Mem. Natl Inst. Polar Res., Spec. Issue, 48, 256–271, 1987

A PRELIMINARY RESULT OF THE OZONE OBSERVATION AT GDR-RESEARCH BASE (70.77°S, 11.85°E) FROM MAY TO DECEMBER 1985

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Abstract: At 70.77°S, 11.85°E, regular balloon-borne ozone soundings were started in 1985. These soundings have been performed using an electrochemical ozone sonde on the basis of the Brewer principle. A comparison was made with ozone soundings at middle northern latitudes (Lindenberg 52.21°N, 14.12°E). During polar spring, the period of extreme ozone depletion, a double peak structure was typical at 71°S. The analysis of the height variations of two peaks suggests that they are due to different physical mechanisms at high southern and middle northern latitudes.

1. Introduction

The behaviour of ozone in high latitudes is of special interest, because there are interesting conditions in regard to solar radiation and dynamics. These conditions play an important role not only for the total amount of ozone but also for the vertical distribution of ozone. Another point to consider is the high energy particle precipitation that may be of importance in auroral and subauroral latitudes. Therefore long-term ozone observations are needed to separate these influences and to investigate the conditions causing a strong depletion of ozone over Antarctica in recent years. However limited information has so far been obtained, because ozone observations at high latitudes are sparse. Recognizing this situation we started joint regular balloon-borne ozone soundings at the GDR-Research Base Novolazarevskaya (70.77°S, 11.85°E). Table 1 lists up the times of 66 launchings carried out from May to December in 1985. The high time resolution from October to December with 39 launchings contributes to the analysis of short-term ozone variations during spring-time at high latitudes.

2. Instrumentation

The ozone soundings were performed by electrochemical ozone sondes (OSE-2). This sonde type was developed by Rönnebeck and Sonntag (1976) on the basis of the Brewer sonde principle. Since 1974 these electrochemical ozone sondes have been regularly launched (once to three times per week) at Lindenberg (52.21°N, 14.12°E). The ozone sonde was launched with the radiosonde RKZ-5 by Totex balloons. The data acquisition was made by means of the radio transmitter of the radiosonde. The same equipment was used in Antarctica. The launching and data receiving were per-

Table 1. Times of 66 ozone sonde launchings from May to December 1985 at station Novolazarevskyaya (USSR) in Antarctica.

Time of observation:	from May to December 1985
Location:	70.77° S, 11.85° E
Sounding heights:	up to about 10 hPa
Sounding method:	balloon-borne
Ozonesonde:	OSE-2 electrochemical
Month	Performed soundings
May	22(00); 24(00); 27(00); 31(00);
June	05(00); 06(00); 13(00); 14(00); 19(00); 20(00); 25(00); 26(00)
July	03(00); 05(12); 10(00); 11(00); 18(00); 26(00)
August	01(00); 07(12); 15(12); 21(12); 28(12)
September	06(12); 12(12); 18(12); 26(12)
October	02(12); 06(12); 06(00); 08(12); 10(12); 12(12); 15(12); 16(12); 18(00); 18(12); 20(12); 22(12); 24(12); 26(12); 28(12); 30(00); 30(12)
November	01(12); 05(12); 07(12); 10(00); 11(12); 13(12); 15(12); 17(12); 20(12); 21(12); 24(12); 25(12); 27(12); 29(12)
December	01(12); 03(12); 05(12); 09(12); 13(12); 17(12); 21(12); 25(12)
XX(YY):	XX—day of sounding. YY—time (UT) of sounding.

formed in cooperation with the aerological staff of the Soviet Station Novolazarevskaya using the technical equipment of this station.

3. Data Analysis

The measured ozone partial pressure needs two corrections in order to convert it into absolute values:

—pump flow correction above the 150 hPa level;

—correction in terms of total ozone content by estimating the residual ozone above the height of balloon burst.

A height-dependent correction factor was used for the pump flow. An independent total ozone observation (Dobson or satellite) was needed for the correction of the ozone profile. As yet no data have been available on total ozone content above our sounding site. Therefore, we can only provide a preliminary data analysis using the pump flow correction. However, the correction by the total ozone observation does not change the estimated structure of the vertical ozone profile. The measured vertical distribution of ozone has been analysed under these circumstances in the following way:

—comparison of height profiles in a qualitative manner;

—structure analysis through classifying ozone maxima, their occurrence and seasonal height variations.

The sounding sites Novolazarevskaya and Lindenberg are located nearly at the same meridian between 12° and 14°E in southern high latitude (71°S) and northern middle latitude (52°N).

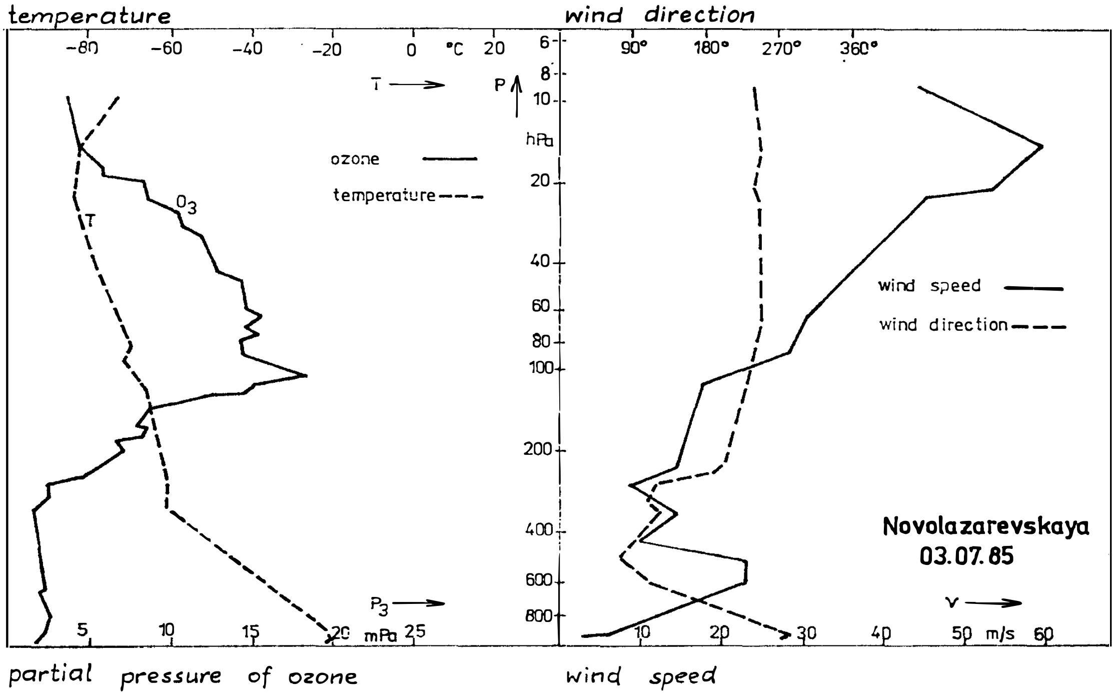

Fig. 1a. Novolazarevskaya, July 3, 1985.

