

L E T T E R S

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ANTARCTIC OZONE HOLE, LATEST 2015 SITUATION ABOUT RECOVERY

1. Ultraviolet (UV) radiations from the Sun in the spectral range 100-280 nm react with the stratospheric atmosphere, and oxygen molecules (O₂) and atoms (O) combine to produce ozone (O₃). Since there are destruction processes also, the equilibrium amount is small, only a few percent of the atmosphere. However, it serves a very vital, useful purpose as it absorbs UV in the spectral range 280-320 nm (termed as UVB), which is very dangerous for terrestrial life and is a cause of skin cancer, etc. Total ozone is measured regularly, earlier by Dobson instrument and now with the Brewer instrument & satellite instrumentation TOMS (total ozone-measuring spectrometer) at several hundred locations, including in the Polar Regions, for the last several decades.

Farman *et al.* (1985) were the first to notice that the total ozone level at the Antarctic station Halley (74° S, 271° W) was decreasing considerably from year to year, probably from 1976 onwards. In the next few years, several workers confirmed this tendency of ozone depletion. It was soon discovered that the loss was due to chemical destruction by anthropogenic causes, namely escaping into the atmosphere of CFC compounds from man-made gadgets like refrigerating units, hair sprays, etc. These compounds spread into the troposphere but eventually reach the stratosphere and destroy O₃ molecules (halogen chemistry, Anderson *et al.*, 1991). The Montreal Protocol (<http://www.theozonehole.com/twentieth.htm>) recommended immediate efforts to reduce or eliminate the use of CFC compounds and this seems to have produced some effect (Montzka *et al.*, 1996; Dutton *et al.*, 2003; Schauffler *et al.*, 2003). In the Polar Regions, a spring-time circumpolar vortex is formed, ozone is captured inside and has no connection with outside ozone; so, CFCs have enough time to destroy ozone until the vortex lasts. In the Antarctic, the vortex is stable for 2-3 months and the ozone depletion is intense, causing the "Antarctic ozone hole". Incidentally, ozone changes can also be due to other causes unrelated to the halogen load as such (Shindell *et al.*, 1997; 1998 a & b; 1999). Another important factor-affecting Antarctic ozone is the effect of stratospheric wind QBO (Garcia and Solomon, 1987). In an earlier communication (Kane, 2002), it was shown that the ozone depletion, which started in late 1970s, continued till about 1996, after which the level probably remained steady up to 2002. Using data for another 4 years 2003-

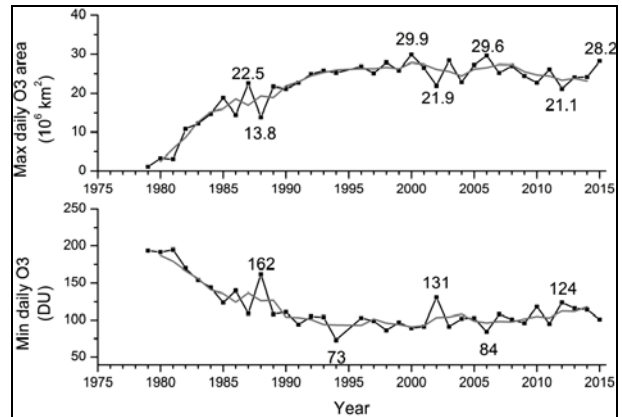


Fig. 1. Plots for 1979 onwards of (top Plot) Ozone hole area maximum (million km², full lines, 3-year running means), and (bottom plot) Antarctic ozone intensity minimum Ozone hole, (DU), (top Plot) Ozone hole area maximum (million km², full lines, one value per year; crosses, 3-year running means)

2006, Kane (2008) reported that the ozone depletion, which started in late 1970s seemed to have reached a maximum level (minimum ozone) in 1996 and a recovery seemed to have occurred thereafter up to 2003. But in the succeeding years 2004-2006, there seemed to have occurred a relapse.

In a recent communication (Kane, 2015) the Antarctic situation was reviewed for 1979 onwards up to 2013. It was reported that ozone hole intensity declined from 200 DU in 1979 to 75 DU in 1994 and a recovery started thereafter but the level hovered around 100 DU, occasionally reaching 125 DU but then coming back to 100 DU, thus indicating no recovery as such. On the other hand, the ozone hole area increased up to 30 in 2000 and then reduced to 22 (20%) in 2002, indicating a partial recovery. Since the ozone area recovery is suspected, a monitoring every year needs to be confirmed. In this communication, we examine the behaviour using the data for the next two years, 2014 and latest 2015.

2. In the Antarctic, the winter months February-July are dark (no sunshine). Sun appears only in August when the ozone level can be measured. However, the ozone destruction starts soon and during the last week of September to the first week of October, the ozone destruction is largest, recovering thereafter. In this study, the parameters considered are the minimum daily value (Dobson Unit DU) in the Antarctic ozone hole and the maximum hole area (million km²), as seen in TOMS data,

one value of each per year, occurring during the last week of September - the first week of October.

3. Fig. 1 shows the plots for 1979 onwards for ozone hole area in the upper plot and the magnitude (DU) minimum in the bottom plot. The superposed line indicates 3-month running averages. The following may be noted:

(i) In the top plot for the ozone hole area, a maximum value of 29.9 million km² was reached in 2000. Since then, there is a tendency of reduction in hole size from ~30 million km², to the 2002 value of ~21.9 million km². This could be an indicator of a possible partial recovery. But then in 2006, the value was high again, 29.6 and though remained low for the next few years, recently in 2015, the value was high again 28.2. Thus, the possibility of recovery is highly dubious.

(ii) In the bottom plot, the minimum ozone level (Full lines: one value per year; Crosses : 3-year running means) was about 200 DU in 1979 but decreased thereafter to 73 DU in 1994. For 1995, no data are available. In 1996, the level was ~100 DU. Since then, the average level seems to have steadied near ~100 DU. In 2002, the level rose to 131, but fell to 91 DU next year and further to 84 DU in 2006. In 2010, the level rose to 118 DU, but fell to 95 DU next year. In 2012, the value rose to 124 DU. But fell to 101 DU recently in 2015.

Thus, our earlier conclusion that since 1994, there was a tendency of a rise is not borne out. The values are hovering around 100 DU.

4. The Antarctic ozone hole intensity fell from a level of ~200 DU in 1979 to ~75 DU in 1994 and has not recovered much since then. It is hovering around 100 DU, occasionally rising to ~125 DU but falling back again to ~100 DU, thus indicating no sure recovery. On the other hand, the ozone hole area showed a reduction, from 30 in 2000 to 22 (27%) in 2002, but showed a high value in 2006 (29), followed by a low value (21) in 2012 but a high value (28) in 2015. Thus, the recovery of area in recent years is not clear and could be misleading, as of now, there is no clear indication of recovery, in intensity as well as in area. After reaching a lowest level of ~75 DU in 1994, the Antarctic ozone hole intensity is hovering around 100 DU, occasionally rising to ~125 DU but falling back again to ~100 DU, thus indicating no sure sign of recovery. The ozone hole area is showing a reduction in recent years, from ~30 in 2000 to ~22 in 2002.

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