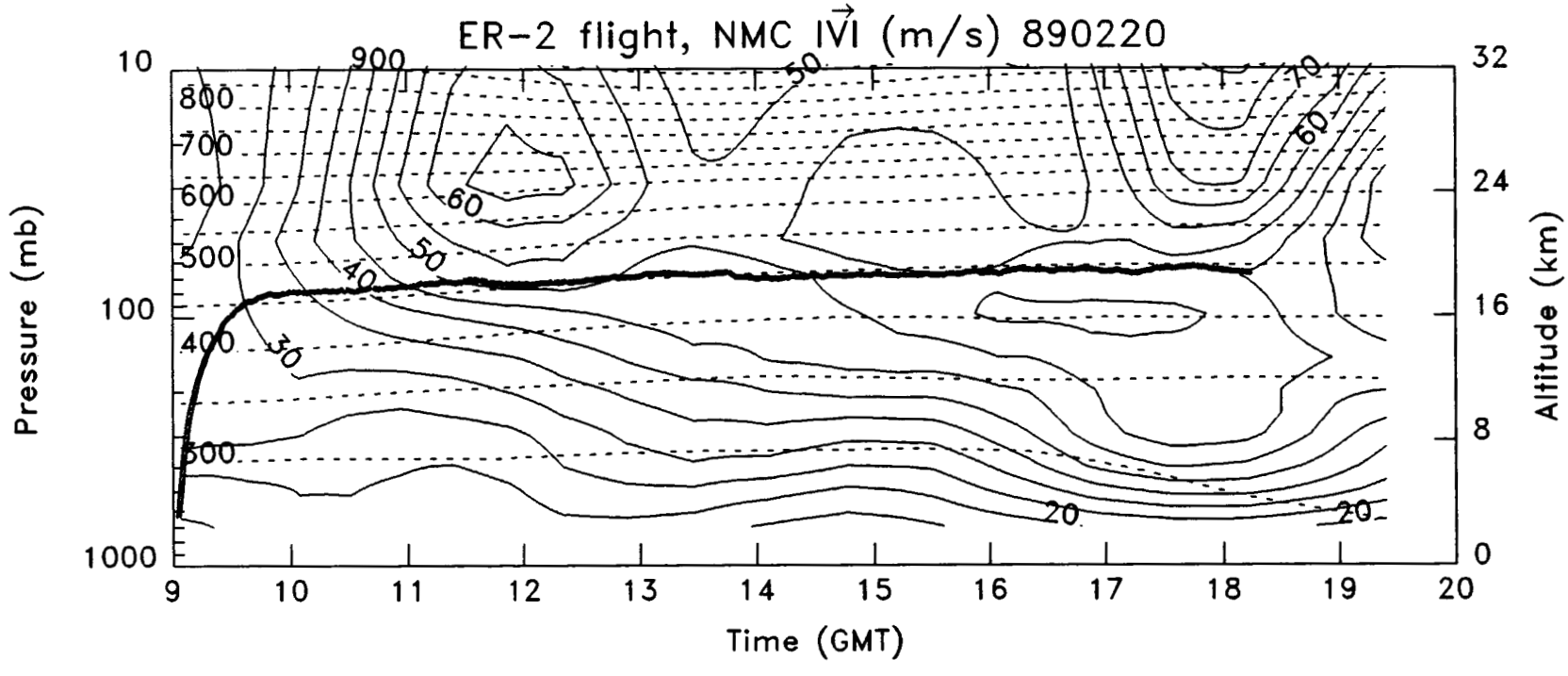

ER-2 Flight, NMC Temp (°K) 890207
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
220
205
210
240
250
230
ER-2 flight, NMC |V| (m/s) 890207
800
700
600
500
400
80
70
60
50
40
30
20
10
Time (GMT)

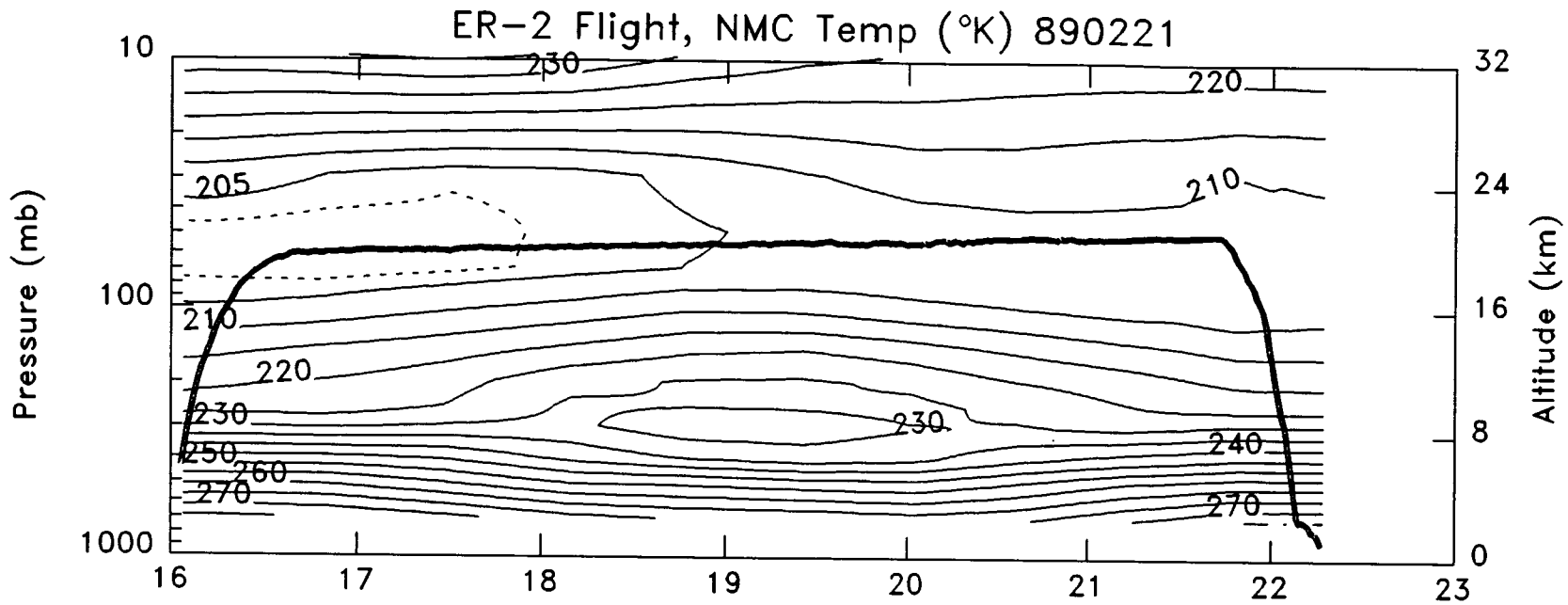

ER-2 Flight, NMC Temp (°K) 890208
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
15
220
200
205
210
220
230
240
250
250
ER-2 flight, NMC |V| (m/s) 890208
800
700
600
500
400
300
80
70
60
50
40
30
20
10
Time (GMT)

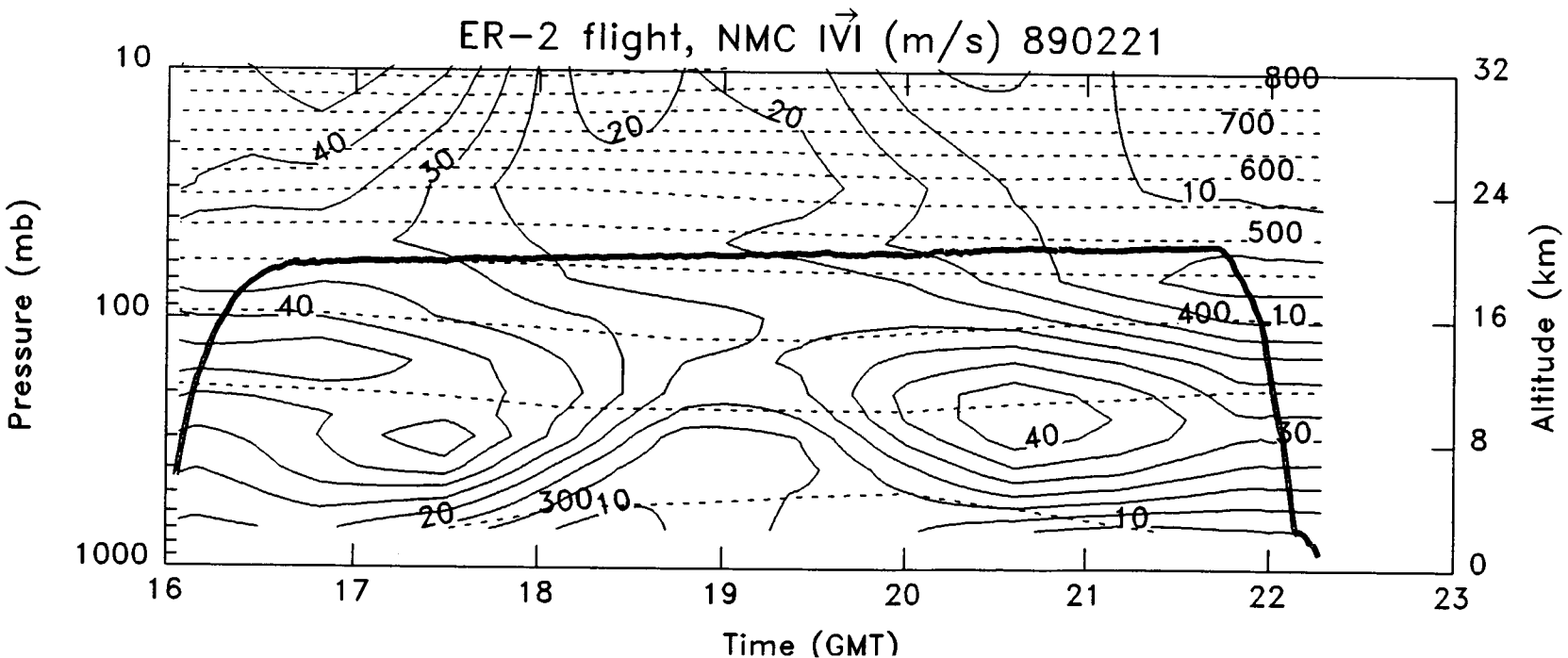

ER-2 Flight, NMC Temp (°K) 890209
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
230
220
430
205
210
240
250
260
8
9
10
11
12
13
14
15
ER-2 flight, NMC |V| (m/s) 890209
800
700
600
500
400
300
80
70
60
50
40
30
20
Time (GMT)


