



The 2007 Antarctic Ozone Hole Summary: Friday 31 August 2007

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Instrumentation and new corrected Earth Probe TOMS data for 1996-2005

Data from the Ozone Monitoring Instrument (OMI) on board the Earth Observing Satellite (EOS) Aura, that have been processed with the NASA TOMS Version 8 algorithm, will be utilized again this year in our weekly ozone hole reports.

On 15 August 2007, NASA announced that corrected Earth Probe (EP) TOMS data (for 1996 through to 2005 inclusive) will be released on 1 September 2007. By mid-2000 the EP TOMS instrument had degraded significantly, so much so that the standard correction procedures could no longer produce accurate ozone. The problem is believed to be an inhomogeneous degradation of the scanner mirror on TOMS, which results in a calibration error that is latitude dependent. An empirical correction based on the NOAA-16 SBUV/2 ozone record has now been applied to the EP TOMS ozone record, and comparisons with ground network stations shows that the resulting ozone is stable within $\pm 1\%$ over the 1996-2005 period.

Once the new EP TOMS ozone record is released the data will be re-analysed by CSIRO for the standard metrics we report on, namely: ozone hole area; ozone minima; ozone deficit; and average ozone amount within the hole. The updated statistics will then subsequently be reported, especially given that most of the records for the above mentioned ozone hole metrics occur in the 1996-2005 period. In addition, the comparison between 2005 OMI and TOMS ozone data for the above metrics (which we reported last year), will be redone with the new TOMS data for 2005.

The 2007 ozone hole

The OMI data show that the ozone minimum dropped below 220 DU at the beginning of August, about the same time as in 2006 and 2005, and, by the end of the 4th week of August, the ozone minimum in the Antarctic ozone hole had dropped to 150 DU, after reaching 145 DU by mid-August before rising to over 190 DU on 18 August. At present the ozone is lower than the corresponding period in 2006, but quite similar to 2005 (Figure 1, top panel). At this stage the 2007 Antarctic ozone hole is heading for the 'deep' category (as have all ozone holes since the early 1990s except for 2002). By the 4th week of August the ozone hole area reached 13-14 million km² (Figure 1, bottom panel) which is similar to 2006 and 2005 at the same date.

Figure 2 (top panel) shows the estimated daily ozone deficit by the end of August had reached 7 million tonnes (similar to 2005), while the average ozone amount in the hole (averaged column ozone amount in the hole weighted by area, Figure 2 bottom panel) shows a minima of under 200 DU at the same time. By mid-August the average ozone had fallen to 190 DU, it has been hovering around 200 DU for the past 2 weeks. The rapid ozone decline in 2005 and 2006 did not start until early September – presumably this will be the case for 2007.

It should be noted that until the polar night reduces to be smaller than the ozone hole, the above metrics are subject to noise and inaccuracies.

WMO Ozone Bulletin #1 (23 August 2007)

WMO have just released the first of their Bulletins on the Antarctic Ozone Hole for 2007. The polar vortex is primed for rapid ozone loss, once illumination is sufficient to release reactive chlorine and bromine radicals from the 'bank' of chlorine and bromine that has accumulated in the vortex from the usual PSC-catalysed chemistry during the winter.

The vortex is cold, the minimum temperature achieved at 50 hPa was in late August (-94°C); in 2006 the same minimum temperature was achieved, but about 2 weeks earlier. The coldest vortex temperature ever recorded is -96°C. Significant warming of the vortex usually starts to occur mid- to late-September. Type I PSCs (HNO₃·3H₂O) form below -78°C and Type II below -85°C.

The PSC Type I formation area reached a maximum (26 million km²) in early August and is currently at 25 million km²; the maximum reached in 2006 was about 31 million km². The current PSC Type 1 area is lower than for any of the winters in the 2003-2006 timeframe.

From the Literature

The full WMO/UNEP report *Scientific Assessment of Ozone Depletion: 2006* was published in March 2007.

