OZONE PROFILES ABOVE PALMER STATION, ANTARCTICA

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Both NASA and the NSF sponsored major expeditions in 1987 aimed at studying the Antarctic ozone depletion phenomenon. In a cooperative effort between these two ventures, NASA's GSFC/Wallops Flight Facility conducted a series of 52 balloon-borne measurements of vertical ozone profiles over the NSF research facility at Palmer Station, Antarctica ($64^{o}46'S$, $64^{o}3'W$) between August 9 and October 24, 1987. High resolution measurements were made from ground level to an average of 10 mb.

Ozone measurements were made with Electrochemical Concentration Cell (ECC) ozonesondes (Science Pump Corporation, Camden, NJ) coupled to meteorological radiosondes for data transmission to a ground receiving station. Prior to its use in a sounding, each sonde was calibrated relative to a UV-absorption ozone monitor (Dasibi Environmental Corp.) that was, in turn, calibrated against a 3-meter UV absorption photometer at Wallops. The sonde's precision in the stratosphere below 10mb is estimated to be 5% (one sigma).

The temporal behavior of the vertical structure of ozone over Palmer Station was rather complex. Meteorological distortions and movements of the polar vortex about the Antarctic continent resulted in Palmer being in the region of maximum ozone depletion on some days, and outside of this region on other days. Figure 1 illustrates this, using two ozone profiles obtained three days apart. The profile of 10/6/87 is "normal," while that of 10/9/87 shows ozone partial pressures to be less than 10nb in the 50-80mb altitude region. Clearly, these profiles were measured in two entirely different air masses. The 9/24/87 profile shown in Figure 2 demonstrates the complex structure sometimes observed in the ozone distribution over Palmer. These features probably result from horizontal mixing between the two types of air masses when the polar vortex boundary is near the Palmer site.

While much variation was seen in the profile amounts of ozone, it is clear that a progressive depletion of ozone occurred during the measurement period, with maximum depletion taking place in the 17-19km altitude region. Ozone partial pressures dropped by about 95% in this region. In Figure 3 are plotted time dependences of ozone amounts observed at 17km and at arbitrarily selected altitudes below (13km) and above (24km) the region of maximum depletion. Ozone partial pressure at 17km is about 150nb in early August, and has decreased to less than 10nb in the minimums in October. The loss rate is of the order of 1.5%/day.

During this same period, there is only a slight decline in ozone amounts at the higher and lower altitudes and, at 24km, there is a slight increase near the end of the period. (The mid-August gap in the 24km data is due to unusually cold stratospheric temperatures that caused premature balloon bursts.) The much smaller ozone differences across the vortex boundary at the lower and higher altitudes are indicated here by smaller day to day variations than are seen at 17km.

The total ozone overburden can be estimated from ozonesonde data by integrating the profiles up to the balloon burst point, and assuming a constant mixing ratio above this altitude. Figure 4 shows how the total ozone, in Dobson units, changed during the measurement period. Again there is a clear trend downward, until near the end of the measurement period. Initially, total ozone amounts sometimes exceeded 300 DU. By early October, minimums are as low as 150 DU. As might be expected given the behavior seen in Figure 3, fluctuations in total ozone closely follow changes in ozone partial pressure at 17km (linear correlation coefficient = 0.86).

In summary, a progressive depletion in stratospheric ozone over Palmer Station was observed from August to October, 1987. Maximum depletion occurred in the 17-19km range, and amounted to 95%. Total ozone overburden decreased by up to 50% during the same period.