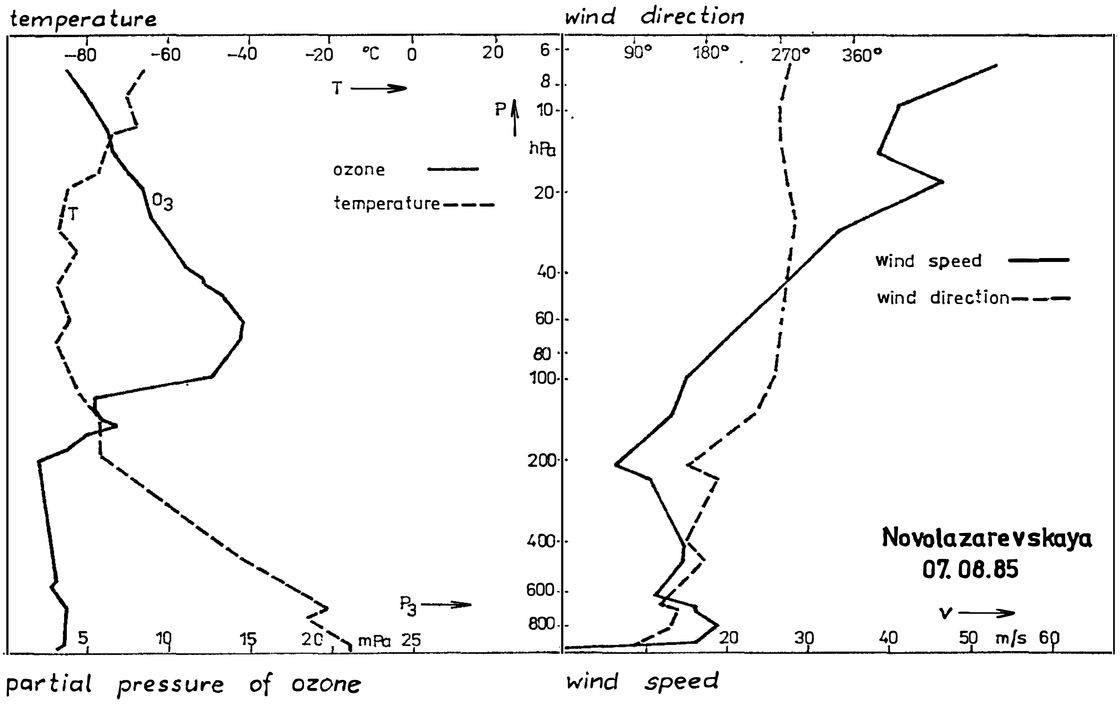

Fig. 1b. Novolazarevskaya, August 7, 1985.

Fig. 1. Profiles of ozone, temperature and wind at middle (station Lindenberg, GDR, 52°N) and high latitude (station Novolazarevskaya, Antarctica, 71°S).

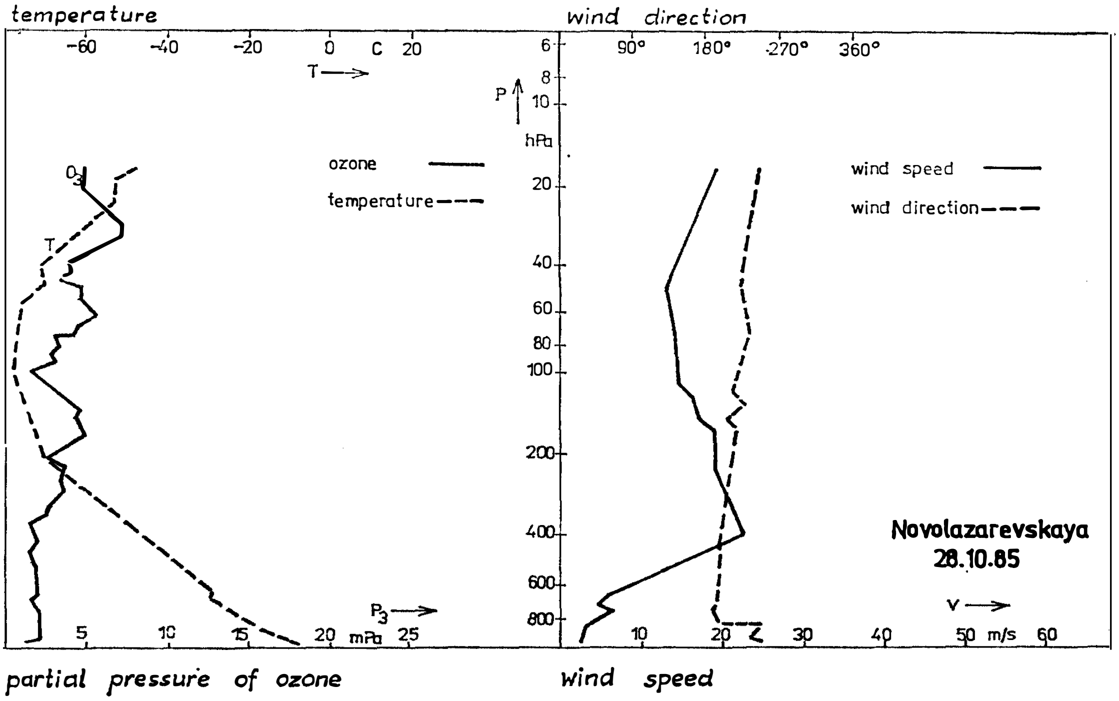

Fig. 1c. Novolazarevskaya, October 28, 1985.

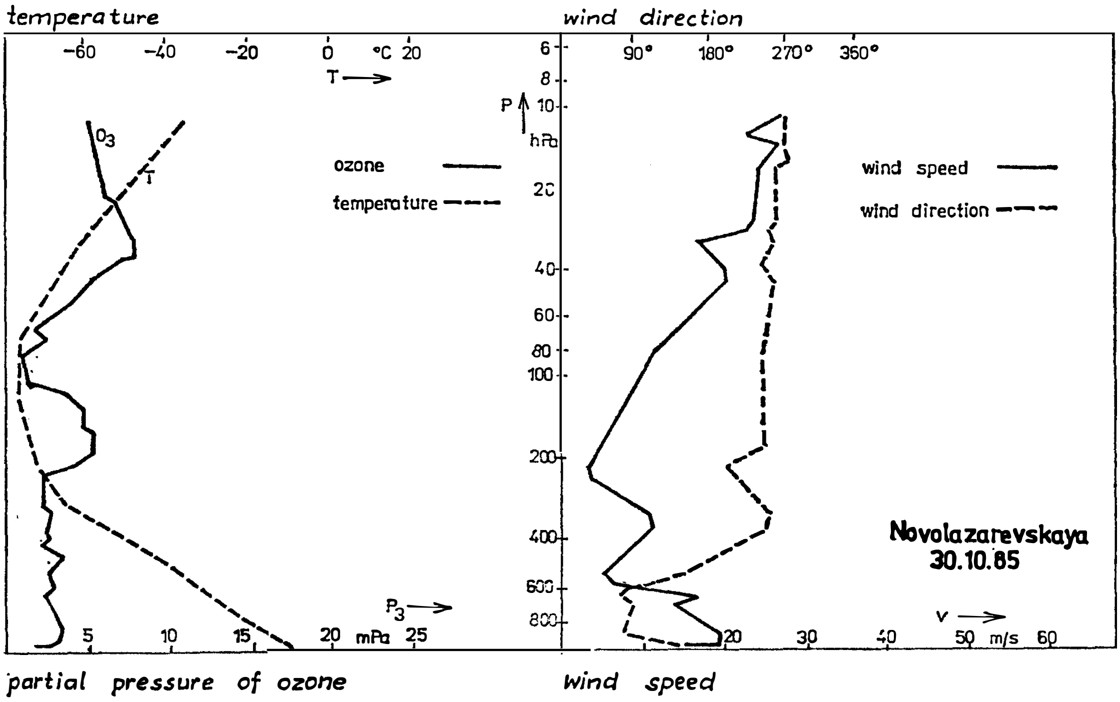

Fig. 1d. Novolazarevskaya, October 30, 1985.