Clerbaux, C., D. Cunnold, J. Anderson, A. Engel, P. Fraser, E. Mahieu, A. Manning, J. Miller, S. Montzka, R. Nassar, R. Prinn, S. Reimann, C. Rinsland, P. Simmonds, D. Verdonik, R. Weiss, D. Wuebbles & Y. Yokouchi, Long-Lived Compounds, Chapter 1 in *Scientific Assessment of Ozone Depletion 2006*, Global Ozone Research and Monitoring Project - Report No. 50, 572 pp, WMO, Geneva, 2007

Scientists (Fraser, Etheridge, Krummel) from CSIRO Marine and Atmospheric Research (CMAR) made a significant contribution to this Assessment. In the first ozone hole report for 2006, the major findings of the WMO/UNEP Assessment were summarized. CMAR also produced a summary of the Report with emphasis of the role of bromine in ozone depletion.

Fraser, P. and P. Krummel, Bromine and stratospheric ozone, Report to Department of Environment and Heritage, Canberra, ACT, 5pp (October 2006).

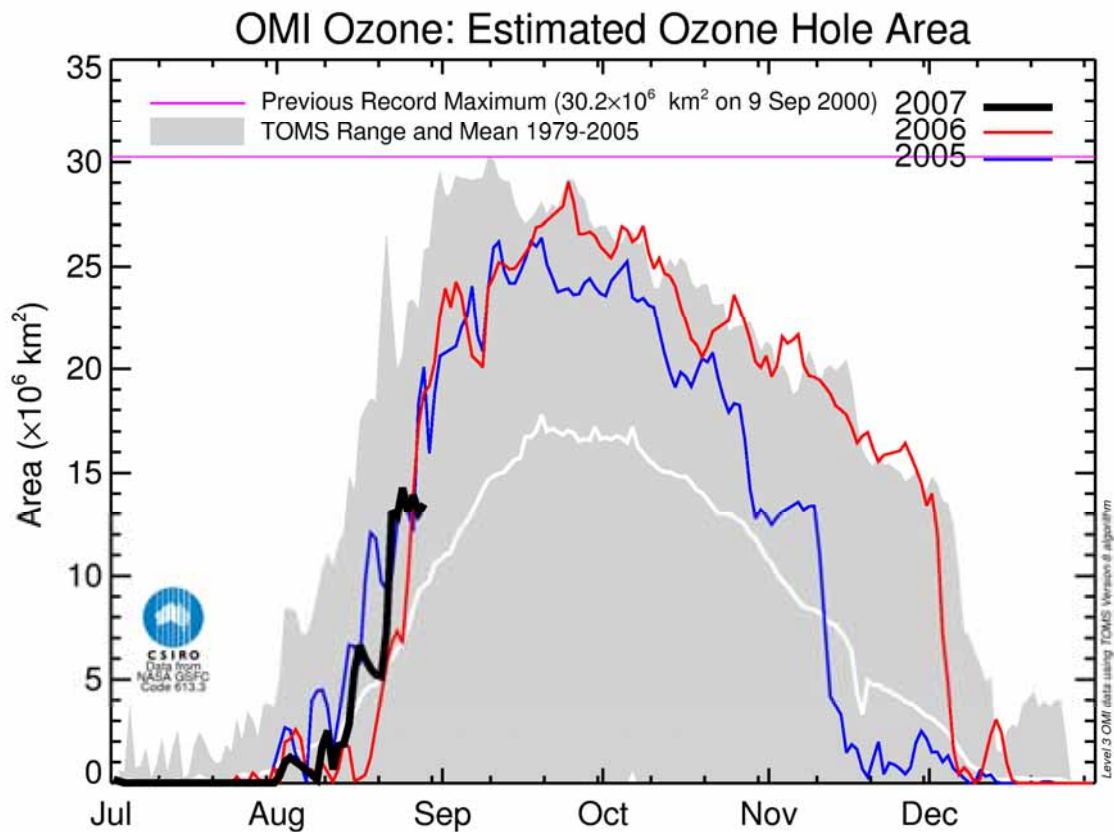
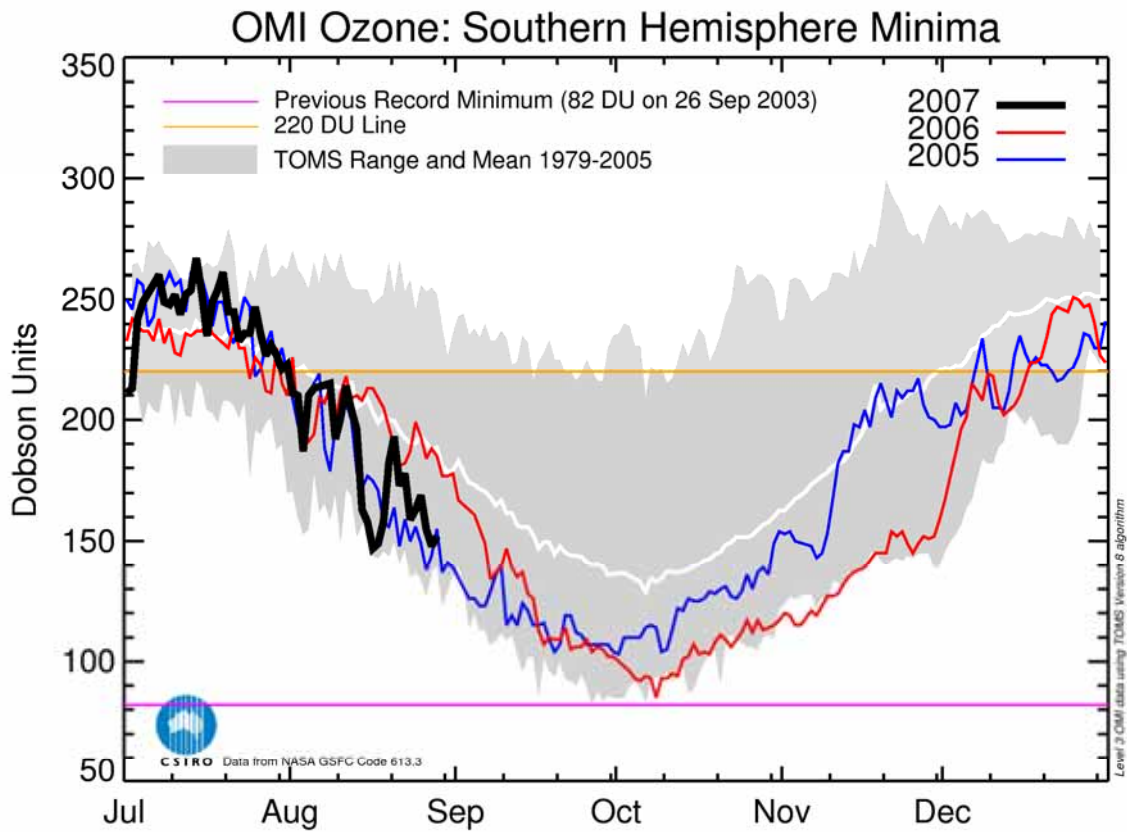
One of the important parameters that is used to correlate with long-term stratospheric variability is stratospheric chlorine. This can be estimated from measurements of tropospheric chlorine, but it is timely to check the veracity of such calculations against actual observations of stratospheric chlorine.