ER-2 Flight, NMC Temp (°K) 890210
Pressure (mb)
Altitude (km)
10
100
1000
8
9
10
11
12
13
14
15
16
0
8
16
24
32
240
230
220
210
205
250
260
ER-2 flight, NMC |V| (m/s) 890210
900
800
700
600
500
400
300
100
90
80
70
60
50
40
30
20
10
Time (GMT)


ER-2 Flight, NMC Temp (°K) 890220
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
16
17
18
19
20
240
250
260
230
210
205
220
230
240
250
260


ER-2 flight, NMC |V| (m/s) 890220
Pressure (mb)
Altitude (km)
Time (GMT)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
16
17
18
19
20
900
800
700
600
500
400
300
60
50
40
30
20
70
60
50
20

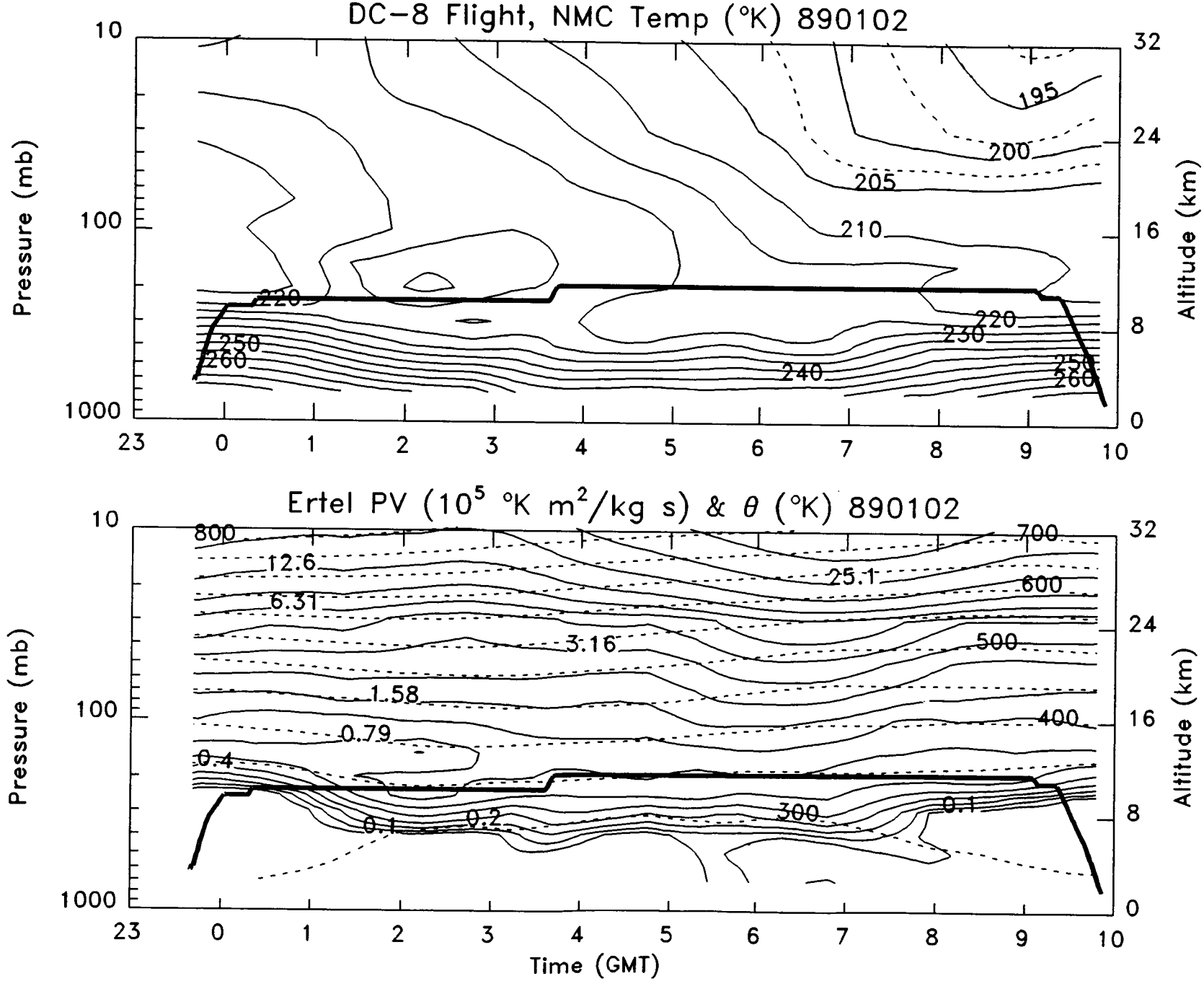

ER-2 Flight, NMC Temp (°K) 890221
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
16
17
18
19
20
21
22
23
230
220
205
210
210
220
230
230
250
260
270
240
270

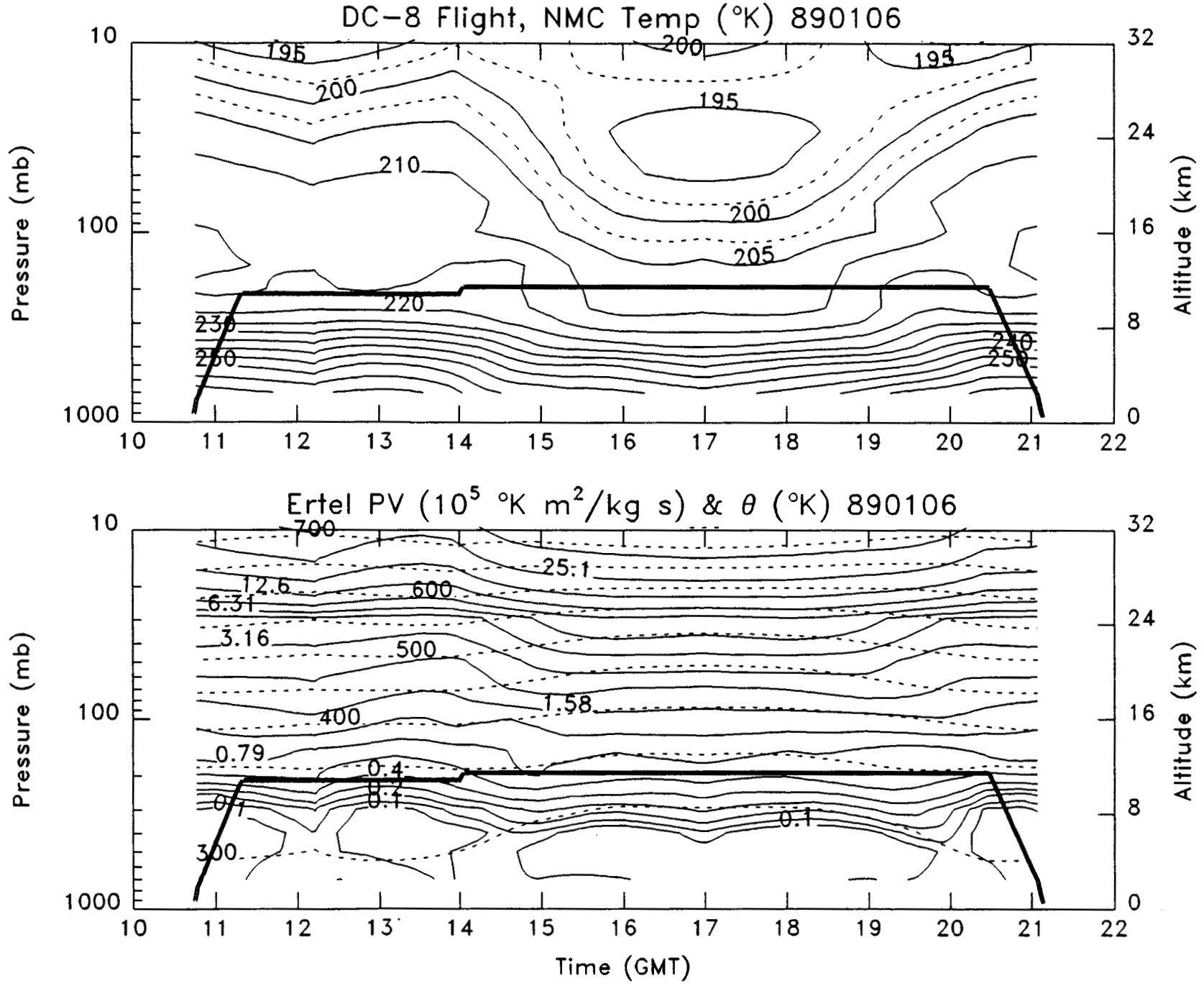

ER-2 flight, NMC |V⃗| (m/s) 890221
Pressure (mb)
Altitude (km)
Time (GMT)
10
100
1000
32
24
16
8
0
16
17
18
19
20
21
22
23
800
700
600
500
400
40
30
20
20
10
40
40
30
20
300
10
10