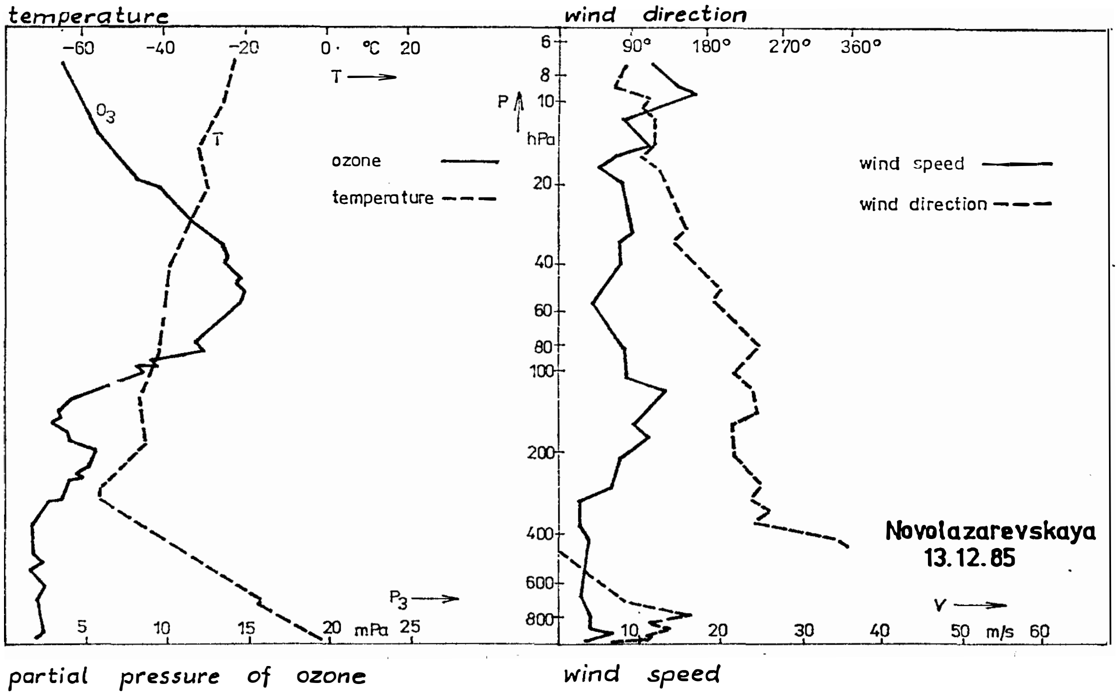

Fig. 1e. Novolazarevskaya, December 13, 1985.

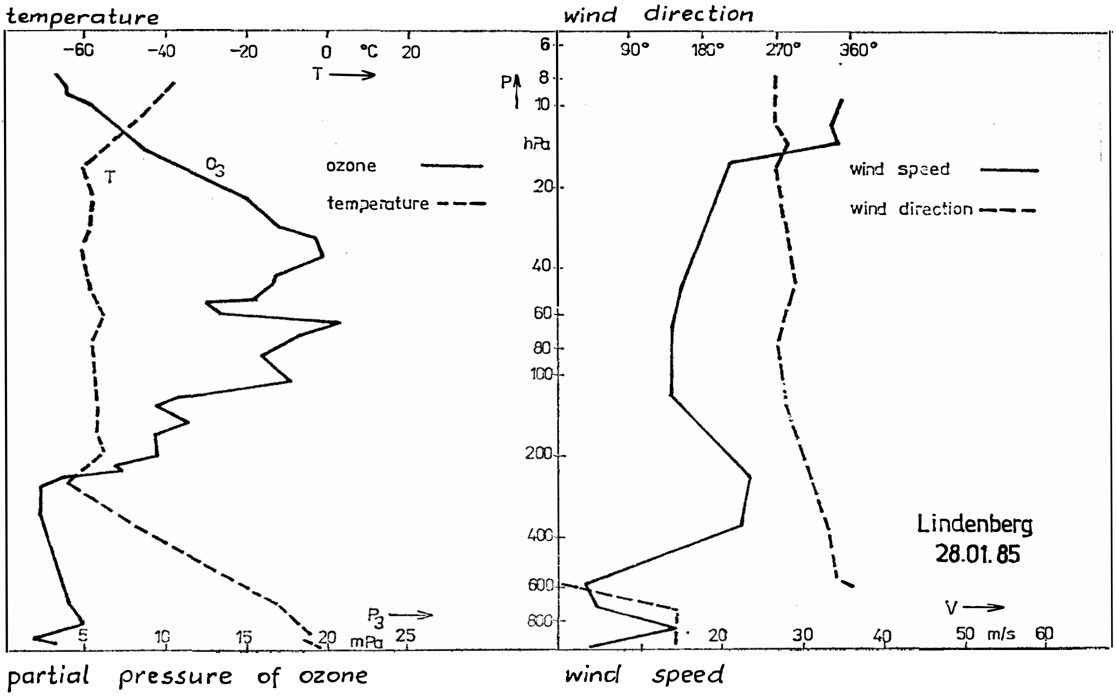

Fig. 1f. Lindenberg, January 28, 1985.

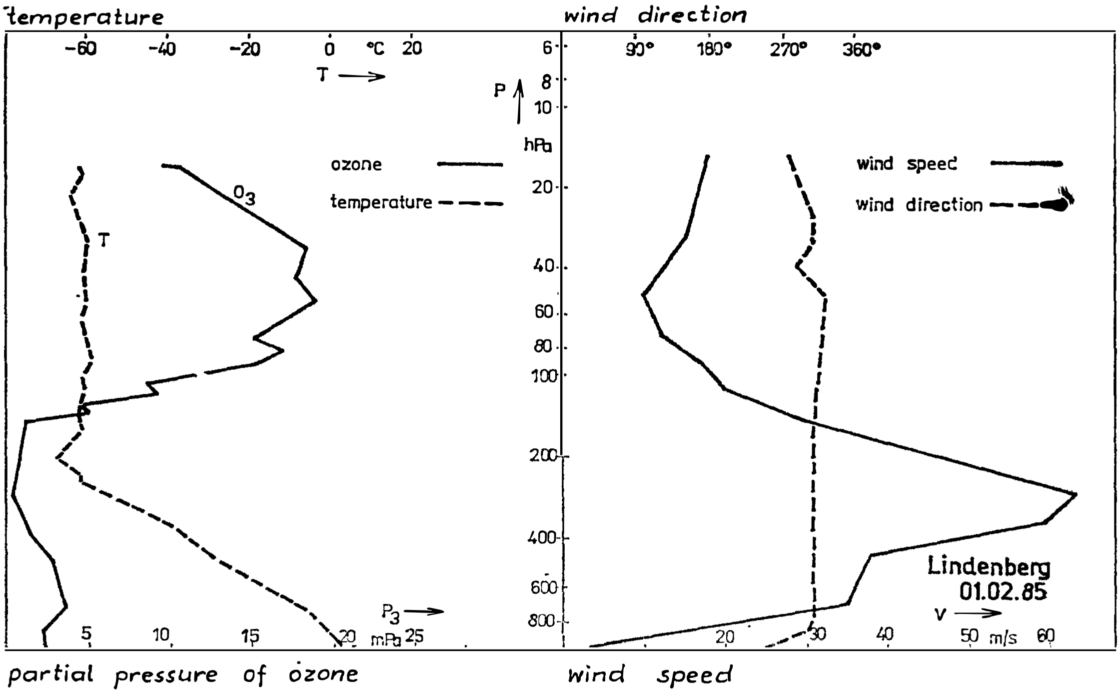

Fig. 1g. Lindenberg, February 1, 1985.