Two recent papers track stratospheric chlorine trends:

Wallace, L. and W. Livingston, Thirty-five year trend of hydrogen chloride amount above Kitt Peak, Arizona, *Geophys. Res. Letts.*, **34**, L16805, doi:10.1029/2007GL030123 (2007).

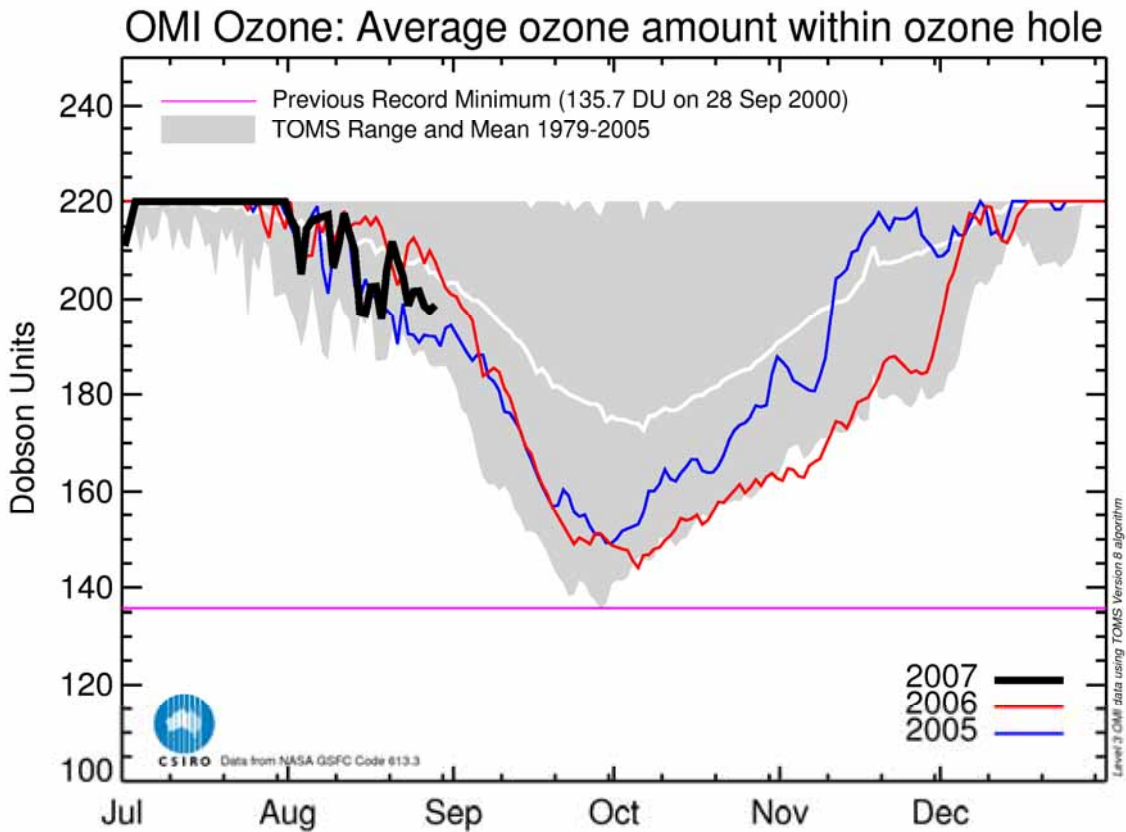
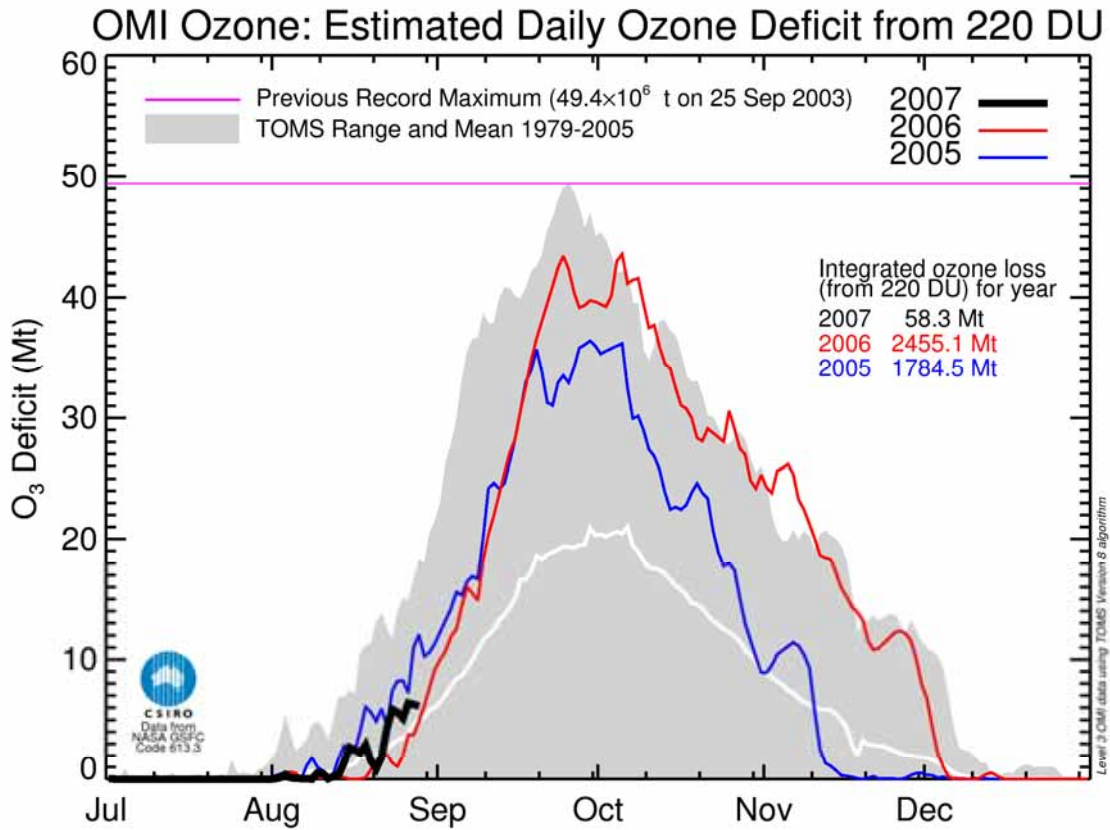
Froidevaux, L. *et al.*, Temporal decrease in upper atmospheric chlorine, *Geophys. Res. Letts.*, **33**, L23812, doi:10.1029/2006GL027600 (2006).