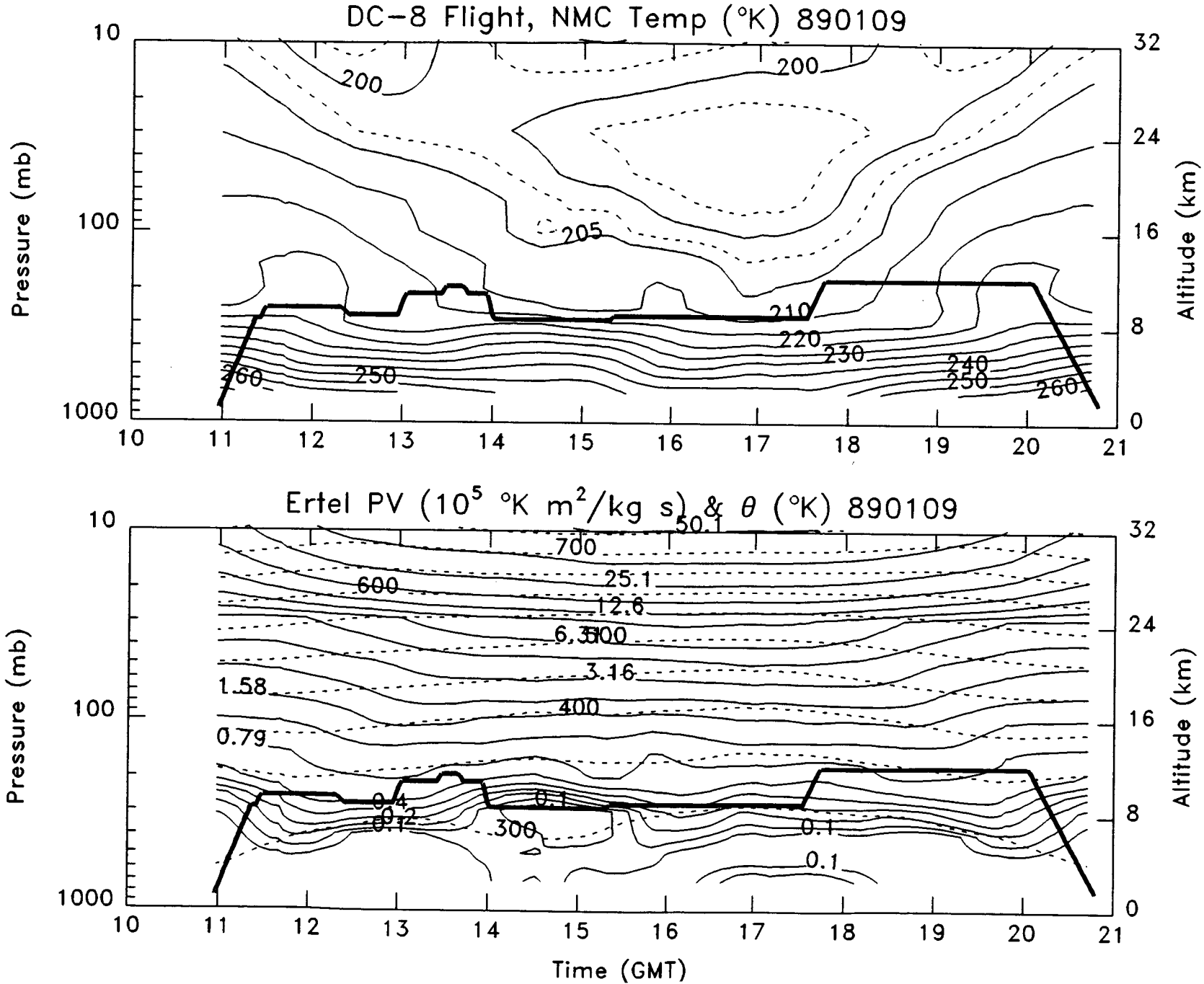
Section IVb, DC-8 Curtain files

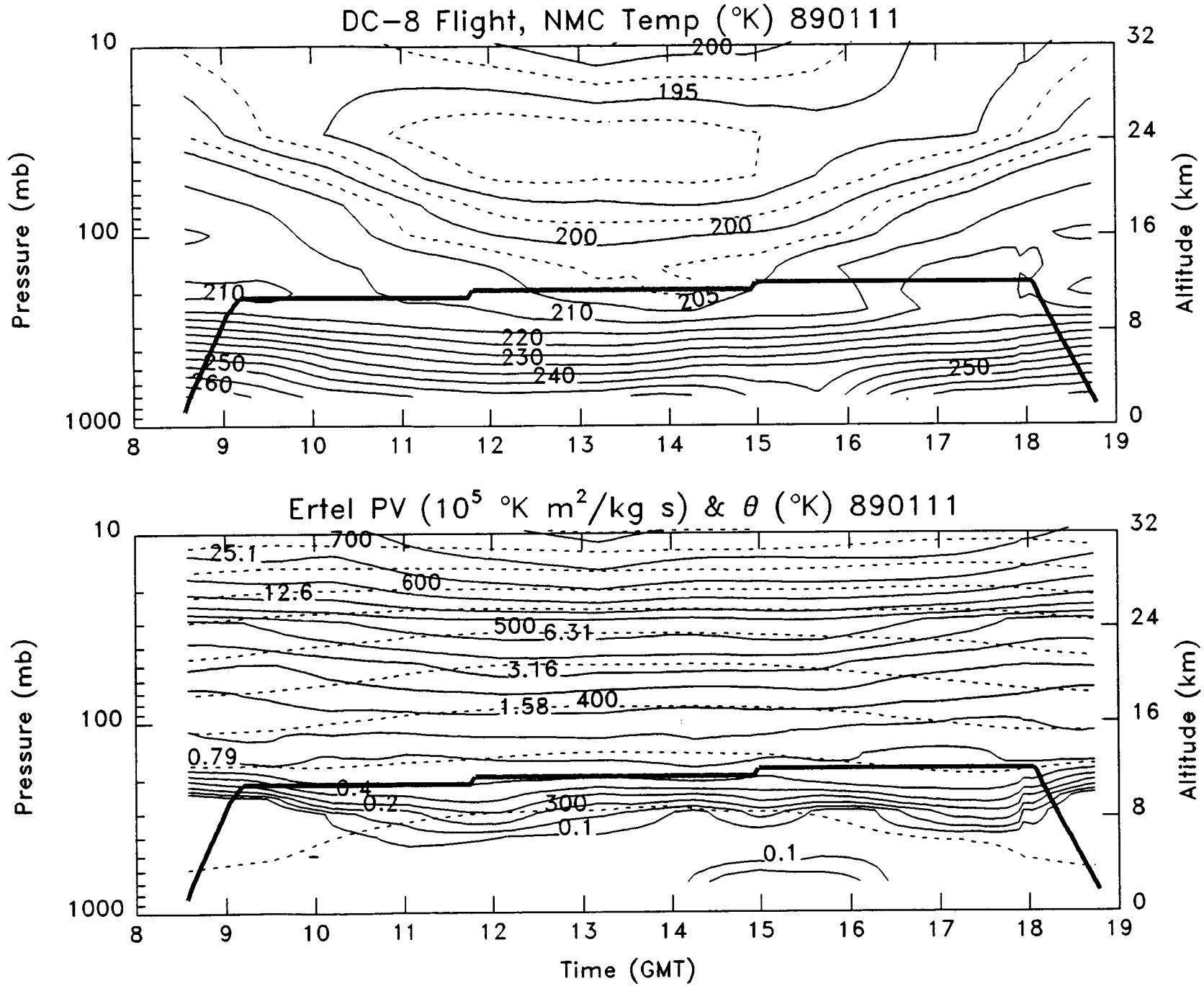
Top: Temperatures following the DC-8. The thin solid lines are at 5 K contour increments, while the dashed lines are at 2.5 K contour increments. The thick solid line indicates the DC-8 altitude. The NMC data are plotted with the log pressure scale on the left hand side, while the aircraft altitude is plotted in terms of pressure altitude on the right hand side. Note: the DC-8 pressure altitude is approximately proportional to log pressure, but the two match only to within about one kilometer.

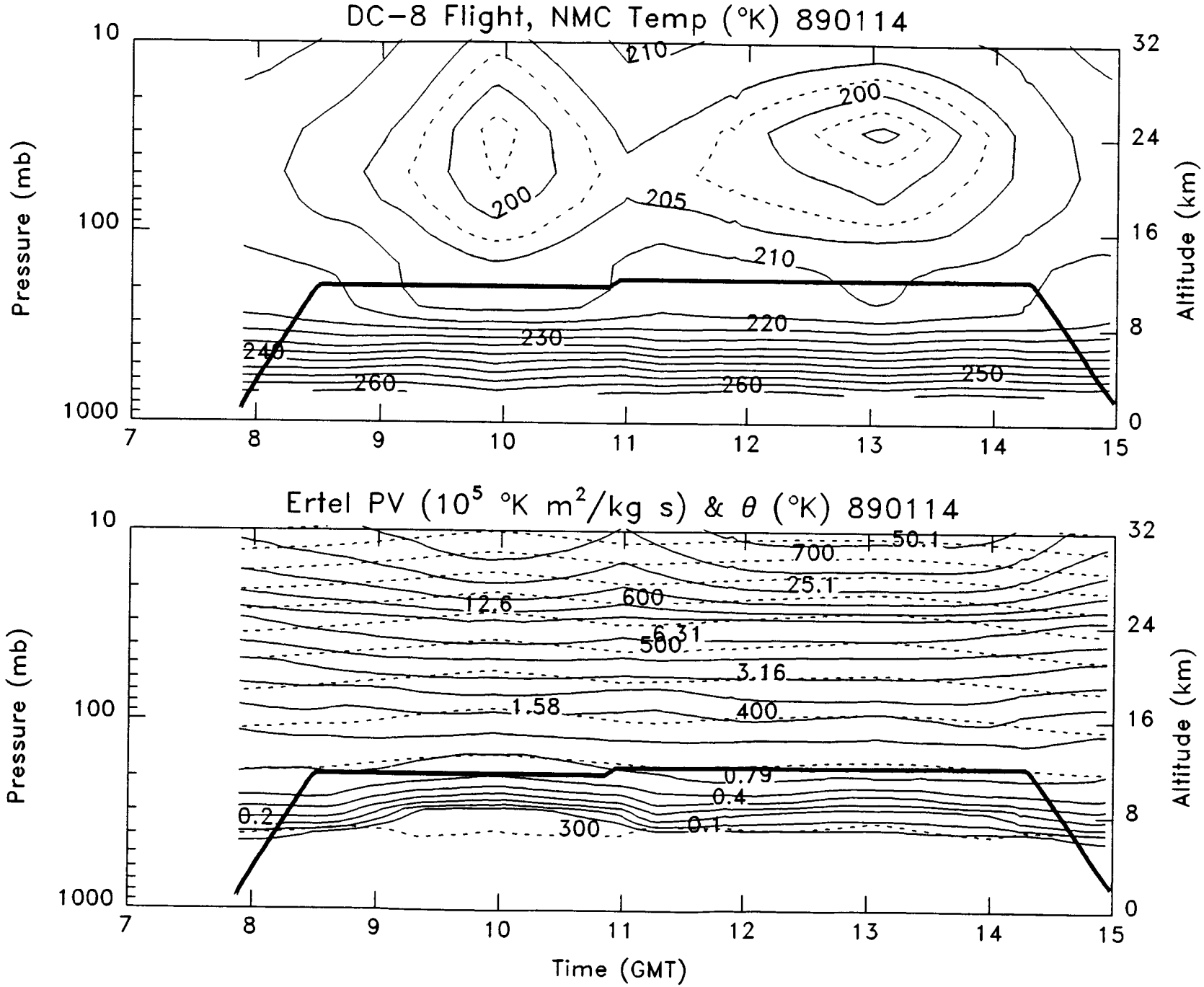
Bottom: As in the top figure, but for Ertel's potential vorticity (solid lines, see text) and potential temperature (dashed lines, 50 K contour increment). The Epv is contoured on a logarithmic scale.

