Total Ozone, Ozone Vertical Distributions, and Stratospheric Temperatures at South Pole, Antarctica, in 1986 and 1987

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Seventy-six ECC ozonesondes were flown at South Pole, Antarctica, during 1987 in a continuing program to document year-round changes in Antarctica ozone that are dynamically and photochemically induced. Dobson spectrophotometer total ozone observations were also made. For the twilight months of March and September when Dobson instrument observations cannot be made at South Pole, total ozone amounts were deduced from the ECC ozonesonde soundings. ECC sonde total ozone data obtained during the polar night (April-August), furthermore, supplemented the sparse total ozone data obtained from Dobson instrument moon observations. Similar ozone profile and total ozone observations were made at South Pole in 1986.

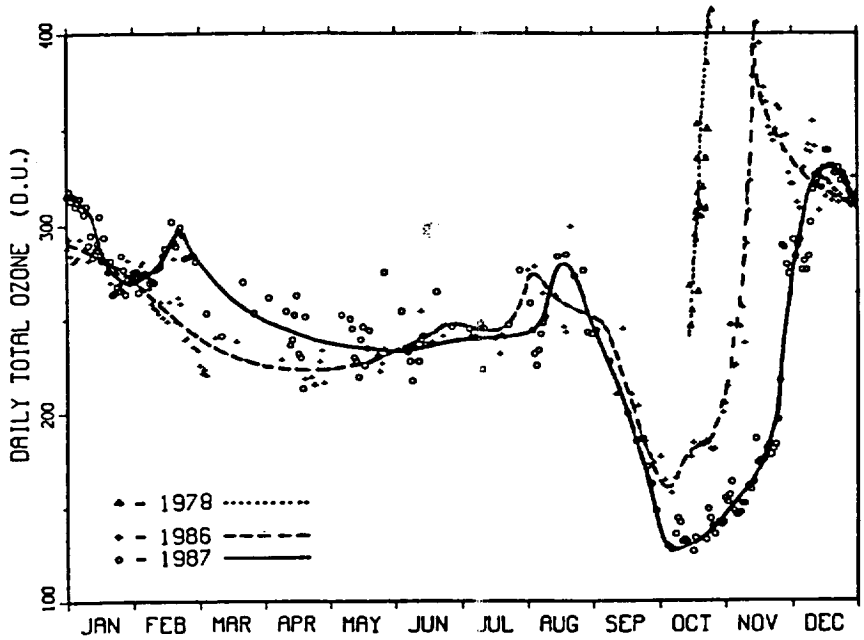

Figure 1. Daily total ozone amounts at South Pole in 1986 and 1987, including a portion of the 1978 total ozone record showing the springtime ozone increase that occurs each year in Antarctica.

As shown in Figure 1, the 1987 annual course of total ozone at South Pole differed significantly from that of 1986. For the time interval January-May, the average total ozone amount in 1987 was larger than in 1986 by about 8%. During the polar night of both years, total ozone increased from about 245 D.U. (D.U. = Dobson unit = milli-atm-cm ozone) in early June to 280-290 D.U. in August. Ozone decreased rapidly during September of both years to a low of 158 D.U. in early October 1986, but to an unprecedented low of 127 D.U. in early October 1987. Thereafter the ozone began to recover, with the recovery proceeding considerably more slowly (with a 3-4 week delay) in 1987 than in 1986. Compared to the time of the springtime ozone increase at South Pole in 1978 (Figure 1), the delay in the 1987 springtime ozone increase was 6-8 weeks. At year end for both 1986 and 1987, the total ozone amount at South Pole was 315 D.U.

The 1987 October (October 15-31) mean total ozone amount at South Pole was 138 D.U. The previous October mean low, of 161 D.U., occurred in 1985. The average total ozone amount for October months at South Pole during 1964-1979 was 292 D.U.

The 1987 November South Pole total ozone mean, of 184 D.U., was also unusually low. The previous November mean low of 238 D.U. occurred in 1985. The 1964-1979 average total ozone amount for November months at South Pole was 351 D.U.