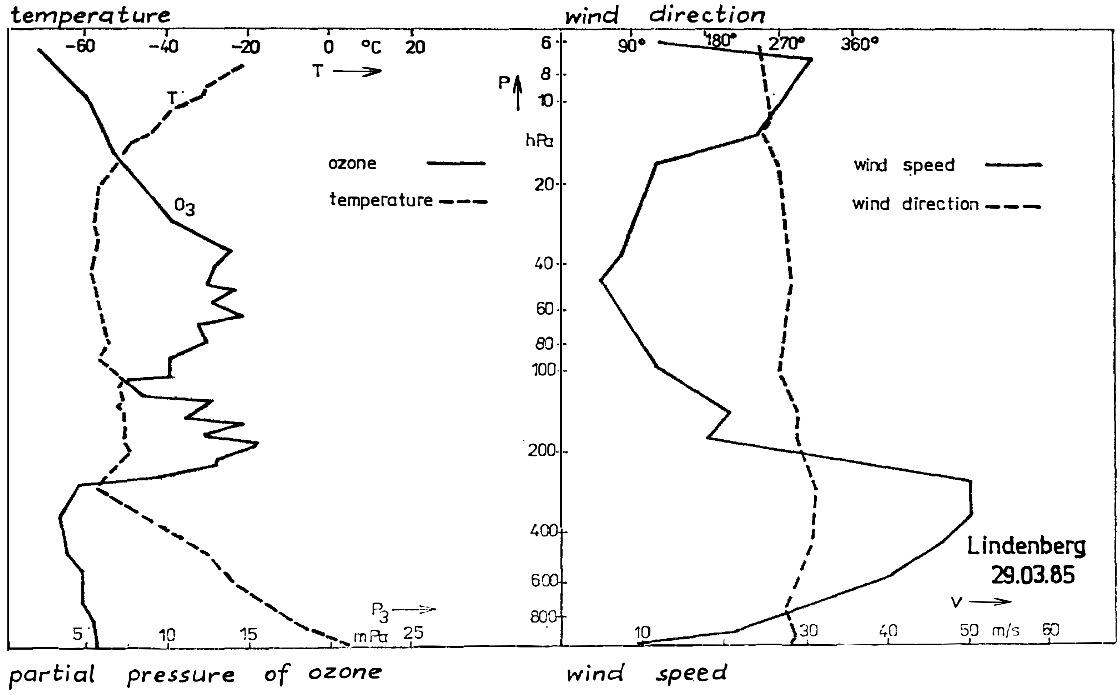

Fig. 1h. Lindenberg, March 29, 1985.

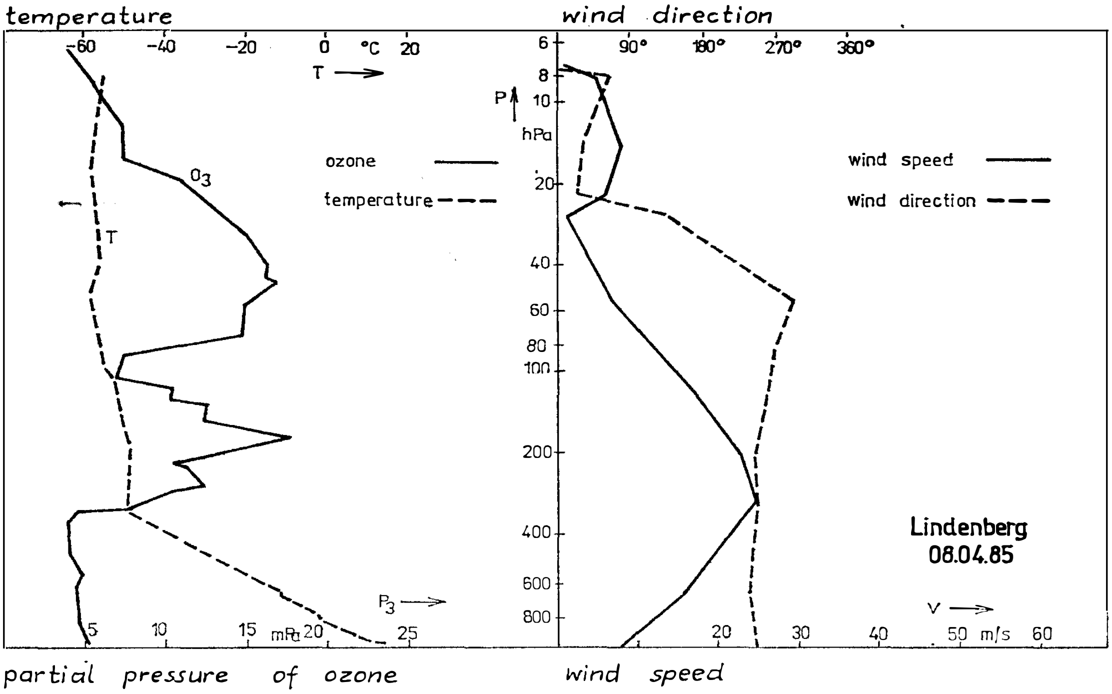

Fig. 1i. Lindenberg, April 8, 1985.

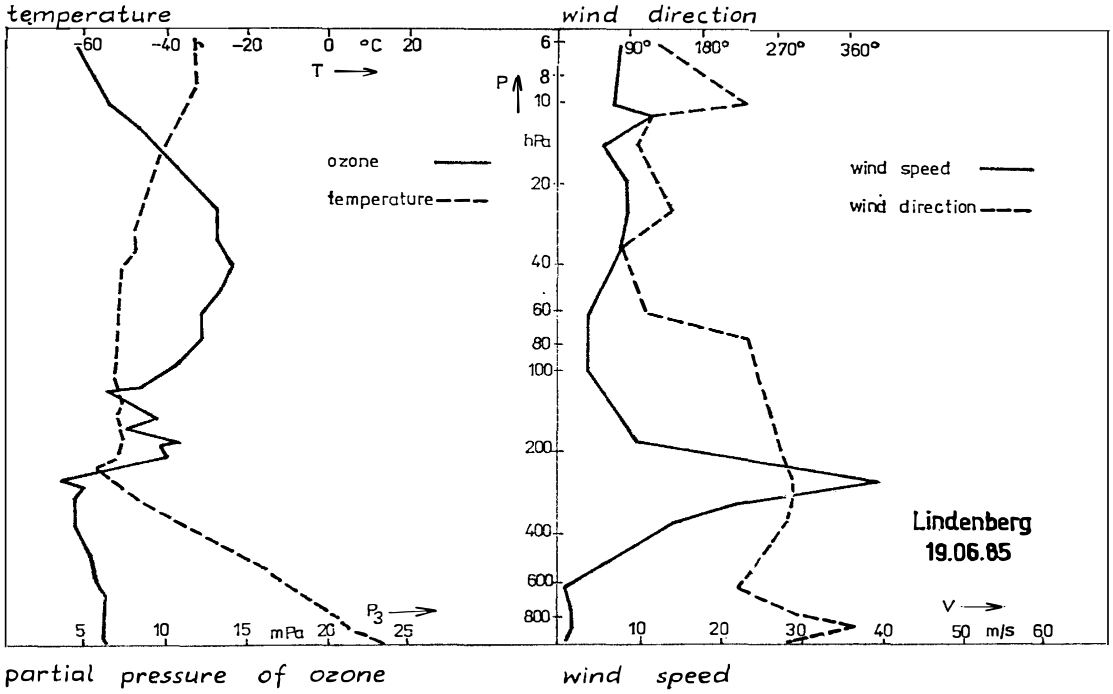

Fig. 1j. Lindenberg, June 19, 1985.

Figure 1 shows 5 individual ozone profiles at middle (52°N) and high latitude (71°S) for different seasons (winter, spring, summer). The temperature and wind profiles give information on stratospheric conditions affecting the ozone vertical distribution. Both in winter and summer vertical profiles show a similar structure (one peak in winter and a double peak in summer) between northern and southern hemispheres. During spring the partial pressure values at 71°S are the lowest among all seasons for the both locations.

4. Results

At first a qualitative comparison is shown in Figs. 2a–2d between southern and northern profiles at different seasons. The profiles at southern high latitude are shown from October to December (spring to polar day) and from June to August (polar night). Two pronounced maxima (upper and lower peak) can be seen in Figs. 2 and 4. During these periods the total ozone content shows the minimum and maximum. During October–December 1985 two steps of sudden increases of ozone partial pressure took place at the upper ozone peak. The lower peak remained at nearly constant values. At the mid-latitude (52°N) a similar structure exists with a double peak, but the increase in ozone partial pressure was observed at the level of the lower peak, while the upper peak remained at nearly constant values. The difference in ozone profile between 71°S and 52°N seems to be a typical feature of the ozone distribution in spring. Such a difference does not exist during other seasons (Figs. 2c, 2d).