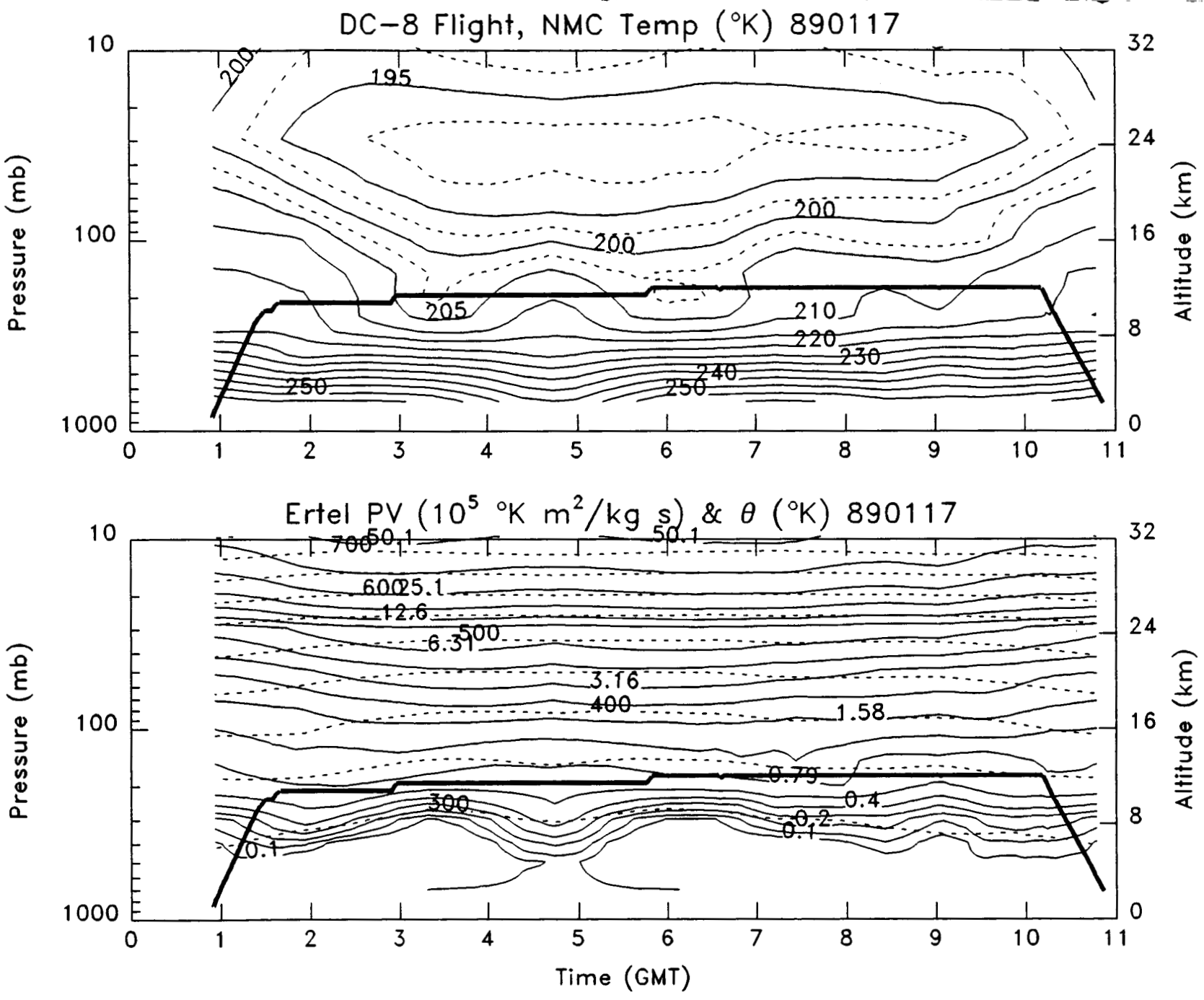

DC-8 Flight, NMC Temp (°K) 890102
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
195
200
205
210
220
230
240
250
260
23
0
1
2
3
4
5
6
7
8
9
10
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890102
800
700
600
500
400
300
12.6
6.31
3.16
1.58
0.79
0.4
25.1
0.1
0.2
Time (GMT)

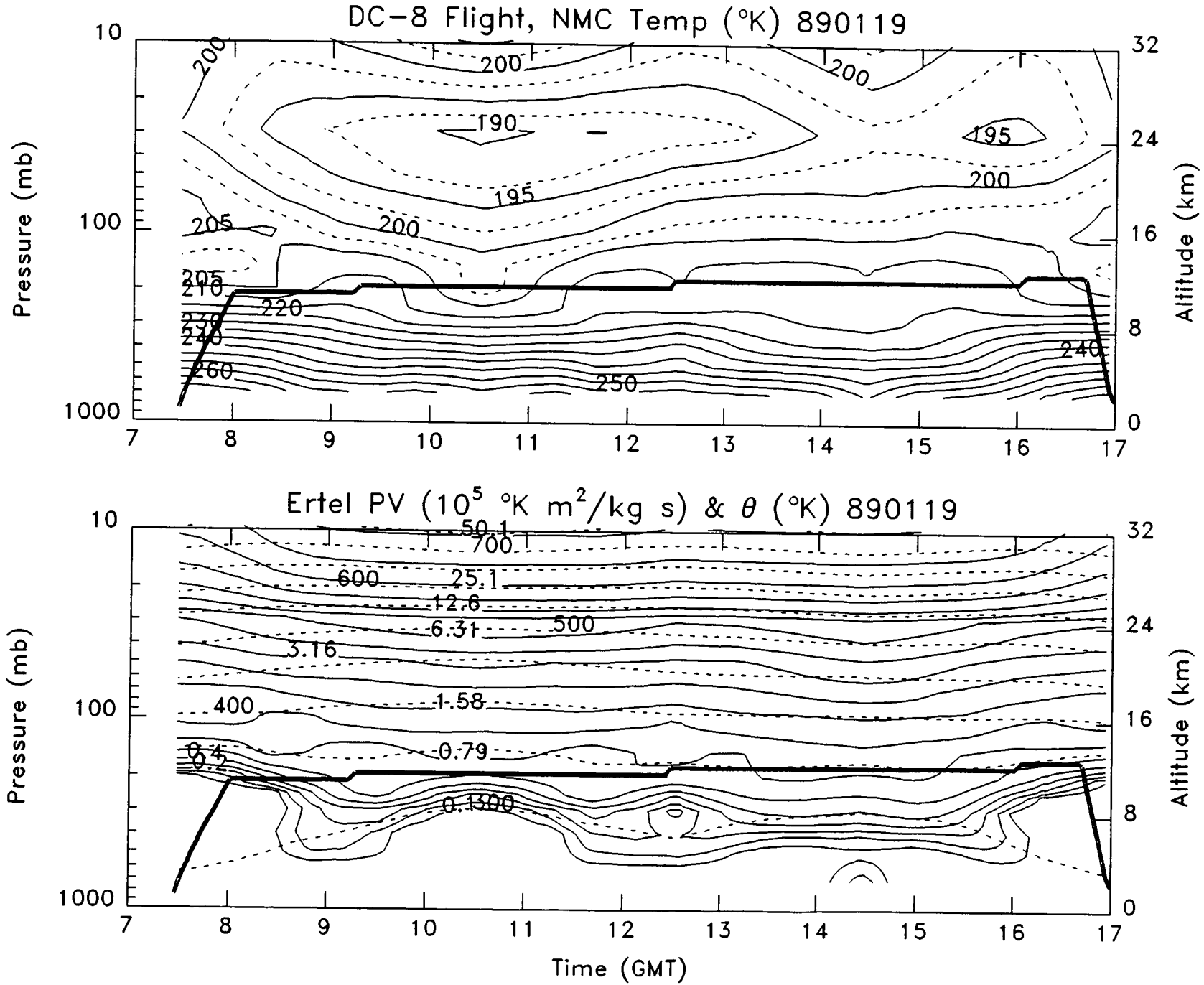

DC−8 Flight, NMC Temp (°K) 890106
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
195
200
210
205
220
230
240
250
10
11
12
13
14
15
16
17
18
19
20
21
22
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890106
700
600
500
400
300
25.1
12.6
6.31
3.16
1.58
0.79
0.4
0.2
0.1
0.1
Time (GMT)