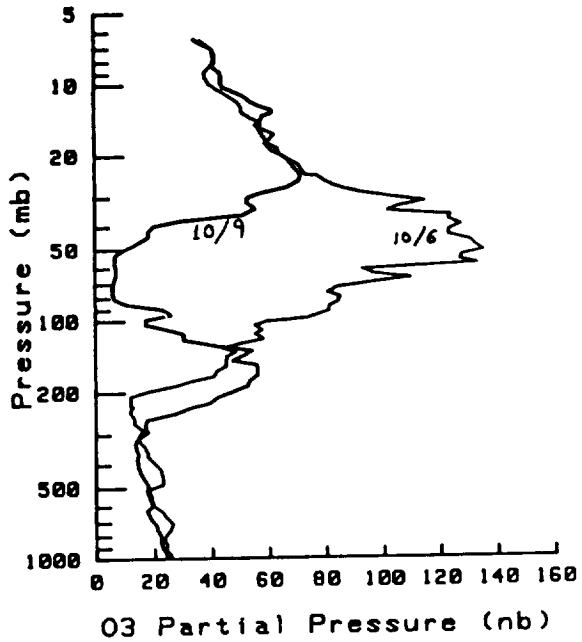

Figure 1. Ozone profiles outside (10/6/87) and inside (10/9/87) region of ozone depletion.

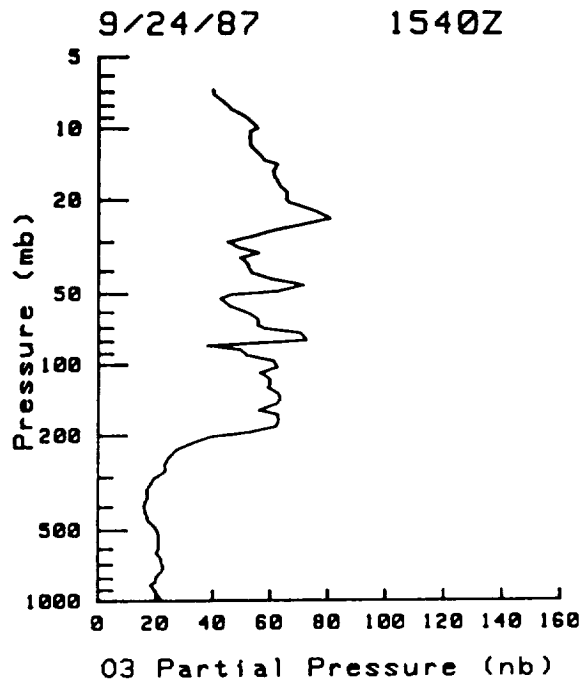

Figure 2. Ozone profile through mixed air masses.

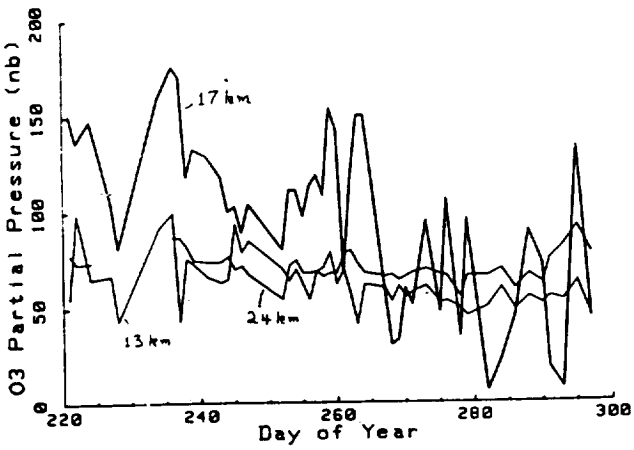

Figure 3. Ozone partial pressures below (13km), in (17km), and above (24km) region of maximum ozone depletion.

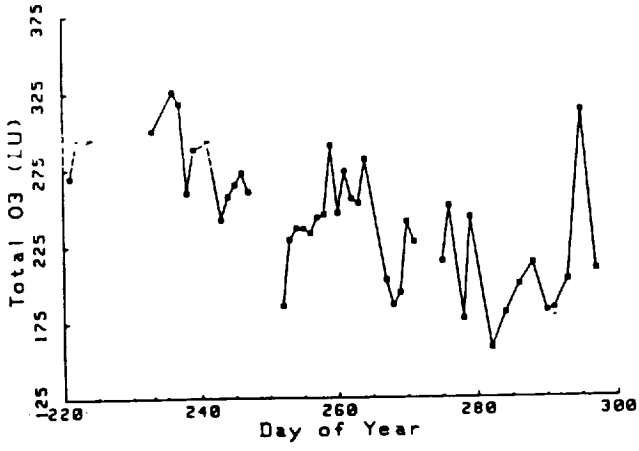

Figure 4. Trends in total ozone over Palmer Station.