ECC ozonesonde observations showed the springtime reduction of ozone between 11 and 22 km (180 and 25 mb) in the stratosphere to be more pronounced in 1987 than in 1986 (Figure 2). Ozone volume mixing ratios (not shown) in

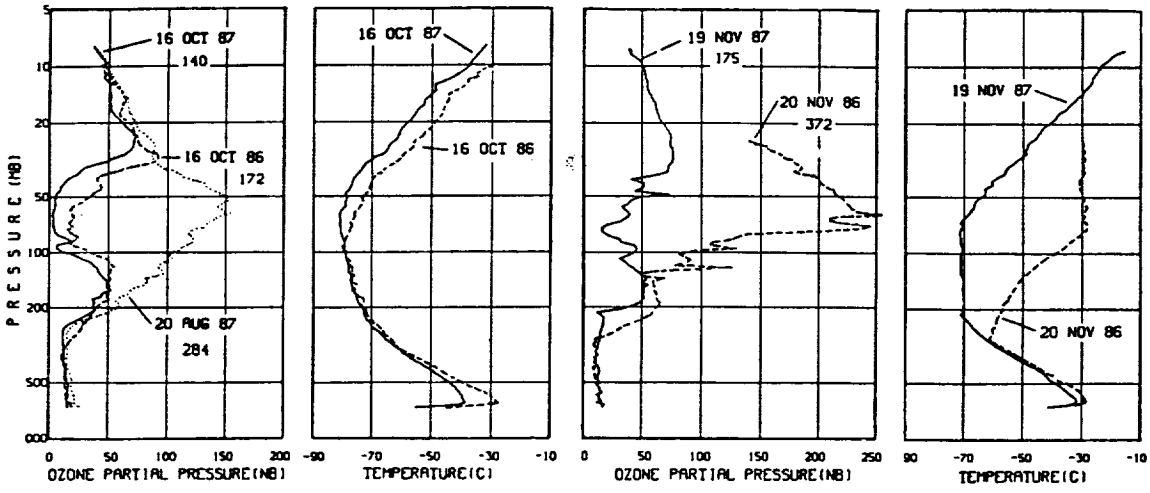

Figure 2. Comparison of South Pole October 16 and November 19-20 ozone and temperature profiles for 1986 and 1987. The August 20, 1987 profile depicts the character of the ozone vertical distribution at South Pole prior to the time of onset of the springtime ozone decrease phenomenon. Numbers under the date labels are total ozone amounts in D.U.

the heart of the ozone depletion region (at ~16 km altitude) ranged from 0.2 to 0.4 parts per million by volume (ppmv) in 1986, but approached 0.04 ppmv in 1987. (Such low ozone volume mixing ratios normally occur in the troposphere and in the low stratosphere). The observed mixing ratios of 0.04 ppmv may have been an artifact of ECC ozone sensor output current "tailing" that occurs at low output currents. Thus, depletion of ozone between 50 and 100 mb at South Pole during early October 1987 may have been virtually complete.

In 1986, at 16 km altitude, ozone decreased during August 20 to September 20 from about 2.0 to 1.0 ppmv, with an exponential decrease half-life of 34 days. During September 21 to October 15, the ozone was additionally reduced from 1.0 to 0.3 ppmv, with an exponential decrease half-life of 11 days.

The ozone reduction in the 16 km stratospheric region was more rapid in 1987. During August 20 to September 31, the ozone mixing ratio decreased from 2.3 to 0.6 ppmv, the exponential decrease half-life being 22 days. Additional ozone reduction during October 1 to 12, from 0.6 to 0.04 ppmv, proceeded with an exponential decay half-life of about 3 days.

Stratospheric temperatures near 50 mb over South Pole during August 20 to September 3 were 2°C colder in 1987 than in 1986 (-90°C vs -88°C). The temperature difference increased with time, becoming 6°C by November 1 (-70°C and -76°C in 1986 and 1987, respectively). With the break-up of the circumpolar vortex about November 15, 1986, the temperature at 50 mb over South Pole soared to -28°C. Cold stratospheric temperatures at 50 mb persisted, however, throughout much of the latter one-half of November 1987, with the temperatures being nearly 40°C colder than in 1986. With breakdown of the circumpolar vortex in late November-early December, 1987, the 50 mb stratospheric temperatures for 1986 and 1987 became comparable at about -33°C.

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