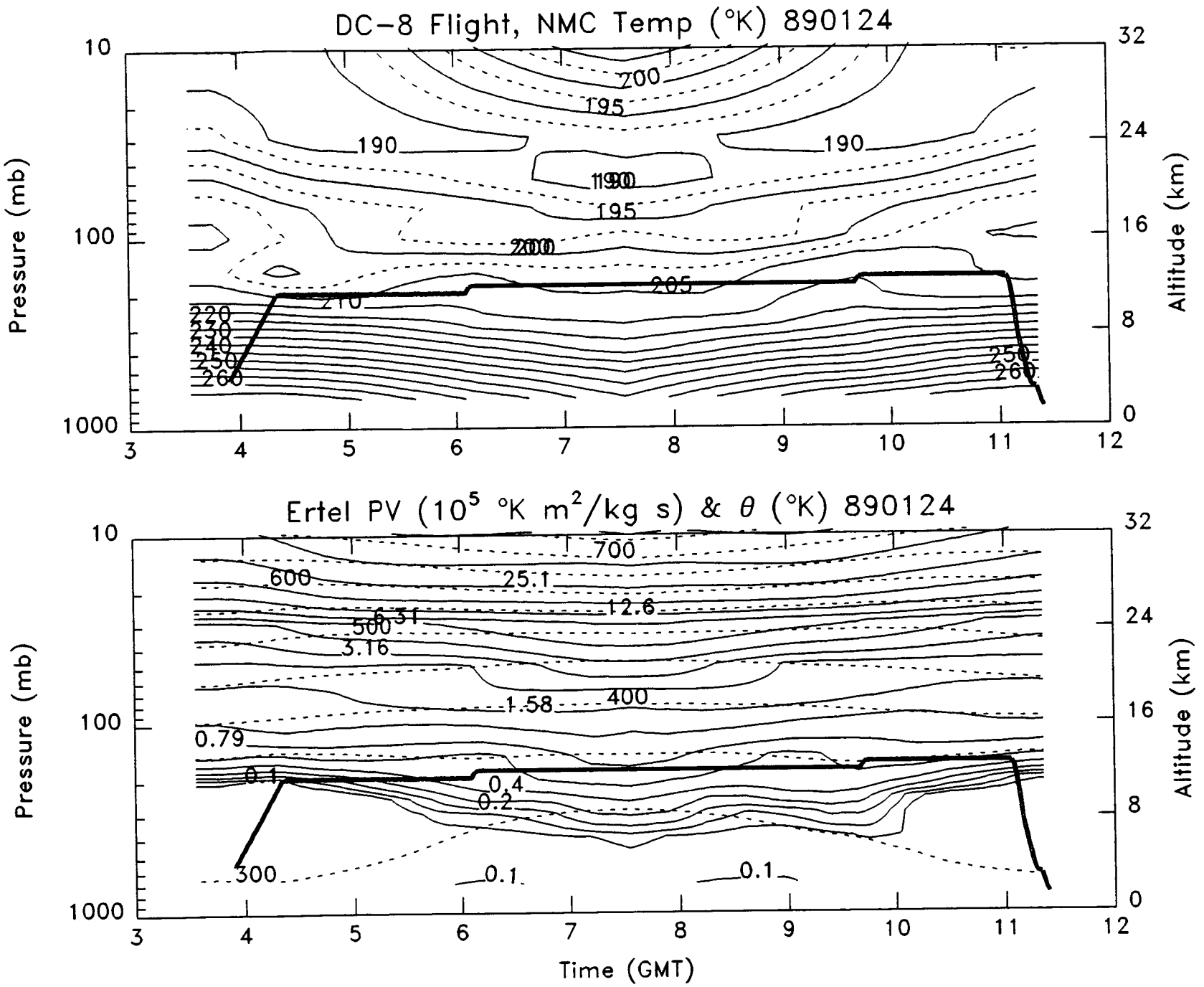

DC-8 Flight, NMC Temp (°K) 890109
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
200
205
210
220
230
240
250
260
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890109
50.1
25.1
12.6
6.31
3.16
1.58
0.79
700
600
400
300
0.4
0.2
0.1
10
11
12
13
14
15
16
17
18
19
20
21
Time (GMT)

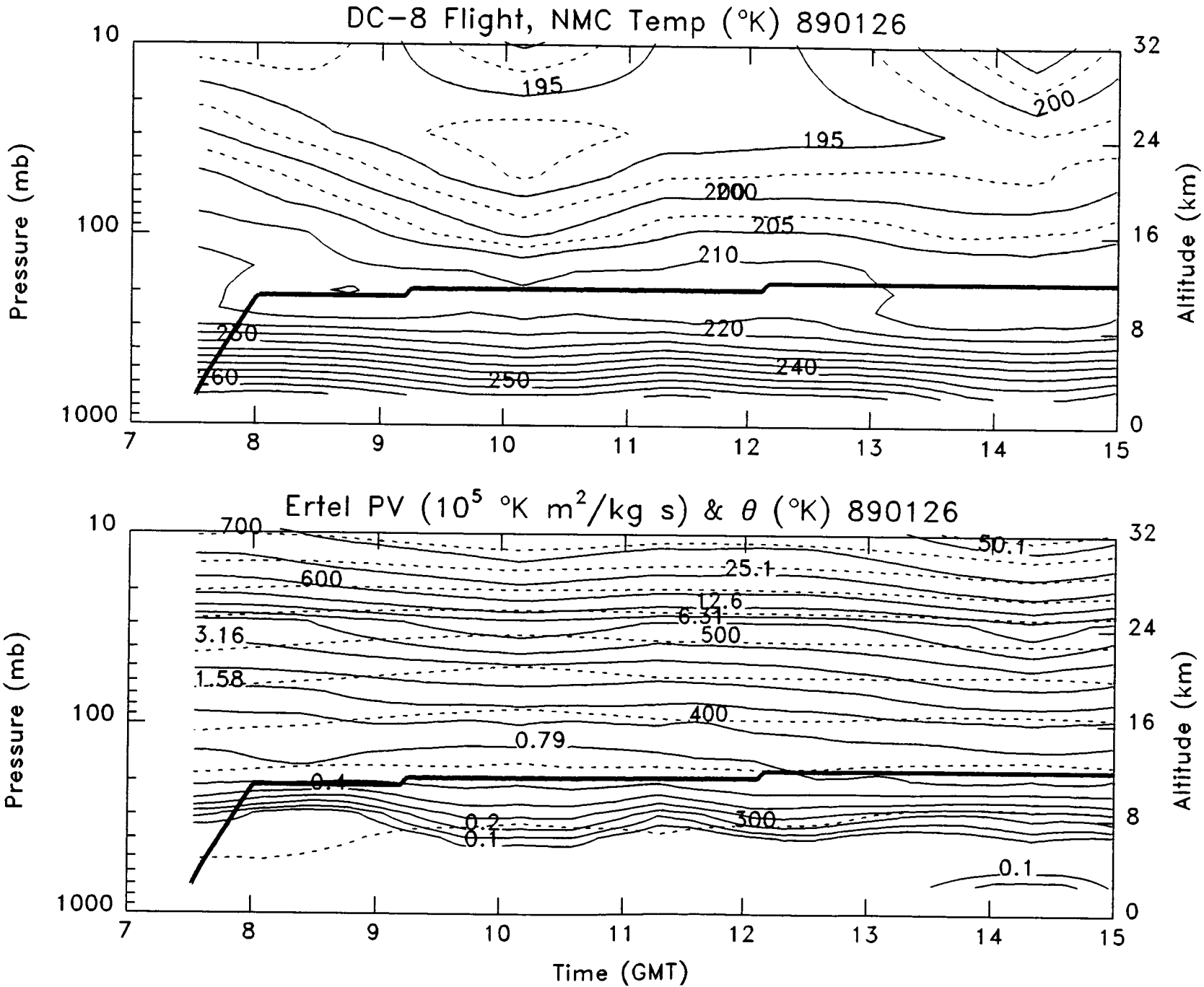

DC-8 Flight, NMC Temp (°K) 890111
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
200
195
200
200
210
205
210
220
230
240
250
250
260
8
9
10
11
12
13
14
15
16
17
18
19
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890111
Pressure (mb)
Altitude (km)
Time (GMT)
700
25.1
600
12.6
500
6.31
3.16
400
1.58
0.79
0.4
0.2
300
0.1
0.1