The time-height cross-sections of ozone (Fig. 3) during spring at the northern (52°N) and southern hemisphere station (71°S) demonstrate the different behaviour of the ozone profile. At 52°N the upper peak at about 40 hPa showed no significant variation. The lower peak of ozone partial pressure between 100 and 200 hPa was more variable than the upper peak. During the total ozone maximum (April 29, 1985) the highest partial pressure occurred in the lower peak region. At the latitude 71°S the highest ozone partial pressure was observed at the 40 hPa height level.

The height variations of the two peaks are shown in Fig. 4. At 71°S the lower peak existed from polar night to polar day. The peak height changed from about 60 to about 250 hPa. An upper peak appeared in October, and it changed its height from 25 to 50 hPa. The double peak structure is typical from October to December at 71°S. At 52°N we find a double peak structure for one and a half month only (March, April). The upper peak showed a strong height variation during winter. The lower peak was not well pronounced in winter and disappeared almost completely during summer.

5. Discussion

At the high southern latitude station (71°S) the clear difference in height variations of the upper and lower peak indicates different physical causes. The upper peak between the 20 and 50 hPa height levels is the normal ozone maximum, which is due to photochemistry and dynamics. The height region from 20 to 30 km is located between regions, where photochemistry and dynamics are both dominant. In the summer

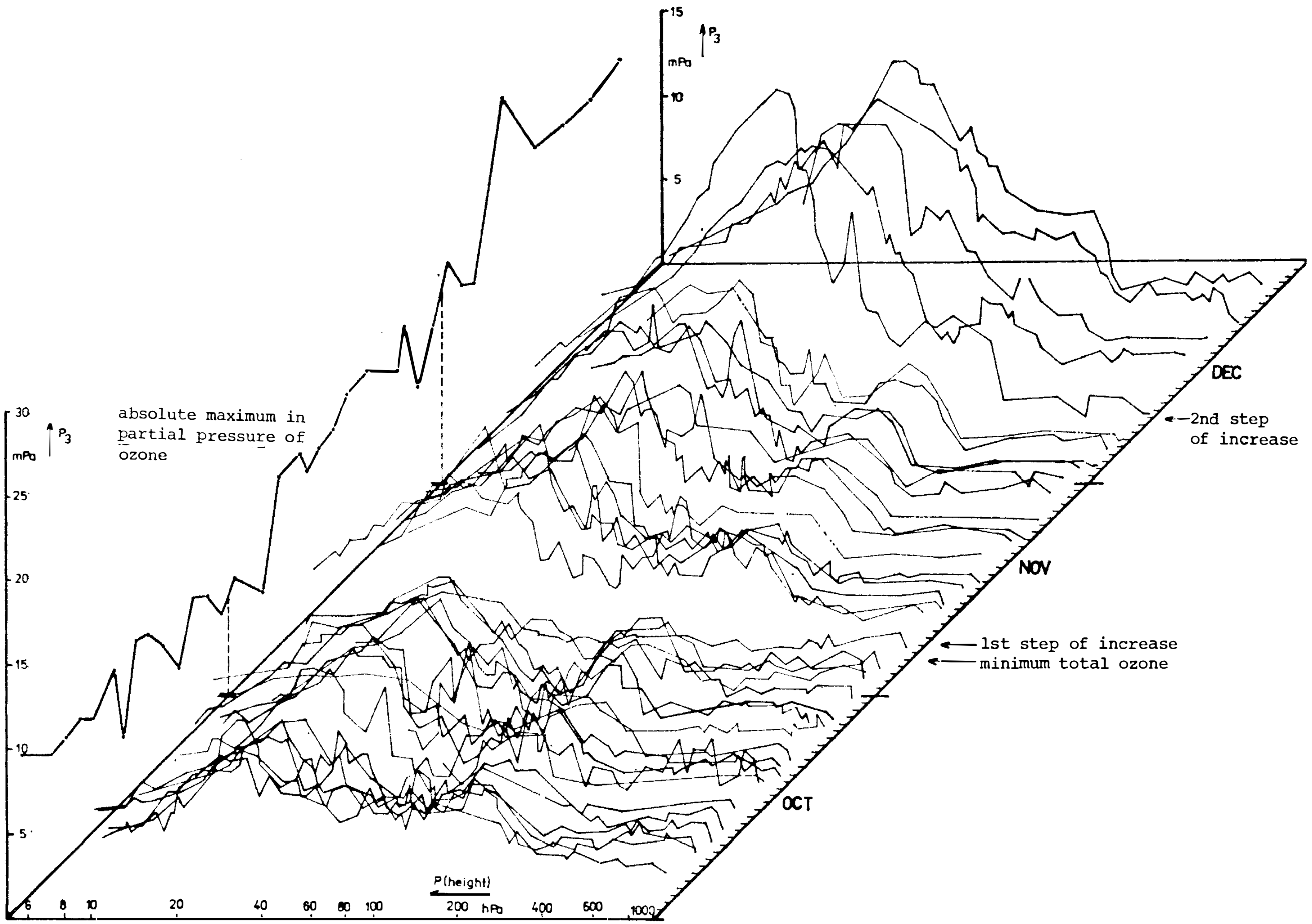

Fig. 2a. Novolazarevskaya, October, November and December 1985.

Fig. 2. Time-dependent ozone profiles at different seasons at the stations Novolazarevskaya (70.77°S, 11.85°E), Antarctica and Lindenberg (52.21°N, 14.12°E), GDR.

