THE 1989 OZONE HOLE

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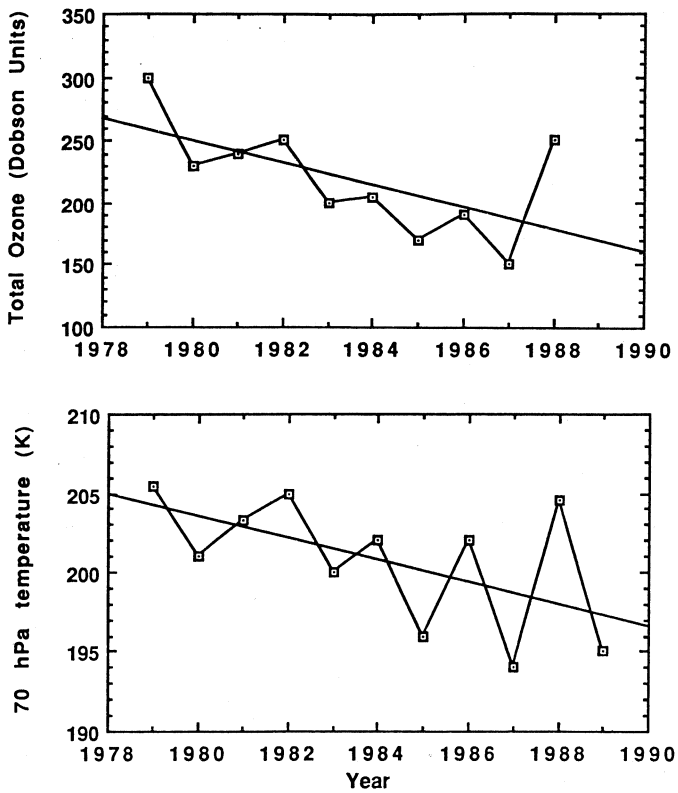
Each springtime since the late 1970s there has been a large, sudden, and unexpected decrease in total ozone over the Antarctic. During the spring months up to 50% of the total ozone column disappears, with depletions of 95% locally between 15 and 20 km altitudes (Hofmann et al., 1987).

This ozone hole has generally been getting deeper and more persistent through the 1980s (Figure 1), with odd-numbered years showing a more severe hole than the even years. In 1987 more than half the ozone over Antarctica disappeared from September until late November, in what has been the deepest ozone hole to date (Krueger et al.,1988).

The Quasi-Biennial Oscillation (QBO) of the tropical stratospheric winds, a meteorological feature which has been associated with the approximate two-

Figure 1 October average values of total ozone (top) and 70 hPa temperatures (bottom) at the South Pole. After Randel and Newman (1988).



yearly cycle of the ozone hole (Garcia and Solomon, 1987), had suggested that the 1989 hole would be less severe than in 1987, and perhaps similar to the milder hole of 1988. The approach of the sunspot activity to its 11-year maximum in 1990 had also indicated that the ozone depletion would be moderated over the next few years.

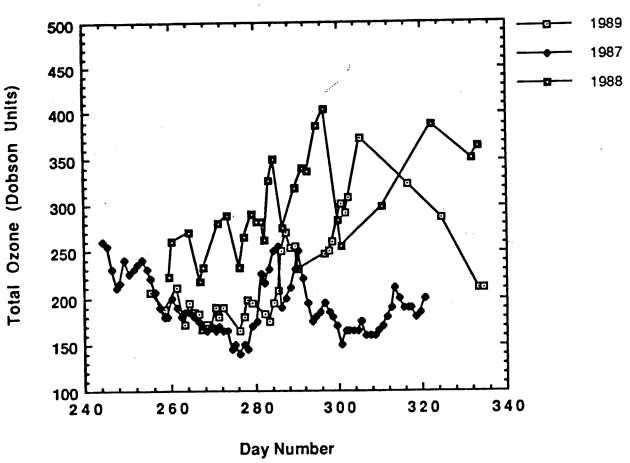
However ozone measurements made by the New Zealand Meteorological Service at Arrival Heights, Antarctica (77.82 S, 166.66 E) with Dobson spectrophotometer No. 17 showed a period of rapid ozone depletion during September, in an almost identical pattern to September 1987 (Figure 2).

In 1989 the total ozone measurements at Arrival Heights were consistently below 200 Dobson Units (DU) from mid-September through until mid-October, with values frequently between 160 and 180 DU. The lowest values of around 160 DU represent a loss of 40-50% of the ozone over that region. In contrast to the 1989 measurements, the lowest ozone measured during 1988 at Arrival Heights was 217 DU on 23 September.

The ozone depletion occurs in the meteorological feature called the polar vortex. The polar vortex is confined by a strong stratospheric circumpolar wind belt which effectively restricts the exchange of air from outside the vortex. The vortex, which forms over winter and lasts until late spring, covers an area as large as the Antarctic continent. The vortex rotates around as a result of atmospheric circulation patterns. This movement means that stations towards the exterior of the Antarctic will not always be under the ozone hole during springtime.

From the end of October 1989 until the end of November more "normal" ozone values of around 300 DU were measured at Arrival Heights. This was a result of the polar vortex being almost permanently centred over west Antarctica. At the end of November relatively low ozone values of 211 DU were again recorded as the

Figure 2 Total ozone measurements from Arrival Heights using Dobson spectrophotometer No. 17 for spring 1988 and 1989. The 1987 data are TOMS satellite data for the McMurdo region (after Hoffman et al, 1988).



vortex moved over the Ross Sea region. Figure 2 shows how the springtime data record from a particular Antarctic station incorporates variations in ozone due to the chemical depletion of ozone and also dynamical changes due to the movement of the polar vortex.

The repeat of a 1987-type hole in 1989 was somewhat unexpected due to the moderating effect of the QBO and the solar cycle. Stratospheric temperature data (Figure 1) have confirmed the nature of the 1989 stratospheric vortex to be similar to 1987.

The principal cause of the ozone hole is chlorine, primarily from chlorofluorocarbons (CFCs). With the continuing use of CFCS there is now 5% more chlorine in the stratosphere than there was in 1988, and 10% more than in 1987. The severity of the 1989 ozone hole could well be due to these increased levels of chlorine.

Acknowledgements

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