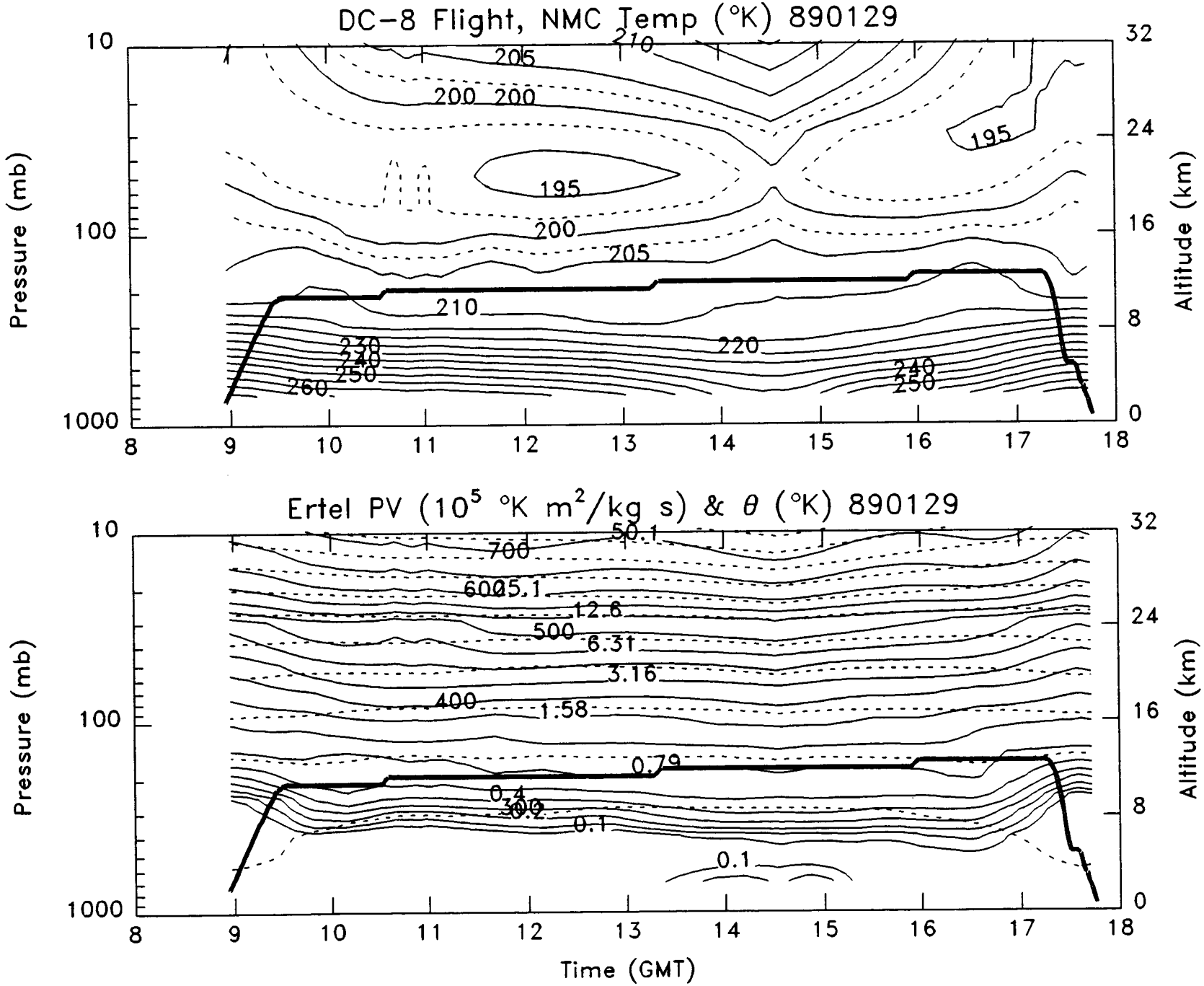

DC-8 Flight, NMC Temp (°K) 890114
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
15
210
200
200
205
210
220
230
240
260
260
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890114
50.1
700
25.1
12.6
600
6.31
500
3.16
1.58
400
0.79
0.4
0.2
300
0.1
Time (GMT)

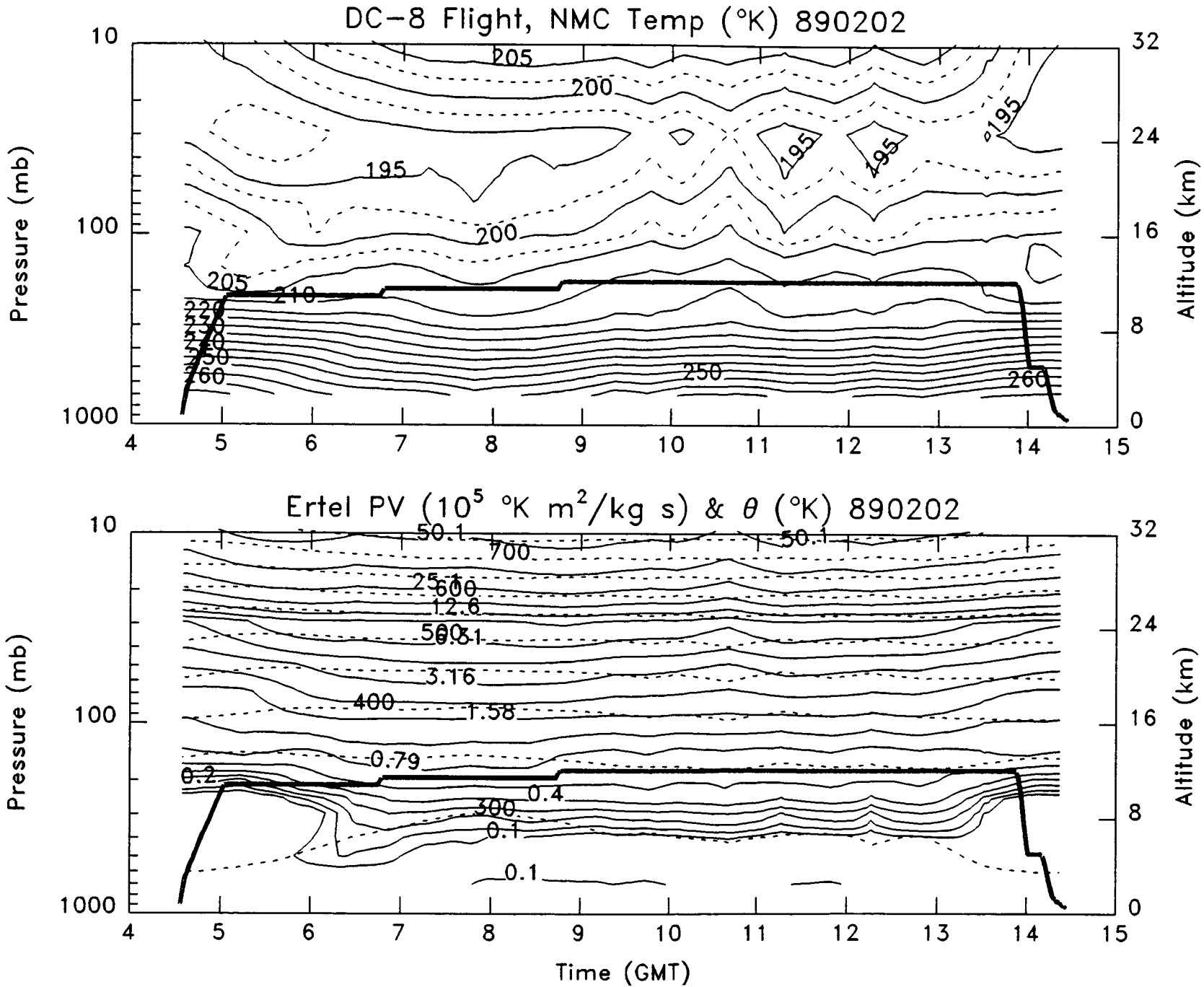

DC-8 Flight, NMC Temp (°K) 890117
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
0
1
2
3
4
5
6
7
8
9
10
11
200
195
200
200
205
210
220
230
240
250
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890117
Pressure (mb)
Altitude (km)
Time (GMT)
700
600
500
400
300
50.1
50.1
25.1
12.6
6.31
3.16
1.58
0.79
0.4
0.2
0.1
0.1

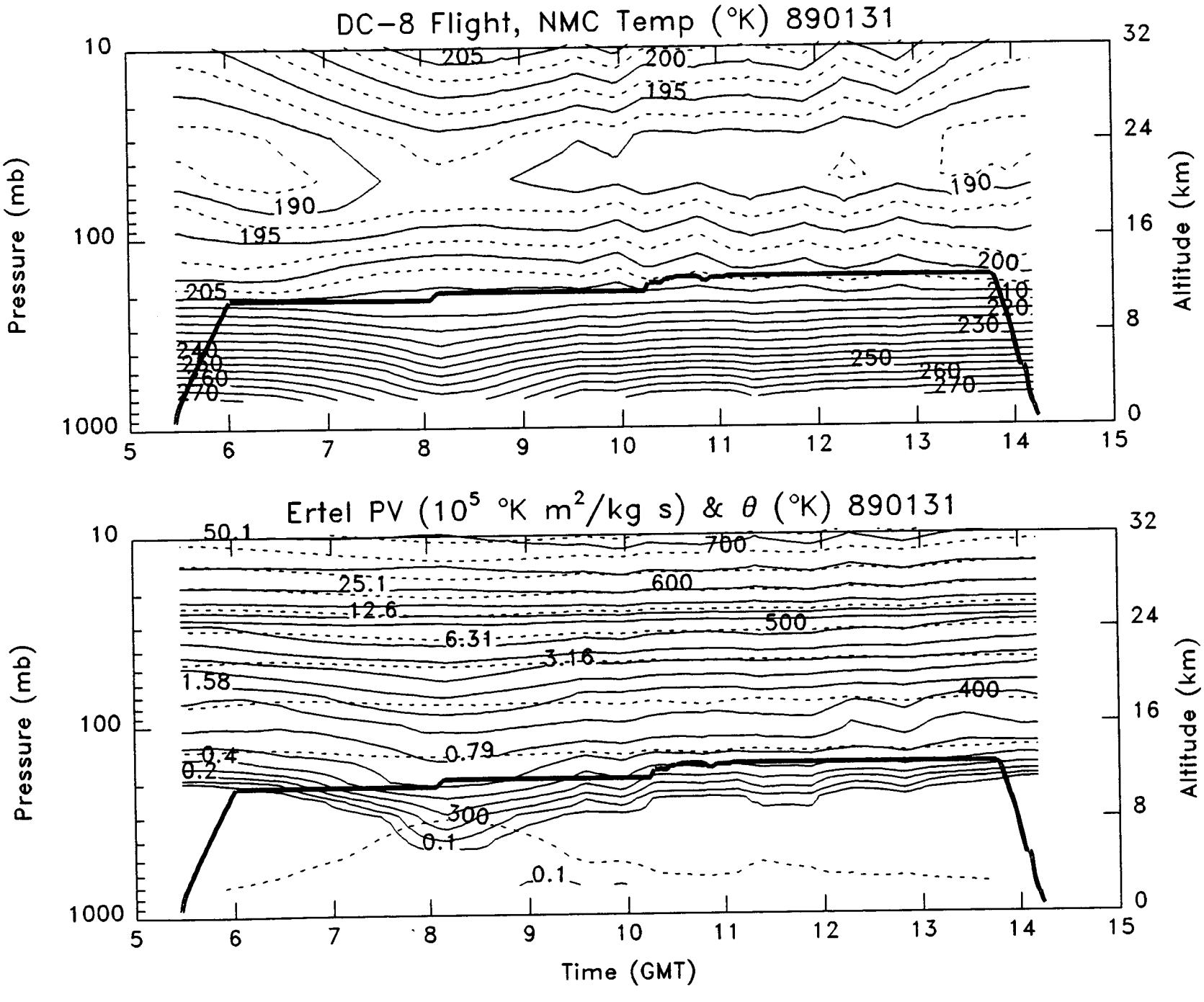

DC-8 Flight, NMC Temp (°K) 890119
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
15
16
17
200
190
195
205
210
220
230
240
250
260
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890119
50.1
700
600
25.1
12.6
6.31
500
3.16
400
1.58
0.79
0.4
0.2
0.1
300
Time (GMT)