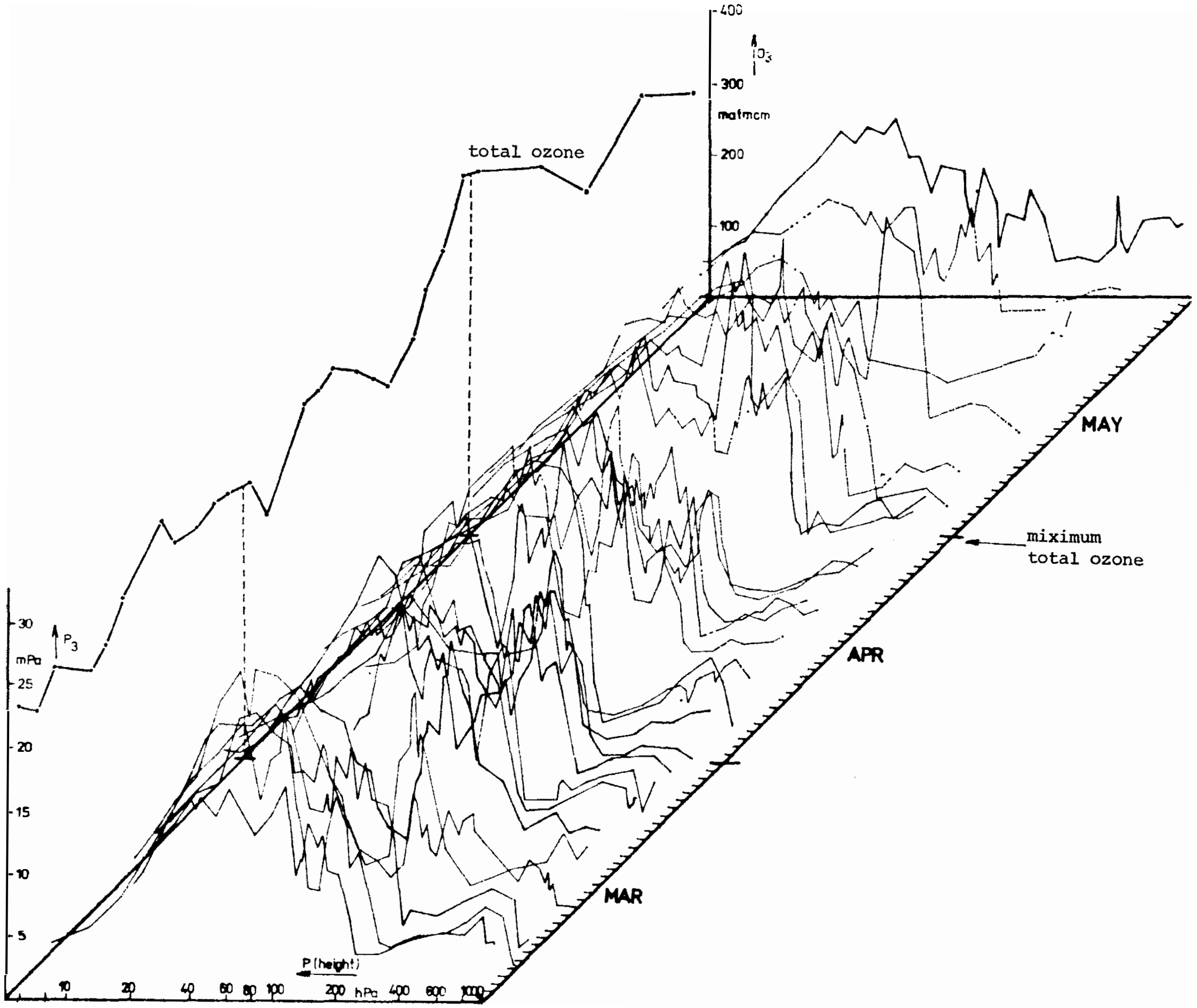

Fig. 2b. Lindenberg, March, April and May 1985.

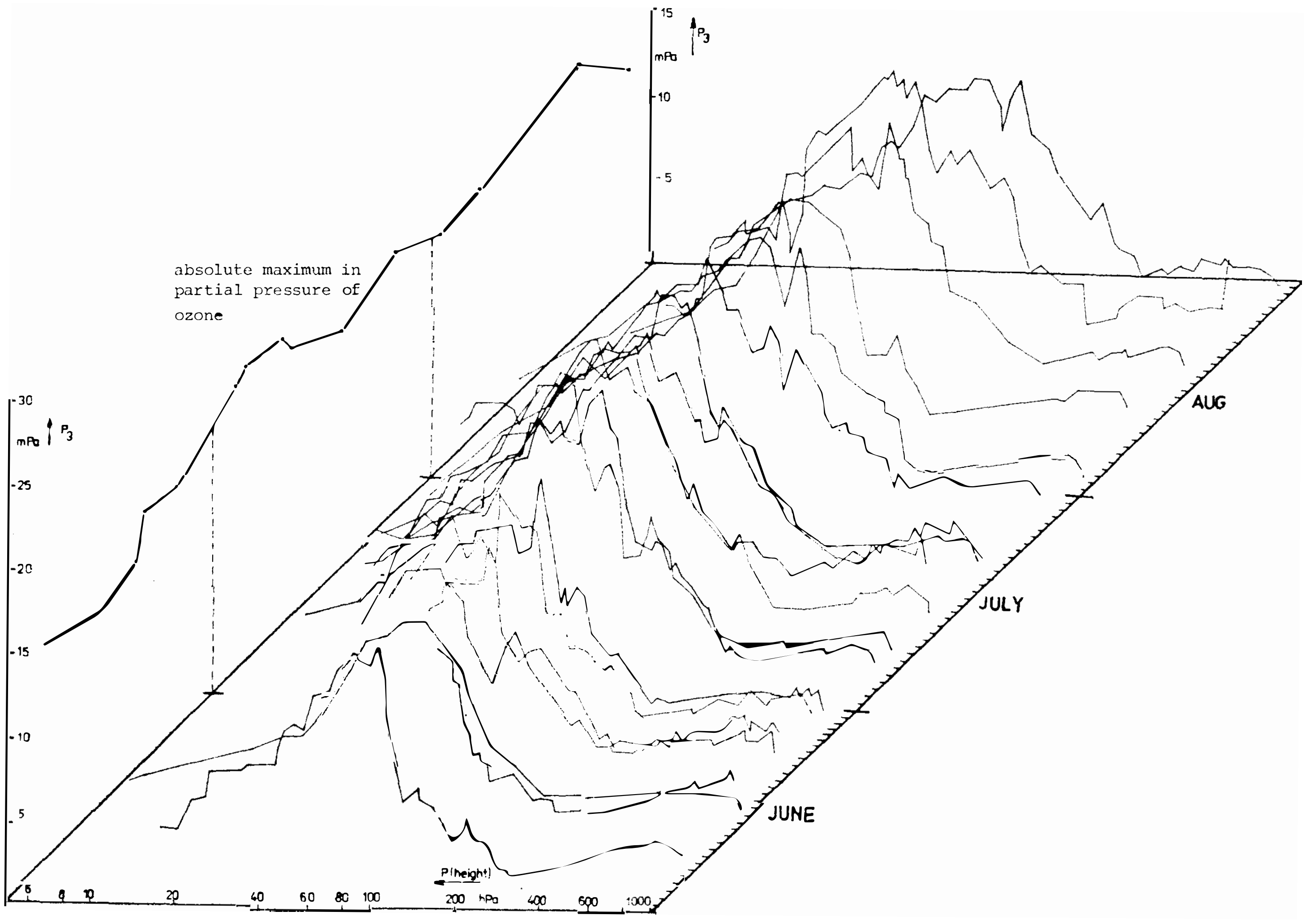

Fig. 2c. Novolazarevskaya, June, July and August 1985.