These papers discuss total column HCl (which largely resides in the stratosphere) and upper-stratospheric HCl, the former showing a consistent rise from 1971 to 1993, a plateau from 1993 to 1997 and a fall from 1997 to 2007, and the latter showing a decrease of -27 ppt/yr (2004-2006). The latter are consistent with observations of tropospheric chlorine about 6 -7 years earlier.



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Figure 1: Ozone hole depth (top panel) and area (bottom panel) based on OMI satellite data, as of August 28 2007.



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Figure 2: Estimated daily ozone deficit (top panel) and average ozone amount within the ozone hole (bottom panel) based on OMI satellite data, as of August 28, 2007.

Definitions

CFCs: chlorofluorocarbons, synthetic chemicals containing chlorine, once used as refrigerants, aerosol propellants and foam-blowing agents, that break down in the stratosphere (15-30 km above the earth's surface), releasing reactive chlorine radicals that catalytically destroy stratospheric ozone.

DU: Dobson Unit, a measure of the total ozone amount in a column of the atmosphere, from the earth's surface to the upper atmosphere, 90% of which resides in the stratosphere at 15 to 30 km.

Halons: synthetic chemicals containing bromine, once used as fire-fighting agents, that break down in the stratosphere releasing reactive bromine radicals that catalytically destroy stratospheric ozone. Bromine radicals are about 50 times more effective than chlorine radicals in catalytic ozone destruction.

Ozone: a reactive form of oxygen with the chemical formula O_3 ; ozone absorbs most of the UV radiation from the sun before it can reach the earth's surface.

Ozone Hole: ozone holes are examples of severe ozone loss brought about by the presence of ozone depleting chlorine and bromine radicals, whose levels are enhanced by the presence of PSCs (polar stratospheric clouds), usually within the Antarctic polar vortex. The chlorine and bromine radicals result from the breakdown of CFCs and halons in the stratosphere. Smaller ozone holes have been observed within the weaker Arctic polar vortex.

Polar night terminator: the delimiter between the polar night (continual darkness during winter over the Antarctic) and the encroaching sunlight. By the first week of October the polar night has ended at the South Pole.

Polar vortex: a region of the polar stratosphere isolated from the rest of the stratosphere by high west-east wind jets centred at about $60^\circ S$ that develop during the polar night. The isolation from the rest of the atmosphere and the absence of solar radiation results in very low temperatures (less than $-78^\circ C$) inside the vortex.

PSCs: polar stratospheric clouds are formed when the temperatures in the stratosphere drop below $-78^\circ C$, usually inside the polar vortex. This causes the low levels of water vapour present to freeze, forming ice crystals and usually incorporates nitrate or sulphate anions.

TOMS & OMI: the Total Ozone Mapping Spectrometer & Ozone Monitoring Instrument, are satellite borne instruments that measure the amount of back-scattered solar UV radiation absorbed by ozone in the atmosphere; the amount of UV absorbed is proportional to the amount of ozone present in the atmosphere.

UV radiation: a component of the solar radiation spectrum with wavelengths shorter than those of visible light; most solar UV radiation is absorbed by ozone in the stratosphere; some UV radiation reaches the earth's surface, in particular UV-B which has been implicated in serious health effects for humans and animals; the wavelength range of UV-B is 280-315 nanometres.

Acknowledgements

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