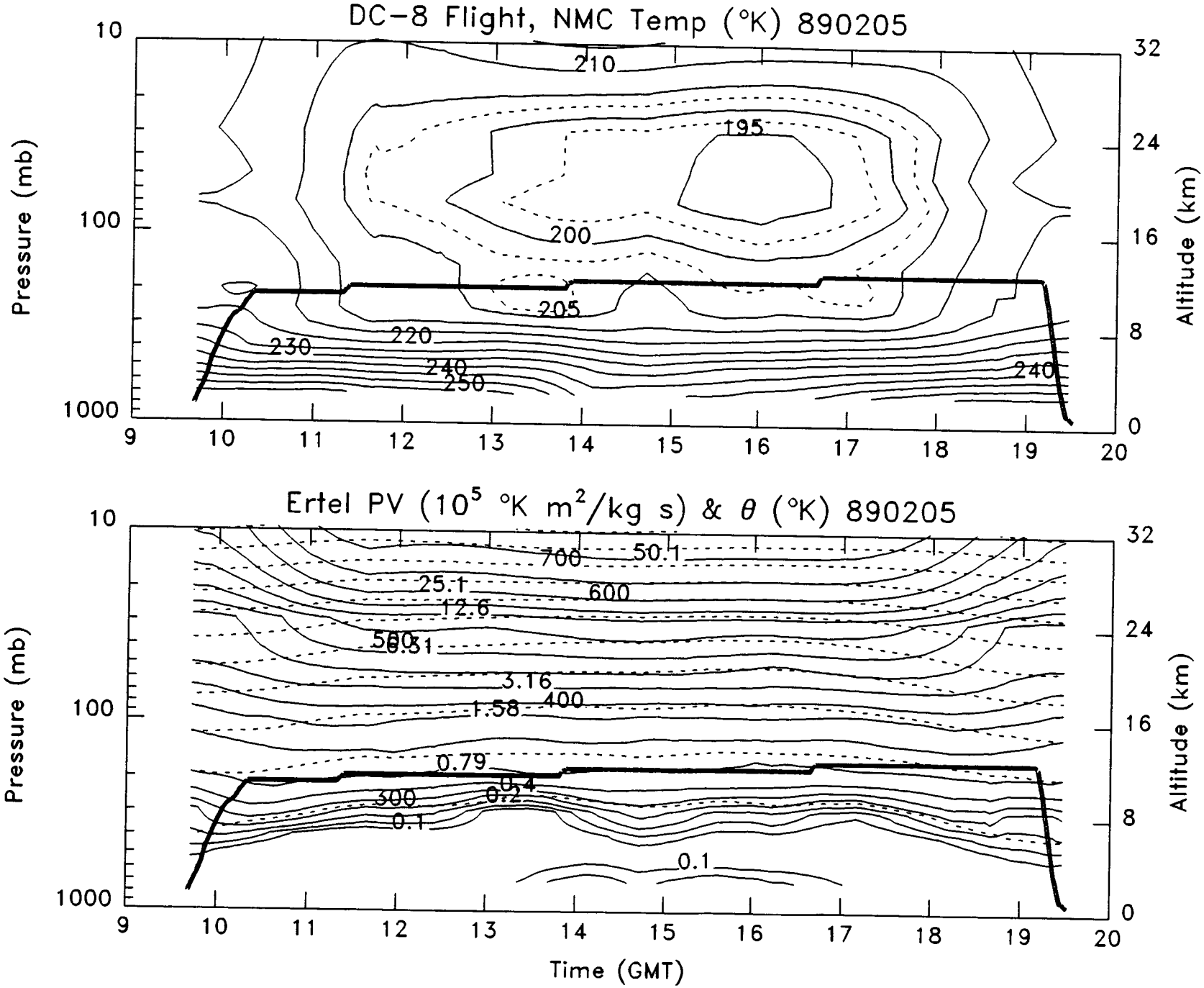

DC-8 Flight, NMC Temp (°K) 890124
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
3
4
5
6
7
8
9
10
11
12
200
195
190
205
210
220
230
240
250
260
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890124
700
600
25.1
12.6
6.31
500
3.16
400
1.58
0.79
0.1
0.4
0.2
300
Time (GMT)

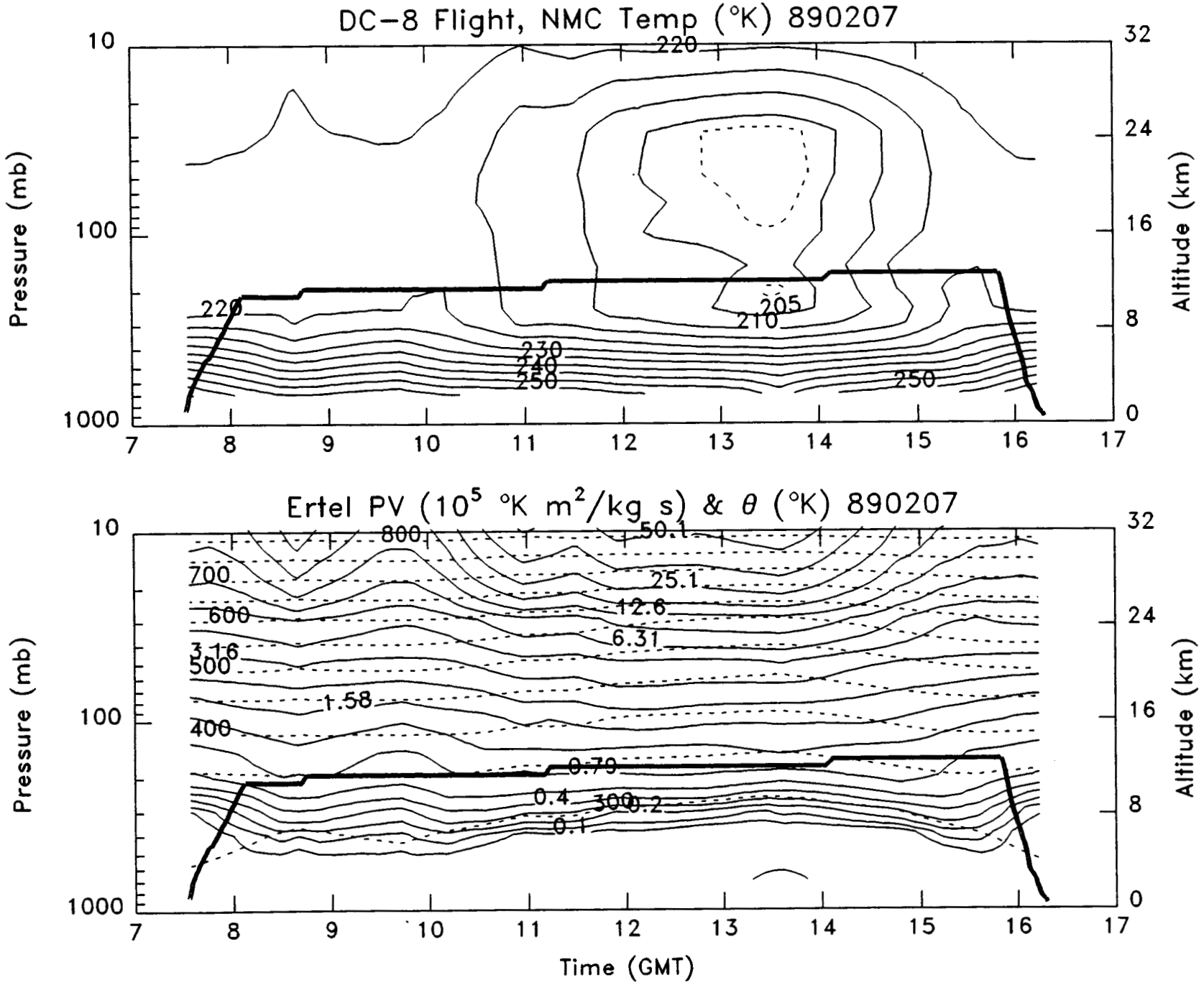

DC-8 Flight, NMC Temp (°K) 890126
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
15
195
200
205
210
220
240
250
260
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890126
700
600
3.16
1.58
0.79
0.4
0.2
0.1
50.1
25.1
12.6
6.31
500
400
300
Time (GMT)