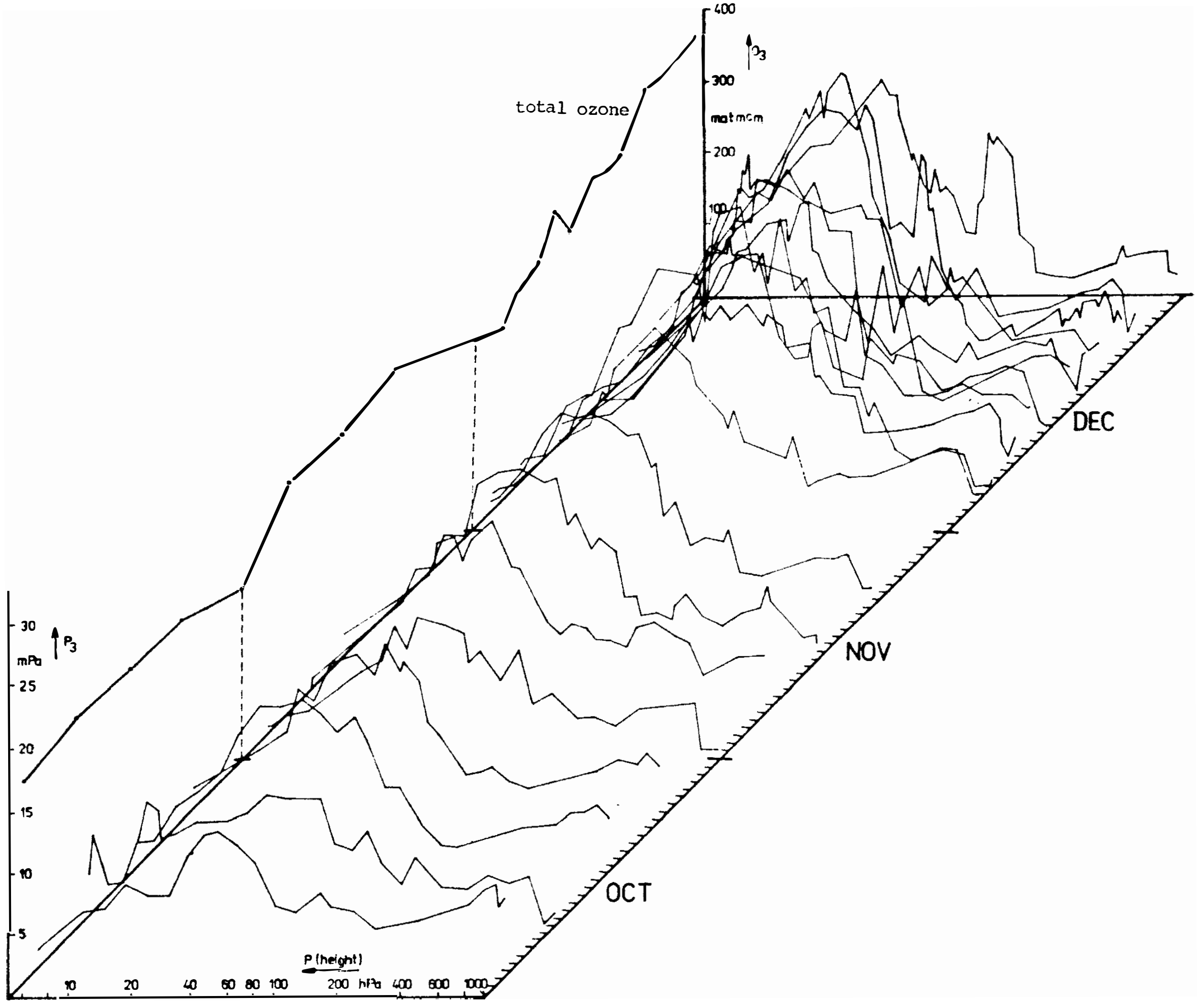

Fig. 2d. Lindenberg, October, November and December 1985.

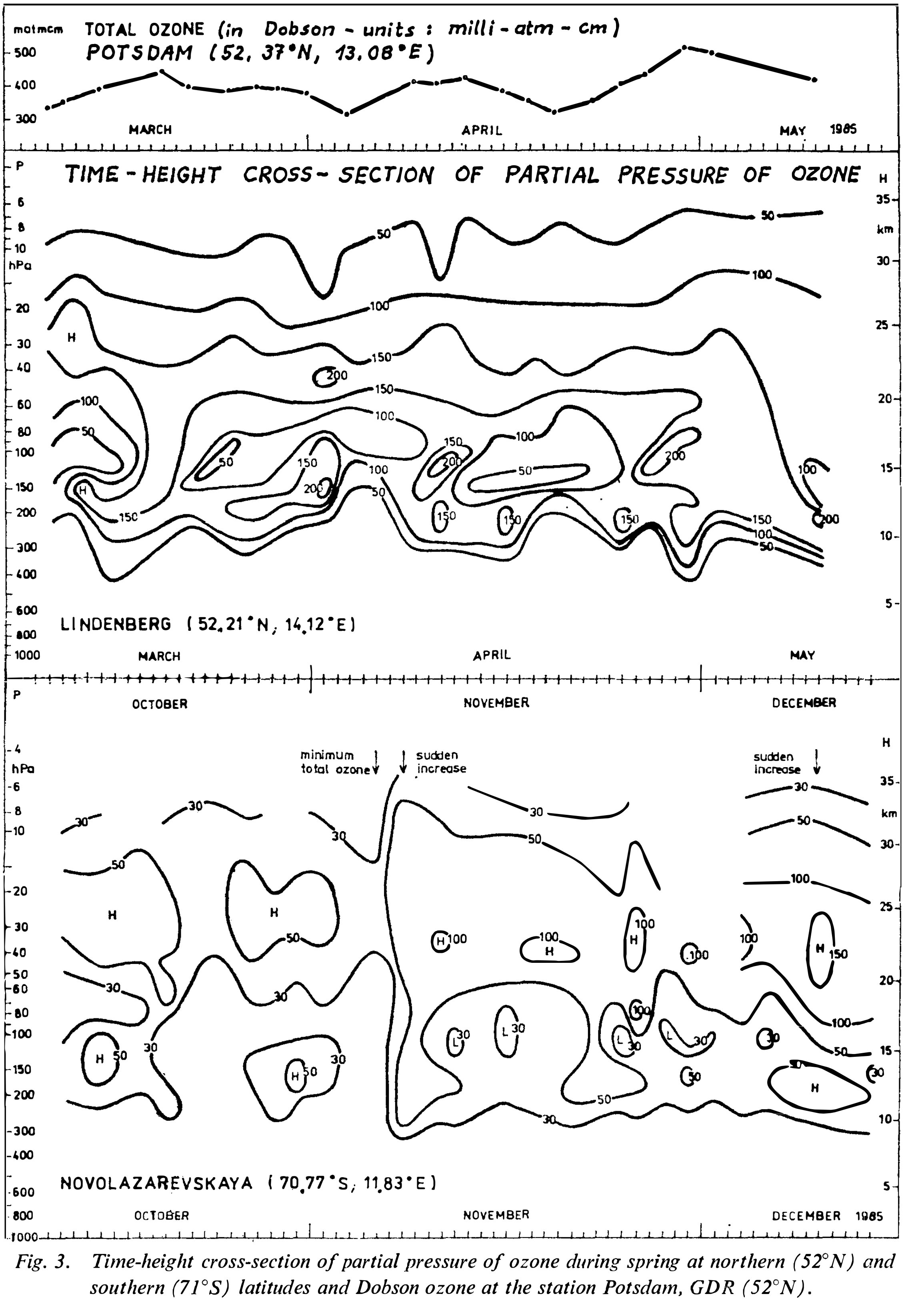

Fig. 3. *Time-height cross-section of partial pressure of ozone during spring at northern (52°N) and southern (71°S) latitudes and Dobson ozone at the station Potsdam, GDR (52°N).*