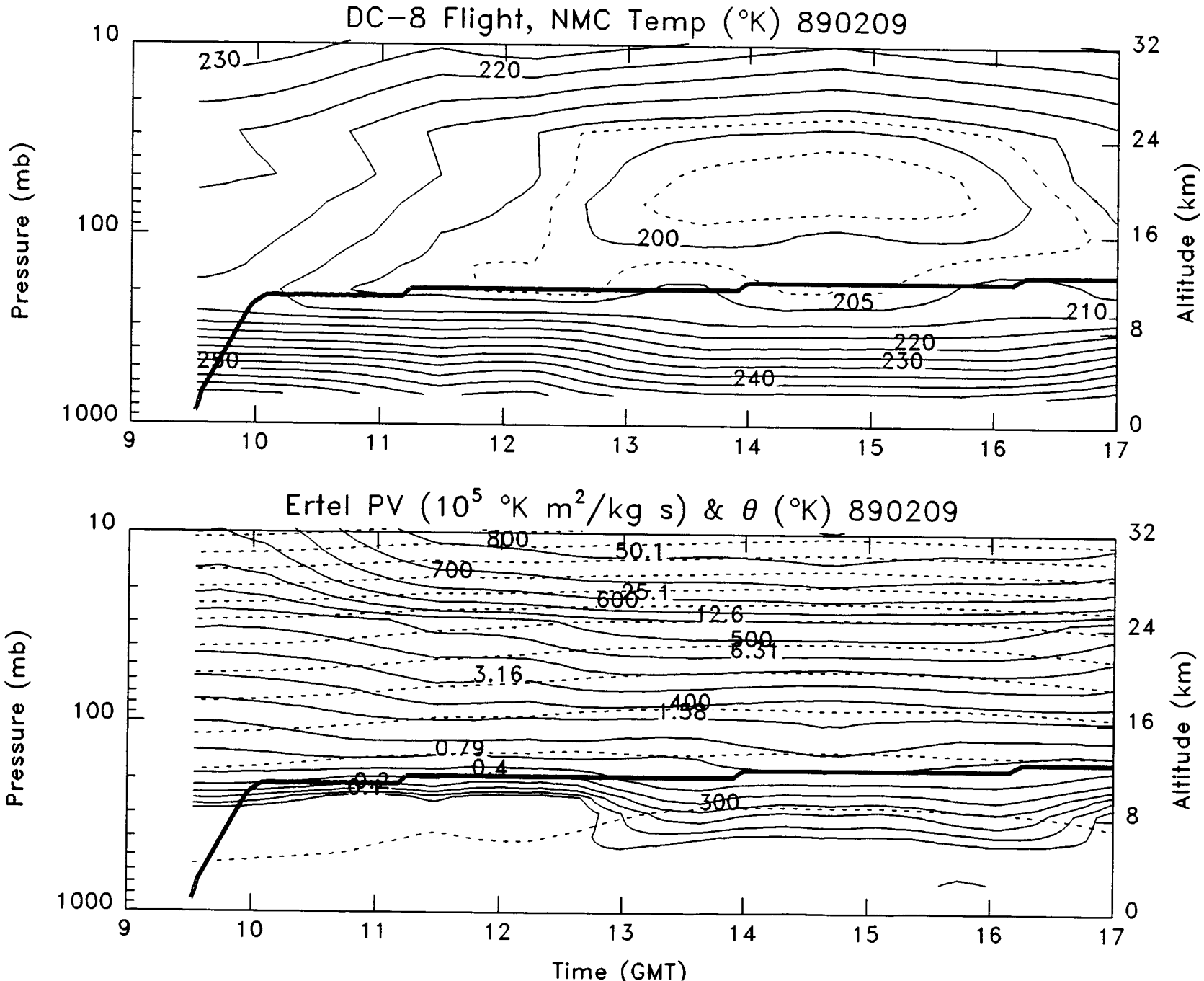

DC-8 Flight, NMC Temp (°K) 890129
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
8
9
10
11
12
13
14
15
16
17
18
210
205
200
200
195
195
200
205
210
220
230
240
250
260
240
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890129
Pressure (mb)
Altitude (km)
Time (GMT)
50.1
700
600
25.1
12.6
500
6.31
3.16
400
1.58
0.79
0.4
0.2
0.1
0.1

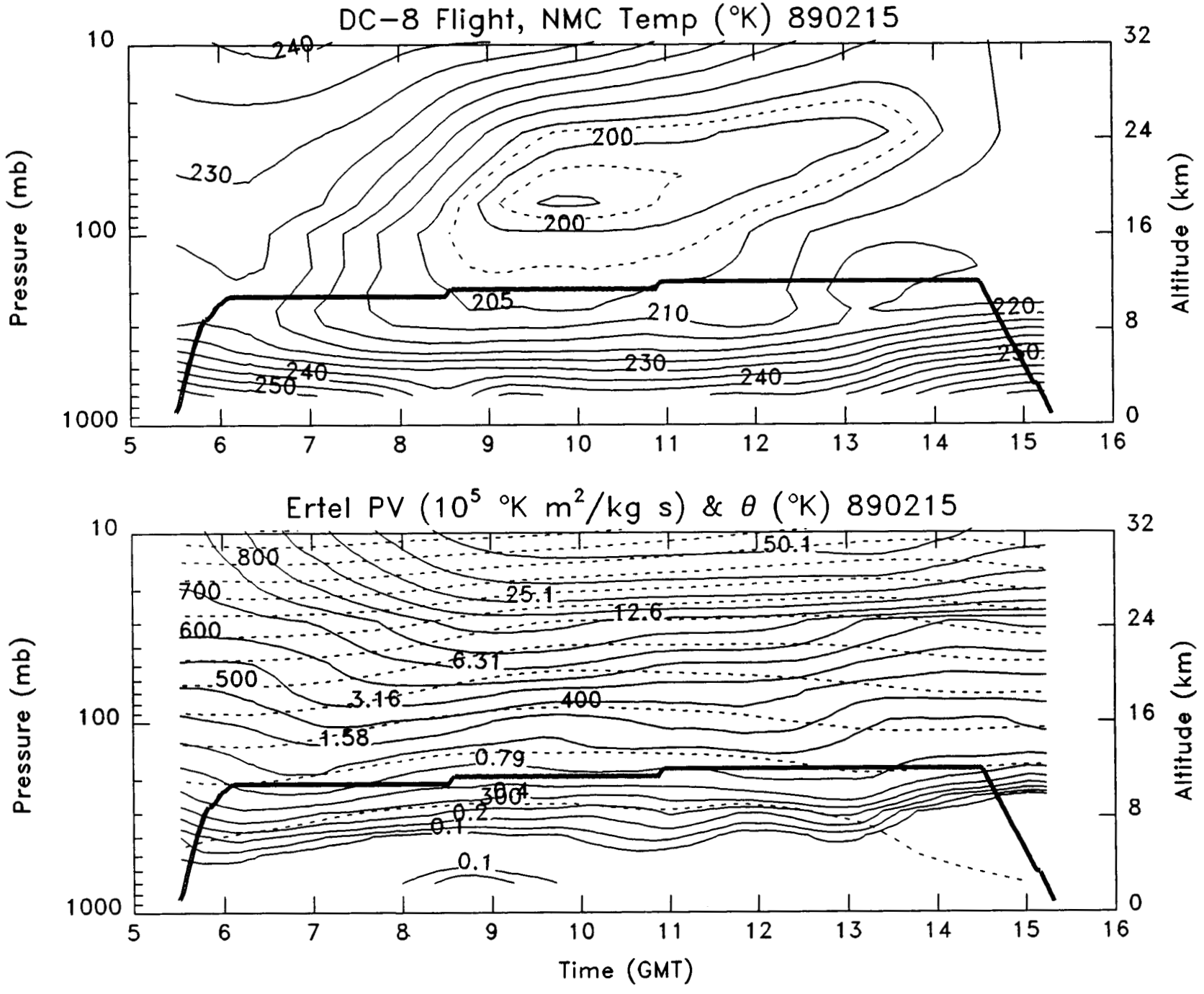

DC-8 Flight, NMC Temp (°K) 890202
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
4
5
6
7
8
9
10
11
12
13
14
15
205
200
195
210
220
230
240
250
260
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890202
50.1
700
25.1
600
12.6
500
6.31
3.16
400
1.58
0.79
0.2
0.4
300
0.1
Time (GMT)


DC-8 Flight, NMC Temp (°K) 890131
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
5
6
7
8
9
10
11
12
13
14
15
205
200
195
190
210
220
230
240
250
260
270
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890131
50.1
25.1
12.6
6.31
3.16
1.58
0.79
0.4
0.2
0.1
700
600
500
400
300
Time (GMT)


DC-8 Flight, NMC Temp (°K) 890205
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
16
17
18
19
20
210
195
200
205
220
230
240
250
240
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890205
Pressure (mb)
Altitude (km)
Time (GMT)
700
50.1
25.1
600
12.6
500
6.31
3.16
400
1.58
0.79
0.4
300
0.2
0.1
0.1


DC-8 Flight, NMC Temp (°K) 890207
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
7
8
9
10
11
12
13
14
15
16
17
220
205
210
230
240
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890207
800
700
600
500
400
50.1
25.1
12.6
6.31
3.16
1.58
0.79
0.4
0.2
0.1
300
Time (GMT)


DC-8 Flight, NMC Temp (°K) 890209
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
9
10
11
12
13
14
15
16
17
230
220
200
205
210
220
230
240
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890209
800
700
600
500
400
300
50.1
25.1
12.6
6.31
3.16
1.58
0.79
0.4
0.2
0.1
Time (GMT)


DC-8 Flight, NMC Temp (°K) 890215
Pressure (mb)
Altitude (km)
10
100
1000
32
24
16
8
0
5
6
7
8
9
10
11
12
13
14
15
16
240
230
200
200
205
210
220
230
240
250
Ertel PV (10^5 °K m^2/kg s) & θ (°K) 890215
Pressure (mb)
Altitude (km)
Time (GMT)
800
700
600
500
400
300
50.1
25.1
12.6
6.31
3.16
1.58
0.79
0.2
0.1
0.1

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16. Abstract

Northern Hemisphere meteorological data for the months of January and February 1989 in the lower stratosphere are shown. National Meteorological Center (NMC) data, and Total Ozone Mapping Spectrometer (TOMS) data are used to display polar stereographic projections of 100-mb temperatures, 50-mb temperatures, 50-mb geopotential heights, total ozone, and Ertel's potential vorticity (Epv) on both 400 K and 460 K isentropic surfaces. In addition, latitude/height cross sections at 10°E of balanced wind isotachs, wind vectors, potential temperature, and temperature are also shown. Horizontal traces of NASA ER-2 and DC-8 flight tracks are also included. Vertical profiles of NMC temperatures following flight paths of both aircraft are shown. In addition, vertical profiles of wind speed are contoured following the ER-2 for estimating the lateral penetration into the polar vortex, while vertical profiles of Ertel's potential vorticity are included for estimating the vertical penetration of the DC-8 into the stratosphere.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Stratosphere Total Ozone Mapping Spectrometer	Unclassified - Unlimited Subject Category 47

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