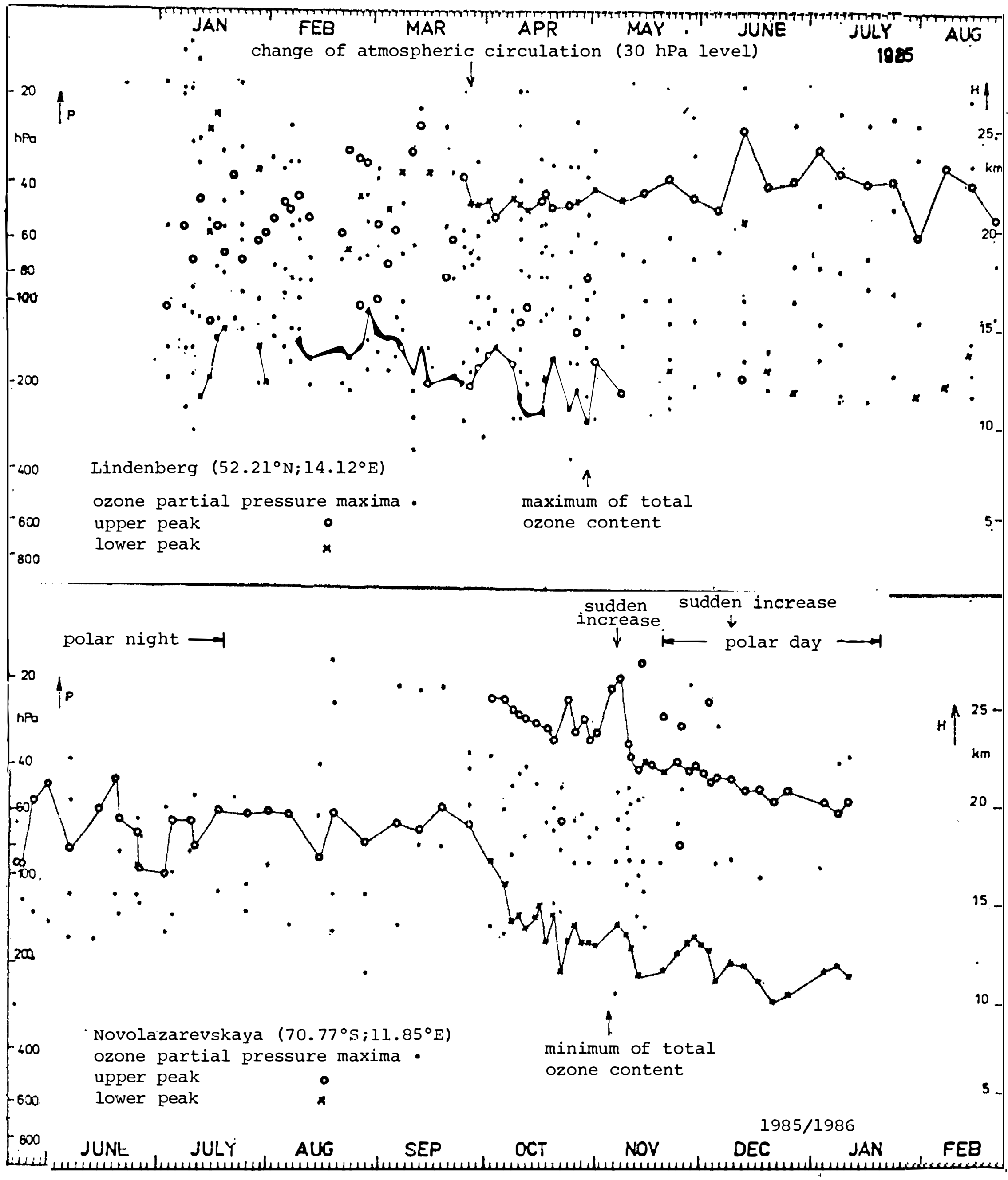

Fig. 4. Height variations of the different peaks of total ozone content at northern (52°N) and southern (71°S) latitudes.

hemisphere dynamics control the ozone distribution below 20 km, but in the winter hemisphere up to a height of 30 km (about 10 hPa) photochemical processes predominate. Therefore at 71°S the observed winter ozone peak is due to dynamical origin. In Fig. 5 three mean ozone profiles are shown for July to December. The lower peak appears between the tropopause and the level of stratospheric temperature minimum, *i.e.* in a region with temperature decreasing with increasing height. Up to the polar day the lower ozone peak descends to the tropopause level and seems to be trapped in the region with negative lapse rate.

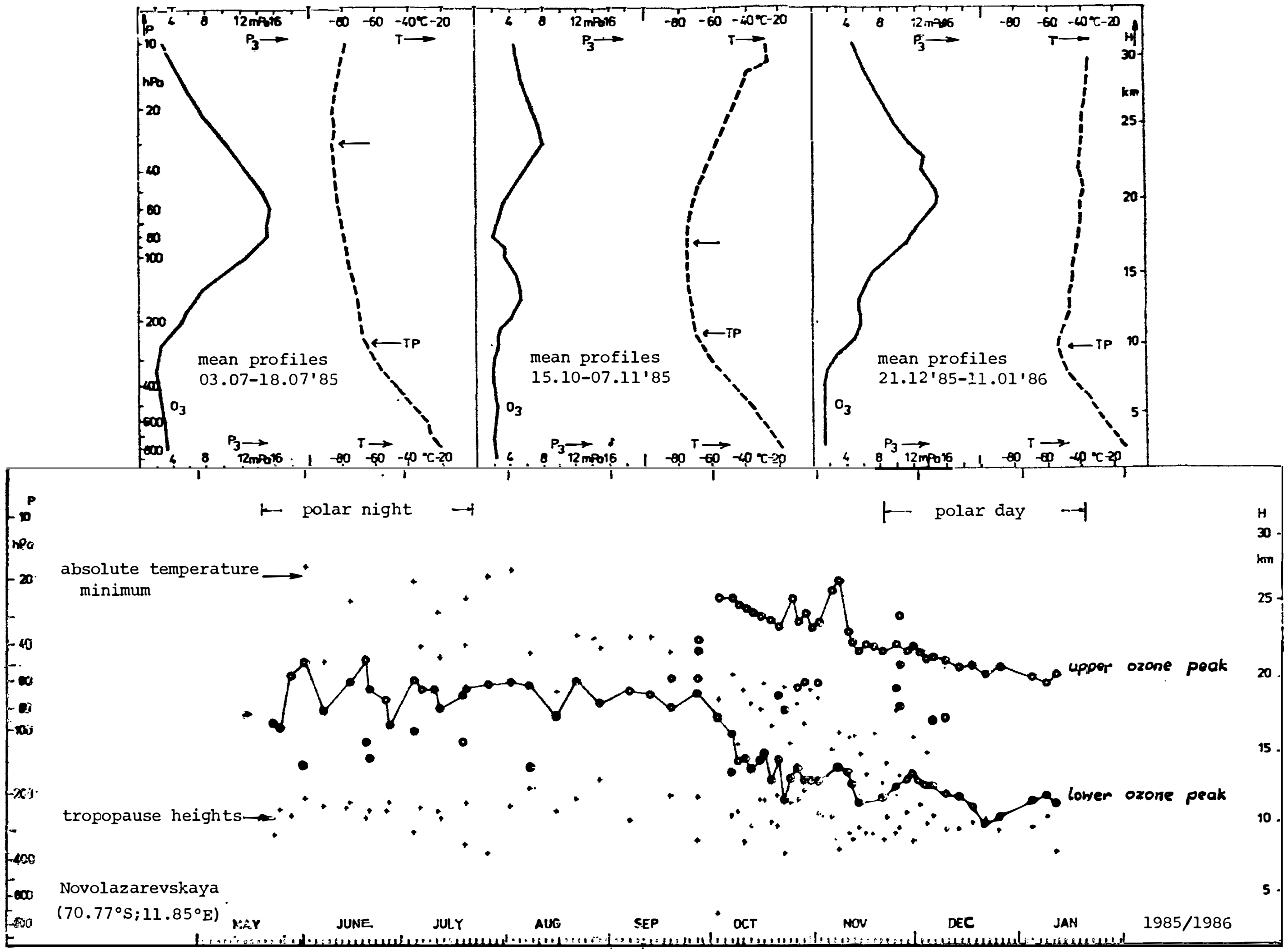

Fig. 5. Mean ozone profiles of three periods (03.07–18.07 '85, 15.10–07.11 '85, 21.12 '85–11.01 '86) and height variations of the upper peak and the lower peak from May 1985 to January 1986 at station Novolazarevskaya.

The large variations of the ozone peak height during polar night may be due to a planetary wave activity in the winter stratosphere. From spring to summer (polar day) the value of ozone partial pressure of the "tropopause maximum" remains nearly constant (Figs. 2 and 5). The observed peak height variation of ozone in the southern hemisphere gives a better understanding of that at middle latitudes (52°N). Both photochemistry and dynamics are involved in controlling ozone content at the heights above 20 km during the whole year. Therefore, the distribution of ozone is strongly affected by a planetary wave activity and an eddy diffusion during winter causing a considerable peak height variation. After the change of the zonal wind field from westerly to easterly the planetary wave propagation disappears and the vertical profile of ozone becomes stable.

It will be difficult to find weak particle effects in the auroral zone because of the dominant dynamics at 71°S. Studies should be made on the appearance of the normal ozone maximum at heights in the photochemical region.

The results of stratospheric ozone soundings at 70.77°S, 11.85°E generally agree with similar observations performed at the station Syowa (69.00°S, 39.58°E) from February 1982 to January 1983 (CHUBACHI, 1984).

Acknowledgements

The authors wish to express their thanks to the members of the aerological team of the Soviet station Novolazarevskaya for their kind cooperation to perform the balloon soundings and data reception. They are indebted to Mrs. HELBIG and Mrs. KUHRAU for preparing this manuscript.

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(Received December 11, 1986; Revised manuscript received May 15